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Ministry of Mahaweli Development

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Maduru Oya Project

Feasibility Report

Annex H
Forestry

ACRES Acres International Limited, Niagara Falls, Canada

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FOREWORD

The Feasibility Report on the Maduru Oya Project, of which this Annex forms a part, is made up as follows:

Main Report

Annex A - The Project Area

Annex B - Soils and Land Classification

Annex C - Hydrology and Water Balance

Annex D - Engineering Works

Annex E - Agronomic Studies

Annex F - Livestock

Annex G - Agroeconomic Studies

Annex H - Forestry

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SUMMARY

Approximately 66 700 ha or 54 percent of the project area is covered by some type of forest. The majority of the forested area (75 percent) is classed as medium forest with smaller areas classed as light forest (parkland) and plantation. Only 1,300 ha is classed as dense forest. The present forest land use in System B is summarized below

	ha	Percent of Total Forest
Dense forest	1 300	1.9
Medium forest	49 800	74.7
Light forest (parkland)	11 200	16.8
Plantation	4 400	6.6
Totals	66 700	100.0

The site of the Maduru Oya reservoir has little merchantable timber remaining as it has been subject to widespread chena farming. Thus most of its 6,100 ha can be cleared by hand and should be done before flooding. It may be necessary to remove a small section of teak plantation at the south end of the reservoir.

A minimum of 1 100 ha of the former Korale Forest Reserve lying north of the highway in the Punanai area can be retained with the development of System B. This area was badly damaged by the November 1978 cyclone and all merchantable timber from the teak and eucalyptus plantations is presently being removed.

It is estimated that approximately 34 000 ha or about 50 percent of the present forest cover will need to be cleared in preparation for agriculture development in System B. The timing of the clearing will be closely related to the construction of the irrigation system.

The project will bring about the systematic harvesting of much of the existing forest resource in the area. If left under present conditions, it is likely that much of the remaining forest would be degraded by chena cultivators who are active on about 25 percent of the project area. It is therefore appropriate to claim economic benefits for the project from the forest areas to be cleared.

There will be considerable demand for fuel wood in the project area, as each family will require the equivalent of 125 ft^3 of firewood each year. To ensure the future availability of fuel wood as well as other forest products, reforestation is proposed. Such reforestation would be of the plantation type, supplemented by the introduction of better utilization methods for parkland areas, and selected plantings on canal banks and in settlement areas. The active participation of the settler/farmer in the reforestation program will be essential.

Only the dense and medium forest and plantation areas will yield commercial volumes of forest products when cleared. The major forest products resulting from clearing an estimated 28 000 ha of forest in these categories are sawlogs, posts and poles, and fuel wood. Estimated yields and total quantities are summarized below.

Commercial timber	(172 ft^3/ha)*	4.8 million ft^3
Poles and posts	(200/ha each 8 ft)	5.6 million items
Firewood	(500 ft^3/ha)	14.1 ft^3

*Weighted average yield from dense and medium forest and plantation areas.

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Commercial timber is valued at Rs 4/ft^3 and thus the area to be cleared would represent a benefit of Rs 19.4 million. Poles and posts are valued at Rs 3 each for a total benefit of Rs 16.9 million. Firewood, valued at Rs 0.30/ft^3, provides a benefit of Rs 4.1 million. All forest product benefits are based on "on stump" values.

In the construction cost estimates for the irrigation system, allowance is made for the full cost of forest clearing. However, once the merchantable timber has been harvested, it is considered that the actual cost of land clearing and grubbing will be lower than that which was allowed in the development of the irrigation system costs. A reduction of Rs 500/ha in clearing costs has therefore been taken as a forestry benefit.

Total forestry benefits are summarized as follows.

	Million Rupees
Commercial timber	19.4
Poles and posts	16.9
Firewood	4.2
Reduction in clearing costs	8.2
Total	48.7

The forestry benefits are spread over 5 and 8 years for Scenarios A and B respectively.

It is desirable that dual purpose plantations be considered for development in System B, as both sawlogs and fuel wood will be required by the settlers. However, only the fuel

wood option is considered in the economic analysis. To meet the needs of the farm families, 1 560 ha of plantation must be harvested annually. Based on a 7-year rotation, a total area of 11,000 ha is required. These plantations should be established as quickly as possible. The reforestation cash flow is based on the annual harvesting of 1 560 ha beginning in Project year 9 and continuing to the end of the project analysis period.

1 - INTRODUCTION

The project area contains forest areas which should not be cleared for agriculture without careful consideration of the consequences to both System B and the Mahaweli Region.

The present land use within System B can be summarized as follows (see Annex A):

	ha
Forest - including plantations	66 700
Paddy lands	13 700
Chena	32 800
Tanks, standing water	3 200
Rock	3 900
Settlements, homesteads, large farms	3 500
Total	123 800

At present, approximately 54 percent of the project area is covered by some type of forest. Figure H-1 shows the distribution of three main forest types and forest plantations.

1.1 - Study Objectives

Considering the overall objectives of the Maduru Oya Feasibility Study, the objectives of this annex are

- to recommend uses for the forest lands in the immediate and longer term

- to indicate volumes and values of wood products to be recovered during clearing of the lands for other uses

- to recommend logging and land-clearing methods and expected costs

- to investigate reforestation aspects.

1.2 - Relationship of the Forest to the Project Area

It could be argued that, in the best interest of Sri Lanka, the project area, and other areas of similar size, should be retained as areas of major forests, inhabited by few people. The forest could then be "farmed" as a permanent source of renewable energy and building materials.

The objective for System B is, however, to settle the maximum number of people that the area can support, in an "acceptable" environment.

The proposed development is not feasible without drastically reducing the forested area. However, in the best interests of present inhabitants and future settlers, the forest to be removed, left, replaced or improved, and the timing of forest-related activities, must be carefully planned.

The satisfactory long-term land use of the overall area requires the management of the forest to provide the following for the projected number of inhabitants

- fuel
- building materials
- protection from sun, wind, and rain
- food and habitat for animals
- prevention of erosion
- retention of moisture.

Because it is not possible to build dams and canals, roads, villages and towns, and create reservoirs and fields for cultivation without removing forest cover, pure forestry considerations must be subordinated in the interest of overall project objectives; however, they must not be ignored or assigned an unrealistically low priority.

1.3 - Methods of Study

The following study methods formed part of the preparation of this annex.

- Study of 1979 aerial photos of the area and preparation of maps to be used as a base for observations in the field.

- Field study of all possible forest areas accessible by road or trail, using 4-wheel drive vehicles. This was complemented by on-foot travel in otherwise inaccessible areas, including the Maduru Oya reservoir area. A total of one month of field time was expended.

- Prior experience in the Sri Lanka forestry and logging sectors included:

  - an examination of part of the forest resource in Systems B and C during a 1979 study for the National Paper Corporation

  - 2-1/2 yr of field experience in local forest engineering, construction and logging in connection with the Singharaja mechanized logging project.

- Discussion with officials and other individuals included:

Forest Department

Mr. Ratnarajah	- Senior Assistant Conservator
Mr. Vivekanda	- Senior Assistant Conservator Forest Research
Mr. Sahajanathan	- DFO Batticaloa

State Timber Corporation

Mr. Kenneth Abeywickrema	- Chairman
Mr. Ranatunge	- General Manager
Mr. Henry Perera	- Operations Manager
Mr. Karunatileke	- Area Manager and Manager of the Mechanized Logging Unit
Mr. S. Liyanage	- Log sales) S.T.C. Minneriya
Mr. G. K. G. Somaratne	-) Sawmill Officials

Livestock Development Board

Mr. J. P. Perera	- General Manager
Mr. Arumugam	- Deputy General Manager for Dry Zone

Cashew Corporation

Mr. Percy Udalagama	- General Manager

Ceylon Institute of Scientific and Industrial Reserach - CISIR

Mr. Saldin	- Extension Director
Dr. Dhamika De Silva	- Charcoal Research Project

Heavy Equipment Contractors, Renters and Sales Personnel

- Haneda Express
- Mr. E. A. Perera
  Managing Director
- United Tractors
- Sales and Service Officials

Fuel wood Merchants in Colombo and Punanai Area

Brick Makers in Polonnaruwa and Punanai Area

2 - GENERAL DESCRIPTION OF FORESTS

The forests of the System B area appear to have been heavily exploited in one manner or another over a long period. Evidence of ancient settlements is found throughout the area in the form of abandoned bunds and tanks and ruins. More recent selective commercial logging has depleted most of the area of railway sleepers and timber logs.

There has also been widespread exploitation for building materials and fuel by the local population. Chena cultivation has left significant scars on the forest.

The original relatively lush Dry Zone forest has therefore turned into badly degenerated scrub jungle, characterized by scattered, short, limby, mature trees of many species, with an understory of shrubs and pole-sized material.

Large parkland areas have developed partly as a result of soil and moisture conditions in addition to the continual use by human and animal populations for chena cultivation and pasturing of animals. Existing forest inventory records for System B are out of date. The actual volumes of wood and forested areas are changing continuously as exploitation (mainly chena clearing) continues.

Forested areas and types were identified from interpretation of the Hunting Technical Surveys 1979 air-photo coverage of the project area. Recoverable volumes were estimated through an approach involving a combination of air-photo interpretation and field examination.

Invariably, the nearer a forest is to an existing settlement, the more timber that has been and is being removed. Forest management has been limited to replanting of clear-cut chena lands.

Table H-2.1 shows the present forest land use in System B by dense, medium and light forest types. About 75 percent of the forested area is characterized as medium forest and less than 20 percent as light forest. Dense forest cover where commercial logging would be feasible accounts for less than 2 percent of the total forested area.

TABLE H-2.1

PRESENT FOREST LAND USE IN SYSTEM B

	Area in ha			Percent of	
	Left Bank	Right Bank	Total	Total Forest	Total System B
Type I					
Dense forest	1 000	300	1 300	1.9	1.1
Type II					
Medium forest	31 800	18 000	49 800	74.7	40.2
Type III					
Light forest (parkland)	9 200	2 000	11 200	16.8	9.0
Plantation	4 200	200	4 400	6.6	3.6
Totals	46 200	20 500	66 700	100.0	53.9

Source: Annex A

Note: Forest classes are based on total number of larger trees (i.e. crowns showing on aerial photographs), including nonmerchantable species such as Wira and other decadent and poorly formed trees not considered suitable for sawlogs; class is based on density, not on commercial value. Consequently a Type II area could contain more sawlog material than a Type I area which has been logged.

3 - FOREST CATEGORIES

Before proceeding to categorize the forest or recommend any specific treatment, including retention of forest cover, it will be useful to emphasize the fuel wood (firewood) requirements of the proposed inhabitants.

Average family firewood consumption is estimated at 124 ft^3/year. Since combustible material is available from crop residues, firewood can also be obtained from the homestead plot and from other forested areas, and there will be some limited kerosene use, only a part of the family firewood requirement need come from plantations. Assuming that 30 percent is obtained from alternate sources, the estimated 36 000 farm families would require 3.1 million ft^3 of fuel wood per year. On the basis of a 7-year rotation period, about 11 000 ha of fuel wood plantation are required. (Details are provided in Appendix H-1). Because the establishment of these plantations will take time and their output will require supplementation, it is important that the existing forest resource be utilized to the maximum extent possible.

Considering the above, the following categories of forest were developed.

- Special Treatment Areas
  - Archaeological Reserves
  - The Maduru Oya Reservoir
  - The Forest Reserve

- Areas to be Cleared Relatively Quickly

- Areas to be Managed or Cleared Later

- Areas to Remain in Forest Indefinitely.

3.1 - Special Treatment Areas

3.1.1 - Archaeological Reserves

The area on the left bank of the Maduru Oya immediately below the damsite and the area surrounding Nelugala in the Right Bank area are known archaeological sites. Both have been designated as Archaeological Reserves and presumably the protection afforded by the designation includes the forest. Leaving the sites undisturbed should present no problem as they do not conflict with irrigation or other potential land uses.

3.1.2 - The Maduru Oya Reservoir

The damsite has already been cleared and a construction camp established. The reservoir area should be cleared before flooding. It would appear logical to discourage immediately all chena cultivation within the area. The chena farmers could form the labor force to clear the reservoir area.

The area to be flooded has been subject to widespread chena farming in the recent past and little merchantable timber remains to be logged. Only some scattered patches of mature forest remain. Consequently, most of the 6,100 ha to be flooded would be suitable for hand clearing. If, however, stumps are to be cleared from the area*, it will be necessary to employ bulldozers.

*The commercial fishing proposal for the reservoir does not require that the area be stumped, although trees should be cut as close to the ground as is practicable.

During low water periods the riverbed presents an excellent route for skidding trees adjacent to the river, including the large Kumbuks overhanging the banks.

A small section of teak plantation may be within the area to be flooded, at the south end of the reservoir. These 4-in. to 8-in. diameter trees, up to 40-ft tall, should be removed if final demarcation of the flood area shows that an appreciable number will be flooded. Hauling appears easiest to the highway in the Pallegama Gallodai area.

3.1.3 - The Forest Reserve

A minimum of 1 100 ha of the former Korale Forest Reserve lying north of the highway in the Punanai area can be retained with the development of System B. All merchantable timber is presently being removed from the old reserve, including the teak and eucalyptus plantations which were badly damaged by the November 1978 cyclone.

The bamboo plantations are of no consequence and should be cleared when convenient. Planted experimentally as a source of long fiber material for the Valaichchenai pulp mill, they have not been successful, primarily due to damage from elephant feeding and from fire. Moreover, the paper mill is presently not equipped to use this material as furnish, and there is no interest in continuing the experiment

The area which is retained as a forest reserve s[illegible] be converted to species suitable as either fuel wood c[illegible] pulpwood to be supplied to the Valaichchenai mill if requ[illegible] The Forest Department plans to plant dual-purpose Eucalyptus Camaldulensis and Casuarina, and fast-growing fuel species. Eucalyptus Tetrigonis, a new hybrid which can have a less poisonous effect on soil, is also being considered.

The exact boundaries and area of the remaining forest reserve are yet to be determined within the context of the project's agricultural land requirements.

3.2 - Areas to be Cleared Relatively Quickly

There will be approximately 34 000 ha* to be cleared of forest in preparation for agricultural production in System B. This estimate includes homestead areas and social intrastructure areas. The timing of the clearing is closely related to the construction of the irrigation system although the homestead areas will be cleared by the farmers according to their own timetable.

The volumes to be recovered represent the immediate benefits, depending upon wood volume, species, quality, accessibility and marketability. In the following section clearing considerations are outlined.

3.3 - Areas to be Managed or Cleared Later

Because of the large area required to be logged and cleared for irrigation, it is advisable to delay the exploitation of all areas not specifically required for agricultural

*This estimate includes Forest Types 1, 2 and 3 and plantation areas as follows:

Type 1	- 700 ha
Type 2	- 24 600 ha
Type 3	- 5,500 ha
Plantation	- 2,900 ha

production or irrigation system infrastructure. It is recommended that all land above gravity command be excluded from initial clearing.

The benefits of this approach will be

- to provide an opportunity to assess more accurately needs for either clearing or retaining these forests

- to extend the period available to the State Timber Corporation for removal of merchantable logs and consequently extend the period during which logs will be available for sawmilling; this will help to avoid any short-term oversupply

- to allow for the allocation of forested homesteads to settlers, for management or partial clearing by them, depending on the forest resource and settler requirements for building materials and fuel wood. (Roughly 70 to 100 poles and an equal number of smaller battens are needed for each settler home.)

3.4 - Areas to Remain in Forest Indefinitely

Forested areas should still be an important component of the System B area after it has been developed for irrigated agriculture. Areas that should remain under forest cover should be identified during the detailed land-use planning for this area. This section will make a number of suggestions as to the types and locations of permanent forested areas.

The Man and Biosphere Ecological Reserve in the Right Bank area should not be disturbed, at least not until it has served its purpose or has succumbed to population pressure and has lost its value for study.

Sun, wind and erosion protection belts will be needed. The climate of the area makes it imperative to leave areas of forest purely for the protection of the quality of life for man and animal alike.

The searing southwest wind, often blowing day and night during the Yala season, can never be completely checked. However, any forested belt or area will help to reduce the wind velocity, reduce the temperature and increase the humidity of the air passing through it; thus it will reduce moisture loss from fields. Studies indicate that forest windbreaks effectively decrease wind velocity over a horizontal distance at least ten times the height of the trees.

Shade from the direct sun during the middle part of the day is vital for man and livestock; usually it is best provided by trees, either scattered or in blocks.

During the heavy seasonal rains, animals and humans need protection from the direct force of the rainfall, often only available under trees. Similarly, the erosion sensitive soil on slopes of more than 4 percent must be protected to avoid serious damage. The crown cover of a forest is generally the most satisfactory protection.

Protective forest belts also serve the more obvious purpose of supplying part of the enormous fuel wood requirement of the projected population.

Recommended locations for such multipurpose forests (protection, fuel and local building materials, and wildlife habitat) include

- the area along the east bank of the Hungamala Ela (and possibly also the west bank area within System C). This is the western boundary of System B in the Left Bank sector (Sector 1) south of the railroad. A 1-mile wide belt is recommended for this presently unpopulated forest area (one half mile on either side of the stream). It is a favored habitat for elephant, deer and other wildlife.

- the degraded parkland area to the east and south of Gunner's Quoin (Dimbulagala) should be reforested to provide fuel wood reserves and to reverse the process of fertility loss imposed by past chena activity.

- the area along the east bank of the Maduru Oya. The west bank has previously been completely cleared for settlement under the Pimburettewa Scheme. A belt of one half mile minimum width* but preferably 1-mile width should be given consideration; it covers a forest area without population at present. Furthermore, a forest strip of 200 to 300 m in width should be planted on the denuded west bank. These belts would be important to present and new west bank settlers and new east bank settlers. They would also provide important habitat for major wildlife.

- minor forest belts should be left along smaller streams (possibly 300 m in width) to provide benefits to the settlers, and provide soil stabilization.

*Upland type levee soils occupy a strip about one-half mile wide along the Maduru Oya south of Welikanda. These soils have been considered to be outside the irrigable area for purposes of calculating agricultural benefits, and would be suitable for river bank forest reserves.

- areas unsuited for paddy, upland agriculture, or settlement should be left in forest. No forested area should be cleared until it has been established that the area in question is specifically required for a different land use. This will be determined during detailed land-use planning in System B.

- areas upstream from existing minor tanks should be left in forest. Such areas of forest are essential to preserve the wildlife (particularly birds) which presently coexists with the local human and domestic animal population. The wildlife scene at a jungle tank must be viewed to be fully appreciated. The necessity of preserving certain forests to enable wildlife to survive and adapt is emphasized in the environmental annex. (See Annex J.)

- where suitable, the ribbon of land between Highway A-11 and the railway, from Manampitiya to Valaichchenai, should be retained for windbreak and fuel wood purposes.

All the above-mentioned forests can and should in future be upgraded (managed) by planting species appropriate to existing conditions and requirements. The local population should be actively involved in forest management activities, since their actions will in large part determine the success of forest management plans.

4 - FOREST CLEARING CONSIDERATIONS

The most important factor influencing the choice of land-clearing methods is timing. The choice is between maximum speed, and maximum employment and wood recovery.

The more time that is available, the more feasible it will be to use traditional labor-intensive clearing methods for the clearing of individual farm holdings and home sites.

Personal involvement of the settlers in clearing their own farms and homesteads should improve morale. The recovery of posts, poles and other building materials would also be increased. However, the disadvantage of using settlers as a clearing force for agricultural land is also a matter of timing: the settler could undergo hardship of one kind or another if he is brought in a number of seasons before actual agricultural production activities can commence. The use of settlers for clearing homestead areas may be more consistent with settlement objectives.

When large agricultural areas are to be cleared by machine, guidelines as to the precise areas to be logged and cleared must be indicated. Clearing maps would show which areas to be left, such as

- areas above command elevation
- major belts along main streams
- narrower belts along minor streams
- rocky areas
- reserve areas (archaeological, ecological, etc).

In many instances, a combination of labor-intensive traditional methods and large-scale mechanized clearing methods can be employed. In the areas to receive irrigation water earliest more mechanized clearing may be required, particularly as many of these areas are also thinly populated. Near existing settlements, it should be possible to use traditional methods since the forest is generally lighter and easier to clear and the labor force is already available and can supply its own tools, food and accommodation. Labor-intensive methods would also be more feasible in areas to receive irrigation water during the later stages of the development, since a larger labor force would then live in the project area.

The role of government agencies such as the State Timber Corporation (STC) and the Forest Department must be considered carefully. Presumably all commercial logging will be arranged and supervised by STC under direction from the Mahaweli Authority to control the timing, sequence and limits (boundaries) of logging. The responsibility for fuel wood recovery could also rest with STC, although it might be worthwhile to establish more local control over the production and utilization of fuel wood (and building materials). Similarly, the production and sale of charcoal, presently under the control of STC, could perhaps be handled by local organizations and groups.

The Forest Department would be a suitable agency to handle the local organization of fuel wood and building material recovery. It could organize village groups and small contractors to participate in recovery operations. The Department is interested in increased recovery per unit area, since it is involved in planning for the provision of the fuel wood requirements of the settlers.

5 - COST OF FOREST CLEARING

5.1 - Clearing of Forest Types I and II

These forest types include brush plus approximately 20 trees/ha in the 12 to 18-in. diameter range.

Mechanical clearing involves about 15 hours of bulldozer and labor time, including ripping and cross ripping. At an hourly cost of Rs 600, this comes to Rs 9,000/ha.* Appendix II shows details of the bulldozer operating costs.

For comparison, in 1978 the Livestock Development Board cleared the Welikanda farm, under contract, for about Rs 7,000/ha. This included clearing, burning, ripping, cross ripping and rough leveling.

Also in 1978, the Cashew Corporation paid the STC Rs 6,875/ha for similarly clearing land in the Welikanda area. STC officials estimate that the current (late 1979) cost would be about Rs 8,750/ha.

A combination of mechanical and hand clearing is estimated as follows

Slashing and piling bush by hand	Rs 1,000/ha
Bulldozer - 11.25 h at Rs 600/h	6,750/ha
Total (including ripping and cross ripping)	Rs 7,750/ha

*Clearing Type III forests would cost about 20 percent less.

5.2 - Clearing of Brush

The clearing of brush areas (no large trees) or regrown chena areas is estimated to cost Rs 3,750/ha, assuming a mechanical approach and no ripping. It would involve 6.25 hours of bulldozer time at Rs 600/hour.

Hand clearing of brush areas is estimated to require 37.5 man-days at Rs 30 per all-inclusive man-day, for a cost/ha of Rs 1 125.

For comparison, the Livestock Development Board cleared areas near Welikanda using hand clearing methods for Rs 875/ha in 1978. All trees exceeding 8 in. diameter were left standing as shade trees in the pasture land.

5.3 - Logging Aspects

Rubber-tired "timberjack" type skidders will probably do the bulk of the logging. However, some contract loggers will use rubber-tired farm tractors, oxen or elephants.

Mechanical logging would be a satisfactory method because most roads will have been built for survey access and canal construction; the ground is relatively flat and firm during the 7-month logging season; the rate of production is important; and food and water for oxen and elephants would be scarce during the dry season in some areas.

Actual cost figures are not available for the STC mechanized logging operation. However, Table H-5.1 shows the estimated logging costs per ft^3 for three levels of productivity. Delivered cost of logs in the System B area is estimated at 9 to 14 Rs/ft^3.

TABLE H-5.1

ESTIMATED LOGGING COSTS FOR SYSTEM B
(Rs/ft^3 for logs delivered to Manampitiya)

	Manual Contract	With Skidders High Productivity	With Skidders Low Productivity
Felling	4.75	0.17	0.20
Skidding*	-	3.75	5.78
Loading	0.75	0.35	0.75
Road construction**	0.20	0.10	0.40
Hauling (Rs 0.06/ft^3/mi)	1.30	1.30	1.30
Subtotal	7.00	5.67	8.43
STC overhead at 50 percent	3.50	2.83	4.22
Royalty and BTT at 12 percent	0.84	0.68	1.01
Totals	11.34	9.18	13.66

* Skidding distance up to 400 m to roadside; skidder productivity assumed at 360 and 540 ft^3/d, for single and multiple chokers.

**Additional roads only; most haul roads would be constructed for purposes other than logging.

6 - ESTIMATES OF RECOVERABLE FOREST RESOURCES

The forest to be cleared will yield large quantities of usable wood of widely varying values. Most production will come from the less valuable species and products. Some of the more numerous merchantable species will be Palu, Godakirilla, Mora, Halmilla, Mayila, Walang and Madan. Wira, the major species, can be used only for fuel and charcoal. A complete list of Dry Zone species is given in Appendix III.

The major forest products resulting from clearing an estimated 34 000 ha will be sawlogs, posts and poles, and fuel wood. The estimates of recoverable quantities reflect judgement as to whether sufficient quantities will be available to justify a recovery operation. Thus, for example, although the light forest (Type III) areas have a certain amount of forest cover, no commercial timber, posts and poles, and firewood yields from these areas are included in the estimates as quantities are small, and may not justify commercial recovery operations. Type III forest is estimated to cover about 5,700 ha of the 35 000 ha of forest area to be cleared.

6.1 - Sawlogs

The STC intends to recover sawlogs to a minimum girth of 2 ft and a minimum length of 6 ft for the more valuable species such as Halmilla. For less valuable species, such as Palu, the girth and length minimum standards will be higher, to make recovery economical.

Because most of the volume logged in System B in past years has been of the more valuable species, the logs left to be removed will generally be of the less valuable species such as Palu, Godakirilla and Mora.

The estimated volume of sawlogs that can be harvested from forests varies from 90 ft^3/ha in plantation areas to 215 ft^3/ha in dense (Type I) forest areas. The medium (Type II) forest areas which account for the majority of the area to be cleared are expected to yield 180 ft^3/ha. The total volume of commercial timber from all areas is estimated to be 4.8 million ft^3.

The average delivered price of logs at the proposed sawmill site at Manampitiya is estimated at Rs 11.50/ft^3.

Selling prices of logs and sawn timber at STC facilities are indicated in Table H-6.1. Using the selling price of Rs 16/ft^3 for logs of girth under 4 ft, which will apply to most timber to be recovered in System B, leaves a net "on stump" value of the commercial timber of Rs 4.5/ft^3. A price of Rs 4/ft^3 can be conservatively used for calculating benefits.

6.2 - Posts and Poles

Construction of the farm settler's "mud and wattle" house will require an average of some 80 poles and posts, plus an equal or greater number of thinner battens.

Construction of 36 000 "mud and wattle" houses* would therefore require some 2.9 million poles and posts and 2.9 million battens.

*The balance of required houses would be constructed with other building materials; these would be the houses of the nonfarm population for the most part.

TABLE H-6.1

PRICES OF LOGS AND SAWN TIMBER*

	Selling Price in Rs/ft^3			
	As Logs		As Sawn Lumber	
	<4-ft Girth	>4-ft Girth	<18 ft Length	>18 ft Length
Above average quality	25	27	66	76
Average quality	16	17	48	56
Below average quality	10	11	22	38

*Selling prices quoted by STC at Minneriya mill and log yard, September 1979.

It is estimated that each hectare of forest to be cleared ultimately would yield some 200 posts, poles and battens, of 8-ft average length. The forest area which will yield posts and poles is estimated at about 28,000 ha, producing 5.6 million items. This would provide sufficient posts, poles and battens to meet the demand for residential building materials of this type.

On forest covered homestead areas of 0.4 ha, the settler would find sufficient material to assist in the construction of his basic shelter. For other forested areas to be cleared, it will be important to salvage and stockpile poles and posts, so that the need for these materials by settlers building on unforested homesteads can be met. Bringing similar materials from outside System B would be unnecessarily costly.

The cost of salvaging a pole has been estimated at Rs 1.60/pole, and is shown in detail in Table H-6.2. If the value of the pole as building material is taken as Rs 5, then a conservative "on stump" value of Rs 3/pole can be assigned.

6.3 - Fuel Wood

Material not suitable for sawlogs or building materials constitutes the fuel wood portion of the forest stands. It includes all species, sizes and qualities of wood, including sawlog rejects and tree tops.

TABLE H-6.2

ESTIMATED COST OF POSTS AND POLES IN SYSTEM B
(each about 8 ft in length, containing 0.65 ft^3 of solid wood)

Average contract price to roadside*	Rs 0.60 each
Loading and unloading	0.10
	Rs 0.70
Overhead and supervision 50 percent	0.35
Estimated royalty	0.05
Cost of pole before transport	Rs 1.10
Transport, assuming 10 miles	0.50
Total cost per pole at depot	Rs 1.60
Total cost per linear foot	Rs 0.20

Note: Estimated Colombo purchase price of a pole would be about Rs 8 or Rs 1/lin ft.

*Assuming production per man-day of 30 poles, at daily rate of Rs 18.

Whether wood will be used as pole or fuel will depend upon the demand for these specific products, timing and supervision of the land clearing; poles could instantly become fuel if the bulldozer reaches the tree before the pole cutter.

The estimated potentially recoverable volume of fuel wood from the 28 000 ha* to be cleared is 500 ft^3/ha or 14.1 million ft^3 in total. This is after sawlogs and posts have been salvaged.

The fuel wood to be cleared from the area is sufficient to meet the energy needs of 110 000 family-years, on the basis that the estimated fuel wood equivalent consumption/family/yr is 124 ft^3.

Assuming that more than 36 000 farm families in System B are dependent on fuel wood, the quantities salvaged from the areas to be cleared would be adequate to meet their needs for 3 to 4 yr at full development. Considering that initially there will be fewer families, the fuel wood needs of the earlier settlers will be met for a longer period; however, when the last settlers come into the area, the salvaged supply of fuel wood may already have diminished to the point where other sources would have to be exploited. Thus early implementation of the reforestation proposals discussed in Section 8 will be an important factor in ensuring adequate fuel supplies in future for the area.

*Very little fuel wood can be extracted from the Type III forest areas.

Organizing clearing in such a way that the settler will have the exclusive use of the forest resource on his allocated homestead would satisfy the needs for some settlers for an extended period, while settlers on unforested homesteads would have to rely on fuel wood from other areas.

After all fuel wood that has been salvaged as a result of clearing has been utilized, other sources will have to be tapped. These include areas that are to remain in forest; such areas, if managed correctly, can be an ongoing source of fuel wood. Privately and publicly reforested areas would also, in time, provide an ongoing supply of fuel wood.

Table H-6.3 shows the estimated cost of recovering fuel wood in System B at Rs 0.02/lb. This low cost per pound is the result of the economies afforded by a major and well-organized clearing operation. This cost does not include splitting and transportation from the roadside to the ultimate user. Such costs could be considerable.

There are wide variations in fuel wood prices in Sri Lanka. These differences reflect varying transportation costs, relative scarcity in the area, etc. Firewood sells for prices ranging from Rs 1.50 to Rs 12.50/ft^3.* Prices at the upper end of this range are equal to or greater than kerosene equivalent fuel wood values. (About Rs 9/10 ft^3).

It has been estimated that the economic hauling distance for fuel wood salvaged in System B is in the order of 80 miles. However, this consideration may be of minor importance as this wood would best be used by residents of the System B area.

*On the highway near Welikanda split dry wood in 1.5 ft lengths sold in 1979 for Rs 0.25/lb (Rs 12/ft^3). In Colombo, split wet rubber wood in 1.5 ft lengths sold in 1979 for Rs 0.13/lb (Rs 6/ft^3).

TABLE H-6.3

ESTIMATED COST OF FUEL WOOD RECOVERY

Average contract price to roadside*	Rs 0.43/ft^3
Loading and unloading	0.15
	Rs 0.58
Overhead and supervision 50 percent	0.29
Estimated royalty	0.10
Total cost before trucking	Rs 0.97/ft^3
	(or Rs 0.02/lb)

*Stacked, unsplit wood cut to 3-ft length; Rs 8.50/yd^3 containing approximately 20 ft^3.

It will only be a matter of time before fuel wood prices across Sri Lanka increase substantially as sources of supply diminish and demand grows due to population growth and the cost of alternative energy. For this reason the salvagable fuel wood supply of System B should be treated as a scarce resource, even though the development rate of the area may create surpluses in the short term.

Although much of the merchantable timber, posts and poles, and firewood will be removed beforehand, a policy that would prohibit the burning of any wood during the land clearing and grubbing process should be seriously considered.

6.4 - Values of Wood Recovered

The value of the existing forest resource in System B is considered on an "on stump" basis, i.e. the cost of recovering the materials (which has yet to be incurred) is reflected in the estimates and reflect current (1979) values for natural forest areas. These are summarized as follows:

Commercial Timber	- Rs 4/ft^3
Poles and Posts	- Rs 3/each (8-ft length)
Firewood	- Rs 0.30/ft^3*

*This "on stump" value reflects the lower end of the range of fuel wood prices discussed in Section 6.3 (i.e. about Rs 1.50/ft^3).

7 - USES OF FUEL WOOD

The greatest demand for fuel wood will come from settler households, who will require fuel wood mostly for cooking fires. It is estimated in Appendix H-1 that the annual requirements of the System B farm population could ultimately be in excess of 3 million ft^3. There are, however, other uses that could potentially increase the demand for fuel wood. Three other uses are discussed.

7.1 - Building Brick Manufacture

Brick and mortar construction is a standard building method in Sri Lanka. Huge quantities of fired clay bricks are manufactured in many parts of the country wherever clay soil and fuel are available, including in System B. Consequently brick manufacture will be of prime importance as a local industry within System B, as the demand for bricks keeps pace with the development.

The traditional method of brick manufacture requires the burning of approximately 40 ft^3 of solid wood fuel per thousand bricks. At present bricks are being made near Manampitiya, Welikanda, Punanai and the Maduru Oya damsite.

Until the reservoir fills, it would be logical to encourage nearby brick manufacturers to use clay and fuel from within the reservoir area.

7.2 - Fish Curing

According to Fisheries Department officials at Polonnaruwa, considerable volumes of fuel wood are used to smoke fish caught by inland fishermen. Usually the wood is taken from the nearest forest--often without permission of the Forest Department.

7.3 - Tobacco Curing

Tobacco is being grown in considerable quantities along the Mahaweli Ganga inside and adjacent to System B. This crop will probably increase in future and if it is to be flue-cured, would require large quantities of fuel wood.

During the curing of green leaf, moisture, representing approximately 88 percent of the total weight, must be removed. The process requires 1 lb. of fuel wood for each pound of green leaf.

The tobacco growers near Kandy are constantly short of fuel wood to cure their crops. The Ceylon Tobacco Company is currently experimenting with large scale manufacture of briquettes made from paddy husk, in an attempt to meet fuel requirements. The Ceylon Tobacco Company could, therefore, be a potential customer for some of the fuel wood to be harvested in System B during the next few years.

7.4 - Disposal of Fuel Wood

Fuel wood from land scheduled for clearing will be available before the majority of the settlers arrive. It will be necessary to plan for the use or disposal of this supply of wood. Three aspects are considered here.

Shipments Out of the Area

Shipment of supplies of fuel wood to industrial markets within economic haul distance, or shipment to residential consumers in the fuel-short upcountry areas, perhaps on a subsidized basis, could be considered. Transportation by railway from Manampitiya or Welikanda could also be considered.

Stockpiling

In the System B climate it is possible to store fuel wood in the open for a minimum of 2 yr without serious loss from decay, if spraying is applied to protect supplies from termites. Modest costs of carrying a fuel wood inventory could be justified considering anticipated price increases.

Charcoal

An attractive method of appreciably increasing the economic shipping distance of wood is by on-site conversion into charcoal. This is discussed in detail below.

7.5 - Charcoal Production

The STC is producing charcoal at Yakkure in System C and is gradually gaining experience and increasing production volumes.

Brick-lined pits, approximately 8.5 ft in diameter and 9 ft deep, convert some 350 ft^3 of solid wood (18 000 lb) into 2 000 lb of charcoal. The system is relatively inefficient--producing only 10 to 15 lb of charcoal per 100 lb of wood--but it is simple and practical considering the readily available supply of wood. Improved kilns are expected to increase efficiency to 25 percent.

The favorite species for charcoal production seems to be Wira, a tree unsuitable for sawlogs because of the poor form of its trunk. However, all species can be successfully converted into charcoal provided one does not mix species in the kiln for any one firing.

Fuel wood cutters, working as subcontractors for the charcoal contractors, are paid Rs 8.50 per stacked cubic yard of wood at roadside--equivalent to Rs 0.43/ft^3 of solid wood. STC officials estimate the cost of 1 lb of charcoal delivered to Colombo at Rs 0.75. The planned selling price in 5-lb bags is Rs 1.00/lb.

Above-ground kilns (not the present pit type) are to be built in the near future to a design by the Ceylon Institute of Scientific and Industrial Research (CISIR). Basically these kilns are an enlarged version of the successful CISIR design for coconut-shell charcoal manufacture; they will have several advantages, including

- an extended production season by eliminating the flooding of the pits, which is presently a problem during the rainy season

- greater yield of charcoal per pound of wood consumed

- easier discharge of charcoal through a base opening.

Under the present system, all charcoal is extracted from the pits by workers, usually girls, who suffer extreme discomfort and serious risk of lung disease from the charcoal dust. Doctors consulted warn of the serious risk of bronchitis and emphysema. They recommend immediate use of a simple surgical type of gauze mask, 6 to 8 layers thick, by workers exposed to the dust.

Wood and charcoal, being renewable, locally available resources, have obvious advantages over kerosene, produced from expensive imported petroleum. Charcoal also has the following further advantages over wood

- it is cheaper to transport

- it has twice the heat value of wood: usable heat value is four to five times greater than wood

- it is clean burning: its smokeless and sootless nature makes it excellent for high density areas

- it stores easily

- it keeps indefinitely, free from rot and insects.

The CISIR have conducted extensive research and experiments into household use of charcoal for fuel. Some of their preliminary reports indicate

- the chosen design of a simple, compact, portable burner made of fired clay will cost approximately Rs 15

- the efficiency of the burner (chosen from several experimental designs) will be approximately 30 percent, compared to 10 percent for normal, "three-rock" wood burners and 35 percent for kerosene cookers

- a simple comparison of calorific values of wood, charcoal and kerosene is of little value because of varying efficiencies of burners

- in actual household cooking 1 lb of charcoal is equivalent to 4.6 lb of wood

- the fuel cost to cook a meal for a family of four (consisting of rice, meat and two vegetables), using earthenware cooking vessels is

  - with charcoal at Rs 1/lb Rs 1.87
  - with kerosene at Rs 10/gal Rs 2.22
  - with wood at Rs 0.13/lb Rs 1.04
  - with wood at Rs 0.25/lb Rs 2.00

The objective of charcoal production is to utilize wood from land clearing that might otherwise be wasted. However, once the burning of charcoal in the home for cooking becomes an established practice the demand for charcoal will remain after the land clearing ends. Wood from other natural forests could become available for charcoal production as stands are converted into more productive firewood plantations.

8 - REFORESTATION

The long-term requirements for large quantities of fuel wood make it essential to maintain all remaining forests at the highest possible productive level. As Forest Department officials point out, it is unrealistic to consider denying the settlers the use of fuel and building materials from the forests. However, the days of free use are coming to an end.

The fuel wood crisis has already come to the uplands of Sri Lanka where forest cover is now only 8 percent of the total area. In time, the same situation could occur in System B if early provisions are not made to retain major areas of forest, upgrade nonproductive stands and encourage tree planting around homesites, canals, and other clear areas. The Forest Department can supply seedlings and seeds at low cost to help accomplish these objectives.

The Forest Department plans to convert the remaining area of the Korale Forest Reserve in System B into a fuel wood type plantation of fast-growing species, including Albizia, Sisbania, Leucaena, Caliender and Gedumba. Some eucalyptus, suitable for either fuel or pulpwood, will also be planted. These same fast-growing multiple-purpose species should be planted wherever land can be allocated for forest. They are recommended for both major and minor fuel wood plantations.

Around individual settler homes, and in hamlets and villages, suitable natural trees should be retained. Early planting of other trees for shade, fuel and food for man and livestock should be organized. Suitable species include

Ipil-Ipil

Fifteen trees per family will provide fuel within 2 years of planting. This tree is only recommended in instances where individuals can protect it from animals who are fond of its leaves.

Gliricidia

A favorite natural fence windbreak.

Sisbania

A nourishing and tasty human and animal food.

Albizia

Its dense small-leaf foliage and spreading crown make it a good shade tree.

Certain areas cleared will subsequently be suitable for reforestation. Areas of unproductive forest and recent chena cultivation areas will require improvement. It is essential that such reforestation be given a high priority if future fuel wood needs are to be met. In the short term, preservation and upgrading of existing forest is to be preferred over reforestation cleared areas. Species planted away from householders' protection should be chosen assuming a maximum of exploitation and a minimum of protection and management.

The Forest Department has developed a very successful system of reforestation using chena-type farmers to prepare the land, plant, and care for the tree seedlings for two years--the critical period during which time they can be overtopped by weeds, browsed, etc. Payments of Rs 750 per hectare (Rs 500 the first year and Rs 250 the second year) are made

to cultivators for satisfactory results. The cultivator also has two seasons of free use of the interspaces for crops which provide him additional benefits.

The key parameters of reforestation are illustrated in Table H-8.1. Costs and returns are based on current reforestation costs and on-stump values of the sawlogs and fuel wood. They are intended to cover single or dual purpose plantation establishment but are also indicative of cost and return parameters for other situations such as forest intensification and planting on homesteads, canal banks, etc.

Based on the values presented, Options 1 and 2 provide the highest economic return. However, Option 5, being specific to fuel wood production, has the advantage of requiring the shortest period before harvesting can take place.

After a seven year period, the fast-growing fuel wood species would yield about 2,000 ft^3/ha of fuel wood. If 70 percent of their fuel wood requirements were met by plantations, 11,000 ha would be required (see Appendix I) to supply the farm settlers.

Additional fuel wood supplies will be necessary to serve the needs of the non-farm settlers. This would be met by the upgraded forested area remaining after development has taken place. Also, forest areas outside System B could be a source of supply. A USAID sponsored environmental study (1979) suggested that the area south of the Right Bank would be suitable for a fuel wood plantation.

TABLE H-8.1

REFORESTATION OPTIONS FOR SYSTEM B*

Species	1 Eucalyptus	2 Eucalyptus	3 Eucalyptus	4 Eucalyptus	5 Fast growing fuel wood Species
Expected Products	Sawlogs, pulp wood and fuel wood	Sawlogs, pulp wood and fuel wood	Fuel wood only	Fuel wood only	Fuel wood only only
Rotational Period	15 years	20 years 1st cut 10 years 2nd cut	10 years	10 years	7 years
Number of Rotations**	2	2	2	2	2
Initial Capital Cost to Reforest One Hectare	1,375	1,375	1,375	1,375	1,375
Volume Harvested (ft^3/ha)					
- at 1st cut	3,000	4,000	2,250	2,250	2,000
- at 2nd cut	2,250	2,000 fuel	2,250	2,000	2,000
1979 value of Product per Cubic Foot (on stump)	Rs 10	Rs 15 1st cut Rs 3 2nd cut	Rs 4	Rs 3	Rs 3

* Intended to cover all situations: denuded lands, canal banks, intensifications of park lands, upgrading existing low density forest, homesteads, etc.

**Over life of initial planting.

As an initial programme, the development of fast-growing fuel wood plantations on approximately 11,000 ha is proposed for System B. This would be sufficient to supply the needs of the farm settlers. Close coordination between Mahaweli land-use planners and Forest Department officials will be necessary to ensure that appropriate areas are selected for development.

In addition to fuel wood requirements, System B at maturity will require substantial quantities of construction materials, some of which could be supplied through dual purpose sawlog and fuel wood plantations. This aspect should also receive careful consideration by land-use planners.

9 - FORESTRY ECONOMIC BENEFITS

9.1 - Rationale for Forestry Benefits

At present, 66 700 ha or about 54 percent of the project area is covered by some type of forest. The distribution of forest by class is shown below. As noted in Table H-2.1, class is based on density, not on commercial value.

	No. of ha	Percent
Dense forest (Type I)	1 300	1.9
Medium forest (Type II)	49 800	74.7
Light forest (Type III)	11 200	16.8
Plantation	4 400	6.6
Totals	66 700	100.0

Although the exact areas to be cleared will not be known until detailed planning and design of settlements and farms is undertaken, it is estimated that 34,000 ha, representing about 50 percent of the present forest cover, will be cleared for development. In settlement areas more selective clearing practices can be applied.

The project will bring about the systematic harvesting of much of the existing forest resource in the area. If left under present conditions, it is likely that much of the remaining forest would be degraded by chena cultivators who already are active on about 25 percent of the project area. It is, therefore, appropriate to claim economic benefits for the project from the forest area to be cleared. These areas will yield a modest quantity of commercial timber and considerable quantities of fuel wood and building materials.

Estimated quantities from the areas to be cleared are summarized as follows

Commercial timber	4.8 million ft^3
Poles and posts	5.6 million items
Firewood	14.1 million ft^3

To ensure the future availability of forest products, particularly fuel wood, reforestation is proposed. Such reforestation will be of the plantation type, supplemented by the introduction of better utilization methods for parkland areas, and selected plantings on canal banks and in settlement areas. The active participation of the settler/farmer in the reforestation program will be essential.

As outlined in Section 8, reforestation of 11,000 ha in a fast growing fuel wood species is proposed as an initial program. This is expected to yield 2,000 ft^3/ha after seven years. This is a very conservative yield expectation and is consistent with the "minimum care, maximum exploitation" policy which is behind the reforestation proposals.

In summary, two types of forestry benefits have been identified as project benefits in the economic analysis. These are

- benefits from clearing forest
- benefits from reforestation.

9.2 - Benefits from Clearing

As indicated in Section 9.1, it is estimated that 35 000 ha of all types of forest will be cleared for development. Four classes of clearing benefits have been identified.

1 - Commercial Timber

The areas to be cleared would yield 4.8 million ft^3 of commercial timber, valued at Rs 4/ft^3. This results in a project benefit of Rs 19.4 million.

2 - Poles and Posts

The areas to be cleared would yield approximately 5.6 million poles and posts with an average length of 8 ft and average diameter of 2 in. The value of each is Rs 3, for a total benefit of Rs 16.9 million.

3 - Firewood

It is expected that about 14.1 million ft^3 of firewood can be extracted from the cleared areas, with a value of Rs 0.30/ft^3 (Rs 10.60/m^3). This gives a total benefit of Rs 4.2 million.

4 - Cost of Clearing

In the construction cost estimates for the irrigation system, allowance is made for the full cost of forest clearing. However, once the merchantable timber, etc has been harvested, it is con sidered that the actual cost of land clearing and grubbing* will be lower than that which was allowed in the development of the irrigation system

*The economic cost of clearing and grubbing averages Rs 4,900/ha for the farm areas.

costs. A reduction of Rs 500/ha in clearing costs has therefore been taken as a forestry benefit, although it could have been taken as reduction in the irrigation system development costs. This applies only to the forested farm areas (including irrigation infrastructure) to be cleared - about 16,000-ha and provides a project benefit of Rs 8.2 million.

The total clearing benefits from the estimated 34 000 ha to be cleared are summarized below.

	Million Rs
Commercial timber	19.4
Poles and posts	16.9
Firewood	4.2
Reduction in clearing costs	8.2
Total	48.7

9.3 - Benefits From Reforestation

As discussed in Section 8, it is desirable that dual purpose plantations be considered for development in System B as both sawlogs and fuel wood will be required by the settlers. However, for purposes of economic analysis, only the fuel wood option (Option 5 from Table H-8.1) is considered.

As outlined in Appendix I, it would be necessary to harvest 1,560 ha annually to meet the needs of all farm settlers. Based on a 7-year rotation, a total of 11 000 ha of plantation would be required.

Output from the fuel wood plantations is valued at Rs 3/ft^3 "on stump" which is considerably higher than the fuel wood value assigned to the existing forest resource. This value reflects the greater utility of fuel wood in the project area after settlement but still is only about 50 percent of the "kerosene equivalent" price.

9.4 - Forestry Benefits Cash Flow

Total clearing benefits of Rs 50.4 million have been applied over the 1981 to 1985 period for Scenario A and over the 1981 to 1988 period for Scenario B. The cost of reforestation is spread over 7 yr for both Scenario A and Senario B. Reforestation benefits, therefore, are realized after 7 years for both scenarios. The reforestation programme should begin as quickly as possible.

Table H-9.1 illustrates the net cash flow for forestry benefits resulting from clearing and reforestation, for Scenarios A and B.

TABLE H-9.1

FORESTRY CASH FLOW SUMMARY
(Rs millions)

Year	Reforestation Cash Flow (both	Clearing Cash Flow		Total Cash Flow	
		Scen. A	Scen. B	Scen. A	Scen. B
1 (1980)	-				
2	(2.2)	9.7	6.1	7.5	3.9
3	(2.2)	9.7	6.1	7.5	3.9
4	(2.2)	9.7	6.1	7.5	3.9
5	(2.2)	9.7	6.1	7.5	3.9
6	(2.2)	9.7	6.1	7.5	3.9
7	(2.2)	-	6.1	(2.2)	3.9
8	(2.2)		6.1	(2.2)	3.9
9	9.4		6.1	9.4	15.5
10	9.4		-	9.4	9.4
11	9.4			9.4	9.4
12	9.4			9.4	9.4
13	9.4			9.4	9.4
14	9.4			9.4	9.4
15	9.4			9.4	9.4
16-22	7.2			7.2	7.2
23-29	9.4			9.4	9.4
30-36	7.2			7.2	7.2
37-40	9.4			9.4	9.4

APPENDIX I

PLANTATION AREA REQUIRED FOR FUEL WOOD

APPENDIX I

PLANTATION AREA REQUIRED FOR FUEL WOOD

- Estimated number of farm families in System B	36 000
- Fuel wood requirement per 5-person family at 17 lb/d	6,200 lb
- Cubic feet of solid wood required at 50 lb/ft^3	124 ft^3
- Fuel wood required if only wood is used by families	4.5 million ft^3
- Assume 30 percent of fuel requirements are met through other sources (e.g. crop residues, other firewood sources, kerosene, electricity), then annual fuel wood requirements are	3.1 million ft^3
- Estimated annual yield of fuel wood plantations at harvest	2,000 ft^3/ha
- Plantation area required to meet annual fuel wood demand	1,560 ha
- Total area of fuel wood plantations required (based on a rotation of 7 years)	11 000 ha

APPENDIX II

MECHANICAL FOREST CLEARING

APPENDIX II

MECHANICAL FOREST CLEARING

The key machine would be the large crawler tractor (bulldozer), preferably in the 200- to 250-hp class. Examples are the Terex 8230; International TD20; Caterpillar D7; Komatsu D80. Equipment would include a heavy-duty toothed brush or agricultural rake; this would make the machine suitable for clearing, rooting, piling and burning. The normal earth-moving blade is required for earth leveling. When winch equipped it is much better balanced and versatile than if ripper equipped. However, rear-mounted ripper-equipped machines are essential for cross-ripping operations. A combination of machines would likely be called for: most with brush blade and winch, and some with solid blade and ripper. The latter would be larger machines.

Cost of mechanical clearing, assuming 200-hp bulldozer CIF Colombo value US$105,000:

	US$/h
Depreciation (8 yr)	6.60
Insurance, interest, etc	7.00
Fuel and lubricants	6.00
Repairs	9.50
Other	0.60
Operator labor	0.50
Subtotal	30.20
Profit at 20 percent	6.04
Operating cost/h	36.24
Operating cost/h	Rs 580 (at US$1 = Rs 16)

This compares to a Komatsu D80 available for rent (September 1979) at Rs 570/h plus board for operator and swamper.

For logging, the 200 series timberjack used by STC is the preferred equipment. Its 75-hp size is adequate for the size of the logs to be skidden. The machine has proven itself under Sri Lanka conditions.

Cost of operating a skidder is as follows, assuming CIF Colombo cost of US$50,000:

	US$/h
Depreciation	5.00
Insurance interest etc.	3.30
Fuel and lubricants	2.30
Tires	1.50
Repairs	3.00
Other	0.20
Operator labor	0.40
Subtotal	15.70
Profit at 20 percent	3.14
Operating costs/h	18.84
Operating costs/h	Rs 300 (at US$ = Rs 16)

APPENDIX III

FOREST RESOURCES DATA

APPENDIX III

FOREST RESOURCES DATA

SPECIES COMPOSITION OF TYPICAL DRY MIXED EVERGREEN FOREST IN THE DRY ZONE

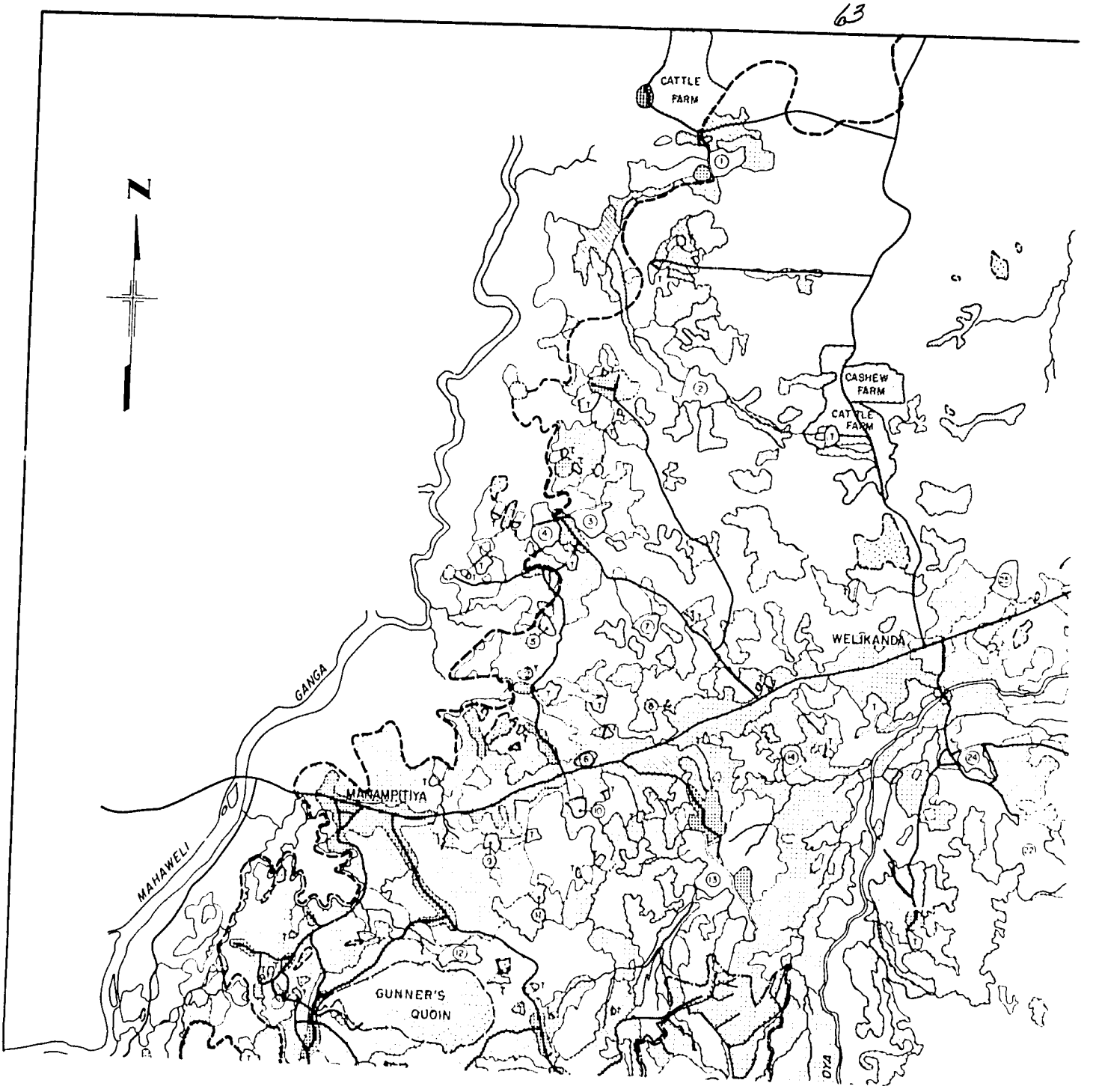
Local Name	Botanical Name	Authority
AHU	Morinda tinctoria	Roxb.
AMBERELLA	Spondias pinnata	(L) Kurz
ARALU	Terminalia chebula	Retz.
BAK-IK	See Hik	
BORADAMINIYA	Grewia polygama	Roxb.
BUK-MI	Nauclea orientalis	(L.)
BU-SERU	Premna tomentosa	Willd.
BULU-PETHA	Not known	
BURUTA	Chloroxylon swietenia	DC.
DAMINIYA	Grewia tiliifolia	Vahl
DAWU	Enogeissus latifolia	(Roxb. ex DC.) Wall
DIKWENNA	Pityranthe verrucosa	Thw.
DIVUL	Feronia limonia	(L.) Swingle
DUNUMADALA	Stereospermum personatum	(Haskk.) Chatertee
EBONY	See Kaluwara	
EHELA	Cassia fistula	L.
ELA-LIYAN	Prosorus cyanospermum	Thw.
ET-DEMATA	Gmelina arborea	Roxb.
ET-LIYAN	See Ela-liyan	
ETA-TIMBIRI	Diospyros affinis	Thw.
GAL-SERU	Tricalysia dalzelli	(Thw.) Alston
GAL-SIYAMBALA	Dialium ovoideum	Thw.
GAMMALU	Ptericaroys narsupium	Roxb.
GODAKADURU	See Kaduru	
GODAKIRILLA	Hotoptelea intgrifolia	(Roxb.) Planch

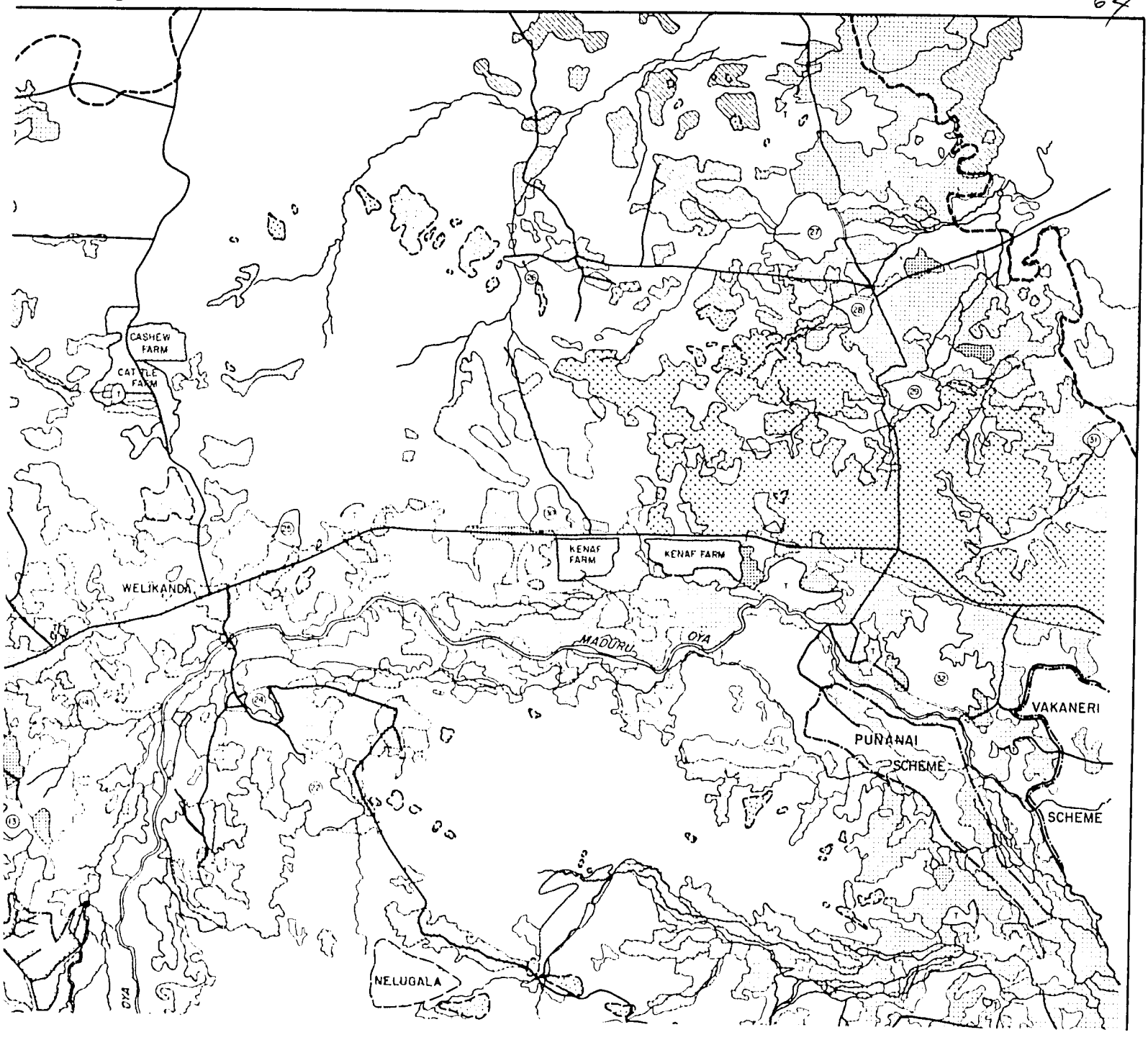
Local Name	Botanical Name	Authority
GODARATMAL	Ixora arborea	Roxb. ex. Sm.
HALMILLA	Berrya cordifolla	(Willd.) Burret.
HAMA	See Mugunu	
HAMARUTHU	Not known	
HELAMBA	Mitragyna parvifolia	(Roxb.) Korth.
HEENKENDA	Xylopla nigricans	Hk.f.Thomas
HIK	Lannea coromandelica	(Houtt.) Merr.
HINGUL	Amoora rohituka	(Roxb.) W. & A.
HULANHIK	Chukrassia velutina	M.Roem
	C.tabularis	A.Juss
INGINI	Strychnos potatorum	L.f.
KADURU	Strychnos nux-vomica	L.
KAHAPENELA	Sapindus trifoliatus	L.
KALATIYA	Polyalthia suberosa	(Roxb.) Thw.
KALUHABARALA	See Thurana	
KALUWARA	Diospyros ebenum	Koenig
KALUWELLA	Diospyros sp.	
KATU-IMBUL	Salmalia insignis	(Wall.) Schott & Endl.
KARA	Canthium coromandelicum	(Burm.f.) Alston
KARUKKUVACHCHI	See Neralu	
KAYA	Memecylon spp.	
KELA	Butes monosperma	(Lam.) Taub.
KEERIYA	Acacia leucophloez	(Roxb.) Willd.
KIHIRIYA	See Keeriya	
KIRIKON	Walsura piscidia	Roxb.
KIRIWALLA	Holarrhena mitis	(Vahl) R.Br.ex Roem & Schult.
KOHOMBA	Azadirachta indica	A.Juss
KOKKATIYA	Garcinia spicata	(Wight & Arn). Hook f.

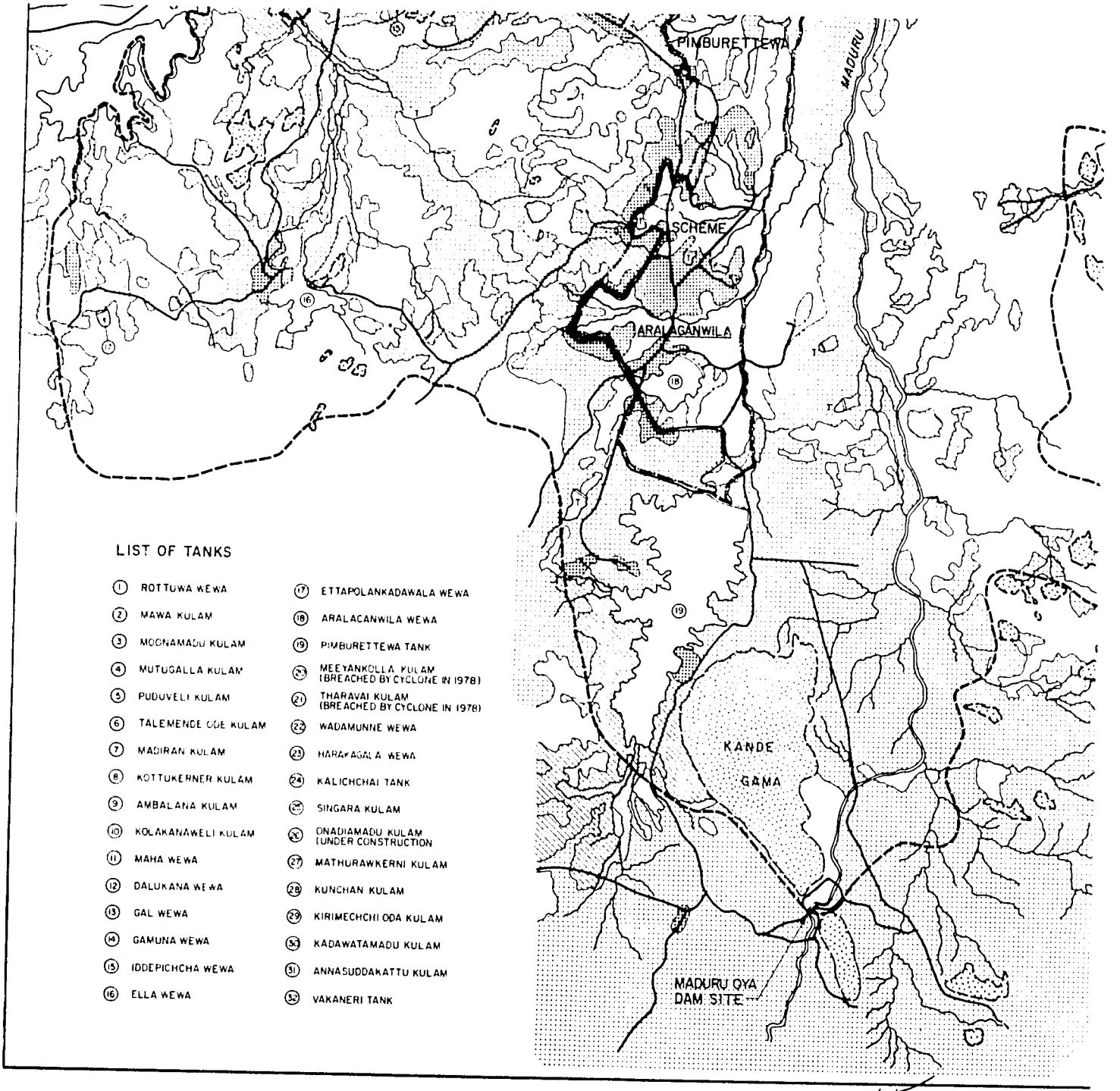
Local Name	Botanical Name	Authority
KOLON	Adina cordifolia	(Roxb.) Brandis
KON	Schleichera oleosa	(Lour.) Oken
KORAKAHA	Memecylon umbellatum	Burm.f.
	M.angustifolium	Weight
KUMA	Gleniea unijuga	(Thw.) Radlk.
KUMBUK	Terminalia arjuna	(Roxb.) W & A.
KUNUMELLA	Diospyros obalifolia	Weight
KURATIYA	Phyllanthus sp.	
KURUNDU	Atalantia monophylla	DC.
LABU	Gyrocarpus americanus	Jacq.
LOLU	Cordia domestica	Roth.
MADAN	Syzygium cimini	(L.) Skeels
MAGULKARANDA	Pongamia pinnata	(L.) Pierre
MAILA	See Mayila	
MAKULU	Hydnicaroys venenata	Gaertn.
MARAILLUPAI	See Owila	
MAYILA	Bauhinia racemosa	Lam.
MI	Madhuca longifolia	L.J.F.Macbr.
MASMORA	See Mora	
MORA	Euphoria longana	Lam.
MUGUNU	Tetrameles nudiflora	R.Br ex. Benn.
MUKUDU	See Mugunu	
NAWA	Sterculia balanghas	L.
NEBODA	Vitex leucoxylon	L.f.
NERALU	Elaeodendron glaucum	(Rottb.) Pers.
OWILA	Polyalthia longifolia	(Sonnerat) Thw.
PALU	Manilkara hexandra	(Roxb.) Dubard
PAMBURU	Atalantia missionis	(Wight) Oliv.
PANAKKA	Pleurostylia opposita	(Wall.) Alst.
PANDERU	Canthium dicoccum	(Gaertn.) Merr.
PANUKARAUW	See Panderu	

Local Name	Botanical Name	Authority
PEDURU	See Panderu	
PENELA	Sapindus emarginatus	Vahl
PILA	See Thurana	
RANAI	See Wewarana	
RATAMBALA	See Godaratmal	
RATU-WA	Cassis roxburghii	DC.
SATIN	See Buruta	
SIYAMBALA	Tamarindus indica	L.
SURIYAMARA	Albizzia odoratissima	(L.f.) Benth
TAMMANA	Mischodon zeylanicus	Thw.
TAMARIND	See Siyambala	
TELAMBU	Sterculia foetida	L.
TELKADURU	Sapium insigne	(Royle) Trim.
THEBU	Costus afer	
THORA	See Thurana	
THENTHUKKI	See Weliwenna	
THUVARAI	See Thurana	
THURANA	Maba buxifolia	(Rottb.) Pers.
TILLAI	See Telkaduru	
TIMBIRI	Diospyros malabarica	(Lam.) Kostel
TUMPALAI	Catica obscura	Trim.
ULKENDA	Polyalthia korintii	(Dunal)Thw.
WA	Cassia siamea	Lam
WAL-AMBERELLA	See Amberella	
WAL-NELLI	See Kuratiya	
WAL-SAPU	See Owila	
WALANG	Pterospermum canescens	Roxb.
WELIWENNA	Dimorphocalyx glabellus	Thw.
WEWARANA	Alseodaphne semecarpifolia	Nees
WIPPANA	See Dikwenna	
WIRA	Drypetes sepiaria	(W & A) Pax. & Hoffm.
YAKADAMARAM	Not known	
YAK DEHI	See Kurundu	

Source: Report on a survey of the resources of the Mahaweli Ganga basin, Hunting Survey Corporation, 1962.


CATTLE FARM
N
CASHEW FARM
CATTLE FARM
WELIKANDA
GANGA
MAHAMPITIYA
MAHAWELI
GUNNER'S QUOIN
DIYA


CASHEW FARM
CATTLE FARM
KENAF FARM
KENAF FARM
WELIKANDA
MADURU OYA
VAKANERI
PUNANAI SCHEME
SCHEME
NELUGALA
OYA


PIMBURETTEWA
MADURU
SCHEME
ARALAGANWILA
KANDE
GAMA
MADURU OYA
DAM SITE
LIST OF TANKS
1 ROTTUWA WEWA
2 MAWA KULAM
3 MOONAMADU KULAM
4 MUTUGALLA KULAM
5 PUDUVELI KULAM
6 TALEMENDE ODE KULAM
7 MADIRAN KULAM
8 KOTTUKERNER KULAM
9 AMBALANA KULAM
10 KOLAKANAWELI KULAM
11 MAHA WEWA
12 DALUKANA WEWA
13 GAL WEWA
14 GAMUNA WEWA
15 IDDEPICHCHA WEWA
16 ELLA WEWA
17 ETTAPOLANKADAWALA WEWA
18 ARALACANWILA WEWA
19 PIMBURETTEWA TANK
20 MEEYANKOLLA KULAM (BREACHED BY CYCLONE IN 1978)
21 THARAVAI KULAM (BREACHED BY CYCLONE IN 1978)
22 WADAMUNNE WEWA
23 HARAKAGALA WEWA
24 KALICHCHAI TANK
25 SINGARA KULAM
26 ONADIAMADU KULAM (UNDER CONSTRUCTION
27 MATHURAWKERNI KULAM
28 KUNCHAN KULAM
29 KIRIMECHCHI ODA KULAM
30 KADAWATAMADU KULAM
31 ANNASUDDAKATTU KULAM
32 VAKANERI TANK

65

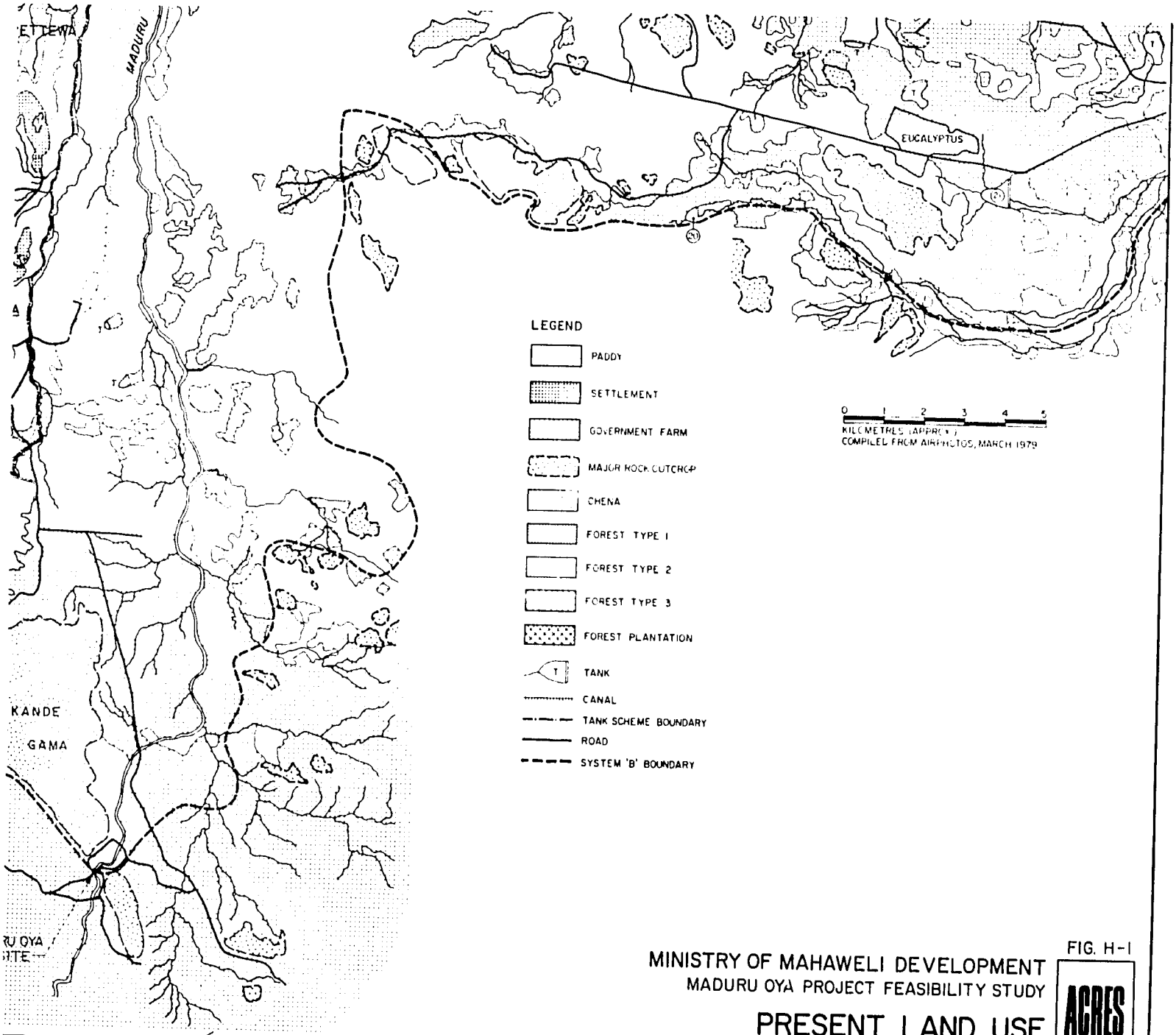


FIG. H-1

MINISTRY OF MAHAWELI DEVELOPMENT
MADURU OYA PROJECT FEASIBILITY STUDY

PRESENT LAND USE

ACRES