

# ECONOMICS OF PADDY PRODUCTION: PAST, PRESENT AND FUTURE

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**Abstract:** Dramatic changes occurred in Sri Lanka's rice production during the last one-and-half decades. The annual production doubled while the area under rice and average rice yield increased by 30% and 44%, respectively. This paper examines the patterns of rice production and consumption and possible avenues for solutions for constraints to rice production in the next decade. In the production increase that occurred during the 1967-75 period 48.8% is attributed to yield increase per unit area and 38.5% to area expansion. For the period 1976 - to date, the production increases are attributed to 46.1% and 41.3% for yield increase and area expansion, respectively. The total production is now reaching a plateau. Cost of rice production has been increasing during the past, and real profits have been declining. Assessment of returns for different holding sizes showed that more income is generated in larger-sized holdings in the dry zone while farmers in the wet zone having smaller holdings obtain lower incomes. Use of production functions showed that in most situations farms are about 70% technically efficient. However, their allocative efficiencies were relatively low, reducing the overall economic efficiency values. The option of producing the total rice requirement locally is an appealing choice to policy-makers. However, this would require a major technological breakthrough with an accelerated and well-focused technology transfer process. Importing rice only when necessary to maintain the minimum consumption level and increasing the domestic paddy production through price supports and input subsidies are two other options available to meet the calorie demand of the growing population. Importing rice could be justified if such a programme is planned to capitalize on the fluctuating international rice market. Price supports and input subsidies could be used to a certain degree, but excess intervention in the market mechanism could lead to inefficiency. A pragmatic approach is required to enhance farm family incomes through different avenues.

## INTRODUCTION

The world today is facing a dilemma, where in some countries, the food production is in excess of the demand, while in the majority of the developing world high demand outpaces the supply, denying the basic calorie and nutritional requirements of the population.

In Sri Lanka the situation in the food front is one of hope and despair.

Hope arises from our ability to produce more food from less land through a combination of technology, services, and government policies. Despair looms large, because of the dimension of hunger is in the midst of plenty. Sri Lanka, with agriculture as the mainstay of her economy, faces increasing economic and social chaos because of huge debt-servicing responsibilities on the one hand and declining export commodity prices,

on the other. This has led to a certain degree of difficult economic re-adjustments.

Hunger is a multi-dimensional problem. Even in a country like the USA, some 12 million children and 8 million adults are reported to be undernourished (Brown, 1987). Recent surveys of the state of the global environment are not encouraging, from the point of view of promoting ecologically sustainable agricultural production systems (Brown, 1987). While we are naturally concerned with the immediate problems of hunger and unemployment, we cannot also overlook problems that are likely to arise from potential changes of the climate.

It is in this global perspective that we consider the paddy production situation in Sri Lanka and what the future holds. The growing demand for rice and other food commodities, over the next decade, will outpace the supply, leading not only to substantial drops in the calorie and other nutritional intake of the population, but also have significant economic effects on the farming community.

Rice continues to be the staple food and the basic livelihood of the majority of Sri Lankans. The political value attached to rice made it a policy focus of all successive governments after independence. Consequently, a host of policies affected rice consumption and production in Sri Lanka during the last 40 years. Area expansion, technology development and, knowledge and skill transfer to farmers have kept its momentum undeterred over time.

Paddy production which was stagnant in the 1950s increased rapidly with the introduction of the old improved varieties (OIV) in the early 1960s and gradually gained popularity giving rise to an increase in the national yield and total national production. These varieties covered over 70 % of the extent under paddy and resulted in the use of about 90,000 t of fertilizer annually by the end of the decade (Table 1). In early 1970s new improved varieties (NIV) with a higher yield potential were introduced. The chemical fertilizer use also increased. Consequently the national average yield passed the 3.0 t/ha level in 1981/82. Development of the paddy sector was steady (Fig.1) and the growth was characterized by the doubling of production in 15 years (1965-1980) and the doubling of the national average yield in 30 years (1950-1980) - a phenomenon comparable with any country in the Asian region. Table 2 indicates the relative position of Sri Lanka in Asia with respect to paddy yields.

Sri Lanka's total paddy production is relatively insignificant in the Asian context amounting to only 0.6% of total Asian production.

This paper examines the disaggregated growth patterns of production and consumption of rice in Sri Lanka during the past 15 years i.e. the period of widespread adoption of NIVs and the related package of technology, the problems likely to emerge in the coming decade regarding the demand and supply of rice, and suggest possible policy alternatives to meet the challenges of the next decade.

**Table 1. Changes in paddy production and major contributory factors (1966-1989)**

<i>Year</i>	<i>Production (‘000 t)</i>	<i>Net harvested extent (‘000 ha)</i>	<i>Average yield (t/ha)</i>	<i>Area under HYV(%)</i>	<i>Fertilizer use (‘000 t)</i>
1966	956	520	1.84	46	42
1967	1147	539	2.13	58	59
1968	1348	562	2.40	54	85
1969	1375	529	2.60	66	86
1970	1617	611	2.65	71	90
1971	1397	590	2.37	67	83
1972	1313	543	2.42	66	82
1973	1313	571	2.30	70	99
1974	1603	681	2.36	83	123
1975	1155	508	2.27	75	44
1976	1253	541	2.32	77	74
1977	1679	666	2.52	84	81
1978	1892	723	2.62	81	113
1979	1918	697	2.75	73	38
1980	2134	728	2.93	79	181
1981	2231	745	2.99	90	146
1982	2157	661	3.26	90	150
1983	2485	690	3.60	91	130
1984	2421	787	3.08	98	158
1985	2662	768	3.47	98	172
1986	2590	739	3.50	98	184
1987	2123	598	3.40	98	157
1988	2484	726	3.42	99	148
1989	2068	612	3.38	NA	NA

Source: Production, area, yield and farm price of paddy, Department of Census and Statistics, 1966-1989

HYV = High yielding variety; NA = Not available

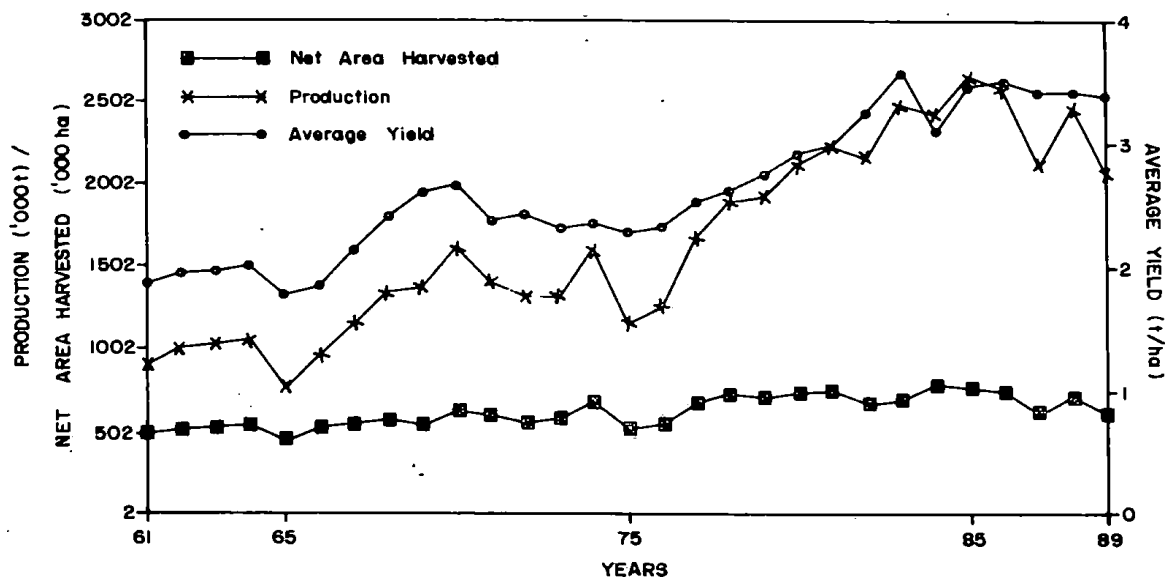


Fig. 1. Paddy production, net area harvested and average yield

Table 2. Average yield of paddy in selected Asian countries

Country	Average yield (t/ha)		
	1981-83	1984-86	1987-89
Bangladesh	2.1	2.1	2.2
China	4.9	5.3	5.3
India	2.0	2.2	2.3
Indonesia	3.8	3.9	4.1
Japan	5.7	6.0	6.1
Korea Republic	6.2	6.4	6.4
Malaysia	2.9	2.8	2.7
Pakistan	2.6	2.5	2.4
Philippines	2.4	2.6	2.7
Thailand	1.9	2.3	2.0
Vietnam	2.5	2.8	2.7
Sri Lanka	2.9	3.2	3.1

Source: World Rice Statistics, International Rice Research Institute, Laguna, Philippines, 1985; FAO Production Year Book, Vol. 39 to 43, Food and Agriculture Organisation of United Nations, Rome

## TRENDS IN PADDY PRODUCTION

Previous examinations of the paddy sector employed linear trend analysis to measure historical growth rates and to make future projections (Edirisinghe and Poleman, 1977; Ranaweera *et al.*, 1980). However, the slowing down of the growth rate experienced in 1980s suggests that extrapolating the historical linear trends could lead to biased results. Comparison of the linear and first degree polynomial trends fitted to production, area harvested and the national average yields strengthens the above hypothesis (Table 3).

It may be argued that the first degree polynomial function fitted best for the data series, only because of the unusual downward movement of variables in the late 1980s and if not for this disturbance, a continuously increasing form of a trend function with no maximum or an asymptote would have been the best fit. Nevertheless, in preliminary analysis the same data series excluding the downward sloping ends were fitted with several functional forms (linear, double log and polynomial) and it was evident that all three variables were approaching maxima. Though an asymptotic functional form was preferred, for the convenience of using ordinary Least Squares procedure, first degree polynomial function was used and the peaks of estimated trends were treated as the approaching maxima of the variables.

Fig. 2 illustrates the trends indicating that paddy production has now reached a plateau at 2.5 million tons per year. The net area harvested has reached

a maximum at 750,000 ha per year and the average yield has peaked at 3.5 t/ha.

The above statistical analysis shows that the paddy area and national average yields are approaching their upper limits. This is a phenomenon being experienced by other Asian countries as well (Sison *et al.*, 1978). With respect to area expansion, only 35,365 ha of land has been planned to be brought under assured irrigation during the period 1988-1992, and this includes both new and existing lands (Ministry of Finance and Planning, 1988). Fig. 3 shows that the area expansion during the past 15 years came through the increase of the area under major irrigation, while the extents under rainfed and minor irrigation conditions remained stagnant.

### Relative contributions of yield and area to production growth

The past 40 years of paddy production in Sri Lanka can be divided into 3 sub-periods based on the varieties dominant at the time—the pre-old improved varieties (POIV) period (1951-1966), the old improved varieties (OIV) period (1967-1975) and the new improved varieties (NIV) period (1976 to date). A marked increase can be seen in the average annual production levels between these periods and this growth is partly attributed to the spread of improved varieties while concurrent area expansion also has contributed partly. Hazell (1982) illustrated that between any two periods,

$$\Delta \bar{Q} = \bar{A}_1 \Delta \bar{Y} + \bar{Y}_1 \Delta \bar{A} + \Delta \bar{A} \Delta \bar{Y} + E$$

**Table 3. Ordinary least square trend estimates of production, net area harvested and yield of paddy (1975-1986)**

Variable	Linear equation	R <sup>2</sup>	1st degree polynomial equation	R <sup>2</sup>
Production ('000 t)	= 1537.23+78.03t (295.2) (17.6)	0.60	= 1096.08+281.63t-145.4t <sup>2</sup> = (147.9) (33.3) (2.3)	0.91
Net area harvested ('000 ha)	= 633.45+6.55t (76.6) (4.8)	0.13	= 530.26+54.18t-3.40t <sup>2</sup> (53.7) (12.1) (0.8)	0.63
Average yield (t/ha)	= 2.400+0.0906t (0.20) (0.01)	0.82	= 2.152+0.2037t-0.0070t <sup>2</sup> (0.14) (0.03) (0.0022)	0.92

Figures within parantheses are the standard errors of estimates

where  $\Delta\bar{Q}$ ,  $\Delta\bar{Y}$  and  $\Delta\bar{A}$  are the differences in mean annual production, mean annual yield and mean annual area harvested, respectively while  $\bar{A}_1$  and  $\bar{Y}_1$  are the mean annual yield and mean annual area for the first period. E denotes the sum of the computational error and any change in Q due to change in covariance between A and Y.

Using this formula the contribution of yield and area changes to production changes between the aforesaid three periods were decomposed (Table 4). Of the production increase that occurred from POIV to OIV period, 48.8% was due to yield increase and only 38.5% was due to area expansion (The interaction term which accounts for 14.1% cannot be further split into the above two categories). In the production change from OIV to NIV period too, yield increase dominated over area expansion. However, yield improvement's contribution decreased to 46.1% while area expansion's contribution

increased substantially to 41.3%. The implication is that despite the adoption of varieties with yield potentials ranging from 5 to 10 t/ha rapid land development became more and more important over time, in its contribution to production growth.

Table 5 presents a similar decomposition of production change from OIV to NIV period, at a more disaggregated level i.e. by different types of irrigation. A striking feature is the reduction in the annual production under minor irrigated areas and only a marginal increase in the rainfed areas while substantial increase was observed for major irrigation. Under major irrigation, the contribution of yield increase (45.9%) is higher than the contribution of area improvement (36.5%). With respect to minor irrigation and rainfed areas, only the area increases have contributed positively. In fact, the negative change of average yields from OIV to NIV periods in these areas have reduced the production levels that could have been achieved.

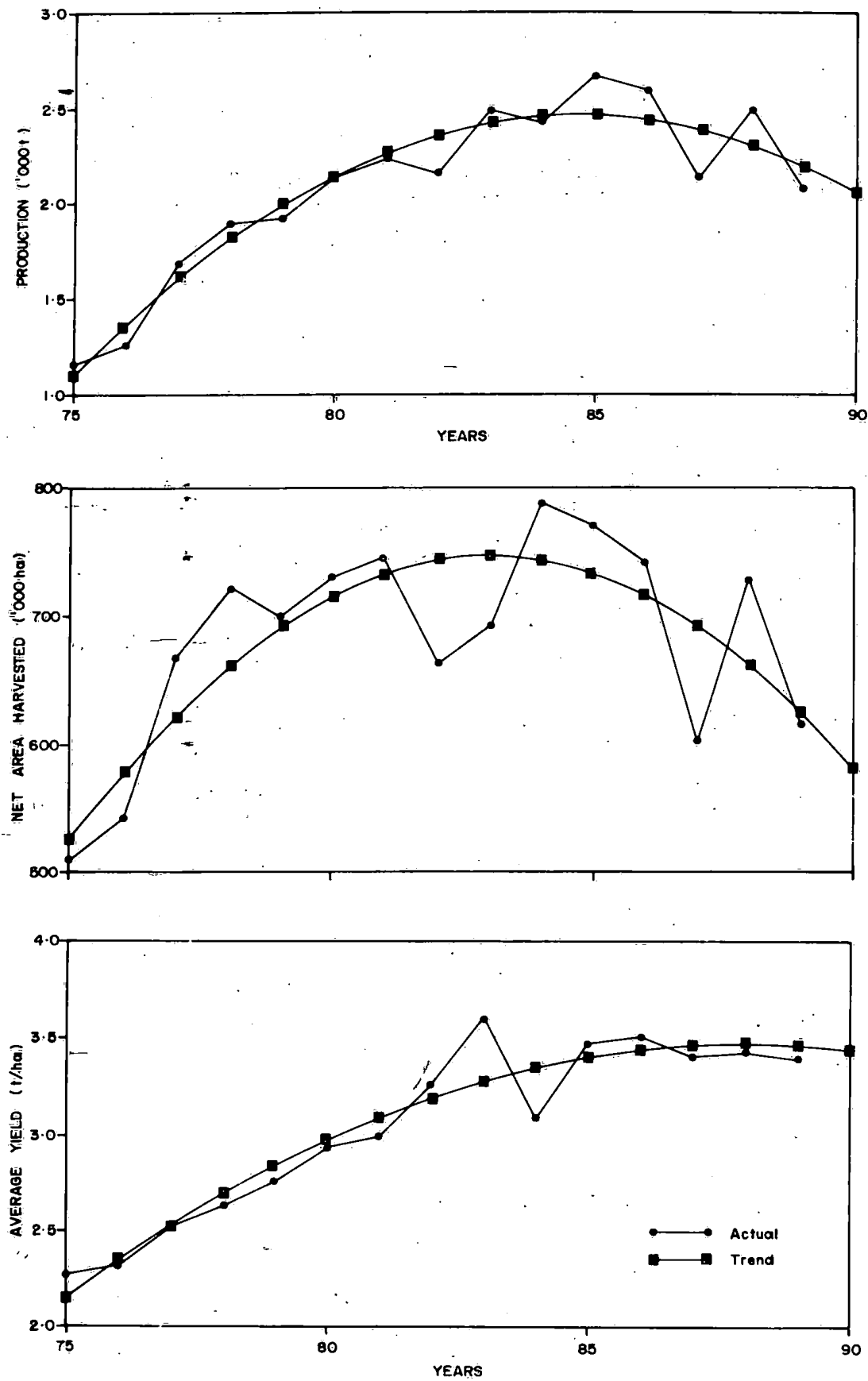


Fig.2. Paddy production, net area harvested and average yield - actual and trend

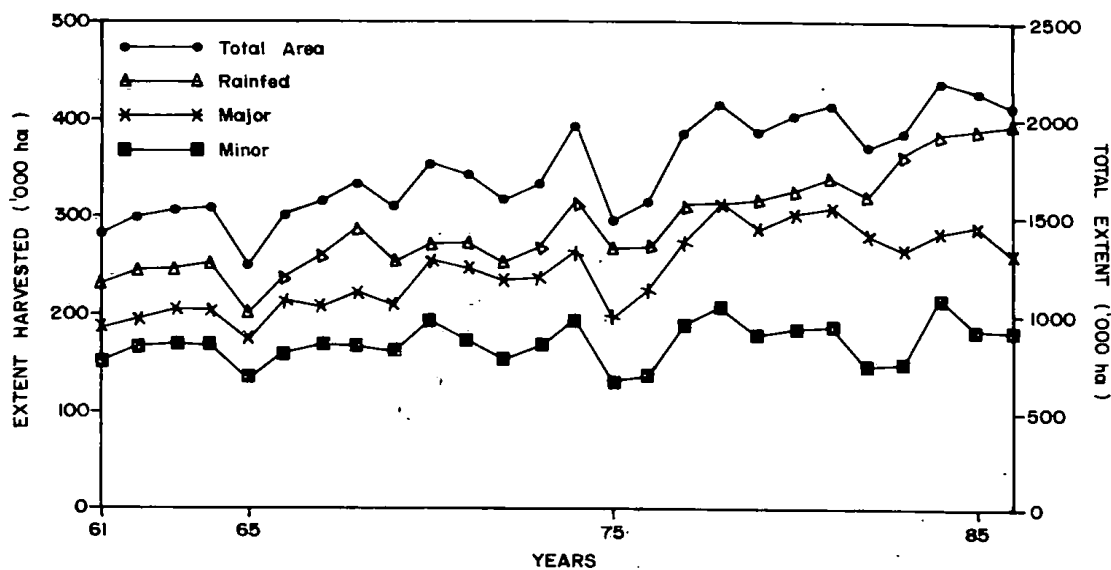


Fig. 3. Gross extent harvested of paddy under major and minor tanks, and rainfed condition

Table 4. Source and their contribution to changes in mean annual rice production from pre-OIV to OIV and from OIV to NIV periods

Source of mean production change	Rice production			
	Pre-OIV to OIV period*		OIV to NIV period**	
	Absolute ('000 t)	Percentage	Absolute ('000 t)	Percentage
Pure effect of yield change $-\bar{A}_1 \Delta \bar{Y}$	281.83	48.8	353.45	46.1
Pure effect of area change $-\bar{Y}_1 \Delta \bar{A}$	222.39	38.5	317.41	41.4
Interaction between yield and area changes $-\Delta \bar{Y} \Delta \bar{A}$	80.68	14.1	82.39	10.7
Error	-7.49	-1.5	12.83	1.7
Total change	577.41	100.0	766.08	100.0

\* 1951-66 to 1967-75; \*\* 1967-75 to 1976-87

**Table 5. Sources and their contribution to changes of mean annual paddy production between OIV and NIV periods in areas under different modes of irrigation**

<i>Source of change</i>	<i>Absolute change</i>		
	<i>Major irrigation</i> ( <i>'000 t</i> )	<i>Minor irrigation</i> ( <i>'000 t</i> )	<i>Rainfed</i> ( <i>'000 t</i> )
Pure effect yield change $\bar{A}_1\Delta\bar{Y}$	251.15	-22.88	-27.68
Pure effect of area change $\bar{Y}_1\Delta\bar{A}$	199.71	24.55	41.24
Interaction of simultaneous area and yield changes $\bar{A}\Delta\bar{Y}$	100.86	-1.27	-1.93
Error	-4.85	-3.51	-4.39
<b>Total Change</b>	<b>546.87</b>	<b>-3.11</b>	<b>7.06</b>

The reduction of the contribution of yield to the growth of rice production shown as a national aggregate can thus be attributed to the consequences of introducing NIVs to areas where water availability is not stable. Plateauing of the national production observed in the recent years can also be ascribed to this phenomenon. If this is so, paying more attention to less favourable areas by research and extension could have made a substantial contribution towards enhancing of rice production in the recent past.

#### **Factors affecting production, area and yield**

Studies conducted by Amarasinghe and Mahendrarajah (1975) and Amarasinghe (1976) concluded that rice

production in Sri Lanka is not responsive to prices, in both the short and long run. However, these studies concentrated on the period before the wide adoption of improved varieties. Under these circumstances the guaranteed price for paddy and state-controlled fertilizer prices have helped the growth of rice production by maintaining farm income levels at desirable levels and by reducing the price risk. Later an indirect supply response study covering all POIV, OIV and NIV periods (Samaratunga, 1984. Unpubl.) showed that the rice supply is slightly price-responsive. The computed own price elasticity was 0.13 and the elasticity with respect to fertilizer price was -0.096. However, all three studies

concluded that non-price factors have a greater influence than price factors in determining the level of production. Accordingly, public programmes on area expansion and technological development were identified as the major causes of long term growth whereas weather, specifically rainfall was found to be the most significant cause of short term fluctuations.

This brief review shows that, with the introduction of the fertilizer technology in mid 1960s, the supply response pattern of rice in Sri Lanka may have changed. Therefore, separate yield and area response functions were fitted to annual aggregate data for the period 1965-1989 (Table 6).

Yield is responsive to lagged price. Area is not responsive as implied by the theoretically inconsistent sign and the statistical non-significance of the estimated parameter. With respect to the lagged nitrogen price, both yield and area showed no significant response, but in both functions the theoretically expected negative sign of the coefficient appears. Percentage area under high yielding varieties, which captures the technological advancement and the zero-one dummy variables for unfavourable and favourable weather were, however the most significant variables in the yield response function. In the area response function the time trend variable which was used as a proxy for increasing land development was most significant. Both functions have good overall statistical fits according to high adjusted  $R^2$  and  $F$  values. Though the Durbin-Watson  $D$  statistic falls within

inconclusive ranges, the low first order auto-correlation coefficients show that auto-correlation had not been a serious problem.

This analysis provides results consistent with earlier studies that price variables could not have caused the uncharacteristic downward trend in late 1980s. Nor were there any public programmes to reduce the rice hectareage. Hence, the downward trend and large fluctuations may only be attributed to civil disturbances and adverse weather conditions i.e. drought and floods.

## IMPROVING PRODUCTIVITY OF PADDY FARMS

### Profitability

The movement of costs and returns from paddy cultivation over a 10 year period is discussed in this section.

Profitability of paddy cultivation in three environments, namely irrigated dry zone, irrigated intermediate zone and rainfed wet zone are presented. Cost of cultivation data compiled by the Division of Agricultural Economics and Projects of the Department Of Agriculture (DOA) were used. Data pertaining to maha season were studied, since data in the form of a continuous time series from 1979 to 1990 were available only for that season. Polonnaruwa, Ampara and Kalawewa districts were selected to represent the dry zone (DZ) irrigated conditions while Matale, Kurunegala and Badulla districts were used to represent the intermediate

**Table 6. Ordinary least squares estimates of yield and area response functions (1965 to 1989)**

<i>Independent variable</i>	<i>Yield</i>	<i>Area response</i>
Constant	1.2838 *** (8.96)	600.69 *** (27.33)
Farmgate paddy price lagged one year	0.0003 ** (2.21)	-0.0342 (-0.33)
Price of nitrogen lagged one year	-0.0838 (-0.60)	-0.0342 (-0.33)
% area under high yielding varieties	0.0101 *** (4.19)	-
Weather dummy	0.2989 *** (3.81)	-
Time trend	-	17.04 *** (3.79)
R <sup>2</sup>	0.91	0.65
F value	67.71	17.77
Durbin-Watson D statistic	1.145	1.464
First order auto-correlation	0.41	0.13

Numbers within parantheses are the t values of coefficients

\*\*\* Significant at 1% level

\*\* Significant at 5% level

zone (IZ) irrigated conditions. Matara, Kalutara and Gampaha districts were selected to represent the wet zone (WZ) rainfed situation.

#### *Nominal returns from paddy cultivation*

Return to land and management (RLM) in the DZ fluctuated between Rs. 127/ha and Rs. 3099/ha during 1979-1989 period before recording negative returns (Rs.-244/ha) in 1988 (Table 7).

Changes observed from year to year in RLM were closely following the changes in average yield and farmgate price. RLM in the IZ was also fluctuating widely with 6 out of 10 years recording negative values (Table 8). Year to year changes in price and yield were found to influence this pattern of fluctuations in RLM. In rainfed areas of the WZ, RLM was negative in 5 out of 12 years studied (Table 9). The average yield in the WZ showed a

**Table 7. Return from irrigated paddy in maha in the dry zone (DZ)**

Year	Nominal return				Real return			
	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>
1979	1959	1476	54.70	1.44	1959	1476	55	1.44
1980	3706	3099	102.07	1.89	2938	2457	81	1.50
1981	3373	1254	40.02	1.50	2267	843	27	1.01
1982	4048	2623	81.94	1.53	2454	1590	50	0.93
1983	3198	1390	58.93	1.35	1702	740	31	0.72
1984	1656	127	34.63	1.20	755	58	16	0.55
1985	3965	1522	54.42	1.44	1783	684	24	0.65
1986	4218	1583	74.09	1.43	1756	659	31	0.60
1987	4646	2028	79.60	1.43	1796	784	31	0.55
1988	2600	-244	42.63	1.24	882	-83	15	0.42
1989	5103	1363	73.71	1.38	1551	414	22	0.42

Rtn = return; fam = farm; lab = labour; lnd = land; mgt = management; md = manday

**Table 8. Return from irrigated paddy in maha in the intermediate zone (IZ)**

Year	Nominal return				Real return			
	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>
1981	2461	-131	28.97	1.34	1654	-88	19	0.90
1982	306	-2752	3.58	1.03	186	-1669	2	0.63
1983	1822	-1510	21.86	1.18	969	-803	12	0.63
1984	-1002	-4964	-12.72	0.91	-457	-2264	-6	0.42
1985	3999	1607	52.23	1.51	1798	722	23	0.68
1986	5216	1679	52.50	1.60	2172	699	22	0.67
1987	1970	-757	26.88	1.23	761	-293	10	0.48
1988	2579	-1001	27.50	1.26	874	-339	9	0.43
1989	11056	6934	100.81	2.18	3360	2107	31	0.66

slight increasing trend compared to the fluctuating trends observed for the DZ and IZ. The fluctuations in farmgate price have contributed more than the yield changes to the differences in the RLM. It was also observed that return to manday of family labour during 1979-1989 fluctuated from Rs. 35 to Rs. 102 in the DZ; from Rs. -13 to Rs. 101 in the IZ and from Rs. 14 to Rs. 56 in the WZ.

In the DZ, return to unit of capital was over 1.20 during the entire period, and it was over 1.35 in 10 out of 12 years. In the IZ, it was not that profitable. However, profitability in terms of return to capital was more attractive in the WZ with 7 out of 12 years reporting values over 1.35.

#### *Real returns from paddy cultivation*

In order to analyze the profitability over time using real prices, a deflator was constructed using the Consumer Price Index (CPI) for all commodities (values published by the Central Bank from 1979 to 1989). This was done by taking the CPI value for 1979 (252.3) as 100 (base value) and calculating corresponding values for subsequent years.

Real values of all three return measures showed a declining trend until 1988 (Tables 7,8 and 9). In the subsequent year, these returns continued to decline in the DZ and WZ while in the IZ they increased. This indicates that the purchasing power of the income earned by farmers from paddy farming has deteriorated over the last 10 year period.

#### *Present level of farm return*

Assessment of returns for different holding sizes showed that returns to land and management from average rice holding in the three different zones varied widely with DZ (1.0 ha) reporting Rs. 1039, IZ (0.75 ha) reporting Rs. 1012 and WZ (0.4 ha) reporting Rs.-827 (Table 10). Therefore, paddy farming contributes more to the farm income in the DZ than in the IZ. In contrast, the farmers in the WZ operate at loss. Larger average holding sizes of paddy in the DZ and IZ help them to obtain higher incomes compared to their counterparts in the WZ.

#### *Economic efficiency*

The productivity of farms can be considered from the point of view of economic efficiency. Economic efficiency (EE) has two components, namely technical efficiency (TE) and allocative (price) efficiency (AE). TE measures actual farm output as a percentage of potential output obtainable from the same level of inputs had the farmer used the 'best practice technology' and AE measures the actual farm profits as a percentage of the 'optimum' profit obtainable if the farm used inputs to the point of equating Marginal Cost (MC) with the Marginal Value Product (MVP) of the respective input. Farm level TE and AE in paddy cultivation in Kurunegala and Anuradhapura districts were measured in a series of studies conducted during a 1984-1985 research project between the DOA and the Australian National University (Shand *et al.*, 1990).

**Table 9. Return from rainfed paddy in maha in the wet zone (WZ)**

Year	Nominal return				Real return			
	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>	<i>Rtn to fam lab lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to lnd &amp; mgt (Rs/ha)</i>	<i>Rtn to fam lab (Rs/md)</i>	<i>Rtn to unit of capital (Rs)</i>
1979	1091	540	26.21	1.38	1091	540	26	1.38
1980	1665	1101	44.64	1.59	1320	873	35	1.26
1981	1494	-208	20.87	1.29	1004	-140	14	0.86
1982	2413	442	35.31	1.38	1463	268	21	0.84
1983	2542	451	37.07	1.41	1352	240	20	0.75
1984	3114	516	41.97	1.45	1420	235	19	0.66
1985	3395	1071	56.31	1.49	1526	481	25	0.67
1986	957	-1915	13.95	1.11	398	-797	6	0.46
1987	1211	-1848	18.48	1.14	468	-714	7	0.44
1988	1069	-2137	16.83	1.11	362	-725	6	0.38
1989	1594	-2068	22.60	1.15	484	-628	7	0.35

**Table 10. Current farm returns from paddy cultivation in DZ, IZ and WZ**

Environment	Production (t)	Price (Rs/kg)	Gross rtn (Rs)	Net rtn lnd & mgt (Rs)	Rtn to fam lab (Rs/md)	Rtn to unit of capital (Rs)	Average holding size (ha)
DZ irrigated	4.3	3.71	15920	1039	65.17	1.35	1.0
IZ irrigated	2.5	4.00	10012	1012	53.17	1.53	0.7
WZ rainfed	1.1	3.90	4415	-827	19.01	1.13	0.4

These studies showed that in most situations farms were about 70% technically efficient. However, they were allocatively less efficient resulting in low overall EE. The difference in farm-specific technical efficiency was mainly explained by the management variables such as timing of fertilizer use and selection of the variety of the right age class. These variables can be manipulated to achieve profits through policy such as better extension. Improvement in AE does not necessarily result in an increase in production, rather, it results in an increase in the farm profit.

### **Forecasting farm returns from paddy cultivation**

#### *Present level of technical efficiency*

As stated earlier paddy farms in the irrigated areas of the DZ and IZ are about 70% technically efficient, indicating an upperbound value of 30% as the incremental yield that is attainable with better management. Farms in the rainfed areas of the IZ were found to be 63% technically efficient. This leaves us 37% as the incremental yield attainable in that area. However, it is not possible to directly extrapolate this finding to rainfed areas in the WZ due to the presence of 'problem' soils. Moreover, a high (37%) unutilized potential yield at the farm level in that area is also doubtful. Therefore, it is assumed that the farms in the rainfed areas of WZ are also 70% technically efficient. The yield gaps were calculated on this basis for the three areas and accordingly, the yield gap was highest (1.8 t/ha) in the DZ followed by IZ (1.5 t/ha) and WZ (1.2 t/ha) (Fig. 4).

#### *Profitability with 100% technical efficiency*

Assuming that 100% technical efficiency is achievable by the year 2000, the profitability measures were calculated with costs and returns projected for the year 2000 (Table 11). According to the results an average paddy farm in the DZ will obtain very high RLM (Rs. 12,994) compared to their counterparts in the IZ (Rs. 7,287) and the WZ (Rs. 896).

According to these projections profitability in terms of RLM and return to unit capital will gradually improve in all three environments. This indicates that the projected yield increase would offset the projected increase in the nominal cost of cultivation. It was also found that RLM in the WZ could become positive in the future.

## **PAST CONSUMPTION AND FUTURE REQUIREMENTS**

### **Past consumption**

Consumption of rice in Sri Lanka experienced a set back in 1966. Consumer subsidies operating on rice since early 1950s had become a severe budgetary burden by mid 1960s, and as a result subsidized ration quota of rice was reduced by 50 % in 1966 (Gavan and Chandrasekara, 1979). Per capita rice consumption dropped to 93 kg per year and remained fluctuating around that level for several years. With the growth of rice production, the per capita consumption increased to 100 kg/year.

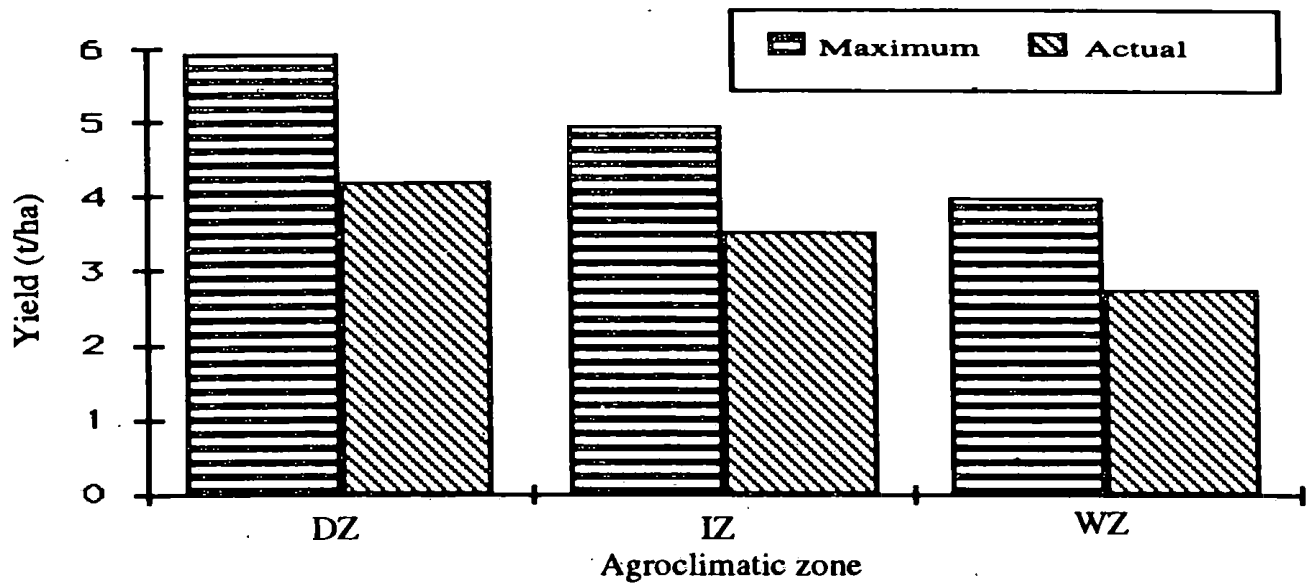


Fig. 4. Yield gap at farm level

Table 11. Farm returns from paddy cultivation in DZ, IZ and WZ with 100% technical efficiency in year 2000 prices

Environment	Production (t)	Price (Rs/kg)	Gross rtn (Rs)	Net rtn lnd & mgt (Rs)	Rtn to unit of capital	Average holding size (ha)
DZ irrigated	6.1	6.86	41935	12994	1.85	1.0
IZ irrigated	3.6	7.23	25760	7287	1.99	0.7
WZ rainfed	1.6	7.03	11339	896	1.46	0.4

The annual consumption of rice increased over time in the past while the consumption of wheat flour decreased. This increase in rice consumption is obviously due to the population growth. However, the reduction of consumption of wheat flour was made possible chiefly by the sustained growth of rice production (Fig. 5). At the same time imports of rice decreased too, specially during the period 1975-1983 (Table 12). These findings show that 5.1% annual growth of paddy production in Sri Lanka which was above the population

growth rate of 1.7% per year has enabled to avoid the advent of a food crisis. Another important outcome of the growth of rice production is that it could maintain the average per capita calorie consumption above the recommended level of 2000 calories per day while reducing the dependence on imported wheat flour (Table 13). However, in maintaining this nutritional requirement increased contribution from other foods, to calorie intake has also played a vital role.

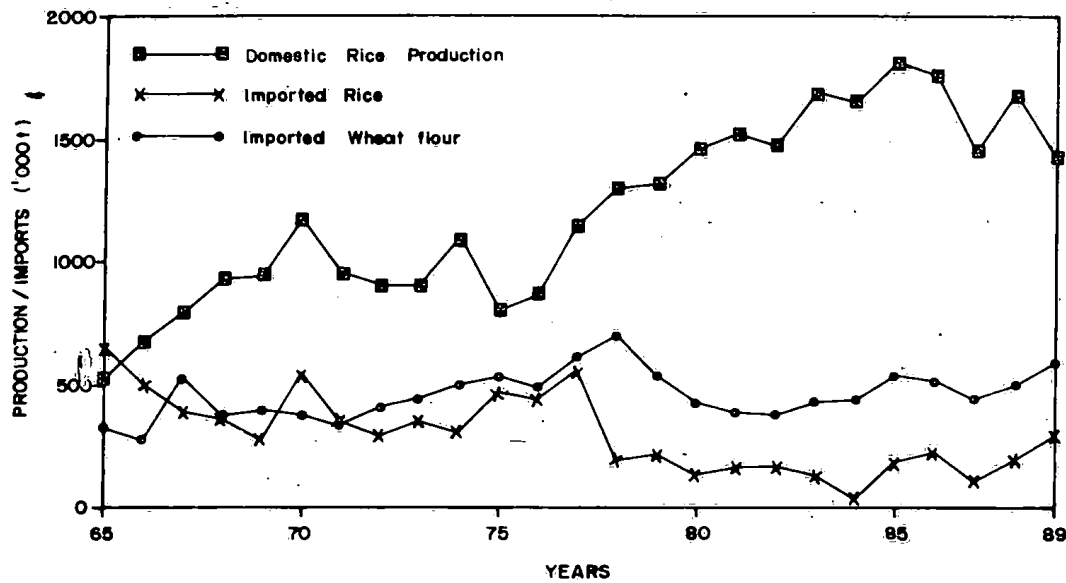


Fig. 5. Domestic production and imports of rice, and imports of wheat flour

Table 12. Domestic production and imports of rice and wheat flour and their per capita consumption levels (1975 - 1989)

Year	Domestic production ('000 t)	Imports ('000 t)	Total avail. ('000 t)	Wheat fl. imports ('000 t)	Per capita consumption	
					Rice/year (kg)	Wheat fl./year (kg)
1975	785	459	1244	528	82.4	38.6
1976	852	425	1277	479	94.0	40.5
1977	1141	542	1683	605	109.0	43.0
1978	1286	187	1472	693	97.2	45.0
1979	1304	211	1515	530	91.9	37.9
1980	1451	129	1579	420	101.0	21.4
1981	1516	157	1673	380	102.8	25.1
1982	1466	161	1627	373	98.8	27.9
1983	1687	123	1812	423	104.9	26.6
1984	1645	26	1672	434	107.9	29.7
1985	1810	182	1992	534	113.0	31.9
1986	1760	220	1980	514	103.4	28.4
1987	1446	102	1549	438	94.4	29.3
1988	1684	189	1873	489	100.7	29.6
1989	1403	291	1695	584	-	-

Source: Food Balance Sheets - Department of Census and Statistics  
 prod = production; avail = availability; fl = flour

**Table 13. Composition of total per capita calorie consumption by food items (1975 - 1988)**

Year	Calories per day per capita				
	Rice	Wheat flour	Other Grains, Root and Tubers	All other Foods	Total
1975	788	368	295	676	2127
1976	897	386	230	660	2172
1977	1042	410	181	710	2343
1978	929	429	175	792	2325
1979	878	362	162	915	2317
1980	966	204	152	907	2169
1981	983	240	158	820	2200
1982	944	265	167	813	2189
1983	1003	236	193	912	2361
1984	1032	283	189	764	2267
1985	1080	304	154	979	2517
1986	989	271	147	970	2377
1987	903	279	113	972	2267
1988	963	282	132	949	2326

Source: Food Balance sheets - Department of Census and Statistics

### Future demand for rice

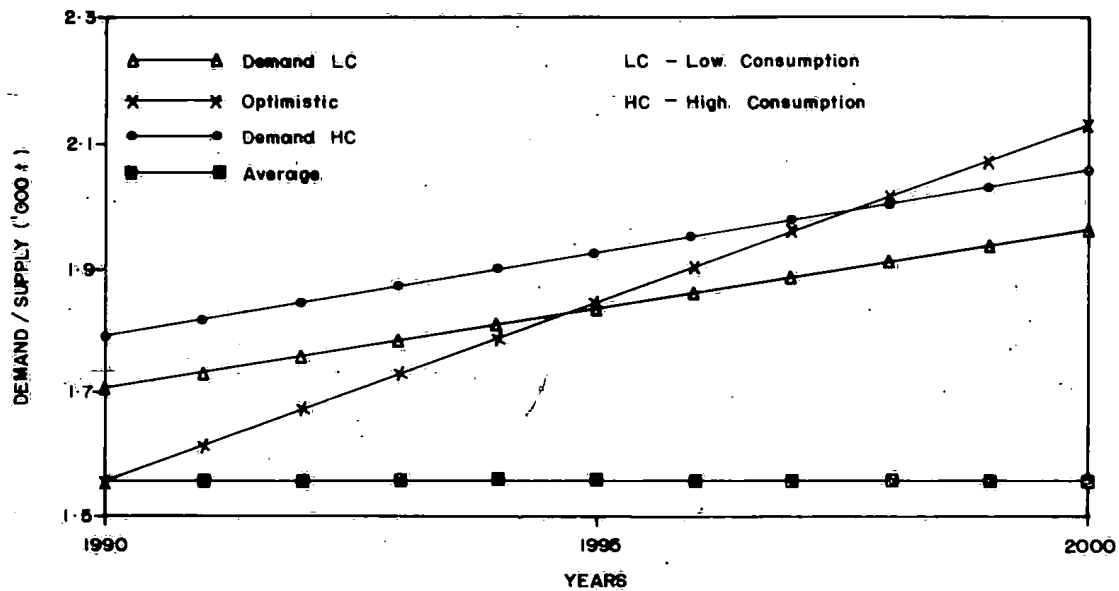
The annual average per capita rice consumption for the period 1975-1988 has been about 99 kg (Department of Census and Statistics, 1975-1988). Of late this value is fluctuating around 100 kg/person/year. Therefore, 100 kg/person/year of rice was considered as a conservative consumption requirement to compute the future demand for rice. Additionally, a higher per capita consumption level of 105 kg/year was also used for comparison purposes. Using these consumption levels and projected population, two series of annual rice demand was computed (Table 14). Only population was used in computing the future demand, assuming that effects that

are due to price and income will be small since price and income elasticities of demand for rice have been reported to be very low (Samaratunga, 1984. Unpubl.; Edirisinghe, 1987).

The future demand and the two predicted levels of domestic rice supply under the two situations are shown together in Fig. 6 and Table 15. If the average production remains constant at the plateau it has reached, the present deficit will widen over time. Nevertheless, using optimistic production projections, Sri Lanka can hope to meet the demand with domestic supply by 1995. If the high consumption of 105 kg per capita is used self-reliance in rice will be possible around 1998.

**Table 14. Future rice requirement at 100 and 105 kg per capita per year**

Year	Population	Requirement	
		at 105 kg per capita ('000 t)	at 100 kg per capita ('000 t)
1990	17053	1791	1705
1991	17292	1816	1729
1992	17534	1841	1753
1993	17779	1867	1778
1994	18028	1893	1803
1995	18280	1919	1828
1996	18536	1946	1854
1997	18796	1974	1880
1998	19059	2001	1906
1999	19326	2029	1933
2000	19597	2058	1960



**Fig.6. Projected demand and supply of rice**

**Table 15. Estimated future rice requirement and estimated domestic supply under two production scenarios**

<i>Year</i>	<i>Requirement</i>		<i>Production scenario</i>	
	<i>at 105 kg per capita ('000 t)</i>	<i>at 100 kg per capita ('000 t)</i>	<i>Optimistic projection ('000 t)</i>	<i>Current plateau ('000 t)</i>
1990	1791	1705	1555	1555
1991	1816	1729	1617	1555
1992	1841	1753	1673	1555
1993	1867	1778	1730	1555
1994	1893	1803	1786	1555
1995	1919	1828	1843	1555
1996	1946	1854	1900	1555
1997	1974	1880	1956	1555
1998	2001	1906	2013	1555
1999	2029	1933	2069	1555
2000	2058	1960	2126	1555

In spite of the above optimistic predictions three questions remain to be answered:

- Is it possible to increase the TE to 100%?
- With increasing cost of living and decreasing or stagnating profitability of paddy production, will the farmers continue to grow paddy?
- How can Sri Lanka bridge the deficit in rice supply, or in a broader sense, the deficit in calorie supply if the above optimistic projections are unrealistic?

#### OPTIONS FOR THE NEXT DECADE

With the different scenarios presented many options are available for discussion. However, for brevity only four options are considered in the present paper.

##### 1. Domestically producing total rice requirement

This option is most appealing to policy makers and even researchers. However, note should be taken that this requires a major technological breakthrough with an accelerated

and well-focused technology transfer process. Questions that arise in this regard are:

Is the capability for this breakthrough available in the country at the moment, if yes, how best could it be exploited? If the expertise is not present, how best can it be developed? What would be the cost of this investment both in terms of time and financial resources? Well-organized investment programmes will be required for such an endeavour.

**2. Importing rice only when necessary to maintain the minimum acceptable consumption level**

A policy directed towards importing rice only when required to stabilize prices could well be justified if such a programme is planned to capitalize on a fluctuating international rice market. This policy would require that the rest of the calorie requirements be met with other products such as wheat flour, root and tubers etc. If this option is adopted the marginal paddy farmers may move out into production of other crops. They may grow paddy only for their home consumption and not for commercial purposes.

**3. Increasing domestic paddy production through price supports and/or input subsidies**

This option is attractive, but needs the financial commitment by the government. Moreover, price manipulations can be used only with certain limitations. Excess intervention in the market mechanism leads to inefficiency, the correction of which, could be more expensive.

**4. Providing alternative off-farm income earning opportunities to farmers family income**

Paddy farming is becoming uneconomic in marginal environments. We may have to consider what incentives can be provided to farmers to enable them to continue paddy farming. At current production levels and costs farmers do not make substantial incomes from farming alone. The average farm size of the majority (70%) being 0.8 ha or less, any calculation of profitability will indicate that paddy farming cannot provide a sufficient income compared to the non-farm sector. Whether this trend will change with technological breakthroughs resulting in higher yielding varieties and significant decreases in costs of production is yet to be seen. Consequently, serious consideration will have to be given to issues relating to encouraging farmers to have off-farm sources of income to supplement farm incomes. A related issue is the size of holding and land consolidation restrictions, particularly in the major irrigation schemes where the production potential is high.

**CONCLUSION**

Paddy production in Sri Lanka has grown significantly over the last three decades, providing a major portion of our calorie requirement and saving valuable foreign exchange by reducing imports. However, the significant advances made early in the decade have not succeeded

in continuing to increase production over time.

In order to meet the growing demand of the increasing population, strategies need to be developed to ensure food security through domestic production and imports. While technological breakthroughs must be attempted, pragmatic approaches are needed to enhance farm family incomes through different avenues to stabilize the total farming system.

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