11. CROP DIVERSIFICATION AS AN AID TO WATER MANAGEMENT—SOME COMPUTER STUDIES ON MAHAKANADARAWA IRRIGATION PROJECT NORTH CENTRAL PROVINCE, SRI LANKA

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1. Introduction

1.1 Traditionally in Sri Lanka irrigation has been for rice cultivation. It is therefore not surprising that rice has been and continues to be the staple food of the large majority of the population. With the country not achieving self sufficiency and the prevailing foreign exchange crisis the authorities evinced great interest in existing irrigation projects, with a view to increasing local rice production. It is however a well known fact that compared with the cereals, and subsidiary food crops, paddy requires a large quantum of water for cultivation. Hence with the limited water resources it became necessary to evolve a diversified cropping pattern that would not only ensure at least one successful rice crop a year but at the same time would require a lesser quantity of irrigation water for optimum production. This would thereby ease the water management problems that are normally encountered in irrigation projects where double cropping of paddy have upto now been practised.

1.2 Under an FAO/IBRD cooperative program, a team of experts visited Sri Lanka and carried out feasibility studies for the rehabilitation of five major irrigation reservoir projects located in the dry zone of the country. The Irrigation Department together with other related agencies assisted the team in carrying out surveys, investigations and other special studies needed for final project evaluation. This paper deals with some aspects of the studies carried out by the Hydrology Division of the Irrigation Department in connection with the proposed scheme of rehabilitation of the five major irrigation projects. More specifically it pertains to details of one of these projects viz. Mahakanadarawa Irrigation Project situated in the North Central Province of Sri Lanka. The location is shown in fig. 1.1.

2. Present status of the Project

2.1 Mahakanadarawa scheme is located in the centre of the dry zone and the water management problems encountered there are typical of those in a number of major colonization schemes in this area. With the assistance of the Tropical Agricultural Research Centre (TARC) of the Ministry of Agriculture and Forestry, Government of Japan, the Irrigation Department is engaged on a special study of the project to make a more detail assessment of the problems now prevailing in the scheme. Once these problems are specifically identified, it would immensely help the authorities concerned to take necessary action to rectify this situation not only at Mahakanadarawa, but in most of the large irrigation projects in the dry zone area which has a gross irrigation potential of over 350,000 Acs. (140,000 ha).

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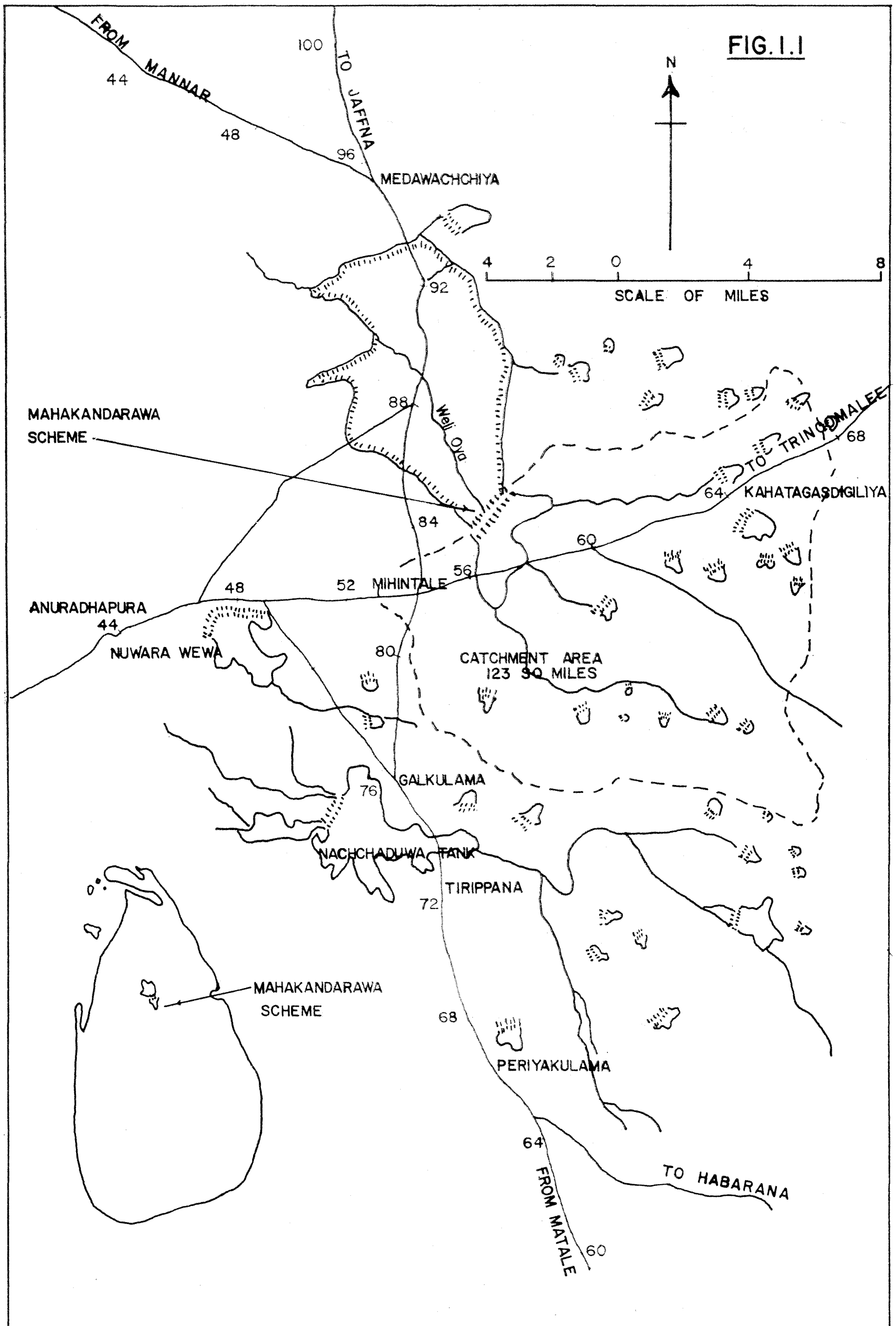


LOCATION OF MAHAKANDARAWA SCHEME.

2.2 Present Cultivation

This ancient reservoir scheme was restored in 1967 and was designed to irrigate an extent of 6,000 Acs. (2,400 ha). The performance of this scheme up to now is however far below expectations. The average cultivation in the Maha Season (October–March) for the past 5 years has been 2,350 Acs. (950 ha) and in the Yala (April–September) season 700 Acs. (280 ha). Although the dry zone did experience an unusually dry spell in this five year period, the figures still give an indication of the necessity for the adoption of remedial measures to improve the situation. The situation becomes even more alarming when one considers the fact that about two thousand families settled in the colony are dependent on this project for their livelihood.

2.4 Cultivation Practises

In the scheme, the colonist farmer practises continuous flow flooding as long as there is water available. He generally does not dry plough the land but uses large amounts of water for weed control and tillage operations at the initial stages of the cultivation. There is very little use of fertilizer and pesticides. Although he is well versed in the advantages of transplanting and row sowing, most farmers still resort to broadcasting of the seed paddy. Another practice which leads to wastage of irrigation water is the staggered planting dates adopted by various farmers which necessitates enormously prolonged issues of water.

2.4 Crop water use

Paddy is cultivated in both seasons. Under the special project water use studies were carried out during the Maha cultivation season in 1973/74 within a specified study area. Due to delayed rains, the cultivation commenced in January 5th 1974, and ended on 30th June 1974. A network of flow measuring points were established within the study area so that the following parameters could be estimated for any time interval during the cultivation:–

i. Issues from the Main Sluices of the reservoir
ii. Issues into the distributary channels within the study area
iii. Flow in the main channels (Left Bank and Right Bank) just outside the study area
iv. Drainage flow or return flow which goes waste
v. Any local inflows into the study area during storms

With this data it was possible to work out actual water consumption levels at different points of the scheme. Moreover the drainage flow measured on non rainy days gave a good indication of wastage of irrigation water. Some of these findings are given in Table 2.1. It will be observed that the gross duty of water as measured at the main sluices is about 11.7 Ac.Ft./Ac. ($3.6 \times 10^4\ m^3/ha$). About 50% of the sluice issues for the entire season has been lost as drainage flow. The monthly peak being 68.3% in January when continuous flooding had been done in the fields. These figures indicate the urgent necessity for good water management.

2.5 Seepage and channel loss studies

2.5.1 Channel Losses

From the studies carried out durnig the cultivation season January to July 1974, it was found that 15% of the main sluice issues were lost in the main channels. Since the irrigation water has to be issued to the fields through additional distri-

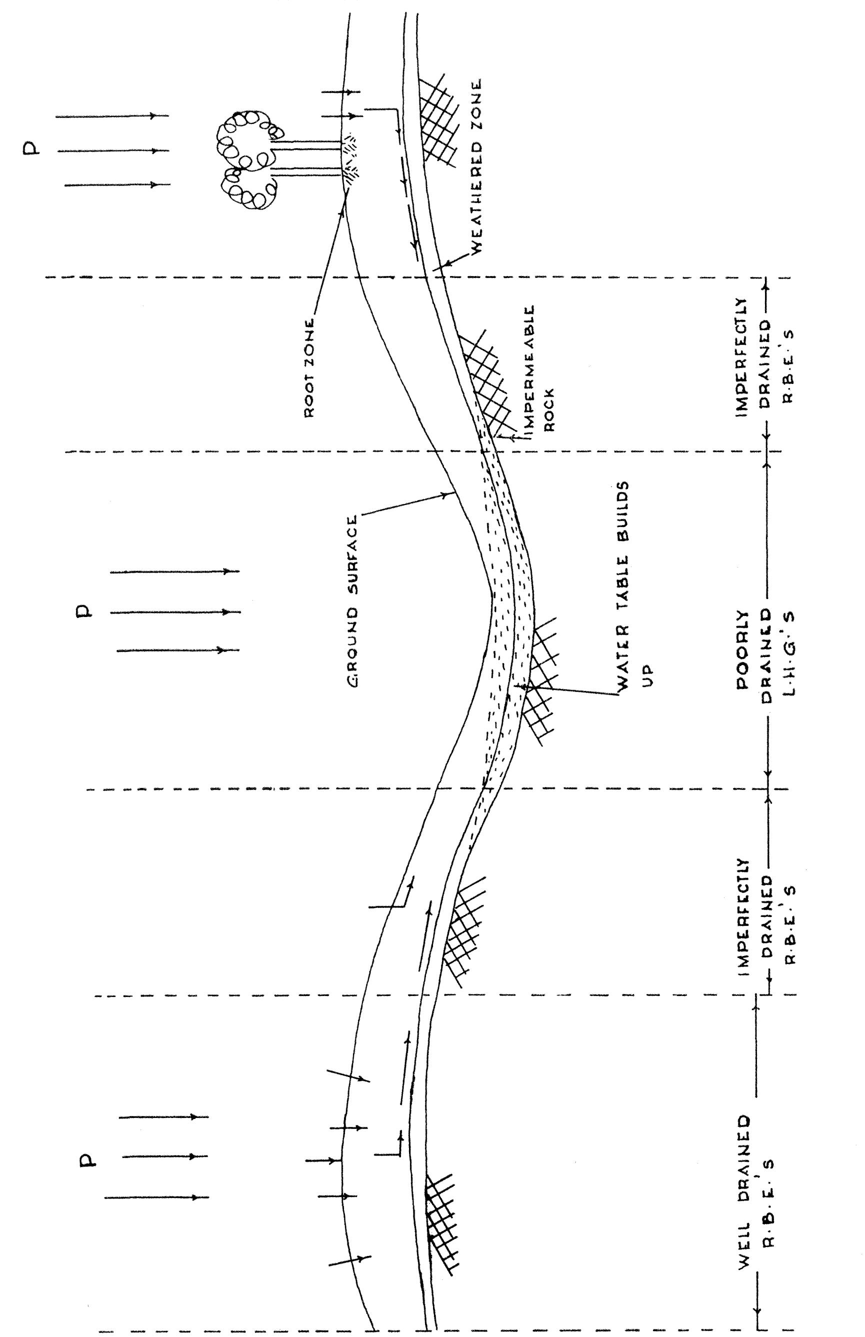
Table 2.1. Water Consumption and Drainage Flows in Study Area. Cultivation Season January to June 1974

Figures in Acre Feet ($\times 10^6$ M^3)

Month	(1) Amount Consumed in Study Area	(2) Total Drainage Measured from Study Area	(3) Percentage Drainage ie. (2)/(1)	(4) Precipitation	(5) (1)+(4)	(6) (2)/(5) %
Jan.	4,997 (6.15)	3,412 (4.19)	68.3	20 (0.02)	5,017 (6.18)	68.0
Feb.	5,640 (6.95)	3,760 (4.61)	66.7	1,090 (1.34)	6,730 (8.30)	55.9
Mar.	3,727 (4.60)	2,175 (2.68)	58.4	775 (0.95)	4,502 (5.55)	48.3
Apr.	3,234 (3.96)	1,595 (1.96)	49.3	3,037 (3.74)	6,271 (7.70)	25.4
May	3,532 (4.35)	1,172 (1.44)	33.2	520 (0.64)	4,052 (4.99)	28.9
June	3,058 (3.76)	166 (0.20)	5.4	0 (0)	3,058 (3.76)	5.4
Total	24,188 (29.6)	12,280 (15.10)	—	5,442 (6.7)	29,630 (36.3)	—
Average	4,034 (4.95)	2,046 (2.52)	50.8	907 (1.11)	4,938 (6.04)	41.4

Extent cultivated under study Area = 2,099 Acs. (840 Ha)
Total water issues from sluice = 24,188 Ac. Ft. (29.6×10^6 M^3)
∴ Duty of water = 24,188/2,099
= 11.7 Ac. Ft./Ac. (3.6×10^4 M^3/Ha)

FIG. 2.1



SECTION SHOWING TYPICAL DISTRIBUTION OF SOILS IN IRRIGABLE AREA butory and field channels, a total conveyance loss of 25% from sluice to field is a reasonable assumption. The greater portion of this loss is inevitable and must be allowed for in all future design considerations.

2.5.2 Seepage losses in paddy field

A seepage meter designed by Yamazaki was used for this purpose. The seepage figures recorded were not consistent but varied from farm to farm. This perhaps may be due to the varying soil types, the prevailing ground water table and the proximity of the plot from the nearest issue channel. In a few instances the percolation was negative, indicating seepage into the field. The maximum value recorded was 31 mm/day. These tests were carried out under wet field conditions. Much higher values were obtained by estimating the steady state infiltration by the ponding method under dry conditions.

2.6 Soil Structure and Land Use

Apart from water availability, the soil structure in the irrigable area should determine the most suitable cropping pattern for the scheme. Unfortunately this aspect was not given due regard and the project was designed for double cropping of paddy purely because of the high priority given to paddy cultivation at the time the scheme was conceived. After observing the performance of this project for the last seven years and noting the several water shortages experienced, a new cropping pattern which would not only fit in with the national programme for food production but at the same time have optimum food production with the available water resources, had to be evolved.

The irrigable area consists of gently undulating land with maximum slopes of 2–3%. There are two major soil types viz. the Reddish Brown Earths and the Low Humic Gleys. The RBE's and the LHG's occur around the crests and the valleys of the undulating terrain respectively. By the mere proximity of these two soil types the RBE's are well drained soil and are more suitable for upland crops; whereas in the case of the LHG's there is a steady build up of the water table with water application and have poor draining qualities, making them more suitable for crops like paddy. Both soil types are structureless and massive and do not form a plough pan with continuous irrigation. Therefore they are suitable for alternate cropping of paddy and upland crops with each change in cultivation season i.e. they are quite suitable for crop diversification. Fig. 2.1 gives a typical cross section of the soil in the irrigable area.

3. Computer Studies

3.1 Procedure

The object of the study is to arrive at a suitable cropping pattern and optimize the extents to be cultivated in each season so that it not only fits into the national programme of food production but also ensures maximum benefits to the colonists settled under the project.

With these objects in view all supporting data necessary was then collected, estimated, or computed. The necessary supporting data is discused below.

3.2 Rainfall Pattern

Some monthly rainfall values for a typical station in the project area is given in Table 3.1. It is seen that appreciable rainfall occurs in the months October, November, December, January and April. In the other months rainfall is either

Table 3.1. Rainfall Data for Project Area (Station:—MIHINTALE)

No. of years Analysed:—30 years.

Figures in Inches (mm.)

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Maha	Mar.	Apr.	May	Yala	June	July	Aug.
Maximum Rainfall	10.64	21.30	20.82	38.35	14.88	7.75	76.7	8.03	12.25	8.05	21.0	2.20	6.93	7.92
	(270)	(540)	(530)	(970)	(378)	(197)	(1950)	(203)	(311)	(205)	(507)	(56)	(176)	(201)
Minimum Rainfall	Nil	3.97	2.46	1.94	0.15	Nil	22.3	Nil	0.99	Nil	4.8	Nil	Nil	Nil
	(Nil)	(100)	(63)	(49)	(4)	(Nil)	(568)	(Nil)	(25)	(Nil)	(122)	(Nil)	(Nil)	(Nil)
25% Probability of	1.1	6.60	5.50	5.75	1.50	0.42	32.5	1.40	3.80	0.90	9.5	0.04	0.15	0.40
Non-exceedence	(28)	(168)	(140)	(149)	(39)	(11)	(826)	(36)	(97)	(23)	(242)	(1)	(4)	(10)
50% Probability of	2.00	9.00	8.70	6.60	4.00	1.50	38.6	2.50	7.20	2.40	13.3	0.07	0.41	1.50
Non-exceedence	(51)	(228)	(221)	(168)	(102)	(39)	(981)	(64)	(183)	(61)	(338)	(2)	(10)	(38)
75% Probability of	3.4	11.60	14.30	13.25	6.70	3.80	46.0	4.40	9.40	4.30	16.8	0.22	1.40	2.80
Non-exceedence	(86)	(294)	(363)	(337)	(171)	(97)	(1169)	(112)	(239)	(109)	(427)	(5)	(35)	(71)

negligible or zero. Hence it is during the rainy months that replenishment of the reservoir can occur and it could also be used by the farmer by timing his cultivation schedules so that the crops could benefit directly by the rainfall instead of depending on the reservoir water always. By this method the reservoir water could be used to feed the crops during lean periods.

3.3 Reservoir yield

For the study it would be necessary to have monthly yield figures for 50 years. Since actual yield figures were available only for a shorter period, a Thomas & Fiering model was adopted and monthly yield figures were generated for the required period. Any river draining a basin subject to strongly seasonal rainfall, as in this case, is likely to have an yield which fluctuates so widely that the mean monthly flow for one month cannot be regarded as equal to the mean monthly flow for another. The Thomas and Fiering model implicitly allows for this type of variation and is most suited for adoption in the studies.

3.4 Cropping Pattern and cultivation Seasons

The cropping intensity for this project has so far been less than 1. Although this has been caused by a prevailing continuous drought, the overall performance was far below designed levels.

Having studied the soil structure of the irrigable area as indicated in para 2.6 above, it is evident that the cropping pattern should include upland crops if water conservation methods are to be effective. But since the country is striving hard to achieve self sufficiency in rice, it is not possible to adopt a cropping pattern without paddy. Since paddy requires much more water for cultivation than upland crops, and since rainfall is maximum in the period October to December (Maha season) it was decided to adopt only paddy in this season. Furthermore with the intention of conserving more water a system of dry sowing is to be adopted with a short 4 month variety being sown, for the Maha. In this method a flush of 4 inches (100 mm) is released from the sluice in late September and then the fields ploughed and sown with the rains that set in October. Since this is a short term variety and rains continue in November and December, very little supplementary irrigation will be necessary. The crop could then be harvested by end of January.

In the next season (Yala) upland crops of 3 months variety could be sown. The cultivations is to commence in early March using the reserve storage in the reservoir and the rains in April. Water issues should cease by end of May and harvesting done by 15th of June. The choice of an upland crop in the Yala season will greatly benefit the water management of the scheme because, if the farmer continues to flood his field, upland crops which are sensitive to water logging would immediately perish. Therefore, the farmer will be compelled to be satisfied, with the very controlled issues that would be made to him. The rains in April are however not as intense as in the Maha and therefore cannot cause a high water table in the LHG.

It is seen that the months June, July and August are extremely dry months. Moreover the reservoir would have depleted to its minimum by the end of the Yala. Further some reserve storage would be necessary for providing any issues in late September for the next Maha season. Therefore no cultivation could be recommended in the period June, July and August.

3.5 Water Requirements of Crops

3.5.1 Efficiencies

The water requirements will depend on the efficiency with which the water is conveyed to the farm and also on the efficiency with which this water is periodically fed into the root zone of the soil to obtain optimum production. There are many efficiencies that could be adopted. But in this study, two basic efficiencies will be used.

i. *Conveyance Efficiency*

$$\text{Conveyance Efficiency} = \frac{\text{Farm Delivery}}{\text{Sluice Issue}}$$

As discussed in para 2.5.1 a conveyance efficiency of 75% was adopted in the study.

ii. *Field Efficiency*

$$\text{Field Efficiency} = \frac{\text{Consumptive Use}}{(\text{Farm Delivery} + \text{Effective Rainfall})}$$

(Effective Rainfall is that portion of actual rainfall that contributes to plant growth. This was computed using some empirical methods).

Field Efficiency cannot be a fixed quantity. It depends on so many factors. The field efficiency could improve with farmer education and with experience. It could also be improved by good extension services. From the expression it is seen that increased field efficiency would reduce farm delivery requirements, thereby conserving water and helping to achieve better management.

3.5.2 Consumptive Use of Crops

Studies have been carried out at the Agricultural Research Centre in Maha Illuppalama. These figures were adopted in the study.

3.5.3 Water Requirement of Crops

It is now necessary to estimate the water requirement of paddy for the months September to January and of upland crops for March, April and May. As explained earlier, the water requirement will also decrease with increase in field efficiency and is therefore not a fixed quantity. For the purpose of the study, the water requirements of Paddy and Upland crops have been estimated, for three different field efficiencies viz. 40%, 50%, 60%. The idea is to assess the performance of the scheme for these different efficiencies and thereby assess the benefit that would accrue by increased field efficiency. A step by step computation of the sluice water requirement of paddy and upland crops for 50% field efficiency is given together with ex-sluice water requirements for 40% and 60% field efficiency in table 3.2.

3.6 Evaporation and Seepage

From pan evaporation data available for a network of Class A Land Pan evaporation stations distributed over the entire island, the Hydrology Division of the Irrigation Department developed a series of mean monthly iso-evaporation maps. The mean monthly pan evaporation for Mahakanadarawa Project area was interpolated from these maps. Using a pan factor of 0.8, the free water surface evaporation for the reservoir was estimated. Reservoir evaporation in the dry season is considerable and has a significant effect on the availability of water for issues. Table 3.3 gives the

Table 3. 2. Mahakanadarawa Project

Water Requirements of Crops.
Maha: September to February—Entirely Paddy.
Yala: March, April, and May—Entirely Upland Crops.
Field Efficiency=(Consumptive Use)/(Farm Delivery+Effective Precipitation)
Conveyance Efficiency (Farm Delivery)/(Sluice Issue)=75%.
In September Farm Delivery=4″ irrespective of Rainfall.

		Field Efficiency=50%							40%	60%
1	2	3	4	5	6	7	8	9	9	9
Sept.	0 (0)	—	4.0 (102)	0 (0)	4.0 (102)	75	5.33 (136)	0.44 (0.136)	0.44 (0.136)	0.44 (0.136)
Oct.	3.9 (99)	50	7.8 (198)	4.7 (119)	3.1 (79)	75	4.10 (105)	0.34 (0.105)	0.56 (0.172)	0.20 (0.061)
Nov.	6.0 (152)	50	12.0 (307)	4.6 (117)	7.4 (190)	75	9.85 (253)	0.82 (0.253)	1.15 (0.351)	0.60 (0.183)
Dec.	8.2 (208)	50	16.4 (417)	4.1 (104)	12.3 (313)	75	16.4 (415)	1.37 (0.415)	1.82 (0.553)	1.07 (0.326)
Jan.	6.0 (152)	50	12.0 (307)	1.3 (33)	10.7 (274)	75	14.2 (365)	1.19 (0.365)	1.48 (0.452)	0.96 (0.293)
Feb.	0 (0)	50	0 (0)	0.7 (18)	0 (0)	75	0 (0)	0 (0)	0 (0)	0 (0)
Total Maha								4.16 (1.274)	5.45 (1.664)	3.27 (0.999)
Mar.	5.3	50	10.6 (270)	1.2 (31)	9.4 (239)	75	12.5 (318)	1.04 (0.318)	1.33 (0.402)	0.87 (0.265)
Apr.	7.0	50	14.0 (356)	3.7 (94)	11.3 (288)	75	15.1 (382)	1.26 (0.382)	1.53 (0.466)	0.89 (0.271)
May	5.3	50	10.6 (270)	0.9 (3)	9.5 (246)	75	12.6 (319)	1.05 (0.319)	1.37 (0.418)	0.90 (0.275)
Total Yala								3.35 (1.019)	4.23 (1.286)	2.66 (0.811)

KEY:
1. Month
2. Consumptive Use ins. (mm)
3. Field Efficiency %
4. Total Farm water requirements ins (mm)
5. Effective Precipitation ins (mm)
6. Farm Delivery in ins (mm)
7. Conveyance Efficiency %
8. Ex-Sluice Water Requirement in ins (mm)
9. Ex-Sluice Water Requirement in Feet (meters)

figures for pan evaporation for Mahakanadarawa project area.

By studying the performance of the reservoir in the months where there was no sluice issue or catchment yield and allowing for reservoir evaporation it was possible to develop a correlation between reservoir seepage and capacity. This data was also used in the study.

3.7 Reservoir Parameters

The following are the essential parameters:–

i. Catchment Area = 123 Sq. Mls. (318 Sq. km)

3. 3. Mean Monthly Pan Evaporation Mahakanadarawa Project

	Pan Evaporation	
	Inches	Milimeters
January	4. 75	121
February	5. 00	128
March	6. 75	172
April	5. 50	140
May	6 25	159
June	6. 75	172
July	6. 75	172
August	7. 00	178
September	7. 00	178
October	5. 75	146
November	4. 50	115
December	4. 25	108

ii. Full Supply Level = 311.0 ft. (94.87 M) above mean sea level.
iii. Full Supply Depth = 19.0 ft. (5.80 M)
iv. Maxmum Capacity = 35,500 Ac.Ft. (43.5×10^6 M^3)
v. Minimum Operating Capacity = 5000 Ac.Ft. (6.2×10^6 M^3)
vi. Capacity Depth Equation –

$$H=0.22\times C^{0.44687}-5$$

$$\left[H=0.677\times\left(\frac{C}{1234}\right)^{0.44687}-1.5244\right]$$

vii. Area — Depth Equation:–

$$H=0.17362\times A^{0.61248}-7$$

$$[H=0.0529(2.47A^{0.61248})-2.134]$$

viii. Seepage — Capacity Equation

$$Sp=1.8793\times 10^{-8}\times C^{2.599}$$

$$\left[Sp=2.319\times 10^{-5}\times\left(\frac{C}{1234}\right)^{2.599}\right]$$

Where
H=Depth of water in Reservoir above sill of sluice in feet (meters)
C=Capacity of Reservoir in Ac. Ft. (M^3)
A=Area of water Surface in Acs. (Ha)
Sp=Seepage/Month in Act. Ft. (M^3)

3.8 Computer Programme

3.8.1 A computer programme for the operation of Mahakanadarawa Reservoir was developed making use of all the data indicated in paras 3.2 to 3.7, and also adding any other constraints necessary so as to achieve a realistic simulation of the reservoir operation.

3.8.2 Cultivable Extents

Mahakanadarawa Project is a colonization scheme with about 2000 colonists under the project, and they have to be ensured at least one successful cultivation per year. This means the entire extent of 6000 Acs. must be cultivated either in the Maha or Yala. Since Maha is the wet season, the Maha Acreage was fixed at 6000 Acs. (2400 ha). The problem would then be to estimate the extent of upland crop that could be cultivated in the Yala to ensure reasonably successful cultivations during the lifetime of the project. To achieve this, a series of Yala extents were fed into the computer for a fixed Maha 6000 Acs. (2400 ha) and the reservoir operated for 50 years for each combination of Maha/Yala extents.

The following combinations of Maha/Yala extents were run on the computer for field Efficiencies of 40%, 50% and 60%.

Case	Maha		Yala	
	Acs.	Ha	Acs.	Ha
a) Field Efficiency 40%				
1	6, 000	2, 400	0	0
2	6, 000	2, 400	1, 000	400
3	6, 000	2, 400	2, 000	800
4	6, 000	2, 400	3, 000	1, 200
b) Field Efficiency 50%				
1	6, 000	2, 400	0	0
2	6, 000	2, 400	3, 000	1, 200
3	6, 000	2, 400	4, 000	1, 600
4	6, 000	2, 400	5, 000	2, 000
c) Field Efficiency 60%				
1	6, 000	2, 400	0	0
2	6, 000	2, 400	3, 000	1, 200
3	6, 000	2, 400	4, 000	1, 600
4	6, 000	2, 400	5, 000	2, 000

3.8.3 Cultivation Success

$$\text{Cultivation Success} = \frac{\text{No. of Successful Cultivations}}{\text{No. of Cultivations studied}}$$

This criterion is used to assess the degree of success of the project for each combination of Maha/Yala extents. That combination of Maha/Yala which gives a cultivation success of about 75% for each season could be accepted as the ideal extent to be recommended under the proposed diversification scheme.

3.8.4 Output of Results

The 12 combinations were fed into the programme and run on a 1901/3S ICL computer. For each combination the following output was obtained in one sheet:–

i. Reservoir Parameters
ii. Average Yield Maha, Yala and Annual
iii. Conveyance Efficiency
iv. Duties (i.e. Ex-Sluice Water Requirements of Crops) for Paddy and Subsidiary (upland) Crops.
v. Average yield month by month
vi. Average Reservoir Storage month by month
vii. Extent under Paddy for Maha

viii. Extent under Subsidiary for Yala
ix. Seasonal demand of water for crops
x. Average evaporation loss for Maha, Yala, Annual
xi. Evaporation/Yield for Maha, Yala and Annual
xii. Mean spilling for Maha, Yala and Annual
xiii. Cultivation Success for Maha and Yala.

The other output sheet contained a month by month end of month storage for the 50 years of operation. A copy of the output of items i/to xiii for one combination of Maha/Yala is given in appendix I.

A summary of the results giving extents cultivated, field efficiency and the cultivation success achieved is given in Table 3.4.

Table 3.4. Mahakanadarawa Project

Extent		Conveyance Eff. %	CULTIVATION SUCCESS %					
			Field Eff. 40%		Field Eff. 50%		Field Eff. 60%	
Maha Acs. (Ha)	Yala Acs. (Ha)		Maha	Yala	Maha	Yala	Maha	Yala
6,000 (2,400)	0 (0)	75	49	100	80	100	98	100
6,000 (2,400)	1,000 (400)	75	49	100	—		—	
6,000 (2,400)	2,000 (800)	75	47	96	—		—	
6,000 (2,400)	3,000 (1,200)	75	43	92	67	94	83	98
6,000 (2,400)	4,000 (1,600)	75	—		67	88	75	94
6,000 (2,400)	5,000 (2,000)	75	—		61	80	73	90

3.9 Recommendations

If the farmers at Mahakanadarawa could achieve a field efficiency of 50% the extents that can be recommended would be Maha 6000 Acs. (2400 ha) and Yala 4000 Acs. (1600 ha) as this gives an average cultivation success of about 76%. However the results also indicate that by crop diversification, the degree of cultivation success with upland crops in the Yala season, is quite high. The restriction of the Yala to March, April and May could also be a contributory factor to this high cultivation success. If the cultivation success for 6000 Acs. (2400 ha) Maha paddy is to improve, then the farmers must achieve at least 60% field efficiency. At this efficiency, for Maha 6000 Acs. and Yala 4000 Acs. the cultivation success would average 85%. The cultivation success achieved at Mahakanadarawa upto now for Maha and Yala paddy is about 30%.

4. Future programme of Study at Mahakanadarawa

The joint project of the Irrigation Department and TARC now in progress at Mahakanadarawa has contributed largely to ascertaining the present status of the scheme. With the enthusiasm shown so far and experience gained, the Department has established an Irrigation Research Centre at Mahakanadarawa, and intends expanding its activities to cover such works as:

i. Channel loss studies in distributory and field channels
ii. Farm losses (work has already been initiated)
iii. Determining water requirements at different stages of cultivation of paddy and upland crops
iv. Effect on Water Management on the incorporation of small reservoirs in the main channel trace
v. Crop yield per unit volume of irrigation water
vi. Control structures for better water management
vii. Channel lining for better water management
viii. Fluctuation of ground water during the seasons.

5. Conclusions

There are over 580,000 Acs. (232,000 ha) under major projects in the island, of which about 380,000 Acs. (452,000 ha) are in the low country dry zone. If the proposed programme of diversification at Mahakanadarawa could be achieved, then there is every prospect of extending this to the other projects in the area. But the degree of diversification will depend partly on the national programme for food production and largely on the circumstances prevailing in each scheme.

The cultivation successes alone are not sufficient to correctly assess the economic viability of a project. Farmer incomes should be computed based on the cultivation successes achieved. The current prices of upland crop produce like onions, chillies, and pulses in Sri Lanka are so high that any judgement on these figures too would be incorrect. But with the increased production of upland produce prices could stabilize. So that an economic analysis should be carried out for these projects using realistic prices for upland crops and rice.

Although crop diversification at the project does help to conserve water and increase food production by making it possible to cultivate a much larger extent than at present, yet the other factors that should go side by side with good water management should not be overlooked. The timing of the seasons must be strictly adhered to. Farmer education and extension services should be ensured. Necessary agricultural inputs should be made available at the correct time. Adequate draught power must be provided at each scheme. The infra structure should therefore be suitably strengthened to make this and other projects a success.

6. Acknowledgements

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Appendix 1.

CASE 3. MAHAKANADARAWA RESERVOIR OPERATION STUDIES

FULL SUPPLY LEVEL	=311.0 M.S.L.
FULL SUPPLY DEPTH	=19.0 FT.
MAXIMUM CAPACITY	=35,593 AC. FT.
MINIMUM CAPACITY (5FT ABOVE SLUICE SILL)	=5,018 AC. FT.
AV. INFLOW MAHA	=43,893 AC. FT.
AV. INFLOW YALA	=18,846 AC. FT.
AV. INFLOW ANNUAL	=62,739 AC. FT.
CONVEYANCE EFFICIENCY	=75 PERCENT.

NOTE: CONVEYANCE EFFICIENCY=(FARM DELIVERY)/(SLUICE RELEASE)
FIELD EFFICIENCY=(CONSUMPTIVE USE)/(FARM DELIVERY +EFF. PRECIP.)=50 PER CENT
MAHA CROP=PADDY (KAKULAN) ONLY COMMENCING SEPTEMBER AND YALA CROP =SUBSIDIARY 3 MONTH VARIETY COMMENCING MARCH.

DUTY	SES.	OCT.	NOV.	DBC.	JAN.	FEB.	MAHA TOTAL	MAR.	APR.	MAY	JUNE	JUL.	AUG.	YALA	TOTAL
PADDY SUB	0.44	0.34	0.82	1.37	1.19	0.00	4.17	1.04	1.26	1.05	0.00	0.00	0.00	3.36	AC. FT/AC.
MEAN INFLOW	922.	3344.	4465.	18309.	9542.	7935.		4438.	5561.	3529.	2230.	1998.	1271.		AC. FT.
MEAN RES. STOR.	9644.	10042.	9483.	18948.	19096.	22069.		18169.	15742.	13131.	13294.	13191.	12484.		AC. FT.

	MAHA	YALA	ANNUAL
PADDY ACS.	6000.		
SUBS. ACS.		4000.	
TOTAL ACS.	6000.	4000.	
TOTAL DEMAND AC. FT.	25048.	13429.	
EVAP. LOSS AC. FT.	3643.	4909.	8552.
EVAP./INFLOW	0.083	0.260	0.136
DEMAND/EVAP.	6.876	2.736	4.499
ESTIMATED FARM WASTAGE AC. FT.	3757.	2014.	5772.
SPILL AC. FT.	387.	0.	387.
CULT. SUC. P. C.	67.35	87.76	

Appendix 2.
Explanatory Notes

Subsidiary Food Croops:—Onions, Chillies, Dahl etc. which are upland Crops.

Maha:—Cultivation Season during the North-East Monsoon. For the purpose of the study it extends from late September to February.

Yala:—Cultivation Season during the South-West Monsoon. For the purpose of the study it is March, April and May only.

Study Area:—Only a part of the entire irrigable area under the project was earmarked for the special study. The total study area was 2377 Acs. (950 Ha) of which only 2099 Acs. (840 Ha) was cultivated during the season January to July 1974.

Thomas-Fiering Model:—This model makes use of the statistical properties of the available observed data to generate more data.

Duty of Water:—Ex-Sluice water requirement per unit area of Crop ie. Ac Ft./Ac. or M^3/Ha.

Question and Answer

N. Yamada, Japan: It seems to me that from the viewpoint of saving water as much as possible it would be desirable to grow rice varieties with short growth duration. I understand that in your country you have already well improved high-yielding varieties of three, or three-and-half month duration. Could I have a reason why not adopting these short growth duration varieties instead of growing 4 month varieties?

Answer: As this study was directed towards assessing the maximum irrigation potential of the project, a 4-month variety was recommended in keeping with the rainfall patern in the scheme area. It therefore includes all varieties of paddy that mature within a period less than four months.

T. Kimura, Japan: 1) Concerning channel loss (page 3.2, 5.1). Is 25% of the total water losses from the sluice to the field including the inevitable wasted water losses which management by the farmer or not? If yes, it seems this figure rather optimistic side, don't you? 2) Concerning Table 3.1. Please explain the figures for the "MAHA" and "YALA" in the table more clearly.

Answer: 1) This does not include the wastage (inevitable) by the farmer within his field. This 25% includes only the conveyance loss done main channel and subsidiary channels, until the water reaches the farm entrance. 2) In the explanatory notes in Appendix 2, "Maha" and "Yala" seasons as applicable to this study have been defined. It deviates slightly from the conventional 6-month periods used in other contexts. The figures in table 3.1 are correct. e.g. The maximum rainfall in each month is the maximum observed in that month for a long period of record. The maximum rainfall in the entire "Maha" is the maximum recorded in each "Maha" season from an entire period of record. Therefore the maximum value for the "Maha" need not be a total of the maximum recorded in each month of the Maha season.

S. Okabe, Japan: From the point of view on reservoir water use, you have suggested that no cultivation could be recommended in the period of June–August. Do you think that the cropping pattern suggested by this study should be economically viable even though no crops are grown in that period?

Answer: Yes. The economic analysis is nécessary to establish the economic viability of the project. But in my opinion, if a 3rd crop is introduced in the very dry months June, July and August, the reserve storage in the reservoir would be significantly reduced, and this could have a very detrimental effect on the following "Maha" season where the entire extent of 6000 Acs. is to be cultivated.