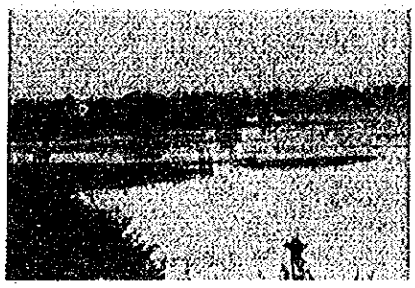
スリランカ共和国
インギニミチヤ灌がいダム計画事前調査
報　告　書

昭和52年1月

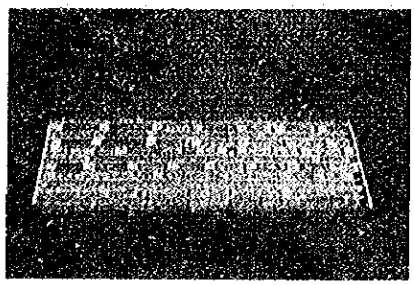
国際協力事業団



（写真－１）　INGINIMITIYA WEWA（貯水池）

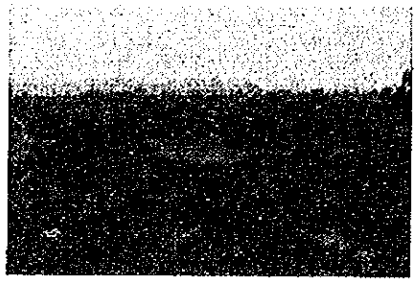
（写真－２）　同　　上　（現存土延堤）

（写真－３）　同　　上　（余水吐予定地）
（３－Ａ）



（写真－３）　（ボーリングコアー）

（写真－４）
下流に点在
する水田

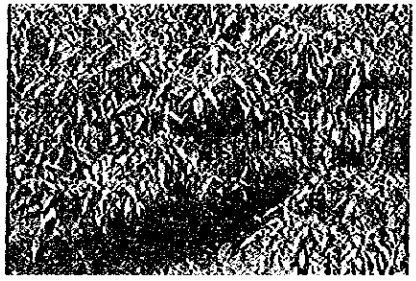


（写真－５）
予定地附近の
ジャングル

（写真－６）
予定地区内の
住民

（写真－７）
水田代かき
作業

（写真－８）
カウピー
（じゅっこくササゲ）



（写真－９）
トウガラシ

〔 単　位　表 〕

1. 重さ・長さ・広さ

1エーカー(Ac)	＝	0.405ヘクタール
1マイル	＝	1.609キロメートル
1平方マイル	＝	2,859平方キロメートル
1フィート	＝	0.3048メーター
1エーカー・フィート	＝	1233.5立方メートル
1キュブ(cule)	＝	2.83立方メートル
1インチ	＝	25.4センチメートル
1キューセック	＝	0.0283立方メーター／秒
1ポンド	＝	0.4536キログラム
1 cwt	＝	50.80キログラム

2. 通　　貨

1米ドル ＝ 8.66ルピー

1ルピー ＝ 0.115米ドル

3. そ の 他

1ブッシェル(籾)＝46ポンド≒20.87キログラム

ヤラ季(Yala Season) ＝ 10月～3月(北東モンスーンによる雨季)

マハ季(Maha Season) ＝ 4月～9月(乾季　但しWet Zone では南西モンスーンによる降雨がある)

はじめに

スリランカ共和国は，ゴム，紅茶，ココナッツ等の輸出により，外貨の大部分を取得しているが，国民の主食である米の不足は著しく，その輸入のために多額の外貨を消費し，将来ともその傾向は持続されると予測されている。

このような情勢をふまえ，同国は昨年１１月バンダラナイケ首相の訪日を機に同国中西部に位置するインギニミチヤ貯水池の建設による米の増産を企図した計画を策定し，わが国にそのための調査の実施を要請してきた。

わが国政府は同首相来日の際の「日・ス共同コミュニケ」に基づいて事前調査を実施することを決定し，昭和５１年１２月１２日から１５日間に亘り，農林省構造改善局建設部開発課農業土木専門官坂根勇氏を団長とする６名のインギニミチャ灌がいダム計画事前調査団を派遣した。調査団は，本格調査に先立って現地を視察し，同国の農業政策における本プロジェクトの位置づけ範囲，問題点を明らかにするとともに，本格調査の調査範囲，調査項目および内容等に関し調査を行った。

ここに提出する報告書は，その結果結果を取りまとめたものである。この報告書が今後予定している本格調査の準備に役立つことを信じるものである。

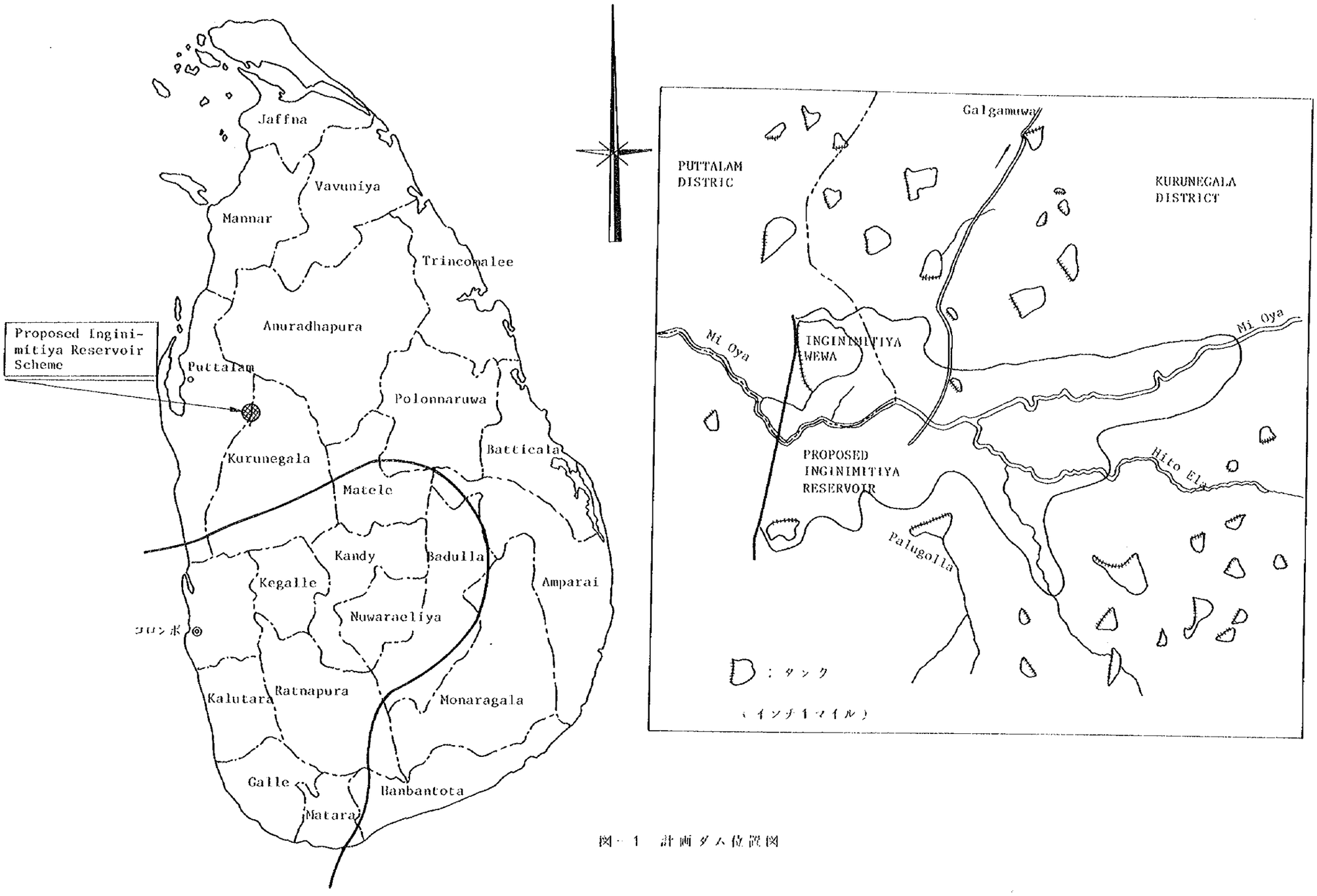
なお，この調査の実施に際し，積極的なご支援と，ご協力をいただいた在スリランカ日本大使館，外務省，農林省の関係各位ならびに熱帯農業研究センター後藤研究員に対しここに深甚の謝意を表明するものである。

昭和５２年１月

国際協力事業団

総裁　法眼晋作

スリランカ



図－1　計画ダム位置図

〔 目　　次 〕

附属資料

1. 収集資料リスト
2. 入札実績表
3. Report on Ioginimitiya Reservoir Project

（図　表　索　引）

I　序　　文

1. はじめに

スリランカ共和国バンダラナイケ首相がわが国政府の招待により１９７６年１１月１２日から１８日までの間わが国を正式訪問された。その際三木前総理大臣に対してインギニミチヤ貯水池計画他２案件についてわが国政府からの資金供与を願望され，１９７６年１１月１７日の共同コミュニケに盛り込まれた。

この共同コミュニケをうけて計画の実施可能性を確認すべく１９７６年１２月１２日から２５日までの間，私他５名の優秀な専門家よりなる事前調査団が編成され現地において事前調査を行ったのである。

出発前，十分な準備をする時間的な余裕もなく，その上，スリランカ政府の受入れ態勢にも若干の不安を抱きつつ慌しく飛び立ったのである。しかし，我々がスリランカ国に到着直後かんがい電力道路省の次官から会談の申し入れがあり，席上事前調査団に対するスリランカ政府の期待とあわせて，共同コミュニケから事前調査団派遣までのかが国政府の取った機敏な措置が高く評価された。調査開始以来，スリランカ政府の友好かつ積極的な対応によって我々の取越苦労は解消し，十分な調査成果をあげることが出来たのである。

スリランカは熱帯地域に位置している関係上，一般的に自然条件に恵まれているが，稲作を中心とした営農を行うためには水が必要であるにもかかわらず降雨が偏るため国土の $3/4$ は水不足地域である。米を主食とするスリランカは毎年大量の米不足に直面しており，毎年外国からの輸入に依存している。このため同国の乏しい外貨の大半は食糧の輸入に費やされることになり，このことが経済開発を制約させるを得ないのが現状である。このために灌がい施設を完備して農地の開発をすすめ，慢性的な食糧不足を解消するとともに失業問題の解消につとめる必要がある。

本プロジェクトはかゝる国状を背景として策定されたもので，水の確保が計画中最も重要な位置付けがなされており今後十分な検討を考えてまいりたい。

本事前調査を行うにあたり多大のご協力を賜わりました関係各省国際協力事業団の担当者，吉岡大使をはじめとする在スリランカ日本大使館員ならびに熱帯農業研究センター派遣後藤研究員スリランカ政府関係諸機関の方々に対し団員一同に代り心から感謝申し上げるとともに，スリランカ農業の発展のために一層のご支援をお願い申し上げます。

インギニミチヤ灌がいダム計画事前調査団

団長　　坂　根　　勇

2. 経緯および目的

1. スリランカ共和国，バンダラナイケ首相一行が日本政府の招待により昭和５１年１１月１２日から１１月１８日まで日本を公式訪問した。

2. 同年１１月１７日発表された「日・ス共同コミュニケ」で，

(1) インギニミチヤ貯水池計画

(2) コロンボ郊外電話網拡充計画

(3) 漁網工場計画

についての協力要請があり，これを受けて，国際協力事業団は１２月１２日から１５日間，スリランカ共和国へ，インギニミチヤ灌がいダム計画事前調査団を派遣した。

3. ５１年末に派遣を予定されている実施調査に先立ち派遣される本事前調査団の目的を下記のごとく設定した。

(1) スリランカ共和国政府の協力要請の具体的内容を確認する。

(2) 同国の農業政策における本プロジェクトの位置付け，範囲，問題点を明らかにする。

(3) 提出のあった報告書（Report on Inginimitiya Reservoir Project）をレビューし，実施調査の調査内容および項目を検討し，それに関する資料，基礎データーを収集する。

(4) 日本側の技術協力および資金協力制度を充分にスリランカ共和国政府へ説明する。

3. 調査団団員

1. 団　長　　坂　根　　勇　（総　括）
　　農林省構造改善局建設部開発課農業土木専門官

2. 団　員　　中塩屋　　茂　（灌がい）
　　農林省構造改善局建設部設計課設計審査第三係長

3. 団　員　　千　田　徳　夫　（栽　培）
　　国際協力事業団内原国際農業研修センター研修室技術参事

4. 団　員　　佐　藤　昭　郎　（経済評価）
　　海外経済協力基金調査開発部開発課長代理

5. 団　員　　大　槻　幸一郎　（協力企画）
　　農林省農林経済局国際部国際協力課資金協力係長

6. 団　員　　矢　追　秀　敏　（調　整）
　　国際協力事業団農林業計画調査部農林業技術課職員

4. 調査行程

日順	月・日	内容	滞在地
1	12月12日(日)	東京 → シンガポール （JL711）	シンガポール
2	13日(月)	シンガポール → コロンボ （SQ581）	コロンボ
		大使館訪問，表敬，日程および調査内容打合せ	
3	14日(火)	灌がい電力道路省，灌がい局およびマハウェリ開発庁（Mahaweli Development Board）訪問，事情聴取，調査項目，関係要求資料について団員打合せ	〃
4	15日(水)	人民銀行（People's Bank），および経済企画庁（Ministry of Planning and Economic）訪問，灌がい局にて調査作業	〃
		大使主催による夕食会	
5	16日(木)	協同組合コミッショナー（Commissioner of Cooperative），土地コミッショナー（Land Commissioner）および農業土地省訪問	〃
		灌がい局長主催による夕食会	
6	17日(金)	〔現地踏査〕 1／17日～1／19日 2泊3日 プロジェクト地区（ダムサイト，ボーリング現場，農協，農家）視察	アヌラハプーラ
7	18日(土)	マパイルパラマ 農業試験場視察 カラウェワ開発地区視察 ポルゴラ計画視察	キャンディー
8	19日(日)	ポルゴラ計画 ― 取水施設を中心に ― 視察	コロンボ
9	20日(月)	灌がい局にて調査作業	〃
10	21日(火)	千田団員は農業土地省，大槻団員は林野局にて調査作業，他団員は，灌がい局長とレポートについて打合せ	〃
11	22日(水)	レポート作成，資料収集	〃
		団長主催による夕食会	

日順	月・日	内容	滞在地
12	12月23日(木)	大使館吉岡大使，在口書記官へ調査報告 灌がい電力道路省へ報告書提出および帰国挨拶 灌がい局長訪問帰国挨拶 資料収集	コロンボ
13	24日(金)	コロンボ → ホンコン	ホンコン
14	25日(土)	調査内容取りまとめおよび報告書作成	〃
15	26日(日)	ホンコン → 東京	

5. 訪問機関および面接人

1) 訪 問 機 関

(1) Ministry of Irrigation, Power and Highways

(2) Irrigation Department, Ministry of Irrigation, Power and Highways

(3) Mahaweli Development Board, Ministry of Irrigation, Power and Highways

(4) Department of Agriculture, Ministry of Agriculture and Lands

(5) Department of Forest, Ministry of Agriculture and Lands

(6) Land Commissioner's Department, Ministry of Agriculture and Lands

(7) External Resources Division, Ministry of Planning and Economic Affairs

(8) Ministry of Cooperative and Small Industries

(9) People's Bank, Ministry of Finance

(10) Maha Illupalluma Agricultural Research Station

(11) Agrarian Research and Trainning Institute

(12) Central Agricultural Research Institute

2) 面 接 人

Ministry of Irrigation, Power and Highways

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

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

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

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

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

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

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

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

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

(10) Dr. W.D. JOHSUA
Acting Head (Land Use), Irrigation Department

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

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

(13) Mr. K. SUBRAMANIAM

District Irrigation Engineer (Machinery),
Irrigation Department

(14) Mr. V. THURAIRAJAH

District Irrigation Engineer (Geology),
Irrigation Department

(15) Mr. V. JAIRAJ

Irrigation Engineer, Irrigation Department

(16) Miss G.C. PADMASIRI

Irrigation Department

Ministry of Agriculture and Lands

(17) Mr. K.N. WEERACKODY

Additional Secretary

(18) Mr. W.R.D. RAJAKARUNA

Land Commissioner

Ministry of Food Cooperatives and Small Industries

(19) Mr. B.S. WYEWEERA

Commissioner of Cooperatives

(20) Mr. M.P. JAYA SINGHE

Deputy Commissioner of Cooperatives

Ministry of Finance

(21) Mr. RANJIT D. De LIVERA

General Manager of People's Bank

(22) Mr. NIHAL JAYAWARDANA

Assistant Chief Development Officer,
People's Bank

Mahaweli Development Board, M.I.P.H.

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

Ministry of Planning and Economic Affairs

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

Ⅱ　要　約

1．協力企画

米の総需要の３４％を輸入にたよっているスリランカ共和国は，食糧自給政策としての米作の推進を従来からの長年の懸案である国際収支の改善，農業所得の向上及び失業者の解消等の観点から国家の基本政策として重要な位置づけをしている。

本インギニミチヤ灌がいダム計画は，５１年秋に来日したバンデラナイケ首相からスリランカ国における米作の推進政策と密接な関係にあるという重要な位置づけに鑑み，政府間借款の可能性につき第１の優先度が与えられた案件として要請されたものでありスリランカ政府の日本政府に対する期待は大きいものといえる。

すでに，本計画についてのスリランカF／S レポートがスリランカ政府の手で完成されており構造物の設計・施行，入植計画，営農効果等が検討されており本計画の熟度は極めて高いとの感触を本調査団は得た。今回の事前調査で入手した数多くの資料を分析，検討する中で資金協力の分野について早急に実現に至る必要性があるものとの判断にたち，今後の調査等の迅速な対応を期待する。

なお，技術協力の分野についても資金協力と同様，今後の日本国とスリランカ共和国との友好協力を一層発展向上させるための方向づけが期待される。

2．灌　が　い

インギニミチヤ灌がいダム計画地域は北西州プットラム（Puttalam）地区のキリメチヤワ（Kirimetiyawa）とカランベ（Karambe），パトウス（Pattus）に位置している。貯水池の利用可能水位は２０２MSLで，有効貯水量は5,3000Ae.Ftである。かんがい面積は6,３００エカーでこの中4,５００エカーは雨期（マハ）と乾期（ヤラ）の両期間を通して水田として利用され，残りの1,８００エカーは雨期には水田として耕作され，乾期は大豆や雑豆が栽培される。

基幹施設として先ず土瓦堤が挙げられる。この土瓦堤は堤長が２マイル４７５０フィートで最大堤高は６０フィートあり，越流幅２０００フィートのコンクリート自然越流型余水吐と越流幅８００フィートの非常余水吐が計画されている。この外両岸取入水路，配水施設，耕作道，コミュニティセンター，学校，診療所などが入植者のために建設される。貯水池や開発地域の建設には５年半の歳月が必要である。そして入植者の入植は３年目から６年目にかけて行われ，４年目に初めての収穫が得られることとなっている。

(a) 基幹施設

主ダム堤の諸元は堤長２マイル４７５０フィート，最大堤高６０フィート，堤頂幅２０フィートで築堤土量は４１７,０００ cubes である。又コンクリート自然越流型余水吐は越流幅が２０００フィートで４０００ cubes のコンクリートを必要とし，８００フィートの越流幅をもつ異常余水吐を含めて１１２,０００ cubes の土工量となる。

取水工は両岸取入れのタワー式水門が設けられる。

(b) かんがい施設

６３００エーカーの新しい土地に導水するため水路の建設が計画されている。左岸水路の延長は１３マイルで右岸水路は 7.5 マイルである。左岸水路の底幅は１６フィート，水深 3.6 フィートであり，右岸水路は底幅１２フィートで水深 2.2 フィートである。

(c) 開　拓

かんがい計画地域はほぼ密林地帯であり，密林を切り開いて伐木，抜根，整地を行って耕地を造成する。

3. 農　業

本開発地域における高位生産の達成とその維持のための基本的条件として掲げられている（Report on Inginimitiya Reservoir Project 4.7），a）迅速な農地開発と入植の安定，b）効果的な C.C.(Cultivation Commitfee），A.P.C.（Agricultural Production Committee）及び協同組合の運営，c）営農資金や生産材のスムースな供給体制，d）運輸施設の改善，e）効果的な入植者の訓練等，これら個々についての具体的実施計画が立案されなければならない。

その為には，本プロジェクトの実施機関を現有の District の出先機関をもってあてるか，あるいはプロジェクト専任機関を設立してこの業務にあたらせるかの決定が高位生産の達成とその維持への緊急な課題である。

(1) 入植者は計画貯水池内に居住する５ケ村の１８７家族及び他の入植家族（従来の慣例から主として周辺地域から募集）の合計 2,５００家族約 6,０００人を予定している。

(2) 経営面積は一戸当り 2.5 エーカー（Mahaweli Project の場合，家族労働主体で３エーカー）で家族労働主体の計画である。

(3) 導入される作付の体系は土壌，水利等の条件から三つのタイプに分類されるが，水稲二期作の計画が全体の約７０％を占める。他の地域においては Maha 期の水稲プラス Yala 期における棉，もしくは大豆，カウピーが計画されている。

(4) 作物毎の予想収量は土地の開発や農地が安定するにつれて漸増する。水稲の場合は５０ブッシェル／エーカーから４年後には８０ブッシェル／エーカーを目標としている。尚，大豆カウピーはそれぞれ１５Cwt／エーカー，および１２Cwt／エーカーとしている。

(5) 圃場の区画や整地計画は既存入植地に比較して改善されており，集約栽培方法（高収量品種の導入，化学肥料，農薬除草剤等の使用）を導入することによって上記の収量を達成する。

(6) 用いられる各作物の品種は目下育成中のものもあるが，現段階における水稲（Oryza Sativa）には100日の生育期間で最も一般的品種はＢＧ３４－６であり，１３０～１４５日系ではＢＧ１１－１１やＬＤ６６等がある。大豆（Glycina Hispida）にはPelican，Bossir があり，カウピー（Vigna Sinonsis）ではＭＩ－３５である。

(7) かくして経営が安定した時点における農家の純益は水稲二期作の場合年間7,３１０ＲＳとなる。これは計画地域の農民の現況に比較すると４～１０倍である。

4. 経済評価

(1) 事業費

スリランカF／Sレポートにおいて，本プロジェクトの事業費は下表のとおり積算されている。

表－１ Summary of construction costs for Inginimitiya Reservoir Project

Pay 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	0.750	0.500
Irrigation facilities for 6300 acres	16.450	8.400	8.050
Land development (heavy jungle clearing and land preparation)	13.500	8.100	5.400
Land settlement (internal roads, service buildings & aid to settlers)	6.300	2.00	4.300
General charges (maintenance building, construction camp, administration, surveys and supervisior)	11.851	5.925	5.926
	80.000	44.150	35.850

積算の前提は，

① 積算時点１９７６．４。類似プロジェクトにおける実績単価を使用。

② 建設機械費は残存価値分（４０％）を差引いて計上している。

③ 各項目における外貨と内貨の区分は，各項目毎の全体事業費に外貨率，内貨率を乗じて算出している。

外貨については，上表における工種別積算と別に資機材項目別の積上げ積算も行っており，その内容は次のとおりである。

表－２　外貨対象品目と数量

No	品　　目	内　　訳	金　額 1000 Rs	額 1,000$
1	建　設　機　械	$\frac{87台}{30.8 M.Rs} \times$ 償却率 0.60	18,500	2,136
2	オ　　イ　　ル	軽油 5.27 M.gal. × 3 Rs/gal. = 15,810	16,725	1,931
		潤滑油 91 1000gal. × 10 Rs/gal. = 0.914		
3	セメント・鉄筋	Cubes 15,000 × 袋/Cubes 13 × Rs/袋 14 = 2,730	3,500	404
		鉄　筋　１式　0.770		
4	スペアパーツ	1 式	2,700	312
5	工具・調査機器等	〃	1,250	144
6	爆　　薬	〃	500	58
7	発　電　機　等	〃	750	87
8	取　水　施　設	〃	225	26
計			44,150	5,098

(2) 便　益

この事業により，受益地域 6,300 エーカーからの農産物増加生産量は，年間もみ 864,000 ブッシェル（17,700ｔ），大豆 27,000 cwt（1,372ｔ），雑豆 21,600 cwt（1,097ｔ），増加生産額は gross 33,552 千ルピー（3,874 千ドル），Net 19,872 千ルピー（2,294 千ドル），これによる輸入節約額は 26,118 千ルピー（3,016 千ドル）となっている。

又この地区の農民は戸当り農地2.5エーカを耕作することにより年間収入として，水稲2期作農家はGross 13,200ルピー（1,524ドル），Net 9,200ルピー（1,062ドル），水稲＋大豆・雑豆農家は Gross 13,590ルピー（1,569ドル），Net 10,126ルピー（1,169ドル）を1戸当り得ることとなる。

本事業は農村道路の建設，入植地域の整備をも実施する総合事業であり，農業物増加による直接便益のほか，雇用効果等の地域開発効果が期待される。

(3) 事業評価

計量的に把握できる農産物増加生産による直接便益のみを本事業の便益として本事業の内部収益率を算定すれば17%となっている。

本事業については，現状における問題点が部分的には存在するものの，今後の検討により本事業の Feasibility が F/S レポートと比較して基本的に変わらないと思われる。

したがってこの事業は，経済的に充分に Feasible であり，社会的にもきわめて有意義なプロジェクトであるといえよう。

Ⅲ　各　論

1．計画の背景

1）スリランカ経済基盤としての農業

スリランカ共和国は，茶・ゴム・ココナッツの三大輸出農産物を含む農林・水産物が国家経済の基盤をなしており，これは実質国民総生産の約３３％（１９７５年）に当り（表－３）輸出においても三大輸出農産物が総輸出金額の７５％をしめている（表－４）。

一方輸入において，国民の主食である米が国内総需要の３４％に当たる３４２千トン輸入され（表－５，６），これに必要とされる経費は総輸入経費の２０％に当該し，小麦，砂糖とあわせ食糧の輸入経費は全体の５０％にも達している（表－７）。

このことは，農産物輸出で外貨を獲得する一方，同様の農産物輸入で外貨を消費するという現象を示しており，農業生産における国土利用の手法に何らかの問題があることを示すものといえる。

表－3　国民総生産（実質生産）の産業別内訳　　（1959年基準価格　単位：百万ルピー）

	1959		1971		1972		1973		1974		1975	
	金額	%	金額	%	金額	%	金額	%	金額	%	金額	%
農林，水産業	2,302	39.1	3,375	34.5	3,478	34.7	3,388	32.6	3,558	33.1	3,602	32.4
鉱業	31	0.5	67	0.7	68	0.7	266	2.6	191	1.8	248	2.2
製造業	682	11.6	1,379	14.1	1,401	14.0	1,417	13.6	1,359	12.6	1,462	13.2
建設業	283	4.8	550	5.6	505	5.0	516	4.9	553	5.1	503	4.5
電気，ガス，水道衛生	10	0.2	29	0.3	310	0.3	31	0.3	32	0.3	33	0.3
運輸，倉庫，通信	541	9.2	920	9.4	988	9.9	1,019	9.8	1,054	9.8	1,100	9.9
卸，小売業	801	13.6	1,316	13.5	1,327	13.2	1,383	13.3	1,450	13.5	1,501	13.5
銀行，保険，不動産業	51	0.9	129	1.3	136	1.4	142	1.4	165	1.5	184	1.7
貸家業	201	3.4	307	3.1	313	3.1	318	3.1	344	3.2	350	3.1
行政，国防	301	5.1	488	5.0	522	5.2	567	5.5	609	5.7	646	5.8
サービス業	728	12.3	1,297	13.0	1,334	13.2	1,379	13.3	1,441	13.4	1,513	13.6
国内総生産（G.D.P）	5,930	—	9,856	—	10,102	—	10,426	—	10,755	—	11,142	—
海外よりの所得	−37	−0.6	−84	−0.8	−76	−0.8	−72	−0.7	−25	−0.2	−27	−0.2
国民総生産（G.N.P）	5,893	100	9,779	100	10,030	100	10,383	100	10,731	100	11,115	100

資料　Central Bank of Ceylon
Review of Economy　1975　及び
年報1973年版

表－4　主要品目別輸出額

単位：百万ルピー

品目	1971		1972		1973		1974		1975	
	金額	%	金額	%	金額	%	金額	%	金額	%
茶	1,144	59	1,162	60	1,261	50	1,360	39	1,932	49
ゴム	307	16	265	14	592	24	738	21	654	17
ココナツ	280	14	266	14	145	6	397	12	397	10
貴石	3	—	12	—	141	6	109	3	180	5
その他	196	10	218	11	346	14	843	24	760	19
国産輸出合計	1,930	—	1,923	—	2,485	—	3,447	—	3,923	—
再輸出	17	1	16	1	21	—	25	1	10	—
合計	1,947	100	1,939	100	2,506	100	3,472	100	3,933	100

資料　税関スリランカ
（Central Bank of Ceylon
Reviw of the Econenuy）

表－5　米・小麦・砂糖の輸入量

	1973	1974	1975	1975／1974 絶対値	変化量 %
米　輸入量（千トン）	335	293	458	+165	+56.3
(paddy) 金額（百万ルピー）	270	720	1,062	+342	+47.50
C.F価格（ルピー／トン）	807.47	2,461.56	2,319.06	−142.50	− 5.79
小麦 輸入量（千トン）	396	402	432	+ 30	+ 7.46
金額（百万ルピー）	453	856	1,002	+146	+17.06
C.F価格（ルピー／トン）	1,144.14	2,131.63	2,319.33	+187.70	+ 8.81
砂糖 輸入量（千トン）	193	67	55	− 12	−17.91
金額（百万ルピー）	321	190	248	+ 58	+30.52
C.F価格（ルピー／トン）	1,663.44	2,846.94	4,526.25	+1,679.31	+58.99

資料　税関スリランカ

表－6　主要農業生産高

品　目	単位	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
茶	千トン	277	222	217	225	220	213	214	214	212	204	214
ゴム	千トン	119	131	147	149	151	160	141	144	154	132	139
ココナッツ	百万個	2676	2461	2461	2602	2440	2447	2682	2875	1957	2031	2447
米（白米）	千トン	445	560	675	791	806	940	820	770	770	841	677

資料：Central Bank of Ceylon

年次報告７５年版より換算　　百万ブッシェル＝２０,８６７Mt

表－７　主要品目別輸入額

単位：百万ルピー

項　目	1971		1972		1973		1974		1975	
	金額	%	金額	%	金額	%	金額	%	金額	%
1. 消費財	1,113	56.0	1,069	51.8	1,424	52.5	2,138	47.0	2,651	50.5
(1) 食品，飲料	895	45.0	917	44.4	1,248	45.9	1,950	42.8	2,520	48.0
(イ) 米	195	9.8	161	7.8	270	9.9	720	15.8	1,062	20.2
(ロ) 小麦粉	206	10.4	193	9.4	453	16.7	857	18.8	1,002	19.1
(ハ) 砂糖	243	12.2	248	12.0	321	11.8	190	4.2	248	4.7
(2) 繊維品	103	5.2	48	2.3	55	2.0	59	1.3	20	0.4
(3) その他（車，電気製品等）	115	5.8	104	5.0	120	4.4	129	2.8	111	2.1
2. 中間材	411	20.7	502	24.3	815	30.0	1,920	42.1	1,888	36.0
(1) 肥料	59	3.0	63	3.1	111	4.1	221	4.9	208	4.0
(2) 石油	26	1.3	38	1.8	295	10.9	905	19.9	872	16.6
(3) 紙類	48	2.2	42	2.0	40	1.5	65	1.4	70	1.3
3. 投資財	419	21.1	438	21.2	452	16.6	457	10.0	653	12.4
(1) 建設資材	118	5.9	121	5.9	107	3.9	147	3.3	169	3.2
(2) 輸送機品	76	3.8	107	5.2	95	3.5	91	2.0	116	2.2
(3) 機械類	200	10.1	181	8.8	224	8.3	183	4.1	322	6.1
4. その他	43	2.2	55	2.7	25	0.9	39	0.9	59	1.1
合計	1,986	100	2,064	100	2,715	100	4,554	100	5,251	100

資料：税関　スリランカ

2） 米作の傾向

米作は食糧自給政策の観点からその耕作地面積を長期的には，徐々にではあるが拡大してきている（表－８）。しかしながら短期的にはその傾向は年により大きく変動しており特に７４－７５年の減少は著しいものがある。この原因はまさに水不足からくる自然災害によるともいえるものでありこのことが先述した大量の米輸入の原因でもある。従っていかにして水を確保し供給するかがスリランカの経済発展のひき金となっているといっても過言ではない。

表－8　主要農産物作付面積

	単位	1967	1968	1969	1970	1971	1972	1973	1974	1975
茶										
総面積	エーカー	598.814	597.490	596.514	597.499	597.171	597.645	598.740	598.466	597.691
再植付		21.662	26.928	33.428	40.285	46.925	53.343	59.296	63.580	67.934
ゴム										
総面積	エーカー	569.121	569.207	568.633	568.900	567.994	567.060	565.000	563.474	561.000
再植林		250.995	264.042	276.126	286.340	294.816	303.538	308.502	315.578	323.558
米										
総面積	千エーカー	1.566.9	1.634.2	1.539.4	1.765.1	1.714.3	1.578.9	1.659.8	1.969.5	1.719.4
Maha 期		1.006.4	1.077.9	1.078.5	1.115.2	1.089.0	1.035.5	1.085.1	1.288.4	1.095.9
Yala 期		560.5	556.3	460.9	649.9	625.4	543.4	574.7	681.1	623.5

資料：Administration Reports of the Tea and Rubber Controller：
Departmeut of Ceusus and Statistics

3) 人口増加と食糧自給

現在の人口は約１３.６百万人と推定（'７１ センサスで１２.９百万人）されているが，これは'７５年の人口増加率1.８４％（表－９）を基本とし試算すると西暦２０００年には２０００万人もの人口となることが予測される。この場合，米の消費量は約2.2百万トンとなる見込みであるが過去１９６６－７５年の米の平均生産実績は７７５千トンであり，これを基本として今後の増収（耕地転用，施肥等による増収）を考慮しても米の生産量は西暦２０００年で約1.２百万トン（現行の５０％増）程度にしかならず1.0百万トンは不足することとなる。この不足量を補うためにも新規に耕地を拡大することが必要となるわけであるがそのための水資源をどのようにして確保するかが極めて重要な課題である。

米作の拡大は，食糧自給という観点のみならず国際収支の改善，失業者の減少（表－１０）という効果を期待できるものであり早急に着手されるべきである。この結果，経済成長を極めて低いものとしていた農業部門の伸びが期待され，'７５年の3.６％を上まわる成長がみられるであろう（表－１１）。

表－9　人口増加率

年	出生	出生率（％）	死亡	死亡率（％）	対前年自然増加人口	対前年自然増加率	人口（千人）
1945	238,494	3.59	142,931	2.15	95,563	1.47	
'50	304,635	3.97	95,142	1.24	209,493	2.78	
'55	325,538	3.73	94,368	1.18	231,170	2.65	
'60	361,702	3.66	84,918	0.86	276,784	2.80	
'65	369,437	3.31	91,728	0.82	277,709	2.49	
'70	367,901	2.94	94,147	0.75	273,785	2.19	12,516
'74	365,765	2.73	119,125	0.89	246,638	1.84	13,393

資料：SLILANKA　YEAR BOOK　1975

表－１０　労働力現況

単位：千人

	1970	1971	1972	1973
雇用者	3,518.0	3,621.9	3,712.2	3,823.5
農業	1,972.0	1,987.6	2,037.1	2,098.3
製造業	368.0	378.6	388.0	399.7
その他	1,178.0	1,255.7	1,227.1	1,325.5
失業者	686.7	735.3	772.0	779.6 (16.9%)

資料　A.D.B　Economic Report on Sri Lanla　1975

表－11　国民総生産と成長率

区分	名目					実質（基準価格 1959年）				
	金額（百万ルピー）			対前年成長率(%)		金額（百万ルピー）			対前年成長率(%)	
	1973年	1974	1975	1974	1975	(1959) 1973年	1974	1975	1974	1975
1. 農林業，漁業	5,026	8,356	8,643	+66.3	+3.4	(2,302) 3,388	3,558	3,620	+5.0	+1.2
2. 鉱業，製造業，電気・ガス等	2,380	2,756	3,576	+15.8	+29.8	(723) 1,715	1,582	1,743	−7.8	+10.2
3. 建設業	802	1,011	1,018	+26.1	+0.7	(283) 516	553	503	+7.1	−9.0
4. 商業，交通，サービス一般	7,057	7,682	8,838	+8.9	+15.0	(2,622) 4,808	5,062	5,294	+5.3	+4.6
1～4 国内総生産 Gross Domestic Product	15,265	19,805	22,075	+29.7	+11.5	(5,930) 10,426	10,755	11,142	+3.2	+3.6
5. 海外よりの所得	−111	−111	−140	—	—	(−37) −44	−24	−27	—	—
GNP－5 国民総生産 Gross National Product	15,154	19,694	21,935	+30.0	+11.4	(5,893) 10,383	10,731	11,115	+3.4	+3.6

資料：　Central Bank of Ceylon
Review of Economy 1975

2．水資源開発計画の現況

スリランカ共和国の自然条件は，年間降水量７５インチ（約１９００m/m）を境界としてDry Zone とWet Zone に区分されており，それぞれ国土の$3/4$及び$1/4$をしめている。Wet Zone は茶をはじめとして，すでにかなりの農業開発が行われており総人口の約７０％がこの地帯に居住しており，残されたDry Zone をいかに緑豊かな農地にするかが課題である。

これまでの米作の問題点として，Wet Zone においては３年に一度は起るという洪水による被害，Dry Zone においては乾期における水の絶対量の不足があげられており水資源について国土全体を総合的に管理する貯水池等の作設が必要とされている。

このため，水資源開発計画として国土を四分し，

(1) Mahaweli Project Region

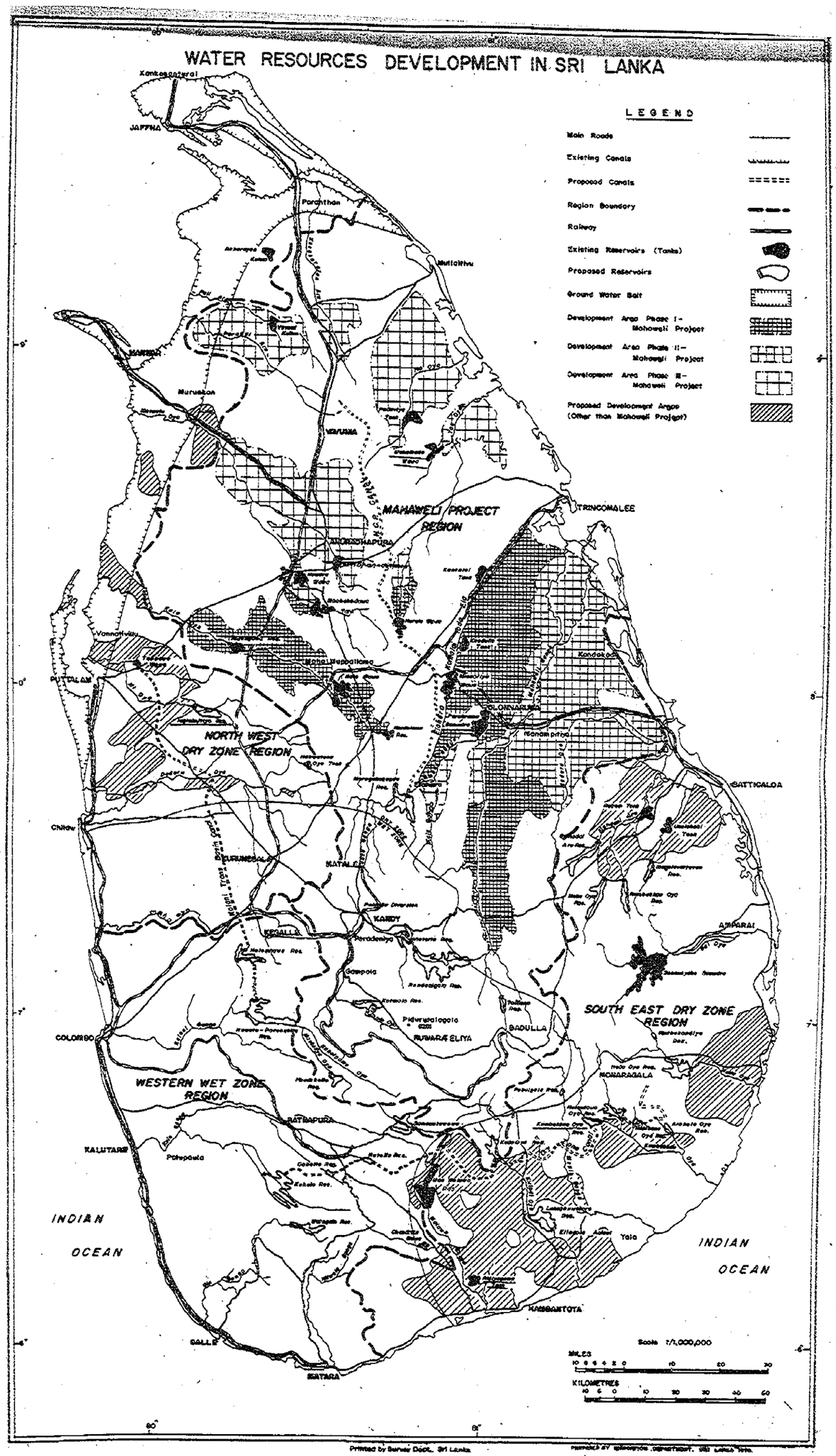
(2) South-East Dry Zone Region

(3) Western Wet Zone Region

(4) North-West Dry Zone Region

の諸計画が着手されつつあり，本 Inginimitya Reservoir Project は North-West Dry Zone Region に位置している。

WATER RESOURCES DEVELOPMENT IN SRI LANKA



Printed by Survey Dept., Sri Lanka.

4 Region のうち最大のものは，Mahaweli Praject であり総工費６７００百万ルピー（ＵＳ＄１４１５百万）をかけて行うものでありすでに部分的な完成をみている。

本Inginimitiya Reservoir Projectについてはすでに総工費７２百万ルピーで'７７年予算書に計上されており，その経費内訳は，労賃３０百万ルピー，機械等資材２０百万ルピー，その他２２百万ルピーとされているが，７７年度分としてどれ程必要となるかについては記載されておらず，日本との円借案件の進展具合を見ながら流動的に決定されるものと思われ早期なる交換公文の締結が期待されている。

なお，本Projectは'７７年予算書に提出されている"Major Irrigation Works"の中で貯水池として最大のものでありスリランカ政府の本件への強い期待をうかがわせる。

以下，上述した4区分されたRegionの開発計画の概要を紹介する。

1) Mahaweli Project Region

本地域は，国土総人口の約２７％が居住するAnuradhapuro, Polonnaruwa, Matale, Trincomalee, Varuniya, Kandy, Nuwara Eliya, Badulla の８県（District）を包含する総面積25,500Km²（9,830sg.miles）であり国土の３９％をしめる。

スリランカ最長の河川であるMahaweli Ganga と Maduru Oya が本Projectを構成し，水の供給量は７６５０百万m^3（6.5百万acre feet）で受益面積は10,450Km²（4,000sg.miles）であり，国土が海中へ放水される総水量の1/5が供給されることとなる。

Mahaweli Ganga は標高1,８３０mにその源を発するため水力発電への利用が期待される。

本計画は１９６５年から６８年にかけてFAOのUNDP チームが調査を行いマスタープランを作成したものである。

これによると，5,８００百万m^3のMahaweli Gangaの流水量を利用し３64,000haのDry Zoneの灌漑を行うこととしている。３64,000haのうち約100,000haはすでに灌漑が行われているところではあるが水不足がはなはだしい。残りの２65,000haは今後新しく開墾される土地である。さらに本計画では施設合計５００MW以上，年電力供給量2,６００百万Kwhの水力発電施設を設けることとしている。

計画は総経費6,７００百万ルピー（ＵＳ＄1,４１５百万－１９６８年－）で３０年をかけて実施される。長期計画は３つのPhase，それぞれのPhaseは数個のProjectで構成される。

(1) Phase Ⅰ

Kala Oya 支流部の Minneriya, Minipe, Kantalai 地区の１３３,０００ha の灌漑を行う。内訳は５８,５００ha は従来からの灌漑地の強化，７４,５００ha は新規の開墾灌漑地である。また，発電容量２００MWで年間８２０百万Kwhの発電施設を設ける。

(2) Phase Ⅱ

Maduru Oya と Taldena site にダムを建設し，既開墾地8,500 ha への灌漑さらに Mahaweli Ganga の下流及び Maduru Oya Valley の新規開墾地84,500 ha への灌漑を行うこととされている。また，発電容量14.5MWで年間48百万Kwh の発電施設を設ける。

(3) Phase Ⅲ

Randenigala, Kotmale の多目的貯水池からの運河により Yan Oya, Ma Oya, Pali Aru, Kanagarayan Aru, Paraki Aru の各河川流域の北中央部，北部に位置する既開墾地33,000 ha，新規開墾地106,000ha への灌漑である。また，293MWで年間1,169百万Kwh の発電施設を設ける。

表－12 Phase による経費，灌がい面積および電力供給量

区分	経費（1968年）		灌がい面積			電力供給量
			既開墾地	新規開墾地	計	
	Rs. Min	US$.Min	1,000 ha	1,000 ha	1,000 ha	百万Kwh／年
Phase Ⅰ	1,550	327	58.5	74.5	133	820
〃 Ⅱ	920	194	8.5	84.5	93	48
〃 Ⅲ	3,113	656	33.0	106.0	139	1,169
合計	※5,583	1,177	100.0	265.0	365	2,037

※ 上記に Transmission lines overhead のコストを加算するとRS 6,700百万（US$ 1,415百万）となる。

現在実施しているのは，Phase ⅠのProject Ⅰでありこれを3つのStage に分けられる。

（Stage Ⅰ）

Stage Ⅰの主構造物は，Elahera Scheme headworks のための Polgolla Complex, Sudu Gange Irrgation Works, Bowatenna Complex と改良計画及び主水路の作設である。

- Polgolla Complex は延長8.06Kmの diversion dam 及び直径5.95 m で流量56.7 m³/sec のトンネルを設けることと，20MWの発電所を設けることで構成される。
- Bowatenne Complex は延長235 m，高さ30.5 m で 60の水門を有するダムの建設と，直径3.96 m，流量28.3 m³/sec のトンネルを6,850 m設けることで構成される。

Stage Ⅰの総経費は，325百万ルピーであり，1976年にすべてが完成した。

（Stage Ⅱ）

Stage Ⅱは Kola Oya Valley に２８,４００haの 新規開発地を設け，農業生産の向上を図るステージである。

この地域の灌漑は Kalawewa Reservoir からの延長１２４Kmの主水路による給水で行われる。

本ステージにより，２３,０００人の新規の農民が入植することが予定されており，１人当り1.3haを与えられる。主たる作物は米，玉ねぎ，チリー，ソヤービーン，パルセス，棉である。

本ステージは，総経費６５０百万ルピーと見積られている。

（Stage Ⅲ）

本ステージでは，Kadulla 及び Kantalai Reservoir の下流に８,１００ha の新規開墾地を設け，さとうきびを植付けることとなっており，１９７７年からの生産が期待されている。

本 Mahaweli Project は，Ministry of Irrigation Power and High ways の下部機関である Mahaweli Development Board が担当しており，他の関係との調整を行っている。

2) South - East Dry Zone Region

本地区は総人口の約８％が居住する総面積１５,５００Km^2の地域で，Hambantota，Moneragala，Amparai，Batticaloa の４District を包含する地域であり多くの地域は，野生鳥獣保護として指定されている。

河川は，Walawe Ganga，Kirindi Oya，Minik Gange Kumbukkan Oya，Heda -Oya，Gul Oya，Mudeni Aru があり，水供給能力は３,４９０百万m^3ある。

すでに本地域では，基本的開発を Walawe，Gal Oya で実施済である。

主な貯水地である Udawalave reservoir は貯水量２６８百万m^3，総灌漑面積２０,０００ha，発電能力６MWである。すでに，基本的部分を終了し，あと１２,０００haの開墾が残されている。

現在計画中のものとしては，Samana lawewe Reservoir がある。これは多目的ダムであり，１２０MWの発電施設を有するものである。この施設による灌漑は８,０９０haの開墾地を含むものである。

Gul Oya においてはすでに多目的貯水池として，Senanayke，Samudra が設けられている。この貯水池は，容量９５０百万m^3であり，４８,０００haの地域の灌漑を行っており，１０MWの発電施設も有している。

本South - East Dry Zone は，本地域内の水資源の開発だけでは不十分であり，Wet Zone にある Kalu Ganga から水を引く計画が作成されている。

3) Western Wet Zone Region

本地域は，総人口の約４７％が居住する Matara，Galle，Kalutara，Ratnapura，Kegalle，

Colombe の district を含む約１1,６００Km²の地域であり，４Regionの中では最も代表的な農業地区である。

主たる河川は，Nilwala Ganga，Gin Ganga，Kalu Ganga，Kelani Ganga であり，以下これら河川流域の概況を述べる。

(1) Nilwala Gangr 流域

Nilwala Ganga は８５０Km² の集水面積を有し，ほとんどが Wet Zone にあり，年間流水量は1,６００百万m³である。

本流域の約６０％の地域で，茶，ゴム，ココナッツ，米が作られており，米作地域は１6,１９０ha あるが，このうち8,０９０ha は３年に１度起こる洪水による被害地であり，排水施設の整備が必要とされる地域である。

(2) Gin Ganga 流域

年間流量2,５９０百万m³の Gin Ganga 流域の５０％は米，茶，ゴムの生産地である。米の生産地は１4,０００ha あるが，このうち５０％の地域は３年に１度の洪水の被害を受けており排水施設の整備が必要とされている。

(3) Kalu Ganga 流域

Kalu Ganga は集水域約2,６００Km²，年間流量7,６４０百万m³のスリランカでは最大級の河川である。

本地域は，約１００,０００ha の米，ゴム，ココナツの主たる生産地であるが，米の生産地25,０００ha のうち５０％以上の地域が洪水の被害を受けており，Kalu Ganga 上流に貯水池を設ける計画が進められている。なお，この貯水池からは，年間1,２３０百万m³の水を South East Dry Region に送る計画も作成されている。

(4) Kelani Ganga 流域

Kelani Ganga は Maskeliya-Oya と Kehelgamuwa- Oya の２つの大きな支流を持つ集水域2,２００Km²，年流量4,９３０百万m³を有している。２つの支流は，水力発電の可能性を有しており，現在 Maskeli-Oya Project の Stage １，２及び Norton，Old Laxapana Power Project で開発中である。これら Project で設けられる貯水池から，North West Dry Zone の62,６００ha 地域に水路により灌漑を行う計画である。

4) North West Dry Zone Region

本地域は，総人口の約１８％が居住する１3,０００Km² の地域であり，Kurunegala，Puttalam，Mannar，Jaffna の District からなる。

主たる河川は，年間流量1,０８５百万m³の Denuru Oya と，１３６百万m³の Mi Oya であり，

本流域の４１,０００ ha 以上が開墾可能であるが水不足のため，あまり手がつけられていない現状にある。

予備的調査では，Western Wet Zone にある Kelani Ganga の水を本流域に引き入れるという提案がなされている。

本地域が他とちがい特徴づけられる点として，海岸ぞいに石炭土壌が分布しているということである。これは，Puttalam，Mannar，Poonari，Paranthan，そして半島地帯まで伸びており，地下水が見つけられている地帯でもある。地下水量は，４９３百万m³と見積られており，本地下水の灌漑への利用が，本地域の開発課題のひとつである。

表－１３　今後２５年間の新規開墾地

地　　域	面　　積
Mahaweli Project Region	２６５,０００　HA
South East Dry Zone Region	６０,０００
North West Dry Zone Region	６０,０００
上記に含まれぬ Trrigation Prajcct	４０,０００
計	４２５,０００

3．計画概要

3－1　事業計画

1）一　般

インギニミナヤ貯水池計画地域は北西州プットラム（Puttolam）地区のキリメチヤワ（Kirimetiyawa）とカランベ（Karambe），パトウス（Pattus）に位置しており，ダムサイトは，ガルガムワ町から約１４マイルの地点にある。

本計画は，ダンブウラム（Dambulla）ヒルにその源を発するミオヤ（Mi-Oya）川の河川流水を貯留し，下流に広がる6,３００エーカーの土地を新たに開発してかんがいを行わんとするものである。

2）貯　水　池

インギニミナヤ計画貯水池の集水面積は２１５mile²であるが，ダムサイト上流アバコラウエワ（Avakolawewa）地点でミオヤ川を横切って６５mile²が流域変更されている。集水地域における４０年間の加重年平均降雨量は５４.６４インチである。アバコラウエワの建設後実測され

た計画ダム地点での年平均流量は94,315Ac-ft でこれは流域変更後の純集水面積150 mile²に相当する流量である。満水位202MSLにおける総貯水量は53,000 Ac-ft であり，一方死水位181MSLでの死水量は4,200Ac-ftである。

貯水池の貯水面積は4,100エーカーで，その殆んどは国有地で現状は密林であるが，この中ラネレウエワア(Ranerewewa)，ワルパルワ(Walpaluwa)およびアンディバクダワラ(Andi-vakudawala) 村の453エーカの水田が水没することとなる。

3) 堰　堤

現在のダムサイドは過去二，三のダムサイト調査を経て最も適したものとして計画されている。堰堤の諸元は堤長2マイル4,750フィート，最大堤高60フィートで，築堤土量は417,000 cubesでローラー転圧によって築堤される。

堤体設計については，堤頂は幅員20フィートの道路を設け，堤体の前法は1：3.0，後法は1：2.5である。コアートレンチは堤高の1/3まで岩床を堀削する。堤体浸透水をプレキャストドレンに導水するため下流基礎堀削線に沿って堤趾フィルターが設けられている。下流法面は全面的に張芝を施工する一方，上流法面は洪水位まで割栗石で保護する。

4) 余　水　吐

自然越流式余水吐は350フィートにわたって堅岩が露頭しているダムの右岸側面に設けられる。余水吐の規模は61,500 cubes最大洪水量を対象として設計されている。越流幅800フィートを有する非常余水吐は異常洪水に対処するため余水吐の右側に設置される。余水吐の接続水路は流入口で越流幅2,000フィートから下流に従って除々にしぼられ2,400フィート離れた地点で300フィート幅となる。そしてミオヤ川まで導かれ総延長7,000フィートに達する。

余水吐の下流ではダムの堤趾が侵蝕されないよう余水吐接続水路の左岸に導水堤(training bund) を設ける。余水吐接続水路の堀削土は築堤用土として流用される。

5) 取水施設

かんがい計画地域はミオヤ川沿いに広がっており，このため取入水門は左右両岸に夫々1門設けられ，その計画取水敷高は下流受益地の標高などから181MSLである。左岸取水量は156 cubesで4,800エーカーに導水する。水路延長は13 mile で水路勾配0.0003，水路側面勾配は1：1である。右岸水門の計画取入敷高は左岸同様181MSLで，取水量48 cubesで1,500エーカーに給水される。右岸水路の延長は7.5 mile で水路側面勾配は1：1，水路勾配は0.0003である。

3－2　施行計画

スリランカＦＳレポートによると，基幹施設の建設や開発地域内のかんがい施設を設置するために必要な機械類や設備は，現在スリランカ国内で使用されているものがすでに老朽化しているため外国からの輸入にまたなければならないとされている。

建設工事の工堂は最初に両岸部の築堤と２つの水門を完成させる。２月から９月までの乾期中に，ダム堤址上流部に締切堤（Coffer dam）を築堤する。締切堤の堤高は１０年に１回の洪水を防御するに十分な高さとする。２月から５月の間にグラウトによる基礎処理と同時にダムサイトの水処理と清掃を行い，最終の締切りは６月，７月及び８月中に施工する。上流締切堤は本堤の上流側築堤として利用する（Annex 4の4－2参照）。

3－3　農　業

1）目　的

従来の農業が主にMaha 期（１０月～３月）の降雨，平均３３.３４インチ（Maha Uswewa，計画地域から4.8Km南西）の天水による水稲年一作およびChena によるトウガラシや雑豆類の栽培によって行われてきた。したがって，Maha 期の稲作も雨量によって左右されることが大きく，スリランカ国内においても低位生産地として今日に至った。

本プロジェクトはかんがい水を確保することにより，安定した水稲二期作を主体にして大豆，カウピー，綿，等を輪作体系に導入することによって土地の周年利用をはかり，労働集約型の土地生産性の向上をはかろうとするものとである。

2）計画地域の農業概況

本プロジェクト計画地域の農民は平均耕作面積4.７５Ａｃであるが，その殆んどはChena Cultivation（一種の焼畑）であって，水稲はMaha（雨期）における限られた面積にだけ栽培可能である。

したがって，水稲の収量は平均２５～３０ブッシェル／エーカー（天水田），Yala 期で，貯水池用水田の平均収量３０～３５ブッシェル／エーカー（１９７３～７４年の全国平均が４２～４８ブッシェル／エーカー）が示すようにスリランカ国でも典型的低位生産地に属している。

現在，最も一般的に栽培されている作物はトウガラシ，カウピー，タラ（雑豆の一種），クラカ（四国ビエ），小麦，及び稲等である。（聞き取調査による）

インギニミチヤの集落（写真）には，学校，寺，及び協同組合が公共施設としてあり，協同組合が生活必需品（食糧品９品目，その他の消費物資１３品目）を取扱うと共に生産材の供給機関でもある。現況は肥料１品目（尿素，化成の２種類）が調査の結果で明らかになった。

3) 農地開発計画及び作付計画

工事着工後4年目から作付を予定し（入植が前提になるが）開発の進展と平行して入植および作付が拡大し，工事着工後6年次，即ち（第一次入植者にとっては3年次）に完工する。作付計画も同様である。

表－14　農地開発計画および作付計画一覧表

年　次	農地開発計画（Ac）	作付計画（Ac）	
		Maha	Yala
4	2,500	2,500	500
5	5,000	5,000	1,000
6	6,300	6,300	1,800
7	6,300	6,300	1,800

4) 目標単位収量

水稲，大豆およびカウピー等の単位収量も開発が進められ，また耕作が安定するにつれて漸次増収し入植後4年次に80ブッシェル／エーカーを目標にしている。

表－15　水稲，大豆およびカウピーの目標単位収量

年　次	水　稲	大　豆	カウピー
	ブッシェル／エーカー	100CWT／エーカー	100CWT／エーカー
4	50	15	12
5	60 〃	15 〃	12 〃
6	70 〃	15 〃	12 〃
7	80 〃	15 〃	12 〃

この目標収量は次に掲げるような計画地域の現況や実験地域，新規入植地の事例を考慮して作成されたものであり，長期的視野からみた目標収量を試験場の成績の60％程度にみたとしている。

表－１６　収量の変異

	現況（H，IH地区）の平均収量	試験場内パイロットプロジェクト平均	Rajangana の青年入植地平均	試験ほ場の平均	短期的にみた予測収量	長期的にみた予測収量
水　稲(130日品種)	—	43	—	150	50	100
〃　(100日　〃)	33	40	50	150	45	90
大　　豆	—	3.3	—	25	5	15
カ　ウ　ピ　ー	5	5.2	—	20	7	12

単位：水　稲　　Busbels／Ac

大豆，カウピー　cwt／Ac ，

Mahaweli Ganga F／S Repert

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5) 作付体系

かんがい局，土地利用部により選定された本計画の作付計画は三つのタイプに分類される。これらは主に土壌の種類および地勢，気象条件によって決定された。これを月別雨量と合せて図示すると次のようになる。

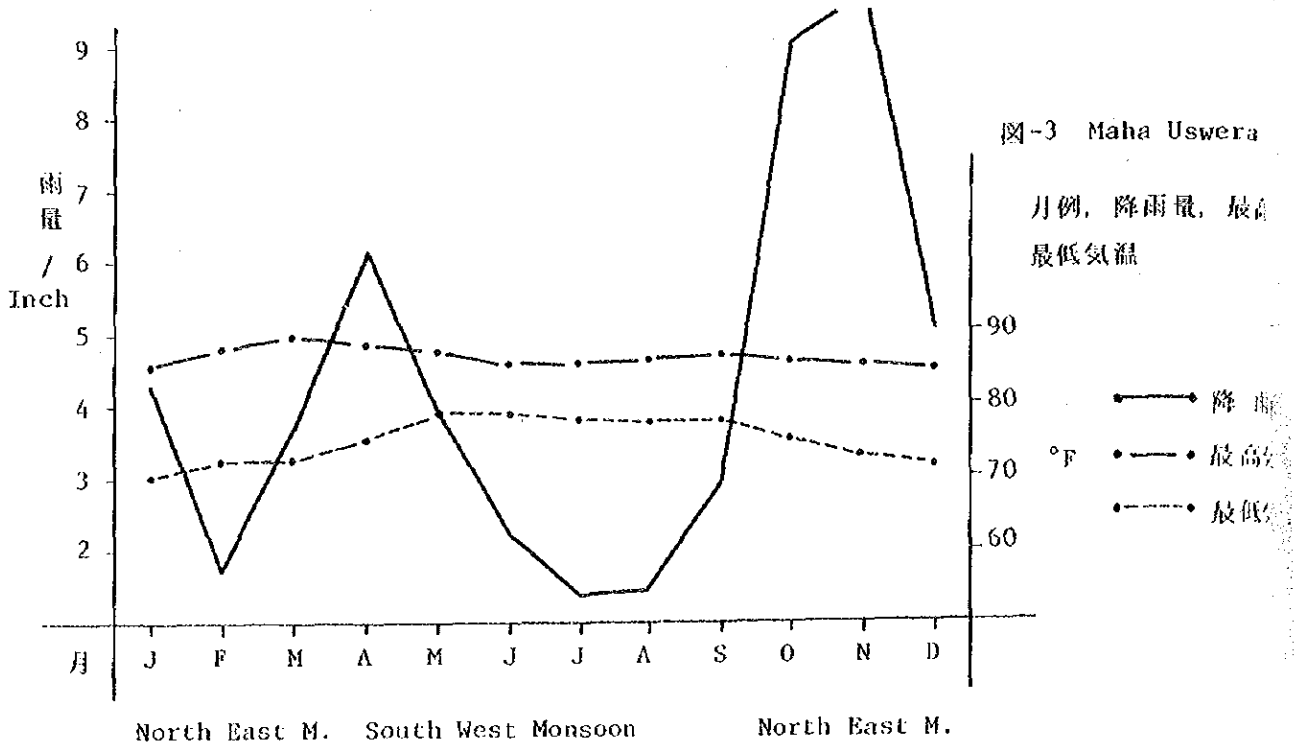
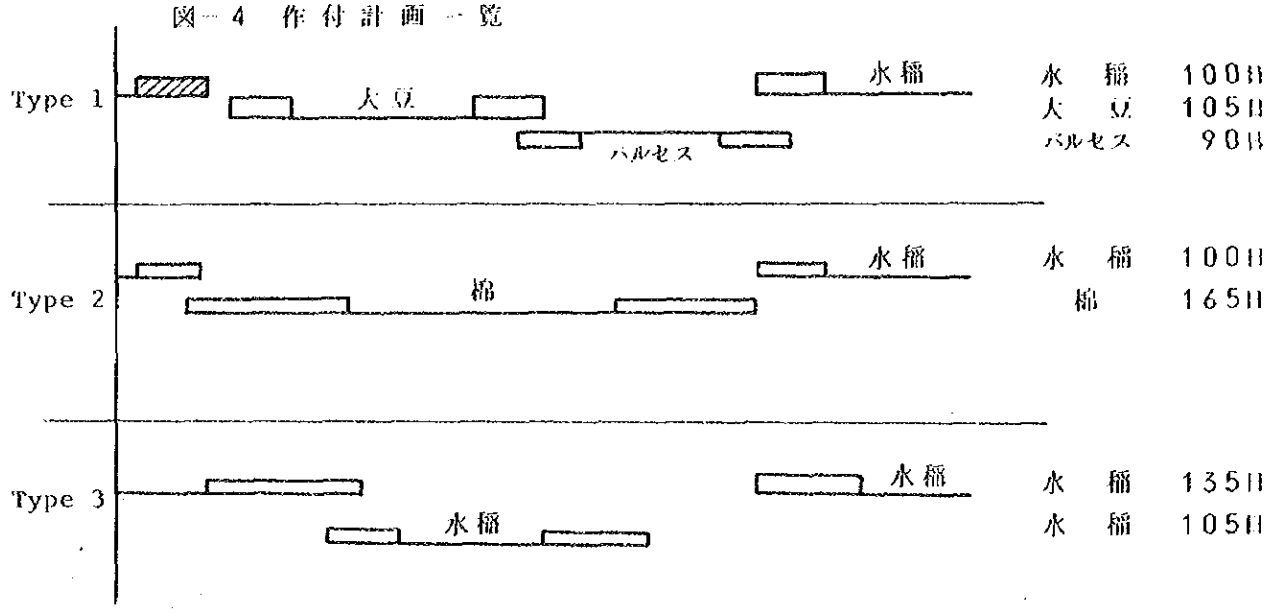


図-3 Maha Uswera
月例，降雨量，最
最低気温

図－4 作付計画一覧



Mahaweli 計画における基本的作付体系は次のようである。

(1) 畑作の場合

a) 自給用野菜，果樹等の周年栽培

b) 玉葱～トウガラシ～他の野菜類～ピジョンピー～玉葱～トウガラシ～玉葱～グリーンピー　の三年輪作

c) 水稲（もしくはメイズ）～トウガラシ

d) 水稲（もしくはメイズ）～落花生か大豆～カウピー

e) 水稲（もしくはメイズ）～棉

(2) 水田の場合

a) 水稲二期作

b) 水稲三期作

つまり本計画の作付体系のうちのタイプ1は Mahaweli 計画1のd)，タイプ2は1のe)，そしてタイプ3は2のa)に相当する。

6) 作業体系

入植農家はその労働源を家族労働を主体に本プロジェクトが策定されていることは先に述べた通りである。この作業体系は耕作面積や作付体系とも密接な関係を有しているが，これらの基本データを Mahaweli開発からみると次のようである。

水田の場合（開発直後と安定時）　８６～　８７日／Ａｃ

畑作の　〃　（　　〃　　）１１１～１１６日／Ａｃ

この内訳を本プロジェクトの対象作物である水稲，大豆およびカウピーについてみると次のような作業体系から成り立っていることが明らかとなる。

表－１７　作物別作業体系および労働時間／Ａｃ

1. 水稲の場合

作業	水稲（１３０日）直播		水稲（１００日）直播		②は開発が進み、水牛を使用した場合 ①は開発当初、水牛使用の場合
	1	2	1	2	
耕起	２０	２０	２０	２０	
畦の改修	３０	３０	３０	３０	
施肥（基肥）	３	３	３	３	
代き，均平	２０	２０	２０	２０	
は種	４	４	４	４	
除草剤撒布	２	１６	２	１６	
追肥	４	１６	４	１２	
虫害防除	４	４０	２	２４	
かんがい作業	５０	５０	４０	４０	
収穫	８０	８０	８０	８０	
脱穀，選別，運搬	１１２	１１２	１１２	１１２	
合計（時間）	３２９	３９１	３１７	３６１	
（日）	４１	４９	４０	４５	

2. 大豆およびカウピーの場合

作業	大豆		カウピー		②は開発が進み、かつ手農具使用 ①は開発当初
	1	2	1	2	
施肥（基肥）	３	３	３	３	
耕地，整地	１００	１００	１００	００	
畦立て	４０	４０	４０	４０	
は種	３０	３０	３０	３０	
除草剤撒布	—	８	—	８	
除草	３２	—	３２	—	
追肥	—	１６	—	１６	
虫害防除	—	１６	—	１６	
かんがい	２５	２５	２５	２５	
収穫	６０	８０	６０	８０	
脱穀，運搬	５２	６５	４２	６５	
合計（時間）	３４２	３８３	３３２	３８３	
（日）	４３	４８	４１	４８	

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7) 生　産　費

かんがい施設の整った開発農地における各作物の生産費の内訳は次のようである。

表－１８　作物別生産費の内訳（ルピー）

項　　目	水　　稲		大　　豆		パルセス（カウピー）	
	単価／エーカー	2.5エーカー	単価／エーカー	2.5エーカー	単価／エーカー	2.5エーカー
種　　子	68	170	52	130	7	18
肥　　料	304	760	118	295	102	235
農　　薬	224	560	43	107	62	155
農　具　等	152	380	75	188	64	160
労　　賃	294	735	348	960	384	960
①耕作資金利子	86	215	34.50	86	28.30	70
②負　担　金	100	125	100	60	100	65
合　　計	1,228	2,945	806.50	1,826	747.30	1,683

※①　Interest on crop loans

②　Land betterment charges

これらを作付体系のうちタイプⅠおよびⅢに挿入してみると，経営面積当りの生産費は次のように算出される。

タイプⅠ	水　稲	2,945ルピー	タイプⅢ	水　稲	2,945ルピー
	大　豆	1,826　〃		〃	2,945　〃
	カウピー	1,683　〃			
	合　計	6,454　〃		合　計	5,890　〃

尚，種子，肥料及び農薬は近年一般農村においても普及してきている。尿素や三要素混合肥料は一般農協ですでに販売されているのが見受けられ，農薬のスミチオン，ＭＣＰＡは開発地域の農協でのみ販売されていた。

次の表は，主な生産材の目標投与量を作物別に示したものである。これらが生産費算出の基礎となっている。

表－１９　作物別肥料農薬等の施用基準

項　　目	単　位	水稲(130日)	水稲(100日)	大　豆	カウピー
種　　子	Bushels	2	2	0.35	0.1
肥料　尿　素	N cwt	1.6	1.2	硫安 0.4	硫安 0.2
重過燐	P_2O_5 cwt.	0.8	0.8	0.4	0.4
塩加加里	K_2O cwt.	1.2	1.2	0.3	0.5
農薬　BHC（6%）	Lbs	100	70	—	セレサン(Kg) 1.0
スミチオン(50%)	fL. oz	60	30	マラソン 60	マラソン 6.0
除草剤　3.4 DPA	Pints	3.5	3.5	—	—
MCPA	〃	1.5	1.5	—	—
Dalapon	Lb	1.0	1.0	リヌロン50% 1.5	—

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8）農家における収支

前に述べた条件を考慮して農家段階における収支を作付体系別に算出してみると：

表２０　作付体系別農家収支

"タイプ－Ⅰ"

作　　目	単位収量 ①	栽培面積 エーカ	販売単価 ① ルピー	粗収量 ルピー/2.5エーカ	生産費 ルピー/2.5エーカ	純収益 ルピー/2.5エーカ
水　　稲	80	2.5	33	6,600	2,945	3,655
大　　豆	15	2.5	84	3,150	1,826	1,324
パルセス(カウピー)	12	2.5	128	3,840	1,683	2,157
		"タイプ－Ⅲの場合"				
水　　稲	80	2.5	33	6,600	2,945	3,655
水　　稲	80	2.5	33	6,600	2,945	3,655

※ ① 水　稲　Bushels
　　その他　cwt.

したがって，"タイプⅠ"の場合の農家一戸当りの年間純益は7,136ルピーであり，"タイプⅢ"のそれは7,310ルピーとなる。

計画地域の農民の現況は平均1,800ルピー以下（Socio-economic Report），（600～720ルピー（聞きとりによる）等に比較すれば，本計画の農家一戸当りの収入は現況農家の4～10倍となる。

9）営農指導，入植者訓練計画

これを分類すれば以下のようになる。

1. 農民訓練
   a）入植者の事前訓練
   b）〃の入植後における定期訓練
   c）農民（入植者）リーダーの訓練
2. プロジェクト関係職員の訓練
   a）事前特別訓練
   b）In-Service training

入植者に対する事前訓練は30名程度を1単位とし約1週間（2週間 Land Commitioner談）新しい農民組織，機構，村落開発の意義，水利用の実際，農業技術や作付体系，関係職員との関連性等について農業試験場や村落開発事務所（Community Development Office），あるいは見学等を通じて実施する。入植後の定期訓練は毎年，農民の15～20%を対象に，新しい栽培技術やかんがい方法等をテーマとして実施し，リーダー訓練も農民組織の意義と責任の重要性を理解させるために行う訓練である。

プロジェクト発足と前後して，開発計画に関与する政府職員を対象に，主に職務に対する理解および事業の重要性，農民との関係について実施する。

これが最も一般的方法として実施されてきたが，本プロジェクトの場合は，その実施体制が完全に確立されるに至っていない。したがって営農指導計画，入植者訓練計画等の具体的計画の策定には至っていない。かなりの時間を要するものと思われる。

10）施設の維持管理計画

幹線水路の維持管理はかんがい局が責任を持ち，末端用水路の維持管理，水利用計画，生産材の需要及びその供給の計画，融資等については，政府の現地駐在機関と受益者によって構成される組織 Agricultural Productivity Committee とその下部組織である Cultivation Committee によって運営される。

3－4　経 済 評 価

1）事　業　費

本事業の事業費の概要は表－1および2のとおりである。別添スリランカ F/S レポートにおいては Annex 5 にさらに詳細な積算資料が記載されている。

この積算の精度についてはつぎのような理由により，かなり高いものと判断される。

(1) 事業費として計上されている各工程については（Rajangana Project 別紙参照），M.I.P.H（灌がい電力道路省）は既に類似プロジェクトにおいて十分な経験を有しており，これらのプロジェクトにおける実績に基づいて積算している。

又，本プロジェクトの各工種は M.I.P.H が直営で実施する。

実施主体　灌漑施設工事 …… Irrigation Department

農地整備工事
地区内道路・移民者用施設等　} Land Development Department

(2) 類似プロジェクトとして WAHAKADE WEWA プロジェクトを主として参考としこのプロジェクトにおける最近時の見直単価を基礎として積算している。

(3) 外貨分の５５％を占める建設機械費の単価は，最近時スリランカにおける国際入札実績（ＩＤＡローン　1976.4）を基礎としている。

建設機械費の内訳は次表のとおりである。これの基礎となったＩＤＡローンによる国際入札実績は資料№２５のとおりである。

この単価については，本プロジェクトがＬＤＣアンタイドローンとなった場合を想定すれば若干の問題がある（Ⅲ－４－４　現状における問題点の項参照）。

表－２１　Price List of Equipment and Machinery

Equipment.5 Machinery	No. of Mc.	Price por maciane in U.S. $	Total price in US $
Tracter Cl.I	8	110,000	330,000
Tracter Cl II	5	50,000	250,000
Scraper	3	60,000	100,000
Moter Scraper	9	100,000	900,000
Sheep foot roller	2	8,000	12,000
Motor Grader	2	49,000	80,000
Excavator	2	100,000	200,000
Lorry Tipper	9	5,000	45,000
Compresser	4	20,000	80,000
Jack Hammer	8	600	4,800
Showel Loader	1	55,000	55,000
Euclid Rear Damper	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
			3,561,010

Note :－　1 U.S.$ = Pe. 8.66

The cost of machinery = Ps. 30.8 m.

Allow a 40% salvage value on the machinery after the completion of the project.

Therefore the cost of machinery used on the project = (30.3 －／2.3)
= Ps. 18.5 million

建設機械の能力，運転経費についてはＩＤで作成した「Evaluation of Unit Prices and Rate Analysis」（資料№３０）を基礎としており，基本的には妥当と考えられる。ただＩＤを含めてスリランカにおいては最新鋭の建設機械を使用して工事を実施した経験が乏しいため（ＩＤの所有している建設機械のほとんどは老朽化している），機械の能力についてチェックする必要はあろう。

2）便　益

プロジェクト完了後（with future）における農産物生産額は下表のとおりである。プロジェクト地域における現況生産額はnegligible であるから，without future における生産額も０と仮定している。したがってＩＲＲの算定にあたっては，with future の農産物生産額をそのまま増加便益額としている。

表－２２

	耕作面積	単位収量	価　格	Gross 生産費	生産費	Net 生産額	Net生産額 プロジェクト地域
	エーカー	ブッシェル／エーカー	ルピー／ブッシェル	ルピー／エーカー	ルピー／エーカー	ルピー／エーカー	1000ルピー
Maha Season							
Paddy	6,300	80	33	2,640	1,050	1,590	10,017
Yala Season							
Paddy	4,500	80	33	2,640	1,050	1,590	7,155
Soya bean	} 1,800	cwt 15	ルピー／cwt 84	1,400	650	750	2,700
Paluses			ルピー／cwt 128				
小　計	6,300						
計							19,872

耕作面積は主として水源河川であるMi Oya の流量の制約により決定されている。

単位収量についてはMaha Illupallama 農業試験場における試験結果，近傍類似プロジェクトであるRajangana プロジェクトにおける実績等に基づいて想定されており，ほぼ妥当であると考えられる。

もみ価格については政府買上げ価格（３３RS／Bushel Paddy）を使用している。この価格を精米換算すると，もみ精米換算率0.６９，１ブッシェル（籾）＝４５ lbs ＝２０.４３Kg，１ドル＝8.６６ルピーとして，$２７０／t となる。

ＩＲＲの算定のための米価については，本プロジェクトの場合，輸入代替であるところから，国際価格を使用することが妥当と考えられるが，その場合，世銀 Price Forcast では１９７７－＄２８０，１９８５－＄２４０となっている。

したがって，米価について国際価格を使用してＩＲＲを見直したとしても，スリランカＦ／Ｓレポートの値と大きな差異はないものと考えられる。

生産費については，農家労働力を自家労働も含めて生産費の中に含めており，ＩＲＲ算定にとって安全側の計算を行っている。

水稲生産費をエーカ当り1,０５０ルピー（１２１＄）としているが，この数値は，他の東南アジア諸国におけるプロジェクトの事例及びスリランカにおける世銀プロジェクトにおける事例と比較すると，むしろ大きくなっているといえる。

3) 経 済 評 価

経済評価についてはスリランカＦ／Ｓ レポート Annex 7 に詳細に記されている。B／C ratio 及びＩＲＲの双方について算定しているが，ＩＲＲの算定表は下表のとおりである。

表－２３ 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% P.W.F. @ 16%	Present value @16% P.V.	Present value @18% P.W.F. @ 18%	Present value @18% P.V.
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	—	—27,449	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 50	4,000		(—4,000)	(0.002)	—8	(—0.0006)	—2
					1,753		—1,007

プロジェクトサイクルは５０年として，４４年目にゲート等の機器類について再建費を計上している。

経済評価の手法については妥当と考えられる。

4．検討事項

4－1　スリランカ国の灌漑技術面は，長は歴史的体験をふまえ，それなりの技術水準にあるものと考えられるが，農業生産の向上のためには，さらに営農技術面の水準向上が必要とされよう。このため，今後日本からの営農技術面の協力体制が検討されるべきであるが，この場合，単に本プロジェクト地域のみにとどまることなく，マハベリプロジェクトも含む広い視野からの技術協力への対応が求められる。

4－2　灌　が　い

1）ダ　ム

(1)　堤軸について部分的検討

ダム軸の選定については過去，下流案（１９６７年 Boring　９孔深度５５′～８７ｆｔ／孔），あるいは上流案（１９６８年 Borring　１９孔深度３０′～１０８ｆｔ／孔）の地質調査を実施したが，何れも余水吐の基盤が深く基礎工に難点があることから現在のダム軸に変更決定されたものである。現ダムサイトの地質調査は完了していないが，すでに計画余水吐軸上で１９７６年４孔の Boring（深度３２～９０ｆｔ／孔）を実施（基盤を確認している（別添図面参照）。

現場踏査の結果によれば抜本的な堤軸変更案は考えられないが，経済性ならびに施工性の観点から部分的な堤軸修正検討を提案するものである。即ち計画貯水池内に現況タンク（堤高約１０ｍ，堤長約１Km）があり，この現況ダム軸（逆アーチ…問題なしとはいえない）と近接した位置にあることから，現況貯水池堤体の活用を図ること即ち計画ダム軸を現況ダム軸に沿わさることにより旧堤，新堤の複合断面としての可否について検討する必要がある（左岸部堤体取付部も旧堤活用により比較検討が必要であると同時にダム堤高と貯水量の検討も必要である）。

堤軸の検討においては，現ダム軸を動かすことによる新たな調査事項は，今後の調査項目にも述べるとおり，ダム軸の基礎地盤調査，旧提築堤材料土質調査，漏水量調査等が必要である。

(2)　堤体形状についての検討

貯水池計画安定解析資料によれば，①ダム高５９ feet で均一であり先端円弧すべりが仮定され②ダムの基礎は盛土された材料と同じ特性をもつものと仮定（今後基礎調査が必要である。）浸潤線は上流側満水面より，下流側基礎より鉛直距離の $1/3$ の点を直線で結んだ。

④建設中にもB（間隙水圧係数）は一定である。

⑤材料の粘着係数C′＝1,150ポンド／ft²，φ′＝0.435 ラジアン，r湿潤＝133.0ポンド／ft （土質試験調査結果を解析し設計数値の決定根拠を明らかにする必要がある）。

⑥上流側法勾配1：3.0，下流側勾配1：2.5及び20フィート幅の道に対する3ケースの最小安全率は以下のとおりである。

(a) 建設時 ＝ 2.24

(b) 安定した浸潤時 ＝ 2.13

(c) 水位急降下（満水時から） ＝ 2.20

以上の解析結果（仮定条件も含む）によれば最小安全率が大であるように思われるので，今後基礎地質調査を実施することにより，物性等を明らかにすると共に，土質調査試験結果を解析し設計数値の決定の根拠を明らかにダムの安全性，施工性，経済性を考慮して，堤体形状について検討する必要がある。

(3) ダム基盤の検討

ダムの基礎掘削の基本的考え方を別途ダム標準図に示すごとく，堤高Hに対して$^{1}/_{3}$ Hをトレンチカットし開削し置換えることとしている。

この基盤の地質調査即ちボーリングによる透水試験，電気探査等が実施されていないので現状で基礎地盤の物性，力学性を先ず明らかにして，トレンチカットの必要性について充分検討すると共に基礎処理工法（ブランケット止水あるいはグラウチング）についても検討する必要がある。

(4) 余水吐の設計について検討

現計画においては，余水吐の越流水深は4フィート，堤長2,000フィートで同一断面で自然越流堰余水吐として計画されているが，前述した余水吐ボーリング結果によれば基盤の深度は一様ではなく，右岸よりになるに従い基盤が深くなっている傾向にある。依って，ゲート式の併用により余水吐幅員を縮少し，施工性，経済性，安全性について検討する必要がある。

(5) 土取場位置の検討

現計画では土取場として2ケ所を選定して，それぞれ土質調査試験（左岸部ピット5坑，オーガーボーリング55孔，右岸部ピット4坑オーガーボーリング59孔）を実施している。

右岸側土取場は高位部にあり施工性については問題はないが，左岸側土取場は低位部（ダム敷現況標高と同レベル）にあり施工性に問題が生ずるのではないかと思われる。

この他，中央部上流側（高位部）に適当な土取場が考えられることより，この土取場についても，材料，施工性，経済性について検討する必要がある。

2） 水収支の検討

必要水量の算定は次の通りである。

必要水量の算出基礎

(1) MTo は，Panman の手法（ＦＡＯ）を用いて計算された。

気候データは，スリランカの典形的な乾燥地帯のものを用いた。

(2) 蒸発散量のクロップファクターはＦＡＯのデータと地域的なものが利用できるときはそれを用いて計算した。

ET crop ＝ ETo × クロップファクター

(3) 有効雨量ＥＲは，２０年間の記録より７５％の確率水準で見積もられ Udvwila （ウデゥウィラ）については次のようである。

水田：ＥＲ＝（Ｒ－１）× 0.６７

ＥＲ＝ 9″ （もしＥＲが9″より大の時）

ＥＲ＝ 0″ （もし Ｒ が1″より小の時）

ＥＲ＝（Ｒ－0.２５）× 0.６７

ＥＲ＝ 3″ （もしＥＲが3″より大の時）

ＥＲ＝ 0″ （もし Ｒ が1″より小の時）

(4) 水田土地改良準備のための必要水量 7″

(5) 畑地 〃 〃 〃 1.5″

(6) 水田における浸透量 6″／月

(7) 畑地における浸透量とロスはかんがい必要量の ５０％

(8) ほ場必要水量は次式で与えられる。

(a) 畑 地

ほ場必要水分量＝（ＥＴ－ＥＲ）× $\frac{100}{50}$ ＋土地改良準備のための必要水量

(b) 水 田

ほ場必要水分量＝土地改良準備のための必要水量＋ＥＴ crop 蒸発散量

＋浸透量－ＥＲ有効雨量

(9) 貯水池容量（Tank Duty）は，ほ場必要水分量の３０％増

CROP FACTORS

Crop and crop factors	Initial stage	Crop development stage	Mid stage	Late stage
Lowland Rice(135 days)	30 days	40 days	45 days	20 days
Crop factor	1.00	1.15	1.20	0.90
Lowland Rice(100 days)	20 days	30 days	30 days	20 days
Crop factor	1.00	1.15	1.20	0.90
Lowland Rice(90 days)	20 days	25 days	30 days	15 days
Crop factor	1.00	1.15	1.20	0.90
Upland Rice(100 days)	20 days	30 days	30 days	20 days
Crop factor	0.90	1.00	1.05	0.90
Upland Rice(90 days)	20 days	25 days	30 days	15 days
Crop factor	0.90	1.00	1.05	0.90
Green Gram(75 days)	15 days	20 days	25 days	15 days
Crop factor	0.50	0.80	1.05	0.70
Chillies(180 days)	30 days	30 days	90 days	30 days
Crop factor	0.65	0.85	1.00	0.90
Ground Nuts(110 days)	20 days	30 days	40 days	20 days
Crop factor	0.65	0.80	1.00	0.80
Soya Bean(105 days)	15 days	20 days	50 days	20 days
Crop factor	0.65	0.85	1.05	0.75
Cowpea(90 days)	15 days	25 days	35 days	15 days
Crop factor	0.70	0.90	1.10	1.00
Pulses(95 days)	15 days	30 days	35 days	15 days
Crop factor	0.50	0.80	1.05	0.50
Cotton(165 days)	25 days	45 days	55 days	40 days
Crop factor	0.65	0.90	1.05	0.90

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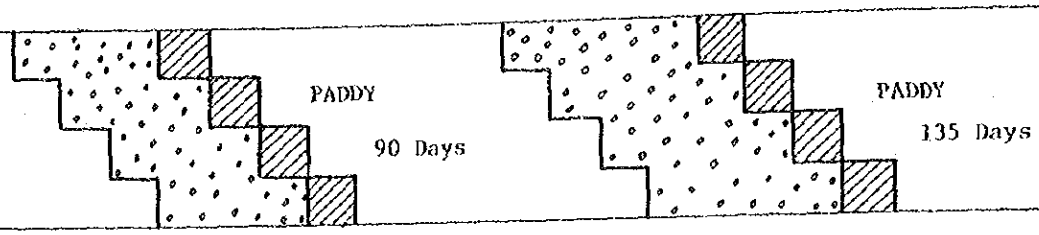
Colombo

wg/

PADDY LOWLAND

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
0 inches	4.7	5.0	6.2	5.9	6.4	6.9	7.5	7.6	7.5	6.2	4.3	4.5
Rain-fall	0.31	0	0.31	1.87	0.22	-	-	-	-	1.82	4.11	1.22
W · R	6.8	1.4	4.9	9.3	13.2	8.9	1.9	1.7	8.5	11.08	6.8	10.1



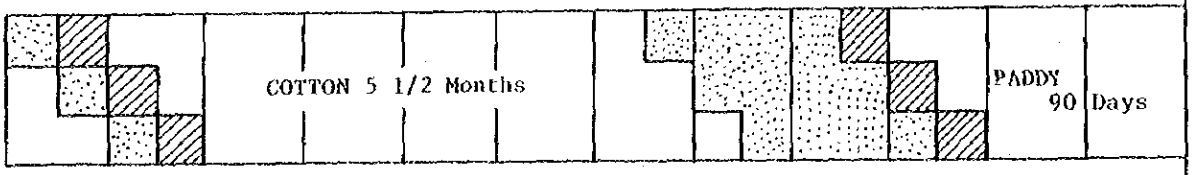
Use Division, Irrigation Dept.
Colombo 7.

LAND PREPARATION

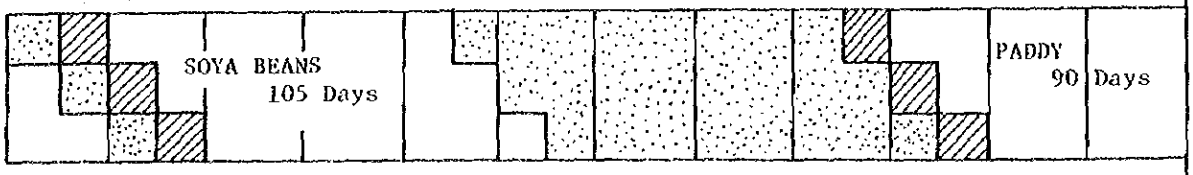
UPLAND

	J	F	M	A	M	J	J	A	S	O	N	D
(inches)	4.7	5.0	6.2	5.9	6.4	6.9	7.5	7.6	7.5	6.2	4.3	4.5
Rain-fall	0.81	0.37	0.81	2.31	0.72	0.23	-	-	0.05	2.32	3.0	1.73
R I	5	4.6	8.2	6.5	11.7	13.2	11.2	2.2	0.9	4.6	5.8	8.9
R II	5.0	4.8	9.5	7.4	8.0	13	-	-	0.9	4.6	5.8	8.0

I (8000 Acs)



II (2000 Acs)



Use Division Irrigation Dept. Colombo 7

LAND PREPARATION

〔計　算　例〕

(a) 畑　作 ―― 4月大豆（作物カレンダー参照）

蒸発散量 $= \frac{1}{3}\left(1.05 \times 5.9 \times \frac{25}{30} + 0.75 \times 5.9 \times \frac{5}{30}\right)$

$+ \frac{1}{3}\left(1.05 \times 5.9 \times \frac{30}{30}\right)$

$+ \frac{1}{3}\left(0.85 \times 5.9 \times \frac{5}{30} + 1.05 \times 5.9 \times \frac{5}{30}\right.$

$= 6.00''$

有効雨量　　ER = 2.31

土地改良準備 = 0

必要水量 $= (6.0 - 2.31) \times \frac{100}{50} = 7.3''$

貯水池容量 = $1.3 \times 7.3 = 9.6''$

(b) 水　田 ―― 4月（作物カレンダー参照）

土地改良準備 $= 0 + 0 + \frac{7}{4} + \frac{7}{4} = 3.5''$

蒸発散量 $= \frac{1}{4}\left(1.00 \times 5.9 \times \frac{5}{30} + 1.15 \times 5.9 \times \frac{25}{30}\right)$

$+ \frac{1}{4}\left(1.00 \times 5.9 \times \frac{20}{30} + 1.15 \times 5.9 \times \frac{10}{30}\right)$

$+ \frac{1}{4}\left(1.0 \times 5.9 \times \frac{15}{30}\right)$

$+ \frac{1}{4}(0)$

$= 3.92''$

浸透量及びロス

$= \frac{1}{4}\left(6 + 6 + \frac{6}{2} + 0\right) = 3.7''$

有効雨量 = 1.37

必要水量 = $3.5 + 3.92 + 3.7 - 1.37 = 9.3''$

貯水池容量 = $1.3 \times 7.3'' = 12.1''$

土地利用課かんがい局

コロンボ

必要水量の算定に使用されている Mahauswewa 地点実測河川流量に見られるように，２０年間の年間最大流量と年間最少流量との比率が２０倍以上となっており，このことは各年間流量変化が著しい事を示すもので，出来得る限り長期間の資料により必要水量を検証する事が望しい。従って，流域内の３地点（Mahauswewa，Galgamuwa，Mediyawa）で観測されている長期降雨記録と流量との相関から流量を算出し，必要水量を確認する事が必要である。

又，必要水量を確保するため貯水池周辺からの漏水の恐れがないかについても充分に調査を行い検討する必要がある。

4－3　農　業

本計画の中の営農部門に関する基礎資料の多くは Mahaweli 開発計画の Stage 2 による。特に栽培関係については Maha Illppallama 農試の試験結果に負うところが大である。したがって，Mahaweli Project Rigion を対象としたこれらの基礎資料がどれだけ本計画に適用し得るかの検討が必要であろう。

同時に再入植者（新規入植者）の技術レベルや営農形態の現況からみたプロジェクトの一戸当り面積，稲作を主体とした集約的栽培法等への順応等見直されなければならない。

一方では計画の飛躍的な単位収量の増加や農家一戸当りの純収益を得る為に必要な技術的諸言の再検討や配水と栽培計画の確立，具体等営農指案計画等，生産活動をとりまく環境についても検討を加える必要がある。

4－4　経済性評価

(1)　Price Contingency

スリランカ F／S レポートでは事業費の算出にあたって，建設機械費を除いて Price Contingency を考慮している。

スリランカにおける最近時の借款プロジェクトの例では世銀の「Tenk Moderniyation Project（１９７６～８０）」があり，ここでは Prie Contingency として，全体事業費の約３０％を計上している。

外貨部分のうち，建設機械費については１０％の Price Contingency を計上しているが，工程からみて第２年度目以降に購入を予定している機械が多いので不足する可能性がある。

上記世銀レポートにおける物価上昇率は下表のとおりである。

（単位　％）

物価上昇率	1976	'77	'78	'79	'80
Civil Works	14	12	12	12	12
Equipments	10	8	8	8	8

スリランカ側は上表の数字を参考にして，本プロジェクトについて新たに Price Contingency を算出する作業を行うとのことである。

外貨分の Price Contingency については今後日本側でも試算を行い，ス側数値と比較して最終事業費を確定することが必要である。

(2) 建設機械単価

スリランカF／S レポートにおける建設機械の単価は最近時のスリランカにおける国際入札実績（ＩＤＡローン，１９７６．４　入札）に基づくものである。この価格を同一機種の日本国内公表価格（１９７６．６物価版）と比較すると，下表の如くむしろ安くなっている。

建設機械単価比較事例

機　種	仕　　様	① F／S 価格	②日本国内公表価格（'76.6　物価版）	③ 比①／②
Tractor Class Ⅰ	Komatya D155 300PS T＝38.6	33,000千円	37,600	0.88
〃 Class Ⅱ	Komatya D85－12 180PS T＝25	15,000	20,900	0.72

上記機械を日本から調達するとすれば，その調達価格は日本国内公表価格＋輸送費＋保険料で日本国内公表価格の２～３割高に，F／S 価格と比較すれば４～７割高となる可能性がある。

ＩＤＡローンによる国際入札実績の状況検討，見積書の徴求による実勢価格の把握等を行い，妥当な価格を算出する必要がある。

(3) 外貨分事業費の確定

F／S レポートで外貨分として計上されている鉄筋，セメントのIndirecs Foreign Cort の取扱い，建設機械費の検討等の作業により外貨分事業費の確定を行う必要がある。

5. 今後必要な調査項目

5－1　水文および貯水量関係

計画されているダムの貯水量を雨量観測と流量観測資料の解析から検討する。

項　　目	国内作業	現地作業	資　　料
1. 水　　文	雨量観測資料解析 （Station　3ケ所）	不足資料の収集，検討	雨量資料 （MONIHLY）
	流量観測資料解析 （Station　1ケ所）	〃	流量資料 Mi-OYA Mahauswewa 日流量
2. 必要水量の算定	計画水量のチェック	〃	クロプファクター 作物別カレンダー 水量算出基礎
3. 貯　水　量	貯水量の検討	〃	貯水量検討図表

5－2　ダム施設

水文解析，貯水量算定に基づき，計画されているダム施設を堤体，堤体軸，基礎処理，余水吐き，取水施設等について検討を加える。

項　　目	国内作業	現地作業	資　　料
1. 計画設計 （現地調査 比較検討	・収集資料の検討 ・ダム軸，ダムタイプの概算 ・工事費および貯水量による比較検討 ・一般計画図，縦横断平面図の作成	電探　6.5Km ボーリング ダム軸5本　20m/本 比較軸4本　20m/本 地質図の作成 平面，従横断 ・比較終線決定となれば現地測量が必要となる	ダムサイト附近 平面図 縦断図 ダム標準断面図 旧堤断面図（未） 土質柱状図 （比較）

項　　目	国　内　作　業	現　地　作　業	資　　料
		・旧堤の活用となれば ①旧堤土質材料調査 ②漏水個所調査 ③旧堤測量 平面，縦横面 ④貯水曲線の作成	
2. 堤体設計	・計画設計のチェック （用土試験データーの解析		用土土質試験資料 土取場平面図
（基本断面と設計数値の検討	・ダム型式の詳細検討と断面の検討		
堤体の安定計算	・3ケース（上・下流面最危険　各1ケース…電算） 限界安全率と近似断面形状を求める		ス政府安定条件表の提示
漏水量および余盛計算	漏水量計算を行う		
設計図	設計図の作成		
数量計算	数量計算		
3. 基礎処理		上記ボーリングと併せ透水試験を行う。	
処理工法検討		ルジョンマップの作成	
床堀，注入方式諸元の決定	方式諸元の作成		
設計図	設計図の作成		
数量計算	数量計算		
4: 余水吐設計			
タイプの検討	タイプ，路線位置を工費で比較検討する。		
水理計算	水理計算		

項　　目	国　内　作　業	現　地　作　業	資　　料
構　造　計　算	構造計算		
設　　計　　図	構造図		
数　量　計　算	数量の決定		
5. 取　水　施　設	計画のチェック		
6. 仮排水路の設計	タイプ，位置，ルートの比較検討		
水　理　計　算	図表による概略計算		
構　造　〃	概略構造		
設　計　図　作　成	概略図の作成		
数　　量	概略数量算定		
7. 施　工　計　画	施工，工程計画の基本的骨子の作成		
8. 仕　　様　　書	主要な特別仕様のみ		
9. 工　事　費　積　算	工事費積算		

5－3　農地造成

項　　目	国　内　作　業	現　地　作　業	資　　料
1. 農　地　造　成	地区内で約100haのモデル地区を設定し，支線，ホ場水路の長さを算定し，造成費用を算出する（単位当りの事業費の算定）		

5－4　営　農

計画の営農部門に関する基礎資料の多くは，Mahaweli 開発計画の Stage II による。特に栽培関係については，Maha Illppallama 農試試験結果に基づいている。従って，不足している下記の項目について検討を加える。

項　　目	国　内　作　業	現　地　作　業	資　　料
1. 計画地区の現況	資料検討	• 農業生産の動向 • 農民の技術レベル • 生産体制	Mahaweli 農試データー F/S レポート
2. 営　農　計　画	資料検討	• 水場要水量，配水計画と作付体系 • 作付体系と労働配分 • 土壌の生産性，投入資材と収量の関係	〃 〃 〃
3. 入植，農民組織	資料検討	• 入植者訓練計画の検討および計画の作成 • 農民組織の検討（ＡＰＣ，ＣＣ）	
4. 大豆，雑豆	• 栽培適応性について検討 • 需要調査結果に基づく生産計画作成	• 大豆需要の動向調査 • 雑豆需要の動向 〃 • 地区内生産計画 〃	

5－5　経済評価

項　　目	国　内　作　業	現　地　作　業	資　　料
1. 事　業　費	資料検討	• Price Contingency の算出 • 建設機械費の積算 • 外貨分事業費の見直しと年度計画の作成 • 借款要請金額の算出 • 借款額変動による工期事業費の計算	IDA Loan 資料 建設機械リスト 他資料３点

項　　目	国　内　作　業	現　地　作　業	資　　料
便　　益	資料検討	・数値の見直し （収量，生産費，価格等）	
事　業　評　価	資料検討	・ＩＲＲ算出 ・感性テスト ①事業費，便益２０％ 変動 ②建設期間の延長 ③　①＋②	

(付 属 資 料)

別紙2　Rajangana Reservor Project の概要

1. 位　　置　North west dry yone region の中央部

Kala Oya 流域，Anuradhapura 州の州都 Anuradhapura の南西約２５マイルの位置

2. 受益面積

当初計画	haddy (Maha season)	15,000	acres
	〃 (Yala 〃)	5,000	
	計	20,000	
変更計画	Paddy (Maha season)	10,500	
	〃 (Yala 〃)	10,500	
	Upland Crops	4,000	
		25,000	

3. 事業計画　Dry yone における水資源開発計画のうち，Kala Oya流域開発計画に優先順位が与えられた。本事業は Kala Oya 流域では Kala Wewa Project (Rajangana Res の上流約４０Km地点) に次じ第２番目の Project として計画された。

Kala Oya 中流部，Putalam-Aruradhapura 幹線道路との交叉地点から上流の両岸に拡がる約１4,500 acres (約１００ acres のポンプ灌漑地区を含む) の農地を整備し，これへ灌漑用水を供給するため，貯水量８2,000 ac.feet (１０1,147千m^3) の Rajangana reservoir，左右両岸に幹線水路及び農地整備工事を実施したものである。

4. 主要工事

堤　体　アースダム，$L = 2^{M}27^{CNS}$，H = 70 feet，V = 450 1000 cubes (1,274千円)

貯水池　貯水量８2,000Ac.feet (１０1,150千m^3)，満水面積 3,700Ac

H - 7.5 feet C.V = 75,000 C Y.

余水吐　コンクリートダム，ラジアルゲート　２０×１０×２０門，

Max discharge 53,000 cusec (1,500 m^3／

取水施設　タワー式 (両岸)　右岸 12m^3／s (１6,000 Ac.)

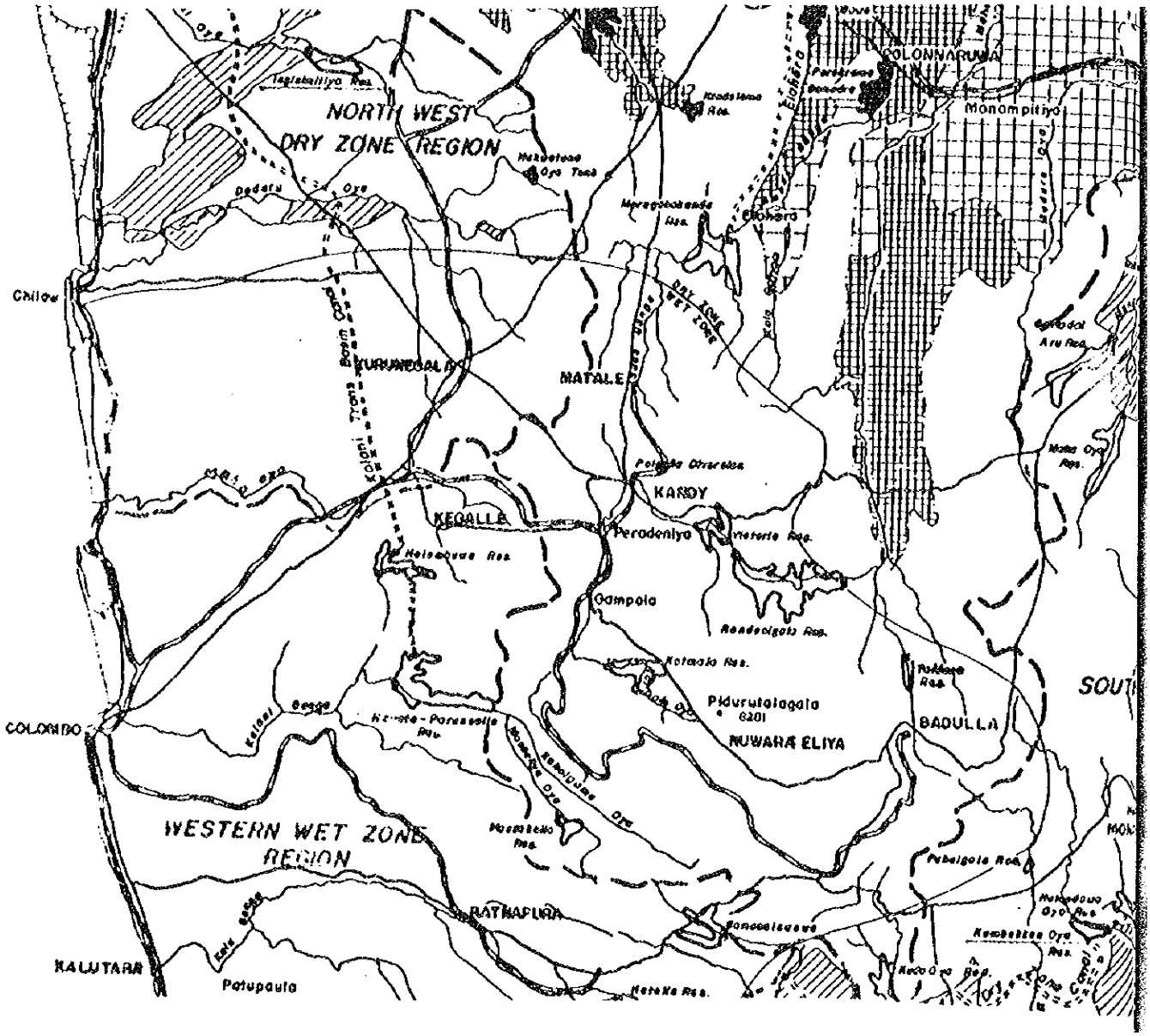
左岸　4m^3／s (4,000 Ac.)

流　域　$A = 622 M^2$ (1,610 Km)　(うち２５M^2は Kalawewa 上流)

計画最大洪水量　６1,000 cusec (1,726 m^3／s)

5. 事 業 費　灌漑工事 31,000,000RS，農地整備工事 22,312,500RS，計 53,312,500RS

6. 工　期　ダム 1962～65



International Bidding on Machinery Under I.D.A. Credit

	Name of M/C	Specification	Price per one unit		Date of bidding	
			US$	SL RS		
1	Tractor Class I	Komatzu D 155A-1 300HP/2000RPM	96,120	722,083	16-3-76	Japan
2	Tractor Class II	Komatzu D85-12 Draw bar pull 35000 lbs at 15 MPH 180HP/1850RPM	64,119	514,886	16-3-76	Japan
3	Scraber	-				
4	Mot Scraber	Bharat Model 'C' 300FHP/2100RPM 22.7 Tons	83,140	667,514		India
5	Sheep foot Roller	Muller Model T22 10HP	509	43,840	27-7-76	Karl Muller Ag, Switzerland
6	Motor Grader					
7	Excavator	Ishikc Model 375 1 cu yd., digging depth 20.4'	41,060	356,232		Japan
8	Lorry Tibber	5 Ton Capacity 90BHP	11,872	95,317		British Layland U.K.
9	Compresser		21,193	163,430	2 2-76	Atlas Copco Sweden
10	Jack Hammer		840	6,483	2-2-76	Atlas Copco Sweden
11	Showol Loader	Komatzu D603 Crawler Capacity 1.8 m^3 Operating wt 17,300 kgm	43,310	347,715	16-3-76	Japan

	Name of M/C	Specification	Price per one unit		Date of bidding	
			US$	SL RS		
12	Euclid Rear Dumper					
13	Crusher	Discharged Capacity 10 Tons/hour	19,780	159,000		
14	Pumb	Diaphragm 4", diesel 13,198 gpn capacity	1,937	15,560	27-7-76	Pumpenvertibs & Service, Austria
15	Water Bowser	Mitsubishi Model T653B 1306 gallons capacity	12,172	97,728	11-3-76	Japan
16	Fuel Bowser	Mitsubishi Model T653B(M) 1302 gall capacity	12,830	98,250	11-3-76	Japan
17	Jeep	J-44 Mitsubishi 104" 80HP/3200RPM wheel base	5,028	40,169	11-3-76	Japan
18	Concrete Mixture	Capacity 7 au ft 4HP	1,496	11,944	13-3-76	India
19	Agricut. Tractor	International Model 444 40 BHP Ground clearence 14"	4,634	37,105	16-3-76	

REPORT ON

INGINIMITIYA RESERVOIR PROJECT

PREPARED BY THE IRRIGATION DEPARTMENT

MINISTRY OF IRRIGATION, POWER & HIGHWAYS

DATE August 1976

C O N T E N T S

Feasibility Report on Inginimitiya Reservoir Project

SUMMARY

(i) This feasibility report on Inginimitiya Reservoir is presented for approval for implementation in 1977.

(ii) The project is located in the Puttalam District in the North Western Province of Sri Lanka, about 14 miles from the town of Galgamuwa. The scope of the project is the irrigation of 6300 acres of new land in paddy, soya beans and pulses. The main items of work will be the construction of a reservoir (53,000 Ac. ft. in capacity) and the development of the new lands by the provision of irrigation facilities and the settlement of 2520 farm families.

(iii) The project area receives its precipitation in the month of October to December and in April, the annual rainfall being about 55 ins. The project lands are flat plains, with gentle grades. Studies show that the 53,000 Ac. ft. reservoir will suffice to cultivate the lands with 90 per cent success. The soils consist of reddish brown earths. Low humic glory soils and alluvials soils, which are suitable for the cropping patterns chosen but irrigation is essential. At present the project area is mostly in jungle interspersed with village tanks under paddy cultivation and chena (shifting) cultivation. The people living under these tanks live at subsistence level.

(iv) The headworks will consist of an earth dam, maximum height 60 ft. on uncontrolled spillway, a emergency spillway and two sluices feeding the left bank canal (13 miles long, 150 cusees) and the right bank canal (7 1/2 miles long, 50 cusecs). An irrigation network to feed 6300 acres of new lands, and the settlement of 2520 farm families are also necessary for the project. The construction of reservoirs and the settlement of peasants in the dry zone has been going on in Sri Lanka for over three decades and supporting experimentation or training will be minimal.

(v) The duration of construction of the project is 5 1/2 years. The project will commence bearing fruit in the 4th year and attain full development in the 9th year. The project will be constructed by the Irrigation Department which comes under the Ministry of Irrigation, Power and Highways. The Land Development Department will construct the buildings and roads in the settlement schemes while the Land Commissioner's Department under the Minister of Agriculture and Lands will attend to the selection and settlement of the peasants. The operating costs will be met by the peasants in the form of a land betterment tax. Farm inputs will be supplied by the Co-operatives and credit by the Peoples Bank. The produce will be bought by the Paddy Maketing Board and the Co-operatives.

(vi) The total cost of the project will be Rs. 80 million. The foreign cost is estimated at Rs. 44.15 million or approximately 5.08 million US $.

(vii) The not value of the annual production is Rs. 23.8 million when the project is in full operation. At present the country is short of about 340,000 metric tons of rice which is being imported and this project along with other projects being undertaken will meet the short-fall. On long term analysis it is estimated that Sri Lanka will be short by one million tons of rice in 2000 A.D. and the market for rice is assured. The Government has been gradually increasing the guaranteed price for rice over the years. Soya beans will be bought up at guaranteed prices -

Oils and Fats Corporation while the pulses will command a ready market in the country. At present, 95% of the country's requirements of pulses are imported. The farm income (annual) assuming all labour hired is Rs.7000/=per 2 1/2 acre farm. This compares well with the average annual income per household in the rural sector of Rs.3600/=.

(viii) The internal rate of return of the project is 17% at market price and 27% at opportunity prices. For opportunity prices, foreign exchange was valued at twice the official rate and unskilled labour at one third the market value. The not foreign exchange saving is Rs.26.1 million per year. It is not feasible to make a estimate of the increase in Government revenues, but it can be stated that a major objective of the Government is to reduce food imports as fast as can be achieved.

(ix) The Inginimitiva Reservoir Project is technically feasible and economically attractive. It has hence being placed as an item of construction in the year 1977.

GLOSSARY

DEFINITIONS

Paddy is the term used for unbusked rice and is measured in bushels, one bushel of paddy weighing 46 lbs.

The Maha Season is the period from October to March in which paddy is grown and harvested. The North-East monsoon occurs during this period.

The Yala Season is the period from April to September in which paddy is grown and harvested. The South-West mensoon occurs during this period but it brings rain only to the wet zone of Sri Lanka. The dry zone in which the Inginimitiya Project is located is hardly affected by these rains.

Chena is cleared jungle land, used for shifting cultivation.

Pattu is a subdivision of a Divisional Revenue Officer's Division.

CURRENCY EQUIVALENT

1.	U.S. $	= 8.66 Sri Lanka Rupee
2.	Sri Lanka Rupee	= 0.115 U.S. $

WEIGHTS AND MEASURES

1	Acre (ac)	= 0.405 hectares
1	Mile (mi)	= 1.609 kilometres
1	Sq. mile (sq.mi)	= 2.589 square kilometres
1	Foot (ft)	= 0.3048 metre
1	Acre feet (ac ft)	= 1233.5 cubic metres
1	Inch (in)	= 25.4 millimetres
1	Cubic feet per sec (cusec)	= 0.0283 cubic metres per second
1	Cube	= 100 cubic foot = 2.832 cubic meters
1	Pound (lb)	= 0.4536 kilograms
1	Hundred weight (cwt)	= 50.80 kilograms
1	Ton	= 1.016 metric tonnes
t	Degrees Farenheit	= (t - 32 $\frac{5}{9}$) deg. centigrade

PLANS

1 Inch = 4 chains corresponds to 1:3168
1 Inch = 8 chains corresponds to 1:6336
1 Inch =12 chains corresponds to 1:9504
1 Inch = 1 mile corresponds to 1:63360
1 Inch = 4 miles corresponds to 1:253,400
1 Inch = 8 miles corresponds to 1:506,808
1 Inch =24 miles corresponds to 1:1,520,640

ABBREVIATIONS

W/I.P.H.	- Ministry of Irrigation, Power and Highways
M/A.L.	- Ministry of Agriculture and Lands

LIST OF ANNEXES

Report on Inginimitiya Reservoir Project for obtaining Capital Aid (Feasibility Report)

1.0 INTRODUCTION

1.1 The scope of the (Inginimitiya Reservoir Project is) the irrigation of 6300 acres of land of which 4500 acres will be in paddy for both season (October - March, wet season and April - August, dry season) and 1800 acres will be in paddy for the wet season and soya beans and pulses in the dry season. The project area is at present, mostly in jungle with few peoples living at subsistence level with the help of small village tanks dispersed throughout the project area. New farmers will be settled in the irrigable area under the project. The project is incorporated in the development plan of the Government and is placed as an item for construction in the year 1977.

1.2 Members of the State Assembly representing the area have constantly voiced the request of the villagers for an assured supply of water for their paddy fields. The soil in the project area is also fertile and in 1951 the project was included in the priority lists of the District Agricultural Committee of the region. This led to a reconnaissance report which recommended a two mile long earth dam at Inginimitiya. Several dam sites were investigated and the present site was chosen as the meet suitable. The Survey Department carried out a large programme of Engineering Surveys of the development area. Drilling and soil investigations commenced in 1965. The investigations are complete and specification disigns for the project finalised. Financial provision has been made in the Government Budget for 1977.

2.0 AGRICULTURAL BACKGROUND

2.1 Tea, rubber and coconut are the major export crops and the main source of the country's foreign exchange (about 75% of the total foreign exchange earnings). The staple food of the people is rice and at present domestic consumption has to be supplemented by imports from abroad. In 1975 for instance 677,000 metric tonnes were produced locally while 342,000 tons were imported. The foreign exchange earned is spent on the imports of food stuffs, consumer goods and equipment for agricultural and industrial development, loading to a depletion of the country's foreign exchange reserves.

The population of Sri Lanka as estimated in 1974 was 13,400,000, the census of 1971 having given a figure of 12,711,000. The rate of national increase per 1000 population was 18.4 in 1974. According to a low projection forecast made by the Department of Census and Statistics, the population of Sri Lanka will reach 20 million in the year 2000 D. The rate of growth has dropped from 2.4 per cent in 1965 to below 2 percent today and is attributed to a favourable response to family planning programme.

Agriculture provides about 35% of the gross domestic product. The

gross national product had a growth rate of 3.6% in 1975. However, the economy was adversely affected by the rise in prices of oil and essential foodstuffs. The adverse terms of trade together with the population growth resulted in the failure of the per capita income (Rs. 1190 in 1973) to increase approciably.

It is estimated that the Island's rice requirements will be about 2.2 million metric tons by the year 2000 A.D. The production of rice in the Island during the period 1966 - 1975 averaged 0.78 million. The productivity of the existing land may be increased by improved agricultural practices and higher input, of fertilizer but with all these efforts the production can be raised to about 1.22 million metric tons in 2000 A.D. Thus, there will be a shortfall of about one million metric tons and new lands must be developed or imports have to increase. The increase in area of irrigated agriculture is the only answer to this problem and to the problem of growing unemployment, due to increase in work force with increasing population. The land is available in the dry zone of Sri Lanka. This, which comprises of about 3/4 of the Island, however needs the storage of water in reservoirs which regulate the uneven inflows from rainfall. All governments of Sri Lanka have adopted the policy of promoting agricultural development and the provision of irrigation to the available land in the dry zone. Sri Lanka also enjoys the advantage of a high literacy rate of 78% which is conductive to the promotion of more intensive agriculture.

2.2 The main institutions concerned with irrigation and agricultur are given below : -

1. Ministry of Irrigation, Power and Highways
2. Irrigation Department
3. Mahaweli Development Board
4. River Valleys Development Board
5. Land Development Department
6. Ministry of Agriculture and Lands
7. Department of Agriculture
8. Land Commissioners Department
9. Survey Department
10. Paddy Marketing Board
11. Ministry of Planning and Economic Affairs
12. Department of Co-operative Development
13. Peoples Bank
14. Bank of Ceylon

1. The Ministry of Irrigation, Power and Highways has the following responsibilities in respect of irrigation works only : -

(1) Investigation, planning and development of water resources for all irrigation works.

(2) Prevision of irrigation facilities, land development, settlement of peasants and provision of reads and civic facilities.

(3) Reclamation of low lying lands for agricultural purposes.

2. The Irrigation Department functions under the M/I.P. & H. and its functions in respect of irrigation works are : -

(1) Preparation of Master Plans for optimum utilization of land and water resources.

(2) Project formulation and detailed designs.

(3) Construction of major irrigation projects costing over RS.2.5 million. This includes drainage and reclamation works.

(4) Development of Ground Water Potential for agricultural purposes.

(5) Applied Research in Hydraulics, Hydrology, Soil Mechanics. Engineering Geology, Agriculture, Soil and Land Use.

3. The Mahaweli Development Board. It functions under the M/I.P. & H. Its function are : -

(1) To promote and operate schemes of irrigation, drainage, flood control within the Mahaweli River Basin Project. area.

(2) To promote agricultural and economic development in the area.

(3) To ensure the necessary coordination between Government and local bodies in the development of this area.

4. River Valleys Development Board. It functions under the M/I.P. & H. Its main functions are : -

(1) To promote and operate schemes of irrigation drainage and flood control within its area of authority. At present the area of authority is the Walawe Basin.

(2) To promote agricultural and economic development within the area.

5. Land Development Department is charged with the development of land and construction of buildings and roads in settlement schemes taken up by the Irrigation Department. It functions under the M/I.P. & H.

6. The Ministry of Agriculture and Lands in charged with the respensibility for : -

(1) Agrarian services, extension, research and training
(2) State and Cooperative Farms
(3) Land reform
(4) Forest development
(5) Animal Husbandry

7. The Department of Agriculture under M(A.L.) undertakes the following functions : -

(1) Agricultural research, extension and training.
(2) Seed and planting material.
(3) Livestock research and extension.

8. The Land Commissioners Department under M (A.L.) has the following functions: -

(1) Administration and development of State Land in the Island.

(2) Alionation and sale of land to settlers in irrigation schemes.

9. The Survey Department under M (A.L.) provides the surveys necessary for : -

(1) The provision of irrigation facilities and highland allotments and settlement.

(2) Alionation of land to the peasants.

10. The Paddy Marketing Board under M (A.L.) handles the purchase of paddy at guaranteed prices.

11. The Ministry of Planning and Economic Affairs is closely linked with all Planning and Programming of Water Resources Development and is mainly responsible for, amongst other functions : -

(1) Formulation of economic policies and their appraisal.
(2) Coordination of policies and programmes of Ministries and Government Departments as regards planning.

(3) Organisation and channeling of External Resources.
(4) Preparation of the annual capital budget
(5) Coordination of the work connected with External Agencies.

12. The Department of Co-operative Development under the Ministry of Food Co-operative and Small Industries is responsible for : -

(1) Supply of speed, fertilizer and agrochemicals to the farmer.

(2) Buying of produce other than paddy at prices guaranteed by the Government.

13. The Peoples Bank under the Ministry of Finance provides credit to farmers for : -

(1) Settlement loans
(2) Purchase of draught buffaloes or farm machinery
(3) Cultivation costs of the farmers.

At district level officers of each of the Departments meet at the District Agricultural Committee along with other persons who have interests in agriculture and rural welfare. The Committee is headed by the Chief Revenue Officer of the District. The field officers of each Department work jointly under agricultural area committees.

2.3 The pattern of cultivation envisaged is the growth of paddy on 4500 acres in both the wet and drier seasons on suitable soils and the growth of paddy on 1800 acres in the wet season together with soya beans and pulses (on these 1800 acres) in the drier seasons. The Mahawell Project Stage 2 envisages similar patterns of cultivation on 61,000 acres in dry zone and pilot projects have been set up and evaluated for this scheme. A World Bank loan is forthcoming for the development of these 71,000 acres. It is only a similar scheme that will be done in the Inginimitiya Reservoir Project. The potential of the country with respect to this type of development is great and the only limiting factor is the lack of finances, for the necessary development of irrigated agriculture in the dry zone of Sri Lanka.

3.0 PROJECT AREA

3.1 Location - The project is located in Kirimetiyawa Pattuwa and Karambe Puttuwa, Puttalam District in the North Western Province of Sri Lanka and the dam site is aboout 14 miles from the town of Galgamuwa. The scheme can be approached by the main trunk roads Colombo - Kurunegala-Galgamuwa.

The total population of the two Puttu is about 8000 persons. This population is mainly engaged in agriculture, mostly in paddy and shift (chena) cultivation. The cultivations are dependent on rain water or are fed by small village reservoirs (tanks). The rainfall is barely sufficient for paddy cultivation and the conditions of living of the peasants are poor. There are no apportunities for industrial employment and unemployment is wide spread.

3.2 Topography - The reservoir is located across the Mi Oya, which originates in the Dambulla hills in the Pallokollo Forest reserve. It drains an area of 592 sq. miles at the mouth, close to the town, Puttalam. The Oya starts at an elevation of about 700 MSL., and drops sharply to 400 MSL in 15 miles. It then drops gradually at about 5 ft. per mile. The principal tributary of the Mi Oya, namely the Nanneri Oya joints the Mi Oya very close to the latters outfall to the sea. The total length of the Mi Oya is 72 miles.

The location of the scheme is relation to the riverse, population centres and roads is shown in Fig. 2. The slopes of the project area average from 0 - 4 per cent.

The aerial survey photographs of the area are available to the scale of 1:40,000. The general topography of the area is available to the scale of 1:63,360. Detail contour plans of the development area are available to the scale of 1:9504 soil maps are available to the scale of 1:63,360.

3.3 Climate - The project area receives its procipitation in the months of October, November, Docember and April. The rains in October and April are due to convection while the rain in November and December are due to the North East Monsoon, aided perhaps by depressions in the Bay of Bengal. The annual rainfall is about 55 ins. The Mi Oya Basin can be said to have the least rainfall in the Island except for the basins around Hambantota in the South East of the Island.

The mean daily temperature of the project area is 81°F with a range of ± 7°F during the year. The marimum was 87.2 F and the minimum 75.2°F. The average relative humidity is about 88% during the year.

The evaporation loss from a free water surface is estimated as 65 inches, the figure being based on data collected at Tabbewa close to the project area.

The wind directions are North Easterly during the months of November to March and changes to South Westerly in the months of April to October. The mean daily wind mileage for Puttalam is about 170 miles.

3.4 Geology - Core drilling has been done with 9 holes varying phie rocks quartze-foldspathic gneisses with biotite are most common on the dam axis. The average geologic section is as follows : -

(a) Fresh quartze foldspathic biotite gneiss
(b) A layer of quartze foldspathic biotite gneiss moderately weathered, fractured.

(c) A layer of sand - medium to fine with mica.
(d) Medium to fine grained sand with clay.

On the right bank flank of the dam axis a prominent outcrop of Tonigala Granite is available. This rock is dipping in a 60°, westerly direction and the strike direction is N 10°E. The rock is massive, fresh and highly jointed.

The cut off trench of the earth dam will be taken to sound rock reduce seepage and little grouting of the rock appears necessary. No harmful minerals or salts are found in the reservoir area.

Suitable construction materials namely earth, sand and coarse aggregate are all available in the vicinity.

3.5 Hydrology - The mean monthly rainfall in inches at Maha Uswewa in the project area is as follows in Table 1 : -

Table 1 - Mean monthly rainfall in inches

Month	Rainfall inches	Month	Rainfall inches
Jan.	4.23	Jly.	1.40
Feb.	1.70	Aug.	1.47
Mar.	3.70	Sep.	2.90
Apr.	6.11	Oct.	8.99
May	3.94	Nov.	9.65
Jun.	2.20	Dec.	5.07
		Year	51.36

Rainfall data collected by the Department of Meteorlogy is also available for the nearby stations of Galgamuwa and Modiyawa.

The unit hydrograph was derived from a single storm with a single peak. The rainfall and runoff history of the storm was obtained, base flow allowed and the unit hydrograph derived. The storm pattern, from which the 100-year hydrograph was obtained, was derived from a statistical analysis of the rainfall at Puttalam. After correction for lesses, etc. a rearranged storm pattern was applied to the unit hydrograph and the ordinates of the design flood hydrograph was obtained. The peak discharge for a 100-year flood was 61,500 cusecs.

From the available data, there appears to be no useful ground water storage, the Mi Oya running dry in June and July. Losses due to evaporation at the Inginimitiya Reservoir has been estimated from pan evaporation data at Tabbowa. The annual loss due to evaporation is about 65 inches.

The quality of water in the Mi Oya is suitable for cultivation purposes and can be used without any treatment.

The yield of the Mi Oya at the dam site for the years 1955 - 1974 are given in Annex 2. - Hydrology. The records have been obtained by the Irrigation Department and are reliable.

3.6 Soil Surveys and Land Classification - Soil surveys of the development area, both highland and lowland coming under the project, were obtained from soil surveys carried out at reconnaissance level under the National Soil Survey Programme and from aerial photo interpretation. The soil map for the project area is given in Annex 3, which gives the details of the seven soil groups found in the project area. The important agriculturally suitable soils are : -

Reddish Brown Earths - Coloured reddish brown. Of moderate depth. Texture sany loam. Soil pH neutral. No accumulation of harmful salts in the profile. Chemical fertility of the soil is quite good, but Nitrogen and Phosphorus has to be supplied regularly. The soils are well drained. Suitable for high economic value crops such as cotton, soya beans and pulses during drier season and paddy with supplementary irrigation during the wet season.

Low Humic Gloy Soils - Moderately deep soils, usually found in the lower topographical areas. Texture sandy loam to sandy clay loam. Imperfect to poorly drained. Soil pH neutral chemical fertility quite good except for nitrogen and phosphorus which will have to be supplied regularly. Suitable for paddy during both wet and drier seasons. Adequate drainage is essential.

Alluvial soils of variable drainage and texture - Deep to very deep, brown soils having variable textures. Imperfectly to poorly drained, loamy to clayey textures. Soil pH is neutral, well suited for irrigated rice cultivation.

3.7 Land Use - The project area is mostly covered with jungle interspersed with village tanks under paddy cultivation and shift (chena) cultivation. The yields of existing rainfed cultivation in the Puttalam District is ....35... bushels of paddy in Maha (wet season) and ...30.. bushels in Yala (drier season). These low figures are due to the uncertainity of rainfall in the area.

3.8 Water Use - The water requirement for one acre of paddy cultivation is 1.37 ac. ft. for Maha (wet season) and 4.91 ac. ft. for Yala (drier season). For soya beans it is 2.83 ac. ft. and for pulses 3.28 ac. ft. These duties represent the water requirement from the reservoir for the entire project area, taking effective rainfall in the project area into account. The regulations concerning water use are governed by the Irrigation Ordinance No.32 of 1946 and amendments and by the Agricultural Productivity Law of 1972. Agricultural Productivity Committees have among other functions, that of management and distribution of water at farm level. Legal provision to prevent waste and misuse of water is made in the Irrigation Ordinance. This specifically prohibits any water from being misused. Where the person responsible cannot be identified, the proprieter of the land receiving such water, shall be liable to pay for the water as the Government Agent may determine.

3.9 Land Tenure and Distribution - The project area is mostly under-jungle, and crown property. There are a few village tanks under which paddy is cultivated. The project area lies in the Kirimetiya and Karambe Pattus, which are themselves a small part of the Divisional Revenue Officers Division called Demala Hatpattu in the Puttalam District. In the Demala Hatpattu Division there were, in the 1962 Consus, 37,777 acres of agricultural holding being operated by 5562 operators. 40 of these operators had holdings with an acreage over 50 acres, totalling 7587 acres. The balance 26,190 acres were operated by 5522 operators giving an average of 4.75 acres per holding. The size distribution of these holdings is as follows :

Less than 1 acre	-	160 operators
1 acre and under 2 acres	-	710
2 acre and under 5 acres	-	2510
5 acre and under 50 acres	-	2142
		5522

The degree of fragmentation is depicted by the following statistics. The total number of percels is 19,103 for the small holding area of 26,190 acres.

Number of operators operating 1 parcel	- 1461
Number of operators operating 2-3 parcels	- 2001
Number of operators operating 4-5 parcels	- 890
Number of operators operating 6-7 parcels	- 660
Number of operators operating 8-9 parcels	- 350
Number of operators operating 10 and over	- 160
	5522

The tenure situation is given below:

Tenure	Acreage
Freehold singly	5,390
Freehold jointly	340
Land Development Ordinance grant or permit	13,000
Crown lease	200
Private lease	240
Ande	1,330
Other lease	170
Rent free, unspecified, etc.	5,520
	26,190

Of the 552 operators, only 30 used hired labour for their work. These thirty had parcels greater than 5 acres in extent. Out of the 5522 operators, 3612 were full time operators, 890 were part time operators with the main income from agriculture and 1020 reported a non agricultural persuit as their main source of income.

Provisional results of the 1973 Agricultural Census show that the average size of the agricultural small holding has declined steadily over the years. A substantial increase in the number of operators has occurred in the last decade.

3.10 Legal Enactments for Tenure - The Paddy Lands Act of 1958 was intended to provide for the security of tenure of tenant cultivators and to specify the rents payable to landlords. The Land Reform Law of 1972 brought about a ceiling on the ownership of lands. For paddy the ceiling is 25 acres.

3.11 Research - The studies of the soils of the project area is the work of the Land Use Division of the Irrigation Department. Research and extension are two main functions of the Department of Agriculture. Investigations pertaining to selection of high yielding varieties of crops, improved cultural practices, use of fertilizers, weed control, pest control and diseases affecting crops are carried out by trained research staff at the Central Research Institute and at zonal research stations organized by the Agriculture Department. The Maha Illupallama Research station is one such station, about 1500 acres in extent and it carries out research on rice, chillies, onions, pulses, groundnet, soya bean, maize, sorgham, cotton and vegetables. There is also a machinery design and testing unit, a farm management unit and also a dairy at this station.

3.12 Extension and Training - Extension work is the function of the Department of Agriculture. The Extension Services personnel of this Department consist of the Directorate in Kandy and a team of officers in each of 22 administrative districts. At the district level, the extension staff is under the control of a Senior Agricultural Officer (referred to as DAEO) who has several years experience in the field and possesses either a University degree in Agriculture or a Diploma from the School of Agriculture run by the Agriculture Department.

Working under the District Agricultural Extension Officer in the District at the Divisional Revenue Officers level are several Agricultural Instructors who have also been trained in Agriculture at the school of Agriculture. At village level there is another grade of officers, the Agricultural Extension Worker (K.V.S.) who have received training at the Practical Farm Schools. The K.V.S. is the direct link between the Extension service and the farmer.

The project area will be served by the following extension personnel: -

(1) District Agricultural Extension Officer - who will also be looking after the rest of the district of Puttalam.

(2) Agricultural Instructors - solely in charge of the project, their qualification being a certificate of the School of Agriculture.

(3) Agricultural Extension Worker - each extension worker will be in charge of 1000 acres, their qualification being the certificate of the Peradeniya Farm School. On the average he will deal with about 700 farm families.

In service training in the form of seminars is hold periodically for the benefit of Agricultural Instructors and Extension Workers (K.V.S.).

3.13 Credit - The Peoples Bank and the Multipurpose Co-operative Societies provide agricultural credit to the farmer. The Peoples Bank is a state owned credit institution set up partly with the aim of solving the problems of rural credit. The Co-operative Societies are guided in their activities by the Commissioner of Co-operative Development. Non institutional services include relatives, traders and money lenders.

The Peoples Bank and the Multipurpose Co-operatives provide credit at interest rates varying from 6 to 12 percent according to the purpose of the loan. Loans are given for settlement purposes, for the purchase of draught buffaloes, farm machinery and for meeting cultivation costs.

The Bank of Ceylon too provides agricultural credit to the farmers in two ways -

(1) Institutional lending to the Agricultural Productivity Committees through a network of Agricultural Service Centres in the rural areas.

(2) Direct lending to cultivaters on credit guarantee Scheme.

Guarantee offered by the Central Bank of Ceylon for agricultural crops such as paddy, soya beans, chillies, onions, pulses, etc.

The Bank of Ceylon is a state owned Bank set up originally for commercial banking. This Bank also has now entered the field of development banking. Out of a programme to set up 490 Agricultural Service Centers, already 330 have been opened. The balance will be set up during 1977.

The Bank of Ceylon provides credit for agricultural purposes at interest rates varying from 9 - 12%.

3.14 Supply of Requisites - The main inputs in non export agriculture are agrechemicals such as fertilizers, weedicides and pesticides and these related to preparatory tillage and other agricultural operations. The importance of making these requisites available in time has been recognized and every attempt is made to do so by the Co-operative Societies.

Fertilizers are supplied by the Co-operatives with 50 per cent subsidy. Pesticides and weedkillers are supplied by co-operative and private traders. Drought animals are generally rented from private owners. There is a scarcity of imported spare parts for 4 wheel tractors. Implements and spare parts for two wheel tractors are made in Sri Lanka. The Department of Agriculture operates a seed certification programme which meets the seed and planting material requirements of the dry zone.

Lack of good transport facilities, good access roads to the farms adequate buildings for storing these inputs and the harvested product form the main obstacles to the intensive use of these inputs.

3.15 Marketting - A satisfactory network of main trunk roads is already available in the area for transport of products to nearby town Galgamuwa. The nearest rail head is 20 miles away. Puttalam on the west coast is 30 miles away and also is a rail head. A network of link roads connecting the project area to these trunk roads will be constructed to facilitate transport of the harvest.

The total output will be consumed in the domestic market and will be marketed in the thickly populated areas of the West coast.

The marketing channels are the Co-operatives, private traders and village fairs. The paddy is locally precessed by the Paddy Marketing Board or by private millers. The Board will increase the milling capacity as required.

The produce is transported by rail, lorries belonging to Co-operatives and private traders and in farmer's carts.

3.16 Co-operatives are meant to play a vital part in the life of the farmers. These societies are a part of the infrastructure provided by the Central Government. Co-operative Societies provide credit, purchase the produce and provide commodities required by the farmer community from outside. The average population served by each Co-operative is about 2500 persons. However, corruption among officials of Co-operatives strained relations between Co-operative officials and farmers detract greatly from the services that the Co-operatives are capable of rendering the farmers. It often happens that a private money-lender sells him goods on credit and

then purchases his produce at a price lower than that guaranteed by the Government.

There is a proposal to form Production Co-operatives besides the present Co-operatives. These Co-operatives would attend to institutional problems, leaving the present co-operatives to act as servicing agents.

3.17 Prices - Sri Lanka will be short by a million tons of rice in the year 2000 A.D. and the internal market prospects for rice are assured. The Government guarantees the price per bushel of paddy at Rs. 33/= per bushel.

Soya beans are intended for the Oils and Fats Corporation for producing oil and foodstuffs to replace fish and meat import. The Government guarantees the prices per cwt. of soya beans at Rs.84/=per cwt.

The production of pulses in the country is limited while the local demand is high. 95% of the country's requirements are imported. They are very important from the nutritional point of view. The prices are subject to market fluctuations and an average price has been assumed.

Sri Lanka imports about 3 million pounds of cotton each year. The Textile Corporation can absorb all the projected production if the alternative of cotton is chosen. Cotton seeds can also be exported to Japan. The Government guarantees the price per cwt. of cotton at Rs. 95/=.

3.18 Gross and Net Value of present Production - The project area is mostly covered with jungle and the value of its present output from the paddy under small isolated village tanks and shift (chena) cultivation may be considered as negligible. The full acreage can never be cultivated due to insufficient water in the small tanks and such cultivation can only be done in the wet season, if this turns out to be faveurable.

4.0 THE PROJECT

4.1 General - Inginimitiya Reservoir Project is located in the Kirimotiyawa and Karambe Pattus of the Puttalam District in the N.W. Province. The reservoir has a capacity of 53,000 Ac. ft. at its full supply level of 202 MSL. It can irrigate 6300 acres of new land of which 4500 acres will be in paddy for both the wet season (Maha) and the drier season (Yala) and 1800 acres of new land, of which will be in paddy for the wet season (Maha) and soya beans and pulses in the dry season (Yala).

The head works consist of the construction of an earth dam, 2 miles 4750 ft. long and of maximum height 60 ft., an uncontrolled concrete spillway 2000 ft. long and an emergency spillway of length 800 ft. It also involves the construction of two canals on either banks, the distribution system, feeder roads, community centres, schools and dispensaries for the benefit of the settlers.

The construction work in the reservoir and in the development area will take 5.1/2 years. The settlement of the settlers will take place

in the 3rd to 6th years and the first harvest obtained in the 4th year. The machinery required has to be supplied to the project from outside. The labour will be from the unemployed within and close to the project area.

All work in the project will be done by the Government and no fresh legislation is necessary. The construction of the headworks, provision of irrigation facilities and the main roads will be done by the Irrigation Department. The main roads will be handed over to the Department of Highways for maintenance. The feeder roads for the transport of agricultural produce, etc. and the access facilities to the homes of the settlers will be done by the Land Development Department. Experimental stations, extension works and any training institutes for the officials and the settlers will be provided by the Department of Agriculture.

The policy and implementation of the project will be in the hands of the Ministry of Irrigation, Power and Highways.

4.2 The proposed works and actions - The project has been planed and designed by the Irrigation Department with the approval of the Ministry of Irrigation, Power and Highways. The Government is very keen to develop this neglected area.

Several dam sites were investigated for the purpose of building a reservoir and the most suitable site was selected. The population in the project area is thin and the labour for construction will be drawn from the unemployed in nearby areas. It is not technically feasible to construct a dam of the size purely by manual labour in the short period of 2 years. Heavy earthmoving machinery has to be used as a time saving method. However, the distributary system in the development area will be heavily labour intensive.

The parameters of the reservoir were based on computerised operation studies for obtaining the most suitable reservoir capacity. The cropping pattern was based on the suitability of soils in the project area. The spillway was designed for a 100-year flood obtained by using a unit hydrograph derived from observed storms and making use of same with a storm pattern based on a statistical analysis of rainfall intensities. Borrow area and construction materials have been done. A socio economic survey of the reservoir bed area has been completed. Drilling investigations have been done at the dam sites. Specification designs are ready.

(a) Headworks - The headworks consist of a earth dam, an uncontrolled concrete spillway and an emergency spillway. The earth dam is 2 miles 4750 ft. long, maximum height 50 ft., top width 20 ft. involving about 417,000 cubes of earthwork. The uncontrolled concrete spillway is 2000 ft. long requires 4000 cubes of concrete and about 112,000 cubes of earthwork inclusive of the emergency spillway of length 800 ft. The outlet work consist of two tower type sluices, one on earth bank.

(b) Irrigation Facilities - The project includes the construction of the canal system to feed 6300 acres of new lands. The L.B. canal will be 13 miles long, and the R.B. canal will be 1/2 miles long. The bed width will be 16 ft. and the depth of flow 3.6 ft. for the L.B. canal. The bed width will be 12 ft. and the depth of flow 2.2 ft. for the R.B. canal.

(c) Land Development - This involves the jungle clearing of heavy jungle in the project irrigable lands (6300 acres) and also includes the preparation of the land (stumping, levelling, ripping, etc.) to make it fit for cultivation.

(d) Land Settlement - The project involves the settlement of 2520 farms (new). These farms will rely an family labour for their development. To provide for a reasonable farm income level and to make optimum use of the available land and family labour, the farm size has been kept at 2.1/2 acres. For the immediate purpose of constructing a temporary dwelling, the settlers will be given Rs.300/=. The settlement includes the provision of internal roads, service buildings (schools, dispensaries, civic centres) and aid to settlers for building their houses and for the supply of planting materials and implements.

4.3 Cost Estimates - Cost estimates were developed in detail for most of the works and the overall cost is considered reasonably accurate. Aerial photographs, one inch to a mile maps, 8 chain maps of the project area, surveys of the dam and spillway axes, soil maps, borrow area surveys, drill hole data were available. The quantities and the rates are reasonably accurate and up to date. A detailed construction estimate is given in Annex 5.

A summary of the construction costs is given below in TAble 2.

Table 2 - Summary of construction costs for Inginimitiya Reservoir Scheme

Pay item	Item cost in M.Rs. Total	Foreign	Sri Lanka Local
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
Spilways (concrete + emergency)	7.800	4.700	3.100
Outlet works - 2 sluices	1.250	0.750	0.500
Irrigation facilities for 6300 acres	16.450	8.400	8.050
Land development (heavy jungle clearing and land preparation)	13.500	8.100	5.400
Land settlement (internal roads, service buildings & aid to settlers)	6.300	2.00	4.300
General charges (maintenance building, construction camp, administration, surveys and supervision)	11.851	5.925	5.926
	80.000	44.150	35.850

The direct foreign currency costs have been estimated on a percentage basis, the indirect currency costs being included in such percentages. Cost of machinery has been included in the foreign component. However a residual value of 40% has been allowed for the machinery. Local currency costs are for domestic materials, skilled and unskilled labour and for transfers. The skilled and unskilled labour for this construction cost estimate is taken as hired labour fully employed on the construction job. Very little off season agricultural labour being available. Even if such labour is available, the rate of payment will be same as for hired labour, which rate is the minimum rate payable according to Government labour regulations.

The construction of the project will be undertaken by the Government of Sri Lanka through the Ministry of Irrigation, Power and Highways and the Irrigation Department with the assistance of the Survey Department, the Land Development Department and the Land Commissioner's Department. The equipment and machinery required is listed in Annex 4. The earth dam on the banks, the outlet works and the spillways will be completed before the main river closure which is programmed for completion in the third year. No major construction problems are expected at the river closure as there is a period of over three to four months will practically no rain the area. The foundation rock is also of good quality requiring little or no grouting.

The construction equipment now available in the country is very old and has outlined its usefulness. The items listed in Annex 4 will have to be imported. The rates for the main items of machine work have been prepared on the basis of cost of the equipment, fuel, spares and labour, etc. required for each specific item. The labour wage rates assumed are as follows - Table 3.

Table 3 - Daily rates of pay (consolidated)

Unskilled	-	6.80
Semi skilled	-	10.88
Skilled - Grade II	-	13.60
Skilled - Grade I	-	15.64
Operators Heavy Equipment - Gr. II	-	16.00
Operators Heavy " - Grade I	-	18.00

The main items of work will be done by the direct employment of labour by the government. Construction of distributory canal and their structures will be done on force account. The rights of way will be acquired by the Government Agent, on plans prepared by the Irrigation Department and the time taken for acquisition will be approximately two months under compulsery regulations in the Land Acquisition Act.

Engineering costs for surveys, exploration and designs have been estimated at Rs 1 million and have been included in the general charges. This sum should enable all plans to be finalised for construction and includes the cost of topographic surveys, sub surface investigation, etc. incurred by the Irrigation Department for the formulation of

the proposals and designs. The supervision of construction will be done by the permanent officers of the Irrigation Department and this cost amounting to Rs. 1.50 million has been allowed inder general charges.

Costs have been broken down into appropriate major features as land and rights of way, access and road deviations, earth dam, spillways, outlet works, irrigation facilities, land development, land settlement and general charges and into further sub headings vide Annex 5.

The operation and maintenance have been worked out on the basis of Rs.100/=per acre giving an annual cost of Ra.0.63 million for the total acreage of 6300 acres. This rate is based on the provious experience of the Irrigation Department.

The replacement costs for the project are estimated at Rs.4 million for the life of the project and will occur in the 44th year of the project life. This cost consists of that required for the sluice gates and the emergency spillway which may breach during the project life.

4.4 Construction Schedule - The construction of Inginimitiya Reservoir Scheme is scheduled for competion in five and half years inclusive of the prevision of irrigation facilities.

The following criteria were used in the preparation of construction schedules : -

1. The full development will be completed in 5.1/2 years.
2. The rainfall pattern is as follows : -

October to January	-	Rain
February to March	-	Little rain
April	-	Rain
May to September	-	Practically no main

3. The earthwork on the dam will be done by machinery and all necessary machinery will be available by the first quarter of the first year. The machinery for construction of the access roads were assumed to be available at the start of the first quarter.

A bar chart showing the construction schedule is given in Annex 4.

Since the work will be done on force account, key dates for bid advertising, etc. are irrelevant. The rights of way will be acquired by the Government Agent, on plans repared by the Irrigation Department. The time for acquisition will be about two months under compulsory regulations in the Land Acquisition Act. No major use of off season labour is planned, hired labour at rates stipulated by the Government will be used for the project.

4.5 Finance - Estimated cost of the Machines as per Annex 4-3 is Rs.23.1 millions, allowing for a residual value of 25%. The total foreign component including Machinery and Materials is Rs. 54.072 millions.

Local capital cost will be voted by the National State Assembly of Sri Lanka. The operation and maintenance cost will be recovered from the beneficiaries.

4.6 Organisation and Management - The Irrigation Ordinance of 1946 is the legislative basis for the implementation of the project. The coordinating and policy making body will be the Ministry of Irrigation, Power and Highways. It has a wide and long experience of water resource development projects of this nature, Uda Walawe (217,800 Ac.ft.) and Rajangana (81,500 Ac.ft.) have been completed by this Ministry in the recent past. The Irrigation Department has the full component of staff required for the construction, land preparation & maintenance of the Project.

The Land Commissioner's Department is responsible for setting the farmers in the project area. It has an Island wide staffing organisation with the Land Commissioner in Colombo. The district level organisation is headed by a District Land Officer who in turn has a field staff in the project area. Similarly the Director of Land Development in Colombo has field staff in the project areas.

The Department of Agriculture has a district organization for extension work, headed by a District Agricultural Extension Officer who is responsible to the Deputy Director of Agriculture (Extension). He has a staff of Extension Officers, each of whom is in charge of a Divisional Revenue Officer's area. The Extension Officer has his Assistants at a village level who are known as Agricultural Officers. (From 1972 Agricul - tural Productivity Committees composed of farmers took the responsibility for supervision of production in the lands.

There is a similar Organisation in the Co-operative Development Department, where the District Head is the Assistant Commissioner of Co-operative Development, who has Co-operative Inspectors functioning under him at village level.

Co-ordination of all these Departments is achieved through the agency of a District Co-ordinating Committee whose Chairman is the Chief Revenue Officer of the District designated the Government Agent.

Where the now lands are concerned, the existing organisation will be strengthened or new offices set up to provide the necessary services and supplies.

No provision is made for outside technical staff to design or supervise the construction of the project. Construction work will be carried out by the Irrigation Department on force account. The Irrigation canals loading to the farm will be constructed by the Irrigation Depart- ment, together with the jungle clearing and the land preparation.

On completion of the project, the maintenance will be under the control of the Irrigation Department. The cultivation dates, water issue dates, etc. in this project will be decided by the farmers at cultivation meetings presided over by the Government Agent. The Resident Engineer (Maintenance) is a member of this cultivation committee for purposes of maintenance and issues.

The farmers elect members of the Cultivation Committee which is established under the Paddy Lands Act. This Committee has the responsibility (under the guidance of the Government Departments which has a representative each as ex. office members in the Committee) for obtaining the cultivation loans in time and for ensuring a certain minimum standard of cultivation within the area.

The Agricultural Productivity Committees formed recently are charged with the full and efficient utilization of land. The cultivation committee will act as agents of the APC's as regards all agricultural operations and their management.

The farmers are also members of the Multipurpose Co-operative Society and therefore play an active part in the proper functioning of these organisations, which are responsible for making various services and facilities available to the members.

Facilities for extension, credit and supply of requisitos are discussed in paras 3.12 and 3.14. The extension staff will be ex-officic members of the Cultivation Committees and the Multipurpose Co-operative Societies and will be constantly advising these bodies about the timing of the various operations and the input of agrechmicals during the cultivation season.

Debts will be collected by the Multipurpose Co-operative Sociaties when it buys the cultivators produce at guaranteed prices. The charges from the cultivator will be collected by the Chief Revenue Officer of the District through his officials.

The development area under the project is almost entirely Crown land and special legislation for consolidation is net necessary. Each farmer will be allocated a 2.1/2 acre allotments in this project.

No administrative or organisational difficulties are envisaged as the project is based on routine patterns of development and settlement. The selection of settlers is the responsibility of the Land Commissioner and this Department has extensive experience in work of this nature. The selected colonists will be paid for their transport into the project area. He will be assisted in the construction of his cottage. For the first six months or until his first harvest he will receive a monthly subsistence allowance. He will be given implements, planting materials, etc. free of charge. The Land Development Department will construct roads, wells, buildings for schools, dispesaries, co-operative stores, post offices, etc. Land settlemtnt in the dry zone has been going on in Sri Lanka for ever three decades.

4.7 Increase in Farm Production and Farm Income - The project area will be transformed from heavy jungle to flourishing settlements. The crops would be for the domestic market. The methods used by the farmer will be labour intensive, as capital is more scares than labour for the farmers. Fields are expected to yield about 80 bushels per acre for paddy, 15 cwt. per acre for soya beans, 12 cwt. per acre for pulses and 20 cwt. per acre for cotton. Cultivators will own 2.1/2 acres of irrigable land and about 1/2 acre of highland for his cottage. The reasearch and extension services will be provided by the Department of Agriculture, credit facilities by the Peoples Bank and the supply of requisites by the multipurpose co-operatives.

For achieving the yields and levels of production planned, 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 project area.

The gross and net value of production is given below:-

Paddy both seasons

Gross value of farm production from a 2.1/2 acre allotment for 2 seasons	Rs.	13,200
Farm production cost (i.e. cost of seed, fertilizer, agrochemicals, farm machinery, interest on loans, contingencies) (Farm labour not included).		4,000
Net farm income on 2.1/2 acres per annum without deducting farm labour and land betterment charges	RS.	9,200

Paddy (one season), soya beans, pulses

Gorss value of farm production -

2,1/2 acres of paddy	6,600
2,1/2 acres soya beans	3,150
2,1/2 acres cow pea	3,840
	13,590

Farm production cost (as above) -

2,1/2 acres paddy (Farm labour not included)	2,000
2,1/2 acres soya beans	806
2,1/2 acres cow pea	658
	3,464

Net farm income on 2,1/2 acres per annum without deducting farm labour and land betterment charges 10,126/=

Capital cost of the project Rs. ,000,000/=

Net value of the production per annum from the project 4500 Ac. x Rx. $\frac{9200/=}{2,1/2}$ 16,560,000/=

1800 Ac. x Rx. $\frac{10,126/=}{2,1/2}$ 7,290,000/=

23,850,000/=

The volume of production will be

(6300 + 4500) Acs. x 80 bushels	- 0.864 million bushels of paddy
1800 x 15 Cwt.	- 27,000 Cwt. soya beans
1800 x 12 Cwt.	- 21,600 Cwt. cow pea

The typical farm budgets are shown in Annex 1.

The budgets are for paddy, soya bean, cowpea (a pulse) and for the alternative cotton of which there would be only one crop to replace soya beans and cowpea. As soon from the budgets the minimum farm income received for the 2,1/2 acre holding would be Rs. 9200 per year.

The output in the area without the project is so small as to be negligible. The present farmers are living at subsistence level and drought relief has to be given to them when crops fail. The present income from the project has been considered as negligible in the economic evaluation of the project.

All the farmers at present in the project area will benefit. The number of such farmers is small. The selection of new settlers for the project is based on the following criteria.

(a) Landless peasants are given preference. The farmers already in the project area and those whose lands will be i dated are given preference.

(b) Peasants with large families are given preference.

(c) Educated farmers are given preference.

4.8 Debt Repayment and Financing - The cultivators will pay the operation and maintenance charges to Government in addition to the contribution they make to tax revenues ad income recipients and consumers. This cost is estimated at Rs. 100/= per acre per annum and will amount to Rs. 630,000/= per annum.

The produce namely paddy, soya beans and pulses, or cotton will substitute for present imports and will thus save foreign exchange, which can be used to import either capital machinery for the Government or for the private sector. Such machinery for the private sector will have local taxes which will help to finance the local component needed to finance the project. The foreign component of the cost is expected to be financed by external agencies and will be paid back in instalments, from foreign exchange earnings of the Government.

5.0 ECONOMIC JUSTIFICATION

The life of the project is taken as 50 years. The project will reach full production in the 9th year from the year of commencement. Costs and income will stabilize at this level with the exception of replacement costs in the 44th year for the sluice gates and the earthwork at the emergency spill.

The yearly costs and benefits are scheduled below -

Year	Cost in million Rs.	Benefits in million Rs.
1	6,000	-
2	19,750	-
3	27,449	-
4	14,600	8,825
5	17,375	19,135
6	17,776	27,315
7	13,095	30,879
8	14.040	32,958
9	14,310	33,552
10 - 43	14,310 per annum	33,552 per annum
44	18,310	33,552
45 - 50	14,310 per annum	33,552 per annum

The economic justification was done on two assumptions -

(a) Market prices and (b) opportunity costs. The foreign exchange component was valued at twice the official value and the unskilled labour component at one third its market value. Domestic materials and skilled labour were costed at market prices for both cases.

The internal rate of return at market prices is 17% and at opportunity values is 27% showing that the scheme is attractive.

The direct benefits are -

(1) Idle resources in the form of land, labour and water will be brought into productive use.

(2) The increased output is from commeditics that will have the country scarce foreign exchange. The value of foreign exchange lies in that the availability governs the rate of growth of the economy.

(3) It will bring prosperity to this backward area in the country where the people at present are imporshed.

The direct costs are the use of capital equipment and personnel for the construction of the project. There are also the operation, maintenance and replacement costs, and the cultivation costs.

The indirect benefits are as follows -

(1) Casual employment of labour during the period of construction and permanent employment for operation and maintenance staff.

(2) Expansion in marketing enterprises and the growth of service industries including carpentry work shops, tile factories, etc.

(3) The provision of better community services such as health education and recreation.

(4) The reservoir will be a source of inland fish for the settler population.

The foreign exchange savings are as follows : -

The value of rice output per year at £ 150 per metric ton = Rs.33/30 per bushel of paddy		28,771,200/=
The value of soya beans per year at £ 3.33 per Cwt. = Rs.52 per Cwt.	=	1,404,000/=
The value of pulses per year at £ 3.33 per Cwt. = Rs.52	=	1,123,200/=
The gross value of foreign exchange saving per year	=	31,298,400/=
The direct foreign exchange cost of production	=	5,180,400/=
Net foreign exchange saving	=	26,118,000/=

It is not feasible to make a reliable estimate of the increase in Government revenues. It must be stated that a major objective of the Government is to reduce the food imports as fast as can be achieved. This project would be another step towards this goal.

6.0 RECOMMENDATIONS

The project now goes into the stage of implementation. The specification designs are complete and all Departments participating in the implementation are ready to commence work on the project. The project is ready for appraisal.

INGINIMITIYA RESERVOIR PROJECT - FARM BUDGET Annex 1

Size of holding: 2,1/2 acres irrigable land cultivated either in rice for two seasons or in rice for one season and soya beans and pulses 2,1/2 acres

Rice 2,1/2 acres: Rice 2,1/2 acres, soya beans 2,1/2 acres pulses 2,1/2 acres

Operating cost	Rs.	Operating cost Soya beans	Rs.	Pulses	Rs.
Seed @ Rs.68/=	170	Seed @ Rs.52/=	130	Seed @ Rs.7/=	18
Fertilizers @ 304/=	760	Fertilizer @ 118/=	295	Fertilizer @ 102/=	235
Agrochemical @ 224/=	560	Agrochemical @ 43/=	107	Agro. @ 62/=	155
Farm machinery & contin.@ 152/=	380	Farm machinery and contingencies @ 75/=	188	Farm. machinery 64/= & contin.	160
Farm labour @ 294/=	735	Farm labour @ 384/=	960	Farm labour @ 384/=	960
Interest on crop loans @ 9%/=	215	Interest on crop loans @ 34/50	86	Interest on crop loans @ 28/30	70
Land betterment charge @100/yr	125	Land betterment charges @ 100/yr.	60	Land betterment change @ 100/r	65
	2945		1826		1683
				One crop pulses 12 x 128 x 2,1/2	3840
				Expenses F.I. for one crop	1683
					2157
Receipts		Receipts			
One rice crop 80 x 33 x 2,1/2	6600	One crop soya beans 15 x 84 x 2,1/2	3150		
Expenses including farm labour	2945	Expenses including farm labour	1826		
Net income per crop	3655	Farm income 1 crop	1324		
Farm income for 2 crops inclusive of cost of labour	7310				

Farm income for rice, soya beans & pulses = = (3655 + 1324 + 2157) = (inclusive of cost of labour) 7136/=

1.1 Climate

Sri Lanka lines between the latitude 5°55'N to 9°50'N. On account of the equater, the climate is tropical with temperatures in the region of 85 - 90° Farenheit. Being an Island with a maximum width of only 140 miles, the oceanic effect reduces the fluctuations of temperature.

Wind velocities rarely exceed 60 mph, the maximum recorded velocity for the Island due to cyclonic netivity being 72 mph. Relative humidity is almost constant throughout the year. The daily variation is from 70% during the day to 90% during the night.

Sri Lanka is generally divided into two zones, the dry and wet, chiefly on account of rainfall. The Mi Oya Basin is situated entirely in the dry zone where most of the rainfall is recorded during October to April.

The atmospheric temperatures in the Mi Oya Basin vary within a range of 15°F in a month and 20°F in a year. The following Table 4 gives the monthly mean maximum and monthly mean minimum temperatures for Pattalam which may be taken as representative of the project area.

Table 4 - Monthly Mean Maximum and Minimum Temperatures for Puttalam in Deg. F

Month	Maximum	Minimum	Mean	Month	Maximum	Minimum	Mean
Jan.	85.7	70.2	77.8	Jly.	86.4	78.3	82.0
Feb.	88.3	70.4	79.4	Aug.	86.8	78.0	82.1
Mar.	90.1	73.0	81.3	Sep.	87.3	78.0	82.2
Apr.	89.5	76.1	82.7	Oct.	86.6	75.8	80.9
May.	88.6	79.8	83.4	Nov.	85.8	73.2	79.4
Jun.	86.7	79.3	82.7	Dec.	84.9	71.4	78.0
				Year	87.2	72.2	81.0

The relative humidity in the project area for which Puttalam is representative remains constant during the year. Table 5 gives the values for Puttalam.

Table 5 - Monthly mean relative humidity for Puttalam

Month	Rela. humidity %	Month	Rela. humidity %
Jan.	93	Jly.	81
Feb.	92	Aug.	84
Mar.	91	Sep.	93
Apr.	90	Oct.	99
May.	87	Nov.	93
Jun.	83	Dec.	93
		Year	88

1.2 Rainfall

The rainfall is Sri Lanka is due to three causes, monsoons, covectional currents and depressions.

Monsoonal rain - During the winter months in the Northern hemisphers, cooling of the large land mass of Asia occurs. The waters of the Indian ocean are comparatively warm and there is a movement of dry cool air masses from the land mass to the Indian ocean. This movement is in a South Westerly direction. The dry cool air masses enter the Bay of Bengal and collect ample moisture. Sri Lanka lies in the direct path of this air mass and most of the moisture collected is deposited over the greater part of the Island. Where conditions are favourable, intense precipitation may be experienced. The monsoon is known as the North East monsoon. It begins in November and ends in February.

Again during the summer months in the Northern hemisphere heating of the large land mass of Asia causes rainbearing wind from the Indian ocean to imping on the South Western quarter of the Island. The south central region of Sri Lanka is mountaineus and hence most of the rainfall is precipitated on the South Western hill slopes. The balance three quarters of the island lie in the rain shadow during this monsoon, and these area are called the dry zone of Sri Lanka. The monsoon is known as the South West Monsoon. It begins in May and ends in August. It has a much higher water content than the North East-Monsoon.

Convectional Rain - Evaporation takes place in the sea around Sri Lanka and water VAPOUR IS ABSORBED BY THE AIR MASS OVER THE SEA DURING THE DAY. The land is also heated during the day and the warm air over the land rises around the hill country. The moist air over the sea moves on the land as a sea breeze and rises as it reaches the hill country. As it rises, it cools and forms large thunder clouds which moves towards the sea in the upper atmosphere. When cooled below dewpoint, the clouds precipitate rain. There are late afternoon thunderstorms in the hill country and evening thunderstorms in the coastal plains. The rains are known as conventional rains and occur in the intermonsoon periods of September - October and March - April.

Depressional Rain - When low pressure areas exist, air tends to move into them from surrounding areas. The low pressure air is displaced upwards to cool and precipitate rain. Such atmospheric depressions occur chiefly over the Bay of Bengal and in the month of November. The wind may attain gale force and the rainfall may be intense. Sri Lanka comes in only for a portion of these disturbances which are usually several hundred miles in diameter.

The October - January rains together with the April - May rains constitute more than 85% of the total precipitation. The annual total of 50 to 60 inches is low. In fact the Mi Oya basin can be said to have the least rainfall in the island except for the basins around Hambantota to the South East of the island.

1.3 Run off

In the rivers in the dry zone the greatest runoff is observed during the North East monsoon period, when the rainfall is heavy. But drought grips the area in June and July when the river may run dry. Although the annual rainfall is 50 to 60 inches, the pan evaporation rate is about 65 inches for the year at Tabbewa within the project area. This accounts for the fact that the Mi Oya Basin lies in the dry zone.

The Mi Oya has a catchment area of 215 sq. miles at the proposed dam site. But the yield available from the 215 sq.miles catchment is not available in its entirely as the diversion of the Mi Oya at Abakolawewa in Stage I reduces the catchment by 65 sq. miles leaving only a balance of 150 sq. miles to provide the runoff. This of course does not consider the return flow from the diversion.

However, the runoff figures used for operation studies was obtained from a gauging station located nearby a mile downstream of the proposed dam site. This station at Maba Uswewa was chosen in 1955 when it was proposed to dam the river once again at Maha Uswewa. However the present dam site is a mile upstream of the gauging stations. The runoff figures obtained at Maha Uswewa from 1955 were used for the operation studies without any corrections. These figures represent a period commencing immediately after the Stage I diversion at abakelawewa.

Table 7 gives the mean monthly yields at Maha Uswewa on the Mi Oya. The figures show extreme variations with a maximum of 336,908 ac.ft. in 57-78 and a minimum of 10,869 ac.ft. in 1974-75. It may be noted that the 57-58 values include the runoff from the exceptionally high flood which occurred in December 1957. The mean annual flow is 94,315 ac.ft. for the 20 year period 1955 to 1974.

Rainfall in the project area - The rainfall is the project area, which lies in the rain shadow during the S.W. Monsoon, is typical of that in the dry zone. The period May to September does not preduce much rain over the project area. In the intermonsoon period of October there is convectional rain with thunderstoms occuring in the evenings. The N.W. Monsoon begins in November and rain is also produced by atmospheric depressions in the Bay of Bengal. The N.E. monsoon continues in December and January but dies out in February, March and April are intermonsoon periode with convectional rain, associated with thunderstorms and evening rains.

The rainfall being mostly utilized for the cultivation of two season paddy is usually considered in two periods October to March and April to September. The seasons are known locally as Maha and Yala.

The Mi Oya Basin lies in the Dry Zone between the mean annual isohyets 40" and 50". The river runs dry during June and July. The rainfall atations within the Mi Oya Basin are Galgamuwa, Mediyawa and Maha Uswewa. Maha Uswewa is located about 3 miles South West of the proposed dam site. The mean monthly rainfall figures are given in Table 6.

Table 6 - Mean monthly rainfall in inches

North East Monsoon	Galgamuwa	Mediyawa	Maha Uswewa
Oct.	8.23	11.88	8.99
Nov.	11.06	11.22	9.65
Dec.	6.56	6.41	5.07
Jan.	4.94	5.23	4.23
Feb.	1.60	1.80	1.70
Mar.	3.86	4.78	3.70
Sub total for N.E.	36.25	41.32	33.34

South West Monsoon	Galgamuwa	Mediyawa	Maha Uswewa
Apr.	6.52	7.07	6.11
May	3.99	4.86	3.94
June	1.08	2.30	2.20
July	1.30	1.79	1.40
Aug.	1.42	1.56	1.47
Sep.	2.70	3.40	2.90
Sub total for S.W.	17.01	20.98	18.02
Total rainfall for the Yr.	53.26	62.30	51.36

TABLE 7 - MEAN MONTHLY YIELD FIGURES FOR MAHA USWEWA

Annex 2-5

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	July	Aug.	Sept.	Total
1955/56	26453	27846	43537	9225	1368	16478	455	222	367	369	369	178	126867
1956/57	20	5641	6617	366	141	145	11375	860	2891	190	61	41	28348
1957/58	6461	59382	157391	24459	6991	16111	52464	6659	1210	1394	1681	2703	336906
1958/59	2697	2620	6326	1443	267	712	Nil	4978	1661	640	346	250	21941
1959/60	10694	19030	20263	5742	3045	1473	3230	2334	988	5928	927	165	73819
1960/61	473	30183	8973	6785	3287	1857	632	695	719	1141	576	303	55624
1961/62	2475	20721	13884	6770	3463	2905	2457	7660	2010	788	3310	1055	67498
1962/63	88666	20582	12211	88518	10817	5350	4162	3926	2043	1485	812	550	239122
1963/64	2647	52912	62382	15430	5934	5696	1772	1388	1141	990	1055	822	152169
1964/65	832	13316	7278	2348	1836	859	9389	21069	2560	719	4439	784	64449
1965/66	8332	13446	47762	4503	4330	1598	13127	3012	1893	505	333	700	99541
1966/67	9680	39953	15721	7801	4499	2366	4025	1572	709	416	297	1210	88249
1967/68	17091	9882	40049	6585	2624	10274	5619	2101	1076	1307	459	259	97326
1968/69	1610	30500	18982	5532	3000	2166	2230	1206	422	87	392	154	66281
1969/70	9356	8902	12662	15254	7968	3632	18275	10740	2604	881	1030	1148	92452
1970/71	4085	7510	6665	4570	2776	2875	5657	5471	1562	826	982	560	43539
1971/72	5683	12058	31011	2582	2101	944	3491	28122	2241	1800	752	1241	92025
1972/73	12999	40851	12805	2728	1847	2160	7486	1005	792	396	293	198	83560
1973/74	2447	3528	12591	4714	772	2132	18869	1552	1653	1146	226	46	49676
1974/75	Nil	172	212	44	3400	190	1420	2435	196	2800	Nil	Nil	10869
Total	212701	419035	536323	215399	70466	79923	166135	107007	28738	23808	8360	12367	1890262
Mean	10635	20952	26811	10770	3523	3996	8307	5350	1437	1190	918	618	94513

The probability of squalling or exceeding an annual yield is given in Table 8.

Table 8 - Probability of equalling or exceeding an annual yield

Annual yield in ac.ft.	Probability %	Annual yield in ac. ft.	Probability %
336,900	5	73,800	55
239,100	10	64,500	70
152,200	15	55,624	75
126,900	20	43,500	85
97,300	30	21,900	95
92,000	40	10,900	100
83,600	50		

1.4 Flood studies

The computations for the design flood hydrograph for the spillway were based on the unit hydrograph theory. As no unit hydrograph was available, it was derived from the storm of 11 November, 1967. This storm was a single storm with a single peak which occurred on 11 November, 1967, and was thus suitable for deriving the unit hydrograph.

The rainfall history for the above flood was obtained from the Meterological Department for the raingauge stations at Maha Uswewa, Medlyawa, Galgamuwa and Puttalam. The runoff history was obtained from the Hydrology Division of the Irrigation Department. The unit hydrograph was then derived from the rainfall and run off figures, allowing for base flow.

The storm pattern, from which the design flood hydrograph was obtained, was derived from a statistical analysis of the intensity of rainfall over Putralam. Point rainfalls varying from 30 mins. to 24 hours duration have been analysis by the Gumbel's method to develop depth duration frequency curves. The return period for the design flood hydrograph was taken as 100 years. The depth of rainfall and duration for a 100-year sterm is given in Table 9.

Table 9 - Depth duration for 100-year storm at Puttalam

Period	Rainfalls inches	Period	Rainfall inches
30 mins.	0.6	12 hrs	8.3
1 hr.	2.4	14	8.4
2	4.8	16	8.5
4	6.7	18	8.6
6	7.5	20	8.6
8	7.9	22	8.6
10	8.2	24	8.6

The storm pattern was determined by a redistribution of the incremental rainfalls. Losses due to infiltration and interception was taken as 0.05 ins/hr. The point rainfall was coverted into areal values using a factor of 0.85. The final rearranged storm pattern (i.e. the rainfall excess) was determined and then applied to the unit hydrograph determined earlier. The ordinates of the design 100-year flood hydrograph were than computed. The peak discharge of this hydrograph was 61,500 cusecs and the spillway will be designed to accommodate this flood.

Provision will be made to have a breaching section at the Right Bank flank of the bund. This will serve as an emergency spillway to take any floods higher than the 100 year design flood.

1.5 Evaporation Data

The pan evaporation data collected at Tabbowa, which is close to the rpoject area, is as follows in Table 10.

Table 10 - Monthly average evaporation in inches at Tabbowa

Month.	Pan evap.	Surface evap.	Month	Pan evap.	Surface evap.
Jan.	4.37	3.50	July	6.04	4.83
Feb.	4.64	3.71	Aug.	6.88	5.50
Mar.	5.95	4.76	Sep.	6.46	5.17
Apr.	5.54	4.43	Oct.	5.30	4.24
May	5.70	4.56	Nov.	4.00	3.20
June	6.02	4.82	Dec.	4.09	3.27

The surface evaporation from the reservoir was taken as eighty per cent of the pan evaporation.

Water Requirement of Crops and Duties at Head Sluice

The major part of the irrigable area will be in paddy with soya beans and pulses or cotton being cultivated in the drier season on part of the acreage found suitable for this type of cropping pattern. Annex sketch gives the cropping patterns adopted, which was recommended by the Land Use Division of the Department of Irrigation. Pattern 1 is paddy, soya beans, pulses, pattern 2 is paddy, cotton and pattern 3 is paddy, The field water requirement for these patterns is also given in annex sketch.

The effective rainfall was obtained from studies made by the Mahaweli Board in the Kalawewa Area which is adjacent to the Mi Oya Basin. A conveyance loss of 30% was used and the duty required at the board-sluice was obtained as given below.

Pattern 1 (Paddy, soya beans, pulses) for R.B.E soils

Month	Field water requirement (FWR) in inches	Effective Rainfall(Rc) in inches	1.3x(FWR-Rc) in inches	Duty at head sluice in Ac.ft./Ac.
Jan.	7.4	2.35	6.57	0.55
Feb.	3.4	1.32	2.70	0.17
Mar.	7.3	1.73	7.24	0.60
Apr.	9.8	4.23	7.25	0.60
May	10.3	1.62	11.28	0.94
Jun.	6.6	0.26	8.24	0.69
Jly.	7.8	0.47	9.53	0.79
Aug.	12.1	0.83	14.65	1.22
Sep.	10.8	1.37	12.26	1.02
Oct.	8.4	6.07	3.03	0.25
Nov.	10.8	6.03	6.20	0.52
Dec.	11.2	5.08	7.96	0.66

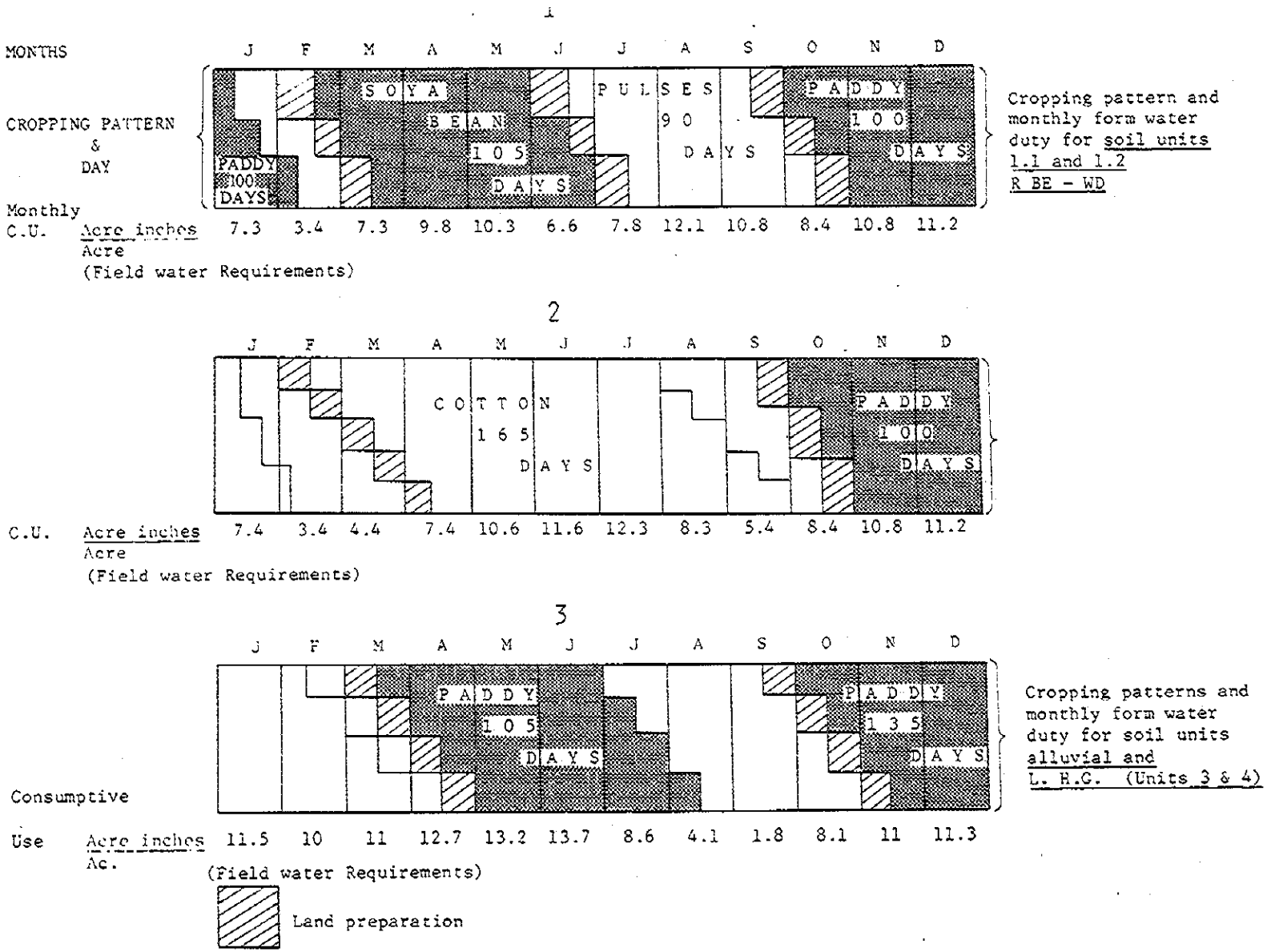
Pattern 3 (Paddy, paddy) for L.H.G. and all soils

Month	Field water requirement (FWR) in inches	Effective Rainfall (Rc) in inches	1.3x(FWR-Rc) in inches	Duty at head sluice in Ac.ft./Ac.
Jan.	11.5	2.35	11.90	1.00
Feb.	10.0	1.32	11.28	0.94
Mar.	11.0	1.73	12.05	1.00
Apr.	12.7	4.23	11.00	0.92
May	13.2	1.62	15.05	1.25
Jun.	13.7	0.26	12.47	1.46
Jly.	8.6	0.47	10.57	0.88
Aug.	4.1	0.83	4.25	0.35
Sep.	1.8	1.37	0.56	0.05
Oct.	8.1	6.07	2.64	0.22
Nov.	11.0	6.03	6.46	0.54
Dec.	11.3	5.08	8.09	0.67

Operation Studies

The 75% probable yield was determined graphically with the 20-year inflow data and found to be 53,000 Ac.ft. Mass curve studies were made of annual flows, for different drawoffs and the required reservoir capacities computed. The results obtained are given below:

Drawoff in Ac.ft./year	78,000	70,000	62,000	40,000
Required capacity of reservoir in Ac.ft.	87,500	59,000	38,000	15,550



CROPPING PATTERN FOR INGINIMITIYA SCHEME

From a graphical plot of drawoff against capacity it was found that most economical size of the reservoir is in the range of 45,000 to 50,000 Ac.ft. of active storage.

Operation studies were carried out on the computer for three reservoir capacities 45,100 Ac.ft., 53,000 Ac.ft. and 61,600 Ac.ft. (gross capacity). Cropping patterns 1 was assumed on 4500 acros and cropping pattern 2 on 1800 acres. The head sluice duties in Ac.ft./Ac. were taken as these given in the proceding section. The evaporation losses were taken from the Tabbewa pan evaporation figures given earlier in this Annex. The results of the computer studies are given in the annexed Table 10A. along with the corresponding costs of the head works.

Table shows that a reservoir with a gross capacity of 53,000 Ac.ft. is met suitable for the Inginimitiya Reservoir. At this capacity, the following results are valid.

Mean annual yield	94,315 Ac.ft.
Gross reservoir capacity at F.S.L. 202 M.S.L.	53,000 Ac.ft.
Dead storage at 181 MSL	4,200 Ac.ft.
Ratio of active reservoir capacity to yield	52%
Mean annual issues	62,220 Ac.ft.
Percentage regulation	66%

The reservoir capacity was hence fixed at 53,000 Ac.ft. grass.

Table 10A Comparison of cultivation seasons with three different Reservoir capacities

Aereage	Cult. period	Crop	RESERVOIR SIZE (1) F.S.L.=200; Cap.=45,150 Ac.ft. Cost of head work : 32.685 million Success	Percent success	RESERVOIR SIZE (2) F.S.L.=202; Cap.=53,000 Ac.ft. Cost of Hd. works=35.595 Mil. Success	Percent success	RESERVOIR SIZE (3) FSI=204; Cap.=61,600 Ac.ft Cost of H.W.=40.123 Mil. Success	Percent success
4500	Oct.-Mar.	Paddy	17/19	89.47	18/19	9.4.74	18/19	94.74
4500	Apr.-Aug.	Paddy	16/19	84.21	16/19	84.21	17/19	89.47
1800	Oct.-Feb.	Paddy	17/19	89.47	18/19	94.74	18/19	94.74
1800	Feb.-Jun.	Soya Bean	16/19	84.21	17/19	89.47	18/19	94.74
1800	Jly.-Oct.	Pulses	15/19	78.195	15/19	78.95	16/19	84.21

LAND CLASSIFICATION

Emphasis has been laid on selecting a suitable cropping pattern for any new scheme that is planned by the Irrigation Department. The cropping pattern chosen should suit the soil topographical and climatic conditions in the area. The soils of the project area were studied from soil surveys carried out at reconnaissance level under the National Soil Survey Programme and from aerial photo interpretation. The soil Map for the project area is shown in Fig. 1. This map shows the distribution of the main soil groups that were identified and mapped.

The soil map shows seven classes of soils, namely -

1.1 Reddish brown earths

1.2 Reddish brown earths (with moderate amount of gravel)

2 Low humic gley soils

3 Alluvial soils of variable drainage and texture

4 Suspected saline and/or alkaline soils

5 Rock knob plains

6 Erosional Remants

A brief description of the above soil units and their agricultural potential is as follows: -

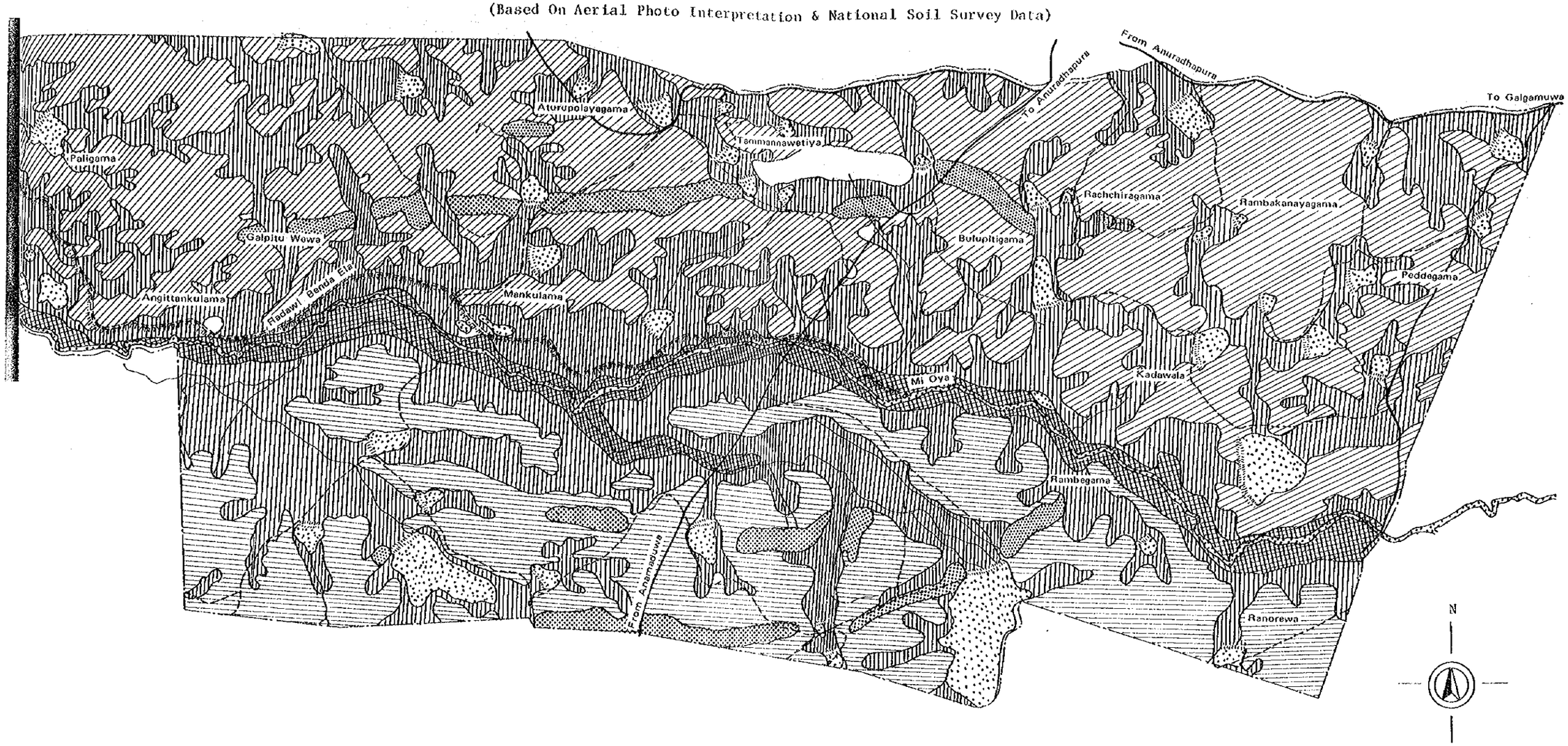
Reddish brown earths

These soils are coloured reddish brown and are of moderate depth. The texture of the surface is sandy loam to sandy clay loam, while the B horizon is heavier. Soil pH is slightly acid to neutral and there is no accumulation of harmful salts in the profile. The chemical fertility of the soil is quite good but nitrogen and phosphorous will have to be supplied regularly. The soils are well drained.

The reddish brown earths are best used for high value economic crops such as cotton, soya beans and pulses during the dry (Yala) season and paddy with supplementary irrigation during the wet (Maha) season. These soils have a fairly high water duty for paddy and require irrigation every 5th or 6th day in dry weather (provided adequate water is supplied at each irrigation).

SOIL MAP OF INGINIMITIYA RESERVOIR SCHEME

(Based On Aerial Photo Interpretation & National Soil Survey Data)



1.1 Reddish Brown Earths.

1.2 Reddish Brown Earths. (with moderate amount of gravel)

2 Low Humic Gley Soils.

3 Alluvial Soils of variable Drainage and Texture.

4 Suspected Saline and/or Alkaline Soils.

5 Rock Knob Plains.

6 Erosional Remnants.

Major Roads

Minor Roads

Streams

Tanks

Irrigation Channels

Survey Boundary

Mile 1 1/2 0 1 Miles

SCALE: One Mile to An Inch

PLANNING BRANCH
IRRIGATION DEPARTMENT

Reddish brown earth (with a moderate amount of gravel)

These soils are similar to the R.B.E. soils described above except that there is a moderately high concentration of gravel throughout the depth of the profile as well as considerable erosion on the surface.

The crops grown on the R.B.E. soils may be grown on these soils also, but the yield will be poorer and longer and more frequent irrigations will be required. Hence, it is preferable to avoid these soils for agricultural crops if other soils are available. These lands may be left as forest, or used for settlements.

Low Humic Gley Soils

These soils are moderately deep soils with periodically high ground water levels and are usually found in the lower topographical areas. The texture is variable from sandy loam to sandy clay loam. The soils are imperfect to poorly drained. The soil pH is neutral to weakly alkaline and occasional concentrations of salts are found in the lower depths of the soil profile. The chemical fertility of the soil is quite good except for nitrogen and phosphorous which will have to be supplied regularly.

These soils are best suited for paddy cultivation under irrigation during both Maha and Yala seasons. Adequate drainage is essential.

Alluvial soils of variable drainage and texture

These soils occur in the flood plains of rivers and streams, as alluvial deposits. They are deep to very deep, brown to yellowish brown and greyish brown soils having variable textures. Most of these soils are imperfectly to poorly drained soils having loamy to clayey textures. The soil pH is neutral.

These soils are well suited for irrigated rice cultivation.

Suspected saline and/or Alkaline soils

These are low humic gley soils, alluvial soils or solonety soils having harmful concentrations of soluble salts (salinity) or a high percentage of sodium in the exchange complex (alkalinity). They can be utilized for paddy cultivation after approximate reclamation measures are taken. These measures are flushing and draining for saline soils and addition of chemical amendments (like gypsum) followed by draining for alkali soils.

The occurrence of these soils is so limited, however, that they present only a localized problem to be tackled at the farm level.

Rock Kurb Plains

These soils consist of shallow, well to moderately well drained soils with low rock outcrops. Generally more than 25% of the surface is covered with rock exposures.

These soils are best suited for reafforesation, forest reservations, recreational uses, roads and buildings.

Erosional Remnants

There are rock outcrops which stand out prominently in the landscape. They may be used for rock quarries, if no ancient temples have been sited in them. These are unsuitable for agriculture.

Construction Programme and Phasing of Expenditure (in million rupees)

	1st year	2nd year	3rd year	4th year	5th year	6th year	Total
Acquisition, Access and Road deviation	1.5M	1.0M					2.500 M
Dam		10 M	10.349M				20.349
Spillway	2 M	2 M	3.800M				7.800
Sluices	0.5 M	0.75 M					1.250
Irrigation facilities		4 M	4 M	3.5 M	3 M	1.95 M	16.450
Land development			5 M	4 M	3 M	1.50 M	13.500
Land settlement			2.3M	1.5 M	1.5 M	1 M	6.300
General charges	2	2	2	2	2	1.851	11.851
Total	6.000	19.750	27.449	11.000	9.500	6.301	80.000

List of equipment and machinery

The equipment and machinery necessary for the construction of Headworks and Irrigation facilities according to the construction programme.

In the preparation of this programme the following assumptions have been made : -

1. Two shifts of 8 hours for a working day.
2. Percentage of the equipment serviceable at all times is 80%

Equipment & Machinery	At the commencement of					
	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.
Tractor Cl.I	2	8	8	6	4	2
Tractor Cl.II.	-	3	5	4	3	2
Scraper	-	3	3	-	-	-
Moterised Scrapers	2	9	9	4	3	-
Sheep foot roller	-	2	2	1	2	2
Motor Grader	1	2		2	2	2
Excavator	-	2	2	2	2	2
Lorry Tipper	2	6	9	9	8	5
Compressor	2	4	4	2	2	1
Jack Hammer	2	8	8	3	3	2
Showel Loader	1	1	1	1	1	1
Euclid rear dump	2	3	8	8	4	2
Crusher	1	1	1	1	1	1
Pump	1	4	4	2	2	2
Water Bowser	2	2	2	2	2	2
Fuel Bowser	-	2	2	2	1	1
Jeep	4	6	6	6	6	6
Concrete Mixer	1	2	2	2	2	1
Agricultural Tractors	-	-	6	9	9	9

EQUIPMENT AND MACHINERY
PRICE LIST

Equipment & Machinery	No. of Mc.	Price per machine in U.S. $	Total price in US $
Tractor Cl.I	8	110,000	880,000
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	6,000	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
Showel 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
			3,561,910

Note : - 1 U.S. $ = Rs.8.66

The cost of machinery = Rs. 30.8m.

Allow a 40% salvage value on the machinery after the completion of the project.

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

Annex 4-4

FOREIGN EXCHANGE COST OF THE PROJECT

(1)	Cost of Machinery	30.8 m. Rs.	
	Less 40% residual value	12.3	
	The cost of M/c for the project		18.500 m. Rs.
(2)	Cost of fuel (Diosoline) 5.27 m. gal. @ Rs. per gal.	15.810 m. Rs.	
	Cost of lubricant 91,370 gals. @ Rs.10/= per gal.	0.914 m. Rs.	16.725 m. Rs.
(3)	Foreign Component of cement and steel 15,000 cubes of concrete for spill, major structures & other structures 15,000 x 13 x 14	2.73 m. Rs.	
	Cost of steel - allow sum	0.77 m. Rs.	3.500 m. Rs.
(4)	Spares for machinery and equipment		2.700 m. Rs.
(5)	Tools, accessories and surveying instruments		1.250 m. Rs.
(6)	Blasting material		0.500 m. Rs.
(7)	Generators, electrical fittings and other accessories for buildings, etc.		.750 m. Rs.
(8)	Foreign component of sluice (gates, lifting gear, etc.)		0.225 m. Rs.
			44.150 m. Rs.

Annex 5

Details of construction estimate

(in Rs.1000)

(1)	Land right of way Access & Road diversion	2,500
(2)	Dam	20,349
(3)	Spillway and tail channels, etc.	7,800
(4)	Irrigation facilities for 6,300 acres	16,450
(5)	Sluices	1,250
(6)	Land development	13,500
(7)	Land settlement	6,300
(8)	General charges	11,851
		80,000

S.I.	Description	Quantities	Units	Rate	Amount	
	Item 1 - Acquisition, Access & road deviations					2,500
1	Acquisition of private land	Item	Allow Sum		1,000	
2	Access during construction	Item	Allow Sum		500	
3	Road deviations	Item	Allow Sum		1,000	
	Item 2 - Dam Structure					20,349
4	Jungle clearing in dam area	170	Acres	1,200	204	
5	Jungle clearing in burrow aron	200	Acres	1,200	240	
6	Stripping 12" top soil for filling of dam	30,000	Cubes	25	750	
7	Stripping 12" top soil in the burrow area	40,000	Cubes	25	1,000	
8	Excavation common in core trenches and spoil to waste	10,000	Cubes	25	250	
9	Excavation common in core trenches and spoil from the dam	8,000	Cubes	30	240	
10	Earthwork in formation of dam from burrow area including part of E/W in spill tail channels and from reduction of spill sites emergency spill sites and approaches	399,000	Cubes	30	11,970	

S.I.	Description	Quantities	Units	Rate	Amount	
11	Rip rap protection for U/S slope of dam	13,500	Cubes	150	2,025	
12	Toe filter with sand, grouted metal and rubble for dam	16,000	Cubes	150	2,400	
13	Turfing slopes of dam	10,800	Cubes	25	270	
14	Coffer damming, dealing with water and clearing foundation in river closure	Item	Allow Sum		1,000	
	Item 3 - 2,000 feet clear overfall spillway & tail channel					7,800
15	Earth excavation in foundation for 2,000 ft. C.O. spill	12,000	Cubes	30	360	
16	Loose rock excavation	1,400	Cubes	100	140	
17	Concrete with nominal reinforcement and dowels, etc. for the spillway & abutments	4,000	Cubes	750	3,000	
18	Earthwork in spill tail channel and training bunds out of total excavations of 168,000 cubes of E/W allow for 68,000 cubes to be used for the dam. Balance 190,000 cubes to be wasted or used for training bunds and emergency spillway	100,000	Cubes	30	3,000	
19	Crossing for R.B. main channel over spillway	Item	Allow Sum		300	
20	Road deviation and unforeseen expenses	Item	Allow Sum		1,000	
	Item 4 - Sluices (outlet works)					1,250
21	Construction of L.B. sluice to discharge 156 cusecs and to feed 4,800 acres	Item	Allow Sum		850	
22	Construction of R.B. sluice to discharge 48 cusecs and to feed 1,500 acres	Item	Allow Sum		400	

S.I.	Description	Quantities	Units	Rate	Amount	
	Item 5 - Irrigation Distributory system - Gravity					16,450
23	Cost of 13 miles of L.B. main channel (Maximum discharge 156 cusecs) feeding 4,800 acres	Item	Allow Sum		5,500	
24	Cost of 7,1/2 miles of R.B. main channel (Maximum discharge 48 cusecs) feeding 1,500 acres.	Item	Allow Sum		1,500	
25	Construction of Distributory channels, field channels, offtake structures, etc. to feed 6,300 acres	6, 00	Acres	1,500	9,450	
	Item 6 - Land Development					13,500
26	Heavy to medium jungle clearing in the irrigable area	6,300	Acres	1,000	6,300	
27	Land levelling	6,300	Acres	500	3,150	
28	Ripping and cross ripping	6,300	Acres	500	3,150	
29	Tidying up and unforeseen expenses	Item	Allow Sum		700	
	Item 7 - Land Settlement					6,300
30	Settlement of colonists, construction of cottages, and provision of marketing facilities, schools, roads, etc.	6,300	Acres	1,000	6,300	

S.I.	Description	Quantities	Units	Rate	Amount	
	Item 8 - General Charges					11,851
31	Maintenance of completed works during construction	Item	Allow Sum		1,000	
32	Provision of camps, water supply, electricity, and other facilities to staff during construction and maintenance of same	Item	Allow Sum		3,000	
33	Administrative cost including cost of supervision by permanent officers and others, pay of overseer, watchers, contribution to approved funds and additional survays, etc.	Item	Allow Sum		2,000	
34	Contingencies	Item	Allow Sum		5,851	
						80,000

PROJECT FEATURES

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

The reservoir will inundate as area of 4100 acres, most of which is in crown jungle. There are however about 453 acres of paddy lands in the villages Ranorewewa, Walpaluwa and Audivakudawala which will be submerged. The road from Nanneriya to Inginimitiya will be submerged and will be diverted above the high flood contour. The village council road from Ranorewa to Andivakadawela will be submerged and will be replaced by a road on the reservoir dam.

5.2 Dam - Several dam sites were investigated and ultimately the present dam site was chosen as the most suitable one. The dam will have a length of 2M 4750 ft. with a maximum height of 60 ft. The embankment will be a rolled fill earth dam involving about 417,000 cubes of earthwork. It will have a 20' wide roadway on its crest and slopes of 1 on 3 and 1 on 2.5 on the upstream and downstream. The core trench will be excavated to bedrock of one third to height of the dam. The too filter provided along the downstream too of the dam will allow clear water to percolate into a system of precast drains. The downstream slope will be turfed fully while the upstream slope will be protected with rip rap up to high flood level.

5.3 Spillway - A 2000 ft. long clear overfall uncontrolled spillway will be located on the right bank flank of the dam, where suitable rock outcrops for a length of 350 ft. The spillway has been designed to discharge a peak flood of 61,500 cusecs. An emergency spillway of length 800 ft. will be provided to the right of the spillway to cater for any catastrophic floods. The spill tail channel will be 2000 ft. wide at the commencement but will gradually be reduced to 300 ft. width within a distance of 2400 ft. It will then be carried to the Mi Oya, the total length of the spill tail channel being 7000 ft. A training bund is provided on rhw lwdr 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 suitable.

Drillings are being done at the emergency spillway on the right of the present spillway and if the rock levels are found suitable, a gated spillway may be considered at this point as the getaway conditions are better at the emergency spillway site than at the spillway site proposed at present. This alternative will be looked into at the final design stage.

5.4 Outlet works - The irrigable area is located on either branks 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 4800 acres. It will commence at a sill level of 181 MSL and be capable of discharging 156 cusecs. The left bank canal will be 13 miles long and will have a bed slope of .0003 and sick slopes of 1 vertical to 1 horizontal. The cost of the L.B. canal is estimated at Rs.5.5 million.

The right bank sluice will feed 1500 acress. It will commence at a sill level of 181 MSL and be capable of discharging 48 cusecs. The right bank canal will be 7,1/2 miles long and will have side slope of 1 on 1 and bed slope of .0003. The cost of the L.B. canal is estimated at Rs.1.5 million.

5.5 Access and Construction - The dam is approached by travelling on the Kurunogala - Puttalam road, turning right at Padeniya and then turning left at the 40th mile post and before roaching Galgamuwa. At the Maha Nanneriya junction one turns left along a gravel road loading to Maha Torawa and right again to reach Inginimitiya. The distance from Galgamuwa to Inginimitiya is 14 miles. As the roads are fairly well developed there will be no difficulty in taking heavy machinery to the dam site.

The machinery and equipment required for the construction of the Inginimitiya head works and providing irrigation facilities to the development area are as given is Annex 4. These will have to be imported from abroad as the machines new in use in the Department are 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 embakment. 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 month of June, July and August. The U/S coffer dams will be incorporated in the upstream slope of the embakment.

5.6 Statistical data for Inginimitiya Reservoir Scheme Reservoir

Drainage area - total	215 sq. miles
- between Inginimitiya & Abakolawewa	150 sq. miles
Maximum annual yield (for 150 sq. miles)	336,906 acre ft.
Minimum annual yield (- do -)	10,869 "
Average annual yield (- do -)	94,315 "
High flood level	206.0 MSL
Full supply level	202.0 MSL

Area of water surface at FSL	410 acres
Area of water surface at HFL	5030 acres
Capacity (gross) at FSL	53,000 acre ft.
Dead storage at 181 MSL	4,200 " "
Live (active) storage	48,000 " "
4500 acres paddy both seasons	
1800 acres paddy) Maha	
) Soya beans, pulses in	
) dry season	

Dam

Type - rolled fill, homogeneous ( ) section	
Length	2 Ml. 4750 ft.
Top width	20 ft.
Crest level	212 ft. MSL
Maximum height	60 ft.
River bed level	153 ft. MSL
Side slopes 1 on 3.0 U/S & 1 on 2.5 D/S ( )	
Borm on downstream width 12 at 181 ft. MSL	
Approximate number of cubes	417,000 cubes

Design flood for spillway

Maximum flood discharge	61,500 cusecs
Return period of M.F.D.	100 year
Flood volume	115,000 Ac. ft.
Catrastrophic flood discharge	76,000 cusecs
Return period of C.F.D.	200 years
Flood volume	156,000 Ac. ft.

Spillway

Type of spillway clear overfall concrete, uncontrolled

Length of spillway to Mi Oya	7000 ft.
Width of spillway	2000 ft.
Slope of tail channel	0.0057
Width of tail channel	300 ft.

Emergency spillway

Length of Mi Oya	10,560 ft.
Width	800 ft.
Slope of tail channel	800 ft.
Width of tail channel	Varying

L.B. sluice

Type of R.C. tower

Discharge	156 cusec
Acreage fed	4800 cusec
Maximum head of water	21 ft.
Sill level	181 MSL

R.B. sluice

Type R.C. tower type

Discharge	48 cusec
Acreage fed	1500 acres
Maximum head of water	21 ft.
Sill level	181 MSL

L.B. Canal

Earth channel	- Bed width at start		16 ft.
Length 13 miles	Full supply depth		3.6 ft.
Side slopes 1 on 1	Free Board		2.5 ft.
Gradient 0.0003	Capacity in cusecs		156
	Irrigable area	3000	-paddy for both season
		1800	-paddy, soya bean & pulses

R.B. canal

Earth channel	Bed with at start		12 ft
Length 7,1/2 miles	Full supply depth		2.2 ft.
Side slopes 1 on 1	Free Board		2 ft.
Gradient 0.0003	Capacity in cusec		48
	Irrigable area	1500	-paddy for both seasons.

Annex 7

ECONOMIC JUSTIFICATION

Precedure Adopted.

The conomic worth of the Inginimitiya Reservoir Project was considered in the light of its effect on the promotion of domestic consumption, present and future. The increased quantity of rice soya beans and pulses produced by the project will premote domestic consumption in the near future.

The costs and benefits, were determined as they occur year by year over a 50 year period of analysis. They were then brought to a common point of time by the use of present values, at discount rates of 6% and 10%, and compared, by obtaining a benefit cost ratio. The internal rate of return was also computed. The economic justification was done on two assumptions for costs and benefits (a) market prices (b) opportunity costs.

The project will feed 6300 acres of new lands. The cropping pattern and calendar are indicated under the Annex on hydrology.

The resources used in the project were allocated into five categeries

(1) foreign component

(2) domestic materials

(3) skilled labour

(4) unskilled labour

(5) transfers

All farm labour was assumed to be unskilled. Percentage allocations of resources are given in Table 11. The foreign and local costs are given in Table 12. When considering opportunity costs, the foreign exchange component was taken as double its official value because it is scare. The unskilled labour component was taken at one third its market value as there is large scale unemployment in the regions close to the project area.

The percentage cost to the economy is also given in Table 11. The market cost of the item is multiplied by the percentage cost to the economy to give the cost of the item to the economy (when working on the assumption of opportunity costs).

The cost and benefits streams have been enumerated clearly in the following pages. The world market price of rice has been taken as £150 per metris tons. These works out to Rs.33/30 per bushel and accounts for the value of Rs.66/=per bushel used when considering the assumption of opportunity costs.

Results of computations

The computations show that -

	Market values		Opportunity value	
	6%	10%	6%	10%
Benefit cost ratio	1.53	1.29	2.52	2.09
Internal rate of return	17%		27%	

Table 11 - Percentage allocation of resources

Item	Foreign component	Domestic materials	Skilled labour	Unskilled labour	Cost to the economy
Acquisition & Access	35	5	20	40	109
Dam	66	3	12	19	150
Spillway	60	10	15	15	150
Sluice	60	10	15	15	150
Irrigation facilities	51	10	15	24	135
Land development	60	15	10	15	150
Land settlement	-	-	-	-	-
General	50	5	15	30	130
Cultivation	40	10	-	50	106
Operation & Maintenance	15	10	15	60	75
Replacements	60	10	15	15	150

Table 12 - Foreign & Local cost of the scheme (in Rs. 1000)

Item	Foreign cost	Local cost	Total	Cost to the economy
Acquisition & Access	875	1,625	2,500	2,720
Dam	13,400	6,949	20,349	35,300
Spillway	4,700	3,100	7,800	11,700
Sluice	750	500	1,250	1,875
Irrigation facilities	8,400	8,050	16,450	22,200
Land Development	8,100	5,400	13,500	20,200
Land Settlement	2,000	4,300	6,300	-
General charges	5,925	5,926	11,851	15,400
Total : -	44,150	35,850	80,000	109,395

Costs

Construction and land development costs are given already.

Other Resources

Operation and Maintenance

Allow Rs. 100/= per acre for operation and maintenance once I.FF. are provided. The programe for provision of I.FF. are as follows : -

Year	Total acreage	Acreage cultivated with sub/crop during Yala	Maintenance cost
4	2500	500	Rs. 250,000/=
5	5000	1000	Rs. 500,000/=
6	6300	1800	Rs. 630,000/=

Cultivation cost

Paddy

Cultivation costs increases from Rs.600/= to Rs.1050/= per year of cultivation and the yields from 50 bushel/crop acre. to 80 bushels/crop acre as shown below.

Year of cultivation	Yield in bushels/crop Ac.	Culti. cost/crop Ac.
1	50	600/=
2	60	750/=
3	70	900/=
4	80	1050/=

Total cost of cultivation for 2,1/2 acres/season - Rs.2945/=

Less interest on loan & land batterment charges - Rs. 340/=

2605/=

Balance

Cost per acre = $\frac{2605}{2.5}$ - 1042/=

Say 1050/=

Soya Beans

Total cost of cultivation for 2,1/2 acs/season - 1826/=

Less interest on loans & land better charges 146/=

Balance 1680/=

Cost per acre = $\frac{1680}{2.5}$ = Rs. 672/=

Pulses

Total cost of cultivation for 2,1/2 acs/season - 1683/=

Less interest on loans & land better charges - 135/=

Balance 1548/=

Cost per acre = $\frac{1548}{2.5}$ Rs. 619/20

Average cost of cultivation per acre of soya beans or pulses = 645/60

Say Rs.650/=

Yields & Prices

Yield of paddy is 80 bushels/acre at the 4th year of cultivation.
Market price of paddy is taken as Rs.33/= per bushel. Since the world market price is Rs.33/20 per bushel the opportunity value of a bushel is taken as 2 x 33/20 = 66/40 -- 66
Yield of Soya beans and pulses are taken as 15 cwt/acre add 12 cwt/acres respectively,
Market prices are Rs.84/= per cwt. and Rs.128/= per cwt. respectively.
Total income from cultivation of an acre of soya bean or pulses is

taken as $\frac{84 \times 15 + 128 \times 12}{2}$ Rs.1398 Say Rs.1400/=at actual value

World market price of soya bean or pulses is Rs.52/= per cwt. and the opportunity value is taken on 2 x 52/= per cwt. = Rx.104/=.

Average income from cultivation of an acre of soya beans and pulses is $\frac{104 \times 15 + 104 \times 12}{2}$ = Rx.1404/= per acre

Say Rs.1400/= at opportunity value.

Total cost of cultivation of paddy for Maha season

Age of scheme	Acreage x cost per season	Cost (in Rs.1000/=)
4	2500 x 600 + 2500 x 600	1,500
5	2500 x 750 + 2500 x 600	3,375
6	2500 x 900 + 2500 x 750 + 1300 x 600	4,905
7	2500 x 1050 + 2500 x 900 + 1300 x 750	5,850
8	2500 x 1050 + 2500 x 1050 + 1300 x 900	6,420
9	2500 x 1050 + 2500 x 1050 + 1300 x 1050	6,615

Total cost of cultivation of paddy, soya beans and pulses during Yala season

Age of scheme	Acreage x cost	Cost (in Rs.1000/=)
4	200 x 600 + 500 x 650 x 2	1,850
5	2000 x 750 + 500 x 650 x 2+200x600+500x650x2	4,000
6	2000 x 900 + 500x650x2+2000x750+500x650x2/ +500 x 600 + 800 x 650 x 2	5,940
7	2000 x 1050 + 500x650x2+2000x900+500x650x2 +500 x 750 + 800 x 650 x 2	6,615
8	2000 x 1050 +500x650x2+2000x1050+500x650x2 +500 x 900 + 800 x 650 x 2	6,990
9	2000 x 1050 +500x650x2+2000x1050+500x650x2 +500 x 1050 + 800 x 650 x 2	7,665

Total cost of cultivation for both seasons

Age of scheme	Cost during Maha	Cost during yala	Total cost
4	1,500	1,850	3,350
5	3,375	4,000	7,375
6	4,905	5,940	10,845
7	5,850	6,615	12,465
8	6,420	6,990	13,410
9	6,615	7,065	13,680

Replacements

After 40 years of operation (44th year) sluice gates, emergency spillway etc. may have to be replaced.

Allow Rs.4,000,000/= for this purpose during the 44th year.

Benefits

Only the primary benefits from agricultural products are considered. Opportunity value for the products are taken as twice the World Market Price.

Yield of paddy during Maha season (in bushels)

4	2500 x 50	125,000 bushels
5	2500 x 60 + 2500 x 50	275,000
6	2500 x 70 + 2500 x 60 + 1300 x 50	390,000
7	2500 x 80 + 2500 x 70 + 1300 x 60	453,000
8	2500 x 80 + 2500 x 80 + 1300 x 70	491,000
9	2500 x 80 + 2500 x 80 + 1300 x 80	504,000

Yield of paddy during yala season (in bushels)

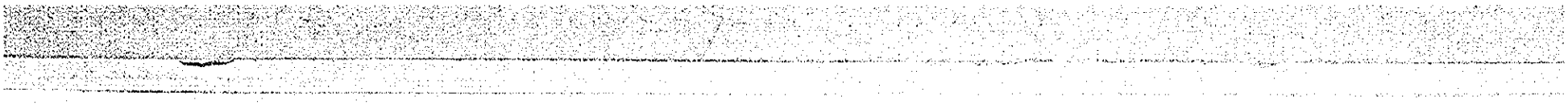
4	2,000 x 50	100,000
5	2,000 x 60 + 2,000 x 50	220,000
6	2,000 x 70 + 2,000 x 60 + 500 x 50	285,000
7	2,000 x 80 + 2,000 x 70 + 500 x 60	330,000
8	2,000 x 80 + 2,000 x 80 + 500 x 70	355,000
9	2,000 x 80 + 2,000 x 80 + 500 x 80	360,000

Income from Soya Beans & pulses during Yala season

4	500 x 1,400 x 2	1,400,000/=
5	1,000 x 1,400 x 2	2,800,000/=
6	1,800 x 1,400 x 2	5,040,000/=
7	1,800 x 1,400 x 2	5,040,000/=

Income from Paddy for both Seasons

	Yield	Income @ Rs.33/=(in Rs.1000/=)	Income @Rs.66/=(in Rs.1000/=)
4	225,000	7,425	14,850
5	495,000	16,335	32,670
6	675,000	22,275	44,550
7	783,000	25,839	51,678
8	846,000	27,918	55,836
9	864,000	28,512	57,024



Cost (in Rs.1000/=) on actual values

Annex 7-8

Yr.	Acquisition Access etc.	Dam	Spill	Sluices	Irrigation faci.	Land develop.	Land settle.	Opera. & mainte.	Cultivation	Replacement	General charges	Total cost	Present value @ 6% P.W.F @ 6%	P.V.	Present value @ 10% P.W.F. @ 10%	P.V.
1	1,500	-	2,000	500	-	-	-	-	-		2,000	6,000	0.943	5,650	0.909	5,450
2	1,000	10,000	2,000	750	4,000	-	-	-	-		2,000	19,750	0.890	17,600	0.826	16,300
3		10,349	3,800	-	4,000	5,000	2,300	-	-		2,000	27,449	0.840	23,100	0.751	20,600
4					3,500	4,000	1,500	250	3,350		2,000	14,600	0.792	11,600	0.683	10,000
5					3,000	3,000	1,500	500	7,375		2,000	17,375	0.747	12,950	0.621	10,800
6					1,950	1,500	1,000	630	10,845		1,851	17,776	0.705	12,500	0.564	10,000
7									12,845			13,095	0.665	8,700	0.513	6.700
8									13,410			14,040	0.627	8,800	0.467	6,550
9									13,680			14,310	0.592	8,450	0.424	6,050
10													0.558	8,000	0.386	5,025
													8.402	120,000	3.770	54,000
44										4,000		4,000	0.0798	320	0.0168	67
50																

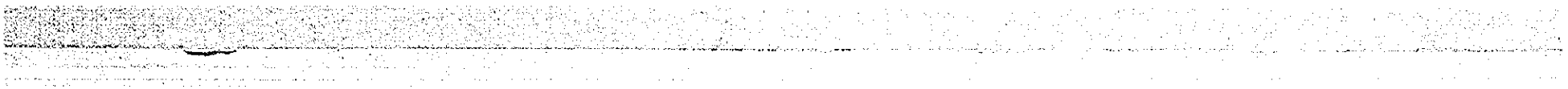
Benefits on actual values (in Rs.1000/=)

Yr.	Income from paddy	Income from soya beans & pulses	Total income	Present value @ 6% P.W.F. @ 6%	P.V.	Present value @ 10% P.W.F. @ 10%	P.V.
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	7,425	1,400	8,825	0.792	7,000	0.683	6,050
5	16,335	2,800	19,135	.747	14,300	.621	11,900
6	22,275	5,040	27,315	.705	19,250	.564	15,400
7	25,839	5,040	30,879	.665	20,550	.513	15,900
8	27,918		32,958	.627	20,700	.467	15,400
9	28,512		33,552	.552	19,850	.424	14,200
10				.558	18,700	.386	12,950
				8.402	282,000	3.770	126,100
					402,350		217,900
90% income (corresponds to 90% yield)					362,000		196,000

Assuming 90% success of cultivation

Benefit cost ratio @ 6% = $\frac{362,000}{237,670}$ = 1.53

Benefit cost ratio @ 10% = $\frac{196,000}{151,542}$ = 1.29



Cost (in Rs.1000/=) on opportunity values

Annex 7-9

Yr.	Acquisition Access etc.	Dam	Spill	Sluices	Irrigation faci.	Land develop.	Operation & maintenance	Cultivation	Replacement	General charges	Total cost	Present value @ 6% P.W.F. @ 6%	P.V.	Present value @ 10 P.W.F. @ 10%	P.V.
1	1,635	-	3,000	750	-	-	-	-	-	2,600	7,985	0.943	7,520	0.909	7,250
2	1,090	15,300	3,000	1,125	5,400	-	-	-	-	2,600	28,515	0.890	25,400	0.826	23,600
3		15,500	5,700		5,400	7,500	-	-	-	2,600	36,700	0.840	30,800	0.751	27,600
4					4,720	6,000	188	3,550	-	2,600	17,058	0.792	13,500	0.683	11,650
5					4,050	4,500	376	7,800	-	2,600	19,326	0.747	14,450	0.621	12,000
6					2,630	2,250	474	11,450	-	4,400	19,204	0.705	13,520	.564	10,820
7								13,200	-		13,674	0.665	9,400	.513	7,020
8								14,200	-		14,674	0.627	9,200	.467	6,850
9								14,500			14,974	0.592	8,850	.424	6,350
10											14,974	0.558	8,350	.386	5,830
44									6,000		6,000	0.0798	480	0.0168	100
50												8.402	126,000	3.770	56,500
													267,170		175,570

Benefits (in Rs.1000/=) on opportunity values

Yr.	Income from paddy	Income from soya beans & pulses	Total income	Present value @ 6% P.W.F. @6%	P.V.	Present value @ 10% P.W.F. @ 10%	P.V.
1	-	- -	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	14,850	1,400	16,250	0.792	12,850	0.683	11,100
5	32,670	2,800	35,470	.747	26,400	0.621	22,000
6	44,550	5,040	49,950	.705	35,000	.564	28,000
7	51,678	5,040	56,718	.665	37,200	.515	29,100
8	55,836		60,876	.627	38,200	.467	31,800
9	57,024		62,064	.592	37,000	.424	26,500
10				.558	34,800	.386	24,200
50				8.402	526,000	3.770	236,000
					747,450		408,700
90% income (corresponds to 90% yield)			=		672,500		368,000

Assuming 90% success of cultivation

Benefit cost ratio @ 6% = $\frac{672,500}{267,170}$ = 2.52

Benefit cost ratio @ 10% = $\frac{368,000}{175,570}$ = 2.09

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

Year	Total	Total income	Net benefit	Present value @ 16% P.W.F. @ 16%	Present value @ 16% P.V.	Present value @ 18% P.W.F. @ 18%	Present value @ 18% P.V.
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	-	-27,449	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		(-5,000)	(0.002)	-8	(-0.0006)	-2
50					1,753		- 1,007

Internal Rate of Return is 17%

Internal Rate of Return on opportunity values (Assuming 90% success)

Year	Total cost	Total income	Net benefit	Present value at 26% P.W.F. @ 26%	P.V.	Present value at 28% P.W.F. @ 28%	P.V.
1	7,983	-	- 7,985	0.794	- 6,300	0.781	- 6,250
2	28,515	-	-28,515	0.630	-18,000	0.611	-17,500
3	36,700	-	-36,700	0.499	-18,350	0.476	-17,500
4	17,058	14,600	- 2,458	0.397	- 960	0.373	- 915
5	19,326	32,000	12,674	0.315	3,960	0.291	3,690
6	19,204	44,600	25,396	0.250	6,349	0.227	5,750
7	13,674	50,250	36,576	0.198	7,250	0.178	6,500
8	14,674	54,750	40,076	0.158	6,350	0.139	5,650
9	14,974	56,000	41,026	0.125	5,150	0.108	4,450
10	14,974		41,026	(0.480)	19,800	0.387	5,200
44	(6,000)			-		-	
50					5,249		-10,925

Internal Rate of Return is 27%

Supporting Data Available

Survey Data

Aerial Photographs	-	1:40,000
Topographic Maps	-	12 chain and 4 chain engineering surveys of dam sites and irrigable area and reservoir bed area.
Soil survey maps	-	See Annex ..... on Land Classification
Railfall, climate, stream flow	-	See Annex 2 on Hydrology

Hydrological Studies - See Annex 2 on Hydrology

Engineering Studies

Site Maps	-	12 chain & 4 chain engineering surveys of dam sites & irrigable area and reservoir bed area inclusive of spill tail channels.
Site investigations	-	Logs of drill holes and soil profile borrow area plan & logs of trial pits. Reconnaissance soil map of the project area.
Sources of materials	-	Borrow area plans
Reservoir area	-	12 chain plan and capacity obtained therefrom.
Preliminary Designs	-	1. Uncontrolled crest spill 2. Plan and L.S. of dam 3. L.B. tower sluice plan
Outline Specifications	-	Available
Development of Cost Estimates	-	Available
Foreign exchange costs	-	Available. See Table 2-Sec.2.3
No special construction problems		

Agronomic Studies

Cropping patterns	-	See Annex 3 on Hydrology
Crops	-	See Annex 2 on Hydrology & Annex 3 on Land Classification.
Yields	-	Data from Mahaweli Project Stage 2 71,000 acres under World Bank Loan available.
Water Requirements	-	Data from Mahaweli Project available.

Economic Studies

Population, etc.	-	See Section 3.1
Present Land Use	-	See Section 3.7
Number of holdings, type of tenure, etc.	-	See Section 3.9
Credit Facilities	-	See Section 3.13
Marketing -	-	See Section 3.15
Processing	-	See Section 3.15
Prices	-	See Section 3.17
Future Agricultural Production	-	See Section 4.7
Future Production Costs	-	See Section 4.7
Future net Production	-	See Section 4.7
Future Farm Income	-	See Section 4.7 and Approx 1 on Farm Budget
Repayments	-	See Section 4.8
Economic Justification	-	See Annex 7

SOCIO ECONOMIC REPORT ON INGINIMITIYA RESERVOIR BED AREA

SUMMARY

By the construction of the Inginimitiya reservoir the village of Inginimitiya in the DRO Division of Puttalam District and the villages of Katuwewa, Andiyatalla, Palugella and Ranorewa in the Kurunogala District will be submerged. These 5 villages are built around 5 village tanks of the same names. The total number of families affected is 187, the total population being 1014. Most children do not attend school, due to the poverty of the villagers. They instead work on the chena (shift) cultivation along with their fathers.

The villagers cultivate paddy under the small village tanks in Maha and a little in Yala. Although the cultivation for Maha is donw with the aid of the small tanks, yet due to lack of water the Maha crop fails often. If by chance the crop is a success then yields of 40 buchels per acre are obtained. The villagers mainly depend on chena cultivation for their living, because the small tanks often go dry. The average income is less than Rs.150/= per month. The life of the villager is pathetic. Drought relief work on the small tanks and the roads is provided by the Government when the tanks are dry. At times there is no water to drink or bathe. Many of the villagers suffer from malnutrition.

Most of the houses of the villagers are thatched with cadjan or straw, and are mud huts in wattle and daub. Practically every house has an attuwa to store paddy in their gardens. The total compensation payable amounts to Rs.1.02 million for private lands, permanent plantation and buildings.

The villagers expressed a desire to have lands under the scheme. All these over 18 years of age should be given lands under the project. The necessary infra-structure for farm life should be provided close to their homes in the new schemes.

The villagers of Inginimitiya belong to one caste and they expressed a desire that they be resettled together in one tract. As these villagers are farmers for generations, they should be given a training in modern agricultural practices to obtain greater productivity for their lands.

Socio Economic Report on Inginimitiya Reservoir Bed Area

1.0 Introduction

By constructing a dam across Mi Oya through the villages of Inginimitiya and Ranorawewa, it would be possible to provide irrigation facilities to about 6300 acres in Rajawanni and Demala Hatpattu, in the Puttalam District. The village Inginimitiya, in the DRO Division of Puttalam District and the villages Katuwewa, Andiyatalla, Palugolla and Ranorewa in the Kurunogala District, will be submerged by the Reservoir formed by the dam.

There are two ways of reaching the reservoir bed. One way is along the Kurunogala-Puttalam road, turning south at Anamaduwa and travelling to Navattegama and then to Katuwewa. The other way is to travel along the Kurunogala-Anuradhapura road up to Galgamuwa and then to approach the right bank of the dam site at Inginimitiya along the Katuwewa-Navattegama road.

The value of the area to be inundated and the buildings therein has to be assessed so that compensation may be paid to these affected. This report also deals with a little of the social and economic aspects of the population in the area and the resettlement of these people in the light of these aspects.

2.0 Present environment in the Reservoir Bed Area

There are 5 villages around small village tanks in the area, which will be submerged. Most of the inundated lands will be under Palugella and Inginimitiya. Ranorawewa and Andiyatalla are two small villages while Katuwewa is situated on the periphery of the proposed reservoir.

The type of tenure under which the uplands in the 5 villages are held is given in Table 45. The number of families in the villages are also given therein. Table is gives the type of tenure in the paddy lands and it is seen that the maximum amount of private paddy lands amount to 102 acres is held in the Palugella village.

The proposed scheme falls into the Kurunegala and Puttalam districts. Electoral-wise it falls into the Nikaweratiya and Yapahuwa Electoral-wise it falls into the Nikaweratiya and Yapahuwa Electorates. According to DRO divisions it falls into Nikaweratiya, Navattegama and Galgamuwa divisions.

The total number of families that will be affected is 187. Of these the largest is from Inginimitiya with 93 families and 496 persons. The statistics of population according to ages in the 5 villages is given in Table 1. The total number of persons affected is 1014, with 538 males and 476 females. The average per family is 5.4 persons.

In the reservoir bed area, the greater part of the children do not go for schooling. Due to sheer poverty the parents cannot afford to pay for schooling the children. There is much chena cultivation going on in the area and the children are made to assist the parents in such cultivation and this is another reason why the children do not go to school. Table 2 gives the number of children that attend school according to the grades in school. Only 87 children out of a possible 297 attend school.

The Inginimitiya children attend the Inginimitiya Junior School while the Palugella and Ranorewa children attend the Palugella Junior school. Generally the children can go up to the G.C.E. level at these schools or at the school at Nanneriya. However only a few children go above Grade 5.

In this reservoir bed area, the people cultivate mainly in Maha and a little in Yala due to the scarcity of water. Often only half of the acreage done is Maha is cultivated in Yala. Although cultivation is done in Maha with the aid of small tanks, yet due to leak of water the Maha crop fails often. After the sowing of the seed, right up to harvest time, one is not sure whether a harvest is possible. In Yala the H_7, H_{10}, BG 34/8 varieties of rice are sown while in Maha H4, H_8, IR_8, are sown. If by chance the crop is a success, then a yield of 40-45 bushel-per acre are obtained in Yala and 40-50 in Maha. Neither transplanting nor planting in rows is done. Seed is sown broadcast. The fertilizer used is urea and ammonia. No compost manure is used. Cattle are kept, but cattle manure is hardly used. Ploughing by tractor costs about Rs.100-150 per acre. These who have no buffaloes obtain them on the promise of pavement in paddy. Pesticides are generally used.

Apart from paddy cultivation, chena cultivation is done in this area. As there is plenty of jungle, the same chena plot is not used for more than one year. Moong (groon gram), kurakkan, gingelly, moneri and maize are the pulses that are sown in the chena. Wattakka, chillies and vegetables are also grown in the chena. The villagers of this area mainly depend on chena cultivation for their living. This is because the small tanks in the area often go dry and the paddy crop fails. The requirement of water for the chena cultivation is not as much as that required for the paddy crop.

If the rains are heavy, the paddy crop is a success and the chena cultivation is also a success, then the income of the villager increases. In some instances, rains have not fallen for 2 years. In such times the life of the villager is pathetic. Drought relief work on small tanks and roads is provided by the Government at such times, for which a payment is made.

The income of a head of a family is less than Rs.150/= per month. Some villagers rear goats. The presence of forests aids them to rear these goats. Actually it is not possible to say that the income is so much per month, because the income from cultivation varies. To sell their produce (chillies, etc.) the villagers go to Galgamuwa, about 14 miles away.

For obtaining medical care the villagers have to travel to

Nawattegama or Manneriya or Galgamuwa. These places have hospitals where people can wait a few days to receive treatment. Many of the villagers are suffering from malnutrition.

The main festivities are during the New Year, Religious observances and the worship of Gods are a part of their culture.

3.0 Compensation for land plantations and buildings

For payment of compensation for land only the private uplands and paddy fields were considered. Government land on lease, L.D.O. allotments, encreachments, etc. were not considered for compensation. The price per acre of paddy field was taken as Rs. 1500/= per acre. The D.R.O. was consulted on this prices. The total extent of private paddy lands was estimated at 250 acres, 2 roods and the compensation payable Rs.375,750/=. As regards uplands, the total extent of private uplands was 108 acres 1 rood. The price per acre was taken as Rs.1000/= per acre and the compensation pavable to Rs.108,250/=.

For payment of compensation for the plantation on the lands, all lands were considered. The advice of the D.R.O. was obtained is assessing compensation for permanent plantations, such as coconut, jak, orange, lime, areconut, etc. Manioc, sweet potate, vegetables, pulses, etc. were not considered for compensation.

The 187 families in the reservoir bed area live in 173 houses. In some houses there were 2 - 3 families. At Inginimitiya there are 93 families in 83 houses which are estimated at Rs.963,000/=. There are two houses estimated at Rs.20,000/= and Rs.15,000/=. The other hosues are estimated at less than Rs.3000/= per house. Most of the houses have roofs thatched with cadjan or straw and are very small.
Katuwewa village is different from Inginimitiya village. There are two houses worth Rs.45,000/= and the other houses are worth more than at Inginimitiya. The worth of the 18 buildings at Katuwewa is estimated at Rs.126,500/=. At Patugella village 55 families own 56 houses. One house is worth Rs.20,000/=. The other houses are as small as these at Inginimitiy. The 14 families of Ranorawewa live in 10 houses, which are like these at Inginimitiya. Table 17 gives the value of the buildings in the villages.

Considering the overall picture, about 95 per cent of the houses have roof thatched in cadjan or straw, and are small. The houses having tiled roofs number 10. The houses having wattle and daub walls, with cement floors and lime washed walls are less than 25 in number. Practically every houses has an attuwa to store paddy in their front gardens.

Considering other infra-structure buildings, there are no bakeries, smithies, weaving centres or hospitals. At Patugella the Government Junior School is 80' x 20' and the teachers quarters is 40' x 18'. The cost of the school building is estimated at Rs.23,000/= and the teachers quarters at Rs.20,000/=. The 80' x 20' Junior school at Inginimitiya is estimated at Rs.23,000/= and the teachers quarters at Rs.15,000/=. The Inginimitiya

Buddhist temple promises is estimated at Rs.10,000/=.

The total compensation payable is as follows : -

		Rupees
Compensation for private uplands	-	109,250
Compensation for private paddy lands	-	375,750
Compensation for permanent plantation	-	151,897
Compensation for houses	-	288,650
Compensation for other infra-structure buildings	-	91,000
		1,015,547

Say 1.02 million rupees

4.0 Problems of Resettlement

At present, the agricultural production in the area is low. This is due to the lack of water. When there is no rain for one or two years, there are times when there is no water to drink or the bathe.

If the Inginimitiya scheme comes up, 1014 persons belonging to 187 families living in 5 villages will have to be resettled. When questioned, some villagers did not show much liking for the scheme. They point to Rajangane scheme and say it has failed. The people of Inginimitiya unlike the other villagers showed a liking for scheme. This is due to the fact that they are having a difficult life, their houses, are small and they do not mind leaving them for better conditions, in the new scheme proposed. The opposition to the scheme is from the Katuwewa and Palugella villagers, who are economically more affluent than the Inginimitiya villagers.

If the scheme is taken up, the villager expressed a desire to obtain lands under it. However they have pointed out that if the scheme is taken up and the jungle cleared, they will not be able to do chona cultivation. In the reservoir bed area, the villagers have been farmers for generations. It is necessary that these villagers be given preference when allotting lands under the scheme. It is just that all these over 18 years be given lands under the now project.

In the resettlement of people, the problem of the children's education is important. The children of this area, who go to school are few in number. In the resettlement area, there should be schools, health institutions, agricultural stations and commercial activities, etc. Co-operatives are essential. At present these people travel to Galgamuwa (about 14 miles away)for their agricultural and other requisites. A place where consumer items can be brought agricultural items can be bought and where they can sell their produce must be established, close to their homes,

under the new project.

The villagers of Inginimitiya belong to one caste namely Bathgama. In resettling them, they should be kept together in one village. They expressed a desire for this. Other schemes have failed because this aspect has not been considered. For instance for some now schemes, people from different places in the country have been resettled together. As their customs are different, there have been many quarrels. If people from the same place are re-established in one tract, such troubles do not arise. heft and criminal offences now occur because people from different places are resettled together. As these people have been farmers for generations, they should be given an agricultural training in modern methods. This will enable them to obtain greater productivity from their lands.

Population according to ages — Table 13 — Annex 9-7

Name of village	Families	Ages 0 - 5 M	Ages 0 - 5 F	Ages 6 - 10 M	Ages 6 - 10 F	Ages 11 - 15 M	Ages 11 - 15 F	Ages 16 - 25 M	Ages 16 - 25 F	Ages 26 - 35 M	Ages 26 - 35 F	Ages 36 - 45 M	Ages 36 - 45 F	Ages 46 - 55 M	Ages 46 - 55 F	over 55 M	over 55 F	Sub total M	Sub total F	Total
Inginimitiya	93	61	39	43	32	33	40	57	50	38	24	18	17	13	8	13	10	276	220	496
Katuwewa	48	3	6	7	7	12	6	13	13	7	3	3	6	5	4	4	4	54	49	103
Anniyatalla	7	3	1	2	4	3	2	4	5	5	4	1	0	2	1	1	0	21	17	38
Palugella	55	22	32	23	25	20	11	35	44	17	16	11	10	7	8	12	4	147	150	297
Ranorawewa	14	3	4	5	6	9	7	10	13	3	1	-	5	4	3	6	1	40	40	80
	187	92	82	30	74	77	66	119	125	70	48	33	38	31	24	36	19	538	476	1014

Schooling Population according to Grades — Table 14

	1 M	1 F	2 M	2 F	3 M	3 F	4 M	4 F	5 M	5 F	6 M	6 F	7 M	7 F	8 M	8 F	9 M	9 F	10 M	10 F	11 M	11 F	12 M	12 F	Higher grades M	Higher grades F	Sub M	Sub F	Total
Inginimitiya	3	2	8	6	4	2	-	1	3	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	19	32	32
Katuwewa	-	4	4	-	4	-	-	-	-	-	-	-	-	4	-	4	-	-	-	-	-	-	-	-	-	-	8	12	20
Andiyatalla	1	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Palugella	-	2	4	2	-	-	-	2	2	2	2	2	2	-	-	-	2	-	-	-	-	-	-	-	-	-	16	10	26
Ranorawewa	1	-	-	1	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			6

Schedule of uplands and its assessment

Table 15 Annex 9-8

Village	Private A R P	L.D.O. A R P	Leased A R P	Encreach A R P	Total No. of familes	Value of Permanent crops in Rs.	Value of private lands in Rs.
Inginimitiya	33-1-0	40-3-0	25-2-0	61-0-0	93	73962	33,250
Katowewa	28-2-0	35-0-0	Nil	1-3-0	18	14260	28,500
Andiyatalla	N i l	13-0-0	Nil	10-0-0	7	3600	
Palugella	30-0-0	28-2-0	11-0-0	45-0-0	55	54645	30,000
Ranorawewa	16-2-0	Nil	Nil	9-2-0	14	5430	16,500
					187		108,250

Schedule of paddy lands and its assessment

Table 16

Village	Private	L.D.O.	Lease	Encreach	Total	Private assessed
Inginimitiya	34-1-0	Nil	10-0-0	62-2-0		51375
Katuwewa	55-3-0	28-0-0	Nil	24-0-0		
Andiyatalla	31-0-0	5-0-0	Nil	7-0-0		
Palugella	102-0-0	4-0-0	Nil	40-0-0		
Ranorawewa	27-2-0	Nil	Nil	7-0-0		41250
Total : -	250-0-0	37-0-0	10-0-0	140-2-0		

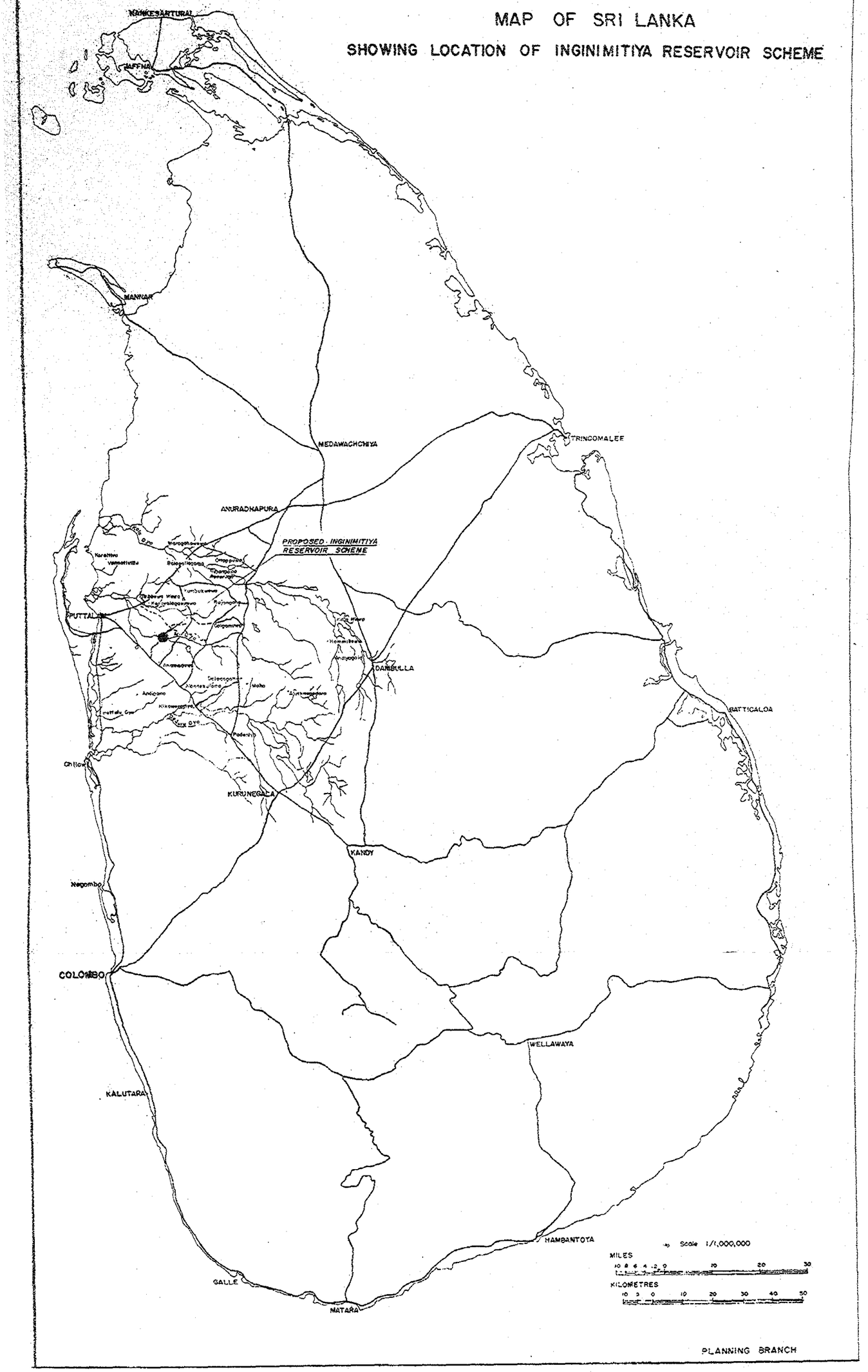
Schedule of residences and its assessments

Table 17

Village	Families	Buildings	Value of residences	Value per building
Inginimitiya	93	83	96,300	1,170
Katuwewa	18	18	126,500	7,050
Andiyatalla	7	6	3,050	507
Palugella	55	56	56,750	1,020
Ranorawewa	14	10	6,050	605
Total : -	187	173	288,650	1,680 per building

MAP OF SRI LANKA

SHOWING LOCATION OF INGINIMITIYA RESERVOIR SCHEME



NIKAWERATIYA - 97

PROPOSED INGINIMITIYA RESERVOIR

SCALE :- ONE MILE TO AN INCH

LEGEND

- Electoral District Boundary
- District Boundary
- D.R.O'S Division
- Minor Headmen's Division
- Proposed Reservoirs
- Proposed Channels
- Existing Channels
- Existing Tanks

Tabbowa Tank

To A'Pura

From Puttalam

RAJAWANNI

RAJAWANNI

Nanneri Oya

PATTUWA

PALATA

Mahamadawachchiya Wewa

PUTTALAM

KIRIMETIYA

Nanneri Oya

PATTUWA

Nawagattegama

Wembuwewa

Paligama Wewa

DISTRICT

PERAWILI

Galkulama Wewa

R. B. CHANNEL

Radawi Bendi Ela

Taraspodiya Wewa

Taraspodiya

EMERGENCY SPILL 800'

Kankadawala

EMEGENCY SPILL TAIL CHANNEL

Hingipattewa

Kadawala

PATTUWA

Mahauswewa

SPILL TAIL CHANNEL

Inginimitiya Wewa

Andivakadawala

Rambegama

Kachchimaduwa Tank

Kalawelagoda

Merungoda

PROPOSED CAUSEWAY

PROPOSED

Walpalawa

Uriya Wewa

KARAMBE

Mawattagama

2000' C.O. SPILL

R. B. SLUICE

INGINIMITIYA

RESERVOIR

Gallawa

KUMARAWAWI

L. B. CHANNEL

Maha Us Wewa

ROAD DEVIATION

Iswetiya

L. B. SLUICE

PALATA

PATTUWA

From Anamaduwa

PROPOSED INGINIMITIYA RESERVOIR

YAPAHUWA - 98

SCALE :- ONE MILE TO AN INCH

N

LEGEND

Electoral District Boundary	Proposed Reservoirs
District Boundary	Proposed Channels
D.R.O'S Division	Existing Channels
Minor Headmen's Division	Existing Tanks

Oya

Nawachchiya

KIRIMETIYA

PATTUWA

Nanneri Oya

GALGAMUWA

MIYEN EGODA

KURUNEGALA

KORALE

HATALISPAHA

To Anuradhapura

Nawagattegama

Weimbuwewa

Mahahonneriya Wewa

GALGAMUWA

WEST

DIVISION

R. B. CHANNEL

Taraspodiya Wewa

EMERGENCY SPILL 800'

ROAD DEVIATION

Kon Kadawala

EMEGENCY SPILL TAIL CHANNEL

Hinetipattewa

Kadawala

DISTRICT

Mahauswewa

SPILL TAIL CHANNEL

Inginimitiya Wewa

Andivakadawala

Rambegama

Merungoda

PROPOSED-CAUSEWAY

PROPOSED

MAHO

Waipalawa

2000' C.O. SPILL

R. B. SLUICE

INGINIMITIYA

GANTIHE

Mawattagama

RESERVOIR

Iswetiya

L. B. CHANNEL

Maha Us Wewa

ROAD DEVIATION

DIVISION

L. B. SLUICE

AMBANPOLA

KORALE

From Kurunegala

From Maho

PLANNING BRANCH

Prepared by Kahingala