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Efficiency of Rice Production Under Major Irrigation Conditions: a Frontier Production Function Approach

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ABSTRACT. This paper investigate the resource use characteristics, profitability and economic and technical efficiencies of farming in a sample of paddy farmers selected from the Mahaweli System H. The empirical application of this study was based on a sample of 92 farmers which compromised three locations representing head, middle and tail areas of the main channel. The data collected relate to two cultivation seasons, Maha 1985/86 and Yala 1986. Paddy was the single most important crop cultivated during Maha, while chilli was the most popular subsidiary crop grown during Yala.

The simple tabular analysis, showed higher average cultivated farm area for Maha than the Yala. The farm size under paddy was 0.77 and 0.51 ha during Maha and Yala respectively while it was only 0.45 ha for chilli. The land size had a decreasing trend along the main channel towards the tail end. A similar trend was observed for paddy productivity during the Maha. With regard to use of labour inputs the head end farmers were found to be more labour intensive in all cases, while this was even more prominent in chilli cultivation.

Labour was found to be the most important cost component accounting for over 50% of the total cost. With regard to profitability, Maha paddy crop was more profitable than the Yala paddy crop. The analysis using the Cobb-Douglas function indicated mis-allocation of resources in most of the locations in the sample area. Land with high elasticity of production was found to be seriously under-utilized by almost all farmers especially during the Maha. The elasticity coefficient for land variable was 0.87, 0.51 and 0.29 for Maha paddy, Yala paddy and chilli respectively. During the Yala, labour was not intensively used indicating a possible increase in paddy productivity by the use of additional labour while the coefficient of the agro-chemical variable was high for chilli production. Fertilizer was efficiently used by the paddy farmers during the Yala while it was over-utilized in all other cases studied. The calculation of returns to scale parameters showed constant and increasing returns to scale for Maha and Yala respectively.

Frontier production function analysis showed that the farmers were more efficient during the Yala than during Maha. The average Timmer efficiency index for Yala and Maha paddy farmers was 55% and 43% respectively while it was only 72% for the chilli growers. The average Timmer efficiency index for tail end farmers was higher than for head end farmers during Maha. Almost all the farmers in the tail end area were at least 40% efficient while in the head area only 40% were above 50% efficient. However, the paddy growers were found to be more technically efficient than chilli cultivators during the Yala.

INTRODUCTION

The peasant sector predominates in domestic food crop production in Sri Lanka. The rapid population growth and associated problems such as high dependency ratios, increased unemployment and poverty during the last few decades made increased food production and self sufficiency in rice and subsidiary food crops urgent priorities in government policy. In spite of programmes for increased food production such as the Food Drive Programme launched in 1967 and introduction of high yielding varieties of rice (HYVs) to farmers the national yields have not increased substantially and remains far below the potential yields at experimental stations. Whilst the potential yields of experimental stations may not be achievable, the non adoption of improved techniques such as proper water control, optimal fertilizer use and weed control *etc.* have further reduced the potential yields.

The major means of increasing agricultural production has been the expansion of irrigation facilities. During the past several decades the Sri Lankan government has invested considerable amount of funds to operate and maintain irrigation projects including village works, major works and river basin development. From 1950 to 1982 the investment in irrigation was Rs. 12,242 million. From 1950 to 1982, the area under irrigation has increased from about 275,000 ha. to over 1,000,000 ha. Diversion of mahaweli waters to the North Central Sri Lanka was to provide development of 365,000 ha. of which 265,000 ha were to be new lands. With completion of the Mahaweli Project this phase of expansion in irrigated land may be over.

The hypothesis advanced by Schultz states that no appreciable increase in agriculture production will result by reallocating the factors at the disposal of the farmers. The hypothesis implies that substantial increase in output is possible through new technologies such as the HYVs. However, new opportunities such as HYVs, irrigation water when introduced into an allocatively efficient traditional system will cause temporary disequilibrium for the farmer, as he is subject to changes to which he must adjust. Initially, yields obtained by farmers who use improved management are far below the potential. This gap exists because farmers use inputs or practices that are allocatively inefficient. Hence the question of how efficiently farmers use resources in peasant agriculture is of considerable importance and the heavy investment the government has made make efficient allocation of resources to increased food production in irrigated agriculture an imperative.

The objective of this paper is to examine the economic and technical efficiency in rice production in a major irrigation scheme in Sri Lanka and to suggest some policy recommendations for improving the efficiency of resource use.

METHODOLOGY

The main analytical framework used in this study is the production function. The ordinary Cobb – Douglas function as well as the frontier production function of the same form were used to examine the economic and technical efficiency respectively. The frontier production function measures efficiency against the best production technology. These functions, which estimate the maximum output obtainable with given inputs, enable the measurement of the farm specific technical efficiency as the vertical deviation of the farm specific output from the frontier output. The frontier production function approach thus provides a better framework for the study of resource use efficiency in agriculture as it is superior to the ordinary function that represents only the average situation.

Several methods have been developed to determine the most efficient production frontier by different researchers (Farrell, 1957; Aigner and Chu, 1968; Timmer, 1970; Aigner, 1977). A simplified version of the Timmer's method was used in this study. In this simplified method, the frontier function was estimated by adding the largest positive residual to the intercept term of the average function until no residual was positive and one was zero. This corrected function could be used to calculate the potential output of each farmer given the level of inputs used in that particular farm. The Timmer measure of technical efficiency (TE) which indicates how much extra output could be obtained if the farm was on the frontier, was estimated by dividing the actual reported output of the farmer Y_i by its corresponding calculated potential output Y^*_i.

DATA COLLECTION

The system H of mahaweli, the first area to be developed under the accelerated Mahaweli Programme was selected as the location for this study. It is divided into 12 sub systems namely H−1 to H−12. The sites selected for the study are under the Kalankuttiya Administrative Block in H−1 and H−2. Each sub system is divided into blocks for work related to water management. The water distribution system to the area consists of a storage reservoir known as the Ihalakalankuttiya tank with a maximum capacity of about 190 ha.m of which about 184 ha.m are effective for irrigation. There is a 11.5 km branch canal as the main off take from the tank. The catchment area of the tank is about 69 Km^2. A total of about 20 distributory channels stretch on either side of the branch channel with design capacities depending on the command area along the main canal. The system is designed for rotational water issues.

The Kalankuttiya Administrative Block consists of five irrigation blocks from which blocks 305, 306 and 307 were selected for this study. A total of 92 farmers were selected from 5 distributory channels representing head, middle and tail positions of the main channel. From each of the sample distributories, turn out areas were randomly selected and all farmers cultivating in these areas were included in the sample.

During the *Maha* season the entire command area of the Kalankuttiya tank is cultivated with rice. During the *Yala* season the water supply was unreliable and inadequate, and most farmers grew non rice field crops. Chilli was the main subsidiary food crop. During *Yala* the betma system of cultivation is used which restricts the area of cultivation to the fields nearest to the tank or channel outlets by allowing all farmers to share this area in proportion to their size of land holdings.

The data collected relates to two cultivation seasons namely *Maha* 1985/86 and *Yala* 1986. The data collected included the cropping pattern and crop related activities, quantum of inputs used and the relevant costs, labour use for each cultivation practice by season and the output of each farm by crop.

RESULTS AND DISCUSSION

The cropping system and productivity

A clearly discernible cropping pattern was observed in the area. Paddy was the only crop grown during *Maha* by all sample farmers while in *Yala* in addition to paddy, chilli was grown as a subsidiary food crop by most of the farmers. The farm sizes were small and variable. The farm size in general appears to be larger at the head end of the main canal and a decreasing farm size was noted towards the tail end of the canal. A similar trend was noted for paddy productivity during the *Maha* season with a 27% reduction in the average paddy productivity from head to tail.

In regard to labour use, the head area was found to be more labour intensive than other areas. Chilli was more labour intensive than paddy. Family labour constitutes the highest proportion in the total labour input followed by hired labour. The total cost of labour for paddy production during *Maha* was higher than *Yala* while this was less at the tail end than at the head end in *Maha* season. The second important cost was the cost of hired equipment followed by the cost of fertilizer. The cost of production of paddy was highest in *Maha* with a value of Rs. 6270 per ha. The cost production of chilli was much higher and amounted to Rs. 18,730 per ha. Both gross and net incomes of paddy were higher for the *Maha* season than for the *Yala* season. The profitability was low in head areas than in middle areas. Net income per unit of land from chilli was higher than from paddy.

The production function approach

The Cobb – Douglas production function was fitted to paddy output which was considered a function of farm size, amount of fertilizer, cost of agro – chemicals, labour used and cost of hired equipment for *Maha* and *Yala* seasons respectively. The results show that around 70 percent of the variation in paddy output among the farmers is explained by variation of the explanatory variables fitted for the total sample for both *Maha* and *Yala* while only 60% of the variability in the yield of chilli was explained by the model (Table 1).

In *Maha*, farm size was the most important variable having the highest positive and significant coefficient of elasticity. It shows that doubling the area cultivated with other inputs held constant would increase the production by about 87% in *Maha*. Land had a positive significant elasticity for both paddy and chilli during *Yala*. The coefficient of labour for paddy in *Maha* was not significant and less than that of land, while it was the reverse for paddy crop in *Yala*, where the positive and significant production elasticity for labour was higher than those of land. The elasticity values for chilli crop were similar to paddy during *Yala* season.

When the functions are fitted separately for head, middle and tail areas along the main channel for *Maha*, the middle and tail end areas had higher R^2 values of 83% and 89% respectively while in the head area the R^2 was only 62%. When compared with the results of *Maha*, the coefficients of determination for *Yala* paddy are lower for middle and tail areas than for the head area. The coefficient for the fertilizer variable is significant in the total sample in the *Maha*. In contrast this coefficient is non significant for all functions both for paddy and chilli in the *Yala*, while it is negative for most functions. The storage of water in *Yala* could explain this result (Table 2).

With regard to the agro-chemical variable, the coefficient in *Maha* is non significant at 5%. Similar results were observed in the coefficients for cost of hired equipment in both seasons. These values were extremely low, indicating very low increases in the productivity with an increase in those inputs. Higher values were found for the elasticities for agro chemicals in chilli production during the *Yala*. The coefficient of the cost of agro chemical variable for the chilli crop in *Yala* was positive and significant in some functions. The returns to scale parameter in almost all areas in *Maha* except in the tail end area is quite close to unity indicating constant returns to scale. In contrast during the *Yala* the returns to scale estimates were greater than one in almost all the areas, for both paddy and chillies.

Table 1. Cobb-Douglas production function estimates for the total sample for *Maha* and *Yala* 1986/87.

Season	Crop	Constant	Farm size (ha.)	Fert. (kg/farm)	Agro-chem. (Rs.)	Labour (mandays)	Hired equip. (Rs.)	R^2	Retn. to scale
Maha	Paddy	7.89610 (19.96958)[b]	0.87406 (10.97066)[b]	0.02830 (1.94502)[a]	0.00026 (0.03431)	0.01820 (0.29375)	0.01974 (0.51083)	0.69	0.94
Yala	Paddy	4.97782 (6.74526)[b]	0.51199 (3.78575)[b]	-0.06457 (-1.18144)	0.05102 (1.93122)[a]	0.65146 (3.30499)[b]	0.02625 (1.71040)	0.72	1.17
Yala	Chillie	0.95094 (1.05955)	0.29538 (1.86987)[a]	0.019308 (0.12608)	0.30409 (2.02032)[a]	0.58272 (3.19283)[b]	0.00509 (0.32267)	0.60	1.20

t - statistics are in parentheses below each estimated coefficient.

a - = 0.05

b - = 0.01

Table 2. Cobb-Douglas production function estimates in rice production in Mahaweli 'H' area *Maha*, 1986/87.

Season	Size	Constant	Farm size (ha.)	Fert. (kg/farm)	Agro-chem. (Rs.)	Labour (mandays)	Hired equip. (Rs.)	R^2	Retn. to scale
Total	92	7.89610 (19.96958)[b]	0.87406 (10.97066)[b]	0.02830 (1.94502)[a]	0.00026 (0.03431)	0.01820 (0.29375)	0.01974 (0.51083)	0.69	0.94
Head end	38	8.40877 (9.0987)[b]	0.87923 (4.8392)[b]	0.02556 (0.6520)	0.00589 (0.4003)	0.10634 (0.8347)	-0.09513 (-0.8871)	0.62	0.92
Middle	30	8.14429 (15.05173)[b]	1.03986 (9.24445)[b]	0.00350 (0.18688)	-0.00999 (-0.90430)	-0.04218 (-0.54765)	0.05405 (1.01550)	0.83	1.04
Tail end	24	7.08687 (9.36247)[b]	0.64162 (4.92066)[b]	0.06932 (3.66944)[b]	0.00175 (0.18683)	0.14216 (0.82615)	-0.00425 (-0.07777)	0.89	0.85

Allocation efficiency

The marginal products for input variables were calculated at the geometric mean levels and the marginal value products for paddy and chilli were calculated using market prices of these commodities, of Rs. 3.10 and Rs. 29.00 kg^{-1} respectively. The prevailing market prices of renting a ha. of land (Rs. 1,500) was taken as the average value of land per ha. The cost of fertilizer for 1 kg was taken as the marginal factor cost for fertilizer. This was computed to be Rs. 3.10 kg^{-1}. The average wage rate for a manday of labour in the area Rs. 30.00 was taken as the marginal factor cost of labour.

Almost all the ratios in *Maha* are significantly different from unity indicating inefficient use of variables. Land is under used in all these areas while fertilizer is over used in the head and middle areas and under-used in the tail end area. An overuse of labour is evident from all these areas in the *Maha*. The marginal value productivities and allocative efficiency indices for paddy and chilli in *Yala* shows that land is under used for both paddy and chilli. However, when compared with the *Maha* the land input appears to be more intensively used. In contrast to *Maha* data, the labour input in *Yala* for the paddy crop is under used. However, an over-use of labour for chilli is evident from head and tail areas (Karunaratne, 1989).

Technical efficiency

The 12 Cobb-Douglas production functions fitted separately for each location in *Maha* and *Yala* were used to estimate the respective frontier production functions. In each of the cases, the frontier function was obtained by adding the highest positive residual to the intercept term of the average function. The highest positive residuals added to obtained these frontiers were 0.8943, 1.621 and 1.477 respectively. The production coefficients of the respective most efficient production frontiers obtained for the total samples for *Maha* and *Yala* paddy and *Yala* chilli are shown in Table 3. The potential yield of each farm was calculated in relation to the frontier function by which the actual observed yield of the farmer was divided to obtain the Timmer measure of technical efficiency. From this can be deduced the value of additional output possible, if a particular farmer is operating on the most efficient production frontier.

Table 3. Cobb-Douglas Frontier production function estimates for the total sample for *Maha* and *Yala* 1986/87.

Season	Crop	Constant	Farm size (ha.)	Fertilizer (kg/farm)	Agro-chemicals	Labour	Hired equipment (Rs.)
Maha	Paddy	8.79	0.874	0.0283	0.00026	0.01819	0.01973
Yala	Paddy	6.5991	0.51198	-0.06457	0.05102	0.65146	0.02625
Yala	Chillie	2.428	0.29538	0.01931	0.30409	0.58272	0.00509

The calculated farm specific technical efficiency values using these three functions are listed in Table 4. The average Timmer efficiency index was highest in *Yala* paddy with a value of 54.8 and a standard deviation of 21.9. However, in the distribution of efficiencies 40% of the farmers operate below 50% efficiency. When compared with paddy farmers the average technical efficiency of chilli growers were low during *Yala*. The figure was 26.6% for chilli with the standard deviation of 15.14 (Karunaratne, 1989). In this case, nearly 95% of the farmers were less than 50% efficient, indicating a possibility of increasing their yields towards the best farmer's technique. During *Maha*, 75% of the farmers were operating below 50% efficiency (Figure 1).

The efficient production frontiers for the farmers in different locations were estimated separately. The average technical efficiency in *Maha* was highest in the tail area (74%) which implies that these farmers obtain 74% of the best practice output of paddy. Almost all the farmers in this area are at least 40% efficient, while nearly 60% of these had an efficiency over 70%. In the middle area the mean technical efficiency was 56% while it was lowest in the head area (46%). In the head only 40% of the farmers were above 50% technically efficient while nearly 95% were less than 70% efficient. This implies the possibility of increasing yields of these farmers towards best farmers' techniques. In both middle and tail areas efficiencies had a skewed distribution while in the head area it is more normally distributed.

These results are, however, in contrast with the results obtained by Ekanayake (1987) who did a comparison of technical efficiencies in head and tail areas using frontier function models for farm data from Mahaweli system H and determined higher average technical efficiency for farmers in the head than in the tail area. The stochastic frontier estimation used on the same set of data showed no technical inefficiency in the head area, where the total deviation of the output from the frontier was explained by purely random factors (Ekanayake and Jayasuriya, 1987).

In *Yala*, the average technical efficiencies for paddy cultivation at all three locations were similar, being around 60%, while the average technical efficiency for chilli was similar to those of *Maha*. In contrast to the *Maha*, around 33% of the paddy farmers in the head area were over 70% efficient during *Yala*. Nearly 30% of the farmers in this area were less than 50% efficient while it was only 26% in the tail end area

Table 4. Technical Efficiency Indices of Individual Farmers (Total Sample).

Maha		Yala – Paddy		Yala – Chillie	
Rank No.	TE	Rank No.	TE	Rank No.	TE
1	1.00	1	1.00	1	1.00
2	0.87	2	0.99	2	0.57
3	0.73	3	0.96	3	0.54
4	0.70	4	0.96	4	0.52
5	0.66	5	0.91	5	0.49
6	0.65	6	0.90	6	0.49
7	0.64	7	0.90	7	0.48
8	0.62	8	0.86	8	0.48
9	0.59	9	0.84	9	0.48
10	0.59	10	0.79	10	0.48
11	0.57	11	0.79	11	0.47
12	0.54	12	0.78	12	0.46
13	0.54	13	0.76	13	0.44
14	0.54	14	0.76	14	0.41
15	0.53	15	0.73	15	0.37
16	0.53	16	0.73	16	0.37
17	0.52	17	0.71	17	0.35
18	0.52	18	0.69	18	0.35
19	0.52	19	0.65	19	0.33
20	0.51	20	0.64	20	0.32
21	0.51	21	0.64	21	0.31
22	0.51	22	0.63	22	0.31
23	0.50	23	0.62	23	0.29
24	0.49	24	0.62	24	0.29
25	0.49	25	0.61	25	0.29
26	0.48	26	0.61	26	0.28
27	0.48	27	0.61	27	0.28
28	0.48	28	0.60	28	0.28
29	0.47	29	0.60	29	0.27
30	0.47	30	0.59	30	0.27
31	0.47	31	0.59	31	0.26
32	0.47	32	0.59	32	0.26
33	0.46	33	0.59	33	0.25
34	0.46	34	0.58	34	0.25
35	0.45	35	0.57	35	0.25
36	0.45	36	0.57	36	0.24
37	0.45	37	0.55	37	0.24
38	0.45	38	0.54	38	0.23
39	0.44	39	0.53	39	0.23
40	0.43	40	0.53	40	0.23
41	0.43	41	0.50	41	0.22
42	0.42	42	0.50	42	0.22
43	0.42	43	0.49	43	0.21
44	0.42	44	0.49	44	0.21
45	0.42	45	0.47	45	0.20
46	0.42	46	0.46	46	0.19
47	0.41	47	0.45	47	0.19

.......Contd.

Table 4. Contd/.......

Maha Rank No.	TE	Yala – Paddy Rank No.	TE	Yala – Chillie Rank No.	TE
48	0.41	48	0.43	48	0.19
49	0.41	49	0.42	49	0.19
50	0.40	50	0.41	50	0.19
51	0.40	51	0.36	51	0.19
52	0.39	52	0.36	52	0.18
53	0.39	53	0.35	53	0.18
54	0.39	54	0.35	54	0.18
55	0.38	55	0.34	55	0.18
56	0.38	56	0.34	56	0.17
57	0.37	57	0.33	57	0.16
58	0.37	58	0.33	58	0.15
59	0.37	59	0.33	59	0.15
60	0.37	60	0.32	60	0.14
61	0.36	61	0.32	61	0.14
62	0.36	62	0.29	62	0.13
63	0.36	63	0.28	63	0.13
64	0.36	64	0.28	64	0.12
65	0.36	65	0.23	65	0.12
66	0.35	66	0.18	66	0.12
67	0.35	67	0.18	67	0.11
68	0.35	68	0.17	68	0.11
69	0.35	69	0.16	69	0.10
70	0.35	70	0.13	70	0.09
71	0.34			71	0.08
72	0.34			72	0.08
73	0.33			73	0.07
74	0.33			74	0.07
75	0.33			75	0.06
76	0.33				
77	0.32				
78	0.31				
79	0.31				
80	0.30				
81	0.29				
82	0.28				
83	0.28				
84	0.27				
85	0.27				
86	0.27				
87	0.24				
88	0.23				
89	0.22				
90	0.20				
91	0.18				
92	0.15				
AVG.	0.43		0.55		0.27
SD.	0.136		0.219		0.154

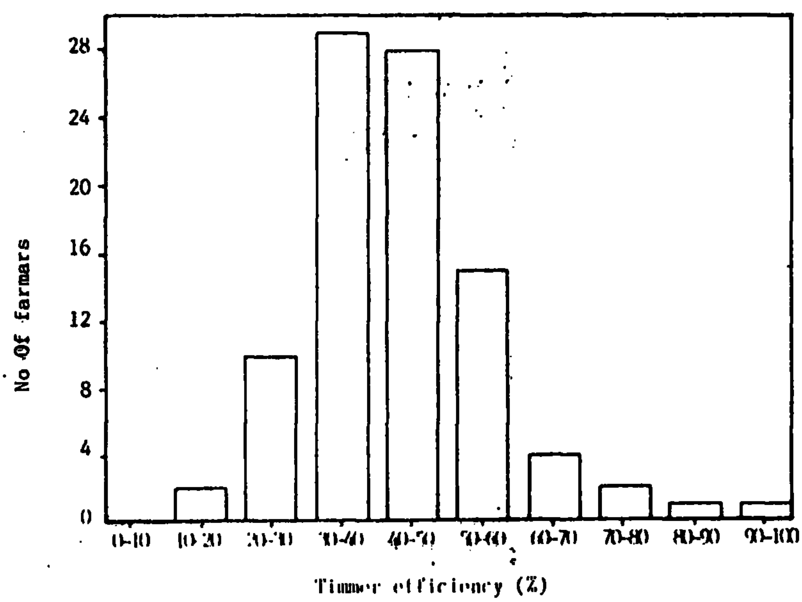

Fig.1. Timmer efficiency frequency distribution (Maha season - total sample)

where 40% of the farmers were above 70% efficient. The tail end chilli farmers had the highest average technical efficiency of 74% with a standard deviation of 0.15. Majority of the farmers in this area were at least 50% technically efficient, while these figures for middle and head areas were 44 and 36 respectively. Of the head chilli farmers, 47% were less than 30% efficient while almost all the farmers in the middle area were above 30% efficient. The frequency distribution of the Timmer efficiency indices for the total samples in *Maha* is given in Figure 1.

Further studies to analyze the factors influencing the technical inefficiencies are reported. Flinn and Mubaric (1986) regressed the farm specific technical inefficiencies of Basmati rice producers against the farm household characteristics in order to determine factors causing the variation in technical efficiency. The level of education and tenure type explained 44% of the variation in technical inefficiency in the model. A positive relationship was observed between the level of education and technical efficiency of farmers. Management factors such as late transplanting, fertilizer application and water shortages were also found to be significantly contributing to yield loss and to technical inefficiency of farmers (Flinn and Mubaric, 1986). Jayasuriya (1989) in this study selecting the optimal cropping pattern in Mahaweli system C, regressed the technical measures of the rice farmers against the years of farming experience and years of formal education of the farmers and revealed a low-level association between these independent variables and their technical efficiency.

It would have been ideal if the present study could have been extended to examine the relationship between technical efficiency indices of the sample farmers with their household characteristics. However, limitations of data prevented such an analysis.

CONCLUSIONS AND POLICY IMPLICATIONS

This study shows a clearly discernible season specific cropping pattern with paddy dominating both in *Maha* and *Yala*. The economic efficiency estimates indicate most resources being used inefficiently. In particular overuse of labour is noted in *Maha* and underuse in *Yala*. The production function estimates showed highest elasticities for *Maha* for land. In *Yala* the elasticity for land was found to be lower than

Maha. The economic efficiency indices indicated an under utilization of land resources in most cases. The under utilization basically arises due to water shortages and thus land utilization could be further improved by improving water availability. The Timmer efficiency measure computed to assess technical efficiency indicate the farmers to be more technically efficient in *Yala* than in *Maha*. A crop wise difference was observed during *Yala* with chilli farmers showing lower average technical efficiency than paddy farmers. Many farmers however showed potential for further increases in yield in relation to the best practice technology. The tail end farmers showed higher technical efficiency than the head end farmers. The same trend was observed for chilli during *Yala* with tail enders having a 75% average efficiency. The average efficiency of paddy farmers during *Yala* season was around 60% in all three locations. Measures to improve water availability appear to be the best approach for further enhancing technical efficiency.

REFERENCES

Aigner, D.J. and S.F. Chu. (1968). On estimating the industry production function. Am. Ec. Rev. 58, 4: 826 – 839.

Aigner, M.J. (1977). Formulation and Estimation of Stochastic frontier production function models. J. Econ. 1: 21 – 37.

Ekanayake, S.A.B. (1987). Technology, farm environment and returns and scale: The performance of new rice technology in a Mahaweli area, Ph.D. thesis, Australian National University Canberra, Australia.

Ekanayake, S.A.B. and S.K.W. Jayasuriya, (1987). Measurement of firm specific technical efficiency: A comparison of methods. J. Agr. Econ. 38, 1: 115 – 122.

Farrell, M.J. (1957). The measurement of technical efficiency. J. Royal Stat. Soc. Part III, 120: 253 – 280.

Karunaratne, M.A.K.H.S.S. (1989). An empirical study of the efficiency of resource allocation in Mahaweli System H, M.Phil. thesis, Post Graduate Institute of Agriculture, Peradeniya University.

Timmer, C.P. (1970). On measuring technical efficiency. Foods Res. Inst. Studies, Agr. Eco. trade development. Vol. 9, 12: 99-271.