3.6.4 Deterioration of Facilities

(1) General

The Nagadeepa Maha Wewa Scheme consists of the Nagadeepa reservoir and its canal network. These irrigation facilities were constructed in 1970. Thereafter the capacity of the reservoir was increased in 1972 by raising the height of the dam by 10 feet.

The existing irrigation facilities in the Nagadeepa Scheme can be classified by the present level of deterioration on the following footing:

A : sound or almost good
(no need for, or only needs minor, rehabilitation)

B : Deteriorated
(needs partial rehabilitation)

C : deteriorated seriously
(need rehabilitation of more than 50% of structures or complete reconstruction)

Table 3.6.8 shows that result.

(2) Nagadeepa Reservoir

a) Dam Embankment

There is no serious deterioration in the dam embankment at present. But the riprap protection on the upstream slope of the embankment is defective in many places; the riprap does not reach the high flood level (H.F.L) in many places and its thickness is not enough in entire reach.

Riprap of sufficient thickness should be extended up to the required elevation.

Table 3.6.8 DETERIORATION CONDITION OF IRRIGATION FACILITIES

Item	Condition			Remarks
	A	B	C	
Nagadeepa Reservoir				
- Dam embankment	**	**	-	riprap and road pavement
- Spillway	***	*	-	gate seals
- Sluice	****		-	gate seals
Main Canal	-	**	**	
Branch Canal	-	**	**	
O/M Road	-	**	**	
Distrributary Canals	-	**	**	with Structures
Field Canals	-	**	**	with Structures
Turnout				
- Structures	-	*	***	
- Gates	**	-	**	
Regulator	***	-	*	need additional regulators
Canal Spill	-		**	
Road Bridge	***	*	-	
Foot Bridge	-	-	****	

Notes * 0 - 25%
** 25 - 50%
*** 50 - 75%
**** 75 - 100%

The side slope of the approach to the bund along the main canal is partially eroded and needs some repairs.

The bund is being utilized as a major road in this area. The bund top surface, however, is in a sloughy condition in the rainy season. The road surface on the crest of the bund should be paved to prevent crown erosion and to maintain its condition as a major road in the area.

(b) Spillway

The gated spillway has four radial gates. The seals of the gates have deteriorated and need replacement. All the wires for lifting the gates also need to be replaced. The metal parts of the gates should be repainted to prevent corrosion. The concrete structure is in a sound condition.

(c) Sluice

The concrete structure has no problems but the gate needs replacement of seals and repainting. A flow measuring device such as a parshall flume is required below the outlet of the sluice to facilitate good tank operation.

(3) Main Canal and Branch Canal

Both the main canal and branch canal have deteriorated badly in sections, (more than 80% of the whole length). The present condition of the canals is shown in Table 3.6.9.

Details of the deterioration and/or defects in the canals are as follows:

a) Inside slopes of the canals have been eroded and the canal beds have widened especially in the first 4 km of the main canal. In consequence the maintenance of F.S.D. involves over-issue of water.

Table 3.6.9 CONDITION OF THE CANALS

Condition	Main Canal			Branch Canal	Total	Remarks
	KM00-4.17	4.17-11.63	0 - 11.63	0 - 7.58		
	Km	Km	Km	Km	Km	
A	-	-	-	1.3	1.3	7%
B	1.70	2.50	4.20	1.27	5.47	31%
C	1.50	2.91	4.41	2.40	6.81	39%
D	0.97	1.50	2.47	1.65	4.12	23%
Total	4.17	/1 6.91	/1 11.08	/2 6.62	17.70	100%

/1 excluding Tank portion of 0.55 Km

/2 excluding Tank portion of 0.96 Km

Conditions:

A : Good

B : Some parts are bad

C : Bad throughout

D : Very Bad

b) There is sedimentation at several points in the main canal due to the sediment inflow from the right bank on which there is no canal bund.

c) The canal beds of the main and branch canals are irregular. Some high level portions in the canals make the flow capacity less.

d) The canal bunds lack height/freeboad at several points in the main and Branch canals. The canal flow sometimes overtop the bund.

e) The canal forms into ponds at several points in the main canal and in the upstream portion of the branch canal due to the fact that there is no bund on the right bank of the main canal/ Branch Canal.

f) There is leakage at points at which there are drainage under-crossings.

g) The canals have heavy seepage due to the pervious soil material.

Therefore both the main canal and the ranch anal are in need of rehabilitation. In particular, lining is needed in the middle section of the main canal and larger portion of the branch canal to eliminate seepage losses.

(4) Small Reservoirs

Two small reservoirs, Rotagolla Wewa and Aawatta Wewa, are linked with the main canal and the branch canal respectively. Both embankments need riprap protection on their upstream faces. The embankment of Rotagolla Wewa does not have sufficient freeboard and needs raising.

(5) O/M Roads of the Canals

The canal bund roads are not only required for operation and maintenance of the canal but also function as important service roads in the area,
Sometimes in Maha season, however, these roads become impassable because of the unpaved surfaces of the roads.

(6) Canal Related Structures

All the structures related to the main canal and the branch canal are listed in Table 3.6.2.

a) The 54 turnouts provided in the canals are in a very poor condition; for instance, the structures are damaged; there are no gates in some turnouts; some of the turnouts are leaking badly and/or cannot be controlled; the turnouts do not have any flow measurement devices etc.

All the turnouts need reconstruction with provision of screw-operated castiron gates and flow measuring devices for better water management.

The Irrigation Department will install new screw-operated gates to 29 turnouts this season (Yala 1985) under the Water Management Experimental Project.

b) Three gated regulators are in need of minor rehabilitation. The other two regulators which are stoplog type have deteriorated badly.

c) Bridge-cum-culvert located at the beginning of the branch canal is in good condition.

d) Spillways in the canals have deteriorated and are in need of overall rehabilitation.

e) The 5 drop structures in the branch canals have deteriorated badly and the other two are in need of rehabilitation.

f) One of drainage under-crossings located in the main canal has been damaged seriously and needs reconstruction. The other ten have deteriorated slightly and need partial repair. There is

leakage from the main canal to these under-crossings. Therefore, these portions should be provided with a concrete lining to prevent such leakage.

g) Road bridges across the main and branch canals are virtually in good condition except for a wooden bridge which is in need of reconstruction. Although all the foot bridges excluding a manufactured wooden bridge are log bridges, 14 bridges in the main canal are very important for villagers. 15 bridges including the wooden bridge, therefore, should be replaced with concrete bridges.

(7) Distributary and Field Canals

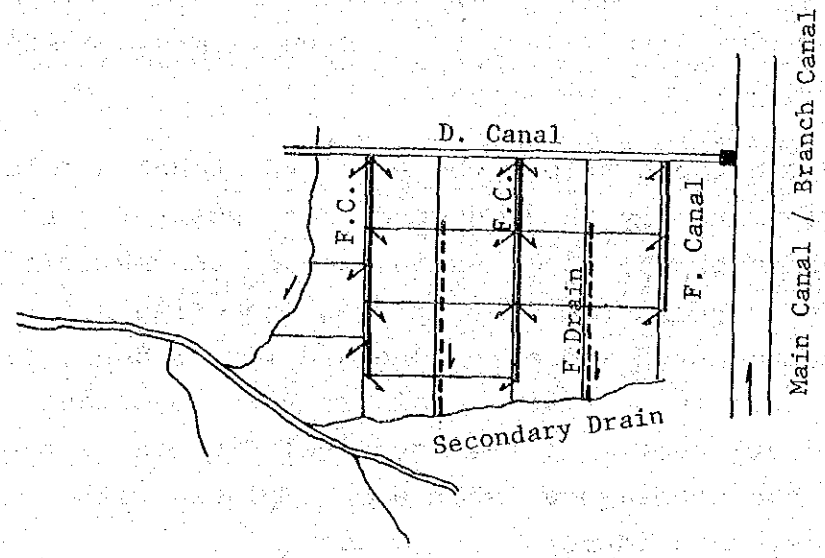
There are 21 distributary canals and 275 field canals in the canal system. These canals have deteriorated badly in 50% of the total length. Their related structures and bund roads are also in a bad condition.

The canals are subject to heavy seepage losses due to the soils being well drained and due to the fact that the canals run along the ridges of hills. 20% of the total length in the distributary canals and field canals need rehabilitation to eliminate seepage losses.

3.6.5 Drainage System

The Nagadeepa area is a hilly locality across which many small steams run in every direction, so that drainage within the area, except in a part the farthest downstream, is discharged freely through these natural streams.

As illustrated next, field drains are so located between field canals on the paddy field in the area as to directly receive drainage water from each lot and drain to the natural streams.



Major drainage rivers comprise three systems as shown in Fig. 3.6.5. Water drained from Tract 1, 2 and 3 flows into the Hepola Oya. Water drained from areas of Tract 4 and 5 is gathered into small streams, which pass under the Trans-basin Canal and flow into the Dambarawa Reservoir. Drainage water in Tract 7 also flows into the same reservoir. Water drained from Tract 6, 10, 11 and 12 flows into the Diyabana Oya Reservoir which was created by the level crossing of the Trans-basin Canal and the Diyabana Oya. The Diyabana Oya receives water discharged through the spillway of this reservoir, and after collecting water drained from Tract 8 and 9 on its way, flows into Sorabora Reservoir.

The catchment area on the right bank of the main canal is relatively small at 7.2 sq.km, of which run off from 2.4 sq.km passes under the main canal through under-crossings provided at altogether nine locations and flows into the drainage rivers earlier referred. The run-off from the remaining 4.8 sq.km of the catchment area flows into the main canal and is discharged through spillways at altogether six locations.

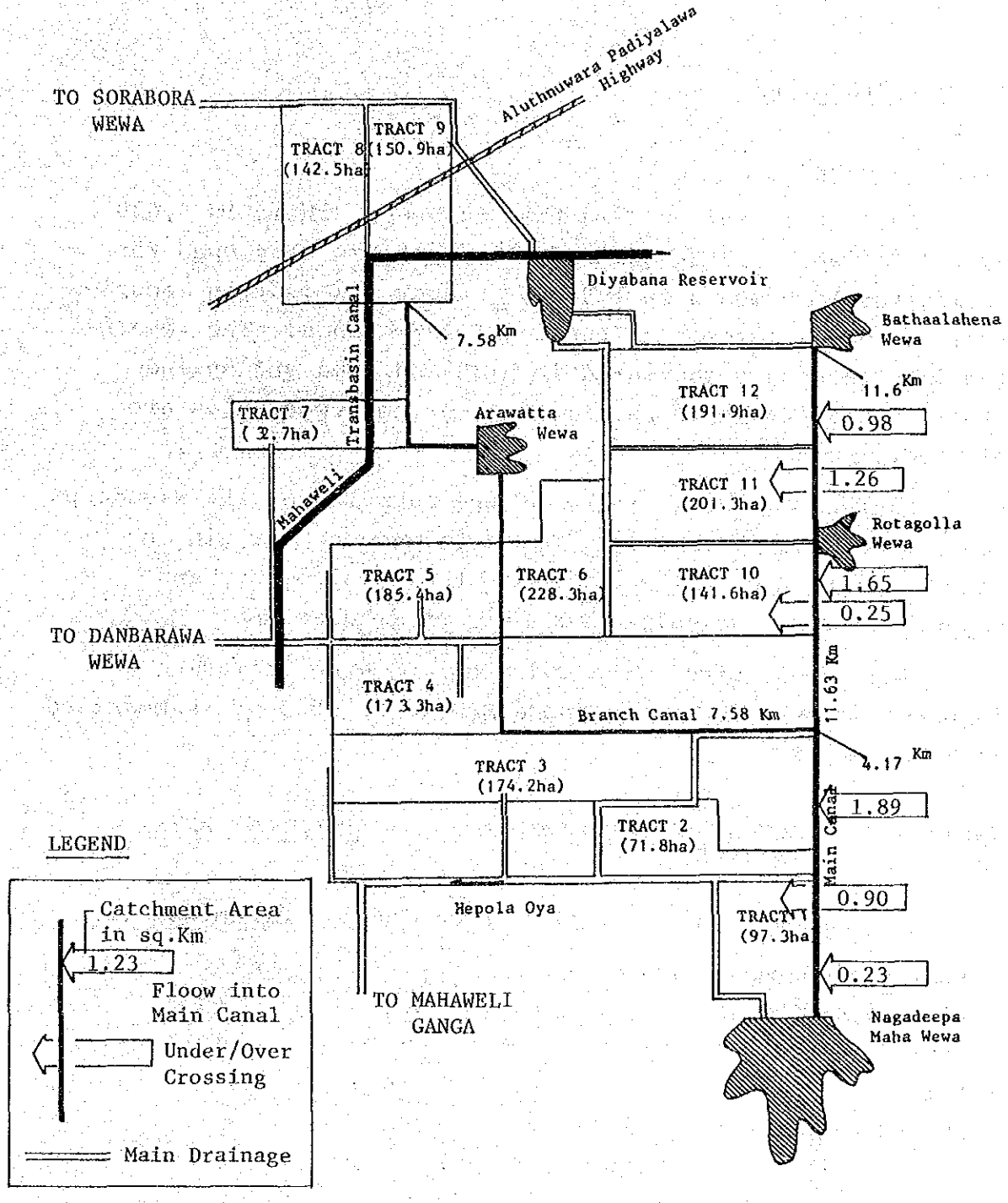


Fig. 3.6.5 OUTLINE OF NAGADEEPA DRAINAGE SYSTEM

There is an area in Tract 8 and 9 along the Diyabana Oya where the drainage is poor. This area is sometimes inundated during the rainy season and damage is caused to the paddy cultivated thereon.

3.7 AGRICULTURE

3.7.1 Land Use

The total land area in the Nagadeepa Scheme is 4,630 ha, out of which, 2,360 ha or 51 percent has been used for agricultural purposes in 1984/85. Paddy cultivation occupies 1,820 ha or 77 percent of the total farm lands. The remaining farm lands are scattered in highland area and upland crops such as field crops, fruit trees and vegetables are planted.

Because of the shortage of the capacity of the Nagadeepa Tank, paddy cultivation is limited to once a year, in the Maha season. Except fruit trees, other field crops and vegetables are also cultivated only in Maha season.

The asweddumized area and highland area including farmers' homesteads in Nagadeepa Scheme in 1985 are summarized in Table 3.7.1

Table 3.7.1 ACTUAL ASWEDDUMIZED AREA AND HIGHLAND AREA IN 1985

Item	Area (ha)	Percentage (%)
Actual Assweddumized Area	-	-
Irrigated	1,513	83
Rainfed	303	17
Total	1,816	100
Highland Area	966	-

It may be noted that ratio of the total asweddumized area to and highland area is 2 : 1. This ratio is the same as the ratio at the time of alienation to the settlers. The location and acreage of uncultivated area is shown in Fig. 3.7.1. The total acreage is 710 ha. The possibility of these lands being used for agricultural purposes should be examined.

3.7.2 Cropping Pattern of Main Crops

The present cropping patterns of the main crops in the Nagadeepa Scheme are given below.

Table 3.7.2 MAIN CROPPING PATTERN IN NAGADEEPA SCHEME

Item	Maha	Yala	Extent Estimated
A. Asweddumized Field			
Irrigated	Paddy	Paddy	0%
	Paddy	Subsidiary Food Crops	0%
	Paddy	Fallow	100%
Rainfed	Paddy	Fallow	100%
B. Highland			
Subsidiary Food Crops	Subsidiary Food Crops	Fallow	100%
Fruit Tree	Fruit	Fruit	100%
Vegetable & Other Crops	Vegetable & Other Crops	Fallow	100%

In the Nagadeepa Scheme, most of agricultural lands remain fallow in Yala season because of the shortage in the storage capacity of the Nagadeepa Tank. Farmers strongly desire an increase in the storage capacity and look forward to receiving a stable irrigation water supply during the Yala season. Important practical countermeasures to be taken to increase the water available for the Yala season, are the strengthening of the functioning of repairing and maintaining the irrigation facilities and the adoption of such cultivation practices in Maha season as would result in the conservation of water.

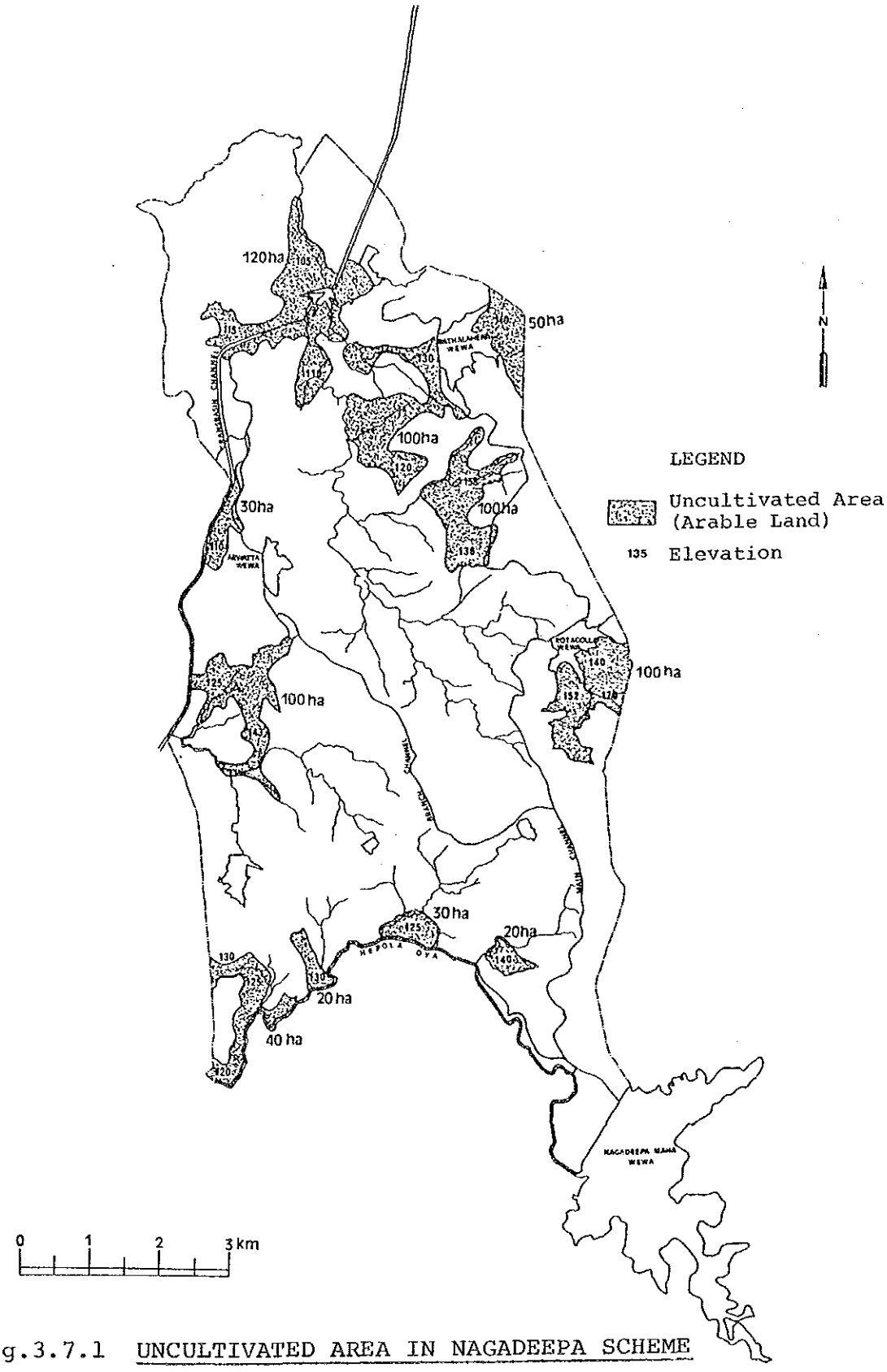
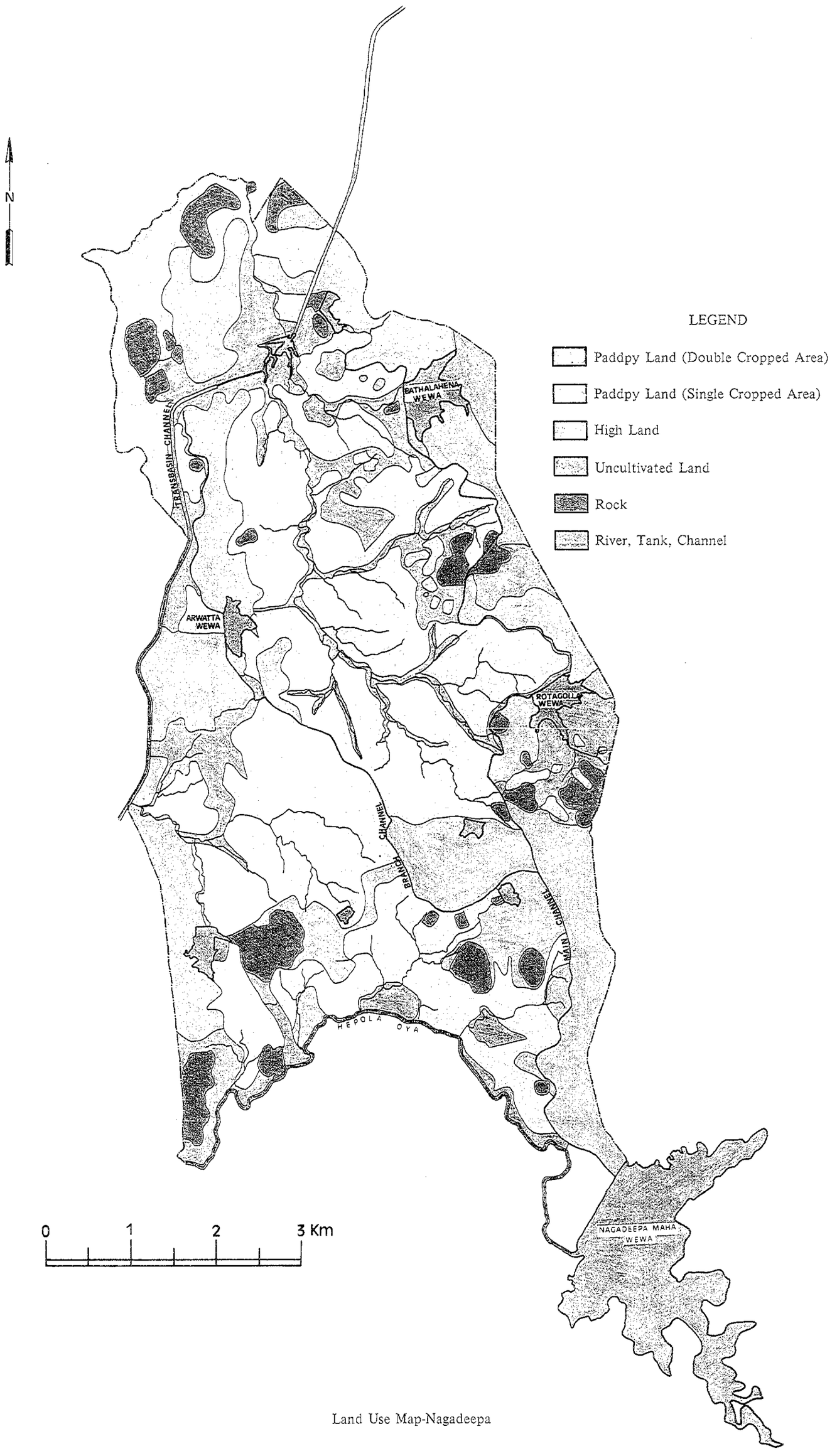


Fig.3.7.1 UNCULTIVATED AREA IN NAGADEEPA SCHEME



Land Use Map-Nagadeepa

3.7.3 Production of Main Crops

The average yields of paddy production in the Nagadeepa Scheme after 1981 are shown in the following table together with the harvested area and the total production.

Table 3.7.3 HARVESTED AREA, PRODUCTION AND AVERAGE YIELD OF PADDY

Harvested Year	Maha			Yala		
	Area (h)	Production (t)	Average Yield (t/ha)	Area (ha)	Production (t)	Average Yield (t/ha)
1981	1,659	5,807	3.5	-	-	-
1982	1,920	3,456	1.8	-	-	-
1983	1,678	5,034	3.0	-	-	-
1984	1,906	5,701	2.9	771	2,003	2.6
1985	1,588	4,839	3.0	-	-	-

As seen in the above table, it is significant that no crops have been cultivated in Yala except during 1984 which was an exceptional year. In the Agricultural Implementation Programme of 1984/85, the target of average yield of paddy production has been fixed at 3.7 t/ha in the Maha season and 3.6 t/ha in the Yala season for the whole country and 3.6 t/ha and 3.1 t/ha for Badulla District. Comparing the figures in the above table with the target yields, it has to be recognized that the average yields in Nagadeepa Scheme are considerably lower both in Maha and Yala and also fluctuate yearly.

The production figures for subsidiary crops are given in Annex 6. The production of these crops is unstable except under irrigated conditions, and its contribution to farmers' income is negligible.

3.7.4 Existing Farming Practice

(1) Use of Improved Varieties

Throughout the Nagadeepa area, new improved varieties of paddy are cultivated and neither old improved

varieties nor local varieties are used at all. In the Maha season, the proportion of cultivations of long-term and short-term varieties is almost same. In case a stable supply of irrigation water is assured under the Project, the cultivation of long-term varieties of more than four months will progressively increase because of their higher yields being higher than those of the short varieties.

As regards the other crops, improved varieties are used for the cultivation of chillies, cowpea, green gram and soya beans. Local varieties are still used for the cultivation of maize, kurakkan and manioc.

(2) Transplanting

In Maha season in 1984/85, about 70% of paddy were transplanted and direct sowing was adopted on the remaining fields. It is generally known that the transplanting brings a higher yield than direct sowing. With a stable supply of irrigation water and procurement of enough labour, the rate of transplanting will increase. The change of planting method will be effective in increasing paddy production. Chillies are also transplanted but other crops are all grown with direct sowing.

(3) Use of Fertilizer

In the Nagadeepa Scheme, the proportion of farmers who are using fertilizer is less than 50%. The average amount of fertilizer per ha is also low. It is about one third of the amount recommended by the Government. The main reason for reduced fertilizer use is assumed to be the unstable supply of irrigation water. The details of fertilizer application in Nagadeepa Scheme are given in Annex 6.

(4) Diseases and Pests

It is estimated that pests cause more damages to the paddy crop than diseases. In recent years, the damage by rice leafroller (Cnaphalocrocis medinalis Guenee) has been significant and its urgent control is required. For the cultivation of upland crops, no controls are exercised at present. In the future, intensive control of pests and diseases will be necessary. The main diseases and pests affecting paddy are summarized in Annex 6.

(5) Farm Power

In the Nagadeepa Scheme, animal power is widely used for ploughing and threshing of paddy. Man power is also used in some farm operations. The number of farm machinery held in the Nagadeepa Scheme is a little bit less than the number in the Minipe Scheme. The methods of ploughing and threshing of paddy are shown in Annex 6 together with the number of agricultural machinery owned by farmers in the Nagadeepa Scheme.

(6) Farm Size

As the result of the sample survey, it was found that the average land area cultivated by a farm family in the Nagadeepa Scheme is the same as the area allocated at the time of settlement. The average farm size held by a farm family is estimated to be 0.8 ha (2 Acs) of paddy field and 0.4 (1 Ac) of highland.

(7) Input Supply

The agricultural inputs in Nagadeepa Scheme are supplied mainly by the multi-purpose co-operative society located at Mahiyangana and the Agrarian Service Centre within the Scheme.

(8) Farm Budget

The average farm budget per ha (1981-85) from paddy cultivation in the Nagadeepa Scheme is shown below.

Farm Income	Maha	Rs.2,696
Farm Profit	Maha	Rs.1,040

3.7.5 Agricultural Supporting Services

(1) Credit

Within the Nagadeepa Scheme, there is only one bank providing agricultural credit. Farmers utilize the credit supplying services either at the Rural Bank within the Scheme or at the Bank of Ceylon Branch located in Mahiyangana. Annex Table 6.1.15 indicates the breakdown of items of the credit supplying services in the Nagadeepa Scheme. As there is very little agricultural activity in the Yala season, farmers' requests for agricultural credit during that season are not entertained. In Maha season of 1984/85 the Bank of Ceylon provided agricultural loans amounting to Rs.308,438 to 131 farmers, with interest of 9% per annum.

(2) Marketing and Processing

As has been seen there is virtually no agricultural activity in Yala due to the lack of irrigation water. In Maha, paddy, the main product in the Scheme is sold by farmers generally to the five co-operative branches and, rarely direct to the two Paddy Marketing Board Branches in the Area. The normal route for paddy is

(1) Farmer ⟶ (2) Co-operative ⟶ (3) P.M.B. ⟶ (4) Milling and thereafter for rice ⟶ (5) Food Department Stores ⟶ (6) Co-operative.

The price of paddy is Rs.2.99/kg in case farmers sell to the Co-operatives and Rs.3.09kg when they bring paddy direct to PMB. There is no PMB store in the Nagadeepa Scheme. The Co-operatives take place the role of PMB. The paddy collected by the Co-operatives is sent to the PMB stores at Mapakada and Mahiyangana. As these stores are not equipped with milling facility, the paddy is transported to the mills in Hasalaka and Badulla or to private small scaled mills.

The paddy purchased by PMB has increased from 92 tons in 1982 to 1,039 tons in 1983. The details are shown in Annex 6. In recent years there have been no purchases in Yala season except in the year 1984. The prices of paddy/rice at certain stages of the route are shown below.

Farmers	PMB Stores	Food Dept.	Co-operatives
	2.99 Rs/kg (Paddy)	6.37 Rs/kg (Rice)	6.50 Rs/kg (Rice)

(3) Prices of Agricultural Products

In the Nagadeepa Scheme, all the main agricultural products are purchased by the Co-operatives. The purchasing prices of Co-operatives are the same as those of Co-operatives in the Minipe Scheme. There are also a few private traders in the Scheme. But their trading activities are restricted in Maha season only.

(4) Agricultural Extension and Training of Farmers

In the Nagadeepa Scheme, the services of agricultural extension and the training of farmers are undertaken by one Agricultural Instructor and five Agricultural Extension Workers (K.V.Ss). These officers are under the administrative control of the Agricultural Officer (A.O.) stationed at Mahiyangan who has the assistance

of two Subject Matter Officers (SMO). The SMO gives specialist advice to the Agricultural Officer on specific subjects as paddy cultivation and plant protection. The organisation and activities of agricultural extention workers are the same as in the Minipe Scheme.

3.8 WATER MANAGEMENT

3.8.1 Nagadeepa Development Society

In 1979, the Assitant Government Agent (AGA), Ridimaliyadda of the Badulla Kachcheri set up the Nagadeepa Development Society as follows:

AGA	Chairman, Badulla Kachcheri (BK)
Deputy Director Development	Agriculture Department (AD)
Assitant Director (Badulla)	Agriculture Department (AD)
Assistant Secretary	Ministry of L & LD (ML & LD)
Irrigation Engineer	Irrigation Department (ID)
03 Technical Assistants	Irrigation Department (ID)
03 Cultivation officers	Agrarian Services Dept. (ASD)
03 Colonisation Officers	Land Commissioner's Dept. (LC)

13 Farmer Representatives at one for each Tract

This Society was active from 1979 to July 1982. The Farmer Representatives were selected mostly on account of their popularity. An Organisation at Field Level was not there to implement the decisions of the Nagadeepa Development Society.

The Society met once a month to discuss problems, all of which were not necessarily solved by the Society. In the matter of water distribution, ad-hoc solutions were sought on an individual basis in the absence of a rotational scheme at that time. A study was made at these meetings of water issues in the past month and adjustments were made as far as possible for the following month to ensure water to those who did not receive it in the previous month.

3.8.2 Special Project Committee

From the experience gained in operating the Nagadeepa Development Society, the Nagadeepa Special Project Committee was formed in July 1982 with membership as follows:

01	Project Manager (Irrigation Engineer)	Chairman (ID)
01	Divisional Officer	(ASD)
03	Cultivation Officer	(ASD)
03	Colonisation Officer	(LC)
03	Technical Assistants	(ID)
01	Agricultural Instructor	(AD)
22	Farmer Representatives (method of selection follows)	
01	Assistant Government Agent (BK)	Ex-officio
01	Range Agricultural Instructor (AD)	Ex-officio

The Special Project Committee had Farmer Representatives at the field level as in Table 3.8.1 while farmer representatives were also selected to function in an advisory capacity for a group of Tracts as in Table 3.8.2.

Thus the total number of Farmer Representatives in the Special Project Committee were 17 + 05 = 22.

Table 3.8.1 FARMER REPRESENTATIVES IN NAGADEEPA AT THE FIELD LEVEL

Tract No.	Extent in acs. Before Mahaweli	No. of Farmer Representatives
1	196	1
2	154	1
3	372	3
4	372	1
5	384	1
6	490	2
7	144	1
8	314	1
9	426	2
10	240	1
11	432	1
12	412	1
13	96	1
Total	4,032 (Specification)	17

Table 3.8.2 ADVISORY FARMER REPRESENTATIVES IN NAGADEEPA

Tract Nos. in Groups	Extent in acs.	No.of Farmer Representatives
1, 2 & 10	590	1
3 & 4	744	1
5 & 6	874	1
7, 8 & 9	884	1
11, 12 & 13	940	1
Total	4,032	05

The Special Project Committee met once a month at least and even more often as required. With a low reservoir during a cultivation season, the Committee met even twice a month to review, discuss and solve the problems within the available resources. When the solution involved adjustment of water issues in the whole scheme, though the shortage was experienced in only a sub-project area, the solution had to be provided by the Special Project Committee.

The Special Project Committee functioned till March 1985 when it was replaced by the INMAS Programme.

3.8.3 Sub-Project Committee

Sub-Project Committee were also established at Nagadeepa with similar functions as the Sub-Project Committees of Minipe. There were two Sub-Project Committee at Nagadeepa as follows:

(1) Main Canal Sub-Project Committee

The Main Canal Sub-Project Committee for 619 ha (1,530 Acs) comprised of Tracts 1, 2, 10 through 12 and the membership consisted of:

01 Farmer Leader	Chairman
01 Technical Assistant	(ID)
01 Cultivation Officer	(ASD)
01 Colonisation Officer	(LC)
01 Works Supervisor	(ID)
06 Farmer Representatives for 619 ha (1,530 Acs)	

(2) Branch Canal Sub-Project Committee

The Branch Canal Sub-Project Committee for 1,013 ha (2,502 Acs) comprises Tracts 3 through 9 and the membership consisted of:

01	Farmer Leader	Chairman
01	Technical Assistant	(ID)
02	Colonisation Officers	(LC)
02	Cultivation Officers	(ASD)
02	Works Supervisors	(ID)
14	Farmer Representatives for 1,013 ha (2,052 Acs)	

(3) Cost for Implementation

The Nagadeepa Development Society (NDS) was not allocated additional/separate funds by any of the Administrative Agencies towards Cost of Implementation of the society's work. To meet costs of Operation and Maintenance (Currently called Water Management) funds were voted to the Irrigation Department on an annual basis as in Table 3.8.1. Almost the entire operation and maintenance cost in a Scheme is a charge to the Irrigation Department. Hence the cost of implementation of NDS was met on a pro-rated acreage basis from the voted funds given in Table 3.8.1.

(4) Water Distribution

The Irrigation Department's Regulatory Rules are applicable to Nagadeepa also. But these are not being strictly adhered to mainly due to general water shortage in the Scheme.

The water issues have taken place as follows:

Cultivation - staggered
Duration of Issue for Land Preparation - One Month
'Interrupted Issue' pattern after one month

Sub Project	Open 1 to 3 days Close 4-6 days	Open 4 to 6 days Close 1-3 days
Along Main Canal	Tracts 1, 2 & 10	Tracts 11 & 12
Along Branch Canal	Tracts 3, 4, 5 & 6 (Part)	Tracts part 6, 7, 8 & 9

Some farmers told the Study Team members that there had always been a shortage of water for cultivation and that it might perhaps be due to the diversion of Hepola Oya upstream of Nagadeepa reservoir for other cultivations.

(5) Discharge Check of Distribution

Measuring devices are not available in the Scheme along the main branch and distributary canals. Hence there are no discharge checks of the distribution.

(6) Water Charges

The same water charges as in Minipe are being levied in Nagadeepa commencing with Rs.100/- per annum in 1984 and increasing in slabs up to Rs.200/- in 1988. However, due to the poor performance of the scheme so far, farmers have not responded to the recovery of water charges in 1984.

3.9 LIVESTOCK

3.9.1 Livestock Population

As already stated in the Section on Minipe, cattle and buffalo keeping by farmers in the study area is extremely popular mainly because of their use for cultivation purposes and the opportunity it provides for using the existing land resources for an alternate farming activity and thereby

ensuring farm incomes. The vast resources of livestock members available within the study area and the farmers' acceptance of the keeping of livestock, especially cattle and buffaloes, as a farming activity offers great potential for the enhancement of the economic conditions of the settler farmers in the area.

The trends in the variation in numbers of all livestock species in Nagadeepa is given in Table 3.9.1.

TABLE 3.9.1 SPECIES OF LIVESTOCK BY TYPES

NEAT CATTLE

	Milk Cows	Other Cows	Bulls	Calves
1982	690	1,997	988	938
1983	725	1,827	971	960
1984	721	1,645	988	985

BUFFALOES

	Milk Cows	Other Cows	Bulls	Calves
1982	-	920	651	398
1983	35	991	670	375
1984	35	948	671	354

GOATS, SHEEP, PIGS

	Goats			
	He	She	Sheep	Pigs
1982	498	820	-	-
1983	555	903	-	02
1984	917	1,137	-	04

	POULTRY					PRODUCTION
	Pig	Cock-Birds	Laying Hens	Other Hens	Chickens	Cow Milk (bottle)
1982	-	1,766	244	2,345	2,621	20,700
1983	02	1,638	2,170	2,091	2,492	38,010
1984	04	1,492	2,012	1,713	2,135	40,130

The trend for cattle and buffaloes and comparison of 1982 Census and estimate is given in Table 3.9.2.

TABLE 3.9.2 THE TOTAL NUMBER OF CATTLE AND BUFFALOES

	Cattle	Buffaloes
1982 Census data	10,479	3,518
1982 Estimates	4,613	4,969
1983 Estimates	4,483	2,071
1984 Estimates	4,439	2,008

The above data show marked variation between the census data and those of estimates. The main reason for this difference is the fact that the census data correspond to the agricultural operators. This makes it possible for livestock numbers to be included in the district where the agricultural operator is living even though the animals he owns may be found in another district. The annual estimate as reported

by the Cultivation Officers, however, relate to the livestock numbers found in the respective A.G.A. divisions.

Additional statistical data relating to the keeping of goats, pigs and poultry are given in Table 3.9.3.

TABLE 3.9.3 DISTRIBUTION OF GOATS, PIGS AND POULTRY

HOLDING			NUMBER OF GOATS & PIGS			
			Goats		Pigs	
Total No.	Holding Keeping Goats	Holding Keeping Pigs	<1 yr.	>1 yr.	<1 yr.	>1 yr.
6,373	259	-	657	966	-	-

HOLDING		TYPE OF POULTRY			
Total No.	Keeping Poultry	Chicks <6 months	Hens	Cock-Birds	Ducks
6,373	921	3,346	3,745	3,490	2

Ridimaliyadda A.G.A.'s Div. (Badulla Dist.)

Statistics given here reveal that the percentage of animals in milk in the study area is very low. This phenomenon is attributable to the low milk production potential of the indigenous animals, both cattle and buffaloes, which constitute the largest percentage of the two types and is also due to the absence of a market for milk and/or milk products. The most popular use for which both cattle and buffaloes are kept is for draught.

The other general remarks made in the section on Minipe regarding livestock are applicable to Nagadeepa as well.

3.10 ROAD SYSTEM

(1) Road Network in the Area

Nagadeepa Scheme is skirted by the National Highway (American Road) on the North, Mahaweli Trans-basin Canal on the Northwest, the mountainous area on the east, (where no main road exists) and Hepola Oya on the south. Seven bridges have been built across the Trans-basin Canal, including an aqueduct serving also as a pedestrian bridge. The road network is shown in Figure 3.10.1.

There is no road connecting Keselpotha with the Trans-basin Canal, (lying in east-west direction in the centre of the Scheme), due to lack of a bridge on the Diyabana Oya at the upstream crossing with the Trans-basin Canal. There are bus routes connecting Keselpotha and Gemunupura with Mahiyangana via the Mahiyangana-Bibile road. Anotehr bus route connects Senehigama with Mahiyangana via the American Road.

Traffic through the operation and maintenance road of the Mahaweli Trans-basin Canal is restricted to O/M vehicles, a barrier being installed. It is learned that this road will not be available for use as a public road even in the future.

(2) Operation and Maintenance Road for the Irrigation System

Operation and maintenance roads for the Irrigation system are maintained by the Irrigation Department. The O/M road of the main canal downstream from Tissapura is covered by high grass because traffic is limited to the village area due to lack of water in Yala and due to the existence of the main road, Tissapura-Kehelpotha-Welanpela, parallel to the main canal.

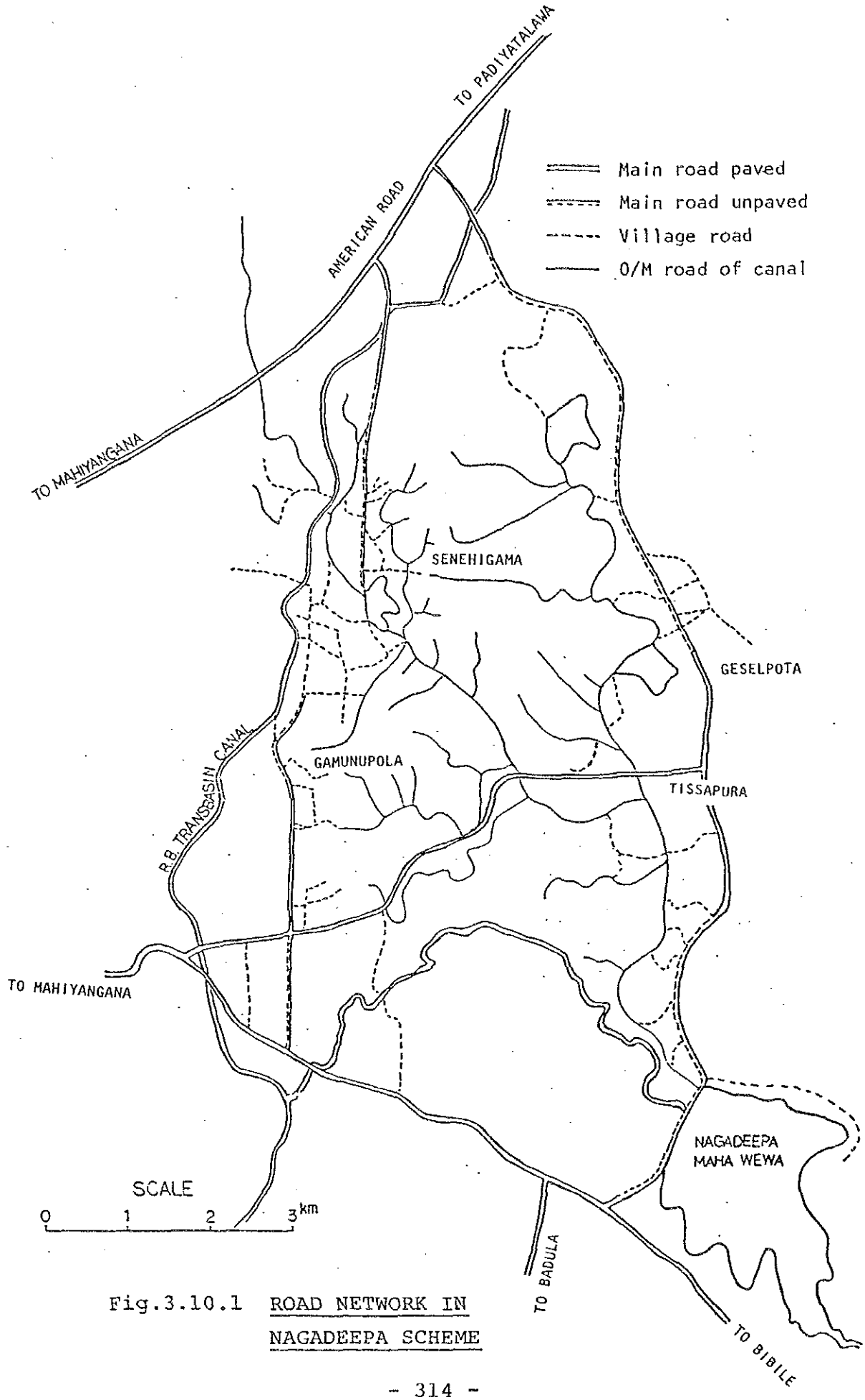


Fig.3.10.1 ROAD NETWORK IN NAGADEEPA SCHEME

It was observed by the Team that farmers were digging trenches in the main canal bund and the Irrigation Department is not directly able to prevent such damage to its structures.

The O/M road of branch canal is well maintained because it is used as the main road connecting Sisapola Takugahaela to Senehigama. The O/M road of D-canal is covered by grass, because hamlet and paddy field exist separately and no traffic is expected in view of lack of water. The motorable O/M roads are shown in Fig. 3.10.1. The O/M road of Tract 11 D1 canal is connected to Senehigama through the crest of Diyabana Oya Anicut, which has been left unrepaired after its destruction.

(3) Village Road

Village roads, not linked to canals, which pass inside villages or connect them, are maintained by the Land Commissioner.

There are no paved village roads in Nagadeepa Scheme. It is understood that the pavement of village roads has low priority compared with that of main roads, of which some parts have not yet been paved. The motorable village roads are shown in Fig. 3.10.1

3.11 RURAL WATER SUPPLY

(1) Source of Domestic Water

There were no water issues during Yala 1985. Some villagers go to the tanks to bathe and to wash their clothes because tank water is used for domestic purpose during the season when there is no cultivation. Other villagers use the wells as a source of domestic water. They wash themselves and wash their clothes at the well. Water is collected for drinking and

cooking and for washing food and utensils. The number of wells is estimated at 290 while the number of villagers per well is 64.

(2) Consumption

There is very little difference between the several stages of the Scheme in the consumption of water collected from wells. This water is used for drinking and cooking and for washing food and utensils. Its consumption is estimated at 25 litres per capita per day.

Domestic per capita consumption has been estimated by extensive studies on many domestic water supply projects in Sri Lanka. It has been already established that with the development of better living standards and improved knowledge of health education, the per capita water consumption will also increase. The evaluated per capita water demand for house connection varies from l.p.c.d. in 1988 to 185 l.p.c.d. in 2008. Furthermore, the per capita consumption from stand posts will remain constant as only the drinking water requirement will be obtained from them. Example of rural water consumption is shown in Table 3.11.1. It is evaluated that the per capita water consumption will be 45 l.p.c.d. for this project in future.

Table 3.11.1 AVERAGE PER CAPITA DOMESTIC CONSUMPTION

Unit : ltrs per capita/day

Place	1988	1993	1998	2003	2008
Hamlets	45	45	45	45	45
3 Townships	55	61	68	78	87

SOURCE : National Water Supply & Drainage Board "FEASIBILITY STUDY ON WATER SUPPLY TO NEW TOWNS & SETTLEMENT AREAS UNDER KIRINDI OYA PROJECT" July 1985

(3) Water Quality

The chemical and physical quality of well water is recorded in Table 3.11.2. The chemical and physical characteristics satisfy the maximum permissible level of the WHO's standard.

Table 3.11.2 CHEMICAL AND PHYSICAL CHARACTERISTICS

		Nagadeepa	WHO Highest desirable level	WHO Maximum permissible level
Discolouration	in unit[a]	48	5	50
Turbidity	in unit[b]	8	5	25
pH range		8.2	7.0 to 8.5	6.5 to 9.2
EC	in ㎲/cm	130	-	-
Total Hardness	in mg/l	200	100	500
Chloride	in mg/l	45	200	600
Copper	in mg/l	0.5	0.05	1.5
Iron	in mg/l	0.2	0.1	1.0

[a] On the platinum-cobalt scale
[b] Turbidity unit

Disinfection is carried out only on the completion of new wells in Sri Lanka. Microbiological quality is poor due to lack of continuous disinfection.

4. THE PROJECT

4.1 BASIC POLICY

In the Nagadeepa Scheme, attainment of the project goal would wholly depend on effective utilization of irrigation water in the Reservoir. Imperative water shortage during the Yala season has tormented the farmers in the Area since commissioning of the Reservoir, while several reservoirs neaby can enjoy sufficient water supplied from the Mahaweli RB canal which has penetrated through the Nagadeepa benefitted area.

Establishment of ways of effective water utilization would be prerequisite to planning and be executed by the following works and programmes:

Work (I)

1) Rehabilitation and improvement of irrigation, drainage and road systems,

2) Encroachment regularisation programme,

3) High percolation paddy investigation

4) Demonstration Farm for paddies and upland crops,

5) Water management manual programme,

6) Pilot project for banana and sugarcane cultivation,

7) Livestock development programmes, and

8) Strengthening line agencies by building INMAS stations, offices, quarters and warehouses.

Work (II)

1) Rural water supply

Rural water supply in the Scheme Area has to put emphasis on keeping sufficient water in quality and quantity during the Yala season.

4.2 IRRIGATION AND DRAINAGE PLAN

4.2.1 Basic Policy

Among major problems in this scheme, the most acute is the lack of irrigation water for cultivation during Yala season.

The water source of the Nagadeepa Scheme depends on a reservoir across Hepola Oya, a right bank tributary of the Mahaweli River.

In 1972, the capacity of the reservoir was increased by raising the dam height by 10 feet, but over spilling has occurred only twice since the dam was completed in 1970. Except in the extraordinary wet years, the farmers in the area have not had the benefit of undertaking paddy cultivation during Yala.

The extreme shortage of irrigation water in Yala season is caused by the following factors:

(i) The Nagadeepa reservoir has a relatively small catchment area, taking into account to the rainfall and the irrigable extent, which has resulted in an overestimation of the designed water storage capacity.

(ii) There is excessive water consumption in the Maha season.

(iii) Quantitative method has not been applied to the present water management.

(iv) A large volume of water is consumed in the encroachment paddy field.

The most important problem facing the project area is, how the limited amount of water being stored in the reservoir could most effectively be utilized and water saving in the Maha season holds the key to the solution of this problem.

It is expected that water leaks mainly through the branch canal and the distributary canals.

Threfore, the rehabilitation plan for the existing irrigation system should be framed so as not simply to restore the system to its original condition but to minimize seepage losses, which form the biggest constraint in the system, through provision of full improvement for the system as a whole.

Besides, the existing system could be transformed into a system, which is assured with effective water utilization and rationalized water management, through improvement of the existing system which has an adverse effect on the water management.

The System after the completion of the rehabilitation and improvement works could have a better water consumption pattern which would result in agricultural production increases in Maha season.

Effective utilization of irrigation water during Maha season could also enable to water to be conserved in the reservoir for the Yala cultivation. In that event, possibility of extending cultivation area during the Yala season could be justified.

4.2.2 Water Requirement

Proposed cropping pattern in Yala season is as follows:

Crops	Cropping Period*	Cropping Area	Starting Date
Chilli	150 days	180 ha	1st April
Pulse	105	180	11th May

* Growing periods include 15 days for land preparation.

Field water requirement is estimated as total of crop requirement and water requirement for land preparation. The result is shown in Fig. 4.2.1 and Annex Table 5.2.1. The total amount of field water requirements is estimated as 626 mm.

The effective rainfall can be obtained by the following formula.

$$Re = 0.67 \times (R - 6.4),$$

where, $Pe = 0$ when $R < 6.4$ mm

$Pe \leq 76$ mm

The total amount of effective rainfall is estimated as 113 mm with the total amount of rainfall of 206.7 mm during April to September in 1983. Where, the above rainfall is almost equivalent to 75% probability rainfall shown in Annex Fig. 5.2.2.

The total amount of field irrigation requirement in the Yala season is estimated as 1,027 mm with assumption of 50% application efficiency. The diversion requirement for proposed cropping pattern is estimated as 1,835 mm for 56% system efficiency. So, the total amount of diversion requirement is estimated as 6.60 million cu.m for the extent of 360 ha cultivated area. (Annex Table 5.2.2)

4.2.3 Water Balance

Water resource for the Nagadeepa Scheme is the Nagadeepa Reservoir only. The study on water availability has been done with reference to the basic policy guidelines. The possibility of cultivation in the Yala season has been evaluated in terms of the water balance study of the Nagadeepa reservoir in the proposed water management system.

The study has been undertaken in relation to 1982/83 Maha and 1983/84 Maha on daily basis and last 10 years on monthly basis because daily records were available above two seasons only.

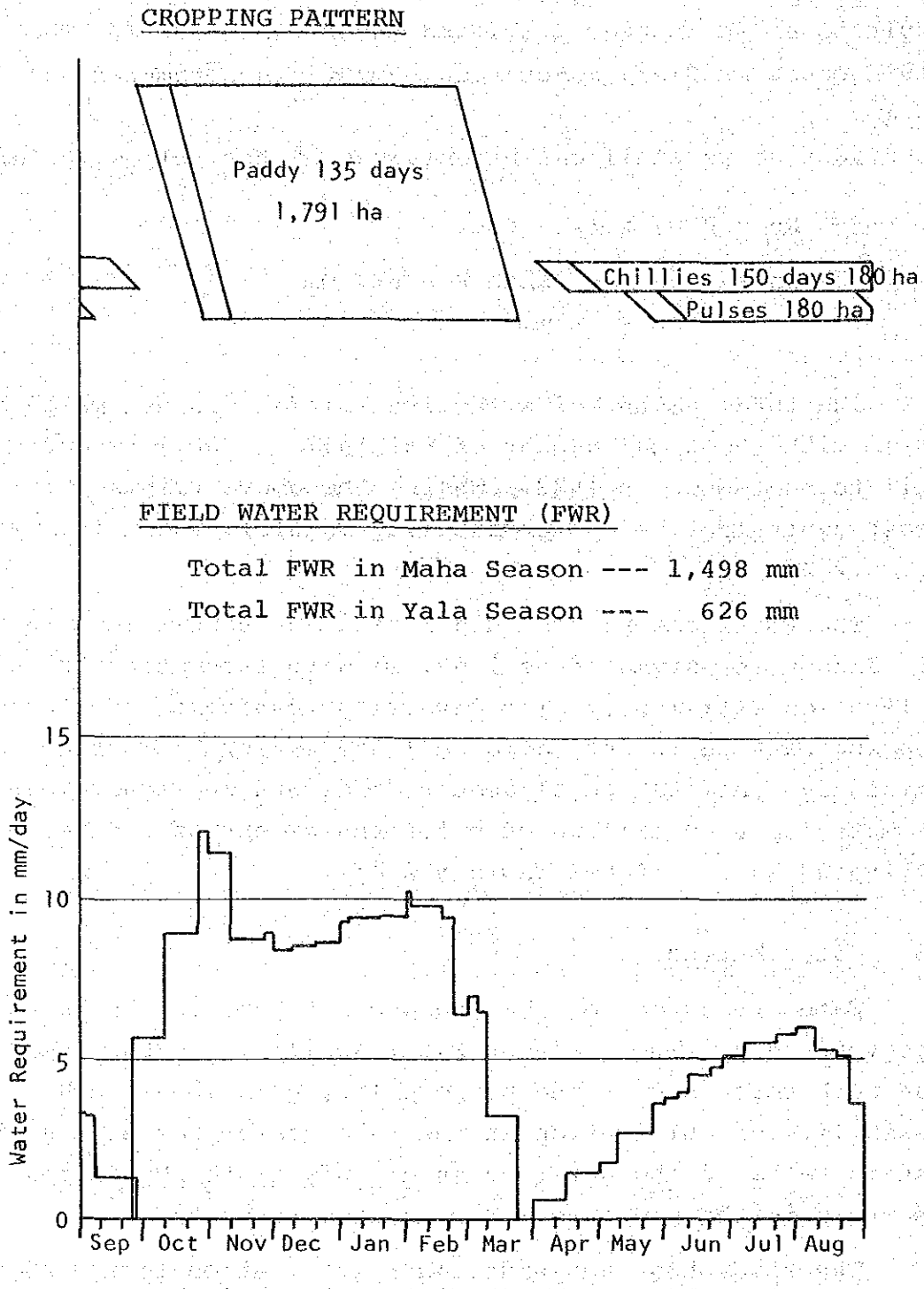


Fig.4.2.1 FIELD WATER REQUIREMENT FOR PROPOSED CROPPING PATTERN

The following conditions have been taken into consideration for the calculation:

- The improvement of the conveyance efficiency in the main canal, the branch canal and in D-canals owing to the rehabilitation,
- Timely operation of the sluice

As anticipated heavy seepage portions in the canal system can be improved by linings raising its conveyance efficiencies. According to the present operation results and proposed rehabilitation, the overall system efficiency could be expected to be 56%.

The amount of irrigation water available at the beginning of Yala season can be estimated as the balance of water left in the Reservoir at the end of Maha cultivation.

The total amount of issued water from the sluice was 26.76 million cu.m as against a total diversion requirement of 19.4 million cu.m in 1982/83 Maha. (Annex Table 5.1.16) A quantity of 8.0 million cu.m could thus have been saved for issue as irrigation water in next Yala reason.

Similar study was done for 1984/85 Maha. The amount of 13.0 million cu.m could have been saved for the irrigation water in next Yala season. (Annex Table 5.1.19)

It would have been possible to make effective savings of water of such magnitude primarily since there was an exceptionally high precipitation in 1984 and secondarily because the sluice had not been properly operated due to lack on considering effective rainfall.

The water balance study from 1976 to 1985 has been done on a monthly basis and the results are shown in Fig. 4.2.2 and Annex Table 5.2.4.

From these studies, total amount of more than 7 MCM irrigation water can be newly used in Yala season owing to the rehabilitation of the canal system and good water management.

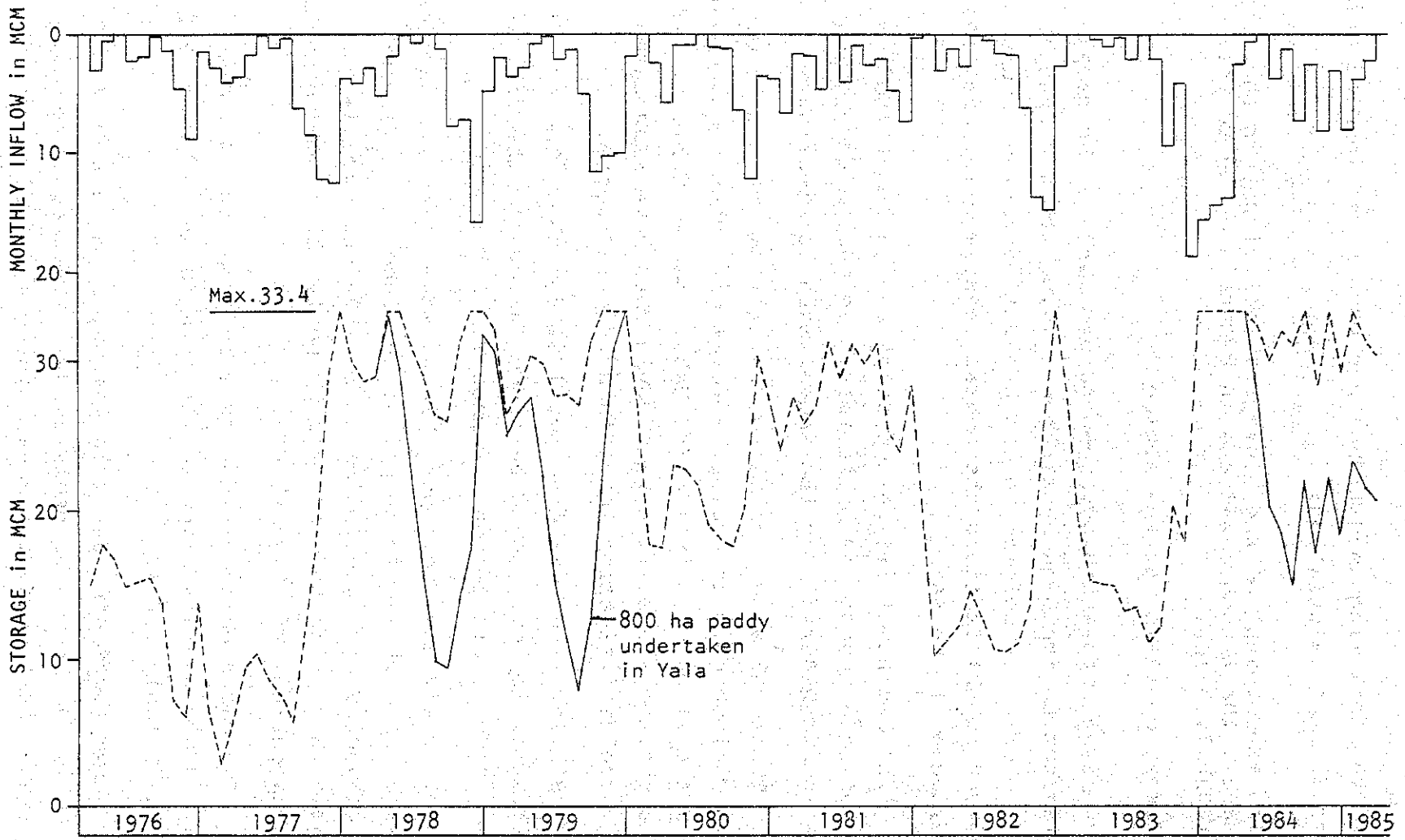


Fig. 4.2.2 WATER BALANCE FOR PROPOSED CROPPING IN MAHA(1,791 ha) and YALA(360 ha)

The total amount of diversion requirement is estimated as 6.26 MCM assuming that 20% of whole irrigable area; i.e. 360 ha can be cultivated. Accordingly, 20% of the whole benefited area in the Scheme could be harvested for upland crops in the Yala season.

4.2.4 Water Distribution

(1) Diversion Requirement in D-canal

The unit diversion requirement for the canal design in the Nagadeepa area has been estimated on the basis of the field irrigation requirement for land preparation which is the maximum value during the cultivation. The field water requirement for land preparation, which is estimated at 17 mm/day, consists of water requirement for land preparation of 12 mm/day and farm losses of 5 mm/day as stated in para. 4.2.2. Effective rainfall is considered as 2.5 mm/day based on the monthly 75% probability rainfall in October prescribed in IDDN. The field irrigation requirement is estimated as 15 mm/day, i.e. the balance of the field water requirement and effective rainfall. The unit diversion requirement at the head-end of D-canals is taken as 2.4 l/s/ha, assuming conveyance efficiency of 75%.

The design discharge of D-canals can be obtained by multipling the unit diversion requirement by acreage of irrigable area.

(2) Design discharge in the Main Canal and Branch Canal

The design discharges of main canal and branch canal have been calculated on the basis of the above unit diversion requirement, irrigable area and a conveyance efficiency of 75%. The design discharges are shown in Table 4.2.1 and Fig. 4.2.3.

Table 4.2.1 CANAL DISCHARGE OF MAIN AND BRANCH CANAL

Canal	Station in km	Discharge in cu.m/sec
Main Canal	0.00 - 4.17	5.4
	4.17 - Rotagolla Wewa	1.6
	Rotagolla Wewa - End	1.2
Branch Canal	0.00 - 1.94	3.3
	1.94 - Arawatta Wewa	2.2
	Arawatta Wewa - End	0.9

4.2.5 Rehabilitation of Facilities

(1) Main and Branch Canals

i) Rehabilitation Method

The following three methods, which are best suited for rehabilitation of canals in the project area, have been selected inter alia.

Type I: Rehabilitation of canals by provision of retaining walls for embankment protection

Type II: Rehabilitation of canals by provision of thin massonry lining

Type III: Rehabilitation of canals by transforming into earth canals having stable slopes and required discharge capacity.

Type IV: Rehabilitation of canals by provision of rubble packing.

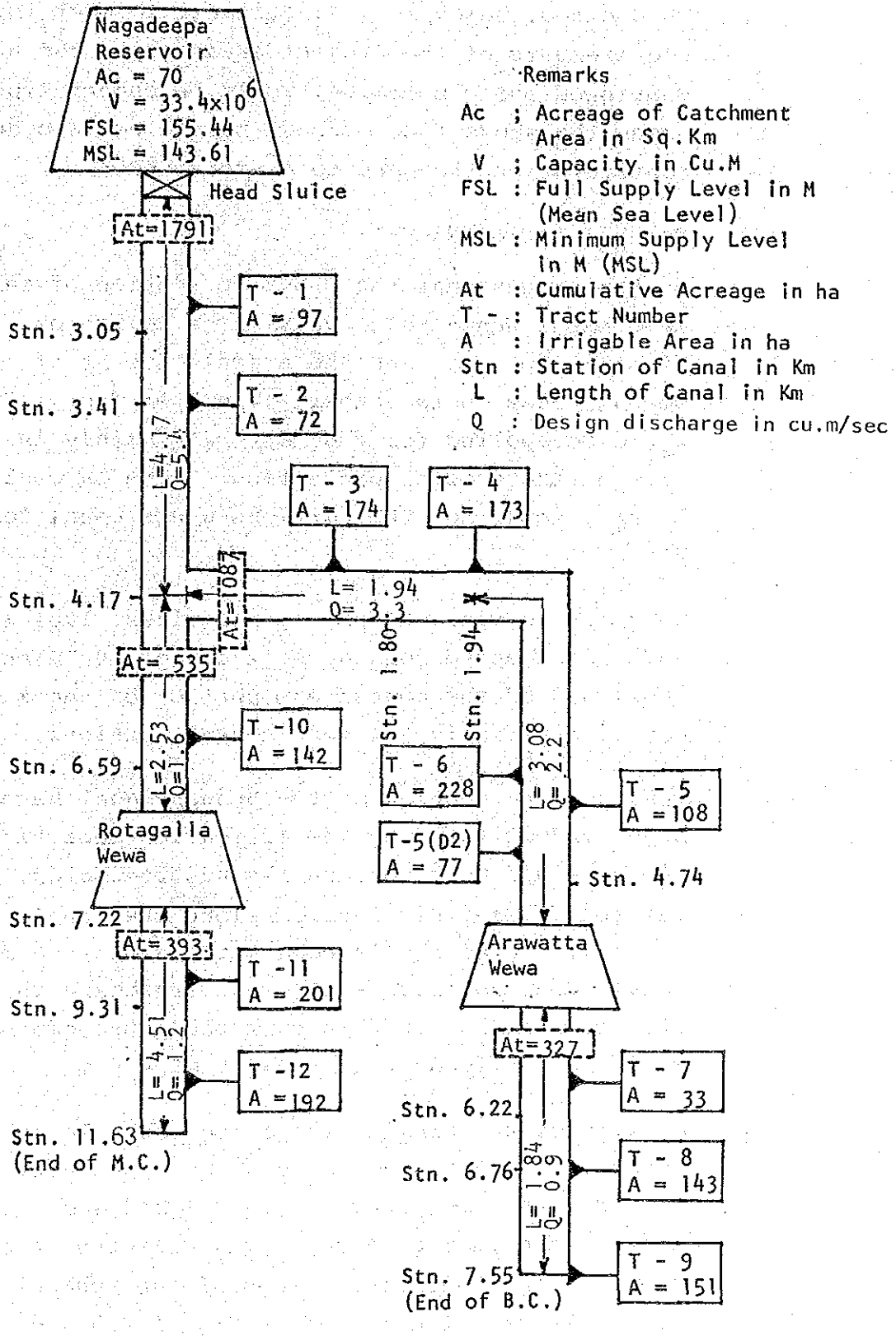


Fig. 4.2.3 DESIGN DISCHARGE OF CANALS

The method, which is most suitable to meet the requirements of the project area as per the above-mentioned basic policies, would be chosen from among the above four methods by taking into due consideration the need to exercise economy.

ii) Rehabilitation Plan

On the ground that the upstream section of the main canal has a relatively large volume of discharge on one hand and a small amount of seepage loss on the other, Type I or Type III would be applied for the left bank mainly in view of the erosion prevention. Type IV would be applicable for the portions where canal forms ponds.

In order to minimize the seepage loss, Type II would be adopted for the sections of the Branch Canal and of the downstream portion of the main canal, especially for double band portions.

The tail end section of the Branch Canal have been rehabilitated by the Irrigation Department. Riprap would be placed on the upstream slope in the small reservoir located along the canal. One of them, the Rotagolla Wewa built along the main canal, does not have sufficient freeboard in its embankment. In this case the extra embanking would be provided at the height of 0.6 m.

Details of the canals, including canal length separately identified in terms of construction methods are summarized in Table 4.2.2 and illustrated in Fig. 4.2.4. The designed sections and the longitudinal sections of the rehabilitated canals are illustrated in Fig. 4,2.5 and DWG. No. 2, respectively.

Table 4.2.2 REHABILITATION PLAN OF MAIN & BRANCH CANALS

(Unit: m)

Canal/Section / Rehabilitation Method	Main Canal			Branch Canal			Total
	M-1	M-2	M-3	BR-1	BR-2	BR-3	
Total Length	4,170	2,530	4,930	1,940	2,800	2,840	19,210
- Left Bank -							
Type I	970	-	-	600	-	-	1,570
(with bed lining)	(300)						(300)
Type II	-	550	950	-	1,550	100	3,150
Type III	3,040	1,860	3,190	1,220	1,210	960	11,480
Rubble pitching	160	120	240	120	40	-	680
Riprap	-	-	550	-	-	480	1,030
No repairs	-	-	-	-	-	1,300	1,300
- Right Bank -							
Type I	300	-	-	-	-	-	300
Type IV	950	-	-	500	-	-	1,450

(2) Canal Related Structures

i) Measuring Devices

Measuring devices are the most important facilities necessary for quantitative water management; such facilities would have to be newly installed since there are no measuring devices at present. The devices, which are designed to be of flume type, would be built at the beginning of the main canal, at the downstream points of the regulators built downwards directly from the branch point, and at the downstream points of the regulators built as outlets of the small reservoirs in both main and branch canals.

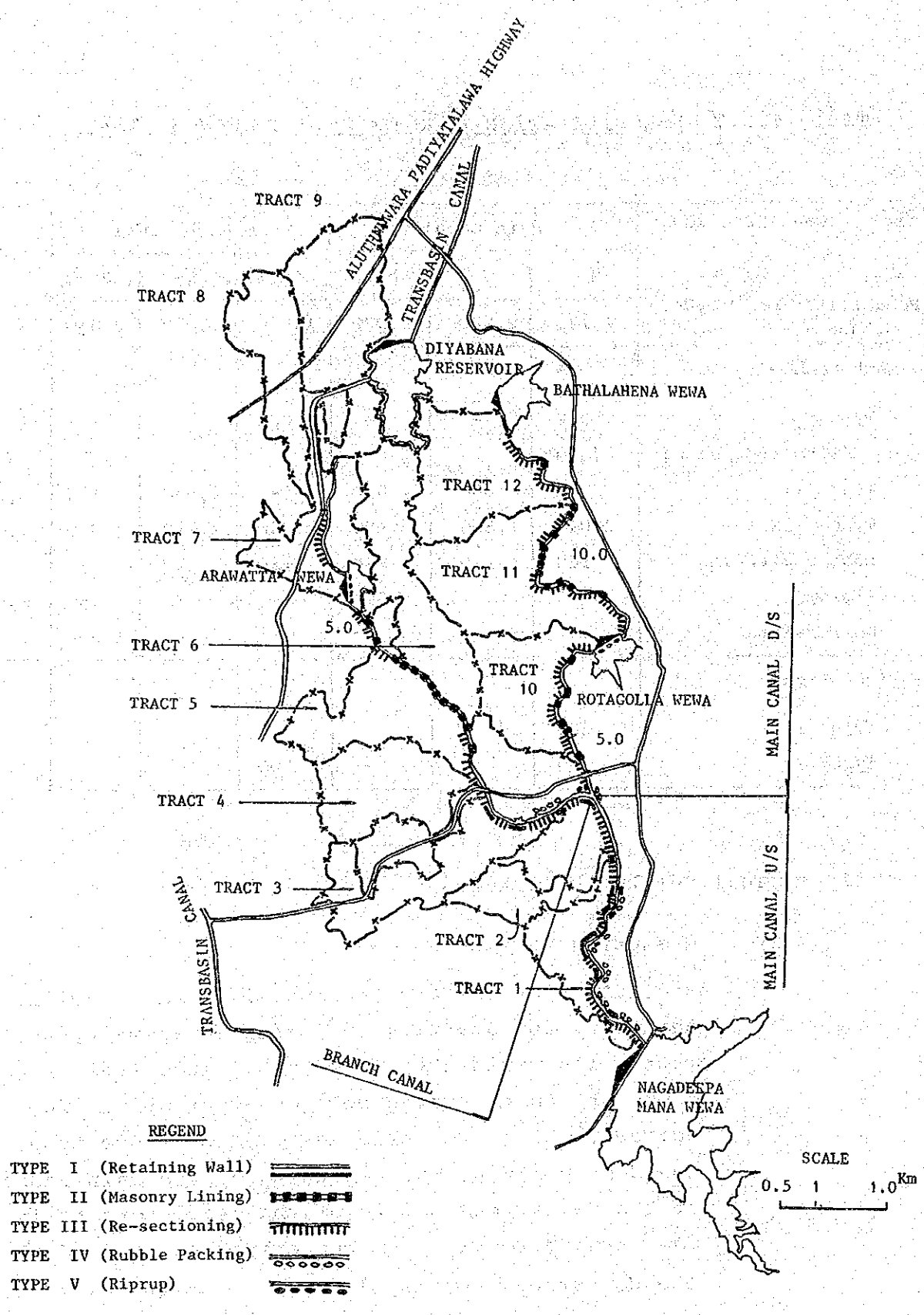
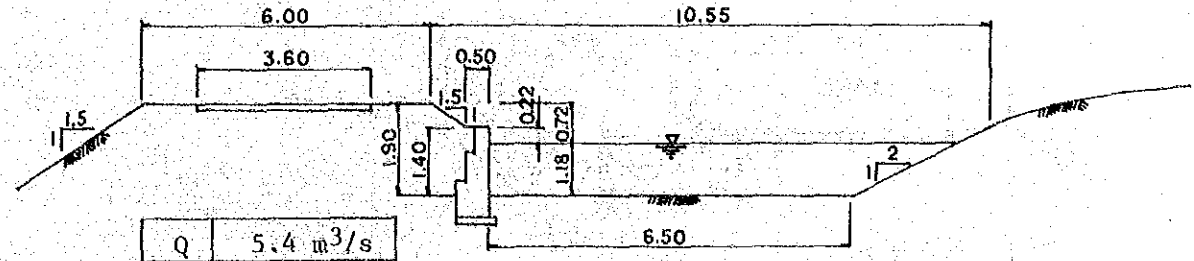
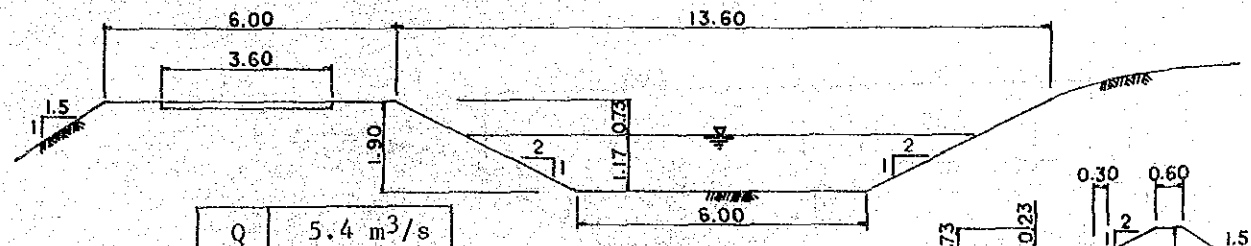


Fig. 4.2.4 PLAN OF CANAL REHABILITATION



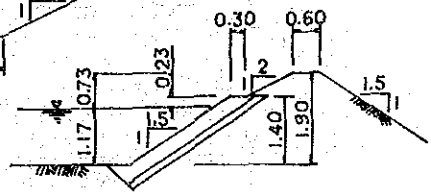
Q	5.4 m^3/s
I	1/3000
V	0.60 m/s

M-1, TYPE I

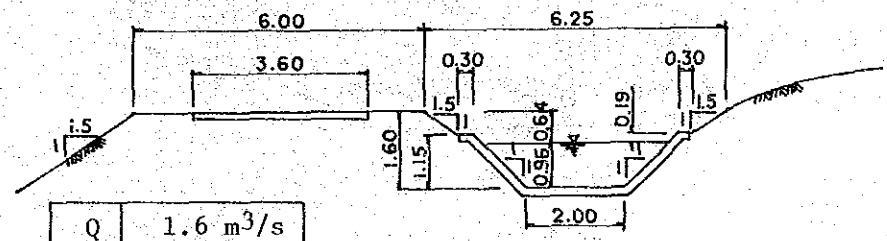


Q	5.4 m^3/s
I	1/3000
V	0.55 m/s

M-1, TYPE III

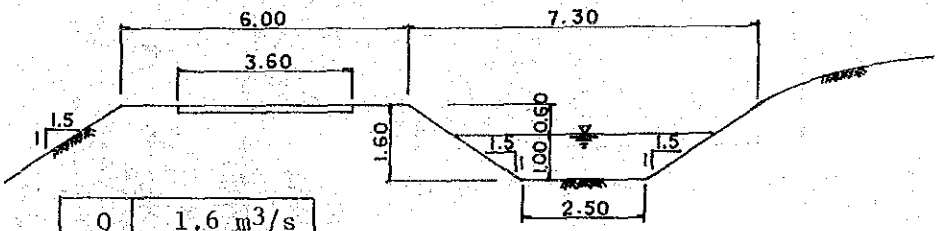


M-1, TYPE IV (R.B)



Q	1.6 m^3/s
I	1/4000
V	0.56 m/s

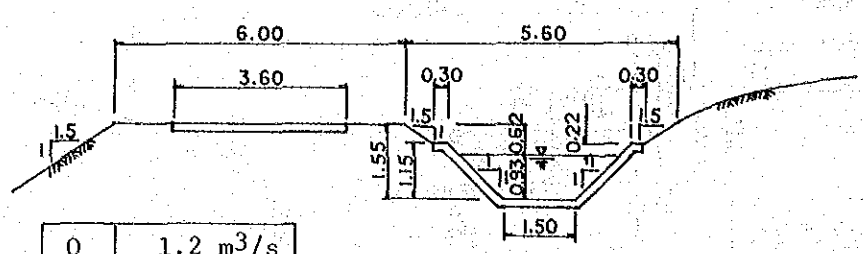
M-2, TYPE II



Q	1.6 m^3/s
I	1/4000
V	0.40 m/s

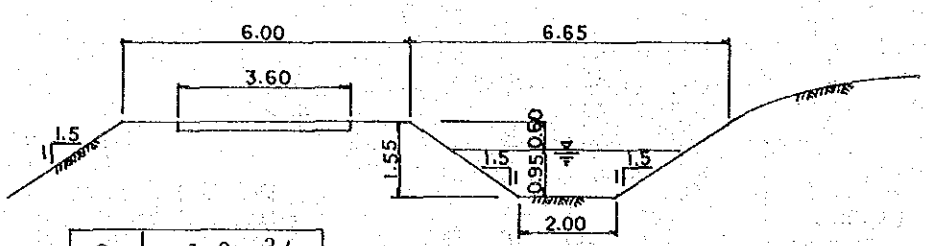
M-2, TYPE III

Fig. 4.2.5a TYPICAL SECTIONS OF MAIN & BRANCH CANALS



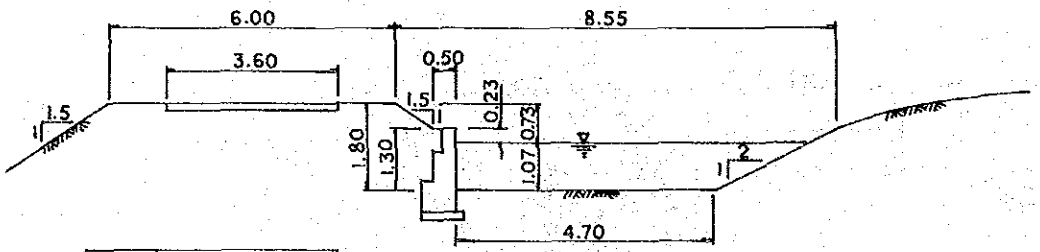
Q	1.2 m^3/s
I	1/4000
V	0.53 m/s

M-3, TYPE II



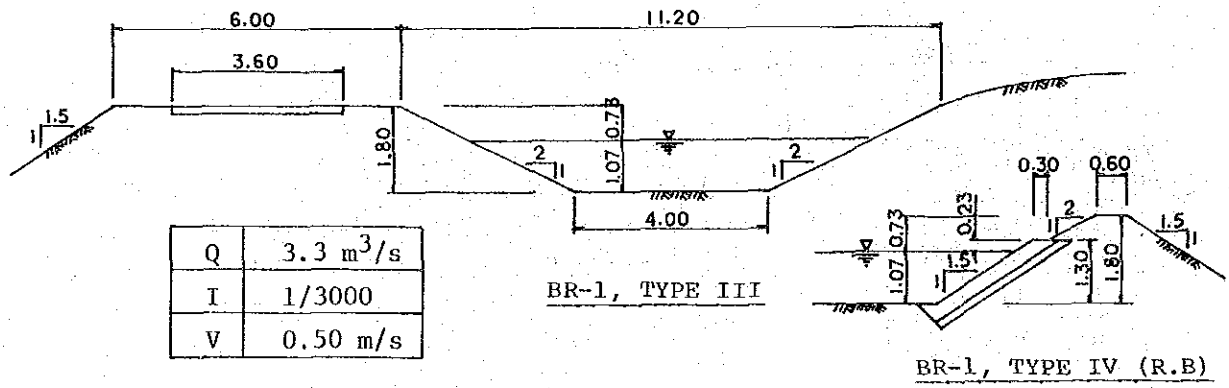
Q	1.2 m^3/s
I	1/4000
V	0.37 m/s

M-3, TYPE III



Q	3.3 m^3/s
I	1/3000
V	0.54 m/s

BR-1, TYPE I

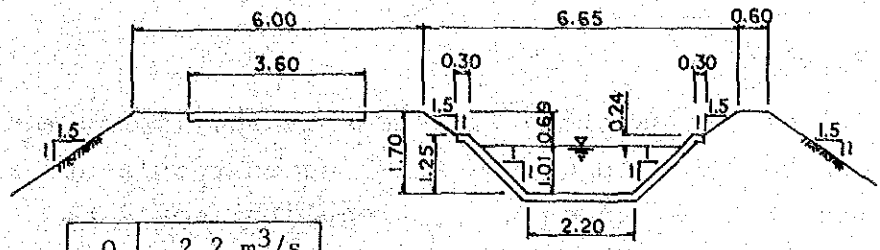


Q	3.3 m^3/s
I	1/3000
V	0.50 m/s

BR-1, TYPE III

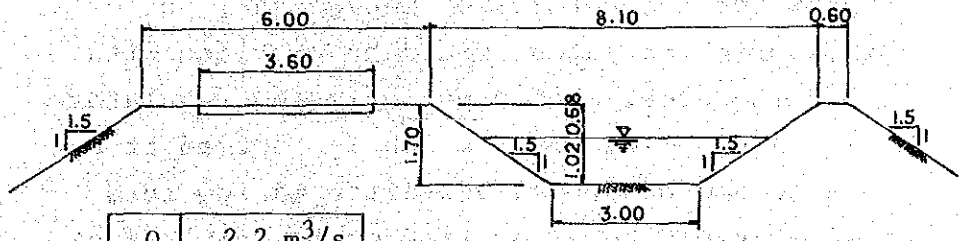
BR-1, TYPE IV (R.B)

Fig. 4.2.5b TYPICAL SECTIONS OF MAIN & BRANCH CANALS



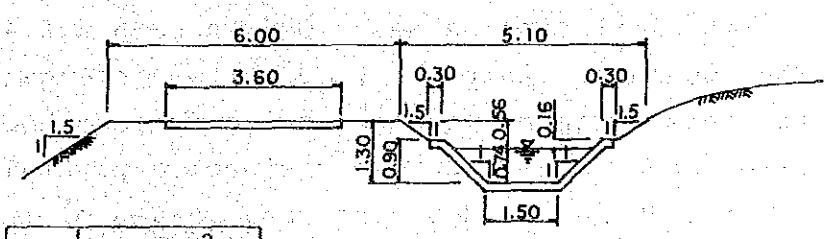
Q	2.2 m^3/s
I	1/3000
V	0.69 m/s

BR-2, TYPE II



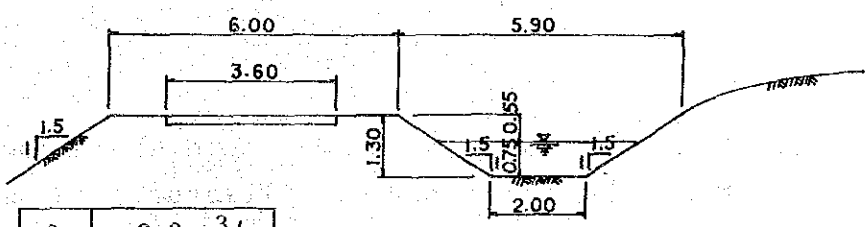
Q	2.2 m^3/s
I	1/3000
V	0.48 m/s

BR-2, TYPE III



Q	0.9 m^3/s
I	1/3000
V	0.55 m/s

BR-3, TYPE II



Q	0.9 m^3/s
I	1/3000
V	0.38 m/s

BR-3, TYPE III

Fig. 4.2.5c TYPICAL SECTIONS OF MAIN & BRANCH CANALS

ii) Regulators

Out of the existing five regulators, improvements can be effected on the three gated regulators and one which is uncontrolled regulator could be demolished and replaced by a gated structure because it is not a suitable structure for good water management. The construction of new gated regulators would be planned at six points to support the adequate water management; out of them, three regulators would be provided with drop structures. The other existing regulator having a stop-log gate, which is located at one point, could be demolished after taking into consideration the allocation of the new structures.

iii) Turnouts

The existing 31 turnouts out of 54 are in need of rehabilitation as described in para 3.6.4. They would be, therefore, converted into gated turnouts equipped with measuring devices because water management has been assigned a pivotal role in this project. Nevertheless, inlets of turnouts, which are proposed by the Irrigation Department to be installed new gates in 1985, would be left as they are, excluding the turnouts of which size are insufficient.

iv) Spillways

One of the existing spillways would be re-constructed. The other seven spillways would be repaired damaged parts and rectified their crest elevation. The spillways to be improved at one

point each of the main and branch canals (respectively) would be equipped with a wastway.

v) Drop Structures

Three drop structures out of existing five would be re-constructed and two of them would be combined with regulators. An additional drop structure combined with regulator is proposed for the tail end section of the Branch Canal.

vi) Undercrossings

There are drainage undercrossings at 11 locations. One undercrossing would be re-constructed because damage to the pipes has been caused by settlement, while the others can be utilized as they are because there is no structural problem. However, the canals would be provided with concrete lining to prevent leakage.

vii) Bridges

Out of the existing 22 bridges, one wooden canal crossing bridge would be replaced by a concrete one, while the rest can be utilized as they are. The construction of new road bridges would not thus be required.

One wooden foot bridge would be replaced by a concrete one due to its age. Further the existing-temporary bridges, including log bridges, would be replaced by concrete foot bridges at 14 points in the order of priority taking into account the public interest importance.

viii) Other Structures

Rehabilitation would not be required for the culvert bridge built at the branch point. Apart

from the above structures, bathing and washing places would be provided in the upstream section of the main canal for the convenience of the villagers. For other sections, they would not be necessarily provided in view of the small size of the canal.

The rehabilitation plans on the above related structures are summarized in Table 4.2.3.

Table 4.2.3 LIST OF CANAL RELATED STRUCTURES TO BE REHABILITATED

Structures	Number of Exist. Str.	No. of Str. to be re-repaired	No. of Str. to be newly or re-constructed	Remarks
Nagadeepa Reservoir Dam Embankment	1	1	-	
- do - Gated Spillway	1	1	-	
- do - Sluice	1	1	-	
Measuring Device	-	-	5	
Regulator	5	3	6	
Turnout	54	23	31	29 exist. gates will be re-used
Spillway	8	7	1	
Drop Structure	5	2	1	
Undercrossing	11	-	1	
Road Bridge	22	-	1	
Foot Bridge	1	-	1	
Temporary foot Bridge	47	-	14*	* Concrete Foot Bridge
Culvert Bridge	1	-	-	
Bathing and Washing Place	-	-	8	av.500m interbal

(3) Nagadeepa Reservoir

The dam body itself is not found to be ageing, but the appropriate riprap treatment would be done to rainforce the upstream slope. Besides the dam crest would be

paved by gravel because it is used as a road which is an important road in this area.

The spillway and the intake facilities are virtually in good condition, but the gate seals would be replaced. Because the intake facilities have no measuring devices, new devices would be installed for measurement of water issue from the reservoir. (This is included in the main canal related structures)

(4) Distributary and Field Canals

The construction of new canals would not be required, because existing canal density of D-canals and F-canals in the project area reaches as high as some 70 m/ha where the canals are steadily ageing, entire rehabilitation would be required for the canals, inclusive of related structures and O & M roads. The following rehabilitation plans have been worked out with particular emphasis on the minimization of seepage loss.

i) The entire section where the distributary canals run mainly through hill ridges and have a high value in seepage loss would be provided with lining.

ii) The present slab lining would be adopted for the section where the field canals, which are relatively large in size, through hill ridges and have a high value in seepage loss.

iii) Apart from the above sections, any section where erosion and scouring are particularly acute at present would be rehabilitated by providing retaining walls.

iv) The canals which have not enough capacity due to increased command area by the encroachment would be improved.

v) The rest of sections would be rehabilitated as necessary.

vi) The O & M roads of the distributary canals are designed to have 4 m width and gravel pavement would be provided for the major sections.

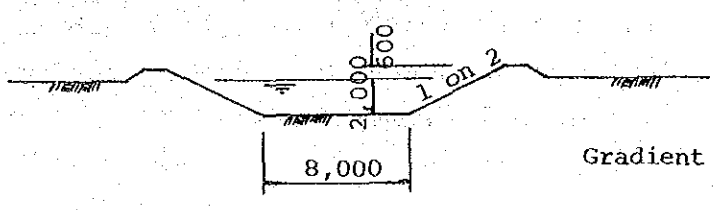
vii) Out of the total, 10% of the existing related structures would be re-constructed and 40% of them would be rehabilitated.

Area wise-proposed rehabilitation plans on the distributary and field canals are summarized in Table 4.2.4.

(5) Drainage Facilities

Since there are no serious drainage problems in the project area excluding the part furthest downstream, as has been described in the Chapter "Present Condition", there is no particular need rehabilitate or re-construct the existing drainage canals as a whole. Nevertheless, the portions where scouring and collapse are found on the slopes at the confluences of the secondary drainage canals (tributaries of small natural streams) would be rehabilitated by the provision of rubble packing for slope protection. Such treatment would be done at one point per 100 ha on an average.

There are adverse drainage problems arising in a part of Tracts 8 and 9 which is at the furthest downstream end of the project area and lies along the Diyabana Oya. This problem is due to the small water flow capacity of the river. In this project, therefore, the river is so designed as to flow at the 25-year probable flood dischange rate of 27 cu.m/sec by means of dredging. The required cross-section is illustrated below.



Gradient : 1/1,000

Table 4.2.4 PROPOSED REHABILITAION PLAN FOR D. & F. CANALS

Item		Tract 1,2	Tract 10,11,12	Tract 3 - 9
Existing				
Irrigation Area	(ha)	169	535	1,087
No. of D. Canal	(No)	2	5	14
Total Length of D. Canals	(km)	2.80	4.63	22.32
No. of F. Canal	(No)	30	83	162
Total Length of F. Canals	(km)	8.51	31.65	54.94
Rehabilitation of D. Canal				
Concrete Lining	(km)	0.21	0.35	1.92
Retaining Wall	(km)	0.14	0.23	1.12
Pre-cast Slab Lining	(km)	0.42	0.69	3.35
Earthen Canal	(km)	2.03	1.29	8.24
Gravel Pavement for O/M Rd.	(km)	1.03	-	7.05
Drop Structure (new)	(No)	1	2	10
- do - (repair)	(No)	4	6	31
F.T.O. Structure (new)	(No)	1	2	10
- do - (repair)	(No)	4	6	29
Other Structures (new)	(No)	-	1	3
- do - (repair)	(No)	1	2	10
Pipe Outlet (new)	(No)	1	1	7
Rehabilitation of F. Canal				
Pre-cast Slab Lining	(km)	1.28	4.75	8.24
Earthen Canal	(km)	2.60	9.50	16.50
Structures (new)	(No)	10	35	65
- do - (repair)	(No)	40	130	260

4.3 WATER MANAGEMENT

4.3.1 Basic Policy

The present organisation on the water management in the Nagadeepa Scheme is based on the Nagadeepa Development Society (NDS) started from 1979. From the experience gained in operating the NDS, the Nagadeepa Special Project Committee was formed in July 1982. The Sub-Project Committees were also established at Nagadeepa with similar functions as the Sub-Project Committee of Minipe.

The current water management programme in the Nagadeepa Scheme is being replaced in March 1985 by the INMAS Programme which has been promoted mainly by the Irrigation Management Division (IMD).

The IMD will function as the administering authority for the Programme on the basis of policy guidelines and direction from the Central Co-ordinating Committee on Irrigation management. Some of the principal functions of the IMD are:

- Administering the O & M collection fund and allocating funds for maintenance work in irrigation schemes,
- Allocation of funds voted to the Ministry for O & M in major irrigation schemes, and
- Monitoring, in major irrigation schemes, the use of irrigation water to optimise its use, and agricultural production activities to increase agricultural productivity respectively.

The INMAS Programme will operates at four levels as follows:

- National Level at which the Central Co-ordinating Committee will function,
- District Level at which the implementation is done by the District Agricultural Committee (DAC) Sub-Committee,

- Project Level comprising a Project Committee of field staff of all concerned agencies in agricultural production. The farmer representatives will determine the programme for implementation in the Scheme.

- A Sub-project Level is included considering of turnout groups of farmers.

The water management activities in the Nagadeepa Scheme have been continued about five years including "Nagadeepa Development Society", and farmers participation has increased. Therefore, the present organisation and operation on water management in the Scheme is required to be continued by the modified organisation under the IMD.

4.3.2 Farmer Organisation

(1) System Features

The Nagadeepa Scheme consists of a reservoir, one main canal, one Branch Canal, 21 nos of D-canals and 275 nos of F-canals covering the benefited area of 1,791.2 ha. An average area covered by one F-canal is about 6.5 ha. The benefited area is originally divided into 13 Tracts but the Mahaweli RB canal has diminished the last Tract.

(2) Modification of Farmer Organisation

In consideration of regularizations of encroachment and the results of investigations at the field study as given in Annex 5, Table 5.1.1 farmer organisation is proposed to be modified by establishment on representation of farmer leaders according to the following basis:

- To select one farmer representative from one Tract less than 100 ha and two farmer representatives from one Tract more than 100 ha.

- One or two representatives shall be selected among assistants who belong to one Tract as one or two sub-areas.

Details on farmer representatives and their assistants are proposed according to sub-area in each Tract as shown in Table 4.3.1.

The present farmer organisation and function in principal are to be continued in future.

4.3.3 Water Management and Operation

(1) Manual Programme

The provision of a water management and operation manual is indispensable to use irrigation water effectively to meet demands in the fields and establishment of system operation as well.

This manual would be required to cover the following aspects:

- Complete diagrams of reservoir operation, the irrigation network specifying the number of D-canals, F-canals, related structures, farm plots including encroachment.
- Field water requirement in each D-canal.
- Basic plan of the network operation including
  - (a) Discharge check at the Main and the Branch Canal measuring points,
  - (b) operation methods of the control structures and measuring devices, and
  - (c) control principles of the Main Canal and the Branch Canal in each Tract.

The water management and operation manual programme is proposed to start immediately after completion of rehabilitation works and continue for three years by the Irrigation Department associated with the line agencies and consultants.

Before proceeding this programme, high percolation paddies investigation including remedy plans would be

required to execute so as to identify the areas and the irrigation demands in each D-canal.

Costs for these programmes are estimated in the Project Support and Engineering Services.

(2) Training

In order to operate the system efficiently by use of the O & M manual, the staffs in charge of water management shall have enough knowledge by training.

The training courses should be organized by the IMD and the related agencies.

These expenditures including construction of the INMAS Stations and strengthening INMAS Programme are provided in the Project Support costs (administrative overhead).

Table 4.3.1 PROPOSED FARMER REPRESENTATIVE AND ASSISTANTS

Canal/ Tract	No. of D-Canal	Extent Area in Ha	Representatives	Assistants
Main Canal				
Tract 1	1	97.3	1	4
Tract 2	1	71.8	1	3
Tract 10	2	141.6	2	5
Tract 11	1	201.6	2	8
Tract 12	2	191.9	2	7
Sub-total	7	703.9	8	27
Branch Canal				
Tract 3	1	174.2	2	7
Tract 4	4	173.3	2	7
Tract 5	2	185.4	2	7
Tract 6	3	228.3	2	9
Tract 7	1	32.7	1	1
Tract 8	1	142.5	2	5
Tract 9	2	150.9	2	6
Sub-total		1,087.3	13	42
Total		1,791.2	21	69

4.4 AGRICULTURAL PLAN

4.4.1 Basic Policy

As the Project aims at agricultural production increase by rehabilitating the existing irrigation and drainage facilities, it is characterized by reorganizing the agricultural activities in the area, differing from a new development Scheme. In the proposed Project Area, however, the land has been fully developed and cultivated by many farmers for long year. It should be recognized that the basic concept for this project is to understand the present condition completely and then make the optimum plan.

The main constraint of agricultural development in the area is the shortage of irrigation water in Yala season, especially at the canal tail-end areas. Accordingly, the agricultural development plan for the Project should aim at the most effective utilization of the limited source of water.

The main crop in the Nagadeepa Scheme is paddy. It is cultivated mostly under irrigated conditions in the Maha season. Other crops grown in Maha season are subsidiary food crops, fruit trees and vegetables. These crops are cultivated under rainfed condition. Because of lack of water in the Yala season, no crops except fruit trees are usually cultivated. After the Project, however, irrigation water would be saved during Yala season and issued to an area of 20% out of the whole irrigated area.

Taking both the present agricultural conditions and the project concept into account, the agricultural plan proposed is on the basis of irrigated agriculture.

The present water shortage is mainly caused by the expansion of the irrigated area by encroachers, and the deterioration of irrigation facilities. Therefore, care should be taken under the INMAS Program not to expand paddy lands after the Nagadeepa Project is implemented.

Through the discussions with the officials in the related agencies and the field investigations, paddy, chillies and pulses (cowpea, green gram and soya bean) have been chosen as the proposed crops for irrigated agriculture.

Paddy is the main crop in Sri Lanka and most farmers adhere to cultivation of paddy. Under irrigated conditions, productivity of paddy is relatively high and its yield is stable compared with other crops. The increase of paddy production is still ranked as the top priority of the national policy, though the import of paddy has decreased in recent years. Therefore paddy would be cultivated in all the irrigated area in Maha season.

In order to save and use the limited water effectively, it is recommended that the cultivation of chillies and pulses should be introduced to the paddy fields to be newly irrigated in the Yala season. In normal years, no crops except fruit trees are cultivated in Yala season, because no water is available. In 1984, however, the irrigation water was available exceptionally even in Yala season and so chillies and pulses were cultivated experimentally with paddy. Chillies and pulse were introduced to save on irrigation water. Though the production of these crops has increased in recent years, it has still not met the domestic demand. In view of the fact that prices of these crops are kept at a relatively high level, the cultivation of chillies and pulses will contribute significantly to an increase of farmers' income and could also be made acceptable to farmers under the national policy of promoting agricultural diversification.

As for adoption of agricultural diversification for the farmers in the Scheme, many difficulties encountered are anticipated due to lack of their experience and knowledge of large scale other field crop cultivation.

Therefore, demonstration farms of other field crop are proposed to be 2 ha and about 6 such demonstration in the Scheme.

These demonstrations will be conducted by providing free seeds, fertilizer and agro chemicals by the Agriculture Department.

In addition cultivation of banana or sugar cane on a large scale has to be studied on future possibility in view of budgetary balance that might give incentive to the farmers.

A pilot project of banana or sugar cane cultivation is also proposed in the Scheme. Funds for these programmes and strenghthening line agencies are provided in "Project Support" costs.

4.4.2 Cropping Pattern

As described in the previous section, paddy, chillies and pulses (cowpea, green gram and soya bean) are the main crops under the Project. The cropping pattern of these crops should be as follows:

(1) In Maha season, paddy should be cultivated in all the Project Area.

(2) In Yala season, the cultivation of subsidiary food crops should be gradually increased up to 20% of the total area by the sixth year after the completion of the Project.

(3) The ratio of cultivation of subsidiary food crops should be chillies 50% and pulses 50%. The cultivated areas of cowpea, green gram and soya bean should be the same.

(4) In and after the target year, the proposed cropping patterns are (i) single crop of paddy annually on 80% of the irrigated land (in Maha season only), (ii) paddy-chillies of 10% and (iii) paddy-pulses on the remaining 10% of the land.

(5) The cultivation of subsidiary food crops should be increased gradually and within six years after the completion of construction works, the cultivated area of such crops should reach to the target area.

(6) In a year exceptionally favoured with sufficient water, cultivation of paddy is recommended as most suitable for the Nagadeepa area; the rainfall in the year of 1984 is said to be a once in five hundred years occurrence. Therefore paddy cultivation in Yala season should be excluded in the agricultural plan.

For the cultivation of the proposed crops, the following cultivation methods are recommended.

(1) Certified seeds issued by the Government should be used, as a rule, once in four years for paddy and every year for subsidiary food crops.

(2) New improved variety of paddy should be used. The long and short growing period varieties should be used in Maha and Yala seasons, respectively.

(3) Seedings of paddy and chillies should be transplanted. Pulses may be sown direct.

(4) Application of fertilizer and agro-chemicals should accord with the recommendations by the Government.

(5) Farmers should follow the decisions on farming practices by each Committee and accept the advice given by agricultural instructors and agricultural extention workers concerned.

(6) Improvement of cultivation methods concerning the variety of crops, establishment method, application of fertilizer and agro-chemicals should be accomplished within six years after the completion of the construction works.

The proposed cropping patterns are shown in the following figure.

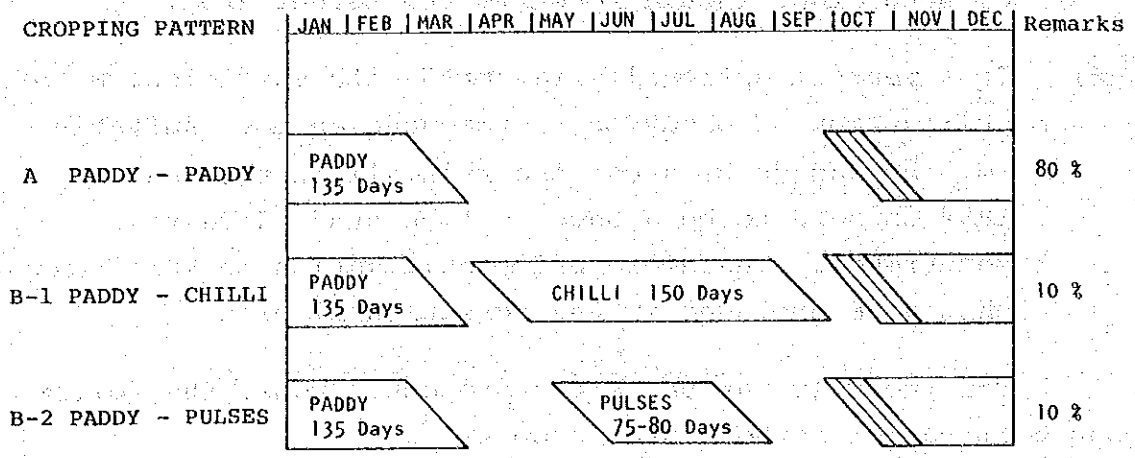


Fig.4.4.1 PROPOSED CROPPING CALENDER

4.4.3 Target of Production

(1) Targets of Yields

At the completion of the proposed rehabilitation works, the yield of each crop in a normal year in Nagadeepa Scheme is estimated, taking into consideration the existing agricultural conditions, the effective use of irrigation water, the introduction of improved cultivation methods and the results of experimental farming.

The target yield of each crop is expected to be achieved within six years after the completion of construction works. The estimated yields during the transitional years are shown in Annex 6.

(2) Target of Production

The crop productions in Nagadeepa Scheme in, and after, the target year have been estimated as given in the following table 4.4.2.

Table 4.4.1 TARGET YIELD OF EACH CROP

Name of Crop	Season	Present Yield (t/ha)*	Target Yield (t/ha)
Paddy	Maha	2.8	5.0
Chilli	Yala	0	1.6
Cowpea	Yala	0	1.8
Green Gram	Yala	0	1.6
Soya Bean	Yala	0	1.7

*: The figures show the average values of 1981-85.

Table 4.4.2 YIELD WITH/WITHOUT PROJECT

		Actural (1981-1985)*			Target Year		
Crop	Season	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
	Maha	1,609	2.83	4,553	1,791	5.00	8,955
Paddy	Yala	0	-	-	0	-	-
	Total	1,609	2.83	4,553	1,791	5,00	8,955
Chilli	Yala	0	-	-	180	1.6	288
Cowpea	Yala	0	-	-	60	1.8	108
Green Gram	Yala	0	-	-	60	1.6	96
Soya Bean	Yala	0	-	-	60	1.7	102

* Source: Kachcheri Offie at Badulla and Nagadeepa A.I. Office Area.

4.4.4 Market Prospects and Prices

After the implementation of this rehabilitation project, the agricultural products will be purchased by the co-operatives and private traders. Agricultural products could easily be transported out from the project area with the proposed road rehabilitation. Access to markets would become considerably better. Paddy, chillie, cowpea, green gram and soya bean would then be extensively transported to other districts.

Government has laid down guaranteed prices for these products. It is expected that this price support scheme will be continued in the future. The prices cannot be decided through this project. The supply and demand of highland products are apt to be tight. There would be no price decrease with the implementation of this project.

4.4.5 Input Supply

The present agricultural input supply for paddy such as seed, fertilizer and agro-chemicals is summarized in Table 4.4.3 and the details are mentioned in Annex 6.

Table 4.4.3 MAIN INPUT SUPPLY FOR PADDY CULTIVATION

Item	Rate	Price	Remark
Seed	52.0 kg/ha	4,630 Rs/kg	Transplanting Culture(1bu/ac)
Fertilizer			
Nursery Basal Vl	62.5 kg/ha	2,955 Rs/kg	
Nursery Urea	12.5 kg/ha	2,875 Rs/kg	
Field Basal Vl	185.0 kg/ha	2,955 Rs/kg	
Field Urea	124.0 kg/ha	2,875 Rs/kg	For Maha
	93.0 kg/ha	2,875 Rs/kg	For Yala
Field TDMl	124.0 kg/ha	2,956 Rs/kg	
Agro Chemical (Ex.)			
Chlorpyripos 20% EC	1.65 ml/ha	360.0 Rs/ha	For Leaf Roller

4.4.6 Labour Requirements

Labour required for cultivating each crop is summarized in the following table. Considering the existing conditions of farm families in the Nagadeepa Scheme, it is estimated that the required labour would be available within the farm itself.

Table 4.4.4 LABOUR REQUIREMENTS FOR THE CULTIVATION OF CROPS (man-day/ha)

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Paddy	10	7	77						7	79	10	10	200
Chillie			15	106	124	81	81	193	114				714
Cowpea					60	27	25	45					157
Green gram					60	27	25	45					157
Soya bean					63	34	32	45					174

4.4.7 Farm Power

Many buffaloes and cattle are bred by farmers in the Nagadeepa area and almost all farmers cultivate by animal power. Subsidiary food crops are to be introduced in Yala season at 20% of the whole paddy fields. The time of operations of such crops differs from each other, but the present animal power would be adequate for the farming practices for subsidiary crops.

4.4.8 Farm Budgets

Based on the agricultural plan, the gross income of the standard farmer of holding 0.8 ha (2 Acs) of paddy field is estimated as shown below. The farm budgets of respective crops are summarized in Annex 6.

Table 4.4.5 ESTIMATED GROSS INCOME FOR STANDARD FARMERS IN NAGADEEPA

(Irrigated Area: 2ac=0.8ha)

Item	Area (ha)	Yield (kg)	Unit Cost (Rp)	Cross Income (Rp)
Status				
Maha Paddy	0.80	2,264	2.99	6,769
Yala Paddy	0.00	0	2.99	0
Chilli	0.00	0	37.0	0
Pulse	0.00	0	13.5	0
Sub Total	0.00	0		0
Total (A)	0.80	2,264		6,769
Target				
Maha Paddy	0.80	4,000	2.99	11,960
Yala Paddy	0.00	0	2.99	0
Chilli	0.08	128	37.0	4,736
Pulse	0.08	136	13.5	1,836
Sub Total	0.16	264		6,572
Total (B)	0.96	4,264		18,532
(B)/(A)				2.7 times

4.4.9 Credit

The demand for the agricultural credit is expected to increase with the wide spread utilization on agricultural inputs and the diversification of the farm practices. Interest rate and other credit conditions are not envisaged to be different after project implementation.

The credit supplying organisations like the Bank of Ceylon and the People's Bank should increase their lending capability. The mortgage system should be re-examined the alteration of land ownership system.

4.4.10 Organisation

The relationship of the four kinds of committee in the Project Area should be strengthened in order to achieve a high target of agricultural production. The Project Area

where the new products would be introduced requires new technology and new agricultural input. The organisation of management would play an important role in agricultural production matters.

4.4.11 Extension and Training

(1) Basic Concept

In Nagadeepa Scheme, agricultural extension and training are carried out by an Agricultural Officer, two Subject Matter Officers, an Agricultural Instructor and five Agricultural Extension Workers. The present agricultural plan envisages the promotion of irrigated paddy cultivation in Maha season and introduction of chillies and pulses cultivations in Yala season with the improvement or rehabilitation of irrigation and drainage facilities. In order to achieve the targets of the plan, it is imperative to give adequate technical guidance and training to the farmers. It is recommended that the following measures should be taken:

a) Assignment to the Project of a Subject Matter Officer (SMD) specialized in cultivation of upland crops and soil and fertilizer.

b) Setting up demonstration farms for paddy, chillies and pulses cultivations,

c) Distribution of a guidebook for cultivating paddy, chillies and pulses to the farmers,

d) Introduction of modes of recognizing and commending farmers' accomplishment, and

e) Exchange of views between personnel concerned with the agricultural extention workers in the adjoining areas.

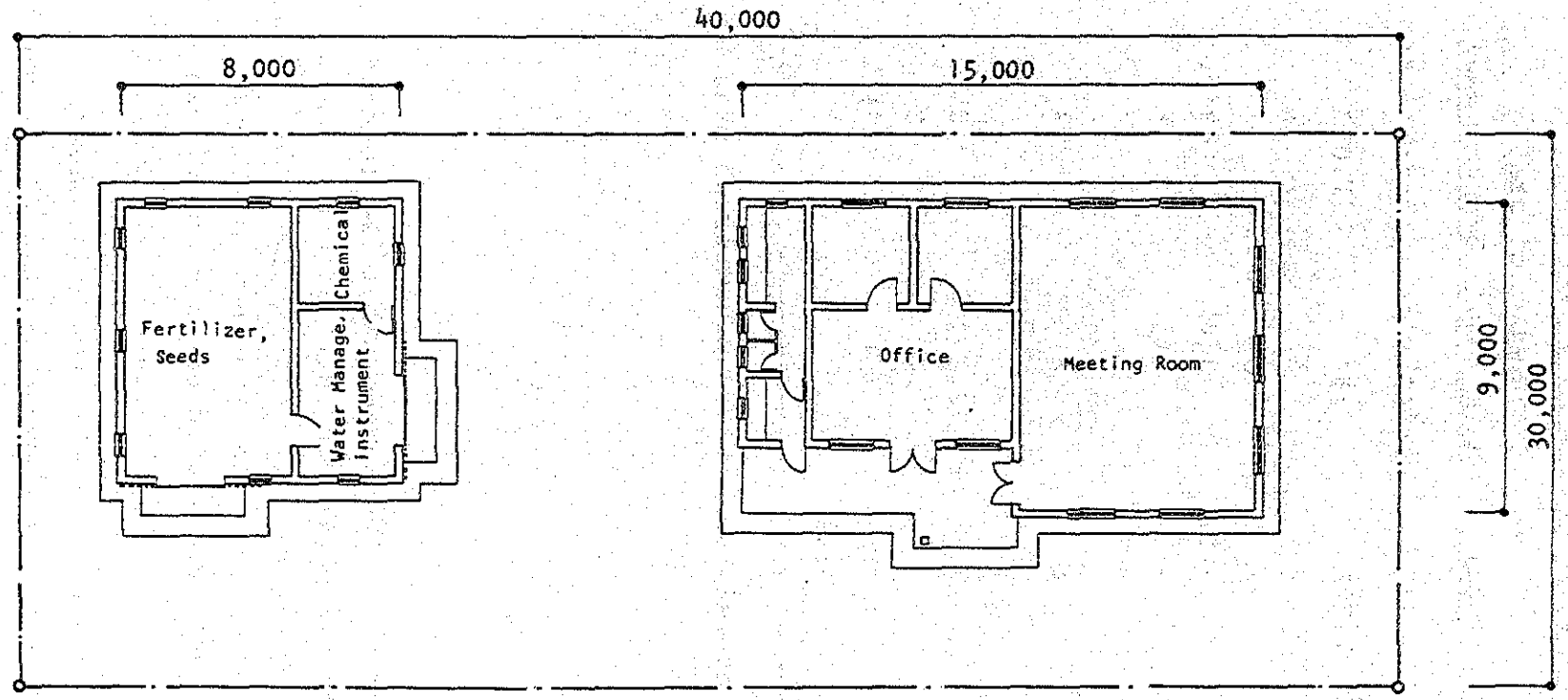
(2) INMAS Station

Training, education and agricultural supporting services to the farmers are to be executed at the INMAS Station proposed two in the area with the participation of related officials, farmers leaders, water distributors, contact farmers and farmer representatives. The INMAS Station will provide opportunities for official-farmer dialogue through meetings and training programme. Carriculum on training and education should include not only water management but also agricultural development aspects.

The Project Manager will be in overall charge of INMAS Station. Among officials in line agencies, 4 or 5 persons will be selected and do duty at INAMS Station to accomplish the planned carriculum for the farmers at the Stage. The staff of the Station should include the Technical Assistant, the Agriculture Instructor, and Divisional Officer.

The INMAS Station will serve normally as an office, and meeting room but as a warehouse also. The meeting room will be used for the education and training of farmers and for meeting of Sub-project committee. The warehouse adjoining the office should be used to store agricultural inputs such as fertilizer, seeds and chemicals before issue to farmers. The water management instruments should also be kept in the warehouse.

The staff to be posted to an INMAS Station should be selected from among the following members shown in Table 4.4.6. The general plan of INMAS Station is illustrated in Fig. 4.4.2.



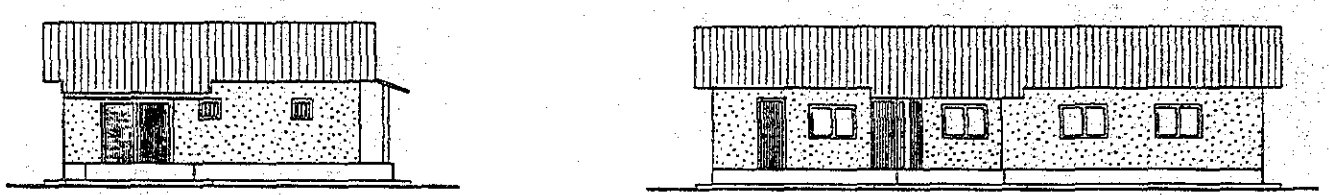


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Fig. 4.4.2 GENERAL PLAN OF INMAS STATION

Table 4.4.6 NOMINEES TO INMAS STATION

Description	Number of Staffs		
	Total	Main Canal	Branch Canal
Tract included	-	1,2,10,11, 12	3,4,5,6,7,8, 9
Irrigable Area in ha	1,791	704	1,087
Farmer Leader	2	1	1
Technical Assistant	2	1	1
Water Distributor	8(0)	3(0)	5(0)
Work Supervisor	4(3)	2(1)	2
Agricultural Instructor	1	1	
Agriculture Extension Worker (KVS)	4	2	2
Divisional Officer	1	1	
Cultivation Officer	3	1	2
Colonization Officer	3	1	2
Farmer Representative	(20)	(6)	(14)
Co-operative	4(0)		

Figures in parenthesis show present number of staffs

4.4.12 Livestock

Livestock development in the Scheme should be focused primarily on ensuring animal power for cultivations at the outset and then developed into dairy to meet the future demands and for marketing. In planning, livestock development for the Project Area should not confine within the Scheme area only.

There are a large number of cattle and buffaloes in the area which have been used for draught as well as for the production of meat and milk. The main constraints for the

development of animal husbandry in the area have been listed as follows:

i. Non availability of permanent grazing land for cattle and buffaloes in these areas;

ii. Inadequate transport facilities;

iii. Inadequate veterinary services;

iv. Lack of marketing facilities for produce like milk;

v. Out break of infectious diseases like Haemorrhagic Septicaemia (HS) and Foot and Mouth Disease (FMD);

The project should take necessary steps, for the removal of these constraints and thus improve services to the farmers. The major proposals for improving animal husbandry in the Project Area are as follows:

i. Demarcation of grazing lands,

ii. Upgrading of cattle and buffaloes through an intensified breeding programme,

iii. Control of infectious diseases prevalent in the area,

iv. Strengthening of veterinary services, and

v. Improved marketing of milk produced in the area.

Expenditures for these proposals are estimated in the Project Support costs.

4.5 ROAD SYSTEM PLAN

4.5.1 Basic Policy

The existing road system in Nagadeepa Area is deteriorated in its all portions, but the plans of road network seems to be adequate without any additional lines.