Irrigation Department data suggest that the area irrigated has remained constant at 9,794 ha throughout the period from 1984 to 1993. As a result, Irrigation Intensity remains constant at 100 percent during both maha and yala seasons.

Irrigation Duty has increased by 8 percent during maha seasons, but has decreased by 7 percent in yala seasons. Compared with the average Irrigation Duty of 1.33 m (4.36 ft.) for maha seasons specified in Technical Note 6 of the Irrigation Department, the duty in this scheme is 3 percent higher than that specified for maha seasons. In the yala seasons, the Irrigation Duty is 10 percent lower than the specified norm of 1.7 m (5.56 ft.).

Relative Water Supply has increased by 8 percent during maha seasons and by 1 percent in yala seasons. The increase in yala has resulted in an increase in performance considering 1.0 as the optimum value of RWS. According to the categorization adopted, present irrigation performance measured by RWS is of a good standard in maha seasons. It is of a fair standard in yala seasons. The best values for RWS were 0.99 in 1984/85 maha, and 0.96 in 1987 yala.

Irrigation Water Productivity has decreased by 18 percent in maha, but has increased by 9 percent in yala. The best values for Irrigation Water Productivity were 408 tons/MCM in 1987/88 maha, and 283 tons/MCM in yala 1992.

Cropping Intensity has increased by 2 percent over the study period. The highest Cropping Intensity of 207 was recorded in 1992/93.

Land Productivity has decreased by 6 percent over the period. The best achievement with regard to this indicator was 4.77 tons/ha, which was recorded in 1989/90.

Total annual production has decreased by 11 percent from 48,300 tons to 42,700 tons in maha seasons. The drop in yala season is 8 percent from 39,400 tons to 36,400 tons. As a result, the annual production has decreased by 10 percent from 87,700 to 79,100 tons. The highest production figures were recorded in 1987/88 maha and 1990 yala when the values were 52,500 tons and 43,900 tons, respectively.

3.3.2 Length of Irrigation Season

The starting dates of the maha seasons vary from mid-October to early November. After maha 1987/88, a clear shift of the maha starting date to early November can be observed. This was probably made to accommodate a longer construction period for ISMP.

There is very little variation in the start of yala. It has started between 10 and 22 April for the entire study period.

The behavior of the length of irrigation season is shown in Table 13.

The duration of the yala seasons has decreased by about 6 percent. The lowest durations were recorded in yala 1988 (126 days) and yala 1989 (125 days). However, changes in maha seasons are comparatively small.

The same indicator calculated using rainfall as an input increased by 8 percent in maha and 1 percent in yala. The best performance with regard to this indicator was also in 1989/90 maha and 1989 yala, when the values were 53 ha/MCM and 84 ha/MCM, respectively.

Table 15. Performance of Rajangane Scheme.

Performance indicator/parameter	Average (1984-93)		Past performance (1985-88)		Present performance (1990-93)		Percent change	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
AIUW (ha/MCM) (irrigation only)	50.0	55.5	42.2	47.2	50.4	49.9	+19	+6
AIUW (ha/MCM) (total water)	41.9	48.2	37.9	43.2	41.1	43.8	+8	+1
Irrigation Intensity (%)	105	99	105	92	105	108	0	+17
Irrigation Duty (m)	2.08	2.03	2.4	2.4	2.0	2.1	-17	-10
Actual Duty/Design Norm (%)	156	119	180	141	150	124	-	-
Relative Water Supply	1.21	1.17	1.26	1.15	1.16	1.20	-8	+4
Irrigation Water Productivity (tons/MCM)	231	130	180	111	268	155	+48	+39
Total annual production (tons)	27,000	13,600	24,900	12,300	30,200	19,000	+22	+54
Cropping Intensity (%)	182		177		206		+16	
Land Productivity (tons/ha)	4.16		4.01		4.37		+9	

Note: AIUW = Area Irrigated per Unit Water.

Apart from that, Irrigation Intensity in maha was 100 percent throughout. As a result, the scope for performance improvement at main system level during maha is small.

Viewed in this background, there are appreciable performance gains in the yala season with respect to water use. These gains correspond well with the changes in the length of the irrigation season.

However, it should be noted that the rainfall received in recent maha seasons is lower than that in earlier maha seasons. This may have increased the irrigation issues resulting in a low value for Area Irrigated per Unit Water and increased the Duty. Insignificant changes in RWS also indicate that increases in irrigation issues were in relation with irrigation demands. Similarly, rainfall in yala shows an increase in the later period. The performance gains can be partly attributed to this, although as previously mentioned, it is difficult to respond to rains during yala.

The data show that rice yields have dropped by 9 percent and 3 percent in maha and yala, respectively. The drop in rice yields and increased water use in maha have contributed to the decline in Irrigation Water Productivity in the maha season. In yala however, despite the drop in rice yields, the Irrigation Water Productivity has increased due to less water use. Similarly, the decline in Land Productivity and the total production can be attributed to the drop in rice yields.

The OFC cultivated area is small both in maha and yala seasons and unlikely to make a significant contribution to water use. However, an upward trend in OFC cultivation can be noticed.

This scheme was included in the INMAS Program and further improved under ISMP. Studies done prior to the improvements suggest that the water supply was inequitable and unreliable (Fowler and Kilkelly 1987a). Under ISMP, flow measurement structures were constructed at distributary canals. The development of farmer organizations and joint management activities were done in a comparatively systematic manner. Hence, greater impacts can be expected at lower levels of the system.

The Parakrama Samudra supplies the Polonnaruwa town with water for domestic purposes. Polonnaruwa is a major town in the North Central Province with the possibility of expanding, which means that water demand for domestic purposes is likely to increase in the future. The implications of this for the sustainability of performance of the scheme need to be studied.

3.4 PERFORMANCE OF RAJANGANE SCHEME

3.4.1 Performance Level and Changes

The estimated level of performance using available data is summarized in Table 15.

The past performance was evaluated using the 1985/86, 1986/87 and 1987/88 maha seasons, and 1985, 1986, and 1987 yala seasons. The present performance was measured using the data from 1990/91 to 1992/93 maha seasons, and 1990 to 1992 yala seasons. The results show that the performance has improved with respect to all the indicators used.

The area irrigated per unit volume of irrigation water has increased by 19 percent in maha and 6 percent in yala. The best performance with regard to this indicator was witnessed in 1989/90 maha and 1989 yala, when the values were 67 ha/MCM and 104 ha/MCM, respectively.

Table 16. Length of irrigation season.

Average		Past		Present		Recommended range	
Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
148	140	158	147	140	131	135-150	105-120

3.4.3 Other Performance-Related Parameters

Changes in the performance-related parameters of rainfall, OFC cultivated area and rice yield are shown in Table 17.

Table 17. Performance-related parameters.

Performance-related parameter	Average (1984-93)		Past performance (1985-88)		Present performance (1990-93)		Percent change	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
Rainfall (mm)	425	248	499	166	453	311	-9	+87
OFC cultivated area (%)	1.17	5.42	1.7	11.6	1.24	2.43	-27	-79
Rice yield (tons/ha—rough rice)	4.86	3.16	4.89	2.94	5.21	3.50	+7	+19

3.4.4 Impacts and Inter-Relationships

This scheme, like Parakrama Samudra, enjoys a reliable supply of water to the tank. Early records show that water use, especially in the maha seasons, was excessive. For example, tank duty in maha 1972/73 was 3.4m (Ponrajah n.d.). More recent studies (ECL 1992) have also stressed this fact as follows:

Irrigation Intensity in maha seasons has remained constant at 105 percent. The highest Irrigation Intensity in maha seasons was 107 percent, which was recorded throughout all the seasons from 1986/87 to 1989/90. Irrigation Intensity in yala seasons show an increase of 17 percent, with highest Irrigation Intensity of 108 percent being recorded in 1992 yala. On the average, annual Irrigation Intensity is 205 percent.

Irrigation Duty has decreased by 17 percent during maha seasons and by 10 percent in yala seasons. Compared with the average Irrigation Duty of 1.33 m (4.36 ft.) for maha seasons specified in Technical Note 6 of the Irrigation Department, the duty in this scheme is 56 percent higher than that specified for maha seasons. In the yala seasons, the Irrigation Duty is 19 percent higher than the specified value of 1.7 m (5.56 ft.).

Relative Water Supply has decreased by 8 percent during maha seasons but increased by 4 percent in yala seasons. The decrease in maha has resulted in an increase of performance considering 1.0 as the optimum value of RWS. According to the categorization adopted, the present irrigation performance measured by RWS is of a fair standard in maha seasons, but of a poor standard in yala seasons. The optimum values for RWS were 1.01 in 1992/93 maha, and 1.06 in 1990 yala.

Irrigation Water Productivity has increased by 48 percent in maha and 39 percent in yala. The best values for Irrigation Water Productivity were 296 tons/MCM in 1989/90 maha, and 191 tons/MCM in 1992 yala.

Cropping Intensity has increased by 16 percent over the study period. The highest Cropping Intensity of 212 was recorded in 1989/90.

Land Productivity has increased by 9 percent over the period. The best achievement with regard to this indicator was 5.24 tons/ha, which was recorded in 1991/92.

The total annual production has increased by 22 percent from 24,900 tons to 30,200 tons in the maha season. In the yala season, the increase was 54 percent from 12,300 tons to 19,000 tons. As a result, the annual production has increased by 32 percent from 37,100 to 49,200 tons. The highest production figures were recorded in 1991/92 maha and 1992 yala, when the values were 33,500 and 21,900 tons, respectively.

3.4.2 Length of Irrigation Season

The maha season in Rajangane Scheme started between mid-September and early November. The yala season started between mid-March and mid-April. The behavior of the length of irrigation season is shown in Table 16.

In the past, it was difficult to identify the length of the season. The data show that there had been several extensions after the official cut-off date of water issues. As a result, the actual closure of the season was decided using personal judgement in some cases. However, in the later seasons, the length of the seasons can be identified more easily.

Results shown in Table 16 indicate that the duration has decreased by 11 percent in maha and yala.

Table 18. Performance of Ridiyagama Scheme.

Performance indicator/ parameter	Average (1986-93)		Past performance (1986-88)		Present performance (1990-93)		Percent change	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
AIUW (ha/MCM) (irrigation only)	49.4	43.8	49.1	44.1	51.3	42.2	+5	-4
AIUW (ha/MCM) (total water)	40.4	39.4	43.4	40.2	37.8	37.4	-13	-7
Irrigation Intensity (%)	89.3	88.7	95.5	92.1	85.5	85.3	-10	-7
Irrigation Duty (m)	2.1	2.3	2.1	2.28	2.0	2.31	-2	+1
Actual Duty/Design Norm (%)	158	135	158	134	151	136	-	-
Relative Water Supply	1.21	1.22	1.11	1.19	1.29	1.28	+16	+8
Irrigation Water Productivity (tons/MCM)	242	215	251	230	235	201	-6	-12
Total Annual Production (tons)	13,500	13,000	12,900	14,200	12,100	11,600	-6	-18
Cropping Intensity (%)	177		185		171		-8	
Land Productivity (tons/ha)	4.82		4.99		4.52		-10	

Note: ALUW = Area Irrigated per Unit Water.

The past performance was evaluated using the 1986/87 to 1988/89 maha seasons, and 1986 to 1988 yala seasons, because rice yield data were available from 1986 only. The present performance was measured using data from 1990 to 1993. The 1992 yala data were not used because the data set was incomplete.

The area irrigated per unit volume of irrigation water has increased by 5 percent in maha, and decreased by 4 percent in yala. The best performance with regard to this indicator was witnessed in 1990/91 maha and 1987 yala, when the values were 64 ha/MCM and 48 ha/MCM, respectively.

Rainfall records were not provided in the Ridiyagama Scheme data set. As a result, rainfall data from Hambantota and Ambalantota rain gauges maintained by the Hydrology Division of the Irrigation

This system has a plentiful supply of water. As a result, farmers cannot be persuaded to cut down wastage although control and measuring devices have been installed.

One may question why farmers should reduce "wastage" in the face of a surplus water supply, nevertheless, the present analysis shows improvements in water use both in maha and yala. Perhaps there may be greater impacts at the distributary and field channel levels.

A comparison of past and present lengths of irrigation seasons shows a decrease in both maha and yala. Apart from this, the irrigation seasons are more clearly defined and water issues in-between the seasons are minimized in the later period. These observations agree with the improvements in water use.

It can be seen that rainfall in maha seasons have decreased in the later period, while the rainfall in yala has increased. This makes the performance increases in maha more significant than increases in yala.

Irrigation performance in yala with respect to RWS had to be categorized as poor, due to the increase in the value of RWS in yala. However, it should be noted that the total seasonal water requirement has decreased by 9 percent during the period. This is mainly due to the reduction in length of the irrigation season. Increased rainfall and reduced water requirement in yala have contributed to the increase of RWS.

The area under the OFC cultivation has decreased over the period. The present level of OFC cultivation is unlikely to have any effect on water use.

A variety of reasons has contributed to the improved Irrigation Water Productivity. In maha, rice production has increased mainly due to improved yields. Irrigation water use has decreased in spite of lower rainfall. The net result is a very significant improvement in Irrigation Water Productivity in maha.

Increase of Irrigation Water Productivity in yala can be attributed to higher rainfall and yields. Rice yields in yala have increased from a fairly low value of 2.9 tons/ha to 3.5 tons/ha—an increase of 19 percent. Rainfall in yala has increased by 87 percent.

The total rice production shows a very significant increase of 54 percent in yala seasons. This is due to the increase in rice yield and Cropping Intensity in yala seasons. Since cropped area increased mainly in yala, the production increase in maha is lower than that of yala.

3.5 PERFORMANCE OF RIDIYAGAMA SCHEME

3.5.1. Performance Level and Changes

The estimated level of performance using available data is summarized in Table 18.

There were substantial differences in the estimated area provided by the Irrigation Department, Agriculture Department and IMD. IMD data are available from 1991 only. A continuous data set for irrigated area was also not available from the Irrigation Department. After inspecting the data and comparing with water issues and rainfall, it was found that the area estimated by the Agriculture Department is reasonably accurate. As a result, it was decided to use the area estimated by the Agriculture Department for this analysis.

Table 19. Length of irrigation season.

Average		Past		Present		Recommended range	
Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
138	143	140	141	141	151	135-150	105-120

Low average values for maha seasons given in Table 16 are influenced by maha 1986/87 and maha 1987/88, for which the durations were 128 and 135 days, respectively. Similarly, the duration of yala 1987—128 days—was the lowest for the study period.

The results do not indicate an appreciable change in the length of maha seasons. The length of yala has increased by 7 percent.

3.5.3 Other Performance-Related Parameters

Changes in the performance-related parameters of rainfall, OFC cultivated area and rice yield are shown in Table 20.

Table 20. Performance-related parameters.

Performance-related parameter	Average (1984-93)		Past performance (1986-88)		Present performance (1990-93)		Percent change	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
Rainfall (mm)	438	237	266	216	659	202	+148	-7
OFC cultivated area (%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rice yield (tons/ha—rough rice)	4.89	4.74	5.09	4.9	4.6	4.63	-10	-6

Note: n.a. = Data not available.

The maha season rainfall in the later period has increased by 148 percent. But rice yield has dropped by 10 percent in the maha season, and by 6 percent in the yala season.

Department were used for the analysis. Area Irrigated per Unit Water including rainfall has decreased by 13 percent in maha and by 7 percent in yala. The best performance with regard to this indicator was witnessed in 1988/89 maha and 1987 yala, when the values were 47 ha/MCM and 44 ha/MCM, respectively.

Irrigation Intensity has decreased by 10 percent in maha and by 7 percent in yala. The best performance was witnessed in 1987/88 maha and 1986 yala, when the values were 97 and 96, respectively.

Irrigation Duty has decreased by 2 percent in maha seasons and increased by 1 percent in yala seasons. Compared with the average Irrigation Duty of 1.33 m (4.36 ft.) for maha seasons specified by the Irrigation Department, the duty in this scheme is 58 percent higher than that specified for the maha seasons. In the yala seasons, the Irrigation Duty is 35 percent higher than the specified value of 1.7 m (5.56 ft.).

Relative Water Supply has increased by 16 percent during maha seasons, and by 8 percent in yala seasons. The increases in maha and yala have resulted in a decrease in performance. According to the categorization adopted, present irrigation performance measured by RWS is of a poor standard in both maha and yala seasons. The optimum values for RWS were 1.02 in 1988/89 maha, and 1.11 in 1987 yala.

Irrigation Water Productivity has decreased by 6 percent in maha and by 12 percent in yala. The best values for Irrigation Water Productivity were 285 tons/MCM in 1987/88 maha, and 251 tons/MCM in 1987 yala.

Cropping Intensity has decreased by 8 percent over the study period. The highest Cropping Intensity of 189 was recorded in 1987/88.

Land Productivity has also decreased by 10 percent over the period. The best achievement with regard to this indicator was 5.35 tons/ha/season, which was recorded in 1988/89.

Total annual production has decreased by 6 percent from 12,900 tons to 12,100 tons in the maha season. In the yala season, the decrease was 18 percent from 14,200 tons to 11,600 tons. Thus, annual production has dropped by 12 percent from 27,100 to 23,700 tons. The highest production figures were recorded in 1988/89 maha and 1986 yala when the values were 15,800 tons and 14,200 tons, respectively.

3.5.2 Length of Irrigation Season

The starting date of the maha season has varied from September to November. The start of the yala season was from March to April. The behavior of the length of irrigation season is shown in Table 19.

4. A Comparison of Five Irrigation Schemes

4.1 PRESENT PERFORMANCE LEVEL

Table 21 describes the present performance level and related parameters of the five irrigation schemes. Values of the most recent three seasons were used in this analysis.

Table 22 shows that the rainfall in the maha season is highest in the Mapakada Scheme. It is approximately 92 percent of the irrigation supply. Rainfall in maha is lowest in Rajangane and Dewahuwa. Accordingly, the dependency on irrigation in maha seasons would be low in Mapakada but high at Rajangane and Dewahuwa.

In the yala season, the rainfall was 10 to 15 percent of the irrigation supply in all the schemes. As discussed earlier, rainfall in yala may not make a significant contribution to the water supply.

The performance indicators and related indices are compared in the following sections.

4.2 AREA IRRIGATED PER UNIT WATER

Area Irrigated per Unit Water (irrigation supply) for the five schemes is plotted in Figure 5. Area Irrigated per Unit Water is highest in Parakrama Samudra in the maha seasons. Performance in the Mapakada Scheme is only slightly lower. In the yala seasons, the best performance is observed in the Dewahuwa Scheme, followed by Parakrama Samudra and Rajangane.

In Figure 6, Area Irrigated per Unit Water with respect to the total water supply is plotted. When rainfall is considered as an input, the best performance is recorded in the Parakrama Samudra Scheme in the maha season, followed by Dewahuwa and Rajangane. In the yala season the best performance is observed in Dewahuwa. This is followed by Parakrama Samudra and Rajangane.

4.3 IRRIGATION INTENSITY

Figure 7 compares Irrigation Intensity in the five schemes. Except in Dewahuwa, Irrigation Intensity is good in the other five schemes. According to the data, there is no room for further improvement in the Parakrama Samudra, Rajangane and Mapakada schemes, with respect to this indicator. However, the Irrigation Department's estimate of irrigated area is based on the agreement reached with the farmers at the cultivation meeting and the estimated maximum cultivable area. The actual area cultivated can differ. In the case of water-short situations, this variation can be substantial. For the Ridiyagama Scheme, the cultivated area estimated by the Agriculture Department was used for the analysis. The comparison of the performances shows that better water management including maximum utilization of rainfall is very important in the Dewahuwa and Ridiyagama schemes.

3.5.4 Impacts and Inter-Relationships

This scheme was included under the INMAS Program in 1991. No major rehabilitation has been done in recent times. The level of farmer participation in the management of the irrigation system is less than in the schemes coming under ISMP or MIRP. The system is not water short, and as a result there is little motivation among farmers to participate in irrigation management (S. Danansooriya. Personal communication. 1994). Similar attitudes among officials can be expected. Another factor affecting the performance may be that the farmer organizations are not as developed as other schemes studied, because of the late adoption of the INMAS System.

The available data show a decrease in irrigation performance in both seasons. The improvement in Area Irrigated per Unit Water (irrigation supply) in maha can be attributed to increased rainfall in the later period. The decrease in the length of the yala season also agrees with the changes in water related performance indicators.

The substantial increase in rainfall in maha has not resulted in a corresponding reduction of irrigation water releases. The slight drop in irrigation water use in maha was insufficient to offset the bigger decrease in rice yields. As a result, Irrigation Water Productivity has decreased in maha. In yala, the drop in Irrigation Water Productivity is higher due to higher water use and the drop in rice yields.

The drop in rice yields is reflected in the decrease in Land Productivity. The decrease in total production is a result of both the drop in rice yields and Cropping Intensity.

Table 22. Irrigation performance-related parameters of the five schemes.

Indicator/ Parameter	Dewahuwa		Mapakada		Parakrama Samudra		Rajangane		Ridiyagama	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
Command area (ha)	1,214	1,214	548	548	9,800	9,800	5,600	5,600	3,440	3,440
Rainfall (mm)	446	166	1,448	201	804	201	453	311	659	202
RF/IS[1]	23	14	92	10	54	14	22	15	-	-
Length of season (days)	145	135	152	136	145	134	140	131	141	151
OFC cultivated area (%)	0	100	0	8.26	4.7	5.4	1.24	2.43	n.a.	n.a.
Rice yield (tons/ha—rough rice)	4.99	-	3.78	3.88	4.36	4.15	5.21	3.5	-	-

[1] Ratio of Rainfall/Irrigation Supply.

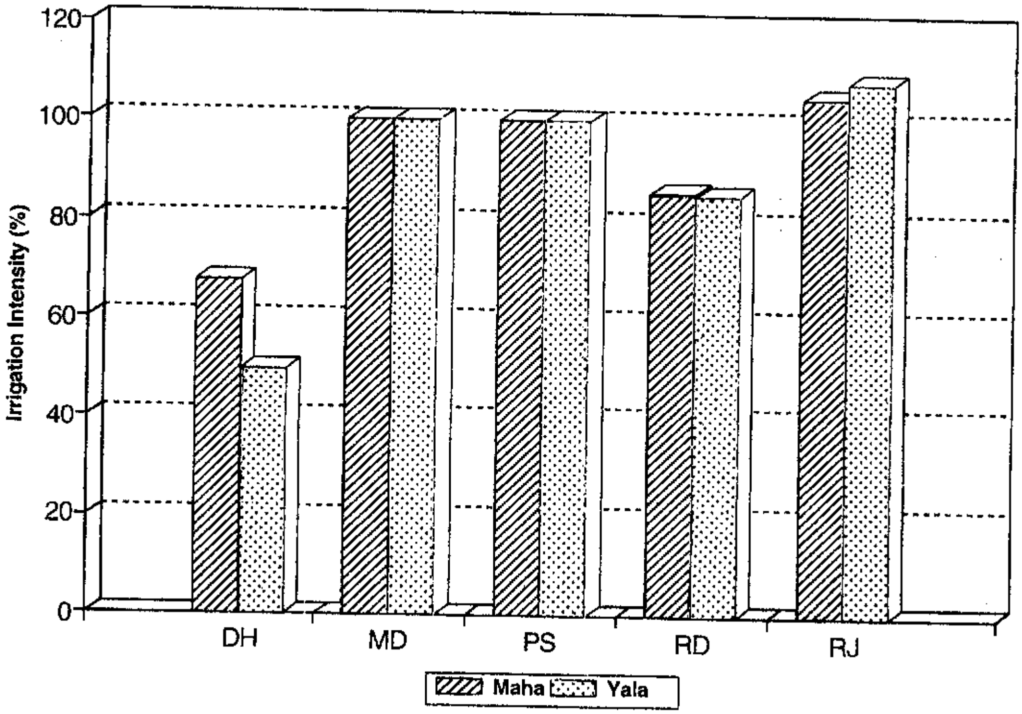
Notes: n.a. = Data not available.
OFC = Other Field Crops.

Table 21. Irrigation performance of the five schemes.

Indicator/ Parameter	Dewahuwa		Mapakada		Parakrama Samudra		Rajangane		Ridiyagama	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
AIUW(I)[1]	52.3	73.2	63.8	46.3	70.4	67.3	50.4	49.9	51.3	43.2
AIUW(T)[2]	42.3	66.7	32.7	42.2	45.4	59.3	41.1	43.8	37.8	37.4
Irrigation Intensity	67	50	100	100	100	100	105	108	85.5	85.3
Irrigation Duty (m)	1.91	1.5	1.6	2.2	1.43	1.5	2.0	2.1	2.0	2.3
RWS[3]	1.08		1.27	0.95	1.07	0.85	1.16	1.20	1.29	1.28
IWP[4]	262		242	185	308	273	268	155	235	201
Production (tons)	4.1		2.1	2.1	42.7	36.4	30.2	19.0	12.1	11.6
Cropping Intensity	117		200		203		206		171	
LP[5]	4.99		3.83		4.26		4.37		4.52	

[1] Area Irrigated per Unit Water (irrigation only) (ha/MCM).
[2] Area Irrigated per Unit Water (total water supply) (ha/MCM).
[3] Relative Water Supply.
[4] Irrigation Water Productivity (tons/MCM).
[5] Land Productivity (tons/ha/season).

Figure 7. Irrigation Intensity.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

4.4 IRRIGATION DUTY

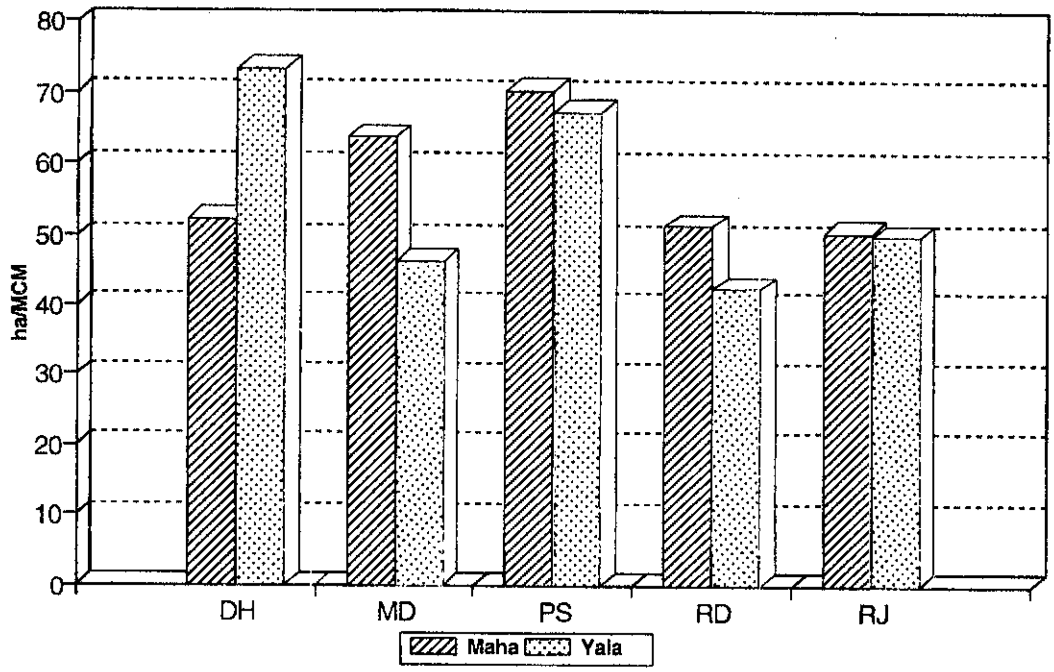
Figures 8 and 9 compare the Irrigation Duty in the five schemes in maha and yala, respectively, with the Irrigation Department's design assumption. Comparatively high duties are observed in Ridiyagama, Rajangane, Dewahuwa (in maha) and Mapakada. Although exceeding the Irrigation Department's value does not necessarily mean excessive water use, the comparison shows that two irrigation schemes recorded lower water duties than the specified norm in yala seasons. Reasons for exceeding the specified value in the maha season need to be further investigated.

4.5 RELATIVE WATER SUPPLY

Figures 10 and 11 compare the Relative Water Supply of the irrigation schemes in maha and yala, respectively. Because of the high OFC cultivation in yala in the Dewahuwa Scheme, the RWS was not calculated there in yala.

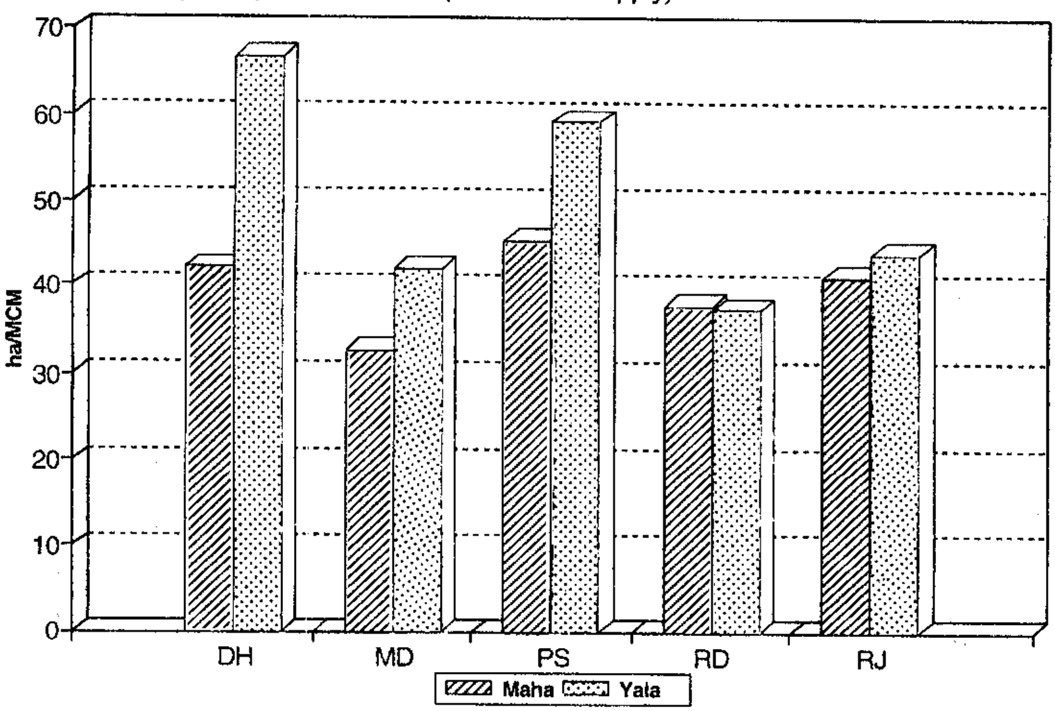
Figure 10 shows that RWS in all the schemes was above 1 in the maha season. The optimum value was recorded in the Parakrama Samudra Scheme. The Mapakada and Ridiyagama schemes recorded high RWS values.

Figure 5. Area Irrigated per Unit Water (irrigation supply).



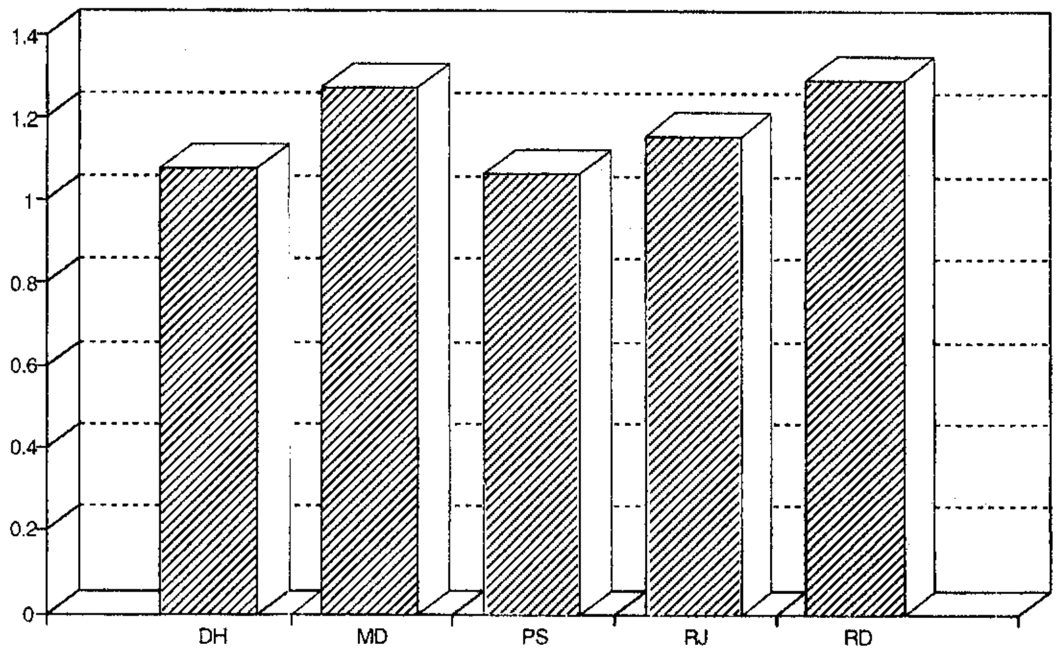
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 6. Area Irrigated per Unit Water (total water supply).



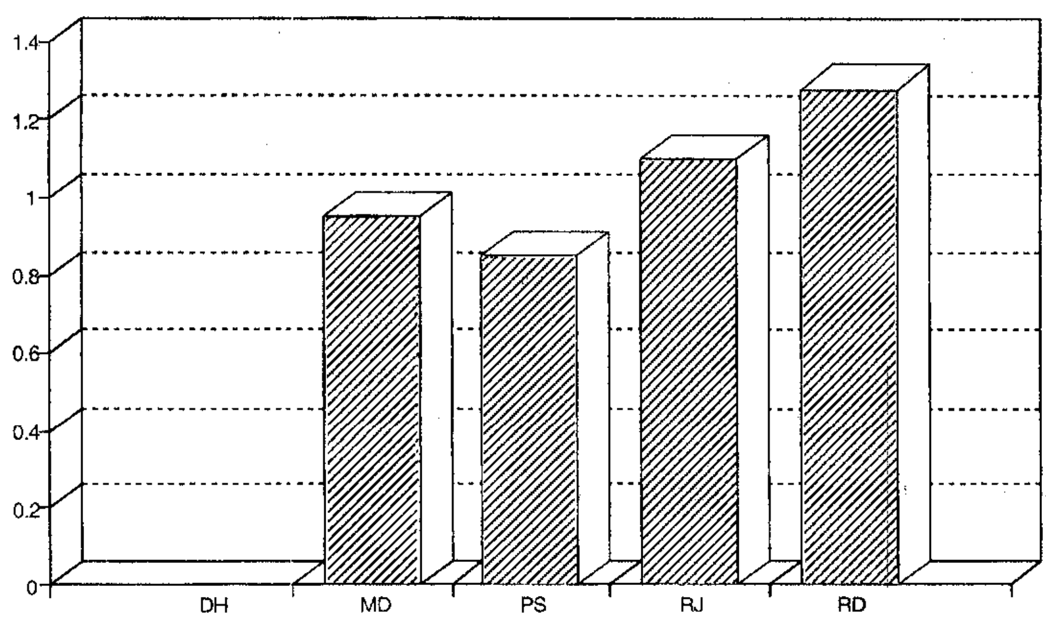
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 10. Relative Water Supply (maha).



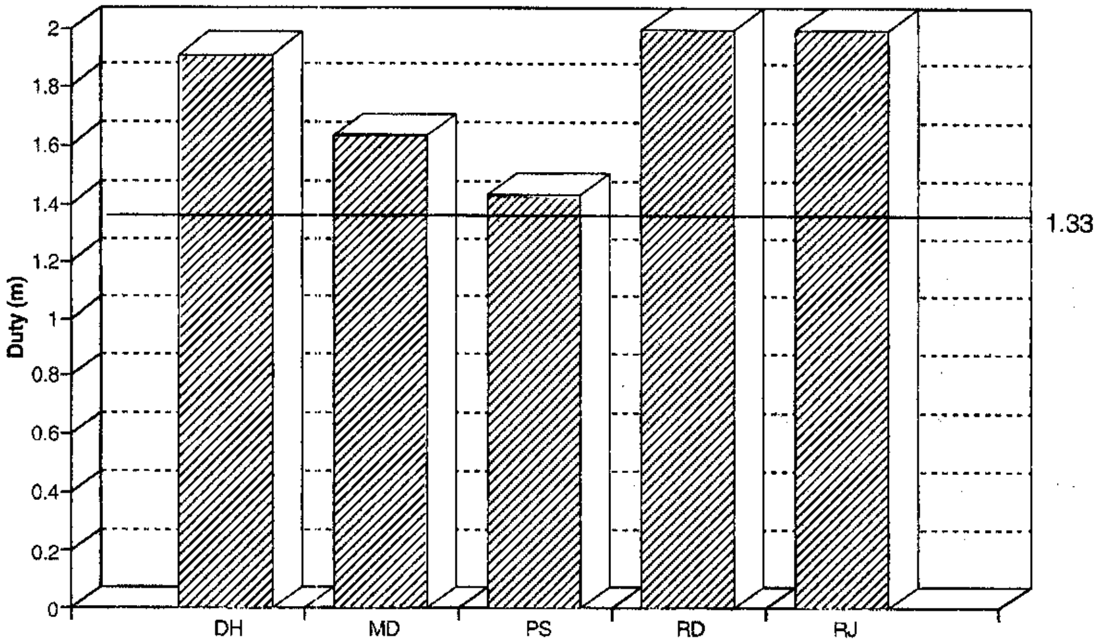
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 11. Relative Water Supply (yala).



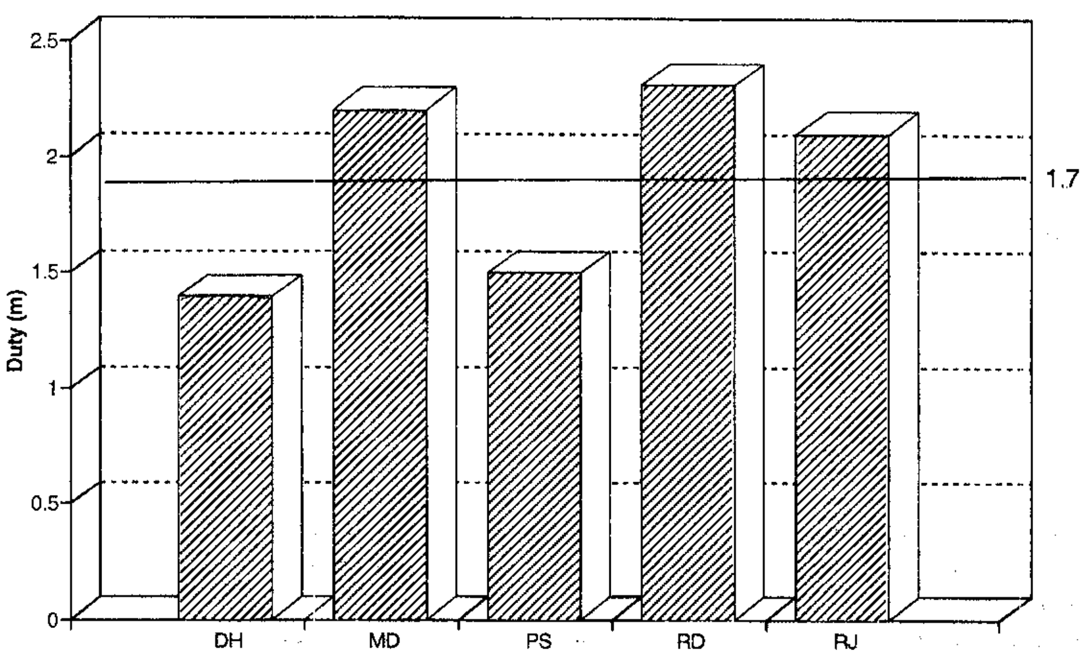
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 8. Irrigation Duty (maha).



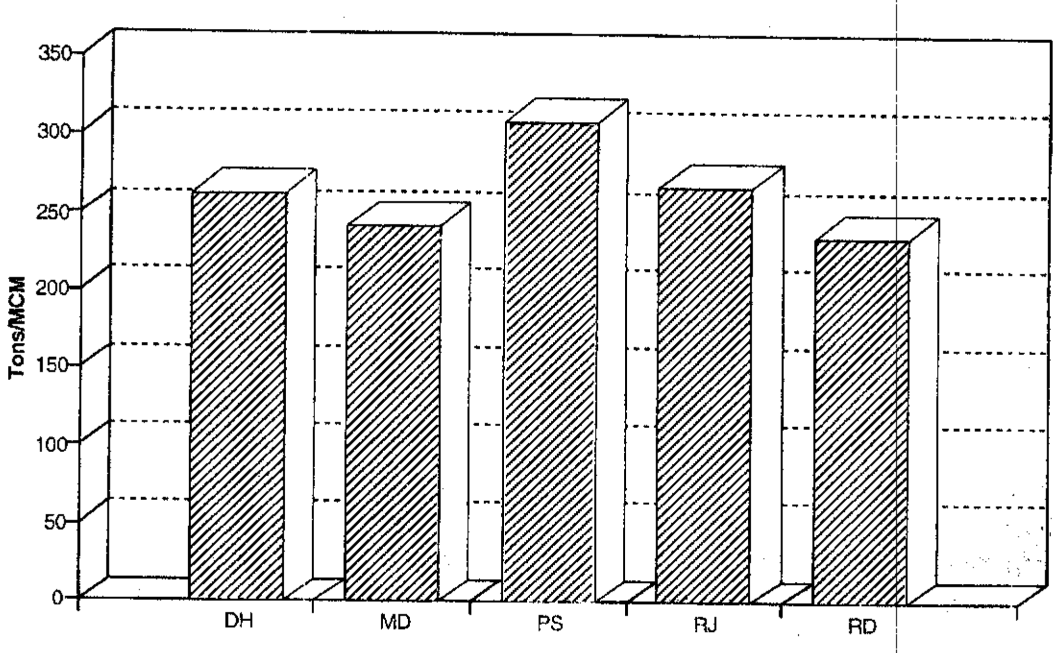
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 9. Irrigation Duty (yala).



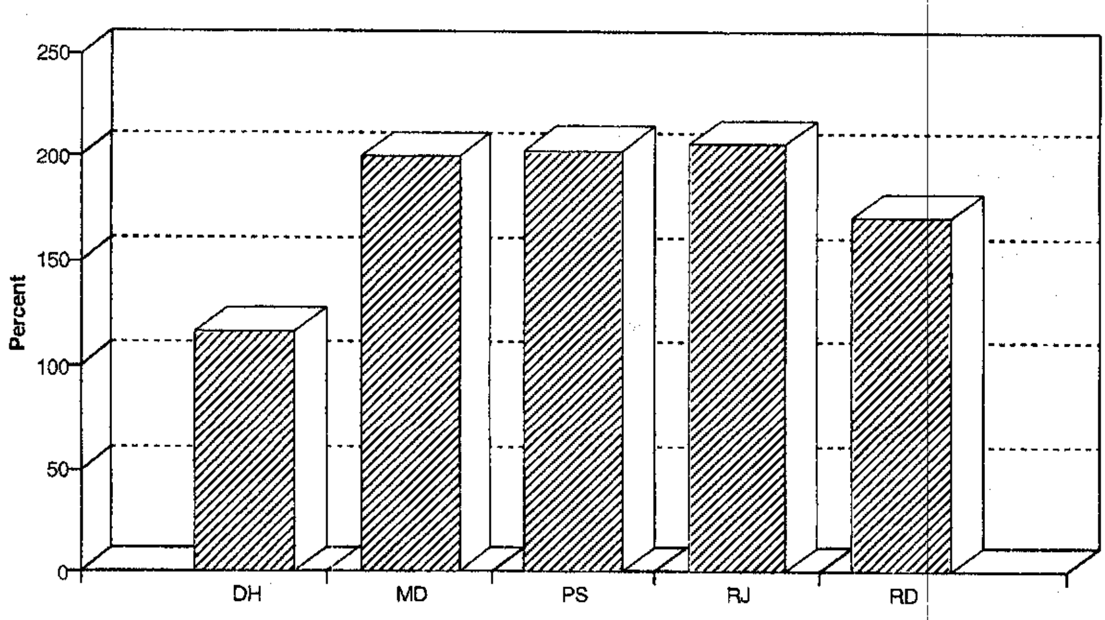
Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 12. Irrigation Water Productivity (maha).



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 13. Cropping Intensity.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

According to Figure 11, the optimum RWS in yala was recorded in the Mapakada Scheme. While RWS of the Parakrama Samudra Scheme is the lowest, the values of Rajangane and Ridiyagama are high.

According to the categorization indicated in Section 1.4.2-d of this paper, the performance of the schemes in relation to RWS can be summarized as in Table 23.

Table 23. A comparison of performance in relation to RWS.

Season	Good	Fair	Poor
Maha	Dewahuwa, Parakrama Samudra	Rajangane	Mapakada, Ridiyagama
Yala	Mapakada	Parakrama Samudra, Rajangane	Ridiyagama

Note: RWS = Relative Water Supply.

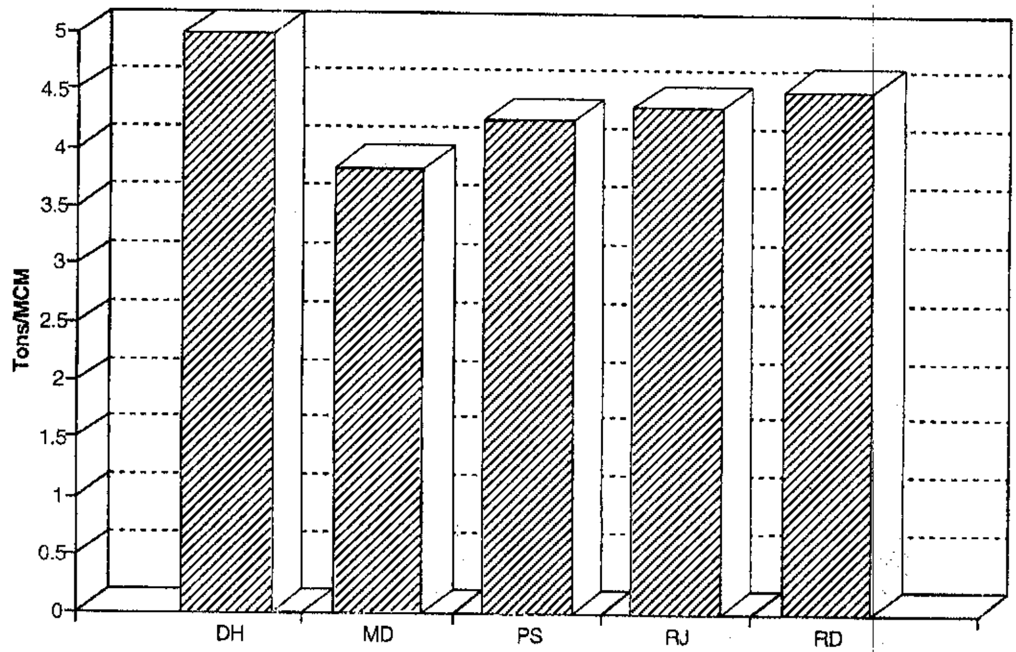
4.6 IRRIGATION WATER PRODUCTIVITY

Due to the varying nature of OFC cultivation in yala seasons in the five schemes, Irrigation Water Productivity is compared for maha seasons only. Figure 12 shows that highest Irrigation Water Productivity is observed in the Parakrama Samudra Scheme. It should be noted that among the Dry Zone schemes, Parakrama Samudra receives the highest amount of rainfall in the maha season (see Table 22). This probably enhances the Irrigation Water Productivity. The Mapakada Scheme, which is located in the Intermediate Zone has not recorded a good Irrigation Water Productivity despite the high rainfall. Table 22 shows that rice yield in Mapakada Scheme is also comparatively low.

4.7 CROPPING INTENSITY

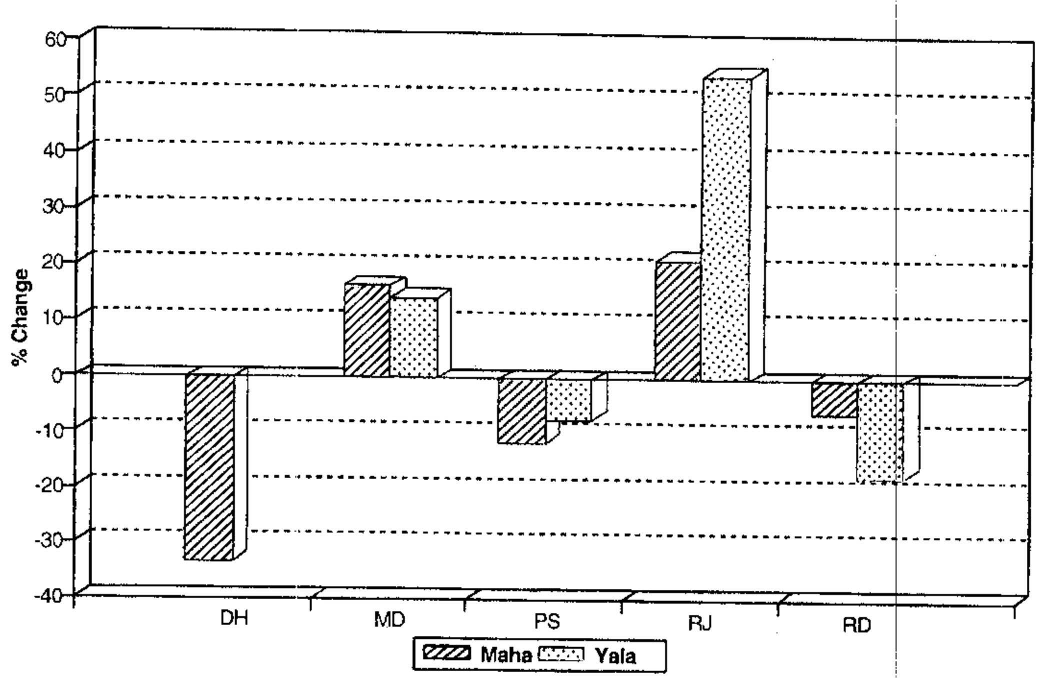
Figure 13, which compares the Cropping Intensity of the five schemes, shows that the highest values were recorded in Parakrama Samudra and Rajangane. Despite high OFC cultivation, Cropping Intensity in the Dewahuwa Scheme is low. Cropping Intensity is largely a function of the available water supply, though it can be enhanced through better management.

Figure 14. Land Productivity.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 15. Changes in rice production.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

4.8 LAND PRODUCTIVITY

Figure 14 shows that Land Productivity is highest in the Dewahuwa Scheme. However, as the records indicate that the rice cultivation in this scheme in yala was negligible, Land Productivity here is based on the maha season data only. Table 22 shows that the maha season rice yield was highest in the Rajangane Scheme. Land Productivity in Rajangane is affected by low yields in the yala season. High rice yields in yala are recorded in the Parakrama Samudra Scheme, though the yields in maha are lower than in both Rajangane and Dewahuwa.

4.9 TOTAL PRODUCTION

The total production essentially depends on the command area of the scheme. Most of the management interventions aim at increasing the total production. Considering these, it is more appropriate to compare the increases of rice production than the actual values of production.

Figure 15 shows that the highest increases in rice production were recorded in the Rajangane Scheme. Production has decreased in the Dewahuwa, Parakrama Samudra and Ridiyagama schemes. The largest decrease is observed in Dewahuwa.

4.10 LENGTH OF IRRIGATION SEASON

The length of the irrigation season in maha for the five schemes is shown in Figure 16. A similar comparison for the yala season is made in Figure 17.

As explained earlier, variations in length of the irrigation season is mainly the result of variation in the land preparation period. In principle, because of the smaller number of farmers and smaller farm area, a shorter land preparation period could be expected from smaller schemes. However, this hypothesis is not supported by the results.

Figure 16 shows that four of the five irrigation schemes managed their maha season within the expected range of duration. This shows that allowing 15-30 days for land preparation is reasonable. However, all the schemes exceeded this range in the yala season, as shown by Figure 17. Some reasons for this may be the following:

1. Cultivation of long-term varieties of rice in the yala season, contrary to instructions from the management.

2. Dependence on irrigation because of low rainfall. Since most of the farmers start land preparation at the same time, there is a heavy demand for water at the beginning of a season. The irrigation requirement for land preparation in yala is more than that in maha, because the rainfall is low in yala. Irrigation canals, constrained by carrying capacities, may not be able to supply the farmers with land preparation irrigation requirements in yala as fast as in maha.

The shortest duration of maha season was recorded in Ridiyagama and Rajangane. Yala season was the shortest in Rajangane followed by Parakrama Samudra.

4.11 RAINFALL UTILIZATION AND DATA COLLECTION

The rainfall in maha seasons is higher in Mapakada (92% of irrigation supply) than in Parakrama Samudra (54% of irrigation supply). But the latter scheme has irrigated more land per unit of water in the maha season. Similar observations can be made in yala seasons. This shows that rainfall utilization can be improved in Mapakada. In both of the schemes, maha rainfall is quite significant.

Since the results of the analysis suggest that performance could be improved with better utilization of rainfall, it is necessary to examine the existing facilities for rainfall measurement. Rainfall is recorded in all the schemes except Ridiyagama. Assuming readings of all the rain gauges are included in the data sets, the area covered by a rain gauge in each scheme is as follows:

Dewahuwa	:	1,214	ha	
Mapakada	:	548	ha	
Parakrama Samudra	:	9,794	ha	(4,897 ha from 1990)
Rajangane	:	5,600	ha	

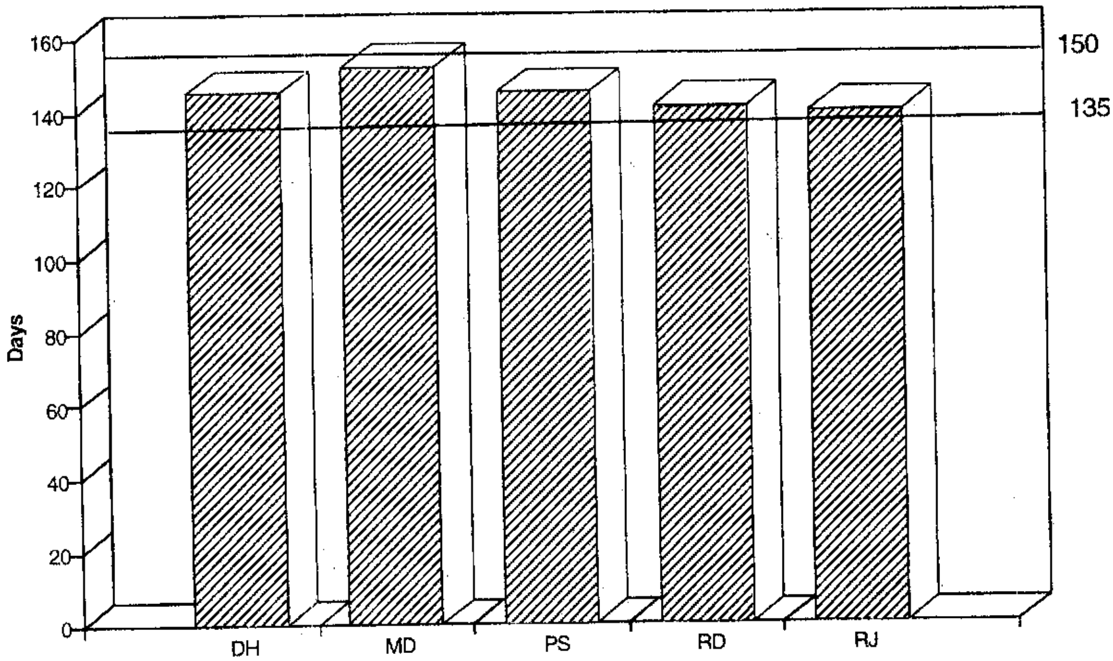
In the Parakrama Samudra Scheme, an additional rain gauge was installed in 1990, using the funds provided by ISMP. This has resulted in a change in the area covered by a rain gauge.

It can be seen that there is a lack of uniformity in the area covered by a rain gauge. The number of rain gauges in larger schemes does not seem to be adequate to enable effective use of rainfall. In the Muda Scheme in Malaysia, there are 57 rainfall stations for 97,000 ha, giving an average of 1,700 ha per rainfall station. Thus, the Muda Scheme is able to make good use of rainfall (Teoh and Chua 1988).

In spite of the apparent inadequacy of rain gauges, the Parakrama Samudra and Rajangane schemes perform relatively well. In Parakrama Samudra, even though the area covered by a rain gauge was halved, the Area Irrigated per Unit Water (including rainfall) registered only a marginal change. This shows that increasing the number of rain gauges alone will not boost the performance. The facilities provided for transmitting data should also be taken into consideration when comparisons are made.

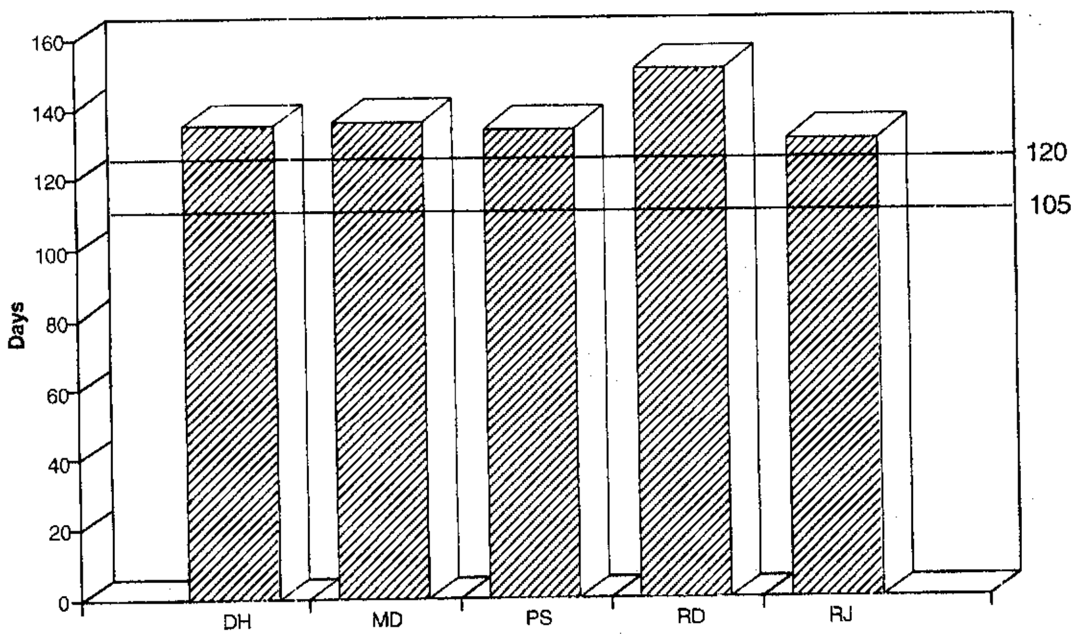
In the Muda Project, telemetric rainfall recorders convey the data directly to a main-frame computer located in the MADA Headquarters. Data from other rainfall stations are sent through four field computer terminals. Such facilities do not exist in Sri Lankan projects. It is also doubtful that they are affordable for the country. However, the transmission of data is an important link in the decision making process, which needs to be improved.

Figure 16. Length of maha season.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

Figure 17. Length of yala season.



Notes: DH = Dewahuwa. MD = Mapakada. PS = Parakrama Samudra. RJ = Rajangane. RD = Ridiyagama.

deviate much from the planned duration. However, the irrigation supply was about 22 MCM which was very high for the Dewahuwa Scheme. The irrigation supply went above 20 MCM only twice in the study period. Records show that in the following yala, only 202 ha was irrigated giving an Irrigation Intensity of 20 percent.

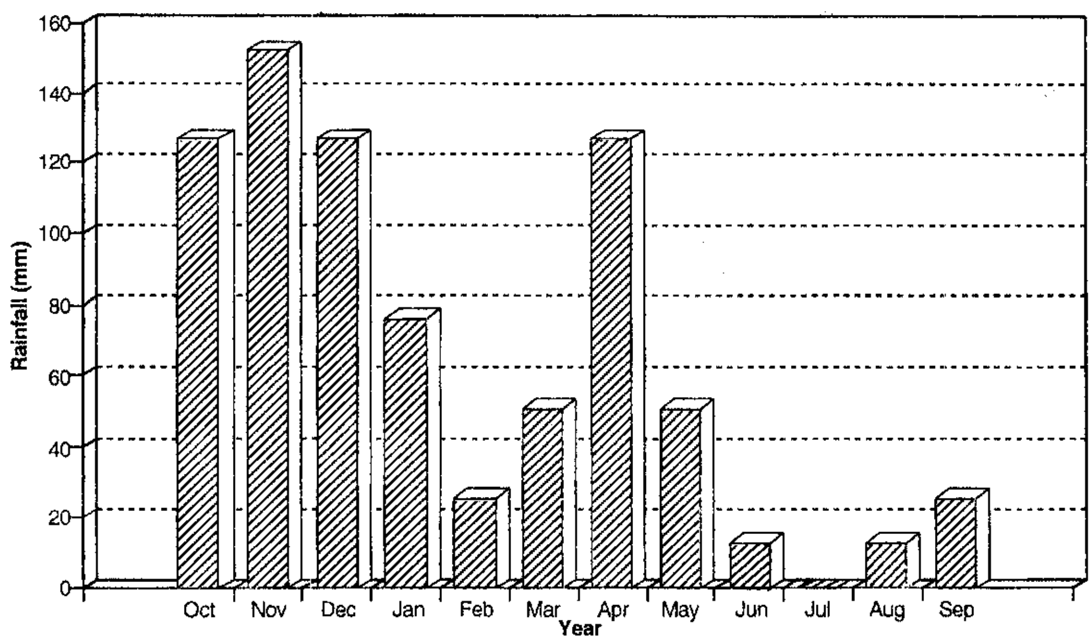
Second, in the Mapakada Scheme, a meda (intermediate) season was planned in 1991. The planned area for irrigation was 81 ha and the planned duration was 122 days, starting from 5 March 1991. However, according to IMD records, 510 ha were cultivated. The duration was extended to 202 days. The irrigation supply was 13.4 MCM, which was the highest in the study period.

4.12 CROPPING CALENDAR AND WEATHER PATTERN

Based on the water issues, the start of the maha season has been between late September and early November. The start of yala has varied between early March and late May.

The implications of rainfall for the starting date of the seasons can be studied with the aid of Figure 18. As the majority of the schemes fall within the Agro-Ecological Zone DL1, the rainfall pattern of the DL1 Zone is plotted in Figure 18. Starting the maha cultivation in October provides the opportunity for maximum utilization of high rainfall in October and November. Further, it allows the harvesting to be done in relatively dry February and March.

Figure 18. Rainfall in DL1 Agro-Ecological Region.



Source: Ponrajah 1982.

In a similar manner, starting yala in late March or early April seems to be the best arrangement with regard to the rainfall pattern. This will allow the high rainfall in April to be utilized for land preparation and harvesting to take place in July or August. However, a cultural problem affects the implementation of this schedule. The Sinhala and Hindu New Year falls around 13-14 April. As Sinhala-Buddhist and Tamil-Hindu farmers are a majority, only a few participate in agricultural activities for about a week in mid-April. Similarly, most officers are also on leave and good supervision is not possible. As a result, some managers prefer to start yala in late April. If the reservoir water level is low after the maha season, April rains can be used to fill up the reservoir.

Deviations from the generally accepted dates for maha and yala seasons were observed on two occasions. On both occasions, heavy water use was observed. First, in the Dewahuwa Scheme, the 1986/87 maha was cultivated in two staggers. The duration of the season was 176 days, which did not

5. Conclusions

5.1 OUTCOME OF THE STUDY

5.1.1 Performance Changes and Inter-Scheme Comparisons

The results show that some schemes were performing at optimum levels even at the beginning of the study period, with respect to indicators like Irrigation Intensity. Another factor to be considered is that the reservoir capacity limits the saving of water in the maha season in schemes such as Parakrama Samudra and Mapakada. As a result, sometimes the scope for performance improvement in schemes with good water availability is small in the maha seasons.

Parakrama Samudra, Rajangane, Mapakada, and Ridiyagama can be considered as irrigation schemes with good water availability in the maha season. Out of the four schemes, Parakrama Samudra and Rajangane show an improvement in performance related to water use. In Rajangane, the improvements are more significant and can be observed in both seasons. The following features of the interventions implemented in the four schemes need to be considered in this context:

1. All four schemes came under INMAS, and farmer organizations were established. In the case of Parakrama Samudra, Mapakada and Rajangane, the INMAS System was established in 1984. Although Ridiyagama was also included in the original plan of INMAS (ML&LD 1984), the system was formally established only in 1991.

2. Improvements to physical infrastructure have been implemented in Parakrama Samudra, Mapakada and Rajangane, but not in Ridiyagama.

3. The level of farmer participation in rehabilitation activities was high in Parakrama Samudra and Rajangane because of the institutional development activities implemented through ISMP and MIRP.

4. Facilities for water management were improved in Parakrama Samudra and Rajangane under the respective rehabilitation projects. The improved facilities included provision of gates and measuring devices for the distributary canals, provision of computer software for canal operation and establishment of weather stations.

In the case of the Rajangane Scheme, the length of the irrigation season has decreased and water issues between seasons have also decreased. These indicate a more disciplined water use by the farmers and a more systematic water distribution by the managers.

Observations on performance changes in the Parakrama Samudra Scheme can be summarized as follows:

1. The length of the irrigation season has decreased in yala. Corresponding performance gains related to water use can be observed in the yala seasons.

There was a substantial difference in the area cultivated reported by the IMD and the area irrigated reported by the Irrigation Department in Mapakada and Ridiyagama schemes. It should be noted that if the lower values of area are adopted, the relative position of performance of these two schemes would be lower.

5.1.2 Comparison of Performance Levels with Potential

The main difficulty in assessing whether an irrigation system has achieved its potential is in estimating the potential itself. For example, the Irrigation Intensity is dependent on available water resources, which can vary with each scheme. Considering the effects of soil properties, water resources, expansion of cultivated area, land use preferences, etc., it is not possible to define a potential for the selected schemes with the available data.

However, the existence of scope for improvement of performance is an indirect indication that the full potential is not achieved. If this argument is accepted, the following observations can be made:

1. The results show that maximum rainfall utilization is not achieved in some schemes, for example in the Mapakada Scheme.

2. The interventions with more emphasis on water management have contributed to increasing performance. However, the level of emphasis on water management varies with the interventions. For example, ISMP and MIRP have heavier emphasis on this aspect. If similar efforts are made in the other schemes, further performance improvements can be achieved.

3. The length of the irrigation season is a parameter which is not affected by site-specific physical conditions. The results show that the value of this parameter varies among the schemes. In yala, the length of the irrigation season is higher than the expected value in all schemes. The season is often extended due to management problems such as inability of the management to provide a reliable water supply, non-adoption of water saving agronomic practices like dry sowing, lack of officer-farmer coordination, and cultivation of long-term varieties in the yala season. If these defects are rectified, there is further scope for improvement of the performance.

4. Lower yields even in systems with adequate water supplies suggest that variables not related to irrigation management have an important impact on performance.

Another method for assessing whether the full potential is achieved is comparing the present performance with the best achievement recorded. The best achievement recorded need not be the potential. However, if the present performance is lower than the best achievement recorded, it means that the performance is lower than the potential as well.

Table 24 presents the current performance levels as a ratio of the best achievements. Irrigation Duty and length of the irrigation season are not included in this analysis because they were already compared with reference values. The following reservation should be noted when referring to this table: The best performance in Area Irrigated per Unit Water in Rajangane were recorded in 1989/90 maha and 1990

2. A decline in agricultural performance can be observed in maha. Because of good water availability and physical improvements, it is unlikely that this is related to the water supply. Available data do not provide an explanation for the decline in agricultural performance.

3. Even at the beginning of the study period, the performance of the scheme was fairly good. The changes in performance should be evaluated on this basis.

In Parakrama Samudra and Rajangane, part of the performance improvements can be attributed to the shortening of the length of the season. One objective of shortening the irrigation season was to accommodate a longer construction period between the end of yala and the start of maha. It should be noted that farmer organizations also participated in construction activities in these two schemes. This also may have helped in making the farmers understand the importance of shortening the length of the season. Hence, in the case of Parakrama Samudra and Rajangane, the performance gains can be attributed to a combination of physical improvements, active farmer participation in management and improved water management.

Observations on the performance changes in the Mapakada Scheme can be summarized as follows:

1. Performance with regard to agricultural productivity has increased over time, although it still remains lower than in some of the other schemes studied.

2. Performance with respect to water use has generally decreased.

3. Lengths of irrigation seasons have not improved.

Because of structural improvements, while water use per unit area has increased, it is likely that the equity and reliability of the water supply have also improved. Available information suggest that further improvement can be made through effective water management.

The major management interventions implemented in this scheme are the structural improvements effected through IRDP and the institutional developments made through INMAS. Hence, the performance gains can be partly attributed to the structural improvements, while substantial contributions would also have been made by the farmer organizations. A more detailed field study would be needed to understand the relative contributions of these interventions. Information on agricultural extension services and input supply are not available at this stage. Hence, the reasons for improved agricultural productivity cannot be identified without further research.

In the Dewahuwa Scheme, the interventions include:

1. Encouraging OFC cultivation.
2. Adoption of the INMAS system.

OFC cultivation is high in yala seasons. The impact of this is reflected in the high values of Area Irrigated per Unit Water and the low values of Irrigation Duty. However, a decrease in the level of performance in Dewahuwa can be observed from the data. Except for a drop in rainfall, available data do not provide reasons for this decrease. Further research is suggested in this case.

Table 24. Current irrigation performance as a ratio of the best achievement in the study period.

Performance indicator	Dewahuwa		Mapakada		Parakrama Samudra		Rajangane		Ridiyagama	
	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
AIUW(I)[1]	71	71	90	89	86	90	75	65	80	88
AIUW(T)[2]	97	73	73	88	72	90	78	66	80	85
Irrigation Intensity	100	50	100	89	100	100	97	100	88	93
RWS[3]	94	-	73	99	86	97	85	85	72	81
IWP[4]	70	-	83	90	75	96	91	81	88	93
Production (tons)	64	-	95	96	81	83	90	87	77	82
Cropping Intensity	78		98		98		97		90	
LP[5]	95		95		89		83		84	

1 Area Irrigated per Unit Water (irrigation only) (ha/MCM).
2 Area Irrigated per Unit Water (total water supply) (ha/MCM).
3 Relative Water Supply.
4 Irrigation Water Productivity (tons/MCM).
5 Land Productivity (tons/ha/season).

Often, these features interact positively, and as a result, it is a combination of these which contribute to good performance. It is difficult to isolate the effect of a single feature.

Similarly, the following factors dampen the effectiveness of management interventions and obstruct the improvement of performance:

1. Lack of motivation due to good water availability.
2. Deviation from usual cropping calendar.
3. Preparation of irrigation schedules without due regard to rainfall pattern.

5.2.2 Maintenance of Irrigation System

An important factor which was not analyzed in this study for want of data was the level of maintenance of the irrigation systems. An indirect indicator of the level of maintenance is money spent on maintenance. Although data specific to individual schemes are not available, the overall fund allocation of the Irrigation Department can be used as a proxy in this context. Available data show that expenditure on O&M was Rs 330 per ha (Rs 134 per ac) in 1982. In 1989, the corresponding figure was Rs 410 per ha (Rs 166 per ac) (Wijesooriya 1990 and Irrigation Department 1990). In 1982 prices, the expenditure in 1989 was Rs 172 per ha, which means a reduction of 48 percent from 1982.

A survey done by the Irrigation Department in 1982 estimated that the average expenditure required for O&M is about Rs 494 per ha (Rs 200 per ac). Compared with this, the money actually spent is about 65 percent less than the requirement. This indicates that the infrastructure of irrigation systems is likely to deteriorate even after a system has benefitted from a rehabilitation program.

5.2.3 Conditions Required for Good Performance

Although a considerable amount of academic literature on performance assessment exists, systematic studies on the relationship between irrigation management processes and irrigation performance are comparatively few. As a response to this situation, a comparative study of three irrigation systems was conducted by IIMI (Merrey et al. 1994). The study is based on data from three irrigation systems in Nepal, the Philippines and Sri Lanka.

The hypotheses verified in this study are as follows:

1. Institutional conditions which both enable managers to do their jobs effectively and provide effective incentives to encourage good performance, are necessary conditions to achieve and sustain good irrigation performance.

2. Presence of a management cycle which plans to achieve the objectives, implements the plan, monitors the implementation and evaluates the achievement of objectives, is a necessary condition for achieving good performance.

3. Regular assessment of key parameters of performance is necessary for sustaining and improving canal irrigation system performance.

The following discussion attempts to ascertain whether the existing irrigation management processes in Sri Lanka are conducive to achieving good performance. As information specific to the five irrigation systems are not available, this would be based on general information.

5.2.4 Effects of Institutional Conditions

The study by Merrey et al. (1994) shows that irrigators' associations and agency staff are both rewarded for achieving targets in the Philippines. However, such a systematic approach to rewarding good performance, especially in system operation, does not exist in Sri Lanka. On the contrary, sometimes the rewards are negative. For example, the officers who attempted to establish a seasonal planning system in the Kirindi Oya Project had to endure harassment and abuse (IIMI 1994). Other studies cite the following reasons for the poor standard of operation of irrigation facilities:

1. Lower level officers, with whom the responsibility of operation usually rests, lack the authority to take decisions.

2. Training in water management provided to officers is inadequate (IIMI 1990).

Since participatory management of irrigation systems has been adopted as the government policy in Sri Lanka, a system to reward good performance should include both public servants and farmer organizations. Although differences exist on the effectiveness of farmer organizations, a systematic organizational setup is present within farmer organizations for farmers to participate in management activities. This provides the necessary ground conditions for an institutional setup in which both the agency staff and farmer organizations benefit from good performance.

5.2.5 Effectiveness of the Management Cycle

Merrey et al. (1994) categorizes the tasks involved in an effective management cycle into four major categories:

The first task in an effective management cycle is identified as **planning the process by which objectives are set or modified, operational targets identified and implementation plan established.**

In general, the present irrigation planning system comprises a water issue schedule with target dates of main cropping activities. In the past, inadequacy of discharge measurement structures prevented the managers from volume-based irrigation planning. However, in most of the modified irrigation systems flow measurement structures are in place now. Hence, the potential exists to plan irrigation based on volumes and discharges.

The lessons learnt from the studies conducted by IIMI are important in this context. Some of them are described below:

The Kirindi Oya Project in southern Sri Lanka has experienced severe water shortages since its inception in 1985. As a result, IIMI was invited by the Government of Sri Lanka and the Asian Development Bank to assist in improving its system performance by conducting a diagnostic survey.

One of the major conclusions of the researchers was that irrigation water use efficiency is low in Kirindi Oya, although a great potential exists to save water through proper management policies. The proposed innovations to improve performance included the improvement of main system management through seasonal planning (IIMI 1991).

Similar research was carried out in the Uda Walawe Scheme by IIMI. The proposed improvements include seasonal planning here too (IIMI 1991).

In Kirindi Oya and Uda Walawe, seasonal water distribution plans based on target volumes of water delivery are being prepared now. Similarly, in the Parakrama Samudra and the Rajangane schemes studied in this report, the rehabilitation packages included computer software for planning water deliveries.

The second task in the management cycle is identified as **implementation of the agreed plan.** The existing infrastructure facilities and staff strength need to be studied further to see whether they are adequate to implement the plans.

Apart from the infrastructure and staff strength, a set of well defined operational rules is necessary to implement the plans smoothly. For example, during a rainfall event, the staff should know the adjustments to be made to the irrigation supply depending on the amount of rainfall. In the Uda Walawe Project, a set of guidelines to respond to rainfall was developed by the consultants to the Walawe Irrigation Improvement Project. They were based on the following parameters:

1. The week in the irrigation season during which rainfall occurred.
2. Location of rainfall event (lower tracts or upper tracts).
3. Intensity of rainfall (IIMI 1990).

Monitoring the implementation of the plan to check whether operations are carried out efficiently and targets are met, is identified as the third task. In other words, this poses the question:

Are the managers doing things right?

In the majority of irrigation systems, water measurement is confined to the main canal. At the field level there is very little monitoring of water distribution (IIMI 1992).

The measures adopted at the Kirindi Oya Project for monitoring are as follows:

1. Introduction of a data collection program and a communication network.
2. Introduction of a computerized Irrigation Management Information System (IMIS).

One of the advantages of using the IMIS for monitoring operations in the Kirindi Oya Project is that it provides the manager with a global view of water use in different areas under the project (IIMI 1994).

The fourth task in a management cycle is **evaluation of performance** to see whether the broader objectives are met. In other words, this poses the question:

Are the managers doing the right thing?

In most irrigation schemes in Sri Lanka comprehensive performance assessment is limited to amendments done under specific research studies. However, this system is not of much use as a management tool. One of the reasons for the present situation is the lack of resources to assess performance in time to make an impact. Studies done in the Kirindi Oya Project (IIMI 1994) and in the Mahi Kadana Project in India (Murray-Rust et al. 1994) show that the introduction of MIS has improved the capacity of management to effectively evaluate performance. The observed benefits of using an MIS as a technique to evaluate performance are as follows:

1. It provides information to evaluate system performance when required.

2. It provides seasonal summary reports which are useful for higher level planners and policy makers.

5.2.6 Performance Assessment System

The importance of performance assessment as a management tool is supported by the following factors which arise from the present review:

1. The foregoing analysis shows that there is potential for improvement of performance in some of the schemes studied.

2. Management interventions such as rehabilitation projects are implemented at a substantial cost with objectives such as increasing the productivity. It is important to see whether these objectives are achieved.

To be effective as a management tool, the set of performance indicators used by the managers should cover a broader spectrum of objectives than what is covered in this study. The range of indicators required to make a comprehensive assessment of irrigation performance can be described as follows:

* Water supply performance.
* Agricultural performance.
* Economic, social and environmental performance (Bos et al. 1994).

In view of the above, the present performance assessment system seems to be inadequate to make a meaningful contribution to irrigation performance. For example, Irrigation Duty, which is widely used as a performance indicator, does not reflect the effect of rainfall. Moreover, specific targets for different schemes have to be set. The present situation does not permit the combination of water, agriculture and other kinds of performance assessment, so any assessment by senior managers is limited.

Even the indicators used in this report do not provide information such as adequacy, reliability and timeliness. Another factor to be considered is the ways and means by which to utilize the performance indicators to improve performance. For this, targets have to established for each indicator.

The Performance Program of IIMI plans to develop a comprehensive system for the assessment of performance and make it available to irrigation managers. As a primary step, a set of performance indicators is being developed now. However, to implement this system, it is essential to have a reliable set of data. Although certain deficiencies exist in this field, it should be noted that several agencies collect data related to irrigated agriculture. They include the Irrigation Department, Irrigation Management Division, Agriculture Department, Department of Agrarian Services and Mahaweli Authority. Sometimes the collected data are duplicated. However, what is lacking is a proper system by which to share these data, especially at the provincial and scheme levels.

5.3 RECOMMENDATIONS

Since this is a subjective assessment of performance, far reaching recommendations are not made at this stage. The following recommendations are based on data analysis and review of management interventions:

1. Performance assessment needs to be adopted by irrigation managers as a tool to improve the performance of the irrigation systems they manage.

2. A methodology should be established to share the data useful for performance assessment, at respective levels. For example, the project level data collected by different agencies should be shared by the project level officers of different agencies and the Project Management Committee. The information can be sent to respective headquarters to form a national level data base and assess national level irrigation performance.

3. Each irrigation system should be equipped with a data collection and feedback system for day-to-day operations and seasonal planning.

4. Volume-based operations should extend at least to the distributary level. Target volumes and discharges should be used for this purpose.

5. Computerized IMIS should be used to process the data speedily, and schedule the operations. The same system can be used to assess performance.

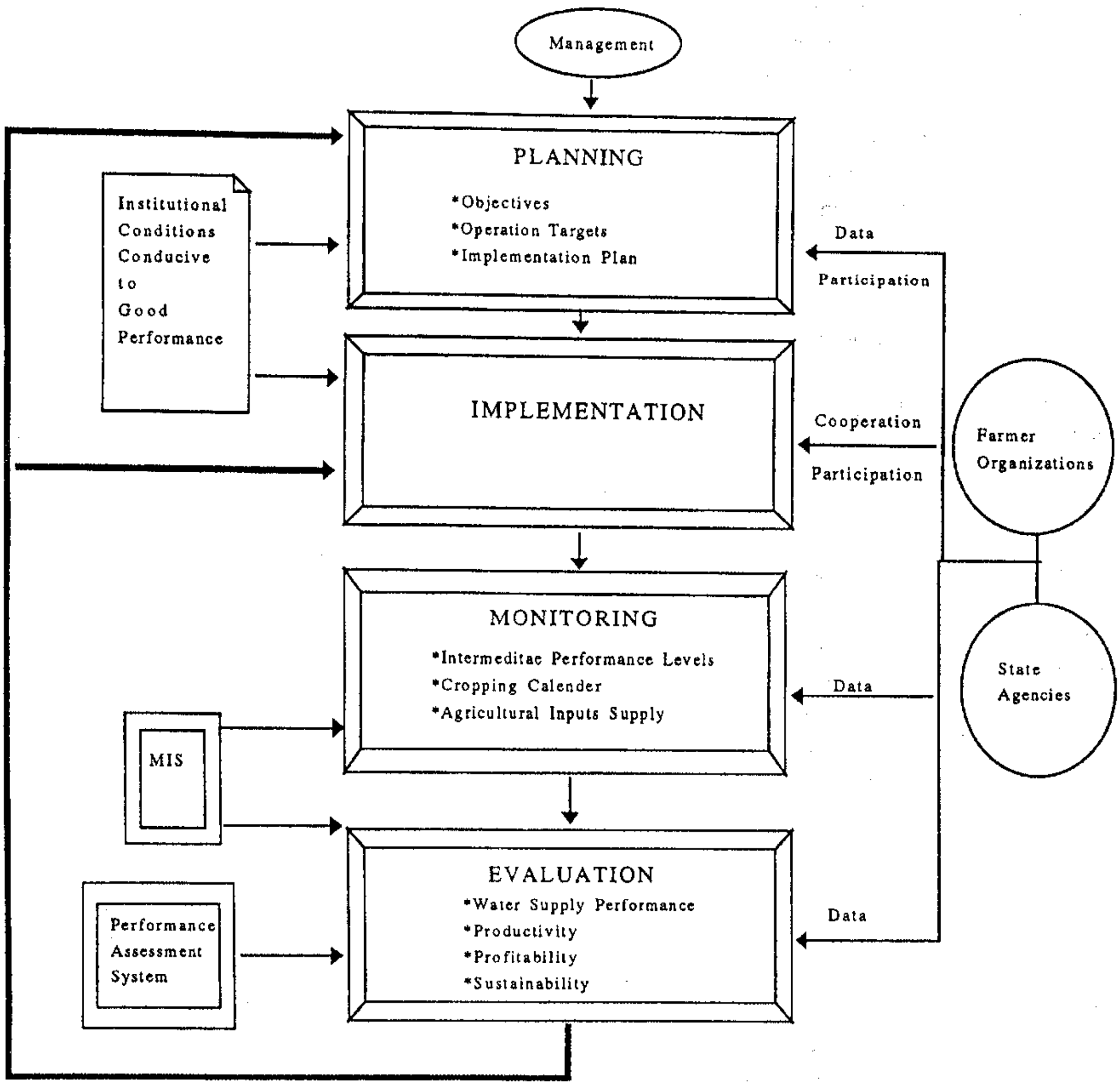
6. The data available at the Irrigation Department headquarters should be computerized, incorporated into an MIS and used for performance assessment.

Based on the review of past studies on irrigation management in Sri Lanka made in Section 5.2 of this paper, it is further suggested that active participation and information feedback from farmer organizations and other state agencies are important to improve the performance through an efficient management cycle.

The importance of sharing information among agencies was observed when the data from the Mapakada and Ridiyagama schemes were analyzed. If there is a continuous dialogue among different agencies, the substantial differences in values of area cultivated could have been avoided.

These recommendations and suggestions are illustrated in Figure 19. The illustration is based on the four major categories of tasks in the management cycle (Bos et al. 1994) discussed above.

Figure 19. Suggestions to improve the effectiveness of the management cycle.



The effectiveness of the task of **planning** is enhanced by the participation and the provision of data by farmer organizations and other state organizations. Appropriate institutional conditions conducive to good performance also contribute positively to the planning process.

Similarly, the task of **implementation** is facilitated by the cooperation and participation of farmer organizations, proper institutional conditions and cooperation of other state agencies.

The **monitoring** process can be strengthened by the data supplied by farmer organizations and other state agencies. Management Information Systems would also make an important contribution to this process, especially in areas such as the calculation of intermediate performance levels.

The effectiveness of **evaluation** will be enhanced by a systematic performance assessment system as well as by the data supplied by farmer organizations and other state agencies. Performance related to productivity and profitability cannot be accurately evaluated without information from farmers and agencies like the Agriculture Department. Management Information Systems also contribute to this task by efficient and timely evaluation of performance using a large data base.

Once performance is evaluated, the information should be used to identify the weak points in planning and implementation. This leads to a cyclic process which eventually enhances the effectiveness of the management cycle.

5.4 FUTURE RESEARCH NEEDS

This study is not definitive. Further data collection at project level is required to quantitatively assess the trends of performance change. Furthermore, the assessment of hydraulic performance is not sufficient to see whether the objectives of management interventions are met. Most of the rehabilitation programs had more far reaching objectives than improving the hydraulic performance of the irrigation system.

Therefore, it is suggested that this study be used as a base for a more comprehensive study including a larger number of irrigation schemes and a larger set of performance indicators. This type of study will provide a representative sample of Sri Lanka's irrigation systems and would provide a better view of the country's irrigation performance. Further, it will validate the suggestions and recommendations made in Section 5.3.

This paper discusses the performance changes which have taken place in several irrigation schemes over a period of time. It also discusses the features of management interventions which may have contributed to these changes. However, to identify the exact causes of these changes, more intensive data collection at the scheme level is necessary. For example, the reduction in productivity can be due to a variety of reasons such as low fertilizer use, climatic factors and water logging and salinity buildup. Similarly, changes in length of the irrigation season can be due to cultivation of short-duration varieties, rehabilitation of the system, transfer of the management to farmers, and improved water management. Identifying these factors and quantifying their effects on irrigation performance would be useful for the managers to improve performance.

Another factor to be investigated is whether the capacity to improve performance exists in the present setup. Although an assessment would show that the potential for improving performance exists, the recommendations for improvement may meet with failure if the capacity for such improvement does not exist. IIMI has proposed a procedure to overcome this problem which is called the *Performance Improvement Capacity Audit* (Merrey et al. 1995). The methodology adopted essentially comprises of a set of questions which will examine the capacity of the management to improve performance level. This capacity audit is a necessary second step after evaluating the potential for performance improvement.

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