DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

FEASIBILITY STUDY ON WALAWE IRRIGATION UPGRADING AND EXTENSION PROJECT

VOLUME I

MAIN REPORT

JANUARY, 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

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MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

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PREFACE

In response to a request from the Government of Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a feasibility study on Walawe Irrigation Upgrading and Extension Project (Left Bank) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team headed by Mr. Toshihito Ohtani, Nippon Koei Co., LTD., two times between September 1991 and October 1992.

The team held discussion with the officials concerned of the Government of Sri Lanka, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

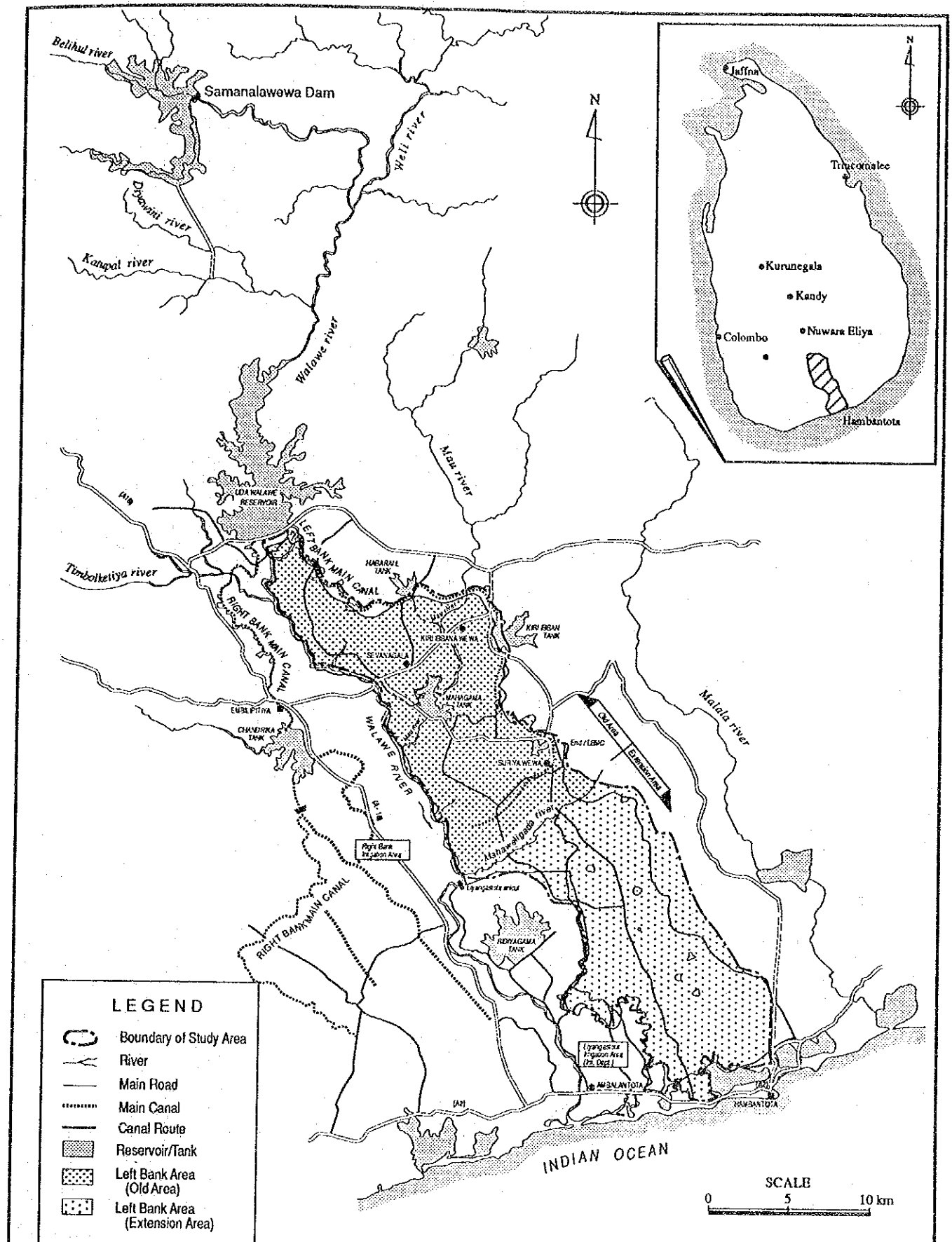
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team.

January 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

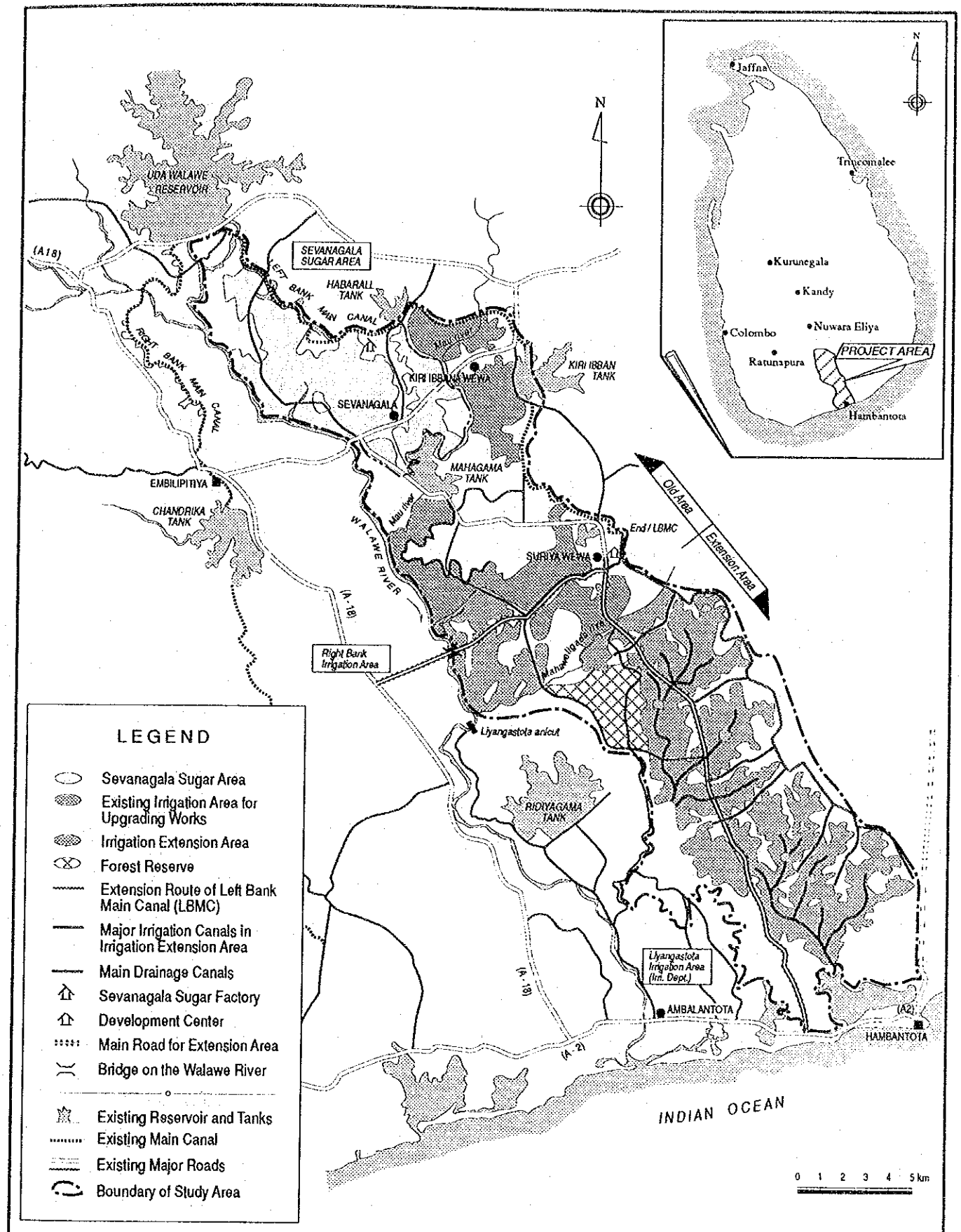


GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE FEASIBILITY STUDY ON WALAWE IRRIGATION UPGRADING AND EXTENSION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF THE STUDY AREA



WALAWE LEFT BANK IRRIGATION PROJECT

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE FEASIBILITY STUDY ON WALAWE IRRIGATION UPGRADING AND EXTENSION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

SUMMARY

1. Authority

This is the Final Report for the feasibility study on the Walawe Irrigation Upgrading and Extension Project (Left Bank). The Report was prepared in January 1993 in accordance with the Scope of Work agreed upon between the Government of the Democratic Socialist Republic of Sri Lanka through the Ministry of Lands, Irrigation and Mahaweli Development (the Government) and the Japan International Cooperation Agency (JICA).

2. Agriculture in Sri Lanka

Sri Lanka is an island country with 65,610 km^2 of land and population of 17.2 million in 1990. The population growth rate during the past decade was 1.5%, population density was 262 persons/km^2, life expectancy was 71 years and literacy rate of adult was as high as 87%. Per capita Gross National Product (GNP) in 1989 was US$430.

The country is divided into the dry zone and the wet zone. The dry zone covers the north, east, and southeast areas of the country, where food crops are principally cultivated. The wet zone covers the west, southwest and central mountainous areas, where tree crops such as tea, rubber, and coconut are grown.

The cultivation area is about 2 million ha: 1.0 million ha of tree crops, about 0.5 million ha of paddy, and about 0.3 million ha of subsidiary food crops. In addition, an estimated 1 million ha is under chena (slash and burn shifting cultivation). Irrigated land is 0.56 million ha.

3. Necessity of Agricultural Development

The agriculture sector plays an important role in Sri Lanka's economy, accounting for 26% of Gross Domestic Product (GDP), 36% of merchandise exports, and 48% of active labour force in 1990.

In the past, paddy dominated the field crop sector. Paddy production increased rapidly during the early 1980s. The major factor which helped to increase paddy yield was the Government's pricing policy ensuring strong producer incentives through successive increases in the official procurement prices, adjustment of retail prices, and continued fertilizer and irrigation subsidies. As a result, Sri Lanka had nearly achieved self-sufficiency in rice in the mid 1980s.

More recently, however, the Government has been taking policy re-orientation measures, which include crop diversification from paddy mono-culture, introduction of private sector in rice marketing, removal of fertilizer subsidy, peoplization of sugar industry, and privatization of seed production.

Since 1987, performance of the agriculture sector has been rather stagnant. Per capita production has decreased more than 10% compared with the 1979-81 level in terms of food, agriculture, crops, and cereals. Sri Lanka has been a food importer for many years and now still imports about 1 million tons of cereals and 0.3 million ton of sugar in each year.

Unemployment is one of the most serious problems in Sri Lanka. In 1990, the total labour force in Sri Lanka was 7 million, of which 1 million or 14.4% was unemployed. Of the active labour force, 48% was employed by the agriculture sector. The labour force increased by 1.84 million during 1981-1990, of which 53% was absorbed by agriculture and 34% by

industry. The unemployment ratio was particularly high in the densely populated districts such as Colombo, Gampaha, Kalutara, Galle, Matara, and Hambantota. Generation of 1 million job opportunities would be urgently required.

The Government's poverty alleviation drive contains the Janasaviya, Food Stamp, and School Midday Meal programmes. The present coverage of the Janasaviya programme up to round 2 is about 258,000 families. 6.8 million persons or 40% of the population received Food Stamps in 1991. More than 60% of the families in the left bank extension area were recipients of either the Janasaviya or Food Stamp programme.

In view of these facts, further efforts would be required of the Government to increase the stagnant agricultural production and restore the momentum of the early 1980s. Also, efforts would be required to increase the incomes of rural people and generate as much employment opportunities as possible. This is the rationale for implementation of agricultural development projects.

4. Background of the Feasibility Study

The Government of Sri Lanka initiated the Uda Walawe Scheme as early as 1963 aiming at irrigation development of 32,000 ha and settlement of people in the southern dry zone of the country. The Scheme comprised the construction of the Uda Walawe dam on the Walawe river and irrigation systems on both banks.

During the 1970s through 1980s, priority was given to the development of the right bank covering 12,000 ha of irrigable land. The Asian Development Bank (ADB) provided loans for two projects on the right bank - the Walawe Development Project (1970-1979) and the Walawe Irrigation Improvement Project (1986-1993).

Meanwhile the left bank with a gross area of 30,000 ha was only partly developed. About 4,400 ha have been reclaimed so far in the northern half, but the southern half there still remains thorn scrub land where unproductive chena cultivation has been practiced on small patches of land.

In order to recover the past investment and ease the ever increasing population pressure in the south of the country, the Government of Sri Lanka decided to further develop the left bank and complete the Uda Walawe scheme as originally planned.

In 1987, the Government of Sri Lanka requested technical assistance from the Government of Japan in undertaking a feasibility study on the Walawe Irrigation Upgrading and Extension Project (Left Bank). JICA and the Government of Sri Lanka concluded the Scope of Work for the feasibility study in 1990.

The objectives of the Study are to formulate comprehensive agricultural water resources development programmes for the Walawe left bank covering a total area of 30,000 ha and to conduct a feasibility study on the irrigation upgrading and extension project. The Mahaweli Authority of Sri Lanka (MASL) is the executing agency of the Project. The feasibility study has been conducted by the JICA Study Team with close collaboration of MASL from September 1991 to November 1992.

5. Study Area

Location

The study area is located on the left bank of the Walawe river in the southern dry zone of the country, about 180 km southeast of Colombo. The study area is divided into the old area in the north and the extension area in the south. The old area is subdivided into the Sevanagala sugar area and the MEA managed area.

Topography

Topography of the study area is a mixture of gently undulating slopes and flat lands. Soils are classified into two major groups: (i) reddish brown earths (RBE) which lie on slopes and are permeable, and (ii) low humic gley soils (LHG) which lie on the valley bottom and are poorly drained. Paddy fields reclaimed on RBE consume much irrigation water.

Meteorology and Hydrology

The study area belongs to the dry zone. The annual average rainfall ranges from 1,000 mm in the south to 1,400 mm in the north.

There are two large dams on the main stream of the Walawe river. The Uda Walawe dam has a catchment area of 1,152 km^2, an average inflow of 900 MCM and a live storage capacity of 240 MCM. The Samanalawewa dam located upstream of the Uda Walawe dam has a catchment area of 353 km^2, an average annual inflow of 527 MCM and a live storage capacity of 218 MCM. The power station with an installed capacity of 120 MW will be commissioned in 1993.

Agriculture

The total population of the Study area was estimated at 95,000 persons, and the number of households was 17,970 including encroachers and non-farm families. The Extension area was sparsely populated.

The landholding size in the MEA area is 1.20 ha consisting of 1.0 ha of irrigated land and 0.2 ha of homestead. In the sugarcane area it is 1.15 ha comprising 0.75 ha of irrigated sugarcane, 0.25 ha of irrigated paddy, and 0.15 ha of homestead.

Gross incomes of farmers in the MEA area and Sevanagala area were Rs. 47,000 and 54,000. However, net reserves of them were Rs. 1,000 and 6,600 respectively.

The Sevanagala sugar area consists of about 1,500 ha of irrigated sugarcane fields and paddy fields. The unit yield of sugarcane was constantly higher than other areas. In future, the area will be extended to 2,750 ha and the capacity of the Sevanagala sugar factory will also be increased to 4,000 tons/day. However, these expansion works are not included in the project works.

The MEA-managed area covers 2,900 ha of irrigated land comprising 2,540 ha of paddy field and 360 ha of upland crops. Statistics show that the Walawe project area has been constantly recording yield levels well above other districts in the country. Crop diversification has been progressing gradually and it was accelerated in 1992 due to the limited supply of irrigation water.

The Extension area has been under chena cultivation. Due to the dry climate, harvest is expected once in four or five years. Production is insignificant even for household consumption.

Existing Irrigation Infrastructure

The existing irrigation infrastructure comprises two gravity irrigation systems: the Uda Walawe system diverted from the Uda Walawe reservoir and the Mahagama system from the Mahagama tank.

Irrigation facilities in the Sevanagala sugar area were constructed in and after 1986. No project work will be proposed since canals are concrete lined and well maintained.

Irrigation facilities in the MEA-managed area will need rehabilitation and improvement works. The main canal has been eroded at several locations and now requires heightening and bank protection. The aqueduct of the main canal crossing over the Mau river has insufficient flow capacity. About two-thirds of existing concrete structures of the irrigation system have collapsed and ceased to function. There are no water management facilities.

In the Extension area, there are a number of old village tanks constructed during ancient times. Most of the tanks are not functioning due to breach or non-storage. Sixteen tanks with a command area of 300 ha in total were rehabilitated recently. The Project work will include rehabilitation of tanks, because they are expected to play an important role in the irrigation water management.

Existing Rural Infrastructure

In the Old area, road network and other rural infrastructures have already been established. In the Extension area, social infrastructure such as health and medical care facilities, education facilities, drinking water supply, communication service, and electrification are nearly non-existent. All roads and paths in the Extension area are unpaved and unmotorable in the rainy season.

6. Objectives and Scope of the Project

Consistent with the Government's sectoral development objectives, the proposed Project is aimed to increase agricultural production, incomes of rural people and employment opportunities in the Project area through upgrading and extension of irrigation facilities and provision of rural infrastructure.

The Project scope includes:

(i) upgrading and rehabilitation of the irrigation system including main, branch, distributary and field canals, and appurtenant structures in the MEA area (2,900 ha);

(ii) construction of an irrigation and drainage system including main, branch, distributary and field canals, regulating tanks, and appurtenant structures in the Extension area (5,340 ha) and the MEA area (1,040 ha);

(iii) provision of rural infrastructure including a rural water supply system, road network, health and medical care facilities, education facilities, electrification, communication, agro-extension facilities, and a development center;

(iv) provision of O&M equipment;

(v) engineering services including survey and detailed design;

(vi) administration and training.

The project will not include any work related to the Sevanagala sugar scheme.

7. Agricultural Development Plan

(1) Land use

The project area is 9,280 ha comprising 2,900 ha in the MEA area where upgrading works on existing irrigation facilities will be implemented and 6,380 ha in the Extension and MEA areas where new irrigation facilities will be constructed. After the project is completed, the total irrigation area on the left bank including the Sevanagala area will be 12,000 ha.

(Unit: ha)

Area	Existing Area	Area to be developed	Total
Old area			
a) Sevanagala sugar area	1,490	1,260	2,750
b) MEA area	2,900	1,040	3,940
Extension area	0	5,340	5,340
Total	4,390	7,640	12,030
Total excl. a)	2,900	6,380	9,280

(2) Cropping pattern

In compliance with the Government's crop diversification policy, the proposed cropping pattern has been worked out comprising paddy, sugarcane, big onion, banana, and vegetables. Sugarcane will be processed at the Sevanagala sugar factory, of which capacity expansion to 4,000 tons/day was assured between the Ministry of Plantation Industries and MASL in July 1992.

(Unit: ha)

Crops	Maha	Yala	Total
Paddy	4,540	4,540	9,080
Big onion	630	630	1,260
Vegetables	500	500	1,000
Banana	610	610	610
Sugarcane	3,000	3,000	3,000
Total	9,280	9,280	14,950

(3) Production

The incremental production of crops under the Project has been estimated comparing the with and without project conditions.

(Unit: ton)

Crops	With	Without	Increment
Paddy	49,940	22,108	27,832
Big onion	15,120	0	15,120
Vegetables	25,000	12,400	12,600
Banana	10,370	750	9,620
Sugarcane	342,000	0	342,000

(4) Production value

The incremental production value resulting from the Project has also been estimated comparing the with and without project conditions.

(Unit: Rs. 1,000)

Crops	With	Without	Increment
Paddy	212,472	86,868	125,604
Big onion	151,200	0	151,200
Vegetables	56,100	16,182	39,918
Banana	92,549	6,616	85,933
Sugarcane	219,825	0	219,825
Total	732,146	103,050	622,480

(5) Farm income

Annual farm income of typical farmers in the Extension area will increase from Rs. 10,000 at present to Rs. 78,000 after the project is completed.

(6) Agricultural supporting services

Agricultural credit facilities should be expanded to cover all crops.

Research activities should be extended to include such subjects as diversifying the varietal spectrum of sugarcane, development of suitable paddy and vegetable varieties, documentation and testing of the natural pest control method and the organic manures method for crop production.

Agricultural extension services should be intensified retaining elements of the training and visit system while maintaining research linkages.

Agricultural inputs supply would be handled by the private sector. Early establishment of dealer networks needs to be encouraged.

8. Irrigation Development Plan

The basic planning concept of the irrigation system is to adopt a tank cascade system. Reddish brown earths in the dry zone are well drained soils and require much water if they are used as paddy field. The tank cascade is the most efficient water re-use system which has been adopted in Sri Lanka since early historic periods. It was invented by ancient engineers to cope with the affluent water requirements for paddy cultivation.

In the Walawe left bank area, there exist many village tanks which were built in ancient times. Most of them will be incorporated into the project facilities after rehabilitation.

Upland crop irrigation is another important aspect. The basic intake rate test demonstrated that furrow irrigation is practicable. Upland irrigation is practised in daytime and requires night storage. The tank cascade will serve effectively for this purpose.

A preliminary study has been made on the Timbolketiya river diversion plan which aims to augment the available water resources in the Walawe river basin by means of diverting the flow of the Timbolketiya river to the right bank main canal of the Uda Walawe irrigation system.

Three alternative diversion plans were examined. Conclusion is that implementation of the plan should be suspended until the project management of the left bank reaches full development scale and/or additional water demand occurs outside the current project area. Further study is recommended.

9. Water Balance Study

The water balance study has been conducted to (i) determine the potential development area on the left bank; (ii) examine the impacts of the left bank development on the existing water users such as the Kaltota scheme, Liyangastota anicut and domestic water supply at Ambalantota; (iii) assess the effects of the Samanalawewa reservoir operation; and (iv) examine the possibility of the Timbolketiya diversion plan.

Water balance calculation has been undertaken at four check points and 25 alternative cases using 30 years monthly data of river discharge and water requirements. For the right bank, two kinds of water requirements are used. The 80% dependability is adopted as judgement criteria.

The result of calculation indicates (i) 6,380 ha of new irrigation development on the left bank is justifiable, (ii) No deficit will occur for the Liyangastota anicut and domestic water supply at Ambalantota, (iii) operation of the Samanalawewa reservoir will bring forth favorable effects to the overall water management of the Walawe basin, (iv) Timbolketiya diversion plan will reduce the amount of deficit of the Uda Walawe reservoir and increase the safety of water management in the Walawe basin, (v) the two kinds of water requirements for the right bank will make no difference in the potential development area on the left bank under the condition of with Samanalawewa and without Timboliketiya, and (vi) deficit of the Uda Walawe reservoir normally occurs in the latter part of Yala season, which gives a certain prospect on the water management method of the Uda Walawe reservoir.

10. Project Works

Project works are summarized below.

(i) Upgrading and rehabilitation of existing irrigation facilities in the MEA area of 2,900 ha, including a total of 190 km of the left bank main canal and subordinate canals and 2,200 of related structures;

(ii) Construction of irrigation and drainage facilities in the Extension and MEA areas of 6,380 ha including 25 km of the left bank main canal, 313 km of subordinate irrigation canals, 47 tanks, 254 km of drainage canals, about 1,000 structures, and 322 km of canal inspection roads;

(iii) Land reclamation for 5,240 ha of paddy and upland fields and construction of on-farm works for 6,380 ha;

(iv) Provision of infrastructure including preparation of 1,200 ha of land for 22 villages, 28 schools, 12 health & medical care facilities, 22 drinking water supply systems, 140 km of roads, 4 electricity supply systems, 4 telecommunication facilities, 22 administration offices, 6 agro-extension facilities, and a development center.

11. Implementation Programme

It will take two years (1993-94) for the budget arrangement and detailed design. The construction will be started in 1995 and completed in 1998. The construction works will be executed by contractors selected by international competitive bidding.

The executing agency of the Project for both the construction and following operation stages will be the Mahaweli Authority of Sri Lanka who has sufficient ability and experience in this kind of agricultural development and settlement project.

12. Cost Estimate

The total project cost (initial investment cost) has been estimated at Rs. 5,483 million (US$124.6 million) based on the price level of August 1992. The project cost consists of the base cost of Rs. 3,991 million and the price contingency of Rs. 1,492 million.

(Unit: Rs. million)

Description	L/C	F/C	Total
A. Direct construction cost	1,090	1,816	2,906
(1) Rehabilitation and upgrading works	(108)	(157)	(265)
(2) Extension work of irrigation area	(545)	(969)	(1,514)
(3) Rural infrastructure work	(427)	(690)	(1,117)
(4) Environmental mitigation measures	(10)	(0)	(10)
B. Associated cost	220	345	565
(1) Administration expenses	(220)	(0)	(220)
(2) Engineering service cost	(0)	(345)	(345)
C. Physical contingency	197	323	520
Sub- total (A + B + C)	1,507	2,484	3,991
D. Price contingency	1,022	470	1,492
Total	2,529	2,954	5,483

13. Justification

(1) Economic evaluation

In the economic evaluation of the Project, the economic internal rate of return (EIRR), benefit-cost ratio (B/C) and net benefit (B-C) have been examined based on economic capital costs, O&M and replacement costs, and economic benefits for 50 years.

As a result, EIRR of 17.3%, B/C of 1.72 assuming discount rate of 10%, and B-C of Rs. 1,771 million have been obtained.

These figures indicate that the Project is economically feasible.

(2) Financial evaluation

A farm budget analysis has been made comparing the with and without project conditions. The net farm income of a typical farmer in the extension area who is allocated 1.0 ha of irrigated land has been estimated at Rs. 78,800 per annum. This compares to the farm income of Rs. 10,000 at present. The Project is viable from the point of view of farmers' income.

(3) Employment generation

The Project will generate about 20,000 employment opportunities including the farmer settlers, farm labourers, employees of sugar factory, workers and merchants in village centers, school teachers, and officers. Total number of beneficiary families will be 11,000 and beneficiary population will be about 60,000.

14. Environmental Assessment

Environmental impacts have been assessed in the aspects of flora, fauna, and sociology.

(1) Flora

In the Extension area, shifting cultivation has been the main occupation of the people supported by the husbandry of cattle and buffalo. Scrub jungle or thorn scrub land and degraded secondary forests are the general matrix of terrestrial vegetation throughout the extension area. The only primary forest is the Madunagala forest which has an area of about 140 ha and forms part of the forest reserve.

As a compensatory measure for the loss of plant cover, tree planting should take place along river banks, canal banks, and in the tank watersheds.

(2) Fauna

Despite the degraded condition the extension area serves as a reasonably good wildlife habitat, sustaining invertebrates to fish, amphibians, reptiles, birds and mammals. In the past 15 to 20 years, these species have been almost completely wiped out from the area, mostly at the hands of poachers. The elephants, however, have managed to hold out amidst great odds. These elephants, numbering over 150, moved in small family groups from one village tank to another feeding in the scrub.

The elephant issue in the Hambantota district can be resolved by creating conditions and means for their judicious dispersal to more suitable areas, thereby eliminating the almost year-round pressure on cultivations and settlements. The mitigating strategies are based on three proposals: (a) to set up electric fencing along the eastern border of the extension area; and (b) evacuation of elephants.

(3) Aquatic environment

Aquatic weeds have a widespread coverage in canals. Biological control of Salvinia may be tried in the project area.

The undesirable impacts on aquatic fauna will arise from the excessive use of fertilizers and agrochemicals. In the long term, breeding varieties resistant to the major pests and diseases and the use of more organic manures will be the right steps.

(4) Physio-chemical environment

Esosion control and soil conservation should be a primary consideration. Analysis of surface waters should be carried out at least twice a year to determine the nature and levels of contamination by organic, inorganic and bacterial pollution. Studies are recommended on salinity problems in irrigated farming and impacts of agricultural run-off into Karangan Lewaya.

(5) Socio-economic environment

Fuel wood coops should be established with fast-growing fuel wood species. In view of the poor quantity of ground water, provision of potable water is considered imperative.

Farmers organizations should be established and responsibility delegated. There should be minimum health care facilities available when settlers arrive.

Archaeological sites and artifacts will have to be reported to the Department of Archaeology.

15. Conclusion and Recommendations

(1) The Project essentially forms part of the 30-year old Uda Walawe scheme and is intended to complete the scheme as originally conceived. It can take advantage of full utilization of past investments such as the Uda Walawe reservoir and irrigation system.

The current feasibility study concludes that the Project is technically feasible and economically sound, and that adverse environmental impacts could be minimized through mitigation measures and the Project outweighs undesirable environmental impacts.

(2) It is recommended that the Government immediately implement the Project.

(3) It is recommended that the Government take measures to ensure the realization of planned crop diversification.

(4) It is recommended that the Government adopt the tank cascade system to realize the most efficient irrigation water management.

(5) It is recommended that the Government make arrangements to synchronize the production of sugarcane by farmers and the expansion of processing capacity of the Sevanagala sugar factory.

(6) It is recommended that the Government take mitigatory measures as a precaution against adverse environmental impacts and undertake a benchmark survey and periodical monitoring of the environment impacts in the Project area.

FEASIBILITY STUDY
ON
WALAWE IRRIGATION UPGRADING AND EXTENSION PROJECT
(LEFT BANK)

MAIN REPORT
(Volume I)

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GROSSARY OF TERMS AND ABBREVIATIONS

ADB	Asian Development Bank
AGA	Assistant Government Agents
Anicut	A diversion weir to abstract water from a natural channel
AP	Environmental Action Plan
ARS	Agricultural Research Station
ARTI	Agricultural Research and Training Institute
BC	Branch Canal
BM	Block Manager
BOD3	Biological Oxygen Demand after 3 days
CA	Catchment area
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CECB	Central Engineering Consultancy Bureau
CFC	Ceylon Fertilizer Corporation
Chena	Burning, slashing and shifting cultivation
COD	Chemical Oxygen Demand
Crop diversification	Increase of area devoted to OFCs
DA	Department of Agriculture
DA&DDP	Draught Animal and Dairy Development Project
DC	Distributary Canal
DM	Department of Meteorology
DWC	Department of Wildlife Conservation
EA	Environmental Assessment
EC	Electricity Conductivity
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FA	Field Assistance
FAO	Food and Agriculture Organization of United Nations
FC	Field Canal
FSWL	Full Supply Water Level
GA	Government Agent
Ganga	River
GDP	Gross Domestic Product
GN	Grama Ndahari, Sub-division of Assistant Government Division
GOSL	Government of Sri Lanka
HAB	Hambantota
HD	Health Department
HIB	Human Inhabited Zone
HIRDP	Hambantota Integrated Rural Development Programme
HUZ	Human Unhabited or sparsely Inhabited Zone
ID	Irrigation Department
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
IRDP	Integrated Rural Development Programme
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
km	Kilometer
KOISP	Kirindi Oya Irrigation and Settlement Project

LB	Left bank
LHG	Low Humic Gley (soils)
M/LIMD	Ministry of Lands, Irrigation and Mahaweli Development
Maha	North-east monsoon season (appox. Oct -Mar.)
MASL	Mahaweli Authority of Sri Lanka
MC	Main Canal
MCM	Million cubic meters
MEA	Mahaweli Economic Agency
MECA	Mahaweli Engineering and Construction Agency
MMP	Motto MacDonald Group (former Sir M. MacDonald & Partners)
NPC	National Paper Corporation
NWSDB	National Water Supply and Drainage Board
O&M	Operation and Maintenance
OFCs	Other Field Crops, meaning all field crops other than paddy rice
Oya, Ara	River
PBME	Project Benefits Monitoring and Evaluation
PCR	Project Completion Report
PHI	Public Health Instructor
PMB	Paddy Marketing Board
PMU	Planning and Monitoring Unit of MASL
RARS	Regional Agricultural Research Station
RB	Right Bank
RBE	Reddish Brown Earth
RPM	Resident Project Manager
RPM	Resident Project Manager
RRS	Rice Research Stations
Rs.	Sri Lanka Rupee
RVDB	River Valleys Development Board
SER	Supplemental Environmental Report
SLSC	Sri Lanka Sugar Corporation
SRI	Sugar Research Station
SRI	Sugarcane Research Station
SSI	Sevanagala Sugar Industries
S/W	Scope of Works
Tank	A reservoir storing water for irrigation
TV	Training and Visit
UM	Unit Manager
US $	United States Dollar
Wewa	Water tank
WHO	World Health Organization
WIIP	Walawe Irrigation Improvement Project
Yala	South-west monsoon season (approx. Apr -Aug.)

CONVERSION FACTORS

1 ft	0.3048 m
1 acres	0.4048 ha
1 cusec	28.32 lit/sec
1 m	3.2808 ft
1 cu-m/s	35.31 cu-ft/sec
1 MCM	1,000,000 cu-m = 810.68 acre-ft
1 ha	2.47 acre
1 in	2.54 cm
1 mile	1,609.34 m
1 $mile^2$	2.59 x 10^6 m^2
1 ac-ft	1,233.83 m^3

CURRENCY EQUIVALENT

(rate in August 1992)

US$1.00 = Rs. 44.0 = ¥126.5

FISCAL YEAR

From 1/Jannuary to 31/December

CHAPTER 1 INTRODUCTION

1.1 Authority

This is the Final Report prepared in January 1993 in accordance with the Scope of Work for the feasibility study on the Walawe Irrigation Upgrading and Extension Project (Left Bank) (the Study) agreed upon between the Government of the Democratic Socialist Republic of Sri Lanka through the Ministry of Lands, Irrigation, and Mahaweli Development (the Government) and the Japan International Cooperation Agency (JICA).

1.2 Genesis of the Study

The Government of Sri Lanka (then Ceylon) initiated the Uda Walawe Scheme as early as 1963 aiming at the irrigation development and resettlement of people in the southern dry zone of the country. The Scheme comprised the Uda Walawe dam on the Walawe river and irrigation systems on both banks.

During the 1970s and 1980s, priority was given to the development of the right bank. The Asian Development Bank (ADB) provided loans for two projects concerning the right bank development - the Walawe Development Project (1970-1979) and the Walawe Irrigation Improvement Project (1986-1993).

Meanwhile the left bank covering a gross area of 30,000 ha was only partly developed. About 4,400 ha has been reclaimed so far in the northern half, comprising 1,500 ha of sugar cane field and 2,900 ha of paddy field. However, the southern half remains as thorn scrub land with scattered trees where unproductive chena cultivation has been practiced sparsely on small patch of lands.

In order to recover the vast investment in the past and ease the ever increasing population pressure in the south of the country, the Government of Sri Lanka decided to complete the 30 year old project through full development of the left bank. In 1987, the Government of Sri Lanka requested technical assistance from the Government of Japan in undertaking a feasibility study on the Walawe Irrigation Upgrading and Extension Project (Left Bank). In response to the request, JICA sent a preliminary study team to Sri Lanka in November 1990 and concluded the Scope of Work for the feasibility study after discussion with the Government. (Attachment)

The Mahaweli Authority of Sri Lanka (MASL) is the executing agency of the Project.

The feasibility study was conducted by the JICA Study Team in close collaboration with MASL during the period from September 1991 to November 1992.

1.3 Main Features of the Study

(1) Objectives

The Scope of Work defines the objectives of the study as follows:

(i) to formulate comprehensive agricultural water resources development programmes for the Walawe Irrigation Upgrading and Extension Project (Left Bank) (approximately 30,000 ha);

(ii) to conduct a feasibility study on Extension of Walawe Left Bank (approximately 15,000 ha);

(iii) to undertake on-the-job training of the Government's officials in the course of the study.

The study area comprises the Old area and the Extension area. The Old area (approximately 15,000 ha) is in the northern half of the study area where farmers have already settled and irrigation facilities have been constructed but necessarily upgraded. The Extension area (approximately 15,000 ha) is in the southern half of the study area of thorn scrub land where new irrigation development and settlement of people are envisaged by the project. In this study, the cropping pattern of the old area will be changed from paddy mono-culture to diversified crops according to the Government's crop diversification policy and certain rehabilitation and upgrading works have been proposed for the irrigation facilities in the old area. Therefore, the objective area of the feasibility study was taken to be the entire study area including the Old and Extension areas in spite of the above definition (ii).

(2) Study Area

The Study area is to cover the Walawe Left Bank (approximately 30,000 ha). (refer to Location Map)

(3) Scope of Work

Phase I Study (September 1991 ~ March 1992)

(i) Formulation of an agricultural development plan for the Walawe Left Bank (old and extension areas);

(ii) Formulation of an irrigation and drainage plan for the Walawe Left Bank (old and extension areas).

Phase II Study (June 1992 ~ November 1992)

(i) Feasibility study on the irrigation development project for the Walawe Left Bank;

(ii) Environmental assessment study and environmental action plan.

(4) Reports

The following reports were prepared and submitted to the Government.

Inception Report	:	September 1991
Progress Report (1)	:	December 1991
Interim Report	:	March 1992
Progress Report (2)	:	August 1992
Draft Final Report	:	October 1992
Final Report	:	January 1993

The Final report comprises the following four volumes.

Volume I	MAIN REPORT	
Volume II	ANNEX-I - IX	AGRICULTURE AND IRRIGATION
Volume III	ANNEX-X	ENVIRONMENTAL IMPACT STUDY
Volume IV	DRAWINGS	

1.4 Performance of the Study

(1) Phase I Study

The Phase I Study was started on the 30th September 1991 when the JICA Study Team arrived in Colombo. A meeting was held to explain and discuss the Inception Report between the JICA Study Team and MASL. A discussion was made on the approach to the Project, study schedule, and MASL's counterpart personnel. Minutes of the meeting are attached in Annex-I.

MASL nominated 18 counterpart personnels. JICA Study Team and counterpart team closely cooperated in the performance of the Study. Monthly regular meetings were held between both teams to discuss the progress and problem of the Study and important technical matters. Each member of JICA Team also worked together with counterpart and conducted on-the-job training throughout the Study period.

Field surveys conducted during the Study included soil, water quality, socio-economic surveys, interviews of farmers representatives, inventory of irrigation facilities, and intake rates of soils. Data were collected regarding natural conditions, agriculture, and infrastructures. The operational policy of the Samanalawewa reservoir was provided by the Ceylon Electricity Board (CEB).

In December 1991, works in Sri Lanka under the Phase I study was completed. Progress Report (1) was prepared and submitted to MASL. Minutes of the meeting for discussion of the Progress Report (1) are attached in Annex-I.

Additional works in Japan were completed from January to March 1992 and the Interim Report was compiled and sent to MASL

(2) Phase II Study

The Phase II Study was started on the 1st June 1992. At first the Interim Report was discussed by the JICA Study Team and MASL. The minutes of the meeting are attached in Annex-I. Another meeting was held to discuss the water requirements of the Walawe right bank which was attended by MASL, representatives from the Asian Development Bank, and JICA. It was decided that Mott MacDonald, the British consultants attached to the right bank project, would reassess the water requirements of the Walawe right bank based on three scenarios of crop diversification and the JICA Study Team would make a sensitivity analysis in the water balance study based on these results.

Field surveys were completed and data were collected with regard to the soil, geology, soil mechanics, topography, land use, agriculture, agro-economy, marketing, irrigation and, drainage.

Environmental assessment study was conducted by a local team comprising an environmental scientist, a zoologist, and a botanist.

In August 1992, works in Sri Lanka under the Phase II study were completed. Progress Report (2) was prepared and submitted to MASL. Minutes of the meeting are attached in Annex-I.

Additional works in Japan followed until October 1992 and a Draft Final Report was compiled. The Draft Final Report was discussed in November in Colombo. This Final Report was completed in January 1993 incorporating MASL's comments.

CHAPTER 2 BACKGROUND

2.1 The Agricultural Sector

Sri Lanka is a small island country with an area 65,610 km^2 and a population of 17.2 million people in 1990. The annual population growth rate during the past decade was 1.5%, population density is 262 persons/km^2, life expectancy is 71 years, and literacy rate of adults is 87%. Sri Lanka's GNP per capita grew at an annual rate of 3% during the 25 years from 1965 to 1989 and reached US$430 in 1989.

(1) Agriculture in Sri Lanka

Sri Lanka's climate is dominated by monsoons. There are two seasons which are locally called the Maha and Yala seasons. The Maha season continues from October to March when the northeast monsoon prevails and brings rainfall to the whole country. The Yala season lasts from April to August when southwest monsoon brings rainfall mainly to the central mountain regions and the south-western part of the country.

The country is divided into dry and wet zones. The dry zone covers the north, east, and southeast of the island occupying three quarters of the total country area. In the dry zone rainfall is less than 1,900 mm annually or less than 500 mm for the Yala season.

The wet zone covers the central mountain region and southwest part of the country. In the wet zone rainfall exceeds the above limits. In the dry zone, major crops are paddy, sugarcane, and other subsidiary food crops grown by small land holders. On the contrary, tree crops such as tea, rubber, and coconuts are cultivated on a estate basis in the wet zone.

The cultivation area is about 2 million ha. Plantation crops (tea, rubber, and coconut) account for 1.0 million ha, paddy about 0.5 million ha, subsidiary food crops (coarse grains, roots and tubers, pulses, oil seeds, spices, etc.) about 0.3 million ha, and other crops, fruits, and vegetables about 0.1 million ha. In addition, an estimated 1 million ha are under slash and burn shifting cultivation, locally known as Chena. The irrigated area is 0.56 million ha, most of which is for paddy.

(2) Performance of the agricultural sector

Agriculture plays an important role in Sri Lanka's economy, accounting for 26% of GDP, 36% of merchandise exports, and 48% of the active labour force in 1990. About 75% of the country's population live in rural areas and are engaged in agriculture-related activities. In addition, much of the manufacturing, transport, and service sector activity is related to the supply of agricultural inputs and to the marketing and processing of agricultural outputs.

Sri Lanka's economy had grown at an annual rate of 3.4% on an average in real terms during 1985-1990. However, the agricultural sector was rather depressed and unstable particularly in the three year period and 1987 to 1989. GDP growth rates of the agricultural sector were -8.1% in 1987, 3.3% in 1988, and -1.9% in 1989. This was due to the low production of rice, tea, and coconuts mainly caused by drought, low international prices of Sri Lanka's major export commodities, and terrorist activity. Recovery of the agricultural sector emerged in 1990 registering 10.8% of annual growth rate.

In recent years, however, performance of the agricultural sector has been stagnant. Agricultural production has decreased more than 10% from the 1979-1981 level in terms of per capita production for food, crops, livestock and cereals. (refer to Table 1)

(3) Trade

Sri Lanka's trade expanded yearly during 1980-1989; exports and imports increased at an annual rate of 6.7% and 2.3%, respectively. However, the balance of payment had been in the deficit constantly.

The structure of trade is changing. Food imports which were 41% of the total imports in 1965, have decreased to 14-19% in recent years. In spite of this drastic reduction, the food imports are still at a high level for an agricultural country like Sri Lanka. Major imported foodstuffs are sugar, wheat, milk products, and rice, of which domestic production and volume of import are shown in Table 2.

During the 1950s production of rice was below 50% of demand. It was the Government's top priority policy after independence to achieve self-sufficiency in rice. By the mid 1980s Sri Lanka had nearly accomplished self-sufficiency. In view of the recent stagnant production, further efforts would be required to restore the past momentum.

Domestic production of sugar is far below the domestic consumption. Self sufficiency in sugar is only 15%. Wheat is not produced in the country because of the unsuitable climatic conditions.

(4) Employment

According to the Government's labour force survey in 1990, the total labour force is about 7 million, of which 6 million or 85.6% is employed and 1 million or 14.4% is unemployed. Sector-wise, agriculture employs 2,851,000 or 47.8% of the active labour force, followed by services sector of 1,786,000 or 29.9% and industry of 1,224,000 or 20.5%. During the nine years from 1981-1989, the work force increased by 1,840,000, of which 976,000 was employed by agriculture, 631,000 was employed by industry and 504,000 was absorbed by services sector.

The highest unemployment is found in the age group of 20-24 years, followed by the age groups of 15-19 years and 25-29 years, of which unemployment rates are 34.8%, 29.9%, and 17.2%, respectively. Geographically, higher unemployment is observed in the densely populated south-western districts such as Colombo, Gampaha, Kegalla, Kalutara, Galle, Matara, and Hambantota. Colombo, Hambantota, and Kegalla show unemployment rates of 20-24%.

2.2 Agricultural Development Strategy

(1) Public investment programme

Public Investment Programmes set out national economic development policy for the coming five years based on the rolling plan concept which can to be reviewed and revised every year. The Public Investment Programme (1990-1994) states that it concentrates basically on the timely completion of ongoing projects in priority areas such as power, irrigation, road rehabilitation, water supply, and telecommunications and that an important consideration in the allocation of resources is the availability of foreign aid to cover a greater part of expenditure.

The major goals of the Public Investment Programme (1990-1994) for the agriculture sector are as follows:

(i) A moving towards a higher degree of self-reliance in basic food commodities, such as rice, fish, sugar, pulses, and milk;

(ii) An increasing the productivity of the tree crop sector to expand export earnings;

(iii) Promoting diversification and encouraging the establishment of agro-industries which will increase incomes and employment opportunities in rural areas.

The projected public investment for the period between 1990 and 1994 amounts to Rs. 200.9 billion of which the agricultural sector makes up 17.5% or Rs. 35.2 billion. Out of the budgeted expenditure in agriculture about 52% goes on irrigation. A large portion of the expenditure still goes into the Mahaweli programme.

(2) Policy for agricultural development

In the past, paddy dominated the field crop subsector. Paddy production increased rapidly during the early 1980s. The increase was attributed to the increase in unit yield rather than an increase in crop area. The major factor which helped to increase paddy yield was the Government's pricing policy ensuring strong producer incentives through successive increases in the official procurement prices, adjustment to retail prices, and continued fertilizer and irrigation subsidies. The other factors which contributed to the improved yield were wide dissemination of improved seed varieties and fertilizer, improved institutional and support services including input supply, agricultural marketing, and processing and credit facilities.

More recently, the Government is taking policy re-orientation measures as follows:

(i) Liberal marketing

The Government promoted a liberal marketing policy encouraging private sector participation in marketing, processing and storage of paddy, and limiting the role of the public sector in maintaining the floor price of paddy at farm level and the ceiling price of rice at consumer level.

(ii) Fertilizer subsidy

The Government subsidy on fertilizer was removed in January 1990, and its effect was reflected in the sharp decline, by 18%, in the use of fertilizer 1990. Paddy sector which accounted for 40% of total issues dropped significantly by 29%. In 1991, fertilizer use in the paddy sector showed a 9% increase over the previous year. With a view to minimize the adverse impact of higher fertilizer prices on farmers, fertilizer recommendations for paddy and some OFCs were revised by the Department of Agriculture in 1990, and use of straight fertilizers were recommended in place of mixtures.

(iii) Peoplization on sugar industry

The development of the sugar industry has, until recently, depended on Government investment and support. This position has changed since the conversion of the Sri Lanka Sugar Corporation into a public company, the Sri Lanka Sugar Company, which owned and managed the plantations and factories in Kanthale, Hingurana, and Sevanagala. This company was converted once more in 1991, to a holding company, and the three plantations and factories were converted

into three autonomous public companies as a prelude to peoplization. It is expected that the process of peoplization of these three industries will be completed in 1992.

(iv) Privatization of seed production

The Seed Division of Department of Agriculture (DOA) through its seed farms and processing units was producing foundation, registered and certified seeds, the latter for distribution throughout the country. The national seed requirement is partly met by private contract growers for the detailed certified of paddy and potato. The Seed Certification Division of DOA provides quality control services. The DOA seed production programme is heavily subsidized but still incurs annual losses. Subsidies to DOA has discouraged private sector participation in seed production and encouraged importation and distribution of mainly vegetable seeds. The Governments decision to withdraw from commercial seed business has necessitated a published seed policy. This is being established with assistance from the Diversified Agricultural Research Project (DARP).

The World Bank/DA assistance has been proposed to establish seed legislation to attract commercial interest, to accelerate the process of introducing new material, and to develop recommendations. The Government policy on the import of seeds and planting materials was crop relaxed in December, 1991, allowing imports in the following categories: (i) without restriction; (ii) with special requirements fulfilled; and (iii) prohibited except to research institutes.

(3) Poverty alleviation

The Government's poverty alleviation drive contains the Janasaviya Programme, Food Stamp Programme, and School Midday Meal Programme.

Under the Janasaviya programme, poor families, who are below the poverty line of Rs. 700 per month, are entitled to receive Rs. 2,500 per month per family which comprises Rs. 1,042 of investment component and Rs. 1,458 of consumption component. The investment component takes the form of a credit collateral support. All Janasaviya families are eligible for bank credit up to Rs. 25,000 which can be used for production projects. Round one of the Janasaviya programme commenced in October 1989 with 190,000 families and Round two with 104,000 families commenced in December 1990. Round three is scheduled in 1992.

Food stamps are available to poor families with monthly incomes of less than Rs. 700. As more families receive Janasaviya, the number of food stamp recipients has shown a decline. In 1991, 6.8 million persons or 40% of the population were receiving food stamps. Later the cash payment were converted to the food stamps of the same value.

The School Mid-day Meal has been implemented since 1969 for the provision of a free midday meal to 4 million school children in 10,000 schools.

2.3 Previous Developments and Development Plans

2.3.1 Water resources developments in Walawe basin

The Walawe river basin covers an area of 2,442 km^2 and extends from the central hills massif of Sri Lanka to the southern coast in the Ranna/Hambantota area. Hundreds of small irrigation tanks which were constructed during the early and middle historic periods are scattered throughout the Walawe river valley. Archaeological study reveals that in ancient times this area supported a much larger population than at present.

In 1889 the Liyangastota anicut was constructed on the Walawe river 21.5 km upstream from the river mouth. The anicut irrigates about 6,200 ha of paddy field on both banks. Later, the Ridiyagama tank was constructed on the left bank to regulate the flow.

The Mahagama tank is one of the ancient tanks built on the Mau river. Relics of stone made sluice with sculptures of cobras remain. The tank was rehabilitated after World War II for 580 ha of paddy irrigation and resettlement.

The Chandrika tank was built in the early 1960s on the Hulanda river for 2,100 ha of paddy irrigation and resettlement of people. This tank system was later brought into part of the right bank irrigation system under the Uda Walawe scheme.

The Habaralu and the Kiriibban tanks were constructed as part of the left main canal. The two tanks are the so called level crossing without regulation function.

The Kaltota irrigation scheme is located downstream of the Samanalawewa dam on the Walawe main stream and irrigates 870 ha of paddy field.

2.3.2 Uda Walawe irrigation development

(1) Walawe Development Project

The programme for rehabilitation and resettlement of this valley was initially included in the Ten Year Plan prepared by the National Planning Council in 1959. In 1962, Engineering Consultants, Inc., USA, conducted a feasibility study of the Uda Walawe Reservoir for the dual purposes of irrigation and power generation. A number of large scale dam-irrigation projects were proposed such as the Samanalawewa project, Weli Oya project, and Uda Walawe project. Each project was allocated a respective river basin, water resources and irrigation area. The Uda Walawe dam was to irrigate 17,400 ha of paddy land using water collected from the downstream basin of the Samanalawewa and Weli Oya Projects.

The Government started construction of the Uda Walawe Dam in July 1963. The planned irrigation area was 20,000 ha and 15,000 ha in the Maha and Yala seasons, respectively. The dam was a 4 km long and 36 m high earth fill dam with 240 MCM of live storage. The installed capacities of power generation on both banks was 5.4 MW. The dam and power plants and part of the right bank and left bank main canals were completed in the later part of 1967. Water of the Uda Walawe reservoir was released for the first time in April 1968 to supplement the irrigation supply of the Chandrika tank. This made it possible to grow a second (Yala) crop on 2,100 ha of paddy field under the Chandrika tank.

Investigation and planning of agricultural development started much later than the engineering side. Two Israeli experts were invited in November 1967 to advise on the establishment of family farms in connection with settlement and colonization under the Colombo Plan. Technical Cooperation Scheme, Hunting Technical Services Ltd, UK, worked out a development plan in August 1968, including cropping, animal husbandry, and farm settlement plans. The plan proposed a development of 42,000 ha; RB 17,200 ha and LB 24,800 ha cultivating paddy, sugar cane, cotton and subsidiary crops on both the settler and estate bases.

In March 1969, the Government of Ceylon requested the Asian Development Bank's assistance in financing part of the development cost of the right bank area of the Walawe Development Scheme. The Walawe Development Project, under ADB finance, aimed at rural and irrigation development exclusively for the right bank area. The Government introduced a new cropping pattern which was not conceived in the previous plans: i) double cropping of rice on lowland soils; ii) sugar cane on high land soils of the northern left bank; and iii) Yala cotton in rotation

with subsidiary food crops in southern zones of both banks. The total area was estimated to be 32,832 ha; RB 13,422 ha and LB 19,410 ha including the Chandrika area.

The executing agency of the project was the River Valleys Development Board (RVDB), a government corporation created in 1965 for overall development of the Walawe river basin. The project started in 1970. The project components included; (i) improvement of the existing irrigation system and land use; (ii) construction of irrigation facilities in the new developed areas; (iii) land settlement and development of social infrastructure; and (iv) provision of facilities for community and agricultural development.

The disbursement period of the ADB loan was originally three and a half years. But, it took nine years until all works were substantially completed in 1979. The project cost was US$33.6 million. An overall assessment of the project works was made by ADB and a Project Completion Report was prepared in 1979.

(2) Walawe Irrigation Improvement Project

The project completion report on the Walawe Development Project prepared by ADB in 1979 indicated that the operational performance of the project was less than satisfactory and the irrigation system had structural and operational problems resulting in inequitable water distribution and low irrigation efficiency. Major structural problems highlighted included design flaws and poor construction quality, excessive canal sedimentation, single bank main canal instead of conventional double bank canal, damaged control structures, an inadequate number of cross regulators and measuring devices, and a limited live storage of the Chandrika tank. The operational problems encountered primarily related to poor system operation and maintenance, lack of effective on-farm water management, inadequate training and extension facilities, and a large number of surplus unskilled staff. The settlement of farm families was beset with encroachment problems and the recommended cropping pattern was not adopted, with farmers preferring to grow rice irrespective of soil type.

ADB recognized that because of the project's current unsatisfactory performance, it would not realize its long term objectives unless a carefully designed rehabilitation and improvement program was undertaken to rectify the physical and institutional problems encountered with the project. These improvements are also needed to ensure adequate water resources for the other existing and planned irrigation development on the left bank of the river. It was anticipated that without further improvement measures, continuing inefficient and excessive water use on the right bank area will prevent full development of the irrigation potential of the left bank area.

The Government and ADB decided to launch an improvement and rehabilitation project. The feasibility study for the Walawe Irrigation Improvement Project (WIIP) was prepared in 1984 by the Government with the assistance from EEC and ADB.

The project aimed at improving agricultural productivity, rural employment, and farm incomes through rehabilitation and improvement of the existing right bank area covering about 12,000 ha. The project focused on improving the physical infrastructure by rehabilitation and rationalization of the existing irrigation system on the right bank and strengthening water management to enable irrigation supplies to be provided more efficiently. It was expected that through implementation of the project, it would allow further development of irrigated agriculture on the left bank area.

The project included completed: (i) irrigation system improvement involving main, branch, distributary canals, on-farm irrigation distribution system and appurtenant structures; (ii) rehabilitation of service roads; (iii) provision of domestic water supply in the scattered settlements and village centers; (iv) adequate research on crop diversification; (v) provision of essential equipment and vehicles for sustained operation and maintenance; and

(vi) establishment of a training unit in the project office. The project work and implementation program was designed in the light of problems encountered and "lessons learnt" from the previous project.

ADB appraised the project in 1984. The proposed cropping pattern was 10,900 ha of paddy in Maha, 9,700 ha of paddy in Yala, 500 ha of subsidiary crops in both Maha and Yala, and 500 ha of sugar cane. The diversion requirements from the Uda Walawe reservoir was estimated at 435 MCM per annum, 405 MCM for irrigation demand and 30 MCM for industrial demand.

The total cost was initially estimated at $13.7 million, of which $11.0 million was financed by ADB. The estimated cost was revised to $23 million in 1989. Main reasons for the increase in cost were the price escalation of the construction works and re-tendering of the works due to a delay in work implementation. The project commenced in 1986 under a five year program. Since 1982 the Mahaweli Authority of Sri Lanka (MASL) under the Ministry of Lands, Irrigation, and Mahaweli Development has been the executing agency responsible for physical implementation of the project as well as for its agricultural development. Due to a severe and violent disturbance to the project by the anti-government groups, arrangements were made by MASL to suspend work for two years during 1988-1989 period, thus delaying the implementation schedule. According to the information from MASL, as at the end of October 1991, some 40% of the project works in terms of physical works have been completed.

It was estimated that the annual irrigated crop area will increase from 16,000 ha to 22,000 ha; cropping intensity from 134% to 185%, and crop yields from an average of 4 mt/ha to 4.5 mt/ha for paddy and 1.0 mt/ha to 1.5 mt/ha for subsidiary crops resulting in an increase in production of about 31,000 mt of paddy, 1,000 mt of subsidiary crops and 21,000 mt of sugar cane; valued at about $7.4 million (1990 price). EIRR was estimated at 35% from the appraisal of ADB in 1984. Direct beneficiaries are estimated at some 11,000 farm households with a total farm population of about 67,000.

(3) IIMI's Study on irrigation management and crop diversification

The study of Irrigation Management and Crop Diversification was conducted by the International Irrigation Management Institute (IIMI) on the Kirindi Oya and Uda Walawe projects under a technical assistance agreement between the Government of Sri Lanka and ADB. It addresses, through field level research, priority issues of importance in the processes of irrigation system management, with particular attention to the rehabilitation processes in Walawe. A sample subsystem selected for intensive sampling covered a distributary canal with associated field channels in the Chandrikawewa block. The study commenced in February 1988 for 30 months duration.

In June 1990, IIMI issued the Final Report in which a number of recommendations were made under these headings: (i) management of the rehabilitation process; (ii) water resources management for long term performance; (iii) water management and design-management interactions; (iv) strengthening institutions; and (v) future rehabilitation and modernization projects.

The research carried out over three seasons provided evidence to held understand the present patterns of operation of the system and the present level of water use efficiency and water delivery performance of the Walawe project. The results obtained from the analysis of water delivery performance would be used to address certain key issues crucial to improving the overall performance of the system. Some of the salient findings and recommendations were:

(i) Irrigation water use per season for rice cultivation in Chandrikawewa block was far in excess of what was allowed in design. The ex-sluice water duty generally

accepted for Sri Lanka irrigation system is 1.0 m for Maha and 1.5 m for Yala after accounting for the effective rainfall. However, the actual water use in the subsystem varied between 2.0 to 3.7 m in Yala and 4.3 to 5.2 m in Maha, at the head of a distributary canal. Considerable effort should therefore be made to save water.

(ii) As noted above, the seepage and percolation losses assumed for the design of the rehabilitated system are significantly lower than the values measured in the field. Thus this crucial parameter needs to be reappraised (the measured value varied between 2.0 to 36.0 mm per day with an average of about 14-17 mm per day against 5 mm per day assumed for the design).

(iii) There exists a vast gap between the design assumptions and what happens in reality during the land preparation period with regard to the time taken to complete various farming activities and the irrigation water used. The land preparation period in a distributary command usually extends to a period of about 7 weeks and the cultivation season extends to a period of about 19 weeks (4.5 months) in Yala and 20 weeks (5 months) in Maha. The total water use from the irrigation system for land preparation ranged from 1,400 to 1,690 mm, without accounting for rainfall, indicating high use and wastage of water.

(iv) There exists a great potential for water saving during the land preparation period. The complex interaction of socio-economic factors with water makes it is difficult to prepare rigid water delivery schedules for the land preparation period. Thus a flexible water delivery schedule should be implemented instead of the conventional continuous delivery at design discharge. Implementation needs close interaction between the field assistants and farmers, using a monitoring and feed back mechanism.

IIMI's field research made it evident that there was a great discrepancy between the design assumptions and the actual water use in the field and that farmers were consuming a much greater amount of water at field level than the water requirements formerly estimated at the project planning stage. It was anticipated that unless certain effective measures could be taken to reduce the wasteful water use in the right bank, the potential development area on the left bank would be very limited.

(4) Water requirements for the right bank

Reflecting IIMI's study and other information, ADB expressed their concern that the left bank development might affect adversely the ADB financed WIIP on the right bank. The subject was discussed by MASL, ADB, JICA, and IIMI at a meeting held on 10th June 1992 chaired by the Director General of MASL.

The ADB mission stated that the water requirement figures in the project appraisal report of 1984 (435 MCM) should not be considered in determining the water requirements for the right bank as substational insight has been gained regarding the validity of the appraisal assumptions for a number of critical irrigation parameters.

It was agreed to request MMP, consultants attached to WIIP, to reassess the water requirements for the right bank taking account the wealth of information on irrigation parameters presently available for the right bank area. For the re-assessment three crop diversification scenarios were to be considered. For each scenario, the soil suitability in each of the blocks was to be considered as well as the canal capacities. The re-assessment was expected to require about two weeks of consulting services. The assumptions and the results of the re-assessment were to be made available to the JICA Study Team for its consideration.

MASL requested the JICA Study Team to continue the Phase II study assuming that the estimated irrigation water requirements of the right bank to be 405 MCM as already indicated by MASL at the previous meetings and to provide a sensitivity analysis for the three scenarios of water requirements provided by MMP.

MMP fulfilled the task and submitted a report in August 1992. The result of the study was that, although it is conceivable that the requirement may eventually be brought below 200 MCM, it is likely in the medium to long-term to be between 250 and 350 MCM in a dry year, or around 50 MCM less in a year of average rainfall. The requirements will depend heavily on the extent to which the current efforts to improve water use succeed. These efforts concentrate in:

(i) crop diversification;

(ii) improvements in water management and system operation at all levels, including more effective use of upper catchment runoff and of return flows;

(iii) improvement of physical infrastructure, particularly facilities for measuring and controlling water, which are of course prerequisites for better water management;

(iv) improved cooperation between farmers, and their improvement in system operation, which are of course powerful aids in achieving the above three goals.

It was decided in the meeting on the 10th August 1992 between MASL and the JICA Study Team that so far as the water requirements of the right bank are concerned, the water balance of the project would suffice to be examined for two cases only: one is based on the original figure of 405 MCM and the other is based on MMP's figure of 350 MCM.

2.3.3 Samanalawewa Hydropower Project

The Samanalawewa hydropower project will be commissioned in 1993. The Samanalawewa dam is located on the Walawe Ganga in the east of Balangoda. The dam is rockfill type with a height of 107 m above the river bed level, a crest length of 480 m and a live storage of 218 MCM. The power station has installs two turbine units with a total capacity of 120 MW and produces a firm 430 GWh of electricity and some secondary energy. CEB is the executing agency of the project.

CEB is studying the operational policy of the reservoir through simulation of the demand and supply on the national grid. The JICA Study Team received the simulation data covering 20 years from 1970 to 1989 for the water balance study.

The Samanalawewa project has been be under control of the Water Management Panel since 1992. The Water Management Panel is the government organization responsible for water management of reservoirs and irrigation systems on major rivers.

2.4 Southern Area Development Strategy

The Government is implementing a series of projects under the Southern Area Development Strategy to develop the southern area, particularly to meet the needs of the skilled and educated but unemployed youth.

Development projects are coordinated by the Southern Province Development Project (SPDP); its office is located in Galle. Projects currently being implemented and/or planned include the Koggala free trade zone, Galle port, Matara-Kataragama railway extension and water resources development projects. Projects for the study area under the Hambantota district are as follows:

(1) Integrated Rural Development Programme (IRDP)

IRDPs are conducted in 15 districts as of 1987. IRDPs were supported by eight donors such as JICA, World Bank, IFAD and NORAD. The Ministry of Policy Planning and Implementation continues to be the responsible agency for IRDP, and co-ordinates with donors. IRDP emphasize low cost, quick yielding, labour intensive investments aimed at better utilization of existing infrastructure and potential. The main advantage of projects are:

(i) the responsiveness to local development needs and priorities;

(ii) the opportunity to achieve, in addition to regional equity, a balance between higher capital cost projects and lower capital cost, quick yielding projects in areas that do not receive significant direct benefits from the higher capital cost projects.

IRDP Hambantota (HIRDEP) which is financially supported by NORAD commenced in 1979 and has carried out some existing tank rehabilitation projects in the project area. The overall objective of HIRDEP are:

(i) to create employment and income generating opportunities;

(ii) to ensure social welfare including raising local capacities for a sustained development process.

According to the above objective, HIRDEP has many kinds projects for employment creation, income generation, small enterprise development, etc. Under this programme, settlements under 2 minor irrigation tanks, situated in the extension area have been provided with assistance: the Wediwewa tank project with 80 families and the Kattana tank project with 15 families. Assistance included housing (Rs. 2,500), allowances for settlement (Rs. 100 per month over 6 months), and land development (Rs. 1,200 per plot). The project also plans to undertake development assistance programmes in 9 more minor irrigation tanks during the next few years. These schemes have already been identified.

(2) Road

A number of road development projects have been identified within the study area for development with ADB financial assistance. Of these, the Suriyawewa-Mirijjawila trunk road that crosses the extension area, has already received approval and fund allocations for immediate implementation. However, the road construction project was suspended by SPDP. Other link roads in the extension area have been suspended, too.

(3) Railway

The Railway Department is planning to extend the railway from Matara to Kataragama. There are three possible options, of which the one proposed by the Provincial Council is through Embilipitiya. The others are closer to the Matara - Hambantota road. No final decision has been made yet.

(4) Cashew Scheme

Sri Lanka Cashew Corporation (SLCC) was allocated a planned area of 618 ha for cashew plantation in the southern most sector of the extension area. At present, 5 ha has been reclaimed and cashew have been planted on half of the 5 ha. However, results of soil test were unfavorable and SLCC has no plans to expand the plantation in future.

CHAPTER 3 STUDY AREA

3.1 Natural Conditions

3.1.1 Location and topography

(1) Location

The Study Area is located on the left bank of the Walawe river in the southern dry zone of the country about 180 km south-east of Colombo (approximately 6 degree North Latitude and 81 degree East Longitude). Two main roads connect Colombo with the Study Area; one is the main road A2 which follows the west coast and reaches the southern part of the Study Area and the other is via main roads A4 and A18 which passe Ratnapura.

The Study Area is delineated by the Uda Walawe dam in the north, the left bank main canal and a ridge of hills in the east, the main road A2 in the south and the Walawe river and the boundary of paddy field under the Liyangastota anicut irrigation system in the west.

The Study Area covers about 30,000 ha of land comprising the Old area and the Extension area. The Old area occupies about 15,000 ha of northern sector where irrigation system has been already constructed and people are settled. There is one township, Suriyawewa, two village centers, and several hamlets which are interconnected by a network of main and secondary roads. The Extension area lies to the south of the Old area occupying also about 15,000 ha which is to be developed under the project. The Mahaweligoda river runs on the boundary of the Old and Extension areas.

(2) Topography

Topography of the area is a mixture of undulating to rolling slopes and flat bottomed valleys. The altitude varies from about El.75 m in the north to nearly sea level in the south.

The land has been classified according to the slope based on a map with a scale of 1:3,170. About 8% of the land is gentler than 1% slope, 19% of the land falls 1~2%, 29% of the land falls 2~3%, 24% of the land falls 3~4% and 20% of the land has slopes steeper than 4%.

A large number of natural streams and channels provide a fairly good system for surface drainage and most parts of the study area are free from drainage problems. The main rivers in the area are the Walawe river and the Mau river.

(3) Base maps and information

Following topographic maps and data are available and were employed for the Study:

(i) Engineering Survey Map (scale of: 1:3,170, prepared in the period from 1956 to 1964, contours at 2 feet (about 0.6 m) intervals);

(ii) National base map (colored map, scale of 1:50,000, CI=30 m (100 ft), published in 1985);

(iii) Aerial photographs (contact print, taken in 1982 and 1983 with a scale of 1:20,000);

(iv) Topographic survey map along the proposed extension routes of Left Bank Main Canal (LBMC) and the two new branch canals (prepared by Walawe Project Office in 1988, scale of 1:2,000);

(v) Block out layouts of Suriyawewa and Kiriibanwewa block (scale of 1:9,230, prepared by MEA-Walawe office in 1991);

(vi) Results of profile and cross section survey of the existing LBMC and Branch canal.

3.1.2 Soils and vegetation

(1) Soils

The physiographic conditions in the Study area was firstly examined by using topographic map of scale 1/3,360, aerial photos of scale 1/20,000 and land use map of scale 1/100,000. Based on the soil map of scale 1/63,360 prepared by Irrigation Department in 1963, the soil condition was examined by means of the available soil check survey including soil profile observation and physical and chemical property analysis of the soil samples taken from selected points in respective area where major soils are distributed.

The soil in the Study area occur in a catenary sequence in the undulating landscape. The well drained and imperfectly drained Reddish Brown Earths (RBE, Rhodustalfs) occur on the convex uplands and mid-slopes respectively. Low Humic Gley Soils (LHG, Tropaqualfs), the poorly drained members of the catenary sequence occurs in the concave valleys and bottomlands. Agriculturally less important soils such as narrow strips of complex alluvial soils are found in some locations along the rivers and streams.

Generally, Reddidh Brown Earths consist of sandy loam to sandy clay loam surface horizon, underlain by sandy clay loam to sandy clay sub-surface soil horizons, usually with a massive and structureless gravel horizon within the solum, which sometimes is thick enough to prevent good root growth. The soil structure is week to moderate sub-anglar blocky. The surface soil aggregates are quite readily broken down. These soils are very hard to extremely hard when dry and sticky and plastic when wet. The Reddish Brown Earths are moderate deep and moderate fine textured soils. The soil reaction is slightly acidic to neutral and exchangeable sodium content is low. The degree of base saturation is very wide, it ranges from 18 to 66%.

The imperfect drained soils on the mid-slopes consist of a dark brown sandy loam to sandy clay loam surface horizon underlain by a sub-surface soil horizon of brown to yellowish brown sandy clay loam to sandy clay. This soil is quite similar to the well drained soils both in physical and chemical properties. Any difference between these two soils are brought about by the fluctuating water table in the imperfectly drained members.

The soil in the bottomland and lower slope of the landscape consist of Low Humic Gley Soil (Tropaqualfs) with slightly alkaline and alluvial soils. The Low Humic Gley Soils are traditionally utilized for irrigated paddy cultivation suited for this group of soils. The Low Humic Gley Soils consist of dark reddish to reddish brown sandy loam to sandy clay loam surface horizons underlain by glayish red sandy clay loam sub-soil horizons, for example, this textured soil is observed at the site of profile number E-15, in the Extension area.

The physical properties of this soil group are somewhat similar to that of the Reddish Brown Earths. However, the exchangeable sodium content is slightly higher than that of the Reddish Blown Earths. The content of available phosphorous is moderate. The exchangeable K content is also moderate, however, addition of all major nutrients are required for intensive cropping and high yield levels to be maintained. The ground water table remains high for a considerable length of time in a year under natural conditions.

The above large soil groups are classified into 4 soil associations such as Walawe, Malabotu, Ranna and Siyambala. From the standpoint of physical and chemical characteristics, the Walawe Association is separated into two; the Walawe Association-Undulating Phase and the Walawe Association Rolling Phase. The legend and mapping symbols using on the soil map and the large soil groups, soil associations and land form in the Study area are summarized as shown follows:

Legend	Mapping Symbol
Walawe Association-Undulating Phase	Wa
Walawe Association-Rolling Phase	War
Malabotu Association	Ma
Ranna Association	Ra
Siyambala Association	Si
Beach Sand and Sand Dunes	B.S
Existing Paddy Land	P
Rock Knob Plain and/or Rock outcrop	Un

Soil distribution is shown as below.

Soil Groups/Soil Associations	Land Form	Area (ha)
Old Area		
RBEs		
Walawe Undulating Phase	Undulating	3,010
Walawe Rolling Phase	Steeper and rolling	2,760
Ranna	The same as Walawe	390
Undifined slope	Rock Knob or outcrop	1,460
LHG		
Malabotu	Flood pain	2,650
Siyambala	Valley bottom	770
Old area Total		11,040
Extension Area		
RBEs		
Ranna	The same as Walawe	12,440
Undifined slope	Rock knob or outcrop	2,510
LHG		
Siyambala	Valley bottom	750
Extension area Total		15,700

The soil check survey was made based on Uda Walawe Soil Map on a scale of 1/63,360. Detailed soil profile description relevant analytical results were provided by the Land Use Division of Department of Irrigation.

The soil samples of 64 were taken from 23 pits in the area where major soils are distributed. After profile observation was made, these samples were taken to Colombo for chemical analysis. The profile description of 64 soil samples and analytical results of physical and chemical properties of those soil samples are as shown in Annex-III.

(2) Vegetation

The natural vegetation in the Study area is the Dry Zone Mixed Evergreen Forest, with individual tree reaching a height of approximately 20 to 25 m, and some dense stands. In the Old area, northern half of the Study area, most of the forest had been cleared when area was developed. Most of arable land are used for sugar cane with irrigation and paddy cultivation with irrigation and localized area of sugar cane under the rainfed condition.

Whereas, in the Extension area located in the southern half of the Study area is covered by the secondary forest having been subjected to chena farming by means of shifting cultivation after clearance of the secondary forest over many years. Much of the forest contains trees less than 10 to 15 m high with small crowns, forming a fairly open stand with light under-growth. This forest now remains in large extent mainly from the southern part of Suriyawewa Block to the boundary of the Very Dry Zone in Hambantota District.

3.1.3 Meteorology and hydrology

(1) General

The Walawe river originates in the mountain range west of Balangoda and drains into the Indian Ocean near Ambalantota. It is 105 km long and has a drainage area of 2,442 km^2. The major tributaries are the Weli river, Timbolketiya river, Hulanda river, and Mau river. The northern and western parts of the Walawe basin are mountainous areas and fall in the wet zone. The eastern and southern parts are plains and are in the dry zone.

The Uda Walawe dam and Samanalawewa dam were constructed on the Walawe main stream. The two dams, having regulating capacities of 240 MCM and 218 MCM, and catchment areas of 1,152 km^2 and 338 km^2, respectively, provide enough water for management of the Walawe river.

In Sri Lanka, meteorological observation is carried out by the Department of Meteorology (MET) and other agencies such as the Irrigation Department (ID), the Department of Agriculture (AGRIC) and certain private institutes. Flow measurement and related hydrological observation in major river basins are carried out by the Hydrology Division of Irrigation Department (ID).

(2) Meteorology in the Study area

There are six meteorological observatories in and around the study area i.e. Hambantota (HAB), Sugar Research Institute (SRI), Agriculture Research Station (ARS) in Angunakolapelessa, Rice Research Station (RRS) in Ambalantota and the MEA observatory at the Uda Walawe dam. HAB and SRI observatories are selected as representing the southern and northern study areas. A summary of meteorological data at SRI and ARS observatories is presented in Table 3.

(3) Rainfall in the Walawe basin

Records of twenty-three rain gauge stations in and around the Walawe river basin are available. Annual rainfall is 4,500 mm at the headwaters of the Walawe river, 1,500 mm at the Uda Walawe dam and 1,000 mm near coast of the Indian ocean. On the basis of mean annual rainfall, an isohyetal map has been drawn as shown in Figure 1.

Considering the isohyet, observation period and location, twelve rain gauge stations have been selected for hydrological study. Most of these gauging stations have records since the 1940s. By applying the Thiessen polygon method, annual basin rainfalls are computed. The results are 2,047 mm for the whole Walawe basin, 2,875 mm for the Samanalawewa dam catchment and 2,384 mm for the Uda Walawe dam catchment.

(4) Assessment of stream flow (refer to Figure 2)

For the Walawe river basin, run-off records are available at thirteen flow gauging stations, out of which four gauging stations are located on the main river course and nine on the tributaries. Continuous and long term records are not available. The Uda Walawe gauging station (Code No. 1805) be operated for only four years from May 1957 to June 1961. After the Uda Walawe dam was completed in 1967, reservoir operation records are available from 1968 to date.

Previous studies provided two kinds of monthly inflow data at the Uda Walawe dam. One is the data covering the period from 1949 to 1985 prepared by CEB in the study on "Master Plan for the Electricity Supply of Sri Lanka". The other is the data from 1942 to 1983 prepared by SOGREAH in the study on "Walawe Irrigation Rehabilitation and Improvement Project". In the CEB study, monthly run-off data were extended from rainfall data at selected rain gauge stations applying the multiple regression method. On the other word, SOGREAH study used the reservoir operation records to estimate the inflow from 1968 to 1984.

Both estimates were analyzed and it was found that the CEB method gave a more conservative estimate. Therefore, it was decided to generate monthly a run-off series by applying the multiple regression method.

Monthly run-off data have been generated for 31 years from 1960 to 1990 for Embilipitiya, Timbolketiya, and Mau river (at Mahagama Tank). Embilipitiya is a flow gauging station located downstream of Uda Walawe station. Since Embilipitiya has 20 year records from 1949 to 1968 against 4 year records for Uda Walawe station, Embilipitiya data have been extended till 1990 and then converted into the inflow for the Uda Walawe dam.

(5) Available water resources

Uda Walawe reservoir

The Uda Walawe dam was constructed mainly for irrigation purpose. The reservoir has a gross storage of 269 MCM, a live storage of 240.5 MCM, a full supply water level of 88.39 m and a reservoir area at FSWL of 34 km^2.

Monthly inflow of the Uda Walawe reservoir has been generated for 31 years from 1960 to 1990. The average annual inflow is estimated at 900 MCM. The maximum annual recorded inflow was 1,627 MCM in 1963 and the minimum annual inflow recorded was 439 MCM in 1968. Inflow is rather low in February, June, July, August, and September. The minimum monthly inflow recorded was 28 MCM which occurred in August. The maximum monthly inflow recorded was 153 MCM which occurred in November. The monthly inflow exceeds 100 MCM in only three months, April, May, and November.

Samanalawewa reservoir

The annual inflow of the Samanalawewa reservoir is estimated at 527 MCM by CEB. CEB provided the JICA Study Team with 20 year data (1970 to 1989) generated in a reservoir operation simulation study. In the water balance study, the inflow of the Uda Walawe reservoir will be adjusted according to these data.

Timbolketiya river

The Timbolketiya river is a right bank tributary of the Walawe river with a catchment area of 269 km^2 and an average basin rainfall of more than 2,500 mm. Two major tributaries, the Rakwana river and Andolu river, join at just upstream of the Timbolketiya bridge. There was a

gauging station on the Rakwana river (Station Code No. 1807). Annual runoff at the station was estimated to be 123 MCM.

Water from the Timbolketiya river could be led to the existing Right Bank Main Canal of the Walawe Development Scheme, through construction of an intake facility and a link canal. Formerly, it was considered the Timbolketiya was needed to satisfy the downstream water users such as the Liyangastota anicut. However, as a result of extensive reclamation of paddy fields on both banks of the Walawe river, return flow from the paddy fields is expected. It appears that the discharge from the Timbolketiya river has been offset by the return flow. Hence, the Timbolketiya diversion plan is worth studying.

Hulanda river

The Hulanda river is a right bank tributary of the Walawe river with a catchment area of 166 km^2 and a basin rainfall over 2,000 mm. The annual runoff at Halmillaketiya (Station Code No. 1803) was estimated to be 41 MCM. The Chandrika tank was constructed on the Hulanda river and the Right Main Canal is linked with the Chandrika tank. There is no possibility to augment the water resources of the Hulanda river.

Mau river

The Mau river is a left bank tributary of the Walawe river with a catchment area of 366 km^2 and a basin rainfall below 1,500 mm. Annual runoff at Mahagama (Station Code No. 1809) is 54 MCM. There are three tanks on the main stream and two tributaries: the Mahagama, Habaralu, and Kiriibban tanks. The Mau river normally drys up during July and September. The flow of the Mau river is scarce and unreliable, and its upstream reach is in the Uda Walawe national park. Because of these reasons, there will be no possibility to exploit further water resources from the Mau river.

(6) Water quality

Water quality has been surveyed at 12 sites to clarify the suitability of water for drinking and irrigation purposes. Surface water samples were taken from the Walawe river at four sites and from waste water aeration ponds of the paper mill and the sugar factory. Groundwater samples were taken from dug wells at six sites. Collected water samples were analyzed at the laboratory of the Department of Chemistry of the University of Colombo. Items measured and analyzed at the site and the laboratory are; atmospheric and water temperatures, pH, electric conductivity (EC), suspended sediment (S.S.), dissolved Oxygen (D.O.), chemical analysis for HCO_3^-, Cl^-, F^-, NO_3-N, Ca^{+2}, Mg^{+2}, Na^+.

According to the result of the laboratory test, the surface water of the Walawe river can be used for drinking and irrigation purposes. On the contrary, the well water exceeds the standard values in terms of E.C., dissolved fluorine and chlorine ions. When the well water is used for drinking and irrigation, treatment will be required. Monitoring should be continued for waste water of the paper mill and the sugar factory.

3.1.4 Geology, soil mechanics, and construction materials

The geological units that have occurred in and around the Study area comprise the Highland Series (the Charnockite Series) and the Vijayan Series of Precambrian age, and the Quaternary sediments. The Study area is covered mostly with the gneisses of the Vijayan Series and with the Quaternary sediments consisting mainly of sandy soils. The rocks of the Vijayan Series strike NS to N45W and dip southwestwards relatively consistently and gently. There are

several anticlines and synclines, and minor scale. No faults have been identified in the Study area. This fact, however, does not necessarily mean that none exist.

Alluvial sediments, thick insitu sediments of the Pleistocene age and the weathered bedrocks have a potential for shallow ground water that can be extracted through dug wells. Most of the shallow wells in use, however, consist of unprotected wells and are liable to get polluted from surface drainage. Fractured zones in the Precambrian rocks can be introduced as deep aquifers. A majority of the existing deep wells yield the small quantity of water and display higher electrical conductivity and higher concentration of fluorides than specified in the WHO standards for drinking water.

At the Walawe bridge site, there is a possibility to place the whole bridge base directly on the weathered bedrocks, if an open-cut excavation for the abutments and piers extends more than 5 m from the original ground surface.

At both weir sites, the Andlu river and Timbolketiya river, there is a possibility to place the whole weir base directly on the fresh or weathered bedrocks, if an open-cut excavation for the weir body extends more than 4 m from the original ground surface.

The canals and tanks shall be constructed on the rocks of the Vijayan Series and the deposits of the Pleistocene and Recent age. The overburden which is composed mostly of silty sand and gravelly silt varies in thickness from 0 m to as much as 6 m in the Extension area. They are commonly thinner (less than 2 m) at the ridge and thicker (more than 3 m) in the valley.

Bellow the overburden the bedrock has weathered down into dense granular layers and granular sandy material with some silt. It seems that weathered bedrock is thinner (0 to 1.5 m) at the ridge and thicker (more than 3 m) in the valley. The overburden and weathered rocks can be scraped by hydraulic ripper.

It may be necessary to take proper measures to protect the steep cut slope of the canal from potential failures caused by erosion where ordinary sandy soils are located.

The permeability test results of sandy soils show that the coefficients of permeability being less than 1×10^{-5} cm/s are low enough for the canal. However, it seems that the coefficients of permeability of the weathered gneiss are much higher than those of sandy soils. Therefore the cut slope and bottom of canal shall be protected from potential seepage by such means as concrete lining.

The embankment shall be founded on the sandy soils which will appear more often than the clayey soils throughout the Extension area. These soils have sufficient bearing capacity for the embankments, but are susceptible to erosion from seepage. Therefore these soils shall be treated properly by such means as a thorough blending with clayey materials, or the bottom width of the foundation shall satisfy the required creep length to withstand a piping phenomenon. According to the particle size test and the atterberg limits test, most of the soil samples in the Extension area are conceived to be suitable for embankment bulk fill materials and core materials. The linear shrinkages indicate that the soils will have a high potential for volume change. This may result in cracking in the embankments when they are dried.

The permeability, being less than 1×10^{-5} cm/s, is low enough for this type of embankment. This result, however, may be variable because of the small number of sample. Soils having a high swelling potential may not exist in the Extension area, according to the swelling tests.

There are considerable sand deposits along the Walawe river that could be used for concrete. The sands are conceived to be good sand materials for concrete aggregate. The aggregate crushing values of rock materials (gneisses) indicate that the materials are not hard enough to be used for high strength concrete such as concrete wearing surface of the road. The materials,

however, are hard enough to be used for other concrete. Charnockite of the Highland Series is conceived to be a good rock material, and can be designated as an alternative rock material but it would be costly because of long haulage.

The swelling properties of sandy soils obtained through CBR tests are regarded favorable for the subgrade of a road. The road embankment will be made mainly of the Pleistocene deposits land nearby the road construction work site. The road metalling materials, however, shall be borrowed from the sources such as charnockite of the Highland Series or gneisses of the Vijayan Series.

3.2 Agricultural Activities

3.2.1 Administrative organization

The administration of the Study area comes under the purview of three organizations, namely, the holding company of Sevanagala Sugar Industries Ltd., Mahaweli Economic Agency (MEA) of the Mahaweli Authority of Sri Lanka (MASL) and the Southern Provincial Council/ Government Agent (GA) Hambantota.

The Sevanagala sugar factory and the plantation were managed by the Sri Lanka Sugar Corporation until the complex was first converted into a public company and in 1991, it was coveted into an autonomous holding company, the Sevanagala Sugar Industries Ltd., as a prelude to peoplization. The holding company is responsible to the Ministry of Plantation Industries. The Resident General Manager at the site has three divisions under him; the Factory Division, the Plantation Division, and the Finance and Administration Division.

The Walawe basin, managed by the River Valleys Development Board (RVDB), was declared a Special Area under the Mahaweli Act of 1979 and its administration, excluding the Sevanagala sugarcane area and the undeveloped Left Bank area, has been brought under the purview of MEA of MASL under the Ministry of Lands, Irrigation and Mahaweli Development from 1982. The unified management system of MEA consists of the Resident Project Manager (RPM), Block Managers (BMs), and Unit Managers (UMs) taking over the responsibility for integration management and development of a geographic area at three different levels. The RPM and BMs are assisted by functional specialists. Kiriibanwewa Blocks in the Study area has six Unit areas and Suriyawewa eight.

Administration of the Extension area was under the GA Hambantota through the Assistant Government Agents (AGA) of Hambantota, Suriyawewa, and Ambalantota. With the implementation of Provincial Government system, the AGA offices have been converted to Divisional Secretariats administered by the Provincial Secretary. The Central Government policy administration is retained by GA.

3.2.2 Population, households, and farmers

Except for the Extension area, recent data on population in the rest of the Study area are not available. The sugarcane plantation was first managed on an estate system through hired labour and subsequently changed into the out-grower system. Land allocation to allotters in the irrigated sector commenced in 1986 and the rainfed sector in 1989. In the MEA managed irrigated area, settlement of farm families has been completed as far back as 1967. Regularization of settlements in the unirrigated MEA area of Suriyawewa Block was undertaken in the late 1980s.

Uda Walawe LB Extension Project Census survey conducted by PMU of MASL reveals that nearly all settlements in the Extension area have taken place during the last five years.

Population estimates are made based on the number of households as shown in the available records and the average family size obtained from the questionnaire surveys. The total number of households in the Study area is reported as 17,970, and the number of farm families in the sugarcane and MEA managed irrigated area as 2,800 and 3,800, respectively. Total population in the Study area is estimated at 95,000.

3.2.3 Land tenure and holdings

Alienation of state lands to individuals or organizations is made under the provisions in the Land Development Ordinance and Crown Land Ordinance. In the sugarcane area, long term land leases to the cane allotters under the Crown Lands Ordinance is being considered. The long term leases are generally for a period of 30 years and an annual land rent, that is revised every five years, is recovered. In the MEA managed area, land grants are made under the Land Development Ordinance, under which three years of proper land use entitles the occupant to receive a 'Swarnabhoomi' grant. Under the Government policy on regularization of encroachments that came into operation in 1989, 1650 families in the southern undeveloped part of Suriyawewa have been regularized. The census of the Extension area shows that out of 6,018 families only 41% are regularized, the balance being encroachments.

The individual landholding size in the irrigated sugarcane area is 1.15 ha which is subdivided into three plots as 0.25 ha of irrigated paddy, 0.75 ha of irrigated sugarcane and 0.15 ha of highland homestead. In the MEA managed irrigated area, the individual landholding is 1.20 ha which consists of 1.00 ha of irrigated plot and 0.20 ha of highland homestead. The average size of landholding in the Extension area, according to the PMU census is 0.52 ha.

3.2.4 Present land use

The present land use condition of the Study area is defined based on the aerial photographs and available topographic maps on a scale of 1 to 50,000 as well as check survey in the filed. The Study area of 32,180 ha is divided into 3 sub-areas for the convenient of the study, namely (i) Sevanagala sugar corporation area of about 5,440 ha in gross, (ii) Old area of 11,040 ha (Kiriibanwewa irrigation block area of about 6,000 ha, Suriyawewa block in the Old area (Northern part of the Mahaweligoda river) of 5,040 ha), and (iii) Extension area of 15,700 ha. The sub-area of items of (i) to (ii) are located in the Old area of the Study area. The study on land use and land capability is concentrated into the Study area except Sevanagala sugar area, since the area is considered as individual sector for the agricultural development and the area has been developed separately from the other sub-areas. The present land use condition of the Study area is summarized as below.

(Unit: ha)

Land use	Sevanagala Sugar Area	Old Area	Extension Area	Total Area
Agricultural land	2,475	5,150	2,780	8,177
(Irrigated land)	(1,490)	(2,900)	(0)	(4,390)
Forest land	620	260	740	1,620
Homestead	1,800	2,490	200	4,490
Shrub/Grass land	-	605	10,310	10,915
Livestock farm	-	25	-	25
Plantations	-	-	20	20
Rock land	60	700	490	1,250
Others	485	1,810	200	2,495
Total	5,440	11,040	15,700	32,180

Note: (1) Agricultural land includes irrigated paddy and sugar cane, rain-fed paddy and upland crops and chena cultivation areas.
(2) Homestead includes garden yard for rain-fed upland crops of farmers
(3) Others includes canal, tank area and roads

In the Extension area, there are 17 minor irrigation tanks. According to the information of Agrarian Service Center in Ambalantota, total commanding area of these tanks is estimated at about 260 ha but irrigation water supply is not stable for the tank area. It is classified that the area under tank is rainfed agricultural land. The western boundary of the Extension area, there are large extent of homesteads of settlers of Ridiyagama Irrigation Schemes. Area is extensively used for shifting chena cultivation. About 20 ha of land in the end of southern part of the Extension area has been cultivated with cashew under Sri Lanka Cashew Corporation.

In the unirrigated homestead area, annual crops such as pulses, vegetables, maize and chillies are the most commonly cultivated in Maha season. The settlements are relatively new, and with the establishment of permanent crops such as banana, mango and other fruit trees in the homesteads, the area available for annual cropping will decline over the next few years.

3.2.5 Cropping pattern and yield

Two cropping patterns can be recognized in the existing irrigated area of the Study area; one in the Sevanagala sugarcane area and the other in the MEA managed area.

(i) Sugarcane area

A rigid cropping pattern with sugarcane in the moderate and well drained Reddish Brown Earth (RBE) soils and paddy in the poorly drained Low Humic Gley (LHG) soils is practiced in the irrigated sector. Sugarcane is cultivated on a 4-5 year cycle consisting of one plant crop of 13-15 month duration and 3-4 ratoon crops, each of 12 month duration. Paddy cultivation conforms with the operational sequence of MEA managed area discussed below.

(ii) MEA managed area

Paddy dominant cropping pattern, with marginal extents under Other Field Crop (OFC) and banana, is practiced in the area. Land preparation commences in the months of October and April for the two seasons and 3 to 3.5 month age class varieties are grown. Harvesting is completed in the months of February and August. Other crops cultivated are banana, chilli, red onion, and vegetables.

(iii) Extension area

Paddy cultivation in the 290 ha command area of 17 seasonal tanks is erratic as the irrigation water supply is highly unstable. Variable extents of highland homesteads and chenas are cultivated in the Maha season with grain legumes, maize and vegetables.

Yield and production in the sugarcane and the MEA managed irrigated area are shown below.

Sugarcane Irrigated Sector	1989	1990	1991
Harvested Area (ha)	646	887	1,072
Yield (t/ha)	-	-	-
Plant Crop	182	166	137
Ratoon I	107	111	96
Ratoon II	103	94	83
Ratoon III	-	91	86
Ratoon IV	-	-	89
Average	136	115	97
Production ('000 t)	88	102	104

Source: Plantation Division, Sevanagala Sugar Industries Ltd.

MEA Managed irrigated area

Crop	1990 Yala			990/91 Maha		
	Extent (ha)	Yield (t/ha)	Prodn. ('000t)	Extent (ha)	Yield (t/ha)	Prodn. ('000t)
Paddy	2,626	4.95	12.99	2,608	5.10	13.28
Chilli	57	0.70	0.04	24	0.64	0.02
Red onion	25	10.00	0.25			
Banana	69	15.00	2.53	219	15.00	3.28
Pulse & Vegetab.	47			28		
Total	2,924	2,879				

Source: Agricultural Division, MEA Walawe Project Office.

3.2.6 Farming practices

(1) Sugarcane

Land preparation in the allotters fields is carried out by the Company using heavy machinery. Planting in the irrigated sector begin usually after May, and 7-9 month old cane from Company selected nurseries are used. Three budded sets are placed in the furrows, spaced 1.4 m apart with overlapping and covered with earth. 10-11 tons of seed cane is used to establish one hectare. Basal fertilizer is applied at planting or following off-baring of ratoons, and top dressings at 2.5 and 3.5 month stage and reshape the furrows. Weeds are controlled by spraying gramaxone and diuron in combination and manually. Irrigation water is shiphoned off lined canals, weekly in the first two months, these are every two weeks. Cane is harvested green after discontinuing irrigation for a minimum of one month.

(2) Paddy

Over 80% of the ploughing is done by 2-wheel tractors after impounding the field with water. Repair and plastering of field bounds are completed prior to puddling and levelling. Pre-germinated 3.5 month paddy varieties are broadcast sown on wet fields at a seed rate of 150-200 kg/ha. Basal fertilizer (V mixture) is applied within one week of sowing followed by top dressings (TDM) at the 7-8 week stage. Urea is applied at 3 and 5 week stages. Regular field wetting is done until crop establishment is complete and thereafter the rotational issues are expected to be followed. Agrochemicals are extensively used for control of pests and diseases as well as weeds.

(3) Banana

Bananas are established using suckers planted in pits spaced 3 m x 3 m usually following the Maha rains. The crop is irrigated fortnightly, fertilized regularly at 3 month intervals and only two daughter plants per clump is retained to reach maturity. The most common variety is 'Embul' which is relatively free of pests and diseases. First harvest is possible in 9-11 months, and thereafter, every week.

(4) Other crops

The areas under other crops are small and the production is mainly for domestic and local consumption.

3.2.7 Livestock

In terms of the present population and the land area required to support it, cattle, both neat and buffalo, assumes priority over other forms of livestock in the Study area. According to a cattle census survey carried out in 1990, about 12,000 heads of cattle are found in the MEA managed area alone. In addition, the largely uninhabited Extension area is used extensively by cattle owners called 'Gambaras' for grazing their cattle. Direct interviews with a few cattle owners revealed that around 8,000 head is owned by nearly 50 Gambaras in the area. However, the herds are moved frequently from place to place in search of drinking water and pasture lands. Areas north of Wediwewa in the Extension area are preferred due to the abundance of village tanks and better pastures.

Some basic concepts proposed for consideration in livestock development planning are as follows:

(i) Based on the field surveys it is estimated that about 12% of the new settlers families will take up animal husbandry in addition to crop husbandry. The on-going extension efforts of the Draught Animal and Dairy Development Programme (DA&DDP) of MASL (presently active in the area), tare aimed at the integrated livestock development to establish a balanced system of mixed farming in the homestead of settlers to be extended to the Extension area.

(ii) Changing the present nomadic system of cattle management to one of privately managed permanent holdings system based on the model livestock farm at Mahagama managed by DA&DDP.

(iii) Promote adoption of improved livestock and pasture management, stock upgrading, stall feeding under such systems.

(iv) Optimize the utilization of benefits that will be available under project conditions such as pasture lands, tanks and ponds as watering places, and cane tops as animal feed.

3.2.8 Agricultural support services

(1) Agricultural research

Sugarcane research activities are conducted by the Sugarcane Research Institute, established at Uda Walawe in 1988. The current research efforts are coordinated toward varietal improvement.

Horticultural and field crop research work relevant to the area is done at the Regional Agricultural Research Station (RARS) of the Department of Agriculture (DOA), situated in the Angunakolapelessa in the Walawe RB. Improvement of Banana, sesame, and groundnut under rainfed conditions is given research priority at present in view of the vast undeveloped areas in the region.

Research activities relating to paddy is carried out at the Rice Breeding Station of DOA, which is located at Ambalantota.

Research work of DOA relating to Mahaweli areas are coordinated through the Mahaweli Research Committee, represented by officials of both organizations.

(2) Agricultural extension

In the sugarcane area, the Plantation Division of the company is responsible for all agricultural activities including extension. Extension services are provided through two Superintendents, six Divisional Officers, and Agricultural Assistants each serving approximately 100 cane farmers.

The extension system in the MEA managed area is a modified version of the World Bank sponsored training and visit (T&V) system, that was implemented island wide from 1976-1986. At the field level, the Field Assistant (FA) is expected to visit the field canal level farmer groups on scheduled dates every fortnight and dissipate the extension messages. The FAs, each serving a Unit area, are trained at the Block level every fortnight by the three Subject Matter Officers (SMOs) attached to the Project Office, assisted by the Block Agricultural Officers. Deputy Resident Project Manager - Agriculture (DRPM (Agr.)) under the RPM is responsible for administration and coordination of all agricultural activities in the Walawe project area. DRPM (Agr.) is supported on technical matters by the Agronomy Division of MEA in the head-office. The agricultural staff is provided with regular pre-seasonal training and in-service training conducted by DOA.

The formal linkage between research and extension is effected through the Regional Technical Working Groups (RTWG), and Walawe region is covered by RTWG based in RARS, Angunakolapelessa. The Group meets in advance of each cultivation season to identify the relevant research and extension needs for the season.

In recent years, operation of the extension system has suffered due shortages of funds and trained staff at field level. MEA has proposed modifications to the system falling in line with IDA assisted Agricultural Support Services Project (ASSPT), for implementation in the Mahaweli areas. It is proposed to create a new carder of Agricultural Assistants who will serve and negotiate with the 900-1,000 farm families under BAOs. The reference group will comprise 40-45 farmers from 3-5 field canal organizations and they will be visited once a month.

In the Extension area, extension services are expected to come from the line departments and organizations under the district administration. The limited rainfed production and poor accessibility has caused the area to be largely neglected.

(3) Agricultural credit

The sugarcane farmers are provided with largely a service and material based credit package by the company. These include land preparation, seed cane and transport, fertilizer, weedicides and alkathene pipes for irrigation. The value of the package averaged to Rs. 13,700 for the plant crop, Rs. 11,200 for the first ratoon and Rs. 5,000 thereafter. The cost of land preparation and seed cane is spread over the first two years. A consumption loan of Rs. 250 per month and a maintenance loan of Rs. 1,500 is also made available to the farmers by the company.

In the MEA area, institutional credit for agriculture in the Kiriibanwewa Block is provided by the Bank of Ceylon and in the Suriyawewa Block by the Peoples Bank. A maximum of Rs. 18,760 is disbursed for one ha of paddy in nine instalments and an annual interest rate of 16% is applied.

The socio-economic survey results indicated that less than 25% of farmers depend on banks for agricultural credit. Private money lenders account for over 20%, while friends and relatives accept for about 17%. The cooperatives and traders were also involved, but to lesser extents of 3% and 5%, respectively.

Rural banks for women have been established under the Janasaviya programme in the Extension area, and these provide low interest loans up to Rs. 2,000 for rainfed cultivation.

(4) Agricultural inputs

Seed cane is issued to the cane farmers from the company maintained primary nurseries and selected secondary nurseries. MEA is responsible for the supply and distribution of seeds and planting materials in the MEA managed area. Seed paddy supply has been affected adversely due to reduced production of certified seeds by DOA, the main producer. Two kg seed paddy packs are supplied to farmers for multiplication. Seeds of OFCs and local vegetables are obtained through the DOA seed production programmes. Seed distribution in the project area is done by MEA, cooperatives, and private dealers.

Fertilizers and agro-chemicals for cane farmers are purchased in bulk for distribution by the company. In the MEA area, part of the requirements, particularly that of Bank credit recipients, are procured and distributed by MEA. The balance requirements are met by cooperatives, private dealers, and Agrarian Service Centers.

3.2.9 Marketing system

Sevanagala Sugar Industries Ltd., purchases the cane produced by the allotters in the company affiliated plantation, farmers in the Walawe RB (Embilipitiya Block), and private growers. The cane is processed in the factory to manufacture plantation white sugar and potable alcohol. Sugar is channeled to consumers through the Cooperative Wholesale Establishment (CWE) and private wholesale traders. Potable alcohol is sold to State Distilleries Corporation for further processing.

The bulk of the paddy produced in the area are purchased by the local collectors and millers. A large number of buying centers operate in the Suriyawewa town, in main bazaars at important

junctions, and the village centers. Two purchasing centers sponsored by the Regional Secretariat operate in the MEA area. Paddy is also purchased by outside millers and the six primaries of the Multi-purpose Cooperative Societies (MPCSs), though the quantities are small. The milled rice is channeled mostly through the wholesale dealers in the southern districts for wholesaling and retailing. Paddy collected by MPCSs is processed in there own mills and retailed through primaries, CWE outlets, and private retailers.

The periodic market fair called the 'Pola' is the most important market outlet for local vegetables and fruits. Pola is a place where farmers, traders, and consumers gather to sell and buy merchandize. Polas in the Study area are held on Sundays, Mondays, and Tuesdays, operating in harmony with those outside the area to enable traders to visit them in a rotational sequence. All Polas of the area are owned by the Regional Secretariat and are offered to private individual on an annual tender to operate. Local assembly agents are non existent and trading takes place directly between the farmer and the trader. The main wholesale market is the Pettah market in Colombo, which also serves as the terminal market for agricultural produce of the country.

Grain legumes are purchased by CWE and Cooperative Marketing Federation (Markfed), through seasonal centers opened in the MEA area, and by the primaries of MPCSs. The main item purchased is greengram. Private collectors also operate purchasing points on behalf of outside wholesalers.

Milk produced in the area is purchased by Milk Industries of Lanka Ltd.(Milco), and Nestle Lanka Ltd., and transported to their processing factories located outside the project area.

3.2.10 Post harvest facilities

The post harvest processing facilities for agricultural produce in the area are limited to milling of paddy, processing of sugarcane, and chilling of milk.

The Sevanagala sugar factory has a mill capacity of 1,430 ton-cane/day (tcd) and is operated yearly for a total 140 days, two crushing seasons. It is operating below capacity level due to insufficient cane.

A substantial milling capacity for processing paddy exists in the Walawe area. The mills, all privately owned, range from large commercial enterprises to small domestic units. The full milling capacity is not utilized, and many of the larger mills close down during the off season. Processing raw rice is the usual activity, though some mills have par-boiling facilities.

The daily milk collection at Milco collecting points is picked up by taken operating on scheduled routes and transported to the chilling center at Embilipitiya. The center has the capacity to handle 4,500 l per day, and transport to the factories is done on alternate days.

3.2.11 Farm household economy

Data for the assessment of the farm household economy were collected mainly through the questionnaire surveys conduced in and around the Study area, supplemented by staff and farmer interviews and published data.

The socio-economic survey of 1991 reveals that farmers in the LB irrigated area earn an average net income comparable to those in the three northern Blocks in the RB area, namely, Embilipitiya, Chandrikawewa and Binkama. The lower average farm incomes of the LB farmers are compensated by off-farm income they earn from part-time labour work and so on.

The farm economy survey of 1992 in the Extension area revealed that 62% of the inhabitants receive Government subsidies, 35.6% are Janasaviya recipients and 27.1% are on food stamps. 44% of the total annual income of Janasaviya beneficiaries is derived from the assistance they receive under the programme. The living conditions of the food stamp recipients are much lower than the Janasaviya beneficiaries. The household economic situation is shown in Table 4.

3.2.12 Farmers intention

An assessment of the farmers intention towards crop diversification and their preference of crops was attempted through the interview surveys. The studies revealed that there is an increasing awareness among farmers of the benefits of growing crops other than traditional paddy. However, continuation of growing paddy, at least in part of their irrigated land, was supported by the majority. The main concern of the inhabitants of the Extension area was to obtain irrigation facilities for crop production. None opposed moving out of the present holding if relocation were necessary as a result of irrigation development. Their response towards diversification was more positive with a wider crop preference.

3.3 Irrigation, Drainage and Rural Infrastructure

3.3.1 Existing irrigation and drainage system

(1) Walawe irrigation system

The Walawe irrigation area extends over both banks of the Walawe river draws water from the Uda Walawe reservoir. Downstream of the Uda Walawe dam, two main canals serve the left and right banks of the lower Walawe basin through a mini hydropower generation station. The right and left bank main canals flow through several smaller tanks on tributaries of the Walawe river such as Chandrika and Kiriiban. The irrigation area of both banks of the Walawe river in the last 5 years is estimated at 12,900 ha in total, comprising a right bank area of 8,800 ha and left bank of 4,100 ha. The main crop irrigated in the system is paddy, 11,200 ha (87%). The other crops irrigated are sugar cane, banana, and other upland field crops.

(2) Irrigation system in the Study area (the left bank area)

Old area

The existing irrigation infrastructure in the Old area serving about 4,400 ha comprises two gravity irrigation systems; about 3,800 ha irrigated by the Uda Walawe reservoir and 580 ha commanded by the Mahagama tank. The water resource of the Mahagama tank is the Mau river, a tributary of the Walawe river, and return flow from the upstream irrigation area which is fed by the Uda Walawe reservoir.

The irrigation area is broadly divided into three irrigation blocks; Sevanagala sugar area (1,500 net ha in 1991) and two irrigation management blocks of MEA/ MASL; Kiriibanwewa block (1,500 net) and; Suriyawewa block (1,400 net ha). Main crops irrigated are paddy, about 3,200 ha, and sugar cane, 850 ha.

Existing irrigation network presently serving the Old area consists of the following:

(i) Left Bank Main Canal (LBMC), 31 km routed along the upper boundary of the irrigation area; design capacity of the canal is about 28 m^3/s (1,000-1,400 cusec) acted the full sketch. There are two major tanks on the canal; from the upstream,

Habaralu tank (1.5 MCM in total capacity) and Kiriiban tank (16 MCM). Water sources of these two tanks are tributaries of the Mau river.

(ii) One branch canal with a length of about 6 km with diverts water off at the end of LBMC; the commanding area of the canal is about 1,200 ha in the Suriyawewa block area. On the other hand, the Mahagama Yoda Ela canal, 16 km long, with commanding area of about 580 ha in Kiriibanwewa block is the main stem of the irrigation network of the Mahagama irrigation system.

(iii) About 43 km of distributary and sub-distributary canals in the MEA area receiving water from LBMC and the branch canals.

(iv) A number of field canals issuing water from the distributary canals to individual farm plots of 0.8 to 1.2 ha on average.

The tanks on LBMC function as (i) buffer ponds for changes of water supply from the upstream, (ii) level crossing of large streams, and (iii) emergency supply of water in a severe drought. Inflows from the tributaries into the tanks have not been taken into consideration in the daily operation, since inflows are not reliable and few, particularly in the dry months.

The principal features of the existing irrigation area are tabulated in Table 5 and shown in Figure 3.

Extension area

There is no systematic and large scale irrigation system since irrigation water from the Uda Walawe reservoir has not yet reached to the area. However, many small-scale village tanks (minor-scale tanks) are scattered in the area, of which only 16 tanks are now in working condition. Irrigation command area of these tanks ranges from 10 ha to 70 ha and is estimated at 300 ha in total. These tanks are located on small streams as a cascade system for storing flood water in Maha season to supply supplemental irrigation water for the downstream area. Most of them were constructed in ancient times and have been rehabilitated recently by the Irrigation Department or local government of Hambantota District of Southern Province. Irrigation canals have been constructed but these conditions are poor due to poor water supply from the tanks and little maintenance work. Irrigation conditions in the commanding area of the tanks are similar to the rainfed condition with no agricultural activities in Yala season due to a dry-up of stream flow. The actual functions of the tanks are to provide a source of drinking water for people and animals, and storage for ground water. It is noted that most of the inhabitants in the area are located just near the tanks though water supply from the tanks is not always reliable and has a limited amount.

(3) Irrigation water resources

The Uda Walawe reservoir constitutes the major source of water supply for the Uda Walawe irrigation system extending on both banks. Average annual water released for both right and left bank areas from the Uda Walawe reservoir in last 20 years, including domestic and industrial supply, is estimated at about 630 MCM in total comprising 470 MCM for the right bank and 160 MCM for the left bank areas.

The left bank area receives some additional supplies from the Mau river and its tributaries. The river flow is caught by the tanks of Habararu, Kiriiban, and Mahagama. The average annual inflow from the Mau river to Mahagama and other tanks totals 41 MCM.

(4) Irrigation water demand

Overall irrigation water demand estimated by the ADB Appraisal Report in 1984 for the on-going rehabilitation work on the right bank area (Walawe Irrigation Improvement Project) was considered by MEA/ MASL as the basic estimate of the irrigation water demand of the Walawe irrigation area. According to the estimate, total annual irrigation demand for the right bank area of about 12,000 ha (10,900 ha of paddy and 1,000 ha of upland crops) is 405 MCM and left bank area of about 5,900 ha is 185 MCM. In addition, the industrial and domestic water supply of 30 MCM/year for the right bank area was also estimated.

On the other hand, the daily water management has been practiced based on a traditional and empirical estimate. The unit water consumption at the head of field canal is estimated at 25 mm/day for the first week of land preparation period, 18 mm/day for the 2nd to 4th week and 14 mm/day after 5th week. The irrigation efficiency between the head of the field channel and diversion point is taken at 72-76%.

According to the information from MEA, the diversion water consumption rates in 1990/91 Maha season by irrigation block were estimated at 2.86 m/crop-season for Embilipitiya block, 2.49 m for Chandrikawewa block, 1.96 m for Binkama block, 1.66 m for Murawasihena block, 2.21 m for Angunukolapellessa block, 2.43 m for Kiriibanwewa block, and 1.53 m for Suriyawewa block. It is considered that the high consumption rate of Embilipitiya block is caused by the permeable soil, which is not suitable for paddy cultivation. The figures show that the blocks located in the upper reach of the main canal such as Embilipitiya on the right bank and Kiriibanwewa on the left bank consume more water than that of the lower reach blocks.

Due to absence of basic data for estimating irrigation water requirement such as percolation rate of paddy fields and basic intake rate in the Study area, both tests were carried out at 71 points in total consisting of 50 points of percolation test and 21 points for basic intake rate. As a result of the test, it is defined that (i) percolation rate of the existing paddy field on the LHG soils is about 5 mm/day and on the RBE soils is higher than 10 mm/day and less than about 30 mm/day, and (ii) basic intake rates over most of the study area are less than 50 mm/hour and surface irrigation method could be applied to upland crop fields.

(5) Irrigation condition

As seen in Table 6, water issues from the Uda Walawe reservoir has no relation with the irrigation commanding area. It is considered that the present water usage, especially in the right bank area, has exceeded the level that was estimated by ADB in the Appraisal.

Because such as excessive amount of water has been supplied to the existing irrigation area, there is water shortage problem in the tail-end area of the canals. Main causes of the water shortage considered are: (i) limited flow capacity of canals for present paddy cultivation since some canals were designed and constructed for upland crops, (ii) improper water distribution due to excess water use in upstream areas of canals, (iii) lack of water control structures and unsuitable design of related structures such as turnouts and regulators, and (iv) lack of co-operation of farmers on water management and maintenance.

(6) Irrigation and drainage facilities in the Old area

Existing irrigation canals in the old area are counted at 460 km in total comprising the left bank main canal of 30 km and branch, distributary, and field canals of 430 km as shown in Table 5. Almost all irrigation canals in the sugar cane area are lined with thin concrete but canals the in other two block areas managed by MEA are earth canals.

There are more than 6,100 elated structures on the irrigation canals in total consisting of 1,400 turnouts and farm outlets, some 4,500 drops, 60 culverts and others. Most structures are made of reinforced concrete and some of stone masonry. About half of water control structures are equipped with wooden gates. On-farm facilities of about 4,500 ha have been constructed; comprising 1,500 ha in the sugar area, 1,500 ha in the Kiriibanwewa block, and 1,500 ha in Suriyawewa block.

Distribution system in the area consists of distributary and field irrigation canals; distributary canals issuing water from main and branch canals, and field canal distributing water from distributary canals to the individual farmers' plots of about 1 ha. The commanding areas of distributary canals varies from 6 ha to 500 ha. If the canals have a large extent of commanding area, several sub-branch canals are provided.

Drainage canals of about 160 km long in total are defined. Natural streams such as Mau and Mahaweligoda rivers are utilized fully as main drains of the area. Smaller natural drains are also utilized as drainage canals. Related structures on the drainage canals are bridges and culverts.

Irrigation and drainage facilities in the Sevanagala sugar area have been constructed recently and managed by himself since 1986. It is considered that the area is one of the industrial water consumers of the Uda Walawe reservoir, and no rehabilitation and improvement works is required at present since most of the irrigation canals were constructed recently with concrete lining and are well maintained by them.

Through field investigation, the following constraints are recognized for the structures in the existing irrigation area managed by MEA:

- canal banks have been eroded at several locations due to inappropriate side slope, and lack of bank protection at the critical points such as sharp bends especially outer side, downstream of control structures, and at the points of human and cattle crossing.

- About two-thirds of the concrete structures such as drops and turnouts, have collapsed and ceased to function. Water management structures such as regulators and measuring devices are practically non-existent in the entire canal network.

(7) Examination of flow capacity of the existing major canals

Flow capacity of the existing LBMC and Beddewewa Branch Canal (BBC) is examined based on the topographic survey data. Findings and constraints obtained through the examination are summarized as follow:

- The flow capacity of the aqueduct on the LBMC for crossing over the Mau river (about 80 m long), with internal dimension 5.5 m wide or 2.1 m high, is estimated at about 15 m^3/s without taking freeboard though the canal capacity of up and downstream canals have a capacity of about 30 m^3/s (1,070 cusec). The main cause of the flow capacity is the reduced dimension of the flow section, especially wall height of the aqueduct.

- The bank height of some sections of LBMC are not sufficient for the flow of more 15 m^3/s taking into account the free board of 1.5 m. Total length of canal with a inappropriate less bank height is estimated at 8 km and maximum and average required additional bank height is 1.7 m and 0.4 m,.

- BBC which is about 6 km in total length has full flow capacity of about 5 m^3/s for the full stretch of the canal except the last 1.3 km stretch. Some sections especially the first stretch of about 1.5 km, however, are required for some heightening work of banks to gain flow discharge of 5 m^3/s and obtaining the proper freeboard of the canals section.

(8) Water management organization and its constraints

MASL has taken over the responsibility for the system operation of the Walawe Development Scheme in 1982. Day-to-day water management for both the right and left bank areas has been made by project office of MEA. The headwork management unit of MASL looks after the reservoir operation. The head sluice of the Uda Walawe reservoir is operated from instructions given by MEA. The irrigation water is released to the right and left bank main canals through hydropower generation turbines. Actual operation of the head sluice has been done by CEB who is managing the power houses.

The MEA project office is responsible for the operation and maintenance of the Walawe irrigation system including canals and tanks. The Project Irrigation Engineer (PIE) from the project office has direct responsibility for the water management and day-to-day operation of the system. PIE is assisted by Irrigation Engineers (IE) for water management, maintenance, and flow monitoring, and block irrigation engineers.

MEA's management area of about 12,000 ha is divided into seven management blocks. Block level O&M staff are responsible for the distribution of water below the head sluice of the branch canal. All direct off-take of the main canals are controlled and operated directly by the project head office.

Although a farmers' organization for active participation in water management have been instituted by the project office of MEA, substantial activities of organizations have not manifested as yet.

Constraints and problems faced in the water management are summarized as follow:

(i) Since there is no discharge measurement device on the main and branch canals nor on major turnouts, discharge control has been made by reading water level gauges installed on the canals. The adequacy of day to day supply has been judged by the reaction of farmers and by general observations and assessment of field operation staff.

(ii) Due to poor design of turnouts and lack of cross regulators on the parent canals such as main and branch canals, excess water supplied in canals to maintain the intake water level of turnouts on parent canal.

(iii) Due to inadequate numbers and incorrect locations of turnouts on the canals, some unauthorized turnouts exist.

(iv) In most of the control gates on turnouts, the wooden leaves have collapsed or were lost.

(v) Most of the drop structures on branch, distribution and field canals are damaged seriously.

(vi) Bank slopes at the outer bend portion of earth canal and up and downstream sides of structures have been seriously eroded.

(vii) A farmers community for adequate irrigation water use has not matured yet.

(viii) Farmer's preference is to grow paddy wherever water is available. After the project was started, the project area was extensively reclaimed to paddy fields irrespective of the soil type and the original land use plan. This is the fundamental factor causing the current water management problems.

(9) Water management in drought

Due to the drought condition in the drainage area of the Walawe river from last Maha season, the Walawe irrigation area is facing severe drought in Yala 1992. In the middle of March 1992, storage volume of the Uda Walawe reservoir was observed at only about 15 MCM, about 6% of the live storage volume of 240 MCM. Water issues from the Uda Walawe reservoir were made for two consecutive days a week as scheduled in the cultivation meeting which was attended by project staff and farmers.

During the 1992 Yala season only 4,100 ha (35%) of the 11,500 ha was irrigated. In the case of the Left bank area, the ratio is about 39%. Paddy is, however, still the dominant irrigated crop on the Left bank area even in severe drought, but cultivation area of paddy in the season is only 20% of the past average.

Findings on the water management in this Yala season obtained in the field are as follow:

- Irrigated area is concentrated in the upper part of the distributary canals, and most of the tail end area of canals remained as fallow.
- Most of the paddy cultivations were made in the low land or valley bottom area where irrigation canals are closely located. It is considered that percolation losses in the areas are low, mostly LHG soils.
- A crop diversification from paddy to other field crops will be realized through strict control of water issue and training of farmers initiated on the project office.
- Upland crops are cultivated in the paddy field by the furrow irrigation method. The locations of this cultivation is just downstream of the paddy cultivation area and among the paddy area.
- Some drainage canals have water which was wasted in the irrigated area.

In the Extension area, drought condition was more severe than that in the existing irrigation area since there is no perennial river and water supply from the Uda Walawe reservoir has not eventuated yet. Most of the small scale tanks scattered in the area have dried up and the ground water level of the shallow aquifers went down. Most of the people in the area have suffered from lack of drinking water. A project office provides drinking water through distribution of water by water tanker.

3.3.2 Existing rural infrastructure

(1) Road network in and around the Study area

The main road in the Uda Walawe area is Route 'A18' which runs on the Right bank of the Walawe river from north to south. The road is connected to 'A2' road at Nonagama. These two routes of 'A2' and 'A4' lead to Colombo about 150 km away. The regional network in and around the Study area is illustrated in Figure 4.

The present condition of the roads and their constraints in the Old area are summarized as below:

- Roads net-work has already been set up
- Main roads are metaled and have enough width.
- Farm roads have enough width.
- Lack of related facilities such as bridges, culverts, and causeways.
- Occurrence of erosion gullies formed in the edge of the shoulders.
- Repair and clearing of embankments, surface leveling, pavement, etc are required.

The extension area has one main road which is connected between Mirijjawala and Suriyawewa. The main road runs from north to south and bisects the area west to east. The road connects to 'A2' road at Mirijjawala, located in southern part of the extension area and 'A18' road at Embilipitiya on the right bank of the Walawe river via Suriyawewa. This road is important road for rural transportation, but the road is in a very unsatisfactory condition especially in rainy season as its unpaved. Internal roads are systematized for connecting tank to tank or village to village, villages are located near tanks. It is considered that road network is not set up yet since the area has not been developed. These roads are in poor condition such as narrow, bumpy and un-jeepable.

(2) Household

Households in the Old area are clustered in the high land areas. In general, the cluster forms a hamlet. A hamlet is the smallest administrative unit. Kiriibanwewa block area consists of 6 hamlets, and Suriyawewa block area consists of 11 hamlets. Three patterns of settlement in the Extension area are observed as follows.

- Regularized settlements under village tanks and along the western boundary of the area. - mostly permanent and semi-permanent houses
- Encroached settlements - mostly semi permanent houses
- Seasonal settlements for rainfed shifting cultivation - mostly temporary houses

(3) Health and medical care facilities

Existing health and medical care facilities are summarized below, and these locations are illustrated in Figure 5.

Facility	Sugar Area	Kiriibanwewa	Suriyawewa (Old area)	Extension area
Gramodaya Health Center	-	-	1	-
Sub Divisional Health Center	-	1	1	1
Divisional Health Center	-	-	1	-
Dispensary	1	1	1	-
Hospital	-	-	-	-

It is noted that a health and medical care facility exists in the northern end of the Extension area and no facility exists in the southern area.

(4) Education facilities

The education facilities in the Study area are summarized as follows, and these locations are illustrated in Figure 5.

Facility	Sugar Area	Kiriibanwewa	Suriyawewa (Old area)	Extension area
Pre Primary	1	14	22	2
Primary School	4	-	2	-
Junior School	-	2	2	-
Senior School	4	5	1	-

(5) Public transportation services

Only the bus service is available as a means of public transportation in the Study area.

(6) Communication and postal services

(i) Telephone facility

No telephone station exists in the Study area, but it is available in Embilipitiya on the right bank of the Walawe river. Dialing system is used for the local calls. Long distance and overseas calls can be made through the operator. Some pay-phone booths are installed within the telephone station. It can be used to make ordinary calls, long distance calls and overseas calls.

(ii) Radio communication

In general, this mean of communication is used for public sector but it is not popular in the area.

(iii) Other communication facilities

Radio set diffusion rate : nearly 100 %
Television set diffusion rate : 15 %

(iv) Postal service

The central post office is located in Embilipitiya city. Divisional post offices are set up in Sevanagala sugar area and Suriyawewa.

(7) Electricity supply

Power is generated at the hydropower station at the Uda Walawe dam. It is distributed to Hambantota and Tangalla. For distribution, power is first reduced from 33 kv to 11 kv at Kiriibanwewa. Existing electricity supply networks are shown in Figure 6. As seen in the figure, only 3 centers in the area are provided with electricity supply, sugar factory village, Kiriibanwewa, and Suriyawewa towns.

(8) Drinking water supply

No drinking water supply facilities are available in the rural area. Public tube wells, private wells, and streams are the predominant sources of drinking water. Most farm families have private wells which are about 10 m deep with water depth of 1.0 - 3.0 m. Some of them, however, dry up in the drought season.

(9) Waste and sewage treatment

Rural areas have no sewer or drainage facilities. In most cases, human waste is buried in the ground by each family. Some of the households in the area are equipped with toilets, but their number is very few. As to miscellaneous water, each farm family has a simple drainage channel within the premises to let the ground naturally absorb the water.

(10) Assessment of present condition

It is considered that basic rural infrastructure in the Old area has been developed and have minimum requirement level. However, provision level of basic infrastructures is extremely low in the Extension area. Construction of most of all types of rural infrastructure is required, including drinking water supply system and education, communication, health and marketing facilities in parallel with the implementation of irrigation and drainage facilities.

CHAPTER 4 AGRICULTURAL AND IRRIGATION DEVELOPMENT PLAN

4.1 Development Needs

The agriculture sector has played the most important role in the economy of Sri Lanka. In 1990, it accounted for 26% of GDP, 36% of merchandise exports and 48% of active labour force.

Owing to the efforts for agricultural development by the Government as well as the nation, the agriculture sector accomplished average annual growth rates of 2.7% for 1965-80 and 2.2% for 1980-89. As a result, Sri Lanka had nearly achieved self sufficiency of rice in the mid 1980s. Since then the Government has been taking policy reorientation measures including (i) the liberal marketing policy encouraging private sector participation in marketing, processing and storage of rice, (ii) removal of fertilizer subsidy, (iii) crop diversification, (iv) peoplization of state owned enterprises including the sugar corporation and (v) privatization of seed production. However, the agricultural production has stagnated since 1987 and about one million ton of cereals have been still imported in recent years. The imported food stuff include rice, sugar, milk products, and flour, of which the first three could be produced locally. Moreover, per capita production indices in terms of food, agriculture, crops, and cereals have declined since 1987 by more than 10% compared with the 1979-81 level. In view of these facts, further efforts would be required to increase agricultural production, in particular basic food commodities such as rice and sugar.

Employment is one of the most serious problems in Sri Lanka. The agriculture sector presently employs most of the labour force (48%) and moreover it had absorbed 53% of the incremental labour force during 1981-1990. Nevertheless, out of 7 million of the labour force of the country, 1 million or 14.4% is still unemployed. Generation of 1 million employment opportunities is urgently needed. For this end, capital investments, and rapid economic growth are required. However, due to the Government's privatization policy, investment in the industry and services sectors largely depends on the private sector. The Government can make direct investment only in the agriculture sector. This investment will undoubtedly generate a substantial number of employment opportunities.

The Government's poverty alleviation policy contains the Janasaviya programme, Food Stamp programme and Midday Meal programme. The recipients of Janasaviya Round one and two were 258,000 families and recipients of Food Stamps were 6.8 million or 40% of the population in 1991. Many of the people in the left bank area are recipients of Janasaviya and Food Stamp programme. Sixty-three (63) % of people in the Extension area are recipients of either Janasaviya or Food Stamp programme. Increase of people's incomes is urgently required.

The Southern Area Development Strategy reflects the Government's special concern in the region. It is to develop the Southern Province to meet the needs of the skilled and educated but unemployed youth. The Walawe irrigation project constitutes a part of the Strategy.

In summary, Sri Lanka would urgently need to increase agricultural production, employment, and incomes of people. For this purpose, agricultural development projects should be implemented. Agricultural development potential is quite high in the Walawe left bank area, because there is plenty of water for irrigation, fertile soils and an abundant labour force available for the project. There are no environmental problems which a solution is difficult.

4.2 Objectives and Basic Development Concepts

4.2.1 Objectives and scope of the Project

Consistent with the Government's sectoral development objectives, the proposed project is aimed at to increasing agricultural production, incomes of rural people, and employment opportunities in the Project area through upgrading and extension of irrigation facilities and provision of rural infrastructures.

The Project covers an area of about 32,180 gross ha on the Walawe left bank comprising the Old area (16,480 ha) and Extension area (15,700 ha). The Old area consists of the Sevanagala sugar area (5,440 ha) and the MEA area (11,040 ha).

The existing irrigation area is 4,390 ha made up of 1,490 ha in the Sevanagala sugar area and 2,900 ha in the MEA area. The proposed irrigation area on the Walawe left bank is 12,030 ha comprising 2,750 ha in Sevanagala sugar area, 3,940 ha in the Old area and 5,340 ha in the Extension area.

The Project scope includes:

(i) upgrading and rehabilitation of the irrigation system including main, branch, distributary and field canals, and appurtenant structures in the Old area (2,900 ha);

(ii) construction of irrigation and drainage system including main, branch, distributary and field canals, regulating tanks, and appurtenant structures in the Extension area (5,340 ha) and the Old area (1,040 ha);

(iii) provision of rural infrastructures including a rural water supply system, road network, health and medical care facilities, education facilities, electrification, communication, agro-extension facilities, and development center;

(iv) provision of O/M equipment;

(v) engineering services including survey and detailed design;

(vi) administration and training.

The project will not include any work related to the extension of capacity of the Sevanagala sugar factory and the irrigated sugar area.

4.2.2 Basic concepts for plan formulation

(1) Compliance with the national agricultural development plan

The public Investment programme 1990-1994 provides the national economic development policy for the coming five years. In connection with this project, the major goals for the agriculture sector are:

- moving towards a higher degree of self-reliance in basic food commodities such as rice, fish, sugar, pulses, and milk;

- promoting diversification and encouraging the establishment of agro-industries and increasing incomes and employment opportunities in the rural areas.

The Walawe Irrigation Upgrading and Extension Project (Left Bank) has been formulated in compliance with the Government's national goals.

(i) Self-reliance in basic food commodities - rice and sugar

In 1991, Sri Lanka imported 133,000 tons of rice (equivalent to 190,000 tons of paddy), 670,000 tons of wheat and 358,000 tons of sugar. The percentage of these three commodities in total imports was 8.0%.

The total production of paddy in Sri Lanka was 2,389,000 tons in 1991. Therefore, the self-sufficiency of rice accounted for 93 %.

On the other hand, the local production of sugar was less than 60,000 tons in 1991. The self-sufficiency of sugar was only 14% and 86% relied on imports. Therefore, the Government's efforts concentrate on increasing local sugar production through the peoplization of sugar companies and maintaining a minimum efficiency price of US$500 per ton for refined sugar. There is no local production of wheat.

The project will produce rice and sugarcane in a considerable extent which will contribute substantially to the higher degree of self-reliance in basic food commodities.

The Walawe project area, being endowed with good and deep soils, enjoys the highest yield of rice in Sri Lanka. The project envisages double cropping of paddy cultivation on 4,540 ha of irrigated land with a unit yield of 5.5 tons/ha and an increase in paddy production of about 28,000 tons per annum.

The project also plans 3,000 ha of irrigated sugarcane cultivation with a production of 342,000 tons per annum which will save at least 34,000 tons of sugar import.

(ii) Crop diversification and agro-industry

The project envisages crop diversification. The extent of paddy cultivation will be limited to 4,540 ha which is about 50% of the total MEA irrigation area of 9,280 ha.

Sugarcane, banana, big-onion, and vegetables will be planted on the rest. The production of banana and big-onion are 10,000 tons and 15,000 tons, respectively.

Out of these crops, sugarcane has the lion's share. The biggest constraint on sugarcane culture is normally the processing plant but it is not the case in this project. Assurance was already obtained between the Ministry of Plantation Industries and MASL that the total production of sugarcane which will be cultivated on 5,000 ha of the Walawe project area (left bank: 3,000 ha and right bank: 2,000 ha) could be accommodated at the Sevanagala sugar factory when the proposed expansion of the factory capacity to 4,000 tons cane per day is undertaken.

Hence, the project will make a big contribution to the development of agro-industry in this region.

(iii) Increase of income

According to the PMU's census survey in 1991, about 6,000 families are living in and around the Extension area. Out of this, 2,100 families or 36% are recipients of the Janasaviya programme and 1,600 families or 27% are recipients of the food stamp programme. Therefore, altogether 63% of families fall in the category of poverty. Most of them are agriculture workers, but due to the sluggish agricultural activity, there are not enough employment opportunities. In the Extension area the

only farming practice is the chena cultivation and rainfed paddy cultivation, which are practicable only once in four or five years due to the dry climate. Most people earn their livelihood as hired labourers outside the Extension area.

According to the interview survey in 1992, the average yearly income of families living in the Extension area is Rs. 28,170 (farm incomes are about Rs. 10,000) and that of food stamp families is Rs. 14,120 (Rs. 11,250 without a government subsidy). This can be compared with the incomes of Rs. 53,320 of a typical paddy farmer in the Old area and Rs. 54,260 of a typical sugarcane farmer.

In the future under the project conditions, the incomes of farm households from 1 ha of irrigated land will increase to Rs. 75,000

(iv) Employment generation

The Project will generate a total of about 20,000 jobs comprising 13,000 persons for farmers, 4,000 persons as hired farm labourers and altogether 4,000 persons as merchants, employees of the sugar factory, school teachers, and other workers of secondary and tertiary sectors.

Therefore, altogether about 11,000 families and 60,000 of the population will earn their livelihood directly from the Project. This is the effect of the project on employment generation.

(2) Compliance with the southern area development strategy

The Government has launched the Southern Area Development Strategy aiming at the development of the Southern Province. The Strategy includes the Koggala free trade zone, Galle port, Matara-Kataragama railway extension, and Southern Province rural development project.

The Uda Walawe basin project is one of the water resources development projects aiming at improvement, rehabilitation and construction of schemes to provide better irrigation facilities.

(3) Irrigation system - Adoption of tank cascade system

The tank cascade system is the most efficient irrigation water re-use system which has been utilized in Sri Lanka since early historic periods. Reddish brown earth (RBE) in the dry zone of Sri Lanka are well drained and require plenty water when they are used as paddy field. The tank cascade system was invented by ancient engineers to cope with this affluent water requirements of paddy cultivation. The Kalawewa irrigation system is an example of typical tank cascade systems in Sri Lanka. Main features of the tank cascade system are as follows:

(i) Due to good drainability of RBE soil and undulating topography of land, paddy fields in the dry zone require more than 30 mm/day of water in depth, except for the valley bottom where low humic gley soils (LHG) occur and water consumption is low.

(ii) A schematic layout of the tank cascade system is illustrated in Figure 7. Three different water consumption areas and two tanks are assumed for example. Overall water requirements for this system are 2,620 mm/annum with the tank cascade system, while those are 5,140 mm/annum without the tank cascade system. This means that the tank cascade system is able to reduce the irrigation requirements to 52%.