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Report No. 951a-CE

Sri Lanka: Appraisal of the Tank Irrigation Modernization Project

November 15, 1976

Irrigation and Area Development Division
South Asia Projects Department

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CURRENCY EQUIVALENTS

Until recently, the Sri Lanka Rupee was pegged to the Pound Sterling at a parity rate of £ 1.00 = Rs 15.60. On May 24, 1976, the Sri Lanka Rupee was officially linked to a basket of currencies with the initial parity rate based on the prevailing Rupee/Pound rate. The current Rupee/US Dollar rate is about US$1.00 = Rs 8.70. The rate below, in effect during the preparation of the report, has been used throughout the report, except where stated to the contrary. 1/

US$1	=	Rs 7.5
RS 1	=	US$0.133
Rs 1 million	=	US$133,333

WEIGHTS AND MEASURES

1 long ton = 2,240 lb	=	1.016 metric tons
1 hundredweight (cwt) = 50.8 kg	=	112 lb
1 bushel (bu) of paddy	=	45 lb
1 pint	=	0.57 liters
1 acre (ac)	=	0.405 hectare (ha)
1 mile (mi)	=	1.609 kilometers (km)
1 square mile (sq mi)	=	640 ac (259 ha)
1 foot (ft)	=	30.5 centimeters (cm)

1/ Through the sale and purchase of Foreign Exchange Entitlement Certificates (FEECs), Sri Lanka effectively practices a dual exchange rate. Most non-foodgrain imports have to pay a surcharge of 65% through the purchase of FEECs. Most non-traditional exports receive a 65% premium over the official rate through the sale of FEECs.

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

ADB	-	Asian Development Bank
APC	-	Agricultural Productivity Committee
ARTI	-	Agrarian Research and Training Institute
BG	-	Batalagoda (a new improved HYV)
CAD	-	Command Area Development
CC	-	Cultivation Committee
CFC	-	Ceylon Fertilizer Corporation
CP	-	Cooperative Program
DA	-	Department of Agriculture
DME	-	Department of Machinery and Equipment
DRI	-	Director Rural Institutions
FAO	-	Food and Agriculture Organization
FEEC	-	Foreign Exchange Entitlement Certificate
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
GOSL	-	Government of Sri Lanka
ICB	-	International Competitive Bidding
ID	-	Irrigation Department
IRRI	-	International Rice Research Institute
KVS	-	Village Level Government Extension Worker (Krushikarma Viyaptha Sevaka)
LHG	-	Low Humic Gley Soils
M	-	Million
MAL	-	Ministry of Agriculture and Lands
MDB	-	Mahaweli Development Board
MIPH	-	Ministry of Irrigation, Power and Highways
MPC	-	Multi-Purpose Cooperatives
MPCS	-	Multi-Purpose Cooperative Societies
O & M	-	Operation and Maintenance
PMB	-	Paddy Marketing Board
RBE	-	Reddish Brown Earth
RVDB	-	River Valley Development Board
SDCC	-	State Development and Construction Corporation
SLTC	-	Sri Lanka Trading (Tractor) Corporation
TCC	-	Tank Coordination Committee
TCEO	-	Territorial Civil Engineering Organization
USBR	-	United States Bureau of Reclamation

FREQUENTLY USED ABBREVIATIONS FOR OFFICERS

ADAEO	-	Assistant District Agricultural Extension Officer
AI	-	Agricultural Instructor
AO	-	Agricultural Officer
APAEO	-	Assistant Project Agricultural Extension Officer
DAEO	-	District Agricultural Extension Officer
DDA	-	Deputy Director of Agriculture
GA	-	Government Agent
KVS	-	Village Level Government Extension Worker (Krushikarma Viyaptha Sevaka)
PAEO	-	Project Agricultural Extension Officer
SAI	-	Senior Agricultural Instructor
SMS	-	Subject Matter Specialist

GLOSSARY

chena	-	slash and burn or "shifting" agriculture
dhal	-	pulse crop (pigeon peas)
District	-	The principal administrative sub-division. There are 22 Districts in Sri Lanka.
ganga	-	major river
jaggery	-	unrefined sugar
maha	-	northeast monsoon season (October to January)
mammotie	-	hoe
manioc	-	cassava - the plant from which tapioca is made
oya	-	minor river
paddy	-	the unhusked grain, obtained after the threshing of the rice crop or the actual rice (oryza sativa) crop itself.
rice	-	the husked rice, ready for cooking (also referred to as "milled rice").
rotational irrigation	-	intermittent irrigation
wewa	-	tank
yala	-	southwest monsoon season (April to July)

FISCAL YEAR

January 1 - December 31

SRI LANKA

APPRAISAL OF THE TANK IRRIGATION MODERNIZATION PROJECT

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This report is based on the findings of an Appraisal Mission including: Messrs. R. Morton; M. Fireman; P. Garg; J. Karl Lee, and A. Seager (IBRD), and R. Shukle, Z. Matmor, and D. Benor (Consultants) who visited the project area in April and May, 1975. During part of the time, the following representatives of prospective co-financing countries accompanied the Mission: Messrs. R. Bailey (Canada); W. Franklin (UK); R. Glazner (Netherlands), and J. Coles, R. Perry and J. Watson (USA). A follow-up Appraisal Mission comprised of Messrs. P. Garg and C.J.R. Bridge (IBRD), E. Yendall (Canada), and W. Franklin (UK), visited Sri Lanka in January/February 1976.

SRI LANKA

APPRAISAL OF THE TANK IRRIGATION MODERNIZATION PROJECT

SUMMARY AND CONCLUSIONS

i. Agriculture dominates the economy of Sri Lanka. It accounts for about one-third of the GNP, more than one-half of all employment, about four-fifths of export earnings and much of the Government revenues. However, Sri Lanka imports about 40% of its foodgrain requirements. Historically, the country has depended upon the export earnings from tree crops -- tea, rubber and coconuts -- to provide for the import of foodgrains and other goods. The worsening terms of trade have prompted a reexamination of the past strategy. Increased food self-sufficiency is now a major objective of the Government's current agricultural policies. Better utilization of existing irrigation facilities and the development of new irrigation potential are two important elements in achieving increased food self-sufficiency.

ii. The dry zone of Sri Lanka has some 180 major tank irrigation schemes, serving a total cultivated area of about 400,000 ac. Deterioration of irrigation systems, poor water management and inadequate agricultural supporting services, are the prime constraints limiting agricultural production in the schemes. The proposed project would be a prototype for bringing these schemes up to their full potential. A successful implementation of this project would open the way for eventual modernization of all the tank schemes. Potentially, that could add one-quarter of a million tons to the foodgrain production of the country (about one-third of current imports).

iii. The project would cover five tank schemes, serving a total cultivated area of 31,500 ac. The project would include: (a) construction works for improving irrigation and drainage facilities; (b) improvement of farm roads; (c) provision of farm equipment for land preparation and plant protection; (d) strengthening of agricultural supporting services, particularly extension; and (e) technical assistance for improving the operation and maintenance of the irrigation systems.

iv. Total project costs are estimated at US$30.0 million equivalent, including about US$7.0 million in import taxes and duties. The foreign exchange component is estimated at US$9.3 million or about 40% of the total net of taxes and duties. The major elements in the cost estimates are: civil works (US$8.7 M); construction equipment and vehicles (US$5.6 M); agricultural equipment and vehicles (US$5.6 M); technical assistance (US$0.3 M); and engineering and administration (US$1.3 M) -- making the base project cost US$21.5 M. Physical contingencies (US$1.7 M) and price contingencies (US$6.8 M) would bring the total project cost to US$30.0 M.

v. With assistance from the Bank Group, GOSL has secured a grant of US$6.0 M equivalent from The UK for financing part of the project costs. Together with the UK grant, the proposed IDA credit of US$5.0 M would finance all foreign exchange costs and some local costs, or about 48% of the total project cost net of taxes and duties.

vi. Project implementation would take five years. The Irrigation Department (ID), under the Ministry of Irrigation, Power and Highways (MIPH) would be responsible for implementation, and operation and maintenance of the civil works proposed under the project. Construction equipment for the ID would be procured by the Sri Lanka Tractor Corporation which would also procure and distribute the farm equipment to project area farmers. The Department of Agriculture in the Ministry of Agriculture and Lands would be responsible for the re-organization and strengthening of the extension service. Responsibility for improving marketing, processing and storage facilities would be with the Paddy Marketing Board. Credit facilities for financing farm equipment would be provided by the Bank of Ceylon and the Peoples' Bank. To facilitate inter-agency coordination, Project Coordination Committees have been established at the Central, District and Tank levels. The committees are respectively chaired by the Secretary, MIPH, Chief Project Engineer, and Project Engineers and include respresentatives from the concerned agencies.

vii. Machinery and equipment to be supplied under the UK grant would be procured in accordance with UK procurement guidelines. Other equipment, vehicles and office supplies would be procured through international competitive bidding in accordance with IDA guidelines. Civil works, proposed under the project, would be simple, labor-intensive, individually small, scattered over large areas and restricted to seasonal construction. Thus, they would be unsuitable for international competitive bidding, and, instead would be carried out by the ID on force account or through small unit-cost contracts.

viii. At full development by 1985, annual foodgrain production in the five tank areas as a result of the project is expected to reach 46,000 tons compared to the current 18,700 tons and a projected 23,700 tons without the project conditions. The project-related increase of 22,300 tons would represent an annual net foreign exchange savings of about US$4.0 million.

ix. The project would directly benefit some 10,000 small farm families, operating mostly about 3 ac each. Present income levels in the Project area are substantially below the national average. At full development, the project would raise them to the national level. The civil works proposed under the project would provide a total of 3 M man-days of employment during implementation. The more intensive cultivation envisaged under the project would generate an annual employment of 0.6 M man-days in on-farm works. Also, there would be a substantial increase in secondary employment in activities such as marketing, processing, and supply of farm inputs. The increased employment would help to relieve the large unemployment and underemployment prevailing in project areas.

x. At projected 1985 world market prices, the project's economic rate of return would be 23%. Sensitivity tests indicate that, even under a variety of adverse assumptions, the project remains economically viable. Economic analysis also indicates that each of the five tank schemes is viable on its own.

xi Subject to the appropriate agreements obtained from the Government, the proposed project is suitable for an IDA credit of US$5.0 M. The Borrower would be the Republic of Sri Lanka.

SRI LANKA

APPRAISAL OF THE TANK IRRIGATION MODERNIZATION PROJECT

I. INTRODUCTION

1.01 The Government of Sri Lanka (GOSL) has requested IDA assistance in financing a Tank Irrigation Modernization Project. Since the beginning of its operations in Sri Lanka in 1954, the Bank Group has made eight loans and extended nine credits totalling US$152.5 M. This would be the Bank Group's fourth project in support of the country's water resources development. Credits 121-CE (US$2.0 M) and 168-CE (US$2.5 M) involved lift irrigation and drainage and reclamation projects, respectively. A combination of Credit 174-CE (US$14.5 M) and a Loan 653-CE (US$14.5 M) financed the construction of the first stage of the Mahaweli Ganga Project. Stage II of the Mahaweli Ganga Project, appraised concurrently with this project, is being processed. Recently, the Association approved a US$25.0 credit for financing an Agricultural Development Project (Cr 595-CE). The project is to support high priority on-going programs for agricultural rehabilitation and development through the provision of critically-needed vehicles, machinery and equipment, spares, supplies and technical assistance. The Agricultural Development Project would complement the proposed project in many respects.

1.02 There are some 180 major tank irrigation schemes 1/ in Sri Lanka, serving a total cultivated area of about 400,000 ac. The tanks were originally constructed to provide supplemental irrigation during the maha season. The emphasis placed on food self-sufficiency in recent years has prompted a re-examination of the irrigation potential of these tanks. Several studies have indicated that substantial increases in cropping intensities, yields and production are possible with rehabilitation and modernization of the water distribution system, improved water management and cultivation practices, and a strengthening of the agricultural supporting services. The proposed project, covering five tank schemes, would be a prototype for testing the validity of this approach at the field level.

1.03 The project was identified and prepared by several Missions from the FAO/IBRD Cooperative Program (CP). Their findings and recommendations are presented in Report No. 17/75 CEY. 7 dated April 25, 1975. The project was appraised in April/May, 1975 by a Bank Group Mission comprising Messrs. R. Morton, M. Fireman, P. Garg, J.K. Lee, and A. Seager (IBRD) and R. Shukle, Z. Matmor, and D. Benor (Consultants). The Mission was accompanied by reprentatives of four prospective co-financing countries 2/: Messrs. R. Bailey

1/ Those with a storage capacity of 2,000 ac-ft or more.

2/ Originally, it was proposed that the processing and co-financing of this project and the Mahaweli Ganga II Project would be dealt with as a package. Following discussions between GOSL, IDA and the co-financing countries, it was agreed that, since the Tank Irrigation Project would be ready for Board presentation ahead of the Mahaweli Ganga II Project and since it would simplify procurement and disbursements, only UK would participate in co-financing this project. Contributions from the other co-financiers would be used for the proposed Mahaweli Ganga II project.

(Canada); R. Glazner (The Netherlands); W. Franklin (UK), and J. Coles, R. Perry and J. Watson (USA). A follow-up Appraisal Mission, comprised of Messrs. P. Garg and C. J. R. Bridge (IBRD), E. Yendall (Canada), and W. Franklin (UK), visited Sri Lanka in January/February 1976. This report, based on the findings and recommendations of the two Missions, was prepared by Messrs. J.K. Lee and P. Garg.

II. BACKGROUND

General

2.01 The Republic of Sri Lanka is a tropical island in the Indian Ocean with an estimated current population of about 13.5 million, 80% of which is rural. Of the total land area of 16.2 million ac (about 25,300 sq mi), about 5 million ac are used for agriculture, 9.3 million ac are under forests, and the remaining 1.9 million ac are water bodies, urban areas or under other uses. About half of the forest land is potentially suitable for agricultural development.

2.02 The island's climate is characterized by nearly constant temperatures but with large variations in rainfall. Based on precipitation, the island can be divided into two distinct zones: the wet zone (average annual rainfall over 75 inches), situated in the southwest quadrant and covering about 30% of the land area, and the dry zone (average annual rainfall 35 to 75 inches) covering the remainder of the island. The wet zone supports more than three-quarters of the total population and accounts for about 70% of the cultivated land.

The Economy

2.03 Per capita income levels (US$145 in 1975) are low. Since 1970, growth in national income has averaged 2.5% a year, only slightly higher than the population growth rate of 2%. A large part of the labor force, perhaps about one quarter, is unemployed or underemployed, and indications are that the employment situation has been worsening for some years. During the last few years, Sri Lanka has been severely affected by rapid deterioration in its terms of trade -- prices of its major imports, foodgrains, fertilizers and petroleum products have shot up, while price increases for its main exports tea, coconuts and rubber have been relatively moderate.

2.04 Past Government programs have emphasized social welfare and equitable income distribution. On the positive side, this has meant an increasingly egalitarian income distribution, a rather well-developed system of health care and other public services and a high literacy rate. These developments, however, have not been accompanied by a satisfactory growth in output, mainly because of inadequate investment in productive sectors. Much of the capital stock of the economy is obsolete and requires replacement and modernization. The country faces a severe foreign exchange gap, and the budgetary

resources of the Government are barely adequate to cover its current expenditure, leaving most capital formation to the vagaries of external assistance. The Government is aware of the problems confronting the economy and has been gradually shifting the emphasis towards production oriented investments, particularly those for increasing food production.

The Agricultural Sector

2.05 Agriculture contributes about one-third of the gross national product (GNP), more than one-half of all employment, over four-fifths of export earnings and much of the Government revenues. Dominance of the sector gives it a pivotal role in influencing the economic activity and the course of development in the country.

2.06 Sri Lanka's climate is suitable for year-round crop production. The major constraint is water; in the wet zone there is sometimes too much while in the dry zone there is often too little. The variations in precipitation and elevation make it possible to grow a wide range of crops including tea, rubber, coconuts, paddy, manioc, chillies, maize, potatoes and millets. About half of the total cultivated area of 5.0 million ac is under tree crops -- primarily tea, rubber and coconuts. The other half is under field crops, the major ones being paddy (1.3 M ac), manioc (0.2 M ac) and chillies, maize and pulses (about 0.1 M ac each). Where sufficient water is available, it is the common practice to produce two or more crops a year. The cropping intensity on paddy lands ranges from about 185% in the wet zone to about 110% in the dry zone, the average for the whole country being about 150%.

2.07 In the decade ending in 1973 (the last "normal" year), agricultural output increased by about 25%, i.e. at an annual rate of only 2.3%; on a per capita basis the rate of increase was insignificant. While foodgrain production increased by about 36% over this period (3.1% annually), output in the tree crop sector increased by only 13%. Paddy production, under favorable weather conditions, reached 77 M bu in 1970 and that level is still to be surpassed. In 1974, the dry zone experienced a severe drought; both the maha and yala crops harvested in 1975 were much below normal. Total paddy production in 1975 was about 55 M bu -- only about two-thirds of the 1970 production.

2.08 The slow growth of agricultural production despite considerable potential may be attributed to a number of factors. The sluggish performance of the tree crop sector is largely a result of inadequate investment due to poor financial returns and an uncertain investment climate. Production of field crops has suffered from poor water management, lack of adequate farm power for timely tillage, inadequate attention to extension, marketing and credit facilities and the system of controls and subsidies which works to reduce incentives to the farmer. 1/

1/ An analysis of the various constraints to agricultural development in Sri Lanka is given in the Bank Group Report No. 579a-CE, Republic of Sri Lanka, Agricultural Policy and Program Review, dated February 19, 1975

2.09 The Government is concerned about the stagnation in agricultural production. Among the measures recently taken to increase field crops output are: increases in guaranteed support prices and elimination of compulsory paddy procurement to provide production incentive; reduction in free and subsidized rations; import restriction on subsidiary crops such as chillies, onions, potatoes and pulses to promote domestic production; establishment of Agricultural Productivity Committees (APCs) to improve the supply of farm inputs and supporting services; and most importantly an increased emphasis on efficient water utilization and management.

Irrigation

2.10 Agriculture in the dry zone depends entirely upon irrigation during the yala season and because of erratic monsoons, supplementary irrigation is necessary even during the maha season.

2.11 Irrigation in Sri Lanka dates back to about 600 B.C. when an extensive network of irrigation tanks (reservoirs) was developed in the nothern part. Over the last century, many of these facilities have been reconditioned and incorporated into new irrigation systems. Currently, they irrigate about 900,000 ac and efforts are continuing to expand this acreage.

2.12 In addition to reconditioning the ancient tank network, the Government has undertaken a number of multi-purpose water development projects; among them are Gal Oya, Uda Walowe and Mahaweli Ganga projects. The last one is being constructed with the Bank Group assistance. With the completion of the ongoing works by 1985, the total irrigated acreage would increase by about 200,000 ac.

2.13 Farmers in Sri Lanka follow the traditional methods of irrigating paddy; they let water run continuously, ponding it on the fields. In addition to meeting the consumptive use requirements of the crop, this method has the advantage of assisting in weed control. However, it is highly wasteful in the use of water, particularly on soils with high permeability. Also, in the tank schemes, paddy is normally sown only after the tanks are deemed to be sufficiently full to assure an adequate water supply to mature a maha crop. If the tanks do not fill until late in the monsoon, sowing is correspondingly delayed. The net effect is that in some years much of the monsoon rain is not utilized for crop production. With proper operation and management of the irrigation systems and improved methods of irrigation, it would be possible to substantially increase the irrigated area with the existing water supply.

III. THE PROJECT AREAS

General

3.01 The five areas proposed for modernization under the project are located in the north central dry zone of Sri Lanka. Three of the tanks

(Padaviya, Mahakanadarawa, Mahawilachchiya) are located in Anuradhapura District; Pavatkulam is in Vavuniya, and the fifth, Vavunikulam, is in Mannar District. Part of the command areas of the Padaviya and the Vavunikulam tanks are also located in Trincomalee and Jaffna Districts, respectively. All five tanks are fed by the runoff from local catchments ranging from 88 sq mi to 208 sq mi. The net irrigable area served by the individual tanks varies from 2,600 ac to 12,500 ac; the total for the five is 31,500 ac. The water supply/demand conditions in the five tanks cover a wide spectrum, varying from highly favorable in the Padaviya tank to rather poor in the Pavatkulam tank. Taken as a group, they are representative of nearly all the major tank schemes in Sri Lanka.

3.02 Before construction of the five tanks, about 20 years ago, the present service areas of the tanks were forest lands and only a limited amount of chena cultivation was practiced. After reconstruction, some 10,500 families were settled, each with a 3 ac allotment of irrigation land. 1/ The current population in the five tank areas is estimated at about 75,000, almost all of it engaged in agriculture.

Climate

3.03 The climate in the project areas is tropical with mean monthly temperatures ranging from 76°F to 86°F, making it suitable for year round cropping. The mean annual rainfall is about 55 inches and about two-thirds of that occurs during the maha season (October-January). Mean relative humidity varies from 69% to 80% and average daily sunshine, from about four hours in December to nine hours during February through April (Annex 1).

3.04 The rainfall pattern is highly erratic. The onset of the monsoon may vary as much as six weeks from year to year. The amount of rainfall also varies considerably from year to year. Precipitation amounting to 6 to 8 inches per week as well as dry periods extending for 2 to 3 weeks are not uncommon during the maha season (Annex 1, Figures 1 to 3). Due to the unpredictability of the rainfall irrigation is necessary even during the maha season.

Topography and Soils

3.05 The north central region in which the five tank areas are located is a large plain sloping gently downward from south to north. The soils of the areas irrigated by these tanks are lateritic and derived from coarse grained granites. They are unusually low in silt and therefore are very hard when dry. They have high permeability and low water-holding capacities. The warm winds that regularly blow over the northern part of the island during the yala season dry the soils out quickly and, therefore, they require frequent irrigation.

1/ In addition, each family was given about 2 ac of unirrigated high land for homesteading and for growing rainfed crops.

3.06 In addition to the general slope, there is local undulation in surface relief which is related to the stream pattern. Generally, three soil types are found within the command area of each tank. These include (i) reddish-brown, moderately coarse, highly permeable soils, located on uplands with elevated rolling topography; (ii) slightly darker, slightly finer, moderately permeable soils with fair drainage, located mostly on the gentle slopes below the uplands, and (iii) brown to grey-brown, slightly finer, less permeable, poorly drained bottom land soils. All the soils are slightly acidic.

3.07 Because of the coarser structure and higher permeability of the reddish brown soils they are best suited for the production of upland crops, while the bottom soils are ideal for paddy production. Even though the soils on the uplands and intermediate slopes are better suited to crops other than paddy, GOSL officially describes them as "paddy soils". Paddy is uniformly grown on them during the maha season (Annex 2).

Farm Size and Land Tenure

3.08 Socio-economic surveys conducted during project preparation indicate that the farm size pattern established at the time of settlement has remained essentially unchanged. Over three-quarters of the sample holdings were between 2 and 4 ac, and none of the holdings was smaller than 1 ac or larger than 5 ac. Most farms also had about 2 ac of highland, part of which was used as household garden plots. In addition, about two-thirds of the farm families practiced chena cultivation on forest lands outside the project area.

3.09 With minor exceptions, the lands in the five tank schemes are State lands on nominal lease to the settlers 1/. The leaseholders can pass the leasing rights on to their children, but are forbidden to mortgage, sublet or fragment the lands. Under the 1973 Sale of State Lands Act, the Government is conferring full titles to the cultivators in such schemes while collecting part of the development costs incurred during settlement. The Land Commissioner, within MAL, expects to complete the new tenure arrangements by the end of 1977.

3.10 The surveys indicate an average family size of about 7.5, of which 4 are available for farm work -- 2.5 on a full time basis and 1.5 on a part time basis. About 60% of the adult farm population is literate.

Agricultural Production

3.11 Paddy is the most widely cultivated crop in the project areas. Sowing of the maha paddy starts in October/November, after the tanks have been filled to a level deemed adequate to ensure the water supply for the

1/ Exceptions are the privately-owned land around a few small village tanks in Purana villages which were incorporated into the schemes in the past at the time of rehabilitation.

crop. Because of inadequate farm power for land preparation and the priority given to chena cultivation, the sowing is extended into late January. The crop is harvested between February and April. Subject to the water availability in the tanks, a second paddy crop, yala paddy, is broadcast during March/April for harvest in June/July.

3.12 Maha paddy is grown on some 24,000 ac and yala on 8,000 ac. The yields are low -- about 0.9 and 0.8 tons/ac, respectively. The lower yala yield is primarily due to the water shortages experienced during the latter part of the cropping season. Farmers prefer broadcasting to transplanting despite the latter's potential for higher yields. Recently row seeding which allows easier weed control, has become popular. Cultivation is done by manual labor, except for land preparation which is mostly done by tractors.

3.13 In addition to paddy, crops such as maize, sorghum and pulses are grown on about 700 ac during the yala season. Some coconuts, bananas and vegetables are grown, primarily for home consumption, on household garden plots. On chena lands, outside the project area, farmers grow millets, pulses, seasmum, and other drought-resistant crops.

3.14 On the 31,500 ac of irrigable cultivated area, the estimated present cropped area is about 33,000 ac giving an overall cropping intensity of 103%. The cropping intensity varies from a low of 85% in Mahawilachchiya tank to about 120% in Padaviya tank. The total production is about 28,000 tons of paddy and about 300 tons of pulses and cereals. Present farming practices, cropping patterns and yields are detailed in Annex 3.

Agricultural Supporting Services (Annex 4)

3.15 Agricultural Productivity Committees and Cultivation Committees. Agricultural Productivity Committees (APCs), established under the Agricultural Productivity Law of 1972, are to be the principal regulatory bodies for all agricultural activities at the field level. There are to be a total of 530 APCs, 1/ each APC serving about 5,000 farm families. The members of the APCs are appointed by the Minister of Agriculture and Lands. At the village level, APCs are assisted by Cultivation Committees (CCs) whose members are also appointed by the Minister of Agriculture and Lands. Both APCs and CCs are assisted by the administrative, engineering and agricultural officers in technical matters. The committees are responsible for ensuring that the agricultural lands are used to the maximum benefit of the country. Towards this end, they have far reaching powers in prescribing the cropping patterns to be followed in their areas as well as in the allocation of inputs such as credit, fertilizer, tractors and irrigation water.

3.16 Agricultural Research: The problems of dry zone agriculture are studied at Maha Illupalama Research Station which is funded by the Mahaweli Development Board (MDB) and is centrally situated for all five tanks (Map 11749). Rice breeding is done at the nearby Badalagoda station. On the whole, agricultural research is well organized and the rice breeding program has consistently produced good results.

1/ Some 430 of these were already in existence in May 1975.

3.17 Agricultural Extension. There are a multiplicity of extension programs in Sri Lanka. In addition to the Department of Agriculture's country-wide program, there are several special programs, some oriented to particular areas and others to particular crops. This multiplicity results in both diffusion and confusion. In addition, extension suffers from a lack of exposure to up-to-date research, a shortage of vehicles, equipment and accommodation for the field staff, and the absence of a well-defined work program for field staff.

3.18 Agricultural Inputs. All seeds are distributed by the extension service and varieties adaptable to all climatic zones and seasons are generally available. Most farmers use fertilizer which has generally been available in sufficient quantity to meet the demand, but sometimes not on a timely basis. Pesticides and herbicides are generally available as needed However, an adequate supply of equipment for application of these has not been available. This either discourages the use of agro-chemicals or results in their untimely application. About 85% of the short- and medium-term credit is provided by private sources. The GOSL provides institutional credit through the Bank of Ceylon and the People's Bank. Due to inadequately trained field staff, lack of supervision in the use of credit and leniency in imposing credit discipline, the recovery rates on institutional credit have, generally, been low. Using APCs to assist in controlling and supervising the use of credit, the Government is trying to improve recovery rates.

3.19 Farm Tractors. About 65% of the farmers in the tank areas use four-wheel tractors for land preparation. Due to lack of foreign exchange to buy spare parts or replacement tractors, the present tractor fleet is inadequate to prepare the land in time. Two-wheel tractors and water buffalo are sometimes used as substitute sources of draft power; however, that requires using scarce irrigation water for pre-softening of the soils.

3.20 Marketing, Transportation and Milling. Until recently, the Paddy Marketing Board (PMB) had a monopoly in the purchase of paddy. Even with the removal of restrictions on private traders, it is expected that the Board will continue to play an important role in paddy marketing and milling. Generally, the paddy is transported by buffalo carts to the purchasing points (about 250 in the Anuradhapura District). From there, it is transported by trucks to the storage centers. At present, Anuradhapura District has about 50,000 tons of storage capacity. The PMB is constructing a silo to augment this by an additional 6,000 tons. Rice milling is done in private mills as well as in those owned by the PMB. The main problems with PMB's marketing and milling operations have been: (i) lack of grading facilities at purchase points, (ii) lack of adequate transportation and storage facilities, particularly during the peak periods, and (iii) poor quality of the milled rice. With assistance from International Rice Research Institute (IRRI), Ford Foundation, and USAID, PMB is undertaking a phased program for improving its operations. The recent decision to allow private sector participation in these activities will also help alleviate some of the problems. Maize and sorghum are relatively minor crops. They are mostly marketed through private channels. However, during the last two years PMB has also entered the market as the residual buyer.

3.21 The entire country, including the north central region in which the five tanks are located, is served by good all-weather roads, most of which are asphalted. The secondary roads are usually graded and many are gravelled. However, the village and farm roads are often nothing more than tracks and are usually impassable during the wet season.

Present Problems

3.22 The main problems which limit agricultural production in the project area are:

(a) inefficient use of rainfall and a wasteful use of stored water;

(b) inequitable water distribution within the irrigation system;

(c) lack of adequate farm power for timely land preparation;

(d) poor access roads, and

(e) ineffectiveness of the current extension service.

IV. THE PROJECT

General

4.01 The project would increase cropping intensities in the command areas of the tank schemes by making better use of rainfall and water stored in the tanks. It would also ensure an equitable water distribution through strictly enforced rotational delivery schedules. The proposed improvement in water use would require: rehabilitation and modification of the existing conveyance system; measurement of water flows at various points along the canals; reduction in delivery losses, and improved water use on the field.

4.02 To derive full benefits from the project, the extension service would be strengthened and supplies of farm inputs would be improved. Also, to enable farmers to cope with the tightened crop calendars and to intensify cropping patterns, the project would provide for a substantial increase in the number of farm tractors for land preparation. Finally, for proper handling of the increased farm production, farm roads would be improved.

Project Works

4.03 The main components of the project are as follows:

Civil Works

(a) desilting and enlarging the entire water conveyance system (main and branch canals, 120 mi; distributaries, 180 mi; and field channels about 500 mi) to provide sufficient capacity for a seven day rotation with only daylight irrigation (estimated earthwork: 0.6 M cu yd);

(b) repairing, enlarging and surfacing with gravel the embankments used as farm roads (estimated earth work: 1.3 M cu yd and gravel work: 0.4 M cu yd);

(c) excavating some 300 mi of drains to improve the drainage (estimated earth work: 1.6 M cu yd);

(d) where necessary, brick lining of the conveyance system to reduce excessive seepage or erosion, and to provide the necessary degree of water control. In addition, all irrigation canals and field channels under the Mahawilachchiya tank would be lined, with different kinds of lining, as a pilot program for determining the effect on seepage losses, and capital and maintenance costs (estimated lining requirements -- main and branch canals: about 6 mi; distributaries: about 7 mi, and field channels: about 50 mi);

(e) repairing and modifying the existing structures in the irrigation system to enable daylight irrigation for each farm on a seven day rotation schedule;

(f) installation of some 170 new regulators in the main and branch canals to increase water control in the conveyance system. Similar regulating structures would also be installed in distributaries and field channels;

(g) installation of devices to measure releases from the tanks and water flows at various points in the system, and

(h) provision of offices, workshops, stores and housing for supervisory and construction crews. For each 6,000 ac units such buildings will include: 2,400 sq ft for temporary offices; 4,000 sq ft each for storage and workshops; temporary quarters for three senior officers; six units of 500 sq ft each for supervisory personnel; two units of 4,000 sq ft each for bachelor officers quarters, and 2,000 sq ft of dormitory space for laborers. After construction is completed, all buildings, except the temporary offices and quarters, would continue to be used in connection with the expanded operation and maintenance (O & M) program for the project.

Construction Equipment and Vehicles

(a) provision of equipment and vehicles (base cif cost about US$3.2 M) for use in the modernization program. After completion of the modernization program, leftover usable equipment, if any, would be used either for the O & M of the completed system or would be made part of the equipment pool of the Department of Machinery and Equipment (DME), Ministry of Irrigation, Power and Highways (MIPH) for use in similar projects.

Farm Equipment and Agricultural Supporting Services

(a) provision of 150 four-wheel and 450 two-wheel farm tractors, all with necessary attachments and equipment for use in land preparation. In addition, the project would provide 150 sprayers for applying pesticides and herbicides, and

(b) reorganization of the agricultural extension service in Anuradhapura District along the lines successfully adopted in a number of Bank Group financed projects in India and Nepal (Annex 4). The project would provide buildings, vehicles, equipment and staff for strengthening the extension service. Under a separate technical assistance grant to GOSL, UK is providing three Subject Matter Specialists (SMSs), each for a period of about two years, to help in the initial implementation of the work program and to provide on-the-job training to counterpart personnel in the proposed extension service.

Technical Assistance

(a) a water management specialist would be engaged for a period of at least two years to assist in layout and design (particularly the field channels and farm drains), in the development of the operating schedules for the tanks and the rotation schedules for the water supply system and to train local engineers, technicians and Cultivation Committee (CC) members on intermittent irrigation. These local staff would then train farmers to help them adapt to the new irrigation practices.

(b) engaging of the Agrarian Research and Training Institute (ARTI) to conduct appropriate benchmark and follow-up surveys in order to evaluate the impact of the project on the efficiency of water utilization, equitable water distribution, O & M costs, cropping patterns, yields and production levels and farm income levels. Emphasis would also be placed on evaluating the merits of various types of canal linings proposed for the Mahawilachchiya tank.

Water Supply, Demand and Quality

4.04 Water Supply: the project water supply is furnished by five existing tanks with an aggregate storage of 213,500 ac-ft as follows:

	Maha-kanadarawa	Maha-wilachchiya	Pavatkulam	Vavunikulam	Padaviya	Total
Tank Storage Capacity (ac-ft)	34,000	32,500	27,000	35,000	85,000	213,500
Area Irrigated (ac)	6,000	2,600	4,400	6,000	12,500	31,500

The tanks regulate inflows occurring mostly from September through January to provide supplemental irrigation water in the rainy season and a full irrigation supply in the dry season. Analysis of the historical inflows to the tanks indicates that water is available to increase the cropping intensity by modifying and improving the existing irrigation practices and the tank operations. Details of the water supply and irrigation operations are discussed in Annexes 5 and 10. The Padaviya tank appears to have inflows in surplus and also additional potentially irrigable lands. The need for additional storage and conveyance and distribution systems to expand irrigated areas below the tank would be evaluated as part of the tank operation training program. The water management specialist to be provided by the project, would guide the study and preparation of plans for future expansion of the Padaviya tank service area.

4.05 An investigation of the catchment areas of the five tank schemes indicates the absence of any significant water use upstream. Also, the Government does not have any plans for development upstream. However, to ensure proper water supplies in the project areas, agreement has been obtained that the Government would not undertake any future development upstream of the five tank schemes which might significantly reduce the water supplies.

4.06 Water Demand. The present irrigation demand is mostly for supplemental irrigation of the maha paddy. Under project conditions, the cropping intensity will be increased from 103% to 156%. The increased demand would be met by better utilization of the rainfall as well as the water stored in the tanks. Firm irrigation seasons would be established and a strict rotational irrigation regime would be enforced. Moreover, irrigational intervals would be determined by the consumptive use requirements of the crops and by the degree of soil depletion, and not by whether there is water actually standing in the paddy fields (Annex 3). A simulation of the proposed regulation of the tank inflows occuring over the period of records available indicates reasonable success in meeting the projected demands under increased cropping intensity (Annex 5, Table 3).

4.07 Water Quality. The water available from the tank is of very good quality for irrigation use.

Implementation Schedule

4.08 Project implementation would take five years (Annex 6, Table 1) Tender documents for construction equipment have been prepared and issued and awards would be made for deliveries by March 1977. Staff mobilization would begin in January 1977 and construction in April 1977. However, due to the need to establish logistical support in the field and put together the necessary construction organization, the progress in the first construction year (1977) would only amount to about 15% of the total. The construction tempo would pick up substantially during the next two years (1978-79) and the work would be completed by 1980. The field channel lining program on the Mahawilachchiya tank would be completed in the first year (1977) so that the results in terms of both costs and water savings would be available for guidance in the modernization of other tanks. Detailed activity network diagrams and construction schedules are shown in Annex 6, Tables 2.

4.09 To minimize interference with crop production and also to take advantage of the favorable construction weather, most of the field work would be performed during the seven-month periods from April to October. No water would flow through the canals during that time and many of the farmers could be employed on project works.

Cost Estimates

4.10 Total project costs are estimated at US$30.0 million equivalent, including about US$7.0 million in import taxes and duties. The foreign exchange component is estimated at US$9.3 million or about 40% of the total, net of taxes and duties. Estimates are based on preliminary design, with unit prices at January 1976 levels. The major elements included in the cost estimate are civil works (US$8.7 M), construction equipment and vehicles (US$5.6 M), agricultural equipment and vehicles (US$5.6 M), technical assistance (US$0.3 M), and engineering and administration (US$1.3 M), totalling to a base project cost of US$21.5 M. Physical contingencies of US$1.7 M (20% of civil works costs) and price contingencies 1/ of US$6.8 M (29% of the base cost plus physical contingencies) bring the total project cost to US$30.0 M. Estimated project costs, presented in greater detail in Annex 7 are summarized below:

1/ Price contingencies have been calculated assuming the following inflation rates:

Rate of Inflation (%)	Year 1976	1977	1978	1979	1980
Civil Works	14	12	12	12	12
Equipment and Vehicles	10	8	8	8	8

	Item	Local	Foreign	Total	Local	Foreign	Total /a	% of Total
		-----(Rs Million)----			----(US$ Million)----			
I.	Civil Works							
	Main and branch canals	9.5	1.5	11.0	1.3	0.2	1.5	5
	Distributaries	8.7	2.3	11.0	1.2	0.3	1.5	5
	Field channels	26.2	6.8	33.0	3.5	0.9	4.4	15
	Drains	8.1	0.7	8.8	1.1	0.1	1.2	4
	Buildings	1.1	-	1.1	0.1	-	0.1	-
	Sub-Total	53.6	11.3	64.9	7.2	1.5	8.7	29
II.	Construction Equipment and Vehicles	22.5	19.5	42.0	3.0	2.6	5.6	19
III.	Agricultural Equipment and Supplies for Extension							
	Farming equipment	16.5	20.2	36.7	2.2	2.7	4.9	16
	Extension vehicles and supplies	3.0	2.3	5.3	0.4	0.3	0.7	2
	Sub-Total	19.5	22.5	42.0	2.6	3.0	5.6	19
IV.	Technical Assistance /b	1.3	0.7	2.0	0.2	0.1	0.3	1
V.	Engineering and Administration 15% of I)	9.7	-	9.7	1.3	-	1.3	4
	Basic Project Cost	106.6	54.0	160.6	14.3	7.2	21.5	71
VI.	Physical Contingencies	10.7	2.3	13.0	1.4	0.3	1.7	6
	Sub-Total	117.3	56.3	173.6	15.7	7.5	23.2	77
VII.	Price Contingencies	37.8	13.6	51.4	5.0	1.8	6.8	23
	Total Project Cost	155.1	69.9	225.0	20.7	9.3	30.0	100

/a Figures may not agree exactly due to rounding.
/b Includes Rs 0.8 M for the project evaluation and for the proposed study on maize and sorghum (para 6.04).

Financing

4.11 With assistance from the Bank Group, GOSL has secured a grant of US$6.0 M equivalent from the UK for financing part of the project costs. The proposed IDA contribution of US$5.0 M, together with the UK grant, would finance the full foreign exchange costs and some local costs, or about 48% of the total project cost net of taxes and duties. Commercial banks and the buyers of the farm equipment (tractors and sprayers) would provide about US$6.0 M for financing the farm equipment. The Government would contribute the remaining US$13.0 M. Net of receipts from taxes and duties on imported project items, the Government's contribution would be about US$6.0 M, or about 26% of the net project cost. A condition of credit effectiveness would be the prior or simultaneous effectiveness of the UK grant agreement.

4.12 Agreement has been obtained from the Government that it would provide adequate funds to the agencies concerned, to cover all project costs and that it would furnish to IDA not later than November 1 each year a detailed plan for the implementation of the project with related financial requirements for the following fiscal year. Agreement was also obtained from GOSL that the goods and services imported out of proceeds of the project would be used exclusively for this project until the construction phase is completed, and that thereafter such part of the equipment as needed and agreed with IDA would be retained by the Irrigation Department (ID), MIPH, for the O & M of the project (Annex 8, Table 1).

Procurement

4.13 Equipment supplied under the UK grant (Annex 8, Tables 1-2) would be procured in accordance with UK procurement guidelines, 1/ while equipment financed by IDA would be procured through international competitive bidding (ICB) procedures in accordance with Bank Group Guidelines. Small off-the-shelf items costing less than US$10,000 each, which cannot be bulked into packages suitable for international tendering, would be purchased through normal Government procurement procedures which are satisfactory to IDA. Such purchases would, however, be limited to an aggregate total of US$100,000.

4.14 Because most of the civil works (base cost US$8.7 M) would be simple, individually very small, labor-intensive, scattered over a wide area, restricted to seasonal construction, and could not be grouped into large contracts, they are unsuitable for international competitive bidding. Work such as excavation of field and collector drains, enlargement of distributaries and field channels, and brick lining would be done through unit-cost contracts with local laborers. The repair of tank sluices and the repair or replacement of structures in the main or branch canals and distributaries would be done by the ID on force account (paras 5.01-5.03).

1/ Procurement restricted to UK.

Disbursements

4.15 Disbursements for 100% of the foreign expenditures for equipment, vehicles and spares earmarked for UK (Annex 8, Tables 1-2) would be made from the UK grant. Disbursements from the proposed IDA credit would be made for (i) 100% of the foreign expenditure for directly imported equipment, vehicles and spares (other than those financed by UK); (ii) 50% of expenditure for locally procured equipment, vehicles and spares; and (iii) 100% of foreign expenditure for technical assistance. In addition, disbursements would be made for 24% of the expenditures--12% by IDA and 12% by UK--on civil works performed under force account or small unit cost contracts. Disbursements against (i), (ii) and (iii) would be fully documented. Disbursements against civil works would be made against statements of expenditure, the documentation for which would not be submitted but would be retained for review during the course of project supervision. During implementation, the disbursement percentages would be adjusted, if necessary, to disburse fully the aid package by the completion of the project. Also, the UK equipment list would be revised if necessary to keep the total UK disbursements against equipment at US$4.5 M equivalent.

4.16 Disbursement from the UK grant would be administered directly by UK. It is expected that disbursements would be completed by June 30, 1981, approximately six months after project completion. An estimated schedule of expenditures of the project, the proposed allocation of the proceeds of the aid package, and a semi-annual disbursement schedule are shown in Annex 9.

Accounts and Audit

4.17 Agreement was reached that the ID and other organizations responsible for carrying out any part of the project would prepare and maintain separate project accounts and financial statements on project expenditures and recoveries thereon, in accordance with sound accounting practices. Such accounts and financial statements would be audited annually by independent auditors acceptable to IDA. Certified copies of the audited accounts and the auditor's reports would be sent to IDA within six months of the close of each fiscal year.

Environmental Effects

4.18 The only known water-related disease in the area is malaria. Schistosomiasis and other similar diseases common in some tropical parts of the world do not occur in Sri Lanka. At one time malaria was practically eliminated, but in recent years the incidence of the disease has been increasing. This has been due to a variety of factors including development of resistance by the vectors to DDT and a general slackening of control measures due to inadequate staffing and budgeting. To combat the problem, the Government's Anti-Malaria Organization is seeking aid from various bilateral agencies to help finance the purchase of Malathion (a DDT substitute), vehicles and equipment, and spare parts. A mission comprised of representatives of WHO and potential bilateral-agenices visited Sri Lanka in February/March to further assess the situation.

4.19 The implementation of the tank program would extend the time during which storage water would be held in the tanks and run in the canals and thus would increase the breeding potential for the mosquitoes. On the other hand, the opening of the natural drains would remove the tailwater from the fields which stagnates in borrow areas and low spots. The Government has agreed, as a precautionary measure, to institute a malaria monitoring system, and if, necessary, to take appropriate preventive and remedial measures in the project area.

4.20 The extension of the irrigation season into the dry season would improve the recharge of village wells and thus improve the domestic water supply. On balance, the net effect of the project on public health and environment would be positive.

V. ORGANIZATION AND MANAGEMENT

Project Implementation

5.01 Civil Works. The ID would be responsible for implementing the civil works proposed under the project. It would prepare final plans and designs, procure the necessary construction materials, and undertake all irrigation and drainage improvements, including the construction of necessary farm roads along the embankments of canals, distributaries and field channels. Procurement of construction machinery and equipment for the ID would be through the SLTC which is the sole authorized agency for such work in Sri Lanka. Responsibility for the maintenance of the construction machinery and equipment would be with the DME which operates a regional workshop at Anuradhapura.

5.02 The ID has been the pioneer agency in the field of water resources development in Sri Lanka. In the past, its responsibilities included planning, construction, and the O & M of both single and multipurpose works. With the emergence of several other organizations 1/ with similar functions, its responsibilities have been gradually reduced and are now limited to planning and to the construction of works costing more than Rs 2.5 M, not specifically assigned to other organizations. Also, ID operates and maintains the works it constructs during the construction stage.

5.03 The ID's current program includes several irrigation and drainage and reclamation projects. Its permanent staff of about 1,200 is well qualified to carry out the program. However, together with its sister organization, its operations suffer from a severe shortage of adequate equipment and vehicles. With the necessary equipment and vehicles to be provided under the project, the ID staff should have no problem in implementing the project civil works.

1/ The important ones are the Territorial Civil Engineering Organization (TCEO), Mahaweli Development Board (MDB), River Valley Development Board (RVDB) and Department of Machinery and Equipment (DME).

5.04 Preparation of final plans and designs and overall supervision of the works would be done from the Department's headquarters in Colombo. The field organization would be headed by a Chief Project Engineer with the overall responsibility for the management and supervision of the construction program. Construction would be done by two field units each capable of modernizing about 6,000 ac per construction season. Each unit would be headed by a Project Engineer. A Chief Project Engineer with the necessary experience and qualifications acceptable to IDA has already been appointed.

5.05 Agricultural Extension and Supporting Services. The Department of Agriculture (DA) under the Ministry of Agriculture and Lands (MAL), would be responsible for the reorganization and strengthening of the extension service and for the procurement of vehicles, equipment and supplies for the extension service (Annex 4). The motorcycles and bicycles to be used by the extension staff would be sold to the staff by the DA on terms and conditions which are satisfactory to IDA. Agreement was obtained that in Anuradhapura District, the Government would establish, by March 1, 1977, an extension organization to implement a work program which is acceptable to IDA.

5.06 The Sri Lanka Trading Corporation (SLTC) would be responsible for the procurement of the farm tractors and equipment and for their distribution to its dealers for resale within the project area. In line with the Government policy, the APCs area would be encouraged to buy and operate the farm equipment on a co-operative basis. However, as the APCs are relatively new organizations, inexperienced in running efficient commercial operations, it is expected that private custom operators would continue to play a major role in providing farm equipment on a rental basis. To ensure availability of farm equipment in the project area on a priority basis and to ensure reasonable rental rates, the private operators would be approved and supervised by the APCs and CCs. Also, a condition of sale to the private operators would be that they agree to do custom work within the project areas, during the peak cultivation periods as specified by the concerned APCs. Credit facilities for the purchase of farm equipment would be provided by the Bank of Ceylon and the People's Bank. Terms of lending would be up to 100% financing for APCs and up to 80% financing for private operators at prevailing interest rates (currently 8.5% annually) with repayment over five years. Refinancing for upto 75% of the total loans for farm equipment would be made available by the Central Bank of Sri Lanka to the Bank of Ceylon and the People's Bank. These terms and conditions are considered satisfactory to IDA.

Project Coordination

5.07 Committees have been established at the Central, District and Tank levels to facilitate inter-agency co-ordination. The committee at the Central level is chaired by the Secretary, MIPH, and includes senior representatives from the concerned departments and agencies. The Director of Irrigation is the member secretary of the committee. The committee is responsible for overall project execution and co-ordination. It would meet quarterly, or more often if necessary, and would make policy decisions, review work program

and progress and approve budgets for the various agencies. The committee is also responsible for submitting quarterly and annual progress reports to IDA and for corresponding with IDA on project matters.

5.08 The committees at the District and the Tank levels are respectively chaired by the Chief Project Engineer and the Project Engineers and include appropriate staff from the various concerned agencies. The committees would provide day-to-day field coordination for scheduling the work program of the various agencies. The District level committees are also responsible for reporting project progress, future work programs and any unresolved inter-agency problems to the Central Committee.

5.09 Assurances were obtained that the Central, District and Tank Coordination Committees would continue to function in a manner satisfactory to IDA and that quarterly and annual progress reports would be promptly sent to IDA.

Technical Assistance

5.10 The ID would employ a well-qualified water management consultant to advise on the design and the operating criteria for each of the five tank projects. The specialist would also work in the field with the extension service and the project operating personnel to effect a viable water management plan compatible with the proposed rotational irrigation. Draft terms of reference for the specialist are given in Annex 10. Agreement was obtained that the Government would employ, by March 1, 1977, a specialist with experience and qualifications acceptable to IDA.

5.11 In view of the prototype nature of the project and its importance to irrigation development in the rest of the dry zone, heavy emphasis would be placed on an in depth evaluation of the project impact. The Government has retained the services of ARTI for this purpose and ARTI has submitted a detailed proposal for evaluation which is being reviewed by IDA.

Operation and Maintenance

5.12 Principal Irrigation Works. The ID would be responsible for the O & M of the project works down to one cusec distributaries (each serving about 50 ac), both during construction and thereafter. The ID would organize O & M units for each of the five tanks. Estimated staffing, equipment and budgetary requirements, for a typical 6,000 ac area, are shown in Annex 10, Table 1. The estimated annual O & M cost would be about Rs 75 per ac. Agreement was obtained that the Government would provide sufficient funds for the proper O & M of the project facilities.

5.13 Field Channels. As stipulated under the Agricultural Productivity Law (Annex 4), the CCs acting under the general supervision of the APCs, and advised by Irrigation Engineers and Agricultural Extension Officers, would be responsible for the maintenance of the field channels and for the distribution

of water among the various users on each field distributary. The CCs would make recommendations to the ID with respect to cropping patterns and calendars and the water issue periods for the distributaries. The CCs would also recommend minimum flows for domestic purposes and livestock. With this information, the ID would then establish the operating calendars for the various tanks which would be strictly followed. The success of this program would require full cooperation of the CCs and the APCs in the adopted water management plans. The ID would oversee the maintenance and water distribution operations of the CCs, and would report any deficiencies to the APCs or higher authority. In case remedial action is not taken, authority would be given to the ID to take these functions and to assess the appropriate costs against the water users with such charges to be collected by the Government Agent (GA). Agreement that such arrangements would be established has been obtained from the Government.

5.14 Agricultural Equipment and Services. Adequate repair facilities and workshops exist in the private sector to provide maintenance services for the farm equipment to be provided under the project. Motorcycles and bicycles sold to the extension staff, would also be maintained by private workshops. The DA would provide a mileage allowance to the extension staff for the operation and maintenance of these vehicles. The maintenance of the other extension equipment and vehicles would be the responsibility of the DA. Funds for such maintenance as well as for fuel, personnel and operating supplies would be provided through the annual budget of the DA. Agreement was obtained that the GOSL would make available adequate funds and personnel for the agricultural extension services in the project areas.

VI. PRODUCTION, MARKETING, PRICES AND FARM INCOMES

Production

6.01 Improved water management and a strengthened extension service envisaged under the project would lead to more intensive cultivation and to higher crop yields. It is estimated that at full development in Year 11, the average cropping intensity in the five tank area would increase from about 103% at present to about 156%. Similarly, the average paddy yield is expected to increase from the present 0.9 tons/ac to about 1.5 tons/ac. Only minor increases in cropping intensity and yields are considered likely under the "without" project situation.

6.02 Paddy would continue to be the dominant crop. However, there would be a significant diversification into crops such as maize, sorghum and pulses. The estimated present and projected future cropping patterns and production levels for the five tank areas are summarized below:

Crop	Area Cultivated (thousand ac) Present	Future Without Project	Future With Project	Production (thousand tons) Present	Future Without Project	Future With Project
Maha Season						
Paddy	24.2	24.2	29.9	21.8	26.6	44.9
Cereals	-	0.6	1.6	-	0.5	1.4
Pulses	-	0.4	-	-	0.2	-
Yala Season						
Paddy	7.7	7.7	10.7	6.5	7.7	15.0
Cereals	0.2	0.5	2.6	0.1	0.4	2.9
Pulses	0.5	0.8	4.3	0.2	0.4	2.8
Total	32.6	34.2	49.1			
Cropping Intensity (%)	103	108	156			

The projected "with" project cropping intensity constrained by the water availability would vary from a low of about 120% for the Pavatkulam tank to about 170% of Mahakanadarawa and Mahawilachchiya tanks. Further details are given in Annex 3.

Market Prospects

6.03 Sri Lanka currently imports about 45% of its estimated annual foodgrain requirements of about 1.6 million tons. Despite the Government's emphasis on food self-sufficiency, it is likely that Sri Lanka will continue to be an importer for the foreseeable future. Accordingly, the project-related increase of about 25,600 tons of paddy (equivalent to 16,600 tons of rice) would be readily absorbed into the domestic market. Similarly no problem is foreseen in marketing the increased production of pulses. Prior to the import ban by the Government in 1970, the per capita consumption of pulses was over three times the current level of 1.5 kgs. The projected annual increase of 2,200 tons would amount to a mere 10% increase over the present production in the country.

6.04 Maize and sorghum, somewhat inferior substitutes to rice and wheat flour, would be consumed either directly or mixed with wheat flour. The Oils and Fats Corporation would also be a likely buyer of these cereals for use as animal feed. The existing marketing channels would be able to handle the project-related incremental production of 3,400 tons of maize and sorghum. However, in view of the potential for greatly increasing the production of these cereals in the dry zone, 1/ there is a need for a study of their

1/ Some 40-50% of the irrigated areas in the dry zone are unsuitable for paddy cultivation in the dry season (Annex 2). For optimal use of limited water supplies, they should be cultivated with upland crops such as maize and sorghum.

demand prospects, their economic and financial competitiveness vis-a-vis paddy, the requirements for their marketing, handling, and processing and the implications for Government's policy on procurement prices. It was agreed that the study would be conducted by ARTI in collaboration with PMB. It was also agreed that by January 1, 1977, a proposal giving the detailed terms of reference, staffing requirements and timing of the study would be submitted to IDA for review.

6.05 The relatively good transportation network and well developed marketing channels would reduce the problems of any localized surpluses. The existing processing and storage facilities, in and around the project areas, augmented by the PMB's planned expansion would be adequate to handle the additional production. The recent decision to allow private trading in paddy would also be helpful in handling the increased production.

6.06 To ensure farmer incentive and confidence, it is important that before each crop season, the Government should set the guaranteed support prices for the various crops at reasonable levels and then procure all the supplies offered at those prices. The Government should take particular care not to lower the guaranteed support price in the middle of a procurement period.

Prices

6.07 For rice and cereals, the estimated future farm gate prices are derived from the Bank's projected 1985 World market prices expressed in 1976 constant prices. Prices for pulses, for which no projections are available, are based on the historical ratios between their prices and the rice prices. On this basis, the estimated future farm gate prices, appropriately adjusted for freight, handling and processing are: US$180 per ton for paddy, US$140 for cereals, and US$270 for pulses.

6.08 For economic analysis, the official exchange rate of U$1 = Rs 7.50 has been adjusted to a shadow exchange rate of US$1 = Rs 12.00 (roughly equal to the FEEC exchange rate). In line with the prevailing Government policy, the foodgrain prices for farm budget analysis are based on an exchange rate between the official and the FEEC exchange rates. 1/ To isolate the project effects from the effects of unusually high foodgrain prices prevailing at this time, the projected 1985 farm gate prices are used even for the present situation. The various price assumptions are discussed in more detail in Annex 11.

Farm Incomes

6.09 Since the farm sizes and cultivation methods are the same under the five tanks, the only variable to be reflected in the analysis is the water availability. Three models have been chosen for this purpose: the

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1/ Roughly at an exchange rate of US$1.00 = Rs 9.00.

first model represents the three tanks with the best water supply (Mahakanadarawa, Padaviya and Mahawilachchiya), the second model, the Vavunikulam tank which has a somewhat poorer water supply and the third model, the Pavatkulam tank which has the poorest water supply. In each model, 3 ac of irrigated land was assumed and both cropping patterns and yields were adjusted to reflect variations in present and prospective water availability and farm management (Annex 12).

6.10 Although the earnings from the chena cultivation and the produce from home garden plots provide significant supplement to the income from irrigated agriculture, only the latter has been included in the following analysis since the data on the former is fragmentary and the project would have very little impact on that part of the income.

6.11 The annual net farm incomes, 1/ including the imputed value of the produce consumed by the farm family (in 1976 prices), for the three representative models are:

	Present	Future Without Project (Year 11)	Future With Project (Year 11)
	Rs		
Model I	2,850	3,950	7,650
Model II	3,100	4,050	7,100
Model III	2,250	2,800	5,900

Thus, the present farm incomes would be more than doubled for all three farm models.

Cost Recovery

6.12 At a discount rate of 10% per annum, the present value of the project investments (in economic terms) is estimated to be about Rs 97 million or about Rs 3,100 per ac. In addition, the O & M of the irrigation system would require an annual expenditure of about Rs 75 per ac. Assuming that the water charges were introduced in phase with the construction schedule but with a one year grace period, it would require an average annual charge of Rs 625 per ac -- Rs 550 for recovery of capital costs and Rs 75 for O & M costs -- to recover fully all the expenditures on this project. These charges would represent about 50-60% of the net incremental farm income (before accounting for family labor).

6.13 Analysis of the farmer's ability to repay the project costs indicates that on the basis of the estimated "project rents", it should be possible to recover full project costs (Annex 12). However, following considerations argue for significantly lower recovery rates:

1/ Before deducting water charges and payments under the Sale of State Lands Act.

(a) Income distribution -- farmers in the project areas have small holdings and their income levels are substantially below the national average. The recoveries under the soon-to-be enforced Sale of State Lands Act (para 3.09), estimated at about Rs 600 per family per year for 20 years, would further depress the income levels in the project areas;

(b) Innovative character of project -- farmers need to be persuaded to adopt the proposed intermittent irrigation methods;

(c) Government's policy on foodgrain prices -- through differentials between the crop procurement prices and their "economic" prices, the Government would indirectly recover a large part (40-50%) of the project cost; and

(d) Tradition -- Sri Lanka has not charged for irrigation water in the past and hence there would be considerable political opposition to setting the charges "too high".

Thus, an average charge of about Rs 300 1/ per ac, introduced gradually, would be more appropriate. Such a charge would represent a cost recovery index of about 50%, a benefit recovery index of 25%, and a rent recovery index of about 40%. Alternatively, the proposed level would mean recovering O & M costs and full capital costs at an annual interest rate of 4%.

6.14 The mechanism for cost recovery would be under the recently enacted Land Betterment Charges Act which inter alia enables the Government to impose charges in irrigation and drainage schemes taking into account factors such as amount and dependability of water supplies, increases in agricultural production, cropping intensity, capital cost and O & M costs. Detailed regulations for the actual implementation of land betterment charges are under preparation and expected to be enacted by early 1977. Also, work is under way to revise, update and prepare the land registers necessary for the administration of land betterment charges. Assurances were obtained that, by January 1, 1978, the Government would complete all administrative and other measures necessary for imposition and collection of appropriate charges in all publicly financed water development projects.

6.15 For the project areas, the Government intends to have the following charges:

(a) from January 1, 1978 an annual O & M charge of Rs 30 per ac. This would be increased gradually to cover full O & M costs of the irrigation works within five years; and

---

1/ In constant 1976 prices.

(b) within eighteen months of completion of each tank scheme an amount equivalent to 20% of the net average incremental farm incomes subject to a maximum of Rs 300 per ac annually (in 1976 prices) as recoveries on construction costs. It is estimated that this would mean an initial capital recovery charge of about Rs 200 to 250 per ac in the project areas.

Also, the Government intends to review and revise, if necessary, on a regular basis every three years, the level of charges collected under the project. Assurances were obtained that the Government would collect from project beneficiaries charges adequate to cover O & M costs and a portion of the construction costs in accordance with a cost recovery plan acceptable to IDA.

VII. BENEFITS AND JUSTIFICATION

7.01 The dry zone of Sri Lanka has some 180 major tank irrigation schemes, serving a total cultivated area of about 400,000 ac. Deterioration of the water conveyance systems, poor water management and inadequate agricultural supporting services, are the prime constraints limiting agricultural production in the schemes. The proposed project would be a prototype for bringing these schemes up to their full potential. Successful implementation of this project would open the way for eventual modernization of all the tank schemes which could potentially add a quarter of a million tons to the foodgrain production of the country (about one-third of current imports).

7.02 On a more direct level, at full development, the project-related increase of about 22,300 tons in foodgrain production (rice, 16,600 tons; cereals 3,400 tons and pulses 2,300 tons) would represent an annual gross foreign exchange savings of US$5.4 million. Allowing for the added imports of fuel, fertilizers, agro-chemicals and farm equipment this would represent an annual net foreign exchange savings of US$4.0 million.

7.03 The labor-intensive civil works proposed under the project would provide a total of 3 million man-days of employment during project implementation. The more intensive cultivation envisaged under the project would generate annual employment of 0.6 M man-days in on-farm works. Also, there would be a substantial increase in secondary employment in activities such as marketing, processing, and supply of farm inputs. All this would help to relieve the large unemployment and underemployment prevailing in the area.

7.04 Almost all the project beneficiaries would be small farmers; their present income levels are substantially below the national average. At full development, the project would bring their incomes to the national level.

7.05 Based on the following assumptions, the project's economic rate of return is estimated to be about 23% (Annex 13):

(a) a five year project implementation and a 30 year project life;

(b) full agricultural development five years after project completion;

(c) projected 1985 world market prices in terms of 1976 dollars for crops, fuel, fertilizers and pesticides;

(d) allowance for the shortage of foreign exchange by using a shadow rate of US$1 = Rs 12;

(e) all farm labor valued at about 70% of the average market wage rate of Rs 8 per man-day (see Annex 13) and construction labor at the market wage; and

(f) only the project related increase in crop production in the five tank areas is included in the benefits. Benefits from improved farm roads, and strengthened extension service in the rest of Anuradhapura District are not included in the analysis.

7.06 To minimize wasteful water use, the project is pioneering a system of strictly enforced rotational irrigation -- a technique which would be a major departure from the free flowing irrigation practiced at present. To this end, in addition to modernizing the physical works, the project would reorganize and greatly strengthen the existing agricultural extension services. There is some risk, however, that despite all this, the proposed system would not be fully accepted by the farmers, resulting in reduced production at full development (Annex 3). Sensitivity tests indicate that even with a reduction of the full development cropping intensity from the projected 160% to about 125%, the economic rate of return would be about 14% and the project would still be viable. However, even if the project were not viable on its own, in view of its implications for irrigation development in the rest of the dry zone, it would still be a worthwhile prototype project.

7.07 Further sensitivity tests indicate that the project remains viable under a variety of adverse assumptions about costs and benefits. Results from some of the important tests are given below:

Alternative	Rate of Return
(a) Basic case	23%
(b) Foreign exchange valued at US$1.00 = Rs 9.00	20%
(c) Foreign exchange valued at US$1.00 = Rs 15.00	25%

(d)	Farm labor valued at the market wage rate of Rs 8.00 per man-day	22%
(e)	A decrease of 25% in net incremental benefits	18%
(f)	An increase of 25% in project investment costs	19%
(g)	A two year delay in realizing the full project benefits	20%
(h)	Combination of (e) and (f)	15%
(i)	Combination of (f) and (g)	17%
(j)	Combination of (e), (f) and (g)	13%

Thus, even in the unlikely event that project costs are 25% higher, net benefits are 25% lower and the build-up of project benefits is considerably slower, the project would still be viable.

7.08 Tests were also made to determine the viability of each tank on its own. They indicate that the rate of return for the individual tanks varied from a high of 29% for the Mahawilachchiya tank to a low of 20% for the Padaviya and the Pavatkulam tanks. Thus, all five tank schemes are viable on their own.

VIII. AGREEMENTS REACHED AND RECOMMENDATIONS

8.01 Agreements on the following points have been reached with GOSL:

(a) the Government would not undertake any future development upstream of the five tank schemes which might significantly reduce the water supplies to the project areas (para 4.05);

(b) the Government would provide adequate funds to the agencies concerned to cover all project costs and that it would furnish to IDA not later than November 1 each year a detailed plan for the implementation of the project with related financial requirements for the following fiscal year (para 4.12);

(c) the goods and services imported out of proceeds of the project would be used exclusively for this project, until the construction phase is completed, and that thereafter such part of the equipment as needed and agreed with IDA would be retained by the Irrigation Department (ID) MIPH for the O & M of the project (para 4.12);

(d) the ID and other organizations responsible for carrying out any part of the project would prepare and maintain separate project accounts and financial statements on project expenditures and recoveries thereon, in accordance with sound accounting practices. Such accounts and financial statements would be audited annually, by independent auditors acceptable to IDA. Certified copies of the audited accounts and the auditor's reports would be sent to IDA within six months of the close of each fiscal year (para 4.17);

(e) the Government would institute a system to monitor the incidence of malaria in the project area and, if necessary, it would take appropriate preventive and remedial measures (para 4.19);

(f) in Anuradhapura District, the Government would establish by March 1 1977, an extension organization to implement a work program which is acceptable to IDA (para 5.05);

(g) the Central, District and Tank Coordination Committee would continue to function in a manner satisfactory to IDA and the Government would promptly send to IDA the quarterly and annual reports on the progress of the project (para. 5.09);

(h) the Government would employ, by March 1, 1977, a water management specialist with experience and qualifications acceptable to IDA (para 5.10);

(i) the Government would provide adequate funds for O & M of the project facilities (para 5.12);

(j) the Government would make such arrangements for the maintenance of field channels as would be acceptable to IDA (para 5.13);

(k) the Government would make available adequate funds and personnel for the agricultural extension services in the project areas (para 5.14);

(l) the Government would complete by January 1, 1978 all administrative and other measures necessary for imposition and collection of appropriate charges in all publicly financed water development projects (para 6.14); and

(m) the Government would collect from the project beneficiaries charges adequate to recover O & M costs and a portion of the capital costs in accordance with a cost recovery plan acceptable to IDA (para 6.15);

8.02 A condition of Credit Effectiveness would be that the UK grant agreement has been, or is being simultaneously, declared effective (para 4.11).

8.03 With the above agreements and together with the UK grant of US$6.0 M equivalent, the proposed project is suitable for an IDA credit of US$5.0 M under standard IDA terms. The Borrower would be the Republic of Sri Lanka.

November 15, 1976

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Climatic Data 1/

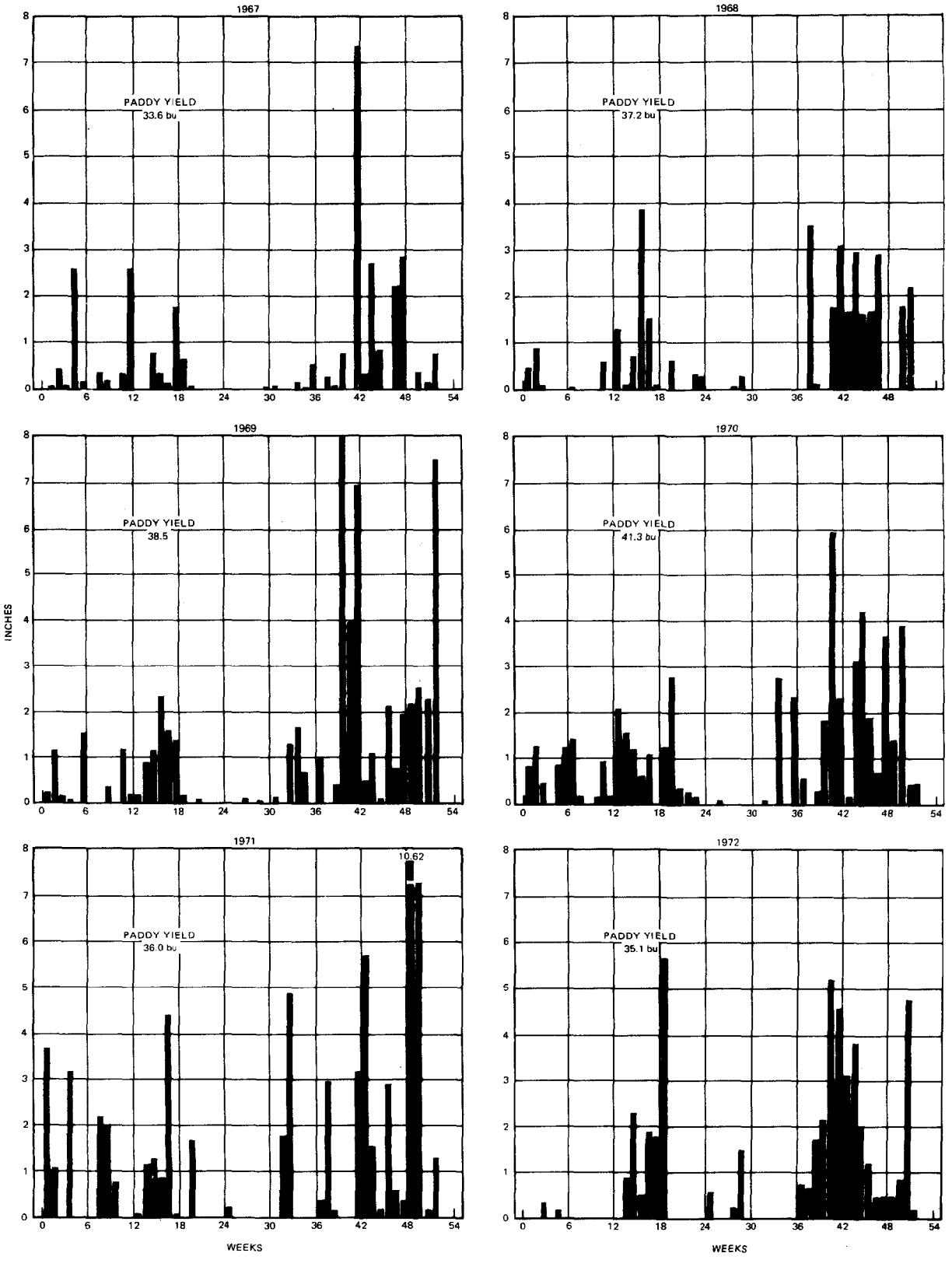
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Temperature Mean monthly (°F)	76	78	82	86	84	83	83	83	84	78	78	77	-
Humidity Mean relative (%)	80	76	72	74	77	72	69	69	70	77	82	84	-
Wind Velocity Mean daily (mph)	3.8	4.1	3.7	3.1	6.9	8.7	8.5	8.1	7.4	4.3	2.7	3.5	-
Sunshine Mean daily (hrs/day)	7.5	9.0	9.3	8.8	7.4	7.7	8.0	7.8	7.7	6.6	6.2	4.4	-
Pan Evaporation 2/ (inches) Mean of project tanks	4.5	4.7	6.2	5.5	6.0	6.8	6.9	6.8	6.8	5.4	4.2	4.2	67.9
Kala Wewa tank	4.7	4.7	6.1	6.0	7.1	7.1	7.4	8.1	8.2	6.2	4.7	4.6	74.9
FAO/Penman method	5.2	6.1	7.4	7.4	8.8	9.7	9.7	8.6	7.4	6.1	4.5	4.5	85.4
Precipitation (inches)													
Padaviya 3/ 75% probable	3.8	0.7	0.3	1.9	1.4	0.3	0.6	2.1	2.9	7.4	7.5	8.5	
50% probable	5.5	2.7	0.7	3.5	3.2	0.6	1.4	3.2	4.5	9.8	11.2	12.0	
Vavuniya 3/ 75% probable	1.2	0.6	0.5	4.0	1.2	0.1	0.2	0.7	0.2	6.4	6.4	5.5	
50% probable	3.0	2.1	1.5	5.0	2.2	0.3	0.5	1.8	2.4	9.0	9.0	11.0	
Anuradhapura 3/ 75% probable	0.8	0.4	1.4	3.7	1.25	-	0.2	0.4	0.5	7.1	5.8	5.5	
50% probable	2.75	1.5	3.3	5.5	2.5	-	0.5	1.2	1.7	9.0	8.0	7.5	
Mean (98 years)	4.8	2.1	3.9	7.4	3.9	0.5	1.2	1.8	2.7	9.2	9.8	9.5	56.8

1/ Meteorological station records, Anuradhapura and Vivuniya.

2/ Tank data from Irrigation Department and Mahaweli Development Board.

3/ Based on 1943-1973 record.

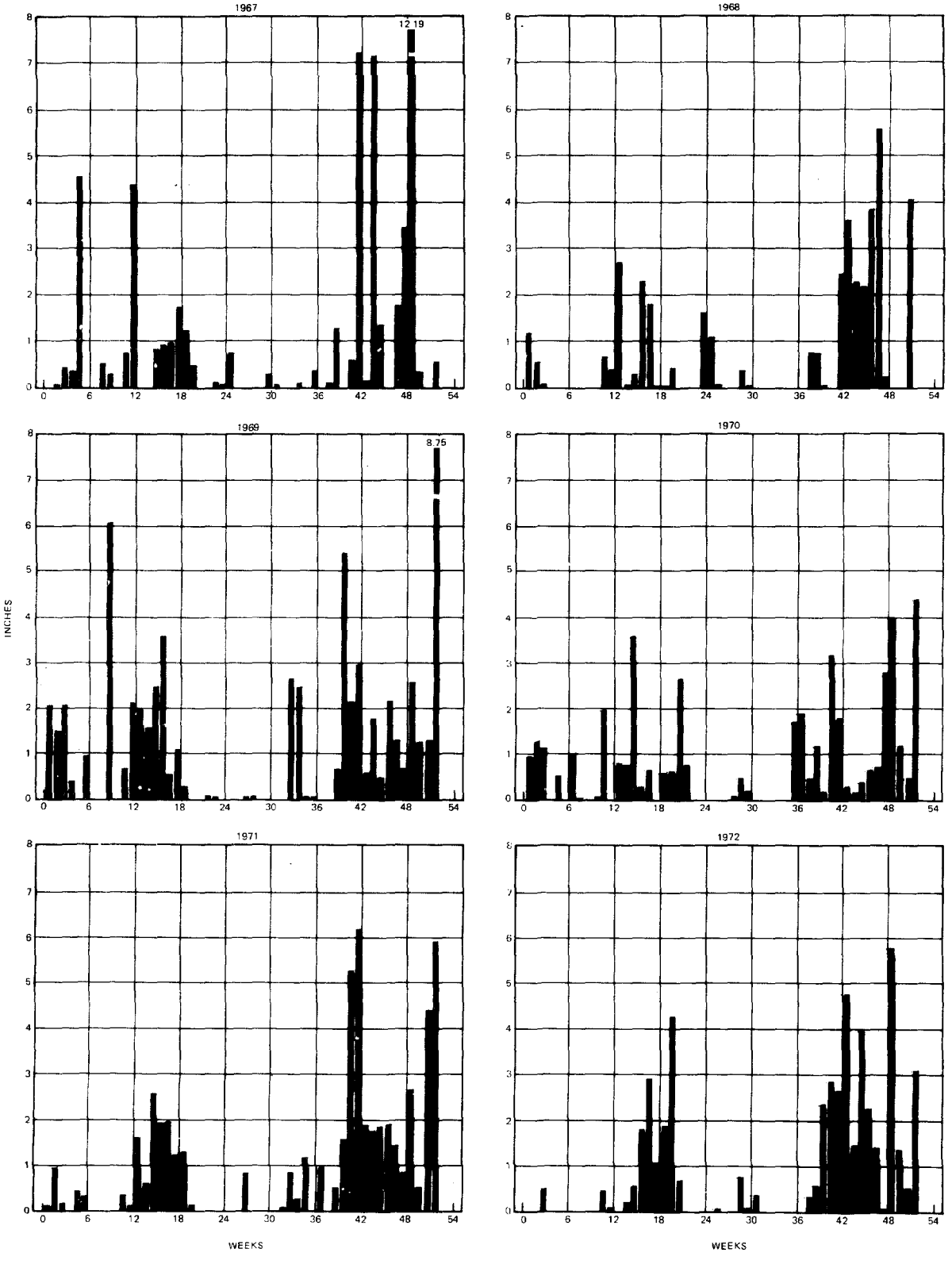
SRI LANKA
TANK IRRIGATION MODERNIZATION PROJECT
WEEKLY PRECIPITATION[1/]
ANURADHAPURA



1/ Crop yields based on planted acreage for entire country.

World Bank-9107 (R)

SRI LANKA
TANK IRRIGATION MODERNIZATION PROJECT
WEEKLY PRECIPITATION
MAHA ILLUPALAMA



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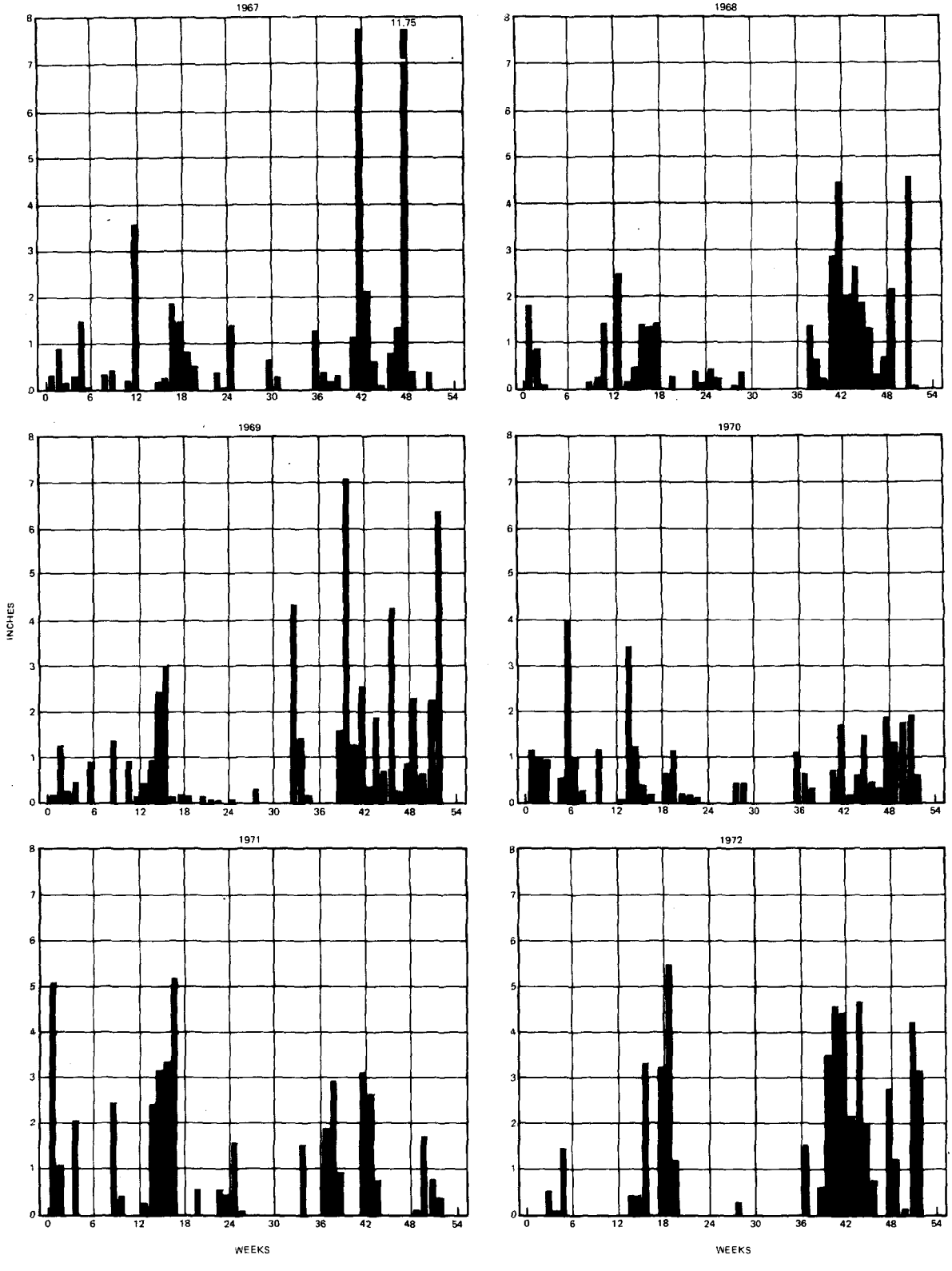
SRI LANKA
TANK IRRIGATION MODERNIZATION PROJECT
WEEKLY PRECIPITATION
KALA WEWA



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SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Topography and Soils

1. The project areas are located in the "dry zone" in north Sri Lanka which is characterized by rolling topography with rough, eroded water catchment areas above the more or less flat lands commanded by the tanks.

2. The soils are residual (i.e. were developed in place), derived from and underlain at relatively shallow depths by granites; and are unusually low in silt content. As a result, infiltration and permeability rates are high, water holding capacities are low and the soils are quite hard when dry. Erosion in the uplands has resulted in the lowlands soils being somewhat finer in texture and lower, but not low, in permeability.

3. Land classifications of the commanded areas, done somewhat along the lines of the United States Bureau of Reclamation method, indicated that there are no Class I soils; that most of the high lands comprising about half those considered irrigable are Class II and III; and the bottom lands, because they are suitable only for paddy, are in Class IVR which is considered excellent for paddy.

4. The soils of the areas are similar in most respects and are composed almost entirely of three types: (1) well-drained, dark brown to reddish brown soils (Reddish Brown Earths or Alfisols) on the crests and upper slopes of the undulating landscapes; (2) imperfectly drained, slightly darker and usually slightly finer brown to reddish brown soils (Haplustalf sub-group of Alfisols), and (3) poorly drained, finer, dark brown to dark grey soils with pseudo-gley and gley horizons (Low Humic Gley, Aqualf sub-order of Alfisols).

5. The most important characteristics of the soils of the project areas, with regard to development and use, are: (1) high infiltration and permeability rates (from a low of 0.17 to more than 3 inches per hour); (2) low available moisture holding capacities (1.2 to 1.6 inches per foot of soil); (3) high bulk densities (mostly 1.6 to 1.7 gram/cm^3), and (4) very low silt contents. The soil clays are mostly of the non-expanding type (illitic and kaolinitic), the pH ranges from 6 to 7, the exchange complex is 80 to 90% base saturated, the silica: sequioxide ratio is about 3, the exchange capacity is 0.5 to 0.6 meq per gram of clay and the exchange capacities range from 4 to 20 meq/100 grams. There are some salt and alkali accumulations in low spots where the drainage is completely

blocked. The organic matter content of the surface layer ranges from 1 to 5% and averages about 2%. Nitrogen and available phosphorous are low and potash is moderate.

6. The infiltration rates of the upland soils are above one inch an hour and of the Low Humic Gley soils, 0.1 to 1 inch per hour. Thus, waterlogged conditions can exist in these soils only where the drainage outlets are blocked. Since the soils retain a relatively small amount of water that is available for plant growth (13 to 16% by volume) and the rooting depth of most crops apparently is restricted, a few irrigations will be required in the wet season, and more often in the dry season. Because of their unusually low silt content, these soils are very soft when wet and very hard when dry and the period when they can be effectively worked for seed-bed preparation is very short. Hence, it will be necessary to provide mechanical equipment for timely land preparation.

7. As implied above, the Reddish Brown Earths (i.e. uplands) are best suited for the production of upland crops such as cereals, pulses, chillies, maize, etc, whereas the Low Humic Gley (bottomlands) are suitable only (in the absence of drainage) for paddy. Even though the upland soils, because of their high permeabilities, are not well suited for flooded paddy culture, they are almost entirely used for paddy simply because it is by far the most profitable crop that can be grown. Since only a few supplemental irrigations would be required to ensure a good paddy crop in the maha (wet) season, the fact that a high proportion of this supplemental water would be lost is not inconsistent with the objective of making effective use of available irrigation supplies in the wet season. No paddy would be grown in the uplands in the dry season.

November 1976

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Cultivation Practices, Cropping Patterns and Yields

1. Paddy is the main irrigated crop grown in the project area, accounting for about 100% of the 103% cropped area. There are two paddy growing seasons -- maha and yala. Maha paddy is broadcast, row-drilled or transplanted during October-January, for harvest during January-April. Yala paddy is planted between February and April and harvested during May-July. Cultivation is by hand labor with draft power for plowing, tilling and leveling supplied by buffaloes and 2-wheel and 4-wheel tractors. Harvesting and threshing are not mechanized. Despite higher yield potential and easier weed control, transplanted paddy is not popular with farmers. Broadcasting is most favored but row seeding, which allows weed control by hand operated rotary weeders, is becoming more popular.

2. Considerable amounts of water are used in paddy cultivation, first in field preparation (saturation and leveling) and thereafter to maintain at least a 2 inch depth of water to help control weeds, reduce labor and animal draft demand. The water is allowed to flow continuously through the fields and therefore no attention to water control is required at night time. Because land preparation usually does not begin until the tanks are sufficiently full to ensure a crop, the maha planting is delayed and insufficient use is made of rainfall. Also, as a result, little if any water is available for the yala crop.

3. A contributory reason for the extended maha and yala sowing periods is the practice of slash-and-burn (chena) agriculture in nearby jungle areas. The slashing begins when the yala rains cease in April-May; the cuttings are burned in August. To make maximum use of the maha rainfall and to enable the crop to keep ahead of the regenerating weeds, planting of the chena lands takes place as soon as it begins to rain. Most farmers look upon their chena land as their major source of food other than rice. Under present conditions, they consider chena cultivation as more dependable than their irrigated agriculture and they are reluctant to do anything that would interfere with its success. Only when the chena lands are secured is attention transferred to paddy lands where, in the meantime, much of the rainfall and often a significant amount of the irrigation water released from the storage for those who sowed earlier has been wasted. Yala plantings are delayed partly by the delays in starting the maha crop and partly by the need to harvest and replant the chena lands, before starting the yala crop on the irrigated lands.

4. The cereal crops consist of finger millet, maize and sorghum. The former is mainly a chena crop because of its great sensitivity to weed competition and is not grown under irrigated conditions. Sorghum has recently been expanding because some good varieties have become available from India and these ratoon well in Sri Lanka. Maize has always been grown, although not to a large extent, in the northern dry area. Neither sorghum nor maize are grown on irrigated lands at present, but investigations in Maha Illupalama show that they can both be grown successfully under irrigation, especially on the more permeable soils.

5. The pulse crops. Cowpeas, green and black gram, and pigeon peas would appear to present good prospects for the future. In the project areas, very little is grown under irrigation at present, but a start has been made to grow them after rice, with little or no irrigation. Elsewhere in the country pulses are being grown some under irrigation. Maha Illupalama has bred good varieties and their performance under field conditions is encouraging.

6. Fruits and vegetables. Tree crops including jack fruit, mango, coconuts and guavas, together with some vegetables are grown on the settlers' upland 2 ac plots.

7. Present yields. Information on present paddy rice yields in the project area is not consistent. The figures used to represent the present situation were derived from composite estimates for Anuradhapura District made by the APCs for irrigation projects. These were related to the actual achievement of 1972-73, which was more or less an average year. For cereals and pulses, the estimated present yields are based on observations of field crops and discussions with farmers and extension and research workers.

The Future "Without" the Project

8. Without the project, it is expected that maintenance work on the irrigation systems would be adequate to maintain the present water supplies and, therefore, it would be possible to maintain the present acreage of paddy. However, the trend to grow "dry" crops in irrigated lands for which no irrigation water is available either through lack of stored supplies or because the time set by the APC for planting paddy is past, could be expected to have some impact. It could also be expected that improvements in crop husbandry would continue at about the same rate as in the past. The present extension service and methods would increase rice yields by a compounded 2% per annum, taking into account both the dissemination of information on better crop husbandry practices and the appearance and gradual adoption of new varieties. It is expected that the area of pulses and cereals would increase somewhat as the extension service persuades farmers to utilize their paddy lands when not actually planted to paddy. Yields would increase, as with rice, at a 2% per annum compound rate. The overall cropping intensity would rise to about 108%.

Projected Cropping Patterns and Yields

9. The main factors contributing to both increased yields and cropping intensities under the project would be improved irrigation supply and drainage, better cultivation practices with the help of a reorganized extension service and enhanced inputs particularly agricultural machinery.

10. Research station yields at Maha Illupalama between 1970 and 1974, have indicated that if sufficient water is available, the paddy yields in the maha and yala seasons are about equal. However, in the case of maize, sorghum and pulses (given sufficient water), the yields during the yala season will exceed those secured during the maha. The difference is due, in part, to more sunshine.

11. Considering the above information as well as farmer practices and the findings of surveys by the Agricultural Research and Training Institute, it is estimated that approximately five years after the completion of project works (assuming a strengthened extension service), average yields would be of the following order:

	Maha	Yala
	---tons/ac-----	
Paddy (broadcast)	1.5	1.5
Pulses		
Pigeon peas	.66	.66
Green gram	.66	.66
Black gram	.55	.60
Cowpea	.70	.75
Groundnuts	.80	.85
Average pulses	.59	.65
Maize	1.00	1.02
Sorghum /a	0.90	1.20
Average cereals	0.90	1.10

/a Including ratoon.

12. Revision of the irrigation delivery schedules would permit earlier pre-season preparation of maha paddy in September and the introduction of intermittent irrigation would conserve water for the yala crops. The maha

planting would be from late September through October, for harvesting in January through early February. Yala planting would be from February and early March, for harvesting in late May and June. The principal agronomic changes would be:

(a) Paddy would be grown in a manner similar to upland crops, i.e., with intermittent irrigation rather than continuous flooding. Irrigation would be applied according to the consumptive use requirements of the crop. The practicability of this has been demonstrated at Maha Illupalama, at IRRI and on two operating projects in Sri Lanka. However, it has not been tried on a farm basis in the northern dry zone, and therefore extensive demonstration must be the first task of the reorganized extension service.

(b) The use of intermittent irrigation would also create an increased weed control problem and would require the use of weedicides or hand hoeing or pulling; the alternative drying and wetting would likely result in some loss of nitrogen through the process of denitrification.

(c) The seedbed for the entire service area of a given tank would be prepared with mechanical power within a short time -- preferably a significant portion of it while dry or following the first monsoon rains. This would decrease the demands on tank storage for pre-irrigation to soften the soil.

(d) Firm irrigation seasons would be established. This would require a much greater discipline of farm operations than at present. The objective would be to compress the crop cycles over the whole area in a shorter span of time than the present 5 to 6 months.

(e) To attain the anticipated results it would also be necessary for farmers to begin to produce other crops such as maize, sorghum, pulses, millet and sesamum on the "paddy" lands during the yala season and perhaps even during the maha season.

As the practices listed above include many techniques that are new to the project areas, if indeed not to Sri Lanka, the Maha Illupalama Research Station (Annex 4) must, at the earliest possible time, focus its attention on these problems in order to provide suitable information to the extension service.

13. Projected cropping pattern and cropping intensities were evaluated for each of the five tank command areas on the basis of water availability and judgment on water requirements giving due weight to system uses, soil permeability and farmers' familiarity with water use. The projected percentage cropping intensities adopted are:

	Mahakanadarawa	Vavunikulam	Pavatkulam	Mahawilachchiya	Padaviya
Maha	100	100	100	100	100
Yala	68	47	18	69	65
Total	168	147	118	169	165

14. Table 1 shows the present and expected future cropping pattern, yield and production in each of the five tanks, and also the composite summary figures. As alternatives, and to test the economic viability of the project even if the expected irrigation regime (para 12) and its implied irrigation efficiencies (Annex 5, Table 2) cannot be realized, Table 2 has been developed. It compares area, production and water requirements at field level for the expected composite cropping pattern shown in Table 1, and two alternatives. The calculations assume that water available in the tanks is 130,000 ac-ft, which is in fact less than what can reasonably be expected from the tanks, but is the requirement on a 55% irrigation efficiency (Annex 5, Table 3). The alternatives were developed by fitting the cropping pattern to meet the overall irrigation efficiency assumed with less experienced farmers in the nearby Mahaweli Ganga (II) project.

November 1976

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Present & Estimated Future Production

	THE FIVE TANKS (31,500 ac) 1/									MAHAKANADARAWA (6,000 ac)									PADAVIYA (12,500 ac)								
	Area (ac)			Yield (tons/ac)			Production (tons)			Area (ac)			Yield (tons/ac)			Production (tons)			Area (ac)			Yield (tons/ac)			Production (tons)		
	P 2/	$\bar{W}$ 2/	W 2/	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W
Maha rice	24,200	24,200	29,900	0.90	1.10	1.50	21,780	26,620	44,850	4,600	4,600	5,700	0.85	1.05	1.50	3,910	4,830	8,550	9,600	9,600	11,900	0.95	1.20	1.50	9,120	11,520	17,850
cereals	-	600	1,600	-	0.80	0.90	-	480	1,440	-	200	300	-	0.80	0.90	-	160	270	-	150	600	-	0.80	0.90	-	120	540
pulses	-	350	-	-	0.45	-	-	157	-	-	100	-	-	0.45	-	-	45	-	-	100	-	-	0.45	-	-	45	-
Sub-total	24,200	25,150	31,500	-	-	-	-	-	-	4,600	4,900	6,000	-	-	-	-	-	-	9,600	9,850	12,500	-	-	-	-	-	-
Maha intensity	77%	80%	100%	-	-	-	-	-	-	77%	82%	100%	-	-	-	-	-	-	77%	79%	100%	-	-	-	-	-	-
Yala rice	7,700	7,700	10,700	0.85	1.00	1.40	6,545	7,700	14,980	550	550	2,100	0.75	0.95	1.40	413	523	2,940	5,300	5,300	6,000	0.85	1.05	1.40	4,505	5,565	8,400
cereals	150	500	2,650	0.65	0.80	1.10	98	400	2,915	-	100	750	-	0.80	1.10	-	80	825	-	100	800	-	0.80	1.10	-	80	880
pulses	500	800	4,250	0.35	0.45	0.65	175	360	2,763	50	100	1,250	0.35	0.45	0.65	18	45	813	200	300	1,300	0.35	0.45	0.65	70	135	845
Sub-total	8,350	9,000	17,600	-	-	-	-	-	-	600	750	4,100	-	-	-	-	-	-	5,500	5,700	8,100	-	-	-	-	-	-
Yala intensity	26%	28%	56%	-	-	-	-	-	-	10%	12%	68%	-	-	-	-	-	-	44%	45%	65%	-	-	-	-	-	-
TOTALS	32,550	34,130	49,100	-	-	-	-	-	-	5,200	5,650	10,100	-	-	-	-	-	-	15,100	15,550	20,600	-	-	-	-	-	-
TOTAL INTENSITY	103%	108%	156%	-	-	-	-	-	-	87%	94%	168%	-	-	-	-	-	-	121%	124%	165%	-	-	-	-	-	-

	MAHAWILACHCHIYA (2,600 ac)									VAVUNIKULAM (6,000 ac)									PAVATKULAM (4,400 ac)								
	Area (ac)			Yield (tons/ac)			Production (tons)			Area (ac)			Yield (tons/ac)			Production (tons)			Area (ac)			Yield (tons/ac)			Production (tons)		
	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W	P	$\bar{W}$	W
Maha rice	1,900	1,900	2,450	0.75	0.95	1.50	1,425	1,805	3,675	4,600	4,600	5,700	0.85	1.05	1.50	3,910	4,830	8,550	3,500	3,500	4,150	0.80	1.00	1.50	2,800	3,500	6,225
cereals	-	50	150	-	0.80	0.90	-	40	135	-	100	300	-	0.80	0.90	-	80	270	-	100	250	-	0.80	0.90	-	80	225
pulses	-	50	-	-	0.45	-	-	23	-	-	50	-	-	0.45	-	-	23	-	-	50	-	-	0.45	-	-	22	-
Sub-total	1,900	2,000	2,600	-	-	-	-	-	-	4,600	4,750	6,000	-	-	-	-	-	-	3,500	3,650	4,400	-	-	-	-	-	-
Maha intensity	73%	77%	100%	-	-	-	-	-	-	77%	79%	100%	-	-	-	-	-	-	80%	83%	100%	-	-	-	-	-	-
Yala rice	200	200	900	0.70	0.85	1.40	140	170	1,260	1,500	1,500	1,300	0.75	0.95	1.40	1,125	1,425	1,820	150	150	400	0.70	0.85	1.40	1.05	128	360
cereals	-	50	300	-	0.80	1.10	-	40	330	100	150	600	0.65	0.80	1.10	65	120	660	50	100	200	0.65	0.80	1.10	33	80	220
pulses	50	100	600	0.35	0.45	0.65	18	45	390	100	150	900	0.35	0.45	0.65	35	68	585	100	150	200	0.35	0.45	0.65	35	68	130
Sub-total	250	350	1,800	-	-	-	-	-	-	1,700	1,800	2,800	-	-	-	-	-	-	300	400	800	-	-	-	-	-	-
Yala intensity	10%	13%	69%	-	-	-	-	-	-	28%	30%	47%	-	-	-	-	-	-	6%	9%	18%	-	-	-	-	-	-
TOTALS	2,150	2,350	4,400	-	-	-	-	-	-	6,300	6,550	8,800	-	-	-	-	-	-	3,800	4,050	5,200	-	-	-	-	-	-
TOTAL INTENSITY	83%	90%	169%	-	-	-	-	-	-	105%	109%	147%	-	-	-	-	-	-	86%	92%	118%	-	-	-	-	-	-

1/ Figures in parenthesis give the net cultivable acreage.

2/ P = Present, $\bar{W}$ = Future Without Project, W = Future With Project.

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Alternative Future Cropping Patterns Compared

	Basic (From Table 1)			Alternative I			Alternative II		
	Area (ac)	Production (tons)	Water in field (ac-ft)	Area (ac)	Production (tons)	Water in field (ac-ft)	Area (ac)	Production (tons)	Water in field (ac-ft)
Maha									
Rice	29,900	44,850	34,883	29,900	44,850	34,883	29,900	44,850	34,883
Cereals	1,600	1,440	920	1,600	1,440	920	1,600	1,440	920
Pulses	-	-	-	-	-	-	-	-	-
Yala									
Rice	10,700	14,980	25,125	7,000	9,800	16,434	5,000	7,000	11,739
Cereals	2,650	2,915	3,997		-	-	1,500	1,650	2,262
Pulses	4,250	2,763	6,410		-	-	2,100	1,365	3,167
TOTAL	49,100		71,335	38,500		52,237	40,100		52,971
Cropping intensity	156%			123%			127%		
Water use efficiency (based on 130,000 ac-ft at tank.)			55%			40%			40%

ANNEX 3
Table 2

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Agricultural Supporting Services

A. Organization of Agricultural Production

1. The Ministry of Agriculture and Lands (MAL) is responsible for the supervision of agricultural production and mobilization of inputs. The Ministry of Irrigation, Power and Highways (MIPH) is responsible for irrigation and land drainage. Recently, Sri Lanka reorganized field supervision of agricultural production by setting up Agricultural Productivity Committees (APCs) to oversee the Cultivation Committees (CCs), as well as Agricultural Tribunals. The Government also proposes to set up District Agriculture and Irrigation Advisory Committees. Four new laws governing agriculture productivity, agriculture insurance, tenancy rights and rent, and sale of State lands, respectively, have been enacted during 1972-1975. Legislation to recover land betterment costs, enacted in September 1976, is significant in that it would enable recovery of irrigation capital and O & M costs. Draft legislation for control of irrigation activities is to be presented to the Legislature in the near future.

2. Agricultural Productivity Committees (APCs) are set up under the Agricultural Productivity Law (APL) which makes it mandatory for all owners and occupiers of agricultural land to use it to the maximum benefit of the country, in a manner prescribed from time to time by the APC. The law deals with all agricultural and livestock production. The duties of the owner and occupier are defined and the processes of enforcement and supervision are also described in the APL. If compliance is not forthcoming, defaulters can be dispossessed. The APCs are to become the principal regulatory bodies for all agricultural activities. About 530 APCs are planned of which about 430 had been set up at time of appraisal. Its members are nominees of the Minister, MAL. At village level, the Cultivation Committees (CCs) are the agents of the APCs and are subject to their direction and control. The Minister may empower APC to act on all sections of the APL. The proposed Irrigation Bill would give further powers to the APCs.

3. The APC functions are to:

(a) direct and control the CC;

(b) promote and coordinate agricultural development;

(c) assist formulation of crop and livestock production programs;

(d) supplement the Minister, MAL's regulations for:

-- the cultivation of irrigated crops;

-- the enforcement of "established customs" in this respect;

-- distribution of water at farm level;

-- the appointment and remuneration of executive agents for the foregoing, and

-- farmers' contributions, in cash or labor, to the irrigation structures for which they are responsible.

(e) regulate repossession by a landlord when a tenant dies intestate;

(f) appoint tenants for land not cultivated for two seasons;

(g) decide seasonal cropping pattern subject to the Government Agent's (GA) approval; Minister, MIPH has the final decision in respect of water releases implied by any specific cropping pattern;

(h) permit the cultivation of crops other than paddy (the 1958 Paddy Lands Act has been repealed);

(i) act as an Agricultural Leasehold Society to take over or lease its members' land subject to appeal to the Minister, MAL only as to the rent payable;

(j) determine the rent payable by tenant to landlord, within the provisions of the law, subject to adjudication of dispute by the Agricultural Tribunal;

(k) determine, for rent purposes, the degree of crop failure;

(l) control water distribution below the 50 ac level (or on canals under 0.5 mi length) subject to the direction of the Engineer nominated by the MIPH;

(m) organize, through the CC, the cultivators to maintain the works associated with (1).

4. The Agricultural Tribunal (AT) acting under the Agricultural Land Law (ALL) is the guardian of tenants' rights, has final ruling powers on inheritance disputes and adjudicates rent payable. Rent is fixed by the

Minister, MAL, but may not exceed 15 bu per ac or one quarter of the crop, or the customary rent, whichever is the lowest. The APC's levy of Rs 6 per ac is payable by the landlord. The AT members are appointed by the cabinet on the advice of the Judicial Services Advisory Board. The AT is the highest authority to whom orders of dispossession are referred and its rulings may only be referred to the Supreme Court on points of law. The ALL recognizes continued occupancy by the tenant and his legal or nominated successor; recognizes rotational occupancy; ensures continuing tenants' rights or change of ownership, and regulates transfer of tenancy to the landlord. Land may be mortgaged, or a charge raised against it, either by the owner or the occupier. Non-payment of principal or interest becomes a first charge on crops or livestock, if their raising was the purpose of the loans. The rights of the prescribed banks to recover confirmed debts are unalienable and not negotiable under the previous law.

5. The Agricultural Insurance Law No. 27 has been enacted to operate a comprehensive agricultural insurance scheme in respect of the paddy crop and of such other crops as may be specified by the Minister to indemnify the farmers against loss. The Board consists of a Chairman appointed by the Minister, MAL, with representatives from the People's Bank and the Bank of Ceylon, the Ceylon Insurance Corporation and the Paddy Marketing Board (PMB). Insurance is compulsory for every person having an interest in the paddy crop, be he the owner, tenant or sharecropper. The premium, which is determined by the Board, is shared according to the interest an "insured person" has in the crop. Crops other than paddy may be insured, as determined by executive order. The law does not state for what causes of loss a claim may be preferred, only that it must be filed within seven days of its occurence. The premium is also not stated but is, at present, around Rs 30 per ac, depending on the location within the country.

6. The Sale of State Lands (Special Provisions) Law empowers the Land Commissioner (LC) acting on a report by the District Government Agent (GA) to determine state land sales conditions. Potential purchasers are selected according to regulations made under the Law and the price is set by the LC. The successful purchasers may elect to pay cash and receive a land grant or pay in installments with interest and receive a use-permit (cancellable on non-payment of installments) to be converted to a land grant when fully paid. The Law prohibits unapproved disposal of land, subdivision and co-ownership. With the wide powers of the Law, the Minister, MAL may make regulations to control land operation and use. The law specifically declares it to be an offense to encroach on land that has been alienated and makes ejection of the encroacher mandatory.

7. The draft Irrigation Bill has received Cabinet approval in principle and is due for presentation to the Parliament in the near future. Its May 1975 draft provides for establishing a District Irrigation Committee with the GA and an Advisory Committee for each major irrigation work or group of works. The law controls both interference with canals and water wasteage; it determines the area to be irrigated in each command in that season and fixes the water charges.

8. The Land Betterment Charges Bill enacted in September, 1976 defines "benefited areas" where the productivity of agricultural lands has improved or is likely to improve as a result of the construction of an irrigation, drainage and flood protection project. Annual charges will be levied, (after making due allowance for whole or partial crop failure) either as a fixed sum per acre, or as a fixed sum for a fixed amount of water and an additional charge for supplies in excess of the minimum, or as a charge based on the water supplied. The charges will be determined on the basis of the following criteria:

(a) capital expenditure and expected life of the works;

(b) operation and maintenance costs;

(c) water availability;

(d) its regularity;

(e) the extent to which the land has benefited;

(f) the likely increase of production due to the project; and

(g) other matters, to be prescribed.

B. Agricultural Research

9. Organization. Agricultural Research is headed by the Deputy Director of Agriculture (DDA), Research, who is based at the Central Agricultural Research Station at Peradiniya, near Kandy. He has a staff of 67 Research Officers of whom 20 are Ph Ds. Some 15 of the Research Officers were abroad for training at the time of appraisal. There are 16 outstations, two of which are significant to the project--Batalagoda, where almost all the paddy breeding is being done and Maha Illupalama where irrigated agriculture is being studied.

10. Rice Research. Sri Lanka has always had a good rice breeding program. During the 1950s and 1960s, the H series of locally bred varieties replaced most of the traditional varieties. Since the advent of high yielding varieties (HYV), Sri Lanka has successfully incorporated the IRRI strains to produce HYVs suitable to its conditions. The most notable feature of the new varieties is a shorter growing season. Of the varieties released BG (Batalagoda) 11/11, 34/4 and 34/2 are outstanding. All are resistant to blast, intermediate in stature (80-90 cm high) and have leaves that become erect as they develop. Most take about 3-1/2 months from seed to seed, a desirable feature for the maximum utilization of rainfall on the yala crop.

11. Research on Other Crops. Research on other crops for the dry zone is concentrated at Maha Illupalama, where irrigation studies are also carried out. Considerable progress has been made in introducing and developing new varieties of chillies, green gram, black gram, pigeon peas (dhal) and cowpeas. Summary of the yields obtained at Maha Illupalama between 1970 and 1974 is as follows:

	Maha	Yala	Yala as percent of Maha
	lb/ac		
Paddy rice (irrigated)	5,097	5,013	98
Pulses			
Dhal	1,897	2,259	119
Green gram	1,531	1,931	126
Black gram	1,407	3,134	222
Cowpeas	2,203	2,395	109
Groundnuts	1,999	2,848	142
Maize	3,215	2,364	74
Sorghum	2,976	2,877	97

It would appear that, if water supplies are adequate, yala rice yields would be about the same as those obtaintable in the maha. In the cases of maize, sorghum and the pulses, given proper crop husbandry practices and adequate irrigation water, future yala yields will at least equal, and possibly exceed, those obtainable in the maha. The yield figures used for compiling Table 1 in Annex 3 have been derived from the foregoing data.

C. Agricultural Extension

The Present Situation

12. Agricultural Extension, one of the functions of the Department of Agriculture, is under the control of the DDA, Extension. His immediate professional staff consists of five graduate Subject Matter Specialists (SMSs) for cereals, pulses, tobacco, plant protection and seed certification and production. Field operations are controlled by a District Agricultural Extension Officer (DAEO) in each of the 22 Districts. In some cases, he has an additional (i.e. deputy) DAEO to assist him. His headquarters staff includes District SMSs, who are usually agricultural diploma holders, and who, by training or inclination have specialized in certain subjects. The field staff consists of Agricultural Instructors (AIs), who are also agricultural diploma holders and Village Level Workers (Sinhalese acronym is KVS -- which stands for Krushikarma Viyaptha Sevaka) who have taken in-service training courses. Their formal schooling is a General Certificate of Education, Ordinary Level (O - level).

13. The District extension organization assists the farmers who are arable in areas that have not received any special benefits from irrigation projects or any other form of land improvement. Irrigation projects, special land development projects and schemes to promote the production of specific crops, are supported by their own extension service which usually has only informal links with the regular District extension service. Coordination at the DDA and project management level is, however, ensured.

14. The proposed project areas are principally in Anuradhapura District but also contain small parts of Mannar, Vavuniya, Matale, Trincomalee and Jaffna Districts. In these Districts, two of the special extension services are active. One group takes care of the so-called "special projects" which were established some 15 or 20 years ago. The five tanks in the modernization program are in this category. They receive more attention than areas served under the regular extension program. There is also a pilot settlement project operating within the boundaries of the Maha Illupalama Research Station and supervised by its staff.

15. The Anuradhapura District include the following extension staff at present:

DAEO			1
Additional DAEO			1
Subject Matter Specialists			3
AIs:	for the District	18)	
	for special projects	23)	42
	at District office	1)	
KVS:	for the District	98)	
	for special projects	47)	147
	at District office	2)	

The staff is responsible for the agricultural extension activities of some 65,000 farm families cultivating an average of about 3 ac of paddy land and about 1.5 ac of upland.

16. Extension activities are technically backstopped by the Maha Illupalama Research Station. However, contacts are not formalized and depend entirely upon the personal relationships of the officers. Maha Illupalama is also the site of a training institute which is designed to service the entire north central region. The institute runs in-service and orientation training courses for all levels of staff, in which the DAEO and his Subject Matter Specialists participate.

17. The Agricultural Productivity Committees, (APCs) and their subordinate Cultivation Committees (CCs) are on the point of being increasingly involved not only in supervision and control of agricultural activities, but also in their medium-and short-term planning, forecasting and managing. They will require more staff and support if they are to be effective. The Multi-Purpose Cooperative Societies (MPCSs) are the sole source of fertilizer and pesticides obtainable with institutional credit, as only they can honor the credit vouchers issued to the farmers. The MPCSs also handle all the improved seeds that originate from Government sources. Coordination between them and the extension service is a means of securing timely availability of inputs at the right place.

18. Factors impeding efficiency of the extension service are:

(a) lack of formal and regular exposure to up-to-date research findings;

(b) lack of clearly defined areas of responsibility and consequent gaps in support;

(c) a serious lack of transport for all levels of staff, militating against regular field visits, and

(d) lack of accommodation which prevents the positioning of key staff at essential locations.

19. The Proposed Extension Service. The proposed extension organization would embrace the whole of Anuradhapura District. It would effect minimal changes in staff numbers but in view of the emergence of the APCs and CCs there would be some need for staff reassignment. The "special projects" group would be reabsorbed in the District Extension Organization. Areas developed under the MDB would become part of a new Extension District as development progresses. Extension Officers servicing the Pavatkulam and Vavunikulam tank areas would also be integrated into their respective District organization but would receive the same special, intensive training that would be given to the Anuradhapura staff.

20. Table 1 shows the organizational chart for the proposed extension service. The functions and brief job descriptions of the various cadres of the proposed service would be as follows:

(a) DAEO and Additional DAEO. The DAEO would be in overall charge and responsible for the work performance and training of all the staff involved in their respective projects. He would be assisted at District headquaters by an additional DAEO who would have charge of the day-to-day operational activities of all extension workers. He would serve principally as a staff officer. Both these officers must be agricultural graduates with several years operational and technical experience.

(b) SMSs. To enable maximixing output and to utilize fully expensive and scarce inputs -- water, mechanical equipment -- there would be SMSs for:

(i) farm machinery maintenance and operations;

(ii) water management and irrigation practices;

(iii) extension methods;

(iv) farm management;

(v) paddy;

(vi) maize and sorghum;

(vii) other upland crops, and

(viii) plant protection.

The SMS would be a university graduate with at least two years specialization in his subject and at least three years general field experience. His functions would be:

(i)	field work, in support of staff in contact with farmers;	60%
(ii)	training courses (lectures and demonstrations);	20%
(iii)	contact with relevant research work and workers, and,	10%
(iv)	preparing material for publication and training courses administration, work planning, short- and long-term	10%

To assist with the training of SMSs in disciplines at present not fully developed in Sri Lanka, the UK has agreed to provide three advisors -- one each in farm machinery maintenance and operations, water management and irrigation practices and farm management -- for a period of about two years. The advisors are expected to be posted by January 1, 1978. Tentative terms of references for the advisors are shown in Appendix 1.

(c) KVS. The cadre having the most frequent contact with the farmers would be the KVS. They must have a rural, farming background and preferably also formal training in a special training institute. They would reside in their work area,

have suitable transport to travel within this area and would be subjected to frequent practically-oriented training courses devised and run by first and second-line supervisors. They would have, within their areas, no more than 700 active farmers but considerably fewer in the early stages of the project or in areas with continuing serious problems.

Methods of operation would be centered around a prearranged and rigidly followed schedule of visits, known to all the farmers in the area, that would bring them back to the same outlet command every fortnight. The KVS would visit, and work with the same contact farmers for at least one season, who would all have been carefully selected as respected leading farmers of the area. Two groups of four contact farmers would be a suitable number for the one day's visit. Other farmers having land in the same outlet commands would be encouraged to participate. Success would be measured by the number who follow the KVSs' recommendations and by the results they achieve. The regular visiting schedule will enable the KVS to assist farmers in matters pertaining to input distribution and administrative procedures. During every farm visit, only the specified extension tasks of the period will be discussed. Other problems will be dealt with on a special day set aside for the purpose or passed on to their supervisor.

(d) The AI. One Agricultural Instructor (AI) would supervise four or five KVSs. He should have at least two years training at an agricultural school and three years field experience. He would be sufficiently well versed in the production of all field crops, plant protection and water management to be competent in back-stopping his KVSs. He would, in turn, visit each of his KVS's farm groups. He would participate in the fortnightly KVS training sessions (para 9) and take personal charge of demonstration plots and the field days conducted on them. He would help organize and take part in the periodic farmers' extension meetings. One AI would be posted to each APC; his office would be located in the APC complex. He would keep the chairman and the members of the committee informed of his activities and would be available to advise and assist them in their function of ensuring proper and efficient farming practices.

(e) Senior Agricultural Instructors (SAI)/Agricultural Officers (AO). Each extension circle would include 8 to 11 APCs. One senior AI or AO would be responsible for an extension circle, reporting directly to the DAEO and supervising the AIs. He should preferably be a university graduate with at least

five years' experience, capable of planning, organizing and supervising the extension activities of his staff. He should be well acquainted with problems facing the farmer in the field of crop production and farm management. The planning of the KVS, AI and farmer training programs would be his specific task. In this he must have access to, and the assistance of, the SMSs. He would spend three days a week in the field, visiting his AIs and ensuring that he sees, in rotation, all his KVSs and all their work areas. The task and the problems in hand would determine whether, and which, SMS accompanies him during the visits.

Promotional possibilities should be open to all grades, subject to satisfactory job performance and the successful conclusion of specially designed training courses.

Training

21. Training would be continuous for all levels of extension staff as well as farmers. The former will consist of one-day sessions and longer courses, run as workshops. The training would be according to the two levels of staff, one for KVSs and another for the graduate staff. The KVSs would receive regular fortnightly training. Between sessions, they would communicate to the farmers no more than the two or three key points of crop husbandry that they, themselves, were taught during the fortnightly courses, during which the preceding period's efforts will also be evaluated. The session may well take place on the fields of a contact farmer or some other suitable location, to ensure that all participants are actually capable of doing the task that they would be called upon to teach and demonstrate.

22. There would be a one-day training session each month for all the AIs during which the previous and the following months' activities would be discussed. There would also be presentations on special problems and some practical training. A seasonal six day seminar of AIs would be organized before each maha and yala season.

23. The program for the graduate staff would cover not only technical matters, but also the practice of supervision, organization, management and extension methods. Thus, involvement by agricultural research groups and operational groups of other projects will be as important as presentations from staff of the Institute of Management and the Institute of Public Administration. Monthly meetings of the group, headed by the DAEO, would determine the training need and the most suitable timing for the seminars. The supervisory staff would be the trainers of the KVSs. It is essential that the AIs not actually making presentations to them also be present, to take part in any follow-up discussion.

24. Before each session, there would be a one week intensive training course, held at the Maha Illupalama Training Institute which would provide for

all KVSs as well as the staff of the two tanks outside Anuradhapura District. The KVSs would be divided into groups so that the course would be completed in one month. Considering the preparations required, this operation would commit the teaching and administrative staff of the Institute for at least six weeks on each occasion. The Institute should be enlarged to accommodate all participants and to enable it to serve also as a farmer training center. The syllabus would consist of lectures on the major crops, discussions on problems encountered, any new production techniques and the most effective extension methods to use. The participants would have the opportunity of utilizing their past experience and newly acquired knowledge and skills to draw up work plans to their areas for the following six months. In developing these plans, emphasis would be placed on the priorities determined, practicability and focusing of efforts. A number of these programs would be presented by their planners for analysis and general discussion. This, in itself, would be an important exercise.

25. Training of Contact Farmers. The expected impact of, and on, the contact farmers cannot be achieved by farm visits alone. Further training would develop their abilities and make the work of the KVS more effective. The training would take the form of practical demonstrations of the crops they are growing, to improve crop husbandry practices by emphasizing key factors such as timely weeding, fertilization, pest control, water management, and most importantly, irrigation methods. Farmers would be taught the most suitable cropping pattern for their conditions, as it was developed or has evolved in their own area. This training would be in the form of short courses taking place either at the In-service Training Institute in Maha Illupalama or at one of the APC centers. The courses would last two to three days and be held before each session, after the KVS courses. Monthly meetings of these same farmer groups would complete this activity. They would be organized by the KVS and AI with the particpation of the Cultivation Committee. The meetings would serve as a forum for discussions concerning crops and farm problems in general. Guidance by the AI and the KVS would highlight the specific tasks to be undertaken during the following weeks.

26. The Working Environment. Suitable transport is essential at all levels. The KVSs should own a bicycle and a suitable operating allowance would be paid. The AI needs a motorcycle which would be his own property. Allowances would only be paid if the vehicle is operational, thereby ensuring good maintenance. Funds must be available to grant loans for purchasing the bicycles and the motorcycles. The SMSs, SAIs or AOs, the ADAEO and DAEO need four-wheel drive vehicles. These would be the property of the Government, unless the officers concerned wish to purchase one. As with the motorcycles, however, compensation for their use should be so structured as to provide the strongest possible inducement to maintain the vehicles in working order.

27. The transport and staff needs for the Pavatkulam and Vavunikulam tank areas would have to be considered separately. The need here is to move all staff once a fortnight to a suitable place in Anuradhapura District,

to enable them to attend the various training courses and for the supervisors to keep in touch with their own as well as with the Anuradhapura District head office for the respective assistance and control required. Therefore, apart from the requisite number of bicycles and motorcycles, there must be a minibus on each location.

28. The AIs and KVSs would be provided with housing, or a housing allowance instead. The budget (Table 2) contains provisions for this expenditure.

Implementation of the Proposed Plan

29. Implementation of the new extension plan is already under way. Four sub-districts -- north, south, east and west -- have been created and three of the extra SMSs required have been appointed and posted. The Special Project areas await reintegration into the District agricultural administration The total staff increases required are shown below:

	Present	Future	Additional
DAEO	1	1	-
ADAEO	1	1	-
SAIs/AOs	0	3	3
SMSs	3	8	5
AIs	41	39	-2
Total Supervisory Staff	46	52	6
KVSs	145	145	-
KVS Assistants to AI; Administration	24	39	15
Drivers	3	10	7
Clerk	10	10	-
Total Executive Staff	182	204	22

The estimated annual operating budget is shown in Table 2. Equipment requirements and capital investments are detailed in Annex 8, Table 3.

D. Agricultural Inputs

30. Farm Power and Equipment. Land preparation at present is done by a combination of four-wheel and two-wheel tractors and buffaloes. The four-wheel tractors, most in the 35-40 hp class, use mainly a tined cultivator (tiller) and only occasionally under dry conditions a disk plough. The two-wheel tractors use a reversible mouldboard plough and rotary cultivator; the buffaloes pull a barpoint plough with a long sole which helps to seal the surface on which it travels, thereby impeding percolation and assisting with water conservation. The farmers' first work choice is buffaloes, followed by the rotary cultivator. Both are consistent with paddy land preparation experienced from other countries. Survey findings show that, at present, 66% of land preparation is done by tractors in Anuradhapura District where three of the five tanks are situated, whereas the figures are 100% in Vavuniya and 97% in Mannar where the other two tanks are located. Since the Anuradhapura tanks have been a special project area, the concentration of tractors is probably higher than in the rest of the District. There is reason to assume that, given access to tractors and spare parts, the trend toward preparation of the seedbed with mechanical equipment will continue. It would, therefore, be desirable to examine the use of tractor implements with a view of emulating more closely the performance of the local plow, or at least to investigate again the possibility of using the rotary cultivator and the disk-harrow behind the four-wheel tractors to achieve some puddling of the soil.

31. Sample socio-economic surveys show some 90 four-wheel tractors in the project area (about 50 are in working order), and about 60 two-wheel units (about 25 are in working order). A blend of four-wheel and two-wheel tractors, working with implements similar to these now popular, should be used for land preparation and the covering of the broadcast seed. Since most of the work would not be under flooded conditions, the following outputs can be expected:

Primary tillage, four-wheel tractor	2 hrs/ac
Secondary tillage, two-wheel tractor	7 hrs/ac

Most of the primary tillage would be done by four-wheel tractors and one-half, reducing to one-third, of the secondary tillage by buffaloes. About one-sixth of the secondary tillage would be done by four-wheel tractors after they have completed primary tillage operations. Tractors would move between areas. It is estimated that about 30% of the need for four-wheel tractors would be supplied from outside the area. A 10% surplus should be available to cover breakdowns and to ensure a measure of competition.

32. The task requiring the most power would be the preparation of the seedbed for the maha season, where the objective would be to prepare the land using the minimum amount of water--irrigation or rainwater--for softening

the soil. Assuming a six-week (40-day) working season, it would be necessary to till about 800 ac per day to cover the entire 31,500 ac within the time allowed. This will require about 200 tractors, of which 150 would be based within the project area. Assuming that the secondary tillage is performed with two-wheel tractors and buffaloes, the number of such tractors required is calculated in the following way:

Total area for secondary tillage	31,500 ac
of which by buffaloes	10,500 ac
balance by two-wheel tractors	21,000 ac
Working time	40 days
Daily work requirement	515 ac
Daily output for each tractor	1.14 ac/day
Number of tractors required	450 units

Some of the two-wheel tractors would undoubtedly be used for primary tillage. However, some of the four-wheel units would also be used for secondary operations. No allowance has been made for the interchange in computing requirements. The cif cost of farm tractors, implements and repair facilities would be about US$2.7 million (Annex 8, Table 2).

33. **Seeds**. Farmers at present obtain their seeds via the extension service and the Multi-Purpose Cooperative Societies (MPCSs), which get them from Government farms and from seed growers. There is a great deal of farmer-to-farmer exchange and also growers saving their own seed, especially paddy seed. There is no seed legislation. The seed testing laboratory at Peradiniya works only in an advisory capacity. The system works well enough for paddy as witnessed by the rapid spread of any good variety released. It would be necessary to introduce statutory controls and standards on pulse seed quality. Pulses usually present serious storage and quality control problems, with rapidly decreasing germination rate and vigor over time. The GOSL is being advised by a team from FAO on legislative and quality control measures. Pending the legislation, an unofficial certification scheme for paddy seed is operating, which is similar to that of the International Seed Testing Association in relation to standards, and recognizes foundation, registered and certified seed. The first two are always grown on Government farms; certified seed is partly produced by certified growers. Inspection in the field and supervision of threshing floor is done by the AIs. In 1974, 400,000 bu, enough to plant about 200,000 ac, were certified. These are sold on consignment by the MPCSs which, in turn, distribute them to farmers.

34. Fertilizers. All fertilizers are imported. The sole importer is the Ceylon Fertilizer Corporation (CFC) which also acts as wholesaler to the dealers selling to the growers. The CFC operates a blending plant that produces NPK blends recommended as basal dressings prior to planting. For top dressings, urea is normally used.

35. Fertilizers are subsidized for paddy and other field crops (onions and chillies do not receive subsidized fertilizers). Prices are reviewed every six months on the basis of the landed costs by handling charges. At the time of appraisal, the unsubsidized price for the basal paddy mixture containing 3-30-13 NPK was Rs 86 per cwt. Certificates of entitlement are issued by the APCs. Other products, besides the basal blends, are sulphate of ammonia, triple super phosphate (TSP), rock phosphate, diamonium phosphate (DAP) and mono ammonium phosphate (MAP). Sulphate of potash is used for tobacco only. Current consumption for field crops is estimated as follows for Sri Lanka (1974/75 was a year of low rainfall):

Fertilizer	Total	Paddy	Other Field Crops
	('000 t)		
N	57	30.5	5.6
P_2O_5	23	12.3	3.1
K_2O	31	10.3	5.7
Total Nutrient Used	111	53.1	14.4

36. The CFC sells the subsidized fertilizers wholesale to the Director of Rural Institutions (RIs) and charges Rs 45 per ton for transport to any point in the country. Before new orders are filled, RI must pay CFC for the previous consignment. The RIs sell to APCs, CCs and MPCSs, charging Rs 20 per ton markup. Transport costs of Rs 5 plus a 5% margin may also be added. The final sellers are allowed a margin of 5% on what they actually pay but some are charging their customers less, to attract business. Farmers may buy directly from RI stores. If the purchase was from RI stores, they get the same terms as the retail buyers, but must pay cash. Thus, the attraction to go to a retail outlet is that they may buy against credit vouchers. Nevertheless, RI stores sell about 25% of their throughput directly to farmers.

37. The lines of the distribution chain are well arranged and CFC and RI management good. Upcountry stores that work on little more than a single turnover per year are underutilized--a situation that will continue until import scheduling can be better controlled.

38. Present fertilizer use on paddy is about 30% of the recommended dosage, due to the recent increase in fertilizer prices and water supply uncertainties. The recommended application, 60-40-30 NPK, is modest by comparison to the standards of other countries growing dwarf paddy varieties. It can be expected, therefore, that under project conditions, by 1986 the recommended amount equivalent to 1.5 cwt urea and 1 cwt of the basic paddy mixture per acre, may be applied.

39. Plant Protection Chemicals. Active ingredients and emulsifiers for all pesticides are imported; most of the formulation takes place in Sri Lanka. Locally established representatives of two major companies have access to proprietary products; most of the non-proprietaries are handled by the Ceylon Petroleum Corporation which is also the only importer for

solvents. The range of pesticides available is comprehensive and adequate, and packaging is good. The flow of product is from the formulator to the distributors who receive a 20% commission which is shared with the final seller. Within this margin, the farmer has a fair range to buy the most suitable product at relatively competitive prices. The retail price which includes the 20% margin, and a transport allowance, is determined by the GOSL. The kind of products that may be marketed are controlled by the GOSL and permission to market them is only given after the product has been field tested. However, there is no statutory control over storage conditions, or shelf life, nor is there an administrative means of sampling the products actually offered to the farmer.

40. All formulations are liquid, therefore, they must be applied through sprayers. The weed killers are systemic, and are effective if put on the leaves of the weeds growing in water or on any part of the weed if there is not standing water. Insecticides, especially for plant hoppers must be applied in small droplets and very uniformly. Many of the sprayers seen would not appear to be of a design that would ensure this. Also, there is some shortage of units. The MPC rent sprayers to their members at Rs 0.50 per hour. However, for full project benefits to be realized it would be necessary to have more and better designed sprayers available, possibly even some tractor mounted models.

41. Under project conditions, the cost of pesticides and hired sprayers used by farmers will amount to about Rs 35 per ac for paddy and Rs 20 for the other crops.

42. Sprayers for hire would have to be made readily available. Under project conditions, motorized knapsacks would provide a useful supplement to the hand sprayers that are available. Their output is about 10 ac per day and the maximum interval between spraying may be a fortnight. Therefore, 225 sprayers would be needed. However, since hand sprayers are available in the area and simultaneous use is unlikely the number of sprayers to be purchased under the project would be 150 units. If locally procured, these could be phased over the Years Two, Three and Four as the project develops. However, if they are purchased abroad, for purposes of convenience, they should all be included in a single tender.

43. Agricultural Credit. Evaluation Study No. 2 by GOSL, entitled "A Short History on Credit for Peasant Agriculture in Sri Lanka", May 1974, briefly outlines the history of credit to peasant cultivators from its inception in 1911 until 1974 and gives full details on credit since that time. Historically, the following points are outstanding:

(a) institutional sources never met more than 30% of the rural credit needs; the present figure is just under 16%;

(b) repayment was always dependent on a good harvest but there were always at least 15% defaulters;

(c) about 1960 when, concurrent with a drive to increase lending, and the write-off of defaults began, the repayment record worsened considerably and the default rate exceeded 30%;

(d) there has never been close supervision on credit use and such control, as was exercised initially, has declined since the mid-1960s. An increase in the rate of defaulters can be traced to this relaxation, and

(e) interest, while charged, was not shown separately in the statements. If included, the default rate would be considerably higher than shown.

44. Recent legislation would improve past problems. Loans would be given by the Bank of Ceylon only to farmers and for purposes approved by the APCs. Coordination is ensured by the bank which has its offices in the APC Building. While there is still no provision for the bank to supervise the use of the loan, their association with and the designated functions of the APCs introduces a substantial element of control. The Agricultural Insurance Law would compensate for crop failures and as it makes the claims of a recognized credit organization the first charge on the payment, this cause for defaults will disappear. A further factor is that under the project, production will be enhanced and generate a cash surplus in excess of living costs.

45. The procedure for applying for credit is set out in the relevant legislation. Applications must be made to the APC who assess its justification either directly or through the extension staff attached to it. Whenever feasible, credit is supplied in kind, in the form of purchasing vouchers. The APC, through the CCs and the extension staff, ensure its proper use within the framework of their general supervisory duties.

E. Storage, Marketing and Processing

46. Paddy. Until recently, the Paddy Marketing Board (PMB) had a monopoly over paddy purchase. Even with the removal of restrictions on private traders, it is expected that the PMB would continue to play an important role in paddy marketing, and milling. The Board buys from farmers at a fixed price (presently Rs 35/bu) through a vast network of purchasing points run by the cooperative societies. Since the price is fixed and does not vary throughout the year, it is to the farmer's advantage to sell as soon as possible and thus avoid the risks associated with farm storage. Because of this, most farmers keep only paddy needed for home consumption and seed. They normally have a small storage room built as part of their house. The PMB is legally required to purchase all paddy offered at the set price.

47. The Village Level Cooperatives get a commission of 75¢ per bushel from PMB for grading, weighing, and sacking. Grading is normally done according to the following standards:

	Grade I	Grade II
Chaff (by volume)	6%	12%
Foreign matter (by weight)	1%	2%
Other varieties (by weight)	10%	10%
Moisture content:	16%	16%

The difference in price is 2¢ per lb in favor of Grade I. Because the purchase centers are not equipped to test for quality variations, they base prices on judgement and experience.

48. The periods of purchase are between March and July inclusive, and again between August and October. The peak period is between March and May, when transport is sometimes a bottleneck which results in accumulation of produce at the purchasing centers and temporary suspension of purchases.

49. In Anuradhapura District, there are 252 purchasing points. Each handles about 350-400 tons and has a storage capacity of about 100 tons. From the point of purchase, the paddy is taken to the PMB stores. Most of the PMB's 47,000 ton storage capacity is owned by the Board. At present, all is flat storage; the first silos are now under construction. There is no drying facility, no forced ventilation, although the stores are well designed for natural ventilation. Average storage time is about four months and annual turnover is only about one time a year. Capacity requirements are affected by the March-May peak purchasing season.

50. Maize and Sorghum. The quantities produced are small and the bulk of the harvest takes place in a relatively dry period. Marketing of surpluses has been mostly through private channels. The GOSL, through the Oils and Fats Corporation, and PMB, which acts for the Flour Milling Corporation, has entered the market. Prices during the last season varied between Rs 2,000 and Rs 1,200/ton, due mainly to the limited market for feedgrains; the Oils and Fats Corporation prefers the much cheaper coconut cake and rice bran. The cooperatives are buyers only up to the extent of recovering outstanding debts. The Flour Milling Corporation uses maize and sorghum for blending with imported wheat flour, or an ad hoc basis. However, as the farmers have been encouraged in 1974/75 to grow maize and sorghum, GOSL has compelled PMB to act as residual buyers without limit. Despite the fact that stocks were damaged, in storage, an export market was found for the surplus. Encouraged by these results, PMB continues to be a residual buyer and has a target of 15,000 tons for 1975-76, of which it expects to export 10,000 tons; Singapore and Japan are the potential markets.

51. In the dry zone, about two-thirds of the country's agricultural area, the agronomic possibilities of maize and suitable varieties of sorghum are potentially great. So are the market possibilities, principally in Japan, where intensive animal husbandry, and the consequent demand of feedgrains, is on the point of rapid expansion. Therefore GOSL should seriously study the production, storage and export marketing problems of these crops that could well occupy considerable portions of upland areas that, either through topography or temporary water shortage, may not be irrigated.

52. Pulses. Consumption has fallen to about one third of the amount used before imports were banned in 1971. Since 1973, prices have increased considerably and this has encouraged production. Although there are a few local marketing difficulties, total consumption is still much below pre-1971 levels. The crop is potentially profitable even at prices below present levels, and no major long-term problem in organizing a profitable and effective marketing system is anticipated.

53. Paddy Storage and Marketing Requirements Under the Project. As planting and, therefore, harvesting would be concentrated into a shorter season, deliveries to the PMB would also have higher peaks and would take place over a shorter time span. It would be necessary to provide additional facilities for both storage and rebagging of paddy. Collection points should be set up along all-weather roads with sufficient capacity to handle the peak (maha) procurement in about four weeks, at the rate of 40 tons (eight truck loads) per day. This would require 28 additional collection points in Mahakanadarawa (8), Padaviya (16), Mahawilachchiya (3), Vavunikulam (5), and Pavatkulam (6). Each collection point would require about 150 tons of storage and working space for a simple auger-fed bagging shute i.e. about 1,500 sq ft of floor space. The building should have large doors at both ends and a loading dock at the end opposite the bagging unit. A moisture tester capable of giving instantaneous reading should be available. Samples above 16% moisture would be accepted at a discounted price and then only if they could be delivered to a drier the same day.

54. Processing. Paddy milling is the only major processing industry of importance in the project area; any sorghum and maize processing that may be necessary would take place either in flour mills or Oils and Fats Corporation feed mills, outside the project area. Rice milling is a two-tier operation. The small village husking mills work on a custom basis to meet domestic requirements. Large commercial privately-owned mills work for the PMB on commission and do 80% of all milling. The PMB mills handle the other 20% but their share will increase in time because the private sector is not allowed to replace its mills. The village mills seen were of poor quality and in a poor state of repair, practically all the grain is broken and much is wasted with the husks. The larger mills, although old, are better maintained, waste little grain, but they do not polish too finely and also have high breakage. Because of the superficial polishing, milling out-turns are about 70%. About 10% of the milled rice is parboiled.

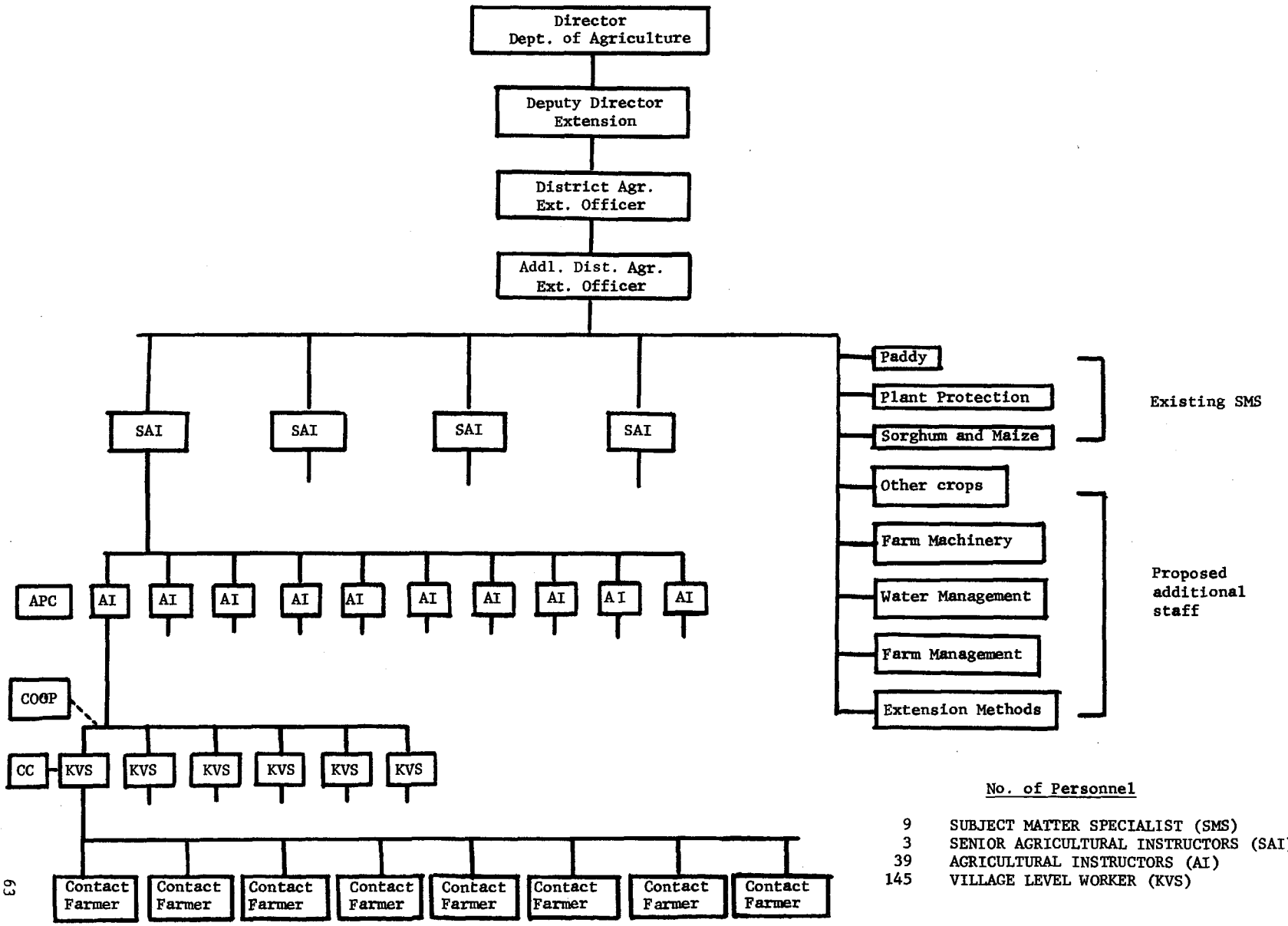
55. Requirements Under the Project. Capacity for rice husking and the milling of cereals and pulses is adequate, even if the quality of some of the installations is poor. Normal investment by PMB and by the village rice millers is likely to keep up with increasing demand.

November 1976

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Proposed Organization Chart for Agricultural Extension Services



No. of Personnel

9	SUBJECT MATTER SPECIALIST (SMS)
3	SENIOR AGRICULTURAL INSTRUCTORS (SAI)
39	AGRICULTURAL INSTRUCTORS (AI)
145	VILLAGE LEVEL WORKER (KVS)

ANNEX 4
Table 1

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Agricultural Supporting Services

Estimated Annual Operating Budget of the Agricultural Extension Services

Anuradhapura District

Item	Cost (Rs)
(a) Salaries and Allowances	
DAEO (1)[1/]	
ADAEO (1)	230,000
SAI (3)	
SMS (8)	
AI (39)	400,000
KVS (184)	1,000,000
Drivers and clerical staff	120,000
Sub-total	1,750,000
(b) Other Costs	
Operating costs for extension vehicles	250,000
Extension Activities	100,000
Training abroad	100,000
Sub-total	450,000
(c) Contingencies	200,000
Total annual costs for Anuradhapura District	2,400,000
Estimated annual costs for Vavunikulam and Pavatkulam tanks	200,000
Grand Total	2,600,000

1/ Figures in parenthesis refer to the total number of positions.

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Job Descriptions for Extension Service Subject Matter Specialist Advisors

All three Advisors would be:

(i) posted in Anuradhapura;

(ii) required on or before January 1977;

(iii) duration needed -- two years.

I. Post Title: Advisor on Farm Machinery Field Maintenance and Operations.

1. Principal Function. To advise and train local Subject Matter Specialists (SMSs) in the operation and routine field maintenance of four-wheel and two-wheel tractors, the selection and operation of tillage implements and the operation and field maintenance of other farm machinery and equipment available to Sri Lanka farmers.

2. Duties. The Advisor will advise and train SMSs of the Department of Agriculture in the field maintenance, operation and field repair of farm machinery now used or to be introduced in the near future. The aim is to generate full understanding of the reasons why systematic maintenance is necessary and the consequence of negligence. The training will include but not be confined to the following:

(a) daily and other routine maintenance of all prime movers in accordance with the appropriate operators' handbooks;

(b) the functions and purpose of all tillage implements, the nature of their work, conditions for which each is chosen;

(c) setting and adjustment of tillage implements for different working conditions; the practical teaching of their operation as regards speed, setting out of fields and expected hourly output under different soil conditions;

(d) maintenance and repair of tillage implements, replacement of wearing parts, effects of not replacing them;

(e) the operation of other farm machinery likely to be introduced; some examples are the mechanical details of hand and power sprayers and the effects of mechanical inadequacies; maintenance and operation of threshing machines and driers if used.

3. The Advisor will also prepare a manual for use by the SMSs and will supervise and assist SMSs in the preparation of suitable manuals for KVS, farmer and machine operator training.

4. Following a period of training in Maha Illupalama, the Advisor will follow up by accompanying the SMSs on their field trips to ensure the completeness of their practical training and will supervise the SMSs as they, in their turn, train AIs, KVSs, farmers and operators.

5. The Advisor will supervise and assist the SMSs in the preparation and delivery of in-service training courses for custom operators of agricultural machinery.

Qualifications

6. The Advisor should have a Bachelor's degree in either agriculture or agricultural engineering or equivalent and have at least five years experience in the field operation of agricultural machinery. Relevant experience in developing countries would be an advantage.

II. Post Title: Advisor on Water Management and Irrigation Agronomy.

1. Principal Function. To advise and train local SMSs in the principles and practice of on-farm irrigation (downstream from farm outlets).

2. Duties. The Advisor will advise and train SMSs of the Department of Agriculture in the most efficient method of irrigating rice and other food crops, with due regard to maximizing water use efficiency consistent with optimum yields and production costs. To this end, the Advisor's duties will include but not be confined to the following:

(a) assist project personnel and work with them in training farmer groups to carry out rotational irrigation along the field channels and to maintain the field channels and related structure to assure performance;

(b) from field observations and perusing past and ongoing relevant work in Maha Illupalama, develop the desirable irrigation depth and frequency, taking into consideration the effective rainfall between irrigations; and

(c) develop a cadre of project personnel and farmers who in turn would train others in the details and routines of project operation and maintenance and new irrigation methods.

Note. Since most of the foregoing are tied to field conditions, training will necessarily be mainly on the job, while actually designing the farm

layout and irrigation and drainage system and methods. As the SMSs gain experience, an increasing amount of the planning will be done by them and the Advisor will be increasingly confined to advising and reviewing the SMSs' performance.

(d) the Advisor will prepare a manual for use by the SMSs. This should contain information on consumptive use (from the Irrigation and Water Management Specialist and Maha Illupalama), moisture availability in the root zone, desirable irrigation depth, irrigation frequency, best irrigation method (furrow, basins, etc.) and desirable flow rates. This information to be presented systematically and precisely according to readily identificable local soil types, slopes and crops;

(e) the Advisor will supervise and assist the SMSs in the preparing and presenting of the same information in a simplified form for use as training and advisory materials for AIs, KVSs and for presentation to farmers;

(f) in collaboration with the SMSs for the respective crop, establish a simple demonstration program designed to show the effects of the different components of the program being executed differently, its effect on yields and water use efficiency. An ongoing program for such demonstrations should be developed, flexible enough to include the examination of new problems as they arise.

Qualifications

3. The specialist should have a Bachelor's degree in agriculture and not less than five years experience in irrigated agriculture including rice growing.

III. Post Title: Farm Management Advisor

1. Principal Functions. The Advisor would divide his time between two main tasks:

(a) He would train his counterpart SMSs to be the principal advisors to the Tank Coordination Committees (TCCs) in developing every season, the general cropping pattern and crop varieties to be grown in the various identifiable sub-areas of the tank commands.

(b) Within this overall plan, he would identify the criteria for successful individual farm management plans in various localities of the area and from them develop models that can be adapted to the physical and managerial resources of the farmers.

2. Duties. The Advisor's training function which is of at least equal importance to technical developments and achievements can only be fulfilled by field studies and enquiries. Therefore these must be carried out either together with the SMSs or by the SMSs under the Advisor's close supervision. All output in respect of the two principal functions would be a synthesis and the application of information gathered, either from outside research, farming and marketing sources or from the close examination and analysis of the environment, be it entire sub-areas or individual farms within these sub-areas. To achieve these aims, the Advisor's duties will include but not be confined to, the following:

(a) assisted by some, or all seven SMSs who concentrate on the other disciplines, as well as the appropriate research workers, soil scientists, within the Ministry of Agriculture collate detailed land capability information for each sub-area, using as many different units as are deemed necessary and practicable. A significant component of the overall picture would be the inclusion of the economically most useful irrigation regime that would optimize returns for water and for land;

(b) considering the foregoing, and taking into account the likely water availabilities for the coming season, advise and assist the TCCs in their decision on the date of water release and the best design cropping pattern;

(c) maintain constant liaison with the rainfed pilot project in Maha Illupalama and adapt and extend their findings to areas in the command of the five tanks of the project that do not get water in a particular season, and, if time permits, to other parts of Anuradhapura Districts not yet served by irrigation;

(d) from individual farmers and other extension staff, an inventory of resources at the farmers' disposal; for example, possible irrigation facilities for upland plots, grazing facilities for livestock, the local availability of hired tillage machinery;

(e) market intelligence from private and public purchasing agents, from which to enable farmers to estimate market prospects of the crops their locality enables them to grow;

(f) farmers who seek advice must be evaluated as to their farming and managerial skill, their attitude, risk-taking potential, ability to implement possibly innovative, unorthodox farm plans, their aptitude and resources to develop machinery operation contracting as a side enterprise or an off-farm livestock program within the resources of the area. The Advisor must concentrate not only on collecting the relevant information concerning responding farmers but also on imputing to his trainees the methods of collecting such information, for future application;

(g) from information thus gathered, developed a detailed, individually designed farm plan, management routine and business line plan which takes full account of the responding farmers' needs, abilities and limitations;

(h) for each completed farm plan, first the Advisor and later, under his guidance, the SMS must record the reasons for the plan as appraised at the time. Follow-up should take place every season from which to learn and to apply when developing future plans;

(i) a routine of follow-up visits must be organized in which details of the original plan are discussed and modifications that appear necessary in the light of developments incorporated.

Qualifications

3. The Advisor should have a Bachelor's degree in agriculture, have had extensive experience in managing tropical field crop production projects and in designing individual business plans for small farmers.

SRI LANKA

TANK IRRIGATION MODERNIZATION PROJECT

Water Supply, Demand and Quality

Water Supply

1. Water for the project is regulated by five separate tanks (Map 11749). The principal water supply features of the tanks are summarized as follows:

Feature	Maha-kanadarawa	Maha-wilachchiya	Pavatkulam	Vavunikulam	Padaviya
Tank capacity (ac ft)	34,000	32,500	27,000	35,000	85,000
Tank surface area (acres)	4,000	3,200	3,000	3,150	6,480
Head on outlet at full supply level (FSL)	19.0	22.0	19.0	24.0	24.0
Catchment area (sq mi)	126	141	115	88	206
Irrigated area (acres)	6,000	2,600	4,400	6,000	12,500
Area irrigated per sq mi of catchment (ac)	47.6	18	38	68	60

2. The monthly inflows to each of the five tanks were computed using measured tank releases, calculated evaporation losses based on pans near the tank, estimated percolation losses and the tank area/capacity diagram. The determined annual inflow for each year of tank operation is shown in Table 1 together with the annual precipitation and related probability of exceedence. No correlation could be established between the rainfall and tank inflows. Also no correlation appears to exist between yields per square mile of the catchments of the tanks.

3. The catchment area of each of the tanks contains many small irrigation and village tanks which intercept and hold water for paddy grown on

the catchment. Depending on the quantities of precipitation and occurrence, the upstream interception and depletion could be substantial. The indeterminant interceptions of flows upstream of the tanks rule out effective correlation.

4. Based on a continuance of the existing upstream regime and considering the short terms of inflow data available as a representative sample of the future with a normal distribution, the probability of recurrence of the inflows was established by the Irrigation Department (ID). The probable annual tank inflow of each tank for 75%, 50% and 25% exceedance thus determined are:

Estimated Annual Inflow

Exceedance Expectancy (%)	Mahakanadarawa	Mahawilachchiya	Pavatkulam	Vavunikulam	Padaviya
		(ac ft)			
75	43,500	21,000	20,500	32,000	127,000
50	60,000	33,000	32,000	57,000	175,000
25	76,000	45,000	43,000	83,000	224,000

Comparing the dry year (75% exceedance expectancy) with historic flows (Table 1), the estimate of tank inflows would have exceeded five years in six for Mahakanadarawa, nine years in 11 for Padaviya, six years in seven for Vavunikulam, seven years in ten for Pavatkulam and only three years in seven for Mahawilachchiya.

5. Evaporation losses for each tank during the maha and yala seasons were developed by the ID based on 75% probable exceedance of inflow and a schedule of tank releases based on an assumed project cropping pattern. These estimates for the five tanks are (ac-ft):

Tank Scheme	Annual Inflow	Evaporation Sept-Apr	May-Aug	Total	Annual Tank Yield
Mahakanadarawa	43,500	5,000	2,700	7,700	34,000 /a
Mahawilachchiya	21,000	4,600	2,300	6,900	14,100
Padaviya	127,000	10,500	5,100	15,600	85,000 /a
Pavatkulam	20,500	4,900	2,500	7,400	13,100
Vavunikulam	32,000	5,500	2,500	8,000	24,100

/a Regulation is limited to an amount equal to tank capacity plus evaporation because filling largely occurs during the maha season when releases are minimal.

6. The ID using the observed data on the five tanks (monthly basis) for about seven to 11 years and employing a computer program for the generation of data from a Thomas and Fiering Serial correlation model, developed monthly yield data for each tank for 50 years. These data were subsequently used in studies to establish a combination of maha and yala acreage that would assure an overall cultivation success of about 75%.

Water Demand

7. Crop Water Requirements. The crop water requirements were developed using a modified Penman method. Water requirements for the maha and yala seasons are shown in Table 2.

8. Project Irrigation Demand. The demand for irrigation water from the tanks is based on the crop water requirements and on judgements on the crop pattern and the extent of the irrigated area projected for the maha and yala. Shown in Table 3 are the area irrigated, water supply required for paddy and dry crops for the maha and yala season and the total irrigation demand for each tank. Also noted in Table 3 are the number of years over the period of record that the tanks could fully meet their expected irrigation demands. The irrigation operations of the tanks to provide the water requirement shown in Table 2 and 3 are discussed at length in Annex 10.

9. Adequacy of Water Supply. The number of years that the tanks could have met the projected irrigation demands over the past years of record shown on Table 3 is a reasonable expression of the probable outlook for each tank's water supply performance. This approach was finally adopted after careful examination of the studies prepared by the Irrigation Department. The Department studies generally indicate greater amounts of water available from the tanks and generally discount the effect of successive near-dry years that could greatly affect the small farm (2-3 ac) holder who predominates in the area. These small farm operators have almost no flexibility of operation and cannot accept much risk in cropping success. The tank water supply would be able to meet the projected crop pattern and cropping intensity within acceptable risks to the small farmer. Should operating experience prove in time that the tanks are capable of providing more reliable water with acceptable risks to the farmer, irrigated area cropping intensity could be increased.

10. Only at the Padaviya tank do the inflows presently indicate possibilities for further expansion of the irrigated land area. The need for additional storage and conveyance facilities would be studied. This evaluation would be part of the project tank operation and training program. The water management specialist to be provided under the project would guide the evaluation and preparation of plans and recommendations of future Padaviya tank irrigation expansion. The terms of reference for the specialist would provide for this activity (Annex 10).

TANK IRRIGATION MODERNIZATION PROJECT

Tank	Year	Tank Inflow: Annual Amount (ac-ft)	Annual Precipitation: Annual (inches)	Annual Precipitation: Probability of Exceedence (%)
Mahakanadarawa	68/69	9,300	35.5	95.5
	72/73	47,900	60.9	42.0
	67/68	53,600	38.8	90.0
	71/72	64,400	52.8	70.0
	70/71	66,950	66.7	23.0
	69/70	119,900	65.4	25.0
Padaviya	68/69	64,250	56.6	62.3
	64/65	106,250	47.8	88.7
	72/73	132,400	52.5	75.5
	71/72	149,900	55.8	63.0
	63/64	159,000	59.5	49.0
	70/71	160,500	63.7	44.0
	65/66	196,600	49.7	79.5
	67/68	220,250	59.1	49.2
	66/67	222,500	61.3	48.0
	62/63	228,100	106.3	3.0
	69/70	276,800	80.3	20.5
Mahawilachchiya	72/73	12,300	60.8	36.0
	70/71	16,800	44.3	85.0
	68/69	18,700	32.8	97.0
	71/72	20,300	48.3	74.5
	69/70	48,700	60.3	36.5
	67/68	54,100	41.6	87.5
	66/67	57,500	39.9	90.0
Pavatkulam	68/69	8,500	35.3	99.0
	70/71	18,700	54.1	67.6
	64/65	19,600	53.7	70.0
	71/72	26,900	40.9	93.0
	72/73	35,100	65.9	32.3
	69/70	37,700	54.7	67.2
	66/67	38,700	48.8	85.0
	65/66	42,400	44.9	90.5
	63/64	47,300	56.1	60.0
	67/68	50,900	60.0	48.4
Vavunikulam	68/69	6,900	33.7	99.0
	66/67	38,950	46.6	74.0
	71/72	50,700	48.4	73.0
	70/71	56,650	63.3	36.5
	72/73	61,350	35.1	98.0
	67/68	84,450	71.2	24.0
	69/70	99,150	68.5	29.0

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TANK IRRIGATION MODERNIZATION PROJECT

Crop Water Demand Per Acre

	Maha						Yala					
	Sept.	Oct.	Nov.	Dec.	Jan.	Total	Feb.	Mar.	Apr.	May	June	Total
Paddy												
Evapo-transpiration (in)	6.7	5.2	4.1	4.3	4.5		5.5	6.7	6.5	7.9	4.2	
Crop factor	-	1.00	1.15	1.20	0.90		-	1.00	1.15	1.20	0.90	
Consumptive use (in)	-	5.2	4.7	5.2	4.1	19.2	-	6.7	7.5	9.5	3.8	27.5
Land preparation (in)	4.0	2.0	-	-	-	6.0	4.0	2.0	-	-	-	6.0
Total water requirements (in)	4.0	7.2	4.7	5.2	4.1	25.2	4.0	8.7	7.5	9.5	3.8	33.5
Effective rainfall 1/ (in)	0.5	3.5	3.4	3.0	0.8	11.2	0.4	1.3	2.5	1.1	-	5.3
Net irrigation requirements (in)	3.5	3.7	1.3	2.2	3.3	14.0	3.6	7.4	5.0	8.4	3.8	28.2
Tank release at 55% overall efficiency (in)	6.4	6.7	2.4	4.0	6.0	25.5	6.6	13.5	9.1	15.3	6.9	51.4
Field Crops												
Evapo-transpiration (in)	6.7	5.2	4.1	4.3	4.5		5.5	6.7	6.5	7.9	6.2	
Crop factor	-	0.4	0.8	0.9	0.6		-	0.4	0.8	0.9	0.6	
Consumptive use (in)	-	2.1	3.3	3.9	2.7	12.0	-	2.8	4.9	7.1	2.6	17.4
Land preparation (in)	4.0	2.0	-	-	-	6.0	4.0	2.0	-	-	-	6.0
Total water requirements (in)	4.0	4.1	3.3	3.9	2.7	18.0	4.0	4.8	4.9	7.1	2.6	23.4
Effective rainfall 1/ (in)	0.5	3.5	3.4	3.0	0.8	11.2	0.4	1.3	2.5	1.1	-	5.3
Net irrigation requirements (in)	3.5	0.6	-	0.9	1.9	6.9	3.6	3.5	2.4	6.0	2.6	18.1
Tank release at 55% overall efficiency (in)	6.4	1.1	-	1.6	3.5	12.5	6.6	6.4	4.4	10.9	4.7	33.0

1/ 75% rainfall exceedance expectency.

ANNEX 5
Table 2

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TANK IRRIGATION MODERNIZATION PROJECT

Irrigation Demand and Supply

Tank	Service Area (ac)	Maha Paddy Area (ac)	Maha Paddy Water (ac ft)	Maha Dry Crop Area (ac)	Maha Dry Crop Water (ac ft)	Yala Paddy Area (ac)	Yala Paddy Water (ac ft)	Yala Dry Crop Area (ac)	Yala Dry Crop Water (ac ft)	Total Irrigated Area (ac)	Total Irrigation Demand (ac ft)	Cropping Intensity (%)	Water Available (ac ft) 1/	Number of Years Demand Met During Period of Record
Mahakanadarawa	6,000	5,700	12,100	300	300	2,100	9,000	2,000	5,500	10,100	26,900	1.67	26,300 3/	5 out of 6
Pavatkulam	4,400	4,150	8,800	250	300	400	1,700	400	1,100	5,200	11,900	1.18	12,600	8 out of 10
Mahawilachchiya	2,600	2,450	5,200	150	200	900	3,900	900	2,500	4,400	11,800	1.69	14,100	5 out of 7
Padaviya	12,500	11,900	25,300	600	600	6,000	25,600	2,100	5,800	20,600	57,300	1.65	69,400 3/	10 out of 11
Vavunikulam	6,000	5,700	12,100	300	300	1,300	5,600	1,500	4,100	8,800	22,100	1.47	24,000	6 out of 7
	31,500	29,900	63,500	1,600	1,700	10,700	45,800	6,900	19,000	49,100	130,000	1.57	146,400	

1/ Annual inflow less tank evaporation.

2/ Excess water supply; not practical to run tanks dry.

3/ Insufficient storage space to regulate entire inflow.

ANNEX 5
Table 3

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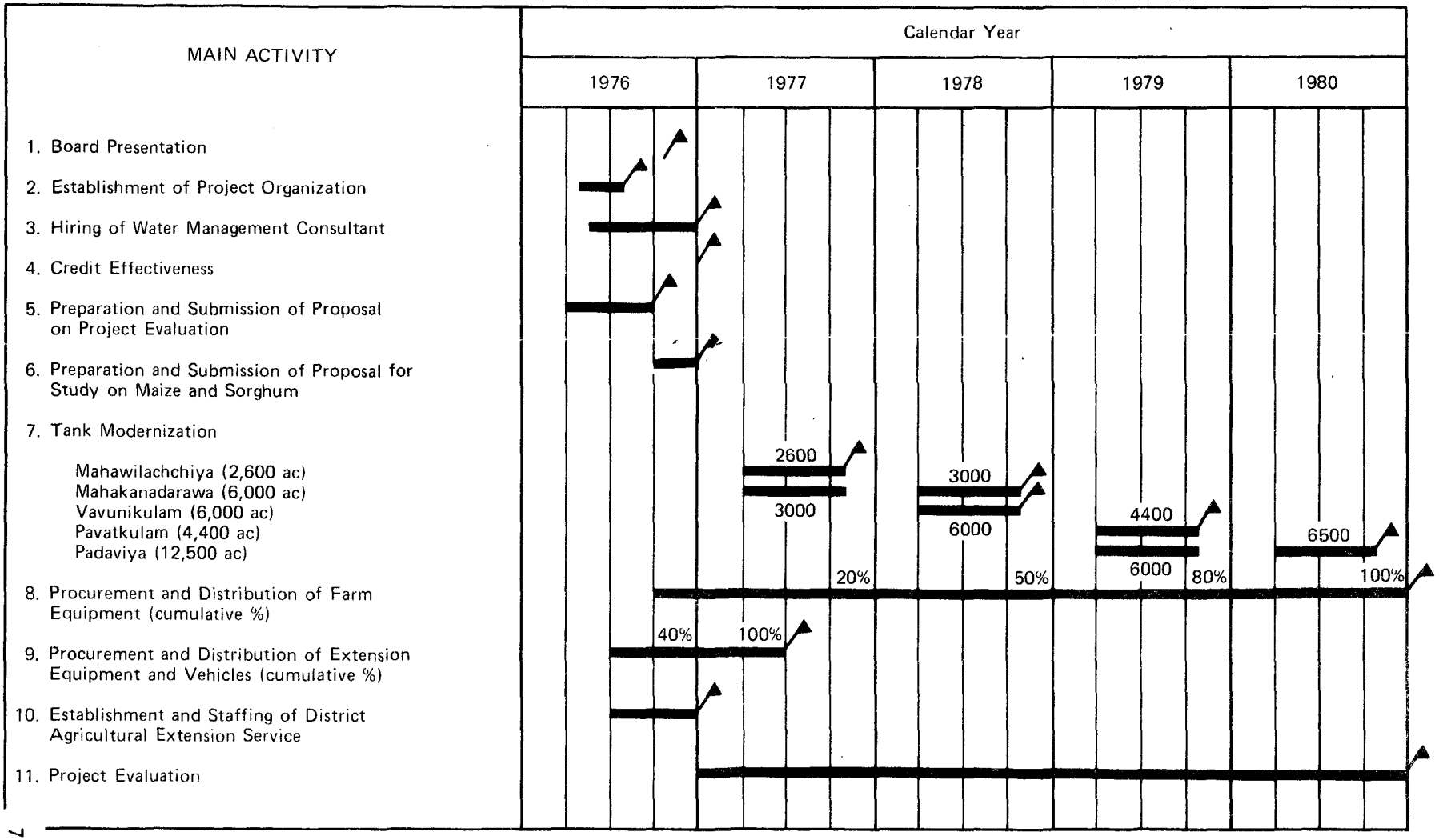
TANK IRRIGATION MODERNIZATION PROJECT
Implementation Schedule



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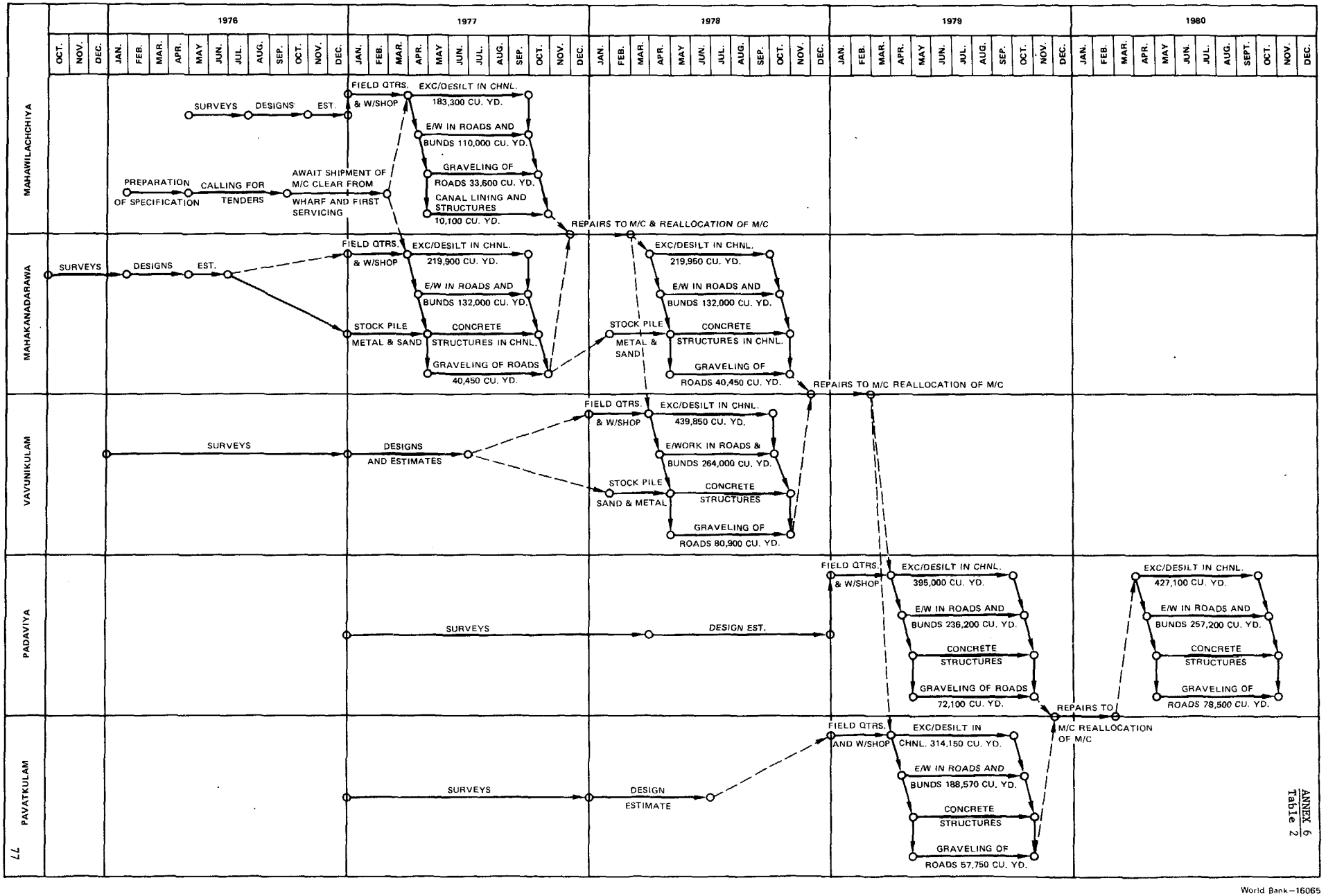
TANK IRRIGATION MODERNIZATION PROJECT
ACTIVITY NETWORK DIAGRAM



ANNEX 6
Table 2

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TANK IRRIGATION MODERNIZATION PROJECT

Cost Estimates

A. Civil Works

1. Costs for civil works were developed from surveys, sample area analyses, and estimates made on similar tank schemes by the ID. Surveys of the improvements required on main canals, distributaries and related structures were made on the Mahakanadarawa and Mahawilachchiya schemes. A 100 ac typical area for each of the three schemes -- Mahakanadarawa, Mahawilachchiya and Padaviya -- was analyzed in detail on modernization needs of the field channels and related structures. Data from these varied sources and judgments exercised by the ID personnel indicated that the conveyance system has the following characteristics:

Type of Channel	Average Length (yd) per Irrigated Acre
Main and branch canals	6.5
Distributary canals	10.0
Field channels	28.0 /a
Drainage channels	17.0 /b

/a This is higher than usual as field channels provide an inlet to every farm (average size 3 ac).

/b Assumed to be about 60% of the length for field channels.

On this basis, the estimated lengths of channels in the 31,500 ac project area are: main and branch canals (205,000 yd); distributary canals (315,000 yd); field channels (882,000 yd), and drainage channels (536,000 yd).

Earthworks

2. Earthworks proposed under the project would fall into two categories: desilting of channels (including excavation of new channels), and the provision of earth and gravel from external soil dumps to make up channel bunds and roads. The following average quantities (cu yd per lineal yd of channel) are estimated:

Type of Channel	Desilting (excavating)	Earthworks for bunds	Earthworks for roads	Gravel for roads
Main and branch canals	2.5	0.6	-	0.3
Distributary canals	0.25	0.5	0.5	0.25
Field channels	-	0.5	0.5	0.3
Drainage channels	3.0 /a	-	-	-

/a The survey suggests that most drainage channels would have to excavated.

3. The following unit rates are based on data provided by the Irrigation Department. They do not include survey, design and supervision, nor the cost of plant and equipment, which are allowed for elsewhere.

(a) Desilting/excavation: this is based on manual labor. The current unit rate is Rs 4.02 per cu yd. The mission has increased this to Rs 5.0 per cu yd as some of the drains may have to be excavated in wet conditions.

(b) Earthworks in roads and bunds and gravelling: these three operations are basically similar. The price includes excavation by a front-end loader, loading into dump trucks of 2.5 cu yd capacity, an average haul of 3 mi, spreading by tractor, consolidation by pedestrian operated roller and minor trimming by hand. The official estimate of Rs 16.97 per cu yd has been increased to Rs 20 per cu yd to allow for additional consolidation.

4. From this, the estimated earth moving requirements and the costs would be as follows:

Item	Quantity (cu yd)	Cost (Rs million)
Desilting/excavation		
Main and branch canals	512,500	2.6
Distributary canals	78,750	0.4
Field channels	-	-
Drainage channels	1,608,000	8.0
Total	2,199,250	11.0
Earthworks in roads and bunds		
Main and branch canals	123,000	2.5
Distributary canals	315,000	6.3
Field channels	882,000	17.6
Total	1,320,000	26.4
Gravelling for roads		
Main and branch canals	61,500	1.2
Distributary canals	78,750	1.6
Field channels	264,600	5.3
Total	408,850	8.1

Lining

5. Lining under the project would be done on a selective basis. The main objectives would be to reduce excessive seepage or erosion, and to provide the necessary degree of water control. In addition, all field channels under the Mahawilachchiya tank would be lined as a pilot program for determining the effects on seepage losses and on maintenance costs. Because of the non-uniform channel cross-sections, lining would be of plastered brickwork, except in Mahawilachchiya tank where various kinds of linings would be tried on an experimental basis. The total lining requirements are estimated to be: main and branch canals (1.6 M sq ft); distributaries (1.3 M sq ft), and field channel (2.4 M sq ft). At for the estimated average unit

cost of Rs 1.00 per sq ft, the lining costs would be Rs 1.6 M, Rs 1.3 M and Rs 2.4 M, respectively.

Other Works

6. The following costs for other works were deduced from the survey and unit rates agreed with the Irrigation Department.

	Costs (Rs) per Acre Served			
Type of channel	Repairs to existing structures	Cross-channel regulators	Measuring devices	Total Cost (Rs million)
Main and branch canals	25	70 /a	3	3.1
Distributary canals	15	15	15	1.4
Field channels	200 /b	25	20	7.7
Totals	240	110	38	12.2

/a Example: total length of main and branch canals on 31,500 ac is 205,000 yd - say 116.5 mi. It is estimated that a cross-channel regulator will be required every 0.75 mi - say 155 regulators, or including subsidiary tanks in the canals, say 170 regulators at Rs 12,500 each. Total cost for 31,500 ac is therefore Rs 2,125,000, or Rs 70/ac including gates.

/b Includes outlets to fields.

B. Equipment and Vehicles

7. The estimated equipment and vehicle requirements for construction, farm operations and the extension services are listed in Annex 8, Tables 1 to 3. The tables also give the estimated cif Colombo unit costs. In addition, provision has been made for covering FEEC charges, appropriate import taxes and duties, and administrative and handling costs.

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TANK IRRIGATION MODERNIZATION PROJECT

Cost Estimates 1/

Item	Local	Foreign	Total	Local	Foreign	Total	% of Total
	(Rs Million)			(US$ Million)			
I. Civil Works							
Main and branch canals	9.5	1.5	11.0	1.3	0.2	1.5	5
Distributaries	8.7	2.3	11.0	1.2	0.3	1.5	5
Field channels	26.2	6.8	33.0	3.5	0.9	4.4	15
Drains	8.1	0.7	8.8	1.1	0.1	1.2	4
Buildings	1.1	-	1.1	0.1	-	0.1	-
Subtotal	53.6	11.3	64.9	7.2	1.5	8.7	29
II. Construction equipment and vehicles	22.5	19.5	42.0	3.0	2.6	5.6	19
III. Agricultural equipment and vehicles							
Farming equipment	16.5	20.2	36.7	2.2	2.7	4.9	16
Extension vehicles and supplies	3.0	2.3	5.3	0.4	0.3	0.7	2
Subtotal	19.5	22.5	42.0	2.6	3.0	5.6	19
IV. Technical Assistance	1.3	0.7	2.0	0.2	0.1	0.3	1
V. Engineering and Administration (15 % of I)	9.7	-	9.7	1.3	-	1.3	4
Basic Project Cost	106.6	54.0	160.6	14.3	7.2	21.5	71
VI. Physical contingencies (20% of I)	10.7	2.3	13.0	1.4	0.3	1.7	6
Subtotal	117.3	56.3	173.6	15.7	7.5	23.2	77
VII. Expected price increases	37.8	13.6	51.4	5.0	1.8	6.8	23
Total Project Cost	155.1	69.9	225.0	20.7	9.3	30.0	100

1/ Totals may not agree exactly due to rounding.

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TANK IRRIGATION MODERNIZATION PROJECT

Equipment List

Equipment and Vehicles for Construction 1/

Item	Quantity	Estimated Unit Cost (cif Colombo)	Total Cost
		(US$ '000)	
Front End Loaders 2/	9	38.0	342.0
Trucks, 5 Tons 2/	9	10.0	90.0
Dump Trucks 2.5 cu yd 2/	40	9.5	380.0
Bulldozer (65 hp) 2/	3	19.0	57.0
Bowsers for transport of fuel 2/ (1,500 gallons)	2	17.5	35.0
Agricultural Tractor (65 hp) with blade 2/	14	9.0	126.0
Agricultural Tractor (65 hp) with Trailer 2/	20	9.0	180.0
Motor graders 2/	2	46.0	92.0
4-wheel drive field cars	10	6.0	60.0
Motorcycle	25	0.5	12.5
Air Compressor 2/	5	17.0	85.0
Jack Hammers	10	1.0	10.0
Concrete Mixers 2/	25	1.5	37.5
Vibrators (Concrete) 2/	25	3.5	87.5
Generators (15 kVa) 2/	5	6.0	30.0
Sludge Pumps	10	5.5	55.0
Water pump for domestic supply	5	0.5	2.5
Rollers, Pedestrian operated 2/	20	3.0	60.0
Stone Crushers 2/	5	24.0	120.0
Workshop Equipment	Lump Sum	-	70.0
Office & Survey Equipment	"	-	40.0
Explosives	"	-	60.0
Radios	6	3.0	18.0
Automatic recorders for Parshall flumes	20 sets	1.0	20.0
Rainfall recorders and Current Meters	Lump Sum	-	10.0
Subtotal			2,080.0
Spare Parts (25%)			520.0
Total			2,600.00

1/ After the construction is completed, the following items would be retained by the ID for O&M purposes: 5 Ton Trucks (5 nos), 2.5 cu yd Dump Trucks (10 nos) Pedestrian Rollers (10 nos), 6 hp Agricultural Tractors with blades or trailers (5 nos), 4-wheel drive field cars (5 nos), Small motor Graders (2 nos) and Motorcycles (20 nos). Rest of the Equipment would be deposited to the DME's Equipment Pool.

2/ Together with 25% spares to be procured under UK assistance.

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TANK IRRIGATION MODERNIZATION PROJECT

Equipment List

Farm Equipment

Item	Quantity (Number)	Estimated Unit Cost (cif Colombo) (US$	Total Cost '000)
4-wheel tractors 1/	150	6.4	960.0
Heavy duty cultivators 1/	150	0.9	135.0
Disc plough 1/	15	1.2	18.0
Offset disc Harrows 1/	15	1.6	24.0
2 Ton Trailers 1/	150	0.9	135.0
Spare parts (25%) 1/	-	LS	318.0
Subtotal			1,590.0
2-wheel tractors	450	0.80	360.0
Rotary cultivators	450	0.30	135.0
Ploughs	300	0.35	105.0
Trailers	450	0.40	180.0
Spare parts (25%)	-	LS	195.0
Subtotal			975.0
Equipment for repair and maintenance facilities 1/	-	LS	75.0
Sprayers	-	LS	60.0
Total			2,700.0

1/ To be procured under UK assistance.

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TANK IRRIGATION MODERNIZATION PROJECT

Equipment List

Equipment and Vehicles for Extension Service

Item	Quanity	Estimated Unit Cost (cif Colombo)	Total Cost
		---------(US$'000)--------	
4-wheel drive field cars	20	6.0	120.0
Motorcycle	50	0.5	25.0
Bicycles	150	0.1	15.0
Mini buses	2	5.0	10.0
Teaching Aids and equipment	Lump Sum	-	30.0
Sub Total			200.0
Spare Parts (25%)	-	-	50.0
Total			250.0

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TANK IRRIGATION MODERNIZATION PROJECT

Schedule of Expenditures

	Total Cost	Years 1976	1977	1978	1979	1980
	(Rs Million)					
1. Civil Works						
Tank Modernization	64.9	-	11.5	18.6	21.4	13.4
Physical contingencies	13.0	-	2.3	3.7	4.3	2.7
Subtotal	77.9	-	13.8	22.3	25.7	16.1
Expected price increases	32.4	-	2.5	7.2	12.3	10.4
Subtotal	110.3	-	16.3	29.5	38.0	26.5
2. Construction equipment						
Machinery and vehicles	42.0	12.6	29.4	-	-	-
Expected price increases	4.5	1.0	3.5	-	-	-
Subtotal	46.5	13.6	32.9	-	-	-
3. Agricultural equipment & vehicles						
Equipment and vehicles	42.0	2.1	10.6	11.0	11.0	7.3
Expected price increases	10.8	0.2	1.5	2.5	3.5	3.1
Subtotal	52.8	2.3	12.1	13.5	14.5	10.4
4. Technical Assistance	2.0	0.2	0.5	0.5	0.4	0.4
5. Engineering management and administration	9.7	1.3	2.0	2.2	2.2	2.0
Expected price increases	3.7	0.1	0.4	0.7	1.1	1.4
Subtotal	13.4	1.4	2.4	2.9	3.3	3.4
6. Total Project Cost						
Rupees (million)	225.0	17.5	64.2	46.4	56.2	40.7
US$ (million)	30.0	2.3	8.6	6.2	7.5	5.4

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TANK IRRIGATION MODERNIZATION PROJECT

Proposed Allocation of the Aid Package

Category	Amount Allocated (US$ million)			% of Expenditure to be financed		
	Total	IDA	UK	Total	IDA	UK
(i) Civil Works (including construction materials procurred locally)	3.0	1.5	1.5	24	12	12
(ii) Equipment vehicles and spares earmarked for UK financing	4.5	-	4.5	100 1/	-	100 1/
(iii) Equipment vehicles and spares (other than those under category (ii)	1.9	1.9	-			
(a) Directly Imported				100 1/	100 1/	-
(b) Locally Procurred				50	50	-
(iv) Technical Assistance	0.1	0.1	-	100 1/	100 1/	-
(v) Unallocated	1.5	1.5	-			
Total	11.0	5.0	6.0			

1/ Of foreign expenditures only.

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TANK IRRIGATION MODERNIZATION PROJECT

Schedule of Disbursements

IDA Fiscal Year and Semester	Accumulated Disbursements (US$ million)		
	Total	IDA	UK
1977			
1st	0.5	0.1	0.4
2nd	2.5	0.5	2.0
1978			
1st	4.0	1.3	2.7
2nd	5.5	2.0	3.5
1979			
1st	7.0	2.7	4.3
2nd	8.0	3.2	4.8
1980			
1st	9.0	3.7	5.3
2nd	10.0	4.2	5.8
1981			
1st	10.5	4.6	5.9
2nd	11.0	5.0	6.0

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TANK IRRIGATION MODERNIZATION PROJECT

Operation and Maintenance

1. The rotational irrigation proposed under the project would be a major departure from the present free flow method. Accordingly, a significant improvement in the present O & M standards would be a prerequisite for realizing the full project benefits.

2. The Irrigation Department (ID) would be responsible for the O & M of the project irrigation works down to the 50 ac level. Below that level, O & M would be undertaken by the CCs under the direction of APCs (Annex 4). The ID would also oversee the O & M of the 50 ac irrigation service areas and report deficiencies to the APCs. The APCs would delegate their water control powers to ID as necessary. A water management specialist provided for a two-year period would assist the ID, APCs and CCs (para 12).

3. The ID would organize an O & M unit for each tank irrigation area. Staffing, equipment and budgetary allocation requirements, for a typical 6,000 ac area, are given in Table 1. The estimated annual O & M costs would be about Rs 75 per ac.

Present Irrigation System Operation

4. The existing tank conveyance systems are designed to supply supplemental irrigation for the maha (paddy) crop. Sowing of the crop is delayed until the tanks are filled by the maha rains to a predetermined level. Following sowing, water is continuously released to the planted areas. Irrigation deliveries supplement the rainfall to provide standing water in the paddies. To the extent that water is available in the tanks at the end of the maha season, the area of the yala crop is determined and irrigated in a similar manner. In dry years, the delay in sowing the maha, coupled with a short monsoon season, results in a heavy draft on the tanks. Also, because of the farmers' present sowing practices, the project area is checkerboarded with fields in different stages of production creating demands on storage water that are physically difficult to meet.

Projected Irrigation System Operation

5. The conveyance system capacity would be increased so as to deliver three inches of water to a 3 ac farm in nine hours. Projected crops for the tank project areas are paddy on all project lands during the maha season, and paddy for the lowlands (40% of area) and field crops for the uplands (60% of area) during the yala season. Irrigation would be intermittent and would not allow for standing water in the fields.

6. The feasibility of the proposed method has already been demonstrated in two other irrigation schemes in Sri Lanka. In those schemes water was released from the tank to provide alternatively four days of continuous irrigation followed by four days with no water. This practice was ultimately accepted by the water users and gave greater crop yields than the continuous flood irrigation.

7. Taking into account the rainfall pattern, the soil moisture capacity of the soils (about 1.0 to 1.6 inches per ft over the 2 ft root zone) and the crop water requirements for paddy (Annex 5), a probable maha irrigation delivery program would be:

-- one, six inch irrigation to the field for land preparation during late September and October;

-- complete preparation of all land and planting within a five-week period (110 day variety); and

-- it would provide supplemental irrigation water as follows:

(a) beginning on the sixth day of no precipitation following any rainfall of two inches or more make tank releases for the total project area on a continuous flow basis for a two day period (representing 2.4 inches delivered to the field) followed by six days without water repeating until a rain of at least two inches occurs, or

(b) beginning on the fifth day of no precipitation following any rainfall of two inches or more make tank releases to provide three inches of water at the field on a seven day rotation (daytime irrigation only) until a rain of at least two inches occurs.

8. In the yala season, when effective rainfall is limited to March and April, a probable full rotational irrigation delivery program for the yala lowland paddy area would be:

-- one six inch irrigation to the fields for land preparation during late February and March;

-- completion of preparation of all project land and crop planting within four weeks (90-100 day variety);

-- delivery of about three inches of water on a seven day rotation following planting;

-- stopping releases from tanks for a period of seven days following a rainfall of three inches or more;

-- resumption of delivery of three inches of water on a seven day rotation schedule six days following any three inch rainfall occuring as a continuous event;

-- delivery of about eleven 3-inch irrigations during the season, and

-- cease irrigation 15 days before harvest.

9. A modified program would be utilized for irrigation of yala pulse and cereal crops as follows:

-- one six inch irrigation to the field for land preparation during late February and March;

-- completion of a land preparation and planting within a four week period;

-- delivery of three inches of water on a ten day rotation during March, April and May;

-- cease releases from tanks for a period of seven days following a rainfall of two inches or more;

-- delivery of three inches of water during June.

10. The above irrigation programs are merely indicative. For developing the exact water release schedules and irrigation intervals best suited to local conditions, it is essential that qualified staff of the Maha Illupalama Research Station should conduct field experiments in the tank areas themselves.

Service Roads

11. The O & M of the service roads along the canals would be the responsibility of the ID.

Training for Project O & M

12. The project would finance an irrigation water management specialist for a two-year period to train personnel of both the ID and the farmer groups. The specialist would:

(a) have at least ten years of experience in monsoon area irrigation;

(b) have managed, operated and maintained an irrigation project, and

(c) be able to set conveyance system design criteria and furnish details and design requirements for measuring and water control devices.

13. The specialist's Terms of Reference would be to:

(a) assist the ID in design of the project conveyance system, including measuring and control features extending from the tank to the farm delivery turnout;

(b) assist and train project personnel in developing tank operating programs to meet projected crop demands and in operating the conveyance system to provide satisfactory and efficient deliveries to the land;

(c) assist and train project personnel in scheduling and executing maintenance routines, preventive maintenance and repairs;

(d) assisted by the SMSs assigned to him, and in consultation with the Irrigation and Water Management Specialist of the Irrigation Department, collect relevant information on rates of infiltration in different parts of the project area and from it develop model field layouts for the different crops and soils. The alignment of irrigation and drainage channels, the length of runs with reference to slope, soils etc., will form part of the models;

(e) develop a methodology within the farmers' ability for the construction of the field channels and drains and including field layout and land shaping.

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TANK IRRIGATION MODERNIZATION PROJECT

OPERATION AND MAINTENANCE

Staff Requirements for a 6,000 ac Module Area

Staff Position	No.	Salary/yr (Rs)	Total Cost (Rs)
Engineer	1	12,000	12,000
Technical Assistant	2	6,000	12,000
Maintenance Overseer	4	3,500	14,000
Maintenance Laborer	40	2,500	100,000
Driver	5	3,000	15,000
Store Keeper	1	2,000	2,000
Clerk	1	2,000	2,000
Sub-total			157,000
Leave and Travel 20%			31,000
Total			188,000

Equipment Requirements for a 6,000 ac Module Area

Item	No.	Hrs/year	Cost/hr (Rs)	Total Annual Operating Cost (Rs)
5-ton Truck	1	1,000	40	40,000
Agricultural Tractor	1	1,000	35	35,000
Dump Truck	2	1,000	20	40,000
4-wheel Drive Field Car	1	2,000	25	50,000
Motorcycle	4	2,000	6	48,000
Pedestrian Roller	1	1,000	10	10,000
Total Annual Operating Cost				223,000
Contingencies 10%				22,000
GRAND TOTAL				433,000

Say Rs 450,000

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TANK IRRIGATION MODERNIZATION PROJECT

Prices for Economic and Financial Analyses

General

1. The estimated future farm gate price of rice, maize, sorghum and agricultural inputs are derived from projected 1985 world market prices in 1976 currency values with appropriate adjustments for freight, handling and processing. Production of other crops such as pulses and vegetables is relatively small and most of the output is consumed locally. Projected farm gate prices for these products are based on the typical ratio between their prices and the price of rice.

2. In recent years, because of severe shortages, foodgrains and fertilizers have commanded unusually high prices in the world markets. In order to isolate the effects of the project from the effects of these temporary fluctuations, projected 1985 prices are used both for present and projected future farm budgets.

Exchange Rate

3. The Sri Lanka Rupee is officially pegged to the Pound Sterling at a parity rate of £ 1 = Rs 15.60 (approximately US$1.00 = Rs 7.50). 1/ However, to promote "non-traditional" exports and to cut-down on non-essential imports, the Government practices a dual exchange rate system through the sale and purchase of Foreign Exchange Entitlement Certificates (FEECs). Currently, about 20% of merchandise exports and about 60% of merchandise imports are subject to the FEEC rate of about US$1.00 = Rs 12.40. Despite this, Sri Lanka has faced severe balance of payments problems for the past several years. The country is also experiencing widespread shortages of essential materials, spare parts and capital equipment. In view of these, the official exchange rate clearly understates the real value of foreign exchange to the Sri Lanka economy. Absence of any economy-wide models and the presence of a complicated system of import restrictions and excise duties makes it difficult to estimate the true opportunity cost of foreign exchange. The unofficial market rate of US$1.00 = Rs 15.00 may be taken as an upper limit, but it partially reflects the demand for luxury imports and for capital flight. A rate of US$1.00 = Rs 12.00 (roughly equal to the current FEEC rate) is perhaps a more reasonable estimate of the value of foreign exchange to the Sri Lanka economy. Accordingly, the economic analysis is based on this assumption. To test the sensitivity of the economic viability of the project to this assumption, the analysis has also been done assuming a 25% error in this estimate.

1/ At the time of appraisal.

4. In line with the prevailing Government policy on paddy procurement prices, the estimated crop prices for farm budgets are based on an exchange rate which is in between the official and the FEEC exchange rates i.e. about US$1.00 = Rs 9.00.

Crops

5. Rice: The projected 1985 price used as a basis for economic and financial analyses is US$235 per metric ton of low-to-medium quality rice (25% - 35% broken) fob Bangkok. 1/ This represents a sharp decline from the shortage-related prices which have recently averaged more than US$400 per metric ton. Adding shipping and insurance costs results in a projected price of US$265 per metric ton cif Colombo. To this are added the estimated average handling, transportation and marketing costs between Colombo and the likely "deficit areas" resulting in an estimated local market price for milled rice of US$300 per ton. Deducting US$25 per ton as the costs of the marketing processing and transportation between the farm and the urban areas close to the project, gives a farm gate price of US$275 per ton rice equivalent. For an estimated milling yield of 65%, 2/ this is equivalent to a paddy farm gate price of about US$180.

6. Cereals (Maize & Sorghum): The 1985 fob Gulf ports prices for maize and sorghum are projected to be about US$110 and US$95 (1976 dollars) per ton, respectively. Assuming a 50-50 mix of the two cereals in project area production and adjusting the fob prices for shipping, insurance handling, marketing and processing, gives an equivalent farm gate price of about US$140 per ton.

7. Pulses: Since pulses are not traded internationally in any appreciable quantity, the Bank Group does not put out a price projection for them. Historical comparisons of rice prices with those for pulses in Sri Lanka and in the neighboring countries indicate that the price ratio remains fairly stable, with pulses commanding a 50-70% premium over the paddy prices. Somewhat conservatively, an average price of US$270 per ton (a 50% premium over paddy price) is assumed in the analysis of this project.

Crop Inputs

8. Fertilizers: It is projected that the 1985 fertilizer prices would be substantially below the unusually high prices experienced during

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1/ The Bank's Economic Analysis and Projections Department's latest forecast for 1985 is US$335 (1976 dollars) per metric ton of high quality rice (5% brokens). The price for low-to-medium quality rice is assumed to be 70% of the price for high quality rice.

2/ This is lower than the 70% yield assumed by the PMB since the rice supplied by the PMB has to be reprocessed before consumption.

the last few years. The price for nitrogen nutrient (fob Persian Gulf) is expected to decline from about US$650 to US$350 per ton; for phosphate nutrient (fob Morocco) from US$720 to US$470 per ton, and for potassium nutrient (fob Vancouver) from US$120 to US$95 per ton. Shipping, insurance, handling and local marketing would add an average of about US$80 per ton nutrient. Accordingly, the per ton farm gate prices for the three nutrients are estimated to be US$430, US$550 and US$175, respectively. For both the commonly used basal mixture of 3-30-13 NPK and for urea (46% N), used as top dressing, the price would be about US$200 per ton.

9. Land Preparation: Much of the land preparation work in the area is done on a custom basis. The current rental charges of Rs 60 per hour for 4-wheel tractors, Rs 15 per hour for 2-wheel tractors, and Rs 10 per day for a pair of buffaloes are considered reasonable and are used as such in the farm budget analysis. For economic analysis, the rental charge for two-wheel tractors is increased to Rs 20 per hour as they are imported without the imposition of FEEC charges.

10. Farm Labor: In the farm budget analysis, the prevailing average wage rate of Rs 8 per day is used for all hired labor. However, in view of the unemployment and underemployment situation prevailing in the area, the market wage rate is considered inappropriate for economic analysis. Accordingly, the economic cost of all farm labor (family as well as hired) is based on a seasonally adjusted opportunity cost in terms of output foregone in alternative employment. The details of the analysis are given in Annex 13.

11. Table 1 of this Annex gives a summary of the various economic and financial prices.

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Prices for Economic and Financial Analysis

Item	Prices	
	Economic	Financial
Crops		
Paddy (Rs/Ton)	2,160	1,620
Cereals (Rs/Ton)	1,680	1,260
Pulses (Rs/Ton)	3,240	2,430
Fertilizers		
Basal (Rs/Ton) (3-30-13 NPK)	2,400	1,500
Urea (Rs/Ton) (46% N)	2,400	1,500
Land Preparation		
4-wheel Tractor (Rs/hr)	60	60
2-wheel Tractor (Rs/hr)	20	15
Buffaloes (Rs/day)	10	10
Farm Labor (Rs/day)	* 1/	8

1/ See Annex 13.

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Crop Inputs and Farm Budgets

General

1. Present agricultural practices in the project area and the expected overall changes in cropping patterns, yields and production due to the project are described in Annex 3. This Annex discusses the impact on the individual farm. The purposes of this micro analysis are:

(i) to estimate the farm incomes for representative farm sizes in order to determine whether the prospective increases in farm income would be sufficient to compensate the farmer and his family for the additional effort and for other production costs they would have to incur;

(ii) to determine the distributional impact of the project and to compare the income levels of the project area farmers with those of farmers in other areas, and

(iii) to analyze the effects of different Government policies regarding water charges.

2. Choice of Farm Models. Insofar as the farm sizes and the cultivation methods are the same under the five tanks, the only variable to be reflected in the analysis is the water availability -- both at present and as expected under future "with" and "without" project conditions. Three models have been chosen for this purpose: the first model represents the three tanks with the best water supply (Mahakanadarawa, Padaviya and Mahawilachchiya), the second model represents the Vavunikulam tank which has a somewhat poorer water supply and the third model represents the Pavatkulam tank which has the poorest water supply. In each model, 3 ac of irrigated land was assumed and both cropping patterns and yields were adjusted to reflect variations in present and prospective water availability and project management.

3. The analysis assumes the following:

(a) Crop Input Requirements: Present and projected unit input requirements are given in Tables 1 and 2. The estimated current levels of inputs are based on the agro-economic surveys conducted during project preparation as well as on the information obtained from the local administrations, the Department of Agriculture and several other surveys in

similar areas of Sri Lanka. Some improvements in farming practices are assumed for future "without project" conditions. Future "with project" requirements are based on recommendations by the Department of Agriculture and on observed cultural practices of the progressive farmers of the area. The future estimates assume that land preparation would be fully mechanized under the "with project" conditions.

(b) Crop Yields: The yields used in the three farm models are taken to be the average yields for the respective tanks (Annex 3, Table 1).

(c) Prices and Subsidies: The prices used in the analysis are the "financial" farm gate prices discussed in detail in Annex 11. The crop prices are derived on the assumption that to promote food self-sufficiency, the Government would keep the Guaranteed Support Prices at 20% above the corresponding import prices (at the official exchange rate). Crop inputs prices (particularly, the fertilizers) assume the elimination of all subsidies.

(d) Hired Labor: The estimated hired labor requirements (about 20% of the total) are costed at the average market wage rate of Rs 8 per day. No value is put on family labor.

Farm Incomes and Incentives

4. Farm incomes on an annual cash flow basis for the three farm models detailed in Table 3, are summarized below:

	Net Farm Income /a (Rs)		
	Model I	Model II	Model III
Present	2,850	3,100	2,250
Future "without" Project	3,950	4,050	2,800
Future "with" Project	7,650	7,100	5,900
% increase over			
(a) Present	168	129	162
(b) Future "without" Project	94	75	116

/a Before deducting water charges and payments under the Sale of State Lands Act.

Thus, it is estimated that the present farm incomes would be more than doubled for all three farm models. These increases are considered to be sufficient incentives for getting the cooperation and participation of the project area farmers.

Distributional Impact

5. The landholding pattern in the project area is rather uniform and as a result, the income levels are fairly even. Whatever income disparities do exist, are largely due to the variations in the quality of irrigation facilities utilized by the various farmers. However, even this difference is partially compensated, since the farmers with inadequately irrigated lands divert more effort to 'chena' cultivation, and increase their income from that source. It is projected that the income levels within the project area would continue to be essentially uniform, even "with" the project.

6. In comparing the project area income levels with the average national income, it is necessary to take into account the farmers' income from sources other than irrigated agriculture. Unfortunately, however, there are no reliable data on this. It is generally agreed though, that the farmers do earn substantial incomes, perhaps about Rs 1,500 per year, from chena cultivation and the cultivation of fruits and vegetables in their homestead plots. Furthermore, if one takes into account the imputed value of other goods and services (e.g. rent on homestead) and differentials in purchasing power it is likely that the farm households have a total net annual income of about Rs 6,000, or a per capita annual income of Rs 800. This is about 80% of the national per capita disposable income of about Rs 1,000 per year. Assuming that the income from other sources remains constant, at full development, the average household income in the project area would increase to about Rs 10,000. Taking into account the population increase during the intervening period, this would mean a per capita income of about Rs 1,100. Assuming that the national per capita disposable income increases about 2% annually, at full development, the project area incomes would be approximately the same as the national level.

Recovery of Project Costs

7. At a discount rate of 10% per annum, the present value of the project investments (in economic terms) is estimated to be about Rs 97 million or about Rs 3,100 per ac. In addition, the O & M of the irrigation system would require an annual expenditure of about Rs 75 per ac. Assuming that the water charges were introduced in phase with the construction schedule but with a grace period of one year, it would require an average annual charge of Rs 625 per ac 1/ -- Rs 550 for recovery of capital costs and Rs 75 for O & M costs -- to fully recover all the expenditures on this project. These charges would represent about 50-60% of the net incremental farm income (before accounting for family labor), at full development. During the development period when the production is below the full potential, the proportion would be even higher.

8. For analyzing the farmers' ability and willingness to pay water charges, it is necessary to estimate the 'project rent'. Simply stated, the project rent is the incremental net income when all factors of production

1/ In constant 1976 prices.

except project supplied services have been paid the returns necessary for their cooperation. In the absence of uncertainty (about yields, crop prices), the project rent would be the net incremental farm income less the necessary rewards to family labor and management for their additional effort.

9. Recently, GOSL enacted a crop insurance legislation (Annex 4) and this should largely eliminate the uncertainty about the returns to the farmers. However, it is assumed that a 10% reduction in the expected gross farm income is necessary to arrive at the certainty equivalent.

10. In economic literature, there is a considerable amount of controversy about appropriate returns for family labor and management. Conservatively, in the following analysis, all family labor is valued at the average market wage rate of Rs 8 per day. An additional 10% of the net incremental income is allocated to farm management.

11. On this basis, the project rent per acre for the three farm models is estimated to be between Rs 720 and 820 per year (Table 4). Since these estimates are based on "typical" farms, they do not take into account the variations in land and human resources for the various farms. Allowing a 10% margin for such variations, a reasonable upper limit for the potential water charges would be about Rs 650 to 750 per ac. This level should be adequate to recover approximately all project costs.

12. While in theory it should be feasible to recover all costs, in the overall socio-economic context it may be better to impose somewhat lower charges. This is because: (a) the income levels of the project area farmers are somewhat below the national average; (b) traditionally, farmers in Sri Lanka have not been required to pay for irrigation water and an abrupt policy change would be difficult to implement politically; (c) because of the prototype nature of the project, there is a need to persuade the farmers to adopt the proposed notational irrigation; and (d) through differentials between the crop procurement prices and their "economic" prices, the Government would, in any case, indirectly regain a large part (about 50%) of the total project cost. In view of these, water charges at an average rate of Rs 300 (in constant 1976 values), would be more appropriate. These charges would represent the following recovery indices:

Cost Recovery Index 1/	:	48%
Benefit Recovery Index 2/	:	20-25%
Rent Recovery Index 3/	:	37-42%

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1/ Cost Recovery Index: Ratio of water charges to annualized O&M and capital costs.

2/ Benefit Recovery Index: Ratio of water charges to net incremental farm income.

3/ Rent Recovery Index: Ratio of water charges to project rent.

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TANK IRRIGATION MODERNIZATION PROJECT

Crop Input Requirements (per acre)

	Paddy			Cereals			Pulses		
	P	$\bar{W}$	W 1/	P	$\bar{W}$	W	P	$\bar{W}$	W
Land Preparation 2/									
4-wheel tractor (hrs)	2	2	2	1.5	1.5	1.5	1.5	1.5	1.5
2-wheel tractor (hrs)	-	-	2	-	-	1.5	-	-	2
buffaloes (days)	1	1	-	1	1	-	0.5	1	-
Fertilizers									
basal (lbs)	30	60	120	-	-	60	-	60	120
top dressing (lbs)	60	90	180	-	60	120	-	-	-
Agro-chemicals (Rs)	15	25	35	-	10	20	-	10	20
Seeds (lbs)	90	90	90	20	20	20	35	35	35
Crop insurance (Rs)	30	30	30	-	30	30	-	30	30
Miscellaneous 3/ (Rs)	50	60	80	30	40	50	40	50	60
Manual labor 4/ (days)	55	55	55	33	33	33	33	33	33

1/ P = Present, $\bar{W}$ = future without project, W = future with project

2/ Project conditions will bring about the replacement of buffaloes by tractors for all land preparation work

3/ Excludes rent and water charges.

4/ Labor requirements for rice and cereals under future situations are expected to remain as at present. There will be reductions in labor as a result of shifting from buffaloes to tractors for seedbed preparation. This is assumed to compensate for the additional labor required for harvesting and threshing resulting from higher yields.

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TANK IRRIGATION MODERNIZATION PROJECT

Monthly Labor Requirements for Various Crops 1/ 2/

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Paddy (Maha)	P	5	8	5	2	-	-	-	2	9	12	7	5	55
	W	10	8	5	-	-	-	-	3	15	7	4	3	55
Paddy (Yala)	P	2	10	12	7	5	12	4	3	-	-	-	-	55
	W	3	15	7	4	3	9	8	5	-	-	-	-	54
Cereals (Maha)	P	3	4	5	-	-	-	-	-	4	9	4	4	33
	W	6	5	-	-	-	-	-	3	6	4	4	3	33
Cereals (Yala)	P	4	9	4	4	3	4	5	-	-	-	-	-	33
	W	3	8	4	4	3	6	5	-	-	-	-	-	33
Pulses (Maha)	P	-	-	-	-	-	-	-	-	-	-	-	-	-
	W	9	2	-	-	-	-	-	-	7	5	4	6	33
Pulses (Yala)	P	7	5	4	6	9	2	-	-	-	-	-	-	33
	W	7	5	4	6	9	2	-	-	-	-	-	-	33

1/ P: Present, W: Future with Project

2/ The future labor requirements without the projects are projected to remain as at present.

ANNEX 12
Table 2

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TANK IRRIGATION MODERNIZATION PROJECT

Farm Budget 1/

	Farm Model I 2/			Farm Model II 3/			Farm Model III 4/		
	P	$\overline{W}$	W	P	$\overline{W}$	W	P	$\overline{W}$	W
Cropped Area (ac)									
Maha - Paddy	2.3	2.3	2.8	2.3	2.3	2.9	2.4	2.4	2.8
- Cereals	-	0.1	0.2	-	0.1	0.1	-	0.1	0.2
- Pulses	-	-	-	-	-	-	-	-	-
Yala - Paddy	0.7	0.7	1.2	0.8	0.8	0.6	0.1	0.1	0.3
- Cereals	-	-	0.3	-	-	0.3	-	-	0.1
- Pulses	0.1	0.1	0.5	0.1	0.1	0.5	0.1	0.2	0.2
Total	3.1	3.2	5.0	3.2	3.3	4.4	2.6	2.8	3.6
Cropping Intensity (%)	103	107	167	107	110	147	87	93	120
Crop Production (Tons)									
Paddy	2.5	3.3	5.7	2.7	3.4	5.2	2.0	2.4	4.6
Cereals	-	0.08	0.51	-	0.08	0.42	-	0.08	0.29
Pulses	0.04	0.04	0.33	0.04	0.04	0.33	0.04	0.07	0.13
Gross Production Value (Rs)	4,150	5,550	10,700	4,450	5,700	9,800	3,350	4,150	8,150
Production Costs (Rs)									
Non-labor inputs	1,050	1,300	2,650	1,100	1,350	2,350	900	1,100	1,950
Hired labor	250	300	400	250	300	350	200	250	300
Total	1,300	1,600	3,050	1,350	1,650	2,700	1,100	1,350	2,250
Net Farm Income (Rs)	2,850	3,950	7,650	3,100	4,050	7,100	2,250	2,800	5,900

1/ P = Present, $\overline{W}$ = Future without Project, W = Future with Project

2/ Mahakanadarawa, Padaviya and Mahawilachchiya

3/ Vavunikulam

4/ Pavatkulam

ANNEX 12
Table 3

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TANK IRRIGATION MODERNIZATION PROJECT

Project Rent For the Three Farm Models 1/

		Farm Model I		Farm Model II		Farm Model III	
		$\overline{W}$	W	$\overline{W}$	W	$\overline{W}$	W
(i)	Expected Gross Production value 2/ (Rs)	5,550	10,700	5,700	9,800	4,150	8,150
(ii)	Certainty Equivalent of (i) (Rs)	5,000	9,650	5,150	8,800	3,750	7,350
(iii)	Crop Inputs 2/, 3/ (Rs)	1,600	3,050	1,650	2,700	1,350	2,250
(iv)	Family Labor (Rs)	1,100	1,600	1,150	1,400	950	1,200
(v)	Net returns 4/ (Rs) (ii) - (iii) - (iv)	2,300	5,000	2,350	4,700	1,450	3,900
(vi)	Management Fee (Rs) 10% of (v)	250	500	250	450	150	400
(vii)	Net Farm Returns (Rs) (v) - (vi)	2,050	4,500	2,100	4,250	1,250	3,500
(viii)	Project Rent (Rs)	2,450		2,150		2,250	
(ix)	Project Rent per acre (Rs)	820		720		750	
(x)	Rent Recovery Index (%) with charges set at Rs 300 per ac	37		42		40	

1/ $\overline{W}$ = without Project, W = with Project
2/ From Table 3
3/ Excluding family labor and management
4/ Before management fee.

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TANK IRRIGATION MODERNIZATION PROJECT

Economic Analysis

Assumptions

1. The economic analysis is based on the following assumptions:

(a) Prices: The farm gate prices used in the economic analysis are derived from projected 1985 world market prices expressed in 1976 currency values. Appropriate adjustments have been made for freight, handling and processing. A shadow exchange rate of US$1.00 = Rs 12.00 is used to reflect the scarcity of foreign exchange. The price assumptions are discussed in more detail in Annex 11.

(b) Benefits: The extension service provided under the project would cover the whole of Anuradhapura District and accordingly would have beneficial effects in areas other than the five tank areas. The improvements in the road network would lower the transportation costs. The project would also have substantial secondary income and employment effects in processing industries and trade and transport. In this analysis, however, only increased crop production due to the project in the five tank areas is counted as a project benefit. Expected crop yields, acreages and production are shown in Annex 3, Table 1. The gross benefits are summarized in Table 1 of this Annex.

(c) Crop Production Costs: Per acre crop input requirements are shown in Annex 12, Table 1. Crop production costs are summarized in this Annex on Table 2.

(d) Pricing of Labor: Based on an equivalent of three full time adults per household, working an average of 250 days per year, the total farm labor availability for the 10,500 farm households in the project area is estimated at about 7.9 million man-days, or an average monthly availability of about 0.65 million man-days. Estimates of the total monthly labor requirements, taking into account the cropping patterns (Annex 3, Table 1) and monthly per acre labor requirements for various crops (Annex 12, Table 2) are shown in Table 3 of this Annex. Thus, presently there is an annual need for about 1.8 million man-days compared to an estimated availability of 7.9 million

man-days. Even in the "peak" month of October, the monthly demand is less than 50% of the availability. At full development in 1986, "without" the project the total labor demand would remain practically unchanged, while the supply is likely to increase by about 20% through population increase, resulting in a further deterioration of the employment situation. "With" the project, the annual labor demand would increase to about 2.4 million man-days, an increase of about 33% over the present. However, this would still leave a large amount of surplus labor. Undoubtedly, cultivation of 'chena' land and upland homestead plots partially relieve the unemployment pressure. Nevertheless, the prevailing average wage rate of Rs 8 per day is considered to be overstating the economic opportunity cost of farm labor. Accordingly, for the economic analysis, the incremental farm labor requirements were valued at Rs 4 per day for the period April to August and Rs 6 per day for rest of the year. On this bases, the total cost of the incremental farm labor requirements of 0.58 million man-days is estimated at Rs 3.3 million or an average of Rs 5.7 per man-day. This rate is about 70% of the prevailing market wage rate of Rs 8 per day. Unskilled construction labor has been valued at the market rate.

(e) Investment Costs: All project costs except price contingencies (Rs 51.4 million), cost of farming equipment 1/ (base cost, Rs 36.7 million) and taxes and duties (Rs 30.5 million) 2/ are included in the economic analysis. On this basis, the investment costs are estimated at Rs 106.4 million of which Rs 36.0 million are in foreign exchange (Annex 7, Table 1). Shadow pricing the foreign exchange component results in an estimated "economic" cost of Rs 128.0 million. Conservatively, no salvage value was assumed for the construction equipment even though some of the equipment is expected to be useable after project completion.

(f) Operation and Maintenance: The annual O & M costs for the irrigation system are expected to increase from about Rs 25 per ac at present to about Rs 75 per ac with the project, or a total annual increment of about Rs 1.6 million. The strengthened extension service would add a further Rs 1.4 million to the operating expenses, leading to a total annual O & M cost of Rs 3.0 million. These costs are used as a cost stream against the project benefits.

1/ Depreciation and O & M of farm equipment (tractors and sprayers) is included as a recurrent crop production cost.

2/ This figure differs from the one in the text (para 4.10) as taxes and duties in the amount of Rs 20.0 million are included in the price contingencies and the base cost of farm equipment.

(g) Development Phasing: Implementation would be phased over five years. It is assumed that full project benefits would be achieved five years after project implementation. The overall phasing of the benefits is estimated to be as follows:

Year	1	2	3	4	5	6	7	8	9	10	11
Net benefitss (% of full development benefits)	0	5	15	35	50	65	75	85	90	95	100

Economic Rate of Return

2. Resulting costs and benefit streams are shown in Table 4. Assuming a 30-year project life, the economic rate of return is estimated to be 23%.

Sensitivity Analysis

3. The most serious risk to the project would result from the possibility that the rotational irrigation proposed under the project would not be fully accepted by the farmers resulting in a lower irrigation efficiency and hence a reduced cropping intensity. Annex 3, Table 2 shows the alternative cropping patterns likely to prevail in case the project irrigation efficiency goes down from 55% to 40%. The resulting cropping intensity would go down to about 125%. Sensitivity tests indicate that the economic rate of return would still be about 14% and the project would remain viable.

4. Further tests were made to determine the sensitivity of the rate of return estimates to various alternative assumptions about costs and benefits. The tests indicate the following:

	Alternative	Rate of Return
(i)	Basic case	23%
(ii)	Foreign exchange valued at US$1.00 = Rs 9.00	20%
(iii)	Foreign exchange valued at US$1.00 = Rs 15.00	25%
(iv)	Farm labor valued at the market wage rate of Rs 8.00 per man-day	22%
(v)	A decrease of 25% in net incremental benefits	18%
(vi)	An increase of 25% in project investment costs	19%
(vii)	A slower development of project benefits /a	20%
(viii)	Combination of (v) and (vi)	15%
(ix)	Combination of (vi) and (vii)	17%
(x)	Combination of (v), (vi) and (vii)	13%

/a Assumed phasing of benefits:

Year	1	2	3	4	5	6	7	8	9	10	11	12	13
Net benefits (% of full development benefits)	0	0	10	25	40	50	60	70	80	85	90	95	100

Thus, the project's rate of return is moderately sensitive to changes in costs, benefits and the build-up of project benefits. However, even in the unlikely event that project costs are 25% higher, net benefits are 25% lower and the build-up of project benefits is considerably slower, the project would still be viable.

Analysis of Individual Tanks

5. Tests were also made to determine the viability of each tank on its own. These tests indicated that the rate of return for the individual tanks varied from a high of 29% for the Mahawilachchiya tank to a low of 20% for the Padaviya and the Pavatkulam tanks. Thus, all five tank schemes are viable on their own.

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TANK IRRIGATION MODERNIZATION PROJECT

Annual Gross Benefits (Economic) 1/

Item	Price (Rs/Ton)	Production ('000 tons) $\bar{W}$	W	Increment	Gross value (Rs million) $\bar{W}$	W	Increment
Paddy	2,160	34.32	59.83	25.51	74.0	129.0	55.0
Cereals	1,680	0.88	4.36	3.48	1.5	7.3	5.8
Pulses	3,240	0.52	2.76	2.24	1.7	9.0	7.3
Sub-total					77.2	145.3	68.1
Less 5% losses in transport and handling					-3.9	-7.3	-3.4
Annual Total					73.3	138.0	64.7

1/ $\bar{W}$ = Future without project
W = Future with project

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TANK IRRIGATION MODERNIZATION PROJECT

Annual Crop Production Costs (Economic)[1/]

	Price	Quantity Used $\bar{W}$	Quantity Used W	Quantity Used Increment	Economic Cost $\bar{W}$	Economic Cost W	Economic Cost Increment
					------(Rs million)------		
Land Preparation							
4-wheel Tractors ('000 hrs)	Rs 60/hr	67.2	94.0	26.8	4.0	5.6	1.6
2-wheel Tractors ('000 hrs)	Rs 20/hr	-	96.0	96.0	-	1.9	1.9
Buffaloes ('000 days)	Rs 10/day	34.2	-	-34.2	0.3	-	-0.3
Fertilizer (Tons)							
Basal (3-30-13 NPK)	Rs 2,400/Ton	900	2,560	1,660	2.1	6.1	4.0
Urea (46% N)	Rs 2,400/Ton	1,330	3,550	2,220	3.2	8.5	5.3
Agro-Chemicals	-	-	-	-	0.8	1.6	0.8
Seeds (Tons)							
Paddy	Rs 2,160/Ton[2/]	1,300	1,660	360	2.8	4.3	1.5
Cereals	Rs 1,680/Ton[2/]	10	40	30	-	0.1	0.1
Pulses	Rs 3,240/Ton[2/]	20	70	50	0.1	0.3	0.2
Farm Labor (million man-days)	Rs 5.7/day[3/]	1.81	2.39	0.58	10.3	13.6	3.3
Miscellaneous	-	-	-	-	2.0	3.7	1.7
Total Crop Production Costs					25.6	45.7	20.1

Annual Net Benefits = (64.7 - 20.1) = Rs 44.6 Say Rs 45 million

1/ $\bar{W}$ = Future without project
W = Future with project
Increment = W - $\bar{W}$

2/ For "without" project case. A 20% premium is assumed for "with" project case to account for improved quality.

3/ See para 1 (d) and Table 3 for details.

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TANK IRRIGATION MODERNIZATION PROJECT

Economic Cost of Farm Labor

Items	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Labor Requirement													
Present	0.15	0.27	0.22	0.11	0.04	0.09	0.03	0.07	0.21	0.29	0.16	0.12	1.76
Future without Project	0.15	0.28	0.22	0.11	0.05	0.09	0.03	0.07	0.22	0.30	0.17	0.12	1.81
Future with Project	0.38	0.45	0.25	0.08	0.08	0.12	0.10	0.06	0.46	0.21	0.12	0.08	2.39
Incremental 1/	0.23	0.17	0.03	-0.03	0.03	0.03	0.07	-0.01	0.24	-0.09	-0.05	-0.04	0.58
Average Economic Opportunity Cost (Rs/man-day)	6	6	6	4	4	4	4	4	6	6	6	6	
Incremental Economic Cost (Rs million)	1.38	1.02	0.18	-0.12	0.12	0.12	0.28	-0.04	1.44	-0.54	-0.30	-0.24	3.30

1/ Future "with" over future "without"

ANNEX 13
Table 3

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TANK IRRIGATION MODERNIZATION PROJECT

Economic Rate of Return

Year	Investment Costs	O& M Costs	Net Benefits
	(Rs million)		
1	12.0	0.5	-
2	50.0	1.0	2.3
3	23.0	1.6	6.8
4	27.0	2.0	15.8
5	16.0	2.5	22.5
6	-	3.0	29.3
7	-	3.0	33.8
8	-	3.0	38.3
9	-	3.0	40.5
10	-	3.0	42.8
11-30	-	3.0	45.0

Economic ROR = 23%

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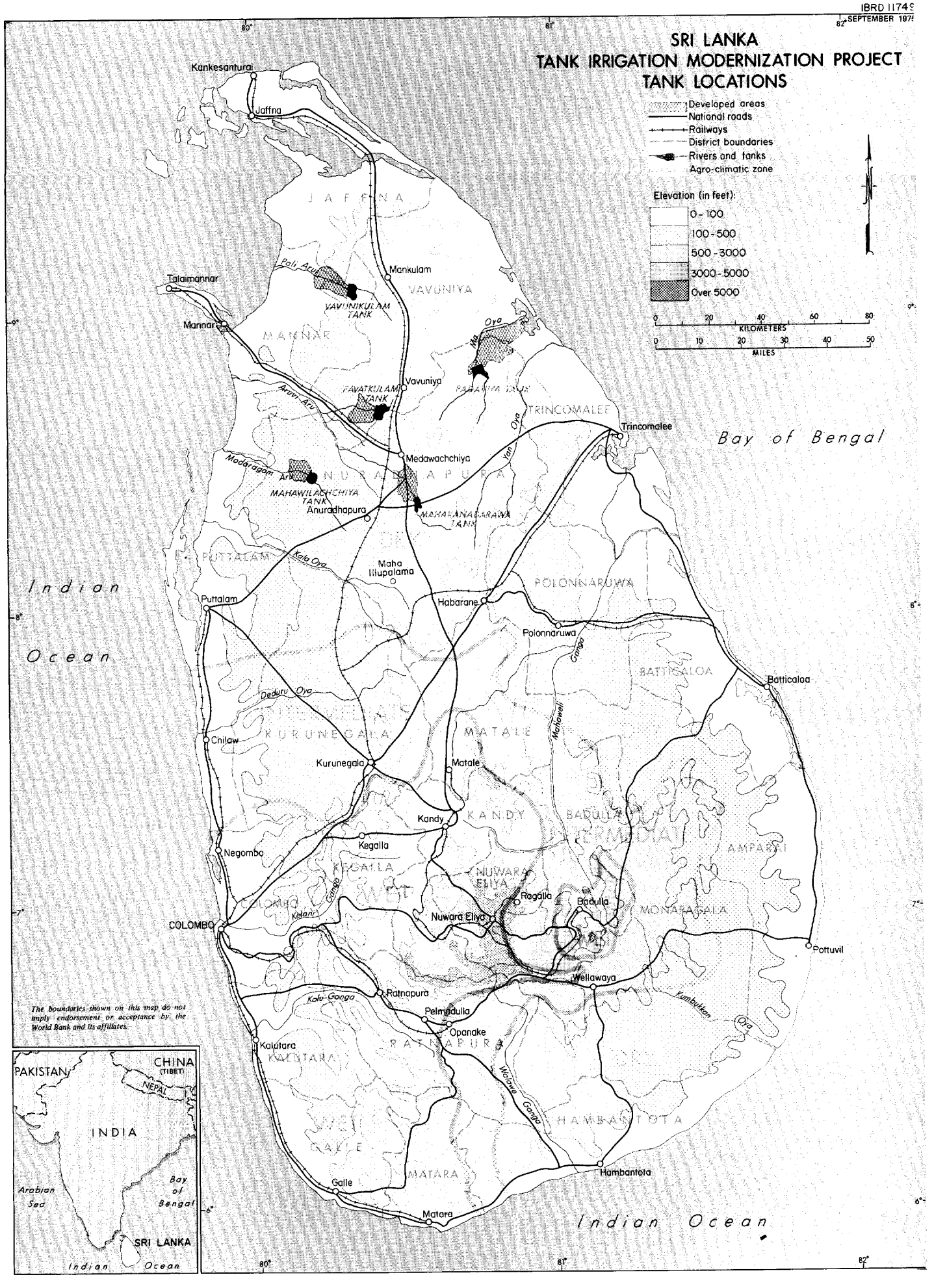
TANK IRRIGATION MODERNIZATION PROJECT
TANK LOCATIONS



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TANK IRRIGATION MODERNIZATION PROJECT
MAHAWILACHCHIYA TANK