PRELIMINARY SURVEY REPORT ON INGINIMITIYA RESERVOIR PROJECT IN THE REPUBLIC OF SRI LANKA

January 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

PRELIMINARY SURVEY REPORT ON INGINIMITIYA RESERVOIR PROJECT IN THE REPUBLIC OF SRI LANKA

January 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

Foreword

In compliance with "The Japan – Sri Lanka Joint Communique" dated November 17, 1976, Japan International Cooperation Agency (JICA) dispatched a preliminary survey team for the Inginimitiya Reservoir Project to the Republic of Sri Lanka for a period of three weeks from December 12 to December 26, 1976. The team consisted of six specialists headed by Mr. Isamu Sakane, Senior Civil Engineer of Construction Department, Ministry of Agriculture and Forestry and its objectives were;

1) to confirm the contents of the request for the request for the Inginimitiya Reservoir Project,

2) to grasp the existing conditions and problems in agricultural development in the Country by data collection, field survey and interviews,

3) to review the Feasibility Study Report prepared by the Government of Sri Lanka and,

4) to make consultation with the personnel concerned of the Government regarding subsequent technical cooperation.

This report contains the results of the surveys conducted by the above team which I believe would be of use for the preparation of the feasibility study to be carried out soon by JICA complementarily.

I take this opportunity to express my hearty gratitude to the officials of the authorities concerned of the Republic of Sri Lanka for their whole-hearted support and cooperation extended to the team, and sincerely wish that our mutual efforts of this kind will serve to strengthen the closer relationship between the Republic of Sri Lanka and Japan.

January, 1977

Shinsaku HOGEN
President
Japan International Cooperation Agency

Proposed Site (Inginimitiya Wewa)

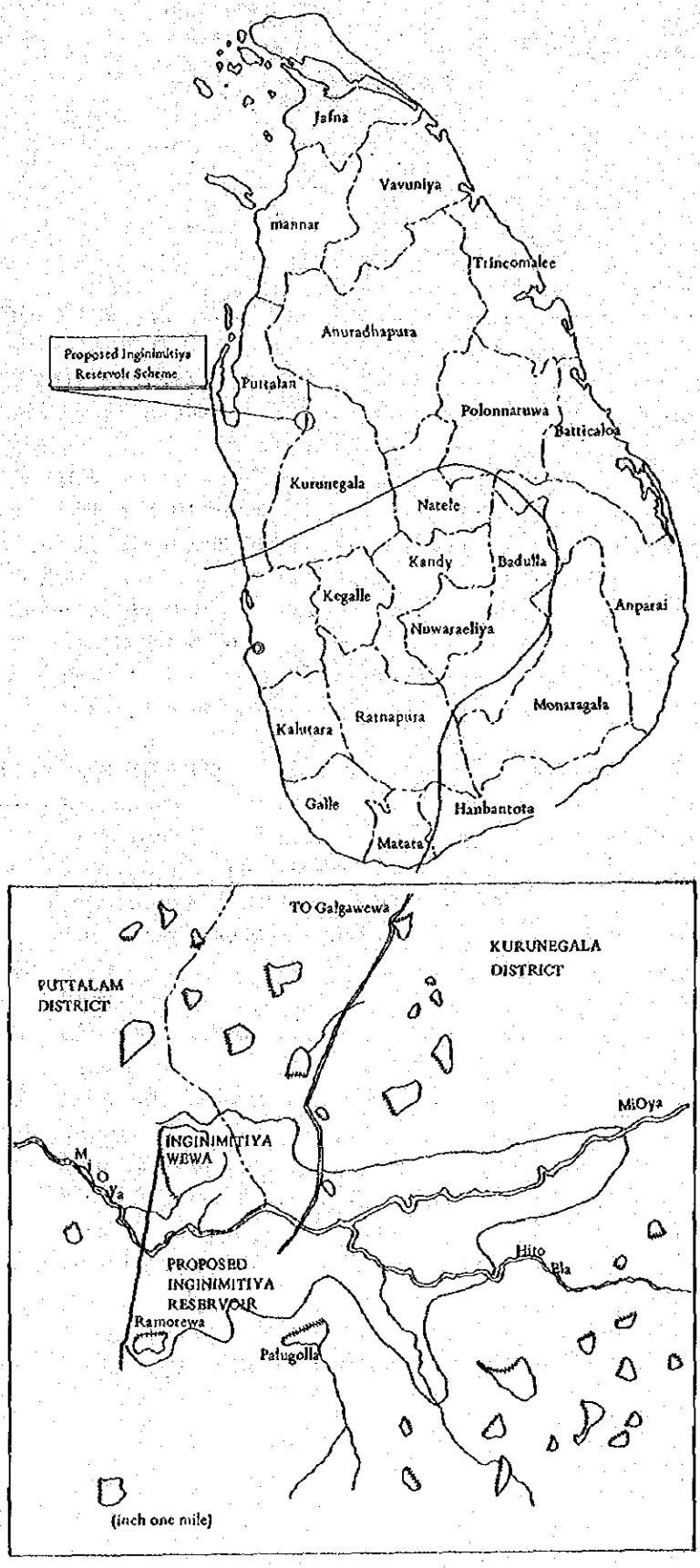


Fig 1. Map of The Republic of Sri Lanka

CONTENTS

		Page
I.	INTRODUCTION	1
II.	SUMMARY OF FINDINGS	11
	1. Cooperation Planning	11
	2. Irrigation	11
	2 - a Headworks	11
	2 - b Irrigation Facilities	12
	2 - c Land Development	12
	3. Agriculture	12
	4. Economic Evaluation	13
	4 - a Construction Cost	13
	4 - b Benefit	15
	4 - c Project Evaluation	15
III.	DETAILED DESCRIPTION	16
	5. Project Background	16
	5 - a Agriculture	16
	5 - b Trends in Rice Production	16
	5 - c Population and Self-Sufficiency in Food	16
	5 - d Water Development Projects	17
	6. Project Outline	18
	6 - a General	18
	6 - b Construction Plan	19
	6 - c Agriculture	19
	6 - d Economic Evaluation	28
	7. Further Study	31
	7 - a Dam Construction	31
	7 - b Water Balance	33
	7 - c Farming	35
	7 - d Economic	36
Attached I		39
	Summary of Preliminary Survey on Inginimitiya Reservoir Project	41

I. INTRODUCTION

1. Prime Minister Sirimavo R.D. Bandaranaike of the Republic of Sri Lanka and her group visited Japan as an official visit of the Japan from 12 to 18 November, 1976.

2. The Japan – Sri Lanka Joint Comminuque announced on November 17, 1976 contained the request by the Republic of Sri Lanka for the Japan's financial assistance for implementation of the following projects:

(1) The Inginimitiya Reservoir Project.

(2) Outside Colombo Area Telecommunication Project.

(3) Fishing Gear Factory Project.

3. According to the Joint Communique, the Government of Japan undertook to conduct a preliminary survey for 15 days from December 12, 1976 in compliance with the aforementioned objectives.

4. Survey Team Member

The survey team comprised the following members;

Name	Assignment	Present Post
Isamu SAKANE	Leader	Senior Officer of Agricultural Civil Engineering, Land Development Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture and Forestry
Shigeru NAKASHIOYA	Irrigation	Chief of Third Design Supervising Section, Design Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture and Forestry
Norio CHIDA	Agronomy	Senior Technical Staff, Education and Training Div., Uchihara International Agricultural Training Centre, Japan International Cooperation Agency

Name	Assignment	Present Post
Kooichiro OHTSUKI	Planning	Chief of Financial Cooperation Section, International Cooperation Div., International Affairs Dept., Ministry of Agriculture and Forestry
Akio SATO	Economic Evaluation	Deputy Manager, Technical Div., Economic Research and Technical Appraisal Dept., Overseas Economic Cooperation Fund
Hidetoshi YAOI	Coordination	Officer, Technical Affairs Div., Agricultural and Forestry Planning Survey Dept., Japan International Cooperation Agency

5. Survey Itinerary

The itinerary of the survey team was as outlined below;

Date	Description	Place of Overmight Stay
Dec. 12 (Sun)	Tokyo - Singapore (JL711)	Singapore
Dec. 13 (Mon)	Singapore - Colombo. (SQ581) Made a countesy call at Japanese Embassy. Made arrangements there with regards to itenerary and survey methods.	Colombo
Dec. 14 (Tue)	Visited Ministey of Irrigation, Power & Highwali High ways, Irrigation Department, and Mahawell Development Board.	Colombo
Dec. 15 (Wed)	Visited the Prople's Bank. Cisited the Ministry of Planning & Economic Affairs. Conducted material gathering work at Irrigation Department.	Colombo
Dec. 16 (Thu)	Visited the Commissioner of Cooperatives, Land Commissioner, and Ministry of Agriculture and Lands. Attended Banquet hosted by the Director of Irrigation Department.	Colombo
Dec. 17 (Fri)	Conducted field survey for three days. 17th - 19th. Inspected the project site, dam site, boring site, local agriculture cooperatives and farmers. Observed Rajangana Project.	Anuradhapura
Dec. 18 (Sat)	Visited Agricultural Experiment Station at Maha Illuppallama. Visited Kalawewa Development Area. and Polgola Project.	Kandy
Dec. 19 (Sun)	Visited Polgola Project. mostly water intake facilities.	Colombo.
Dec. 20 (Mon)	Visited Irrigation Department to conduct the work.	Colombo
Dec. 21 (Tue)	Team member Chida visited the Ministry of Agriculture and Lands to corect data. Team member Otsuki visited the Forestry Ministry to collect data. The other team members met with the Director of the Irrigation Department to discuss about the report.	Colombo
Dec. 22 (Wed)	Report compilation work. Material gathering.	Colombo
Dec. 23 (Thu)	Reported results of survey to Ambassador Yoshioka at the Japanese Embassy. Submitted report to the Ministry of Irrigation, Power & Highways. Visited the Director of the Irrigation Department to bid farewell.Material Gathering work.	Colombo
Dec. 24 (Fri)	Colombo - Hong kong.	Hong kong
Dec. 25 (Sat)	Sorted survey materials. Compiled survey report.	Hong kong
Dec. 26 (Sun)	Hong kong - Tokyo.	

6. Acknowledgement and Personnel Concerned

The team is much indebted to the many personnel for the valuable assistance given it throughout the survey period. The names of the personnel concerned are given below.

(1) Ministry of Irrigation, Power and Highways

(a) Mr. T. SIVAGNANAM
Secretary, Ministry of Irrigation, Power and Highways

(b) Mr. P. H. PERERA
Additional Secretary,
Chairman of River Valleys Development Board

(c) Mr. A. MAHESWARAN
Director, Irrigation Department

(d) Mr. S. SIVASUBRAMANIAM
Deputy Director, Irrigation Department

(f) Mr. R. U. FERNANDO
Deputy Director, Irrigation Department

(g) Mr. K. B. Des. KARUNARATNA
Deputy Director (Research), Irrigation Department

(h) Mr. O. A. GUNAWARDANA
District Irrigation Engineer, Irrigation Department

(i) Mr. H. A. WICKREMARATNE
Irrigation Engineer, Irrigation Department

(j) Dr. T. SIVAPATHAM
District Irrigation Engineer (Soil), Irrigation Department

(k) Dr. W. D. JHOSUA
Acting Head (Land Use), Irrigation Department

(ℓ) Mr. S. V. A. BUDDHADASA
Divisional Irrigation Engineer, Irrigation Department

(m) Mr. M. GOMEZ
District Irrigation Engineer (Hydrology), Irrigation Department

(n) Mr. K. SUBRAMANIAM
District Irrigation Engineer (Machinery), Irrigation Department

(o) Mr. V. THURALRAJAH
District Irrigation Engineer (Geology), Irrigation Department

(p) Mr. V. JAIRAJ
Irrigation Engineer, Irrigation Department

(q) Miss G. C. PADMASIRI
Irrigation Department

(2) Ministry of Agriculture and Lands

(a) Mr. K. N. WEERACKODY
Additional Secretary

(b) Mr. W. R. D. RAJAKARUNA
Land Commissioner

(3) Ministry of Food Cooperatives and Small Industries

(a) Mr. B. S. WYEWEERA
Commissioner of Cooperation

(b) Mr. M. P. JAYA SINGHE
Deputy Commissioner of Cooperatives

(4) Ministry of Finance

(a) Mr. RANJIT D. De LIVERA
General Manager of People's Bank

(b) Mr. NIHAL JAYAWARDANA
Assistant Chief Development Officer, People's Bank

(5) Mahaweli Development Board, M.I.P.H.

(a) Mr. K. R. De SILVA
General Manager, Mahaweli Development Board

(6) Ministry of Planning and Economic Affaris

(a) Mr. S. VELAYUTHAM
Director, External Resources Division

7. List of Collected Data

The data collected by the team during survey period are given below.

1. The Uhana Colony Village (Case study No. 2)

2. New Settlement Schemes in Sri Lanka (Research Study No. 5)

3. A Study of Agricultural Extension Training and Communication in Colombo Dist. (R.S.S. No. 15)

4. Socio-economic Survey of the Baminiwatte Agricultural Productivity Committee Area (R.S.S. No. 13)

5. Land Settlement in Sri Lanka (R.S.S. No. 16)

6. The Role of Statistics in Research (Occasional Publication Series No. 12)

7. Production of other crops in paddy field in Yala 1972 (R.S.S. No. 4)

8. Cost of production of paddy Yala 1972 (R.S.S. No. 1)

9. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 1 Hambanteta Dist.) (R.S.S. No. 6)

10. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 2 Kandy Dist.) (R.S.S. No. 7)

11. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 3 Polonnaruwa Dist.) (R.S.S. No. 8)

12. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 4 Aburadhapura Dist.) (R.S.S. No. 9)

13. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 5 Colombo Dist.) (R.S.S. No. 10)

14. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka (Part 6 Comparative analysis) (R.S.S. No. 11)

15. Sri Lanka and the international Food Crisis (Occasional publication S No. 11)

16. Agricultural implementation programme 1976/77

17. Half yearly Report, Maha – 1975/76

18. Thannimurrippu paripalana sabai (O.P.S. No. 1)

19. The role of Cultivation Committees in Agricultural planning of Village Lavel (O.P.S. No. 9)

20. Fragmentation of paddy land (O.P.S. No. 5)

21. Socio-economic factors in rural indebtedness (O.P.S. No. 7)

22. Water amanagement and paddy production in the dry zone of Sri Lanka (O.P.S. No. 8)

23. A study of seven selected Agricultural Productivity Committees and Cultivation Committees (O.P.S. No. 9)

24. Some aspects of paddy and rice narketing in Sri Lanka (O.P.S. No. 10)

25. International Bidding of Machinery under I.D.A. Loan

26. List of Machinery and Equipment for Land Development Work

27. List of Machinery and Equipment for construction work (other than L.D.)

28. Annual foreign exchange cost of the Project

29. WAHAKADE WEWA SCHEME -- Comparative statement of expenditure and revised estimate

30. Irrigation Department -- Evaluation of unit prices and rate analysis.

31. Specification, schedules and drawings for the construction of the spillway dam and irrigation intakes Rajangana Reservoir

32. Estimates of the revenue and expenditure of the government of the Republic of Sri Lanka for the Financial Year, 1st January 1976 to 31st December 1976.

33. MAHAWELI GANGA DEVELOPMENT
Project 1 F/S for Stage 11
Volue I -- Feasibility Report

34. MAHAWELI GANGA DEVELOPMENT
Volume II -- Agriculture

35. MAHAWELI GANGA DEVELOPMENT
Volume III -- Land Classification

36. MAHAWELI GANGA DEVELOPMENT
Volume IV – Land Classification (Maps and Tables)

37. MAHAWELI GANGA DEVELOPMENT
Volume V -- Engineering Report

38. MAHAWELI GANGA DEVELOPMENT
Volume VI – Engineering Drawings

39. MAHAWELI GANGA DEVELOPMENT
Volume VII -- Settlement Planning and Development

40. MAHAWELI GANGA DEVELOPMENT
Volume VIII -- Marketing and Credit

41. Sri Lanka Year Book

42. Central Bank of Ceylon

43. Statistical Abstract of Ceylon 1970 - 71

44. Statistical Pocket Book of Sri Lanka 1975

45. Country Report from Sri Lanka for World Water Conference

46. Aerial photograph (Indicator Map)

47. Estimates of the Revenue and Expenditure of the Government of the Republic of Sri Lanka for the Financial Year, 1st January, 1977 to 31st December, 1977

Part I	General Estimates	Volume I

48. Estimates of the Revenue and Expenditure of the Government of the Republic of Sri Lanka for the Financial Year, 1st January, 1977 to 31st December, 1977

Part I	General Estimates	
Part II	Advance Account Activities	
Part III	Appendices	Volume II

49. Report on Inginimitiya Reservoir Project
Prepared by the Irrigation Department
Ministry of Irrigation, Power and Highways — August, 1976

50. Population Growth and Economic Development in Ceylon
by Gavin W. Jone and S. Selvaratnam

51. Food and the People
by R. L. Brohier

52. Birds of Ceylon (Sri Lanka)
by W. W. A. Phillips
Wildlife and Nature Protection Society of Ceylon 1975

53. Annual Report 1973 People's Bank

54. Balance Sheet as at 31st December 1975
People's Bank

55. Sale of State Lands (Special Provisions) Law, No. 43 of 1973 of the National State Assembly

56. Road Map of Sri Lanka

57. Mahaweli

58. Monthly rainfall data (Galgamuwa)

59. Monthly rainfall data (Mediyawa Tank)

60. Monthly rainfall data (Mahasuwewa)

61. Geologic log of drill holl

62. Borrow area plan

63. Borrow area geological map

64. Soil laboratory test

65. Basis of computation of water requirements

66. Cropping pattern

67. Stability analysis

68. Volume-water level of dam

69. General plan (1/63360)

70. Proposed general plan

71. Dam site plan (two sheet)

72. Longitudinal section of dam axis

73. Typical cross section of dam

74. Intake facilities drawings

75. Spillway plan

76. Boring location map

77. Typical section of canal of Lunuganwehera

78. Canal profile of Lunuganwehera

79. Layout of turn out area of Lunuganwehera

80. R. B. tract 6 layout of Lunuganwehera

81. R. B. tract 1 layout of Lunuganwehera

82. Schematic layout of distribution system of Lunuganwehera

83. Calculation of number of machinery and equipment for Inginimitiya Reservoir Project

84. Technical report on Nagadeeta Mahawewa project

85. Progress 1970 - 75

86. Progress and project

87. Jalavrudhi

88. Dawn Mahaweli Ela

89. General layout of Mahaweli Ganga Development Project

90. Project plan for development of 71,000 ac. Mahaweli Ganga Project

II. SUMMARY OF FINDINGS

1. Cooperation Planning

The Republic of Sri Lanka, depending 34% of its total domestic rice consumption on import, places great emphasis in promoting rice production as one of the most basic and important national policies to attain self sufficiency in food, to improve its foreign trade balance, to increase farm income and to alleviate the unemployment situation.

Prime Minister Bandaranaike who visited Japan in the autumn of 1976 places top-priority on the realization of the Inginimitiya Reservoir Project as being tightly knit with its national policy to boost rice production and as being the most probable project to acquire Japanese Government Loan.

The Sri Lanka government has already prepared the Report on the Inginimitiya Reservoir Project (hereinafter reffered to as "The Report".) And studies to draft the headworks and related facilities, construction work plan, land settlement program and cost estimates have nearly been completed, thus showing signs that the tide is high.

Based on the results of the preliminary survey, it is proposed that a feasibility study be conducted by a team consisting of about 6 members for a period of around 40 days as soon as possible.

2. Irrigation

The project area is located in Kirimetiyawa, Karambe and Pattus of Pattuwa District in the North Western Province of Sri Lanka.

53,000 ac. ft. is expected as the capacity of the projected reservoir at its full supply level 202 MSL. The total irrigable area will be 6,300 acres which 4,500 acres will be in paddy for both Maha season and Yala season and 1,800 acres of which will be in paddy for Maha season and soya beans and pulses in Yala season.

The headworks consist of an earth dam, an uncontrolled concrete spillway an emergency spillway. It involves two canals on both side, the distribution system, feeder roads, community centers, schools and dispensaries.

2 - a Headworks

According to the Report, the earth dam is designed 2 miles 4,750 feet in length, maximum height 50 feet, top width 20 feet involving about 417,000 cubes of concrete and about 112,000 cubes of earthwork inclusive of the emergency spillway of 800 feet in length.

The outlet work consists of two tower type sluices on each bank.

2 - b Irrigation Facilities

The irrigation facilities comprise the two main canals so as to feed 6,300 acres. The left bank canal will be 13 miles long, and the right bank canal will be 7.5 miles long.

2 - c Land Development

The jungle opening work is required and also the land consolidation must be done to make it fit for cultivation of paddy and upland crops.

3. Agriculture

For achieving and maintaining the yields and levels of production planned at the projected site, the Report says in Chapter 4 - 7 that it is essential that:

a. there would be uniform and rapid development of the holdings.

b. efficient functioning of the Cultivation Committees and Multipurpose Co-operative Societies.

c. timely availability of loans, availability of fertilizer and agrochemicals.

d. good road access and transportation facilities.

e. adequate farmer training in the projected area.

Prompt and positive plans for executing the above mentioned conditions are necessayr. To supervise the construction work of the project at the site, we must either establish an exclusive field office or make the best use of the available district office located there.

(1) The project involves the settlement of 187 families presently living at the reservoir bed site plus the successful applicants from the neighboring areas totalling roughly 2,500 families in all involving 6,000 people.

(2) These farm families will rely on family labor provided with 2.5 acres of farmland per family. (Mahaweli Project provided 3 acres per family on family labor basis.)

(3) Due to soil and water use conditions, the yields are classified into three types. However, both-season paddy cultivation will account for about 70% of the total yielding crops. In other areas, paddy during Maha season and soya beans, cotton or cowpea in Yala season.

(4) The yields of each crop will increase as the land development program and farm land quality becomes consistent. In four years, the yield of 50 bushels per acre of paddy is expected to boost to 80 bushels. The fields are also expected to produce 15 cwt per acre of soya beans and 12 cwt per acre of cowpea.

(5) Farm lands will be developed, divided and prepared in an orderly manner comparable to those in other similar scale projects. The introduction of collective farming method introducing high yield variety, fertilizer, agrochemicals, etc., will enable the farmlands to attain the aforementioned production levels.

(6) The recommended high-yield variety for each crop are now under study. However, the generally recommended variety for paddy (Oryza Sativa) are BG 34-6 growing in 100 days BG 11-11 harvested between 130 and 145 days and LD 66. For soya beans (Glycina Hiapida) are Pelican and Bossir, and for Cowpea (Vigna Sinonsis) MI 35.

(7) The annual income per farm family is expected to reach 7,310 rupees for both-season paddy or four to ten times more than the present income.

4. Economic Evaluation

4 - a Construction Cost

The Report estimates the construction cost of the project as follows:

Item	Item cost in M. Rs.		
	Total	Foreign	Sri Lanka
Land, right of way Access and road deviations	2.500	0.875	1.625
Earth dam (2 miles 4750 ft. long)	20.349	13.400	6.949
Spillways (concrete + emergency)	7.800	4.700	3.100
Outlet works - 2 sluices	1.250	-.750	0.500
Irrigation facilities for 6,300 acres	16.450	8.400	8.050
Land development (heavy jungle clearning and land preparation)	13.500	8.100	5.400
Land settlement (internal roads, service buildings, aid to settlers)	6.300	2.000	4.300
General charges (maintenance building, construction camp, administrtion, surveys and supervision)	11.851	5.952	5.962
	80.000	44.150	35.850

The cost estimates are based on the followings:

(1) Each item cost was prepared on the basis of actual cost needed to construct a similar project. (as of April 1976)

(2) The residual value of 40% has been allowed for construction machinery.

(3) The direct foreign and local currency costs have been estimated on a percentage basis.

Besides the foreign exchange cost listed in the above table, the Report provides another table:

Item	Remarks	(M.Rupees)	($1,000)
Cost of machinery	Less 40% residual value	18.500	2,136
Cost of fuel	Kerosene 5.27 m.gal x 3 rs/gal = 15.810 Lubricant 91 m.gal x 10 rs/gal = o.914	16.725	1,938
Coment and Steel	15,ooo cubes x 13 bg/ x 14 rs/t (cement) = 2.730 Steel = 0.770	3.500	404
Spares for machinery and equipment		2.700	312
Tools, accessories and surveying instruments		1.250	144
Blasting material		0.500	58
Generators, electrical Fittings and other accessories for buildings, etc.		0.750	87
Foreign component of sluice		0.225	26
	Total:	44.150	5,098

4 - b Benefit

The project, irrigating 6,300 acres of new land, is expected to increase the annual farm production as follows: 864,000 bushels of paddy (17,700 tons); 27,000 cwt (1,372 tons) of soya beans and 21,600 cwt (1,097 tons) of cowpea. The production income would gross 33,552 rupees (3,874 dollars) and net 19,872 rupees (2,294 dollars) saving 26,118 rupees or 3,016 dollars.

Since the cultivators will hold 24 acres of irrigable land per family, the estimated income for each 2-season paddy farm family is gross 13,200 rupees ($1,524) or net 9,200 rupees ($1,062). And for paddy, soya bean and pulse farm family: gross 13,590 rupees ($1,569) or net 10,126 rupees ($1,169).

As the project involves the construction of roadways and other public facilities plus land development in the settlement area, it is in effect a significant regional development program alleviating the unemployment problem besides directly benefitting those concerned.

4 - c Project Evaluation

The internal rate of return of the project is 17% when considering only the direct benefits from the quantative increase in farm production. Although some questionable points may remain under the present circumstance, furhter improvements would enable the feasibility of the project to become nearly identical with that stipulated in the Report.

III. DETAILED DESCRIPTION

5. Project Background

5 - a Agriculture

Tea, rubber and coconut are the three major exporting items of the nation. Agriculture and fishery provide about 33% (1975) of the country's gross domestic product. And the three major export items account for 75% of the total foreign exchange earnings.

However, the staple food of the people is rice. At present nearly 34% (342 tons) of the domestic rice consumption is supplemented by imports from aborad. This accounts for 20% of the total foreign currency reserve spendings. The nation expends 50% of its total foreign exchange earnings on foodstuffs including wheat, sugar, etc.

While the nation depends heavily on farm produce for its foreign exchange earnings, a good percentage of its foreign currency reserves is spent on import of foodstuffs. It seems that the nation lacks something in effective nationwide land utilization program that should lead to increased farm production.

5 - b Trends in Rice Production

Based on the policy to attain self-sufficiency in rice, the available farm area is expected to increase, although slowly, over a long period. In a short term, however, this trend seems to be easily troubled by natural disasters, in short water shortage, depending upon the year. A good example of this is the notable decrease in farm lands in 1974 - 75 which forced the nation to import rice from abroad in large quantity. Therefore, without hesitation, it can be said that the key to Sri Lanka's economic development is to secure stable and sufficient irrigation water.

5 - c Population and Self-Sufficiency in Food

The population of Sri Lanka is 13.6 million. (The 1971 consensus had given a figure of 12.9 million). The rate of national increase per 100 population is 1.84%. Therefore, the population is expected to mark 20 million in the year 2000 AD.

It is estimated that the nation's yearly rice consumption will be about 2.2 million metric tons by the year 2000 AD. The production of rice in the nation during the period 1966 - 1975 averaged 775,000 tons per year. The productivity of the existing land may be increased by improved agricultural practices, higher input and fertilizer. But with all these efforts the production can only be raised to about 1.22 million metric tons in 2,000 AD. Thus, there will be a shortfall of about one-million metric tons of rice and new lands must be develop-

ed or imports have to increase. The increase in area of irrigated agriculture is the only answer to this problem and to the problems of growing unemployment and worsening international trade balance.

If prompt action is taken, there would be a notable increase in farm production exceeding the 3.5% mark of 1975 giving impetus to the nation's total economic development program.

5 - d Water Development Projects

The climatic conditions of Sri Lanka divide the nation into a Dry Zone and a Wet Zone bordering on areas registering an annual rainfall of 75 inces or about 1,900 millimeters. The Dry Zone occupies roughly 3/4th of the total land area while the remaining 1/4th being the Wet Zone. And seventy percent of the nation's total population is concentrating in the Wet Zone where considerable farm development has been attained including enhancement of tea plantations. The remaining problem is to fast increase irrigable farm lands in the Dry Zone.

But the Wet Zone rice farming industry also faces problems. The rice crop is heavily damaged by floods once in every three years, while the long drought in the Dry Zone hampers the development of farm lands. Therefore, the government of Sri Lanka feels a pressing need to envisage an effective water development program encompassing the total land area by constructing reservoirs, lakes, etc.

The government divides the country in four major regions to promote irrigation, drainage and flood control:

1. Mahaweli Project Region.
2. South-East Dry Zone Region.
3. Western Wet Zone Region.
4. North-West Dry Zone Region.

And various construction work is presently in progress. The said Inginimitiya Reservoir Project belongs to the North-West Dry Zone Region Developmental Program.

Of the four regional projects, the partly completed Mawaweli Scheme is the largest with a total construction cost of 6,700 Rupees or 1,415 million dollars.

With regard to the subject Inginimitiya Reservoir Project the government has already appropriated a part of the total construction cost (72 million dollars) in the 1977 national budget.

The breakdown of the estimated costs are:

Labor	30 million rupees
Machinery & Material	20 million rupees
Others	22 million rupees

However, the actual sum provided for all these projects in the 1977 budget is unclear. At any rate, the Sri Lanka government expects much from this reservoir, the largest in the nation, when completed.

6. Project Outline

6 - a General

1 General Outline

The project area is located in Kirimetiyama Pattuwa and Karambe Pattuwa, Puttalam District in the North Western Province of Sri Lanka. The proposed dam site is about 14 miles from the town of Galgamuwa. The proposed project stores water of the River Mi-Oya which starts at the Dambulla hills irrigating 6,300 acres of land in its lower reaches.

2 Reservoir

The proposed Inginimitiya reservoir will have a catchment area of 215 square miles, though a water shed of 65 square miles is diverted away at Abakolawewa which it also crosses the Mi Oya. The weighted average annual rainfall in the catchment area for 40 years is 54.64 inches. The mean annual yield at the proposed dam site is 94,315 acre/feet, this yield being that from the net catchment of 150 square miles and was obtained from gaugings taken after the construction of Abakolawewa. The gross storage at full storage limit (FSL) of 202 MSL is 53,000 acre/feet while the dead storage is 4,200 acre/feet at 181 MSL.

The reservoir will inundate and area of 4,100 acres, most of which is crown jungle. There are however about 453 acres of paddy lands in the villages Ranerewewa, Wwlpaluwa and Andivakudawala which will be submerged.

3. Earth Dam

Several dam sites were investigated and ultimately the present dam site was chosen as the most suitable one. The north dam will have a length of 2 miles 4,750 feet with a maximum height of 60 feet. The embakment will be a rolled fill earth dam involving about 417,000 cubes of earthwork. It will have a 20 feet wide roadway on its crest and slopes of 1 on 3 and 1 on 2.5 on the upsatream and downstream. The core trench will be excavated to bedrock of one third to height of the dam. The toe filter provided along the downstream toe of the dam will allow clear water to percolate into a system of precast drains. The downsteam slope will be turfed fully while the upstream slope will be protected with rip rap up to high flood level.

4 Spillway

A long clear overfall uncontrolled spillway will be located on the right bank flank of the dam where suitable rock outcrops of ra length of 350 feet. The spillway has been designed to discharge a peak flood of 61,500 cubes feet. An emergency spillway of 800 feet in length

will be provided to the right of the spillway to enter for any catastrophic floods. The spill tail channel will be 2,000 feet wide at the commencement but will gradually be reduced to 300 feet width within a distance of 2,400 feet. It will then be carried to the Mi Oya, the total length of the spill tail channel being 7,000 feet. A training bund is provided on the left bank of the spill tail channel to prevent any scouring of the dam too. The excavated material in the spill tail channel will be used on the dam where possible.

5 Intake Facility

The irrigable area is located on either banks of the Mi Oya. Two sluices at 181 MSL sill level will be provided, one on the left bank and the other on the right. The left bank sluice will feed 4,800 acres. It will commence at a sill level of 181 MSL and be capable of discharging 156 cu sees. The left bank canal will be 13 miles long and will have a bed slope of .0003 and side lsopes of one to one.

6 - b Construction Plan

According to the Report, the machinery and equipment required for the construction of the headworks and providing irrigation facilities to the development area will have to be imported from abroad as the machines now in use in the country are all very old.

The sequence of construction would be to first complete the earthwork on both banks and the two sluices. During the dry season from February to September, a coffer dam would be constructed in the upstream toe section of the embankment. The height of the coffer dams should be sufficient to allow the construction to proceed without interruption from floods of a ten year frequency. The dewatering and cleaning up of the dam site as well as grouting the foundations would be done from February to May and the final breach closure done in the months of June, July and August. The upstream coffer dams will be incorporated in the upstream slope of the embankment. (See Annex 4 4 - 2)

6 - c Agriculture

1 The cropping pattern of the villagers in Maha Uswewa, about 4.8 kilometers southwest of the proposed dam site during the Maha Season when it registers an average rainfall of 33.3 inches is one-season paddy and chena cultivation raising chillies and pulses. Since paddy cultivation is easily affected by the amount of rainfall, the area has been neglected and considered as one of the most underdeveloped farming areas in the nation.

But with the completion of the project work, the famers here will be able to perform both-season paddy and yield soyabeans, cowpea and cotton in an orderly pattern with consistent water supply. Thus, the project will be able to maximize land use and land productivity by labor intensive.

2 Present Farming at the Projected Area

The villagers at the project site presently cultivate ar. average of 4.75 acres of land per family mainly depending on chena cultivation for their living. Paddy farming is conducted only during the rainy Maha Season and only limited areas. Therefore, the average annual yield there is only between 25 and 30 bushels for paddy per acre or the lowest rate in the nation. The most commonly raised crops there are chillies, cowpea, tara (a kind of pulse), kurakkan, wheat and rice, according to what the villagers told us.

Public facilities including the co-operative building and the school building are available at Inginimitiya. Villagers can purchase their everyday necessities at the co-operative store handling 9 kinds of foodstuffs and 13 other merchandise. The co-operative also functions as a farm material supplier. (We found only fertilizer: urea and chemical there).

3 Farm Land Development Program

The construction work in the reservoir and the development area will take about 6 years. The settlement of the colonists will take place in the 3rd to the 6th years, and the first harvest obtained from the project is expected in the 4th year. Therefore, the farm land development program in the area is expected to mature in the 6th year.

Year	Lands Development (Acre)	Crop Cultivation	
		Maha(Acre)	Yala (Acre)
4th	2500	2500	500
5th	5000	5000	1000
6th	6300	6300	1800
7th	6300	6300	1800

4 Increase in Farm Production and Farm Income

Increase in farm produce of paddy, soyabeans and cowpea is expected as the work of the project progresses. In the 4th year of cultivation, the farm lands are expected to yield about 80 bushes per acre for paddy:

Year	Paddy	Soya bean	Cowpea
4th	50 (Bushel/acre)	15 (cwt/axre)	12 (cwt/acre)
5th	60	15	12
6th	70	15	12
7th	80	15	12

This production target was compiled by bearing the following facts;

(1) The present farming condition in the project area.

(2) Referred to the results attained at experiment farms and new settlements in other project areas.

(3) From a long range viewpoint, the production target is around 60% of the results attained at the pilot project farms.

Corp	Present Average Yield at H. IM District	Pilot Project Average at Test Farm	Youth Farm Aver. Rajangana	Average Test Farm	Target	
					Short Term	Long Term
Paddy (130 days)	-	43	-	150	50	100
Paddy (100 days)	33	40	50	150	45	90
Soya Bean	-	3.3	-	25	5	15
Cowpea	5	5.2	-	20	7	12

Units: Paddy.....bushels/acrea
Soyabean, Cowpea.....cwt/acre
(From Mahaweli Ganga F/S Report: Stage II: Vol II: Page 62)

5 Cropping Patterns

The Land Use Division of the Department of Irrigation recommends three types of cropping patterns in accordance with the types of soil and climatic conditions.

The basic cropping patterns adopted by the farmers in the Mahaweli Scheme were as follows:

(1) Field

a) Vegetables and fruits for self consumption . . . full year.

b) Onion, chilly, other vegetables, pigeon pea, and onion, pepper, green pea . . . rotation of crops in three years.

c) Paddy (or maize), pepper.

d) Paddy (or maize), peanut or soyabean, cowpea.

e) Paddy (or maize), cotton.

Fig - 1 M0nthly Rainfall and Maximum/Minimum Tempratures at Maha Uswera

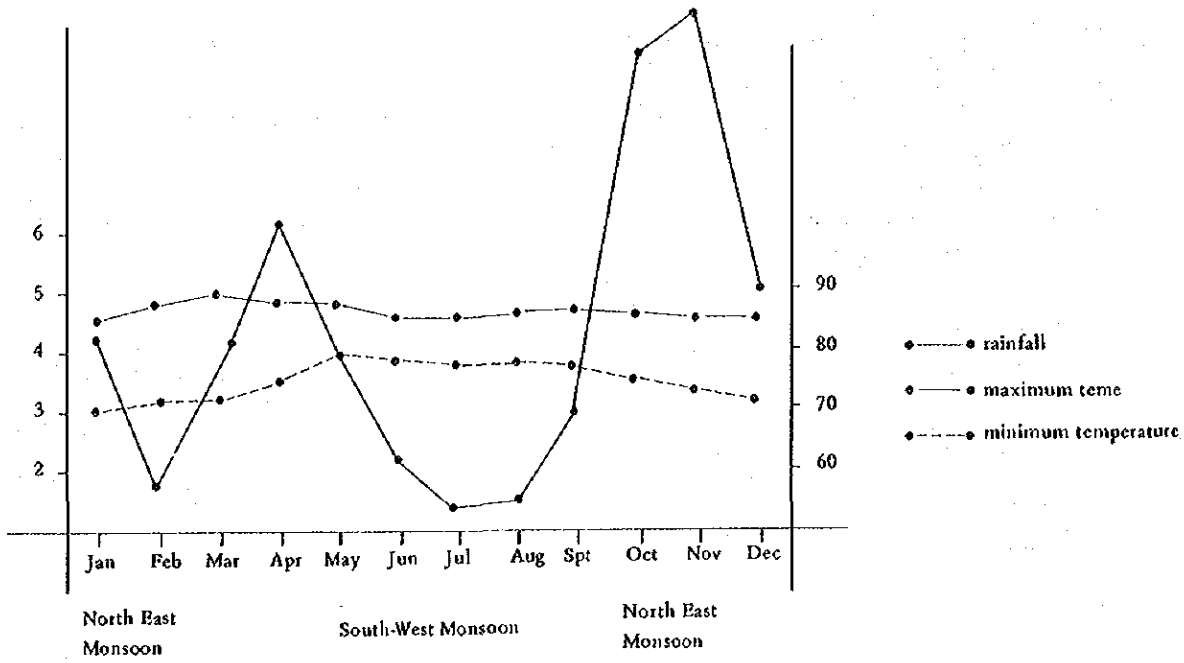
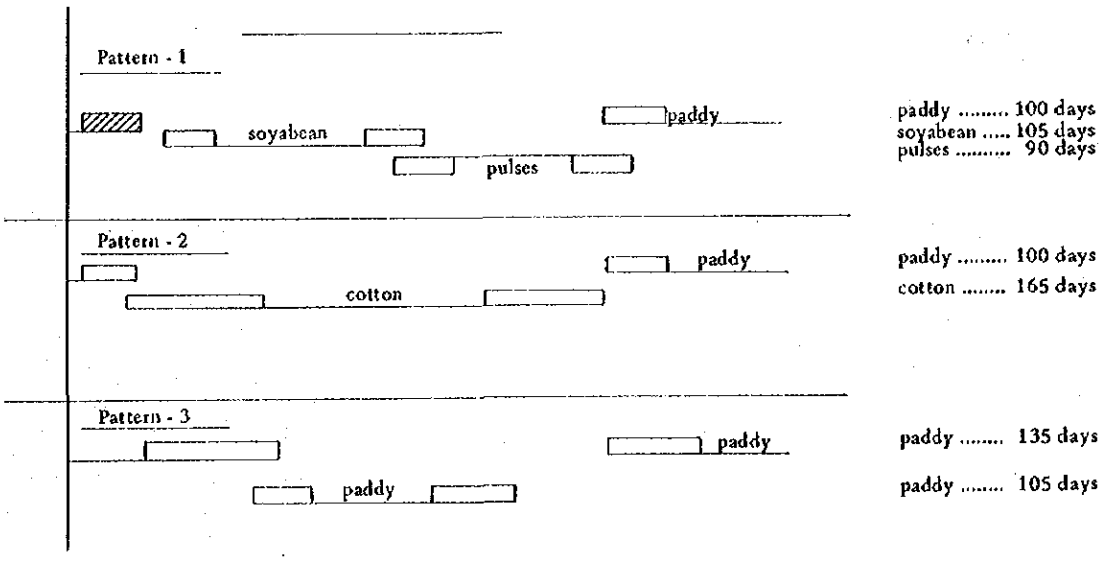


Fig - 2 Cropping Pattern



(2) Paddy

a) Both-season paddy

b) Three-season paddy

The Corpping Pattern I in this project corresponds to Pattern I-d of Mahaweli Scheme: Pattern 2 to I-e and Pattern 3 to 2 - a.

6 Farming System

As previously mentioned, the settlers will rely on family labor as the only work source in this scheme. And this farm work pattern is closely related to the size of cultivating land and the cropping patterns employed. The basic data of the Mahaweli Project indicate:

Crop:	Farm Work
Paddy	between 86 and 87 days/acre
Paddy	between 111 and 116 days/acre

were required to reach the stable stage in farming since commencement of tilling.

Table - 6. Indicates the field operation based on crops

In Table - 6, (1) means to use buffalo from the early stage of development. (2) means buffalo was used after reaching a certain stage of development.

Table 6. Field Operation Based on Crops (Hours/Acre)

1. Paddy

Description of work	Paddy (130 days)		Paddy (100 days)	
	(1)	(2)	(1)	(2)
Tilling	20	20	20	20
Dike Repairment	30	30	30	30
Fertilization (basic dressing)	3	3	3	3
Land Levelling	20	20	20	20
Sowing	4	4	4	4
Herbicide Application	2	16	2	16
Fertilization (top dressing)	4	16	4	12
Pest Control	4	40	2	24
Water management	50	50	40	40
Harvesing	80	80	80	80
Threshing, Winnowing, Transportation	112	112	112	112
Total: (hours)	329	391	317	361
(days)	41	49	40	45

2. Soyabeans, Cowpea

Description of work	Soyabeans		Cowpea	
	(1)	(2)	(1)	(2)
Fertilization (basic dressing)	1	3	3	3
Tilling and Levelling	100	100	100	100
Ridging	40	40	40	40
Sowing	30	30	30	30
Herbicide Application	–	8	–	8
Weeding	32	–	32	–
Fertilization (top dressing)	–	16	–	16
Pest Control	–	16	–	16
Irrigation	25	25	25	25
Harvesting	60	80	60	80
Treshing & Transportation	52	65	42	65
Total: (hours)	342	383	332	383
(days)	43	48	41	48

(1) indicates the use of farm implements from the initial stage of farm development.

(2) indicates the use of farm implements after reaching a certain stage of development work.

(Compiling from Report on Mahaweli Project Stage II. Volume II of VIII. Appendix IV.)

7 Farm Production Cost

The breakdown of production cost of each crop upon completion of the project scheme is as follows:

Item	Paddy Unit Cost/		Soyabean (Rupees) Unit Cost/		Pulses (Cowpea) Unit Cost/	
	Acre	2.5 Acre	Acre	2.5 Acre	Acre	2.5 Acre
Seed	68	170	52	130	7	18
Fertilizer	304	760	118	295	102	235
Agrochemical	274	560	43	107	62	155
Farm Machinery	152	380	75	188	64	160
Farm Labor	294	735	348	960	386	960
Interest on Corp Loan	100	215	34.50	86	28.30	70
Land Betterment Charges	100	125	100	60	100	65
Total	1,228	2,945	806.50	1,826	747.30	1,683

When this Table (7) is applied to Patterns 1 and 3, the production costs of total average is as follows:

Pattern 1

Paddy	1,945 Rupees
Soyabean	1,826 Rupees
Cowpea	1,683 Rupees
Total:	6,454 Rupees

Pattern 2

Paddy	2,945 Rupees
Paddy	2,945 Rupees
Total:	5,890 Rupees

Seeds, fertilizer and agrochemicals are generally available at average farming villages. the average sized cooperatives also sold urea and three-element mixed fertilizer. Agrochemicals such as sumithion and MCPA were only sold at the cooperatives in the project area.

The following table shows the required amount of fertilizers and agrochemicals for each crops so as to calculate the production costs.

Item	Unit	Paddy		Soyabean	Cowpea
		130 days	100 days		
Seed	Bushels	2	2	0.35	0.1
Fertilizer					
Urea	N cwt	1.6	1.2	0.4	0.2
Phosphoric Acid	P_2O_5 cwt	0.8	o.8	0.4	0.4
Potassium Chloride	K_2O cwt	1.2	1.2	1.2	0.5
Agrochemical					
BHC (6%) 1bs	1bs	100	70	–	1.0
Sumithion (50%)	fl.oz	60	30	Malathon 60	Malathon 60
Herbicide					
3.4 DPA	pint	3.5	3.5	–	–
MCPA	pints	1.5	115	–	–
Dalapon	1bs	1.0	1.0	Linubin 1.5	–

From A Report on Mahaweli Project: Stage II: Vol I of VIII
Appendix III

8 Farm Income

According to the cropping patters and based on the previously mentioned conditions, farm income per family can be calculated as follows:

[Pattern - I]

Crop	Yieled per Acre		Market Price (Rupee/Bushel)	Gross Income (Rupee)	Production Cost (Rupee)	Net Income (Rupee)
	(Bushel)	(Acre)				
Paddy	80	2.5	33	6,600	2,945	3,655
Soyabean	15	2.5	84	3,150	1,826	1,324
Cowpea	12	2.5	128	3,840	1,683	2,157

[Pattern - III]

Paddy	80	2.5	3.3	6,600	2,945	3,655
Paddy	80	2.5	3.3	6,600	2,945	3,655

The annual net farm income of Pattern-I per family is 8,136 rupees and of Pattern-III is 7,130 rupees.

According to the Socio-Economic Report on the Ingimimitiya Reservoir Bed Area, the average farm family income is less than 1,800 rupees at the minimum (600 - 700 rupees when we asked the villagers.) This mean the completition of the project would boost their income 4 to 10 times.

9 Training Programs

The breakdown of the training program is as follows:

1 Farmer's Training:

a) Training of Settlers before settlement.

b) Periodic training of settlers after settlement.

c) Training of leaders.

2 Training of Project Personnel

a) Special training preceding Project work.

b) In-service training.

Training of settlers prior to their settlement in the project area will be conducted in groups of about 30 farmers each to be continued for about a week. (The Land Commissioner says 2 weeks.)

The farmers will be oriented about the new farmers' organization and system; the significance of village community development; the fact about water utilization program; updated farming techniques and recommended cropping patterns; the probably relationship between farmers and project technicians and officers; facts about the farm test laboratory and also the functions of the Community District Development Office. The training sessions also include visits to various sites, etc.

The Post-settlement Periodic Trainings will be offered to 15 - 20% of the farmers on new cultivating techniques and effective water management.

Also trainings will be held to allow selected leaders to understand more thoroughly the significance and the responsibility of the important co-operatives organized by the farmers.

Training sessions, directed to government people to understand their responsibilities and roles in their work, will emphasize the importance of relationship between them and the settlers.

10 Project Maintenance

The Department of Irrigation is responsible for the maintenance of the Project; planning the cultivation dates, water issue dates, and farm machinery procurement plans; and helping farmers obtaining cultivation loans in coordination with the Cultivation Committee under the Agricultural Productivity Committee organized by elected farmers and presided over

by government agents.

6 - d Economic Evaluation

1 Construction Cost

The construction costs estimated for this project are as listed in Table-10. However, Annex-5 of the Report on Inginimitiya Reservoir Project gives in detail the construction estimates. And based on the followings given below, the estimates are seemed to be reliable:

(1) The Ministry of Irrigation, Power & Highways of Sri Lanka is highly seasoned in computing estimates based on wide and long experience in constructing and developing projects of the same nature, including the Rajangana Project.

Furthermore, the Ministry is directly in charge of all operations in this project. The Ministry's Department of Irrigation looks after all irrigation facilities. And the Ministry's Land Development Department directly supervises the development of land, and the construction of buildings and roads in the settlement scheme master-minded by the Irrigation Department.

(2) The estimates are made with computations based on actual costs to construct the similar Wahakade Scheme, converted to updated rates.

(3) The unit costs of the construction equipment and machinery accounting for 55% of the total foreign cost for this project are based on the most recent international tender showings in Sri Lanka. (April 1974 . . . IDA Loan.)

The breakdown of the prices and costs of construction equipment and machinery is as follows: (The showings of international tender for IDA Loan as listed in Reference 25 served as the basis of the estimates.) ((Problems do remain when this project is subjected to the LDC United Loan)) Refer to III-4-4 which quotes the problems.

Equipment and Machinery	Number of Machine	Price per machine in U.S. $	Total Price in US $
Tractor Cl.I	8	110,000	380,000
Tractor Cl. II	5	50,000	250,000
Scraper	3	60,000	180,000
Motor Scraper	9	100,000	900,000
Sheep foot roller	2	100,000	12,000
Motor Grader	2	40,000	80,000
Excavator	2	100,000	200,000
Lorry Tipper	9	5,000	45,000
Compressor	4	20,000	80,000
Jack Hammer	8	600	4,800
Shovel Loader	1	55,000	55,000
Euclid Rear Dumper	8	55,000	440,000
Crusher	1	30,000	30,000
Pump	4	2,200	8,800
Water Bowser	2	7,000	14,000
Fuel Bowser	2	7,500	15,000
Jeep	6	3,000	18,000
Concrete Mixer	2	1,500	3,000
Agricultural Tractor	9	2,500	22,500
			3,238,100
		Add 10% for price escalation	323,810

Note: 1 U.S. $ = Rp. 8.66 The cost of machinery = Rs. 30.8m.
Allow a 40% salvage value on the machinery after the complection of the project.

Therefore the cost of machinery used on the project
= (30.8 - /2.3) = Rs. 18.5 million

The operating costs of the construction equipment and machinery are based on the "Evaluation of Unit Prices and Rate Analysis" (Reference No.30) compiled by the Irrigation Department.

2 Benefit

The farm production estimates after the termination of the project work (with future) are given below. As the farm output today in the Inginimitiya area is so small (without future) as to be "negligible," it can be rated "zero." Therefore, the amount of farm product gained after the project work as 'increased profit amount' when computing the IRR'

Item/Crop	Acre	Unit Cost Bushel/ Acre	Cost Rupee/ Bushel	Gross Production Product Cost Net Farm			Net Farm Products
				Rupee/ Acre	Rupee/ Acre	Rupee/ Acre	Proj. Area 1000 rps.
Maha Season	6,300	80	30	2,640	1,050	1,590	10,017
Paddy	6,300	80	30	2,640	1,050	1,590	10,017
Yala Season							
Paddy	4,500	80	30	2,640	1,050	1,590	10,017
Soya Beans Pulses	1,800	15 cwt	84 rps/cwt 128 rp/cwt	1,400	650	750	2,700
Sub total	6,300						
Total							19,872

The area of arable land depends on the flux condition of the Mi-Oya, the major water suppling river. The output estimate of each unit is based on the hypothesis deriving from test results at the Maha Illupallama Agricultural Experiment Station and the achievements registered at the neighboring Rajagana Project, a scheme of the same nature.

The market price of paddy set by the government is 3.3 rupees per bushel. Converting this into the price of unhusked rice (Conversion Rate 0.69) 1 bushel = 450 lbs. = 20.43 kg Therefore, it will be $270/t. (Exchange rate: 1 US Dollar = 8.66 rupees)

With regard to the market price for paddy to figure out the internal rate of return, it is considered most appropriate to quote the world market price for paddy cultivated in the project area which is intended to supplement import of rice. The World Bank forecasts the world market price for rice at $280 in 1977 per ton and $240 per ton in 1985.

Therefore, the paddy price quoted in the Report and that forecast by the World Market are virtually the same even if the former includes the internal rate of return.

The governmental Report on Inginimitiya Reservoir Project estimates the paddy output per acre as 1,050 rupees. ($121). This figure is higher than those estimated in other similar projects in Southeast Asia and in the World Bank Project in Sri Lanka.

3 Economic Justification

Annex 7 of the Report on Inginimitiya Reservoir Project carries in detail the economic justification of the scheme. Annex 7 also shows the computations of Benefit Cost Rate and Internal Rate of Return. The calculation of Internal Rate of Return is as follows:

Table 12. Calculation of Internal Rate of Return on Actual Values
Assuming 90% success of Cultivation
(Assuming 90% success)

Year	Total Cost	Total Income	Net benefit	Present Value @16%		Present Value @18%	
				P.W.F.	P.V.	P.W.F.	P.F.
1	6,000		−6,000	0.862	−5,175	0.847	−5,100
2	19,750		−19,750	0.743	−14,650	0.719	−14,200
3	27,449		−17,449	0.641	−17,650	0.608	−16,700
4	14,600	7,950	−6,650	0,552	−3,670	0.516	−3,430
5	17,375	17,250	−125	0.476	−59	0.437	−55
6	17,776	24,600	6,824	0,411	2,810	0.371	2,530
7	13,095	27,800	14,705	0.354	5,200	0.314	4,625
8	14,040	29,600	15,560	0.305	4,780	0.266	4,150
9	14,310	30,200	15,890	0.263	4,175	0.225	3,575
10				1.639	26,000	1.060	23,600
44	4,000		(−4,000)	(0.002)	−8	(0.0006)	−2
50							
					1,753		−1,007

The project cycle is 50 years. Replacement of sluices and other machinery in the 44th year is also appropriated.

7. Further Study

7 - a Dam Construction

1 Examination of dam core

Geological surveys were conducted in the past to select the core of dam and to investigate the possibilities of two dam site proposals: the downstream dam (boring work conducted in 1967 depth 55' - 87 ft/bore) and the upstream dam (boring conducted in 1968: 30' - 108 ft/bore). The surveys revealed that the foundations of spillways of both proposed sites were too deep thus hampering smooth construction work and lead to the selection of a new site (the present site).

Geological survey of the present proposed site is yet incomplete, and boring of four holes from stop the spillway core has been conducted. (Depths 32 - 90 ft/bore) The quality of the bedrock has been confirmed. (Refer to attached sheet)

According to the results of our field investigations, provided there will be no substantial change in the position of the dam core, we intend to propose a partial modification

with regards to the dam core from the standpoints of economy and construction work efficiency.

In other words, in the reservoir bed area, there is a small tank with a bank height of 10 meters and a length of 1 kilometer. There should be ways to make the best use of this existing inverse-arch dam (although not in a perfect state) situated so close to the proposed dam site by considering the possibility of building the projected dam along the old existing one as its compound oblique section. (Comparative studies should also be conducted on the work at the left bank flank of the dam when making the best use of the old tank. Simultaneously, further studies are necessary to determine the height of the bank and the pondage.)

When considering the dam core, the bedrock survey of the dam core, and the component and soil analysis plus water leakage survey of the old dam should be included.

2 Studies on Dam Type

According to the Safety Analysis Material for the Reservoir Project:

(1) The dam height is consistently 59 feet with a circular arc crest with a sliding surface.

(2) It is assumed that the materials of earth embankment and of the foundation of the dam are of the same characteristics.

(3) A seepage line is drawn at points one third of the vertical distance between the maximum water surface level on the upstream side and the foundation level on the downstream side.

(4) B (pore water pressure coefficiency) is consistent even during construction work.

(5) The cohesion coefficiency of material is $C' = 1.150$ lbs/ft^2. $\Phi' = 0.435$ radian γ moist = 133.0 lbs/ft. (It is important to clarify the determining basis of design values after analyzing the results of soil survey.)

(6) The minimum factors of safety of the upstream slope of 1 on 3, the downstream slope of 1 on 2.5 and the 20 feet wide roadway on its crest are:

a) During construction work = 2.24

b) Stable seepage time = 2.13

c) Rapid water-level drop = 2.20

According to these analytical results (including the hypothetical conditions) as the minimum safety factors appear to be large, it is necessary to conduct further studies on the dam-

type by bearing in mind the safety, exectuion and economy of the work by clarifying the determinig factors of design values after viewing the analysis of the soil survey test.

3 Dam Foundation Study

As the basic idea of dam foundation boring is indicated in the attached standard dam plan, the core trench will be excavated to bedrock of 1/3 (1/3 H) to height (H) of dam. Soil surveys, (permeation tests and electric investigations) are not yet conducted. Therefore, the property and mechanics of the foundation soil must first be clarified to throughly discuss the necessity of trench cut. In the meantime, further sutides of the foundation processing methods (blanket cut-off, grouting, etc.) should be considered.

4 Study of Spillway Design

The spillway in this project is designed as 2,000 feet-long (clear overflow uncontrolled type) with identical cross section specifications throughout the length with an overflow depth of 4 feet. But the spillway borings revealed that the bedrock depth was inconsistent, being deeper towards the right bank. Therefore, it is necessary to consider the safety, work execution and economy of the spillway by narrowing down the width and introducing a sluice at the spillway.

5 Borrowing Areas

The project plan includes the construction of borrowing areas at two locations where soil survey has already been conducted: (left bank: 5 pits 55 holes of auger boring) (right bank: 4 pits: 59 holes, auger boring). The work at the right bank which is at a lower level (the same with the dam base level) poses problems with regard to work execution. However, an appropriate borrowing area can be considered at the mid-section on the upstream side (high level). Thus further considerations should be made on the material, work execution and economy of this new borrowing area.

7 - b Water Balance

The computations for required water volume are:
The basis of calculation:

(1) ETo is computed by the Panman Method (FAO). The climate data is based on those of a typical Dry Zone in Sri Lanka.

(2) The Evaporation Crop Factor is based on FAO data and also on all available regional data.
ET crop = ETo x Crop Factor

(3) Effective rainfall (ER) is 75% of the mean rainfall in the past 20 years, a probably criteria. The effective rainfall in Uduwil is computed as follows:

Paddy ER = (R−1) x 0.67
ER = 9" (When ER is larger than 9")
ER = 0" (When R is smaller than 1")

Field ER = (R − 0.25) x 0.67
ER = 3" (When ER is larger than 3")
ER = 0" (When R is smaller than 1")

(4) Required water volume for land improvement preparation for paddy: 7"

(5) Required water volume for land improvement preparation for farm field: 1.5"

(6) Paddy field percolation volume 6'/month

(7) Farm field percolation volume and loss 50% of required irrigated water.

(8) Required water volume for nursery beds can be obtained from the following equations:

(a) Field

Required water volume in nursery bed =
(ET-ER) x 100/50 + Needed Water Volume for Land Improvement Preparation

(b) Paddy

Required water volume in nursery bed =
Needed Water Volume for Land Improvement Prep.
+ ET crop Evaporation quantity
+ Percolation volume − ER (effective rainfall)

(9) Tank Duty is 30% plus Required Water Volume for nursery beds.

(Computation examples)

(a) Field cultivation: April: Soyabeans (See Crop Calendar)

Evaporation Volume = 1/3 (1.05 x 5.9 x 25/30 + 0.75 x 5.9 x 5/30)
+ 1/3 (1.05 x 5.9 x 30/30)
+ 1/3 (0.85 x 5.9 x 5/30 + 1.05 x 5.9 x 5/30)
= 6.00"

Effective rainfall ER = 2.31
Land Improvement Preparation = 0
Required Water Volume = (6.0 – 2.31) x 100/50 = 7.3"
Tank Duty = 1.3 x 7.3 – 9.6"

(b) Paddy field cultivation: April (See calendar)

Land Improvement Preparation = 0 + 0 + 7/4 7/4 = 3.5"

Evaporation = ¼ (1.00 x 5.9 x 5/30 + 1.15 x 5.9 x 25/30)
+ ¼ (1.00 x 5.9 x 20/30 + 1.12 x 5.9 x 10/30)
+ ¼ (1.0 x 5.9 x 15/30)
+ ¼ (0)
= 3.92

Percolation and loss = ¼ (6 + 6" 6/2 + 0) = 3.7"
Effective rainfall = 1.37
Required Water Volume = 3.5 + 3.92 + 3.7 – 1.37 = 9.3"
Tank Duty = 1.3 x 7.3" = 12.1"

Land Use Department, Colombo.

The water requirement computation is based on the river hydrometry at Mahauswewa where the maximum and minimum rates of flow register a great difference (twenty times) over 20 years. This indicates that there is a marked difference in annual mean flow rate over the years. Therefore, we suggest an introduction of a longer period data to verify the flow rate.

Therefore, the flow rate should be estimated on the correlative basis of mean rainfalls and flow rates observed at Mahauswewa, Galgamuwa and Mediyawa checkpoints over a long period.

Also to secure the necessary water volume, additional care must be exerted to check the possibility of any water leakage from anywhere near the reservoir.

7 - c Farming

The majority of basic materials related to farm management in Sri Lanka was based on the Mahaweli Development Project Report State 2. With regards to farm cultivation information, we had relied greatly on to the results of farm tests at Maha Illppallama.

In the meantime, with regard to the present level of farming techniques and management of the expected resettlers (new settlers), it is of importance to reappraise the adaptability of the colonists to the intensive farming centering on paddy cultivation in view of the size of farmland alloted to each family.

On the other hand, to realize rapid increase in per-acre production and per-family income, it is necessary to review and reconsider our proposals on technical suggestions, water distribution & crop cultivation plans, positive farm management guidance and various productio activity plans.

7 - d Economic Evaluation

1 Computation of Pricce Contingency

The Report sets aside 10% for Price contingency for imported equipment and machinery. But as the work schedule requires the procurement of such equipment and machinery from the second year after commencement of work, the budget appropriated for these items may be insufficient.

The World Bank anticipates the rice in commodity prices as follows:

	1977	1978	1979	1980
Civil works	14	12	12	12
Equipment	10	8	8	8

Therefore, it is necessary to compare the evaluations prepared by the Sri Lanka government with our Price Contingency calculations based on the reference material provided by the World Bank with respect to the FIO of foreign cost in making final estimates of the total construction cost. Also special attention must be diverted to the double checking of the expenses for construction equipment and machinery.

2 Unit Price of Construction Machine

The estimated unit price listed in the Report for construction machinery is based on the figures of the recent international tender held in Sri Lanka. When the prices quoted in the Sri Lanka Government's report are compared with Japan's public announced prices for the same machinery (as of June 1976), they are 10 to 20% cheaper as listed below

Machinery	Model	Sri Lanka's Report (1)	Public Price in Japan (2)	Ratio 1/2
Tractor Class I	Komatsu D-155 300PS 38.6t	¥33,000,000	¥37,600,000	0.88
Tractor Class II	Komatsu D85-12 180PS 25t	¥15,000,000	¥20,900,000	0.72

Usually in yen credit, records show that the prices are useally 20 to 30% higher than the Japanese public announced prices due to expenses for transportation and insurance. Therefore the prices quoted by the Report are expected to be checked up from between 40 and 70%.

3 Determination Imported Components and Quantity

Table 13. Foreign Exchange Costs of the Project
(Based on the Report on Inginimitiya Reservoir Project)

No.	Item	Content	Price MRs	Price $	Direct or Indirect
1.	Machinery	87 units less 40% residual value	18.500	2,136	D
2.	Fuel	Diesel Oil 5.17 M.gal x 3Rs/gal =15,810			
		Lubicant 91,000 gal x 10 Rs/gal =0.914	16.725	1,931	I.D.
3.	Cement Steel	15,000 cubes x 13 bag/cubes x 14 Rs/bags = 2,730			
		Steel: ohe set = 0.770	3.500	404	I.D.
4.	Spare parts		2.700	312	D
5.	Tools, accessories and Surveying instruments		1.250	144	D
6.	Blasting material		0.500	58	D
7.	Generators, electrical fittings and other accessories for buildings, etc.		0.750	87	D
8.	Foreign component of sluice		0.225	26	D
	Total		44.150	5,098	

Cement and steel are indirect foreign cost. (No. 3) But in the past, indirect foreign cost is rarely a subject to Yen-credit. And when oil procurement is based on the Credit and becomes LDC Untied, it is most likely to be exempted from the foreign cost list. Thus further studies of the subject are needed.

Attached I

23rd of December, 1976

Mr. T. Sivagnanam,
Secretary,
Ministry of Irrigation, Power and Highways

Dear Sir,

Re: SUMMARY OF PRELIMINARY SURVEY ON INGINIMITIYA RESERVOIR PROJECT IN THE REPUBLIC OF SRI LANKA

I have a great pleasure to submit herewith the summary of the Preliminary Survey on Inginimitiya reservoir project in the Republic of Sri Lanka carried out by the survey team from the Government of Japan, just before our leaving.

The contents, however, are tentative and accordingly subject to be modified on making the report.

I wish to express our hearty gratitutde for your cooperation with us and your convenience and hospitability given us all through the survey.

I remain,

Respectfully yours,

Isamu SAKANE

Leader of Japanese Preliminary
Survey Team for Inginimitiya
Reservoir Project in Sri Lanka

Summary of the Preliminary Survey on

Inginimitiya Reservoir Project

23rd of December, 1976

Japanese Preliminary Survey Team for

Inginimitiya Reservoir Project in Sri Lanka

1. Objectives of the Survey

In response to the request from the Government of Sri Lanka for financial assistance for the implementation of Inginimitiya Reservoir Project, the Government of Japan decided to send a preliminary survey team consisting of six members to the Government of Sri Lanka from December 13 to December 23, 1976.

The objectives of the survey team are as follows:

(1) To confirm the detailed contents of the request for Inginimitiya Reservoir Project.

(2) To explain the technical and financial assistance system by the Government of Japan.

(3) To grasp the present conditions and the existing problems in the agricultural development by data collection, site reconnaissance survey, and interviews.

(4) To review the F/S Report prepared by the Ministry of Irrigation, Power and Highways.

(5) To study and find out the forthcoming step so as to meet the above mentioned system.

(6) To provide the sufficient informations concerning of the project to the Japanese Authorities concerned.

2. Findings and suggestions

(1) It is necessary to confirm the available water volume being affected by co-relation of river discharge and rainfall, and by percolation and seepage from reservoir.

(2) Further study analysis on construction cost and stability of the dam are seemed to be required.

(3) Better water management must be introduced into the project area to minmize water losses.

(4) Land Utilization programme should be established not only by soil classification but also by irrigability in the project area.

(5) Referring to the effective use of water for agriculture production, the followings are to be mentioned:

(1) to import a intensive pre-training on the water management and regular maintenance of field channels to the settlars,

(2) to demonstrate an economical water use on the field level,

(3) to execute the in-service training of officials,

(4) to establish the disciplins for water management on field level.

(6) Cost estimate of price contingency

Cost of price contingency has not been calculated as separate item but as allowance of unit cost in each item.

However, taking the price increase ratio of recent years into consideration, the figure above estimated in the F/S Report seems to be small.

Appropriate price contingency based on the correct data should be re-estimated prior to E/N.

(7) Basis of foreign currency costs

Some amount of foreign currency costs estimated on a percentage basis.

In order to smooth the procedure for the loan, foreign currency costs should be estimated at every materials concreatly.

(8) Foreign fund requirement

Total amounts of foreign fund requirement needs to be re-estimated after the further study of (5) and (6).

3. Member of the survey team

Mr. Isamu SAKANE	Leader	Senior Officer of Agricultural Civil Engineering, Land Development Division, Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture and Forestry
Mr. Shigeru NAKASHIOYA	Irrigation	Chief of Third Design Supervising Section, Design Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture and Forestry

Mr. Norio CHIDA	Agronomy	Senior Technical Staff, Education and Training Div., Uchihara International Agricultural Training Centre, Japan International Cooperation Agency
Mr. Kooichiro OHTUSKI	Planning	Chief of Financial Cooperation Section, International Cooperation Div., International Affairs Dept., Ministry of Agriculture and Forestry
Mr. Akio SATO	Economic Evaluation	Deputy Manager, Technical Div., Economic Research and Technical Appraisal Dept., Overseas Economic Cooperation Fund
Mr. Hidetoshi YAOI	Coordination	Officer, Technical Affaris Div., Agricultural and Forestry Planning Survey Dept., Japan International Cooperation Agency

4. List of collected data

1. The Uhana Colony Village (Case study No. 2)
2. New Settlement Schemes in Sri Lanka (Research Study No. 5)
3. A Study of Agricultural Extension Training and Communication in Colombo Dist. (R.S.S. No. 15)
4. Socio-economic Survey of the Beminiwatte Agricultural Productivity Committee Area (R.S.S. No. 13)
5. Land Settlement in Sri Lanka (R.sS.S. No. 16)
6. The Role of Statistics in Research (Occasional Publication Series No. 12)
7. Production of other crops in paddy field in Yala 1972 (R.S.S. No. 4)
8. Cost of production of paddy Yala 1972 (R.S.S. No. 1)
9. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
   (Part 1 Hambanteta Dist.) (R.S.S. No. 6)
10. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
    (Part 2 Kandy Dist.) (R.S.S. No. 7)

11. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
(Part 3 Polonnaruwa Dist.) (R.S.S. No. 8)

12. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
(Part 4 Anuradhapura Dist.) (R.S.S. No. 9)

13. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
(Part 5 Colombo Dist.) (R.S.S. No. 10)

14. The Agrarian situation relating to paddy cultivation in five selected Dists. of Sri Lanka
(Part 6 Comparative analysis) (R.S.S. No. 11)

15. Sri Lanka and the International Food Crisis (Occasional publication S No. 11)

16. Agricultural implementation programme 1976/77

17. Half yearly Report, Maha - 1975/76

18. Thannimurrippu paripalana sabai (O.P.S. No. 1)

19. The role of Cultivation Committees in Agricultural planning of Village Level (O.P.S. No. 3)

20. Fragmentation of paddy land (O.P.S. No. 5)

21. Socio-economic factors in rural indebtedness (O.P.S. No. 7)

22. Water management and paddy production in the dry zone of Sri Lanka (O.P.S. No. 8)

23. A study of seven selected Agricultural Productivity Committees and Cultivation Committees (O.P.S. No. 9)

24. Some aspects of paddy and rice marketing in Sri Lanka (O.P.S. No.10)

25. International Bidding of Machinery under I.D.A. Loan

26. List of Machinery and Equipment for Land Development Work

27. List of Machinery and Equipment for Construction Work (Other than L.D.)

28. Annual foreign exchange cost of the Project

29. WAHAKADE WEWA SCHEME – Comparative statement of expenditure and revised estimate

30. Irrigation Department – Evaluation of unit prices and rate analysis.

31. Specification, schedules and drawings for the construction of the spillway dam and irrigation intakes Rajangana Reservoir

32. Estimates of the revenue and expenditure of the government of the Republic of Sri Lanka for the Financial Year, 1st January 1976 to 31st December 1976. (Volume I)

33. MAHAWELI GANGA DEVELOPMENT
Project 1 F/S for Stage 11
Volume I – Feasibility Report
(Volume I of D111)

34. MAHAWELI GANGA DEVELOPMENT
Volume II – Agriculture

35. MAHAWELI GANGA DEVELOPMENT
Volume III – Land Classification

36. MAHAWELI GANGA DEVELOPMENT
Volume IV – Land Classification (Maps and Tables)

37. MAHAWELI GANGA DEVELOPMENT
Volume V – Engineering Report

38. MAHAWELI GANGA DEVELOPMENT
Volume VI – Engineering Drawings

39. MAHAWELI GANGA DEVELOPMENT
Volume VII – Settlement Planning and Development

40. MAHAWELI GANGA DEVELOPMENT
Volume VIII – Marketing and Credit

41. Sri Lanka Year Book 1975

42. Central Bank of Ceylon, Review of the Economy 1975

43. Statistical Abstract of Ceylon 1970 - 71

44. Statistical Pocket Book of Sri Lanka 1975

45. Country Report from Sri Lanka for World Water Conference

46. Aerial photograph (Indicator Map)