FAO FORESTRY PAPER 17 Sup. 1

economic analysis of forestry projects:

case studies

policy and planning service
forestry department

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome 1979

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Foreword

The case studies in this publication have been developed by FAO in the course of a programme to provide training in project analysis and planning to those responsible for these activities in the forestry sector in developing countries. They are now being published in order to make them more widely available both for teaching purposes and as reference materials for forest economists and planners. This publication has been made possible through a special budgetary contribution to FAO from the Swedish International Development Authority (SIDA).

The case studies are based on actual projects in developing countries. The material in each has undergone a lengthy period of working, reworking and use in order to improve its usefulness as a reference and teaching source. However, it is in the nature of case studies that this is a continuing process. Each use of the case is likely to disclose new facets, alternative interpretations and additional queries. Users of the cases are therefore invited to write to the Planning and Investment Studies Unit in FAO's Forestry Department, at the address given at the end of the Introduction, about their experience with them and to raise any difficulties they encounter.

The case studies have been prepared by J. E. M. Arnold and A. H. Contreras of the Planning and Investment Studies Unit of the Forestry Department of FAO and H. M. Gregersen and T. W. Houghtaling of the University of Minnesota. The basic material used to develop each case study was the project appraisal report which is identified in the foreword to that study, supplemented by information gathered during field visits to the project and discussions with those involved in its preparation and management. FAO is deeply grateful to all those, too numerous to mention by name, who took the time and trouble to share their experience and knowledge of these projects. FAO also wishes to express its appreciation to the governments of the countries in which these projects were located, and to the World Bank and other financing agencies which supported these projects, all of which were good enough to make available the necessary information to FAO and to agree to its use in this way.

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Introduction

The six case studies in this publication have been selected as representing many of the commonest situations encountered in forestry, and the issues that arise in applying economic analysis in such situations. They are based on projects in Africa, Asia and Latin America. They all describe projects designed to produce wood and/or wood fibre[1], but cover situations involving production for sale, production for a captive market and production for subsistence use, and scales of production ranging from tree-growing at the farm level, through village woodlots to large-scale production for forest industry — a range of forestry production situations which entails many different quantification, valuation and analysis problems.

Case studies are of value in illustrating how a methodology is applied in practice, in particular situations. They help to put flesh on the bones of methodology, and to bring to life the complex of interrelating factors which make up an actual project. But they have limitations. A case study can seldom develop in full the reasons why a particular value or quantity was arrived at; some understanding by the reader of the underlying concepts has to be assumed. Equally, they do not describe the whole process of the project cycle; only one part of it.

Case studies should therefore be used to complement a knowledge of economic analysis. The case studies in the present publication are designed to be used in conjunction with Economic Analysis of Forestry Projects, by H. M. Gregersen and A. H. Contreras (FAO Forestry Paper No. 17, FAO, Rome, 1979). However they are constructed in such a way that they can also be used on their own by someone with a knowledge of economic analysis. Each case study is a self-contained document.

The aspect of project planning that these case studies are designed to illustrate is that of the detailed analysis of the economic worth and soundness of that one project design which has emerged from the process of project identification and preparation as the solution which is apparently best suited to that particular situation. Readers of the cases should keep in mind that in each project there first has to be this lengthy process of identifying, testing and choosing among alternative technologies, designs, factor mixes, scales of operation, etc.

It is important also to keep in mind that each case presents a solution which is specific to a particular situation. Though this might well give useful guidance to possible solutions to similar project situations elsewhere, it should not be considered to be a model which can be transferred intact. Every situation needs to be analysed separately. Similarly readers should bear in mind that the physical and value data are specific to one situation, and to the time at which they were collected.

The Case Studies

Case Study No. 1, PHILIPPINE SMALLHOLDER TREE-FARMING PROJECT.

This case concerns a forest plantation programme which forms part of a rural development effort. Loans are made available to smallholders, with an average of some 10 ha of land, to enable them to grow a fast-growing tree (Albizzia falcataria), that is usable as pulpwood, on part of their land. The farmers sign an agreement with a local pulp and paper company which guarantees them a price and a market, but leaves them free to try to sell their output at a higher price elsewhere. The case study considers the project mainly from the point of view of the farmer and the government. The analysis is based on a typical farm unit rather than the project as a whole.

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[1] See H. M. Gregersen and K. Brooks, "Economic Analysis of Watershed Projects: Special Problems and Examples", in Economic Analysis of Forestry Projects: Readings, FAO Forestry Paper No. 17, Supp. 2, FAO, Rome, forthcoming, for a discussion and case material illustrating the application of the same methodology to forestry projects with water and soil protection outputs.

Case Study No. 2, VILLAGE FUELWOOD PLANTATIONS IN KOREA

This case study deals with a village fuelwood programme in the Republic of Korea which constitutes a component of a large integrated rural development project. Like the Philippines project it includes a great number of small sub-projects, but in this case in different parts of the country. The overall programme is analysed as one project. Some of the problems of averaging input/output relationships for diverse elements in a large programme are brought out. The study also emphasizes the organizational aspects of this type of project, and the problems involved in dealing with shadow pricing of inputs and outputs and future demand and markets.

Case Study No. 3, SOUTH AMERICAN NATURAL FOREST UTILIZATION PROJECT

This case study deals with a project for expanding an integrated forest industry development based on a natural tropical hardwood resource[1]. The emphasis is on a practical approach to appraising such a project and the elements to consider in a financial analysis, including treatment of loans and various government fees and tax incentives.

Case Study No. 4, KENYA I SAWLOG AND PULPWOOD PLANTATION PROJECT

This case examines a six-year time slice of an on-going sawlog and pulpwood plantation programme in Kenya. At the time this project was appraised, Kenya had experience growing and processing only sawlogs. This project included some of the country's first pulpwood plantations, which were established near the site of a proposed pulpmill. The mill was designed to meet Kenya's increasing domestic demands for paper products. In addition, the project financed the continuing sawlog plantation programme, which was designed to supply domestic sawmills which produce lumber for domestic use and export. The case provides an example of analysing project components separately, and illustrates problems associated with estimating import substitution and export benefits.

Case Study No. 5, KENYA II SAWLOG AND PULPWOOD PLANTATION PROJECT

This case deals with a further six-year time slice of the on-going Kenya sawlog and pulpwood plantation programme. This project continued and expanded its predecessor, the Kenya I project. At the time of the Kenya II appraisal, the pulpmill had been completed and was just starting production. As before, the project was made up of separate pulpwood and sawlog components. A comparison of this case with the Kenya I case shows the evolution of the project planning approach over time in a particular situation. For example, in Kenya II input and output prices and quantities were revised in the light of the Kenya I experience.

Case Study No. 6, ZAMBIA INDUSTRIAL FORESTRY PROJECT

Like the Kenya case studies, this one deals with a large-scale government afforestation programme, and shows how to deal with a "time slice" project. It is concerned with a situation where there is still uncertainty about both yields from the plantations and about the outlets that will be available, and shows how such uncertainty can be dealt with. It also illustrates various aspects of the relationships between forestry and forest industry activities which have to be taken into account in an integrated project.

Using the Case Studies

The case studies may be read simply as a record of how a number of successful forestry and forest industry projects were developed and analysed. But they can also be used to provide a basis for a more systematic and in-depth assessment of the structure of project analysis. FAO's Economic Analysis of Forestry Projects suggests the following major components of an economic analysis:

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[1] For a case study of the internal planning process of a very large integrated forest industries company based on a mixed tropical hardwood resource in Asia see: "Planning for a Large Scale Integrated Forestry and Forest Industries Project: A Case Study of the Paper Industries Corporation of the Philippines", FO:MISC/79/9, FAO, Rome, 1979. As the company is the one involved in the smallholder tree-farming project in the Philippines, this document also provides supplementary information to Case Study No. 1.

(1) Specification of objectives, goals and project points of view.

(2) Design of alternatives to meet the goals and identification of direct and indirect impacts associated with each.

(3) Valuation of costs and benefits or negative and positive impacts.

(4) Comparisons of costs and benefits, including treatment of uncertainty.

(5) Other considerations, such as additional measures of project impacts and presentation of conclusions and recommendations.

It could be useful, therefore, to examine the case studies following this structure and ascertaining how each step was handled, what alternative methods or techniques might have been employed, what additional factors might have been taken into account, how the latter would have had to be handled, etc. A sixth category of questions that can be asked concerns the reasons for the success of each project.

A separate publication, Economic Analysis of Forestry Projects: Users' Guide to Case Studies (FO:MISC/79/17, FAO, Rome, 1979), setting out a series of discussion questions under each of these headings, and suggesting points that should be raised in discussion of each, is available to those using the case studies for teaching purposes. It can be obtained by writing to the Planning and Investment Studies Unit, Forestry Department, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100, Rome, Italy. Some of the main issues that users may wish to consider are also identified in the Introduction to each case study.

ECONOMIC ANALYSIS OF FORESTRY PROJECTS: FAO FORESTRY PAPER 17,

CASE STUDIES SUPPLEMENT 1

CASE STUDY NO. 1

PHILIPPINE SMALLHOLDER TREE-FARMING PROJECT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

Preface

This is one in a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate methods of preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation for this purpose from the Swedish International Development Authority (SIDA). This case study has been prepared by FAO with the assistance of the College of Forestry at the University of Minnesota.

The project reported on in this case study is a project of the Government of the Philippines and the Paper Industries Corporation of the Philippines, which has been supported by a loan from the World Bank. The case study is based largely on material contained in an appraisal of the project carried out by the World Bank (Report No. 424a-PH, 5 May 1974). Additional information was generated during a field visit to the project site. The case study describes the project as it was perceived at the time of the appraisal in 1974. The material has been released to FAO by the World Bank and the Government of the Philippines exclusively for the purposes of teaching forestry planning methods. It may not be quoted or reproduced in part or in whole without permission.

ABBREVIATIONS

DBP	=	Development Bank of the Philippines
FRR	=	Financial rate of return
P	=	Philippine Peso
PICOP	=	Paper Industries Corporation of the Philippines

CURRENCY EQUIVALENTS

P 1	=	US$0.148
US$1	=	P 6.7585

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INTRODUCTION

1. This project forms part of an on-going Agro-Forestry Development Plan initiated in the late sixties by the Paper Industries Corporation of the Philippines (PICOP) with the objectives of ensuring raw material supplies for its mill complex at Bislig Bay in Eastern Mindanao and improving the socio-economic conditions of smallholders in the area. This is a "time slice" project.

2. Under the terms of the project, loans will be granted by the Development Bank of the Philippines (DBP) to some 1 300 smallholders in the Bislig Bay area to assist them in planting tree crops and in developing crop and/or livestock production. The present case study examines only the financial and economic appraisal of the tree crop element.

3. Smallholders will plant about 10 400 ha of Albizzia falcataria over a seven-year period. Trees will be grown on an eight-year rotation. PICOP will provide the seedlings at cost and technical assistance in exchange for first rights to the mature pulpwood at the prevailing market price. Table 1 shows the total expected magnitude and timing of the project.

4. The total cost of the project is estimated at about US$1.5 million with foreign exchange costs of approximately US$150 000.

5. The case is divided into four sections: Section A presents background on the project; Section B identifies the costs and benefits involved; Section C values the financial and economic costs and benefits; Section D shows the derivation of the financial and economic rates of return and looks at the sensitivity of results to changes in assumptions.

6. This case study records an example of a successful forestry project designed to involve and benefit a segment of the rural poor. One use of the study can thus be to illustrate the institutional arrangements and technical provisions that helped make it possible[1]. Issues of substance and concept that the user may wish to consider include the size of the incentives provided to the smallholder. Points of appraisal technique that arise include the structure of the appraisal (on the basis of a typical farm unit rather than for the project as a whole), and difficulties in establishing economic values for the inputs and outputs and the use of sensitivity analysis to explore the implications of uncertainty about these values.

A. BACKGROUND

Forest Resources

7. About one-third of the 30 million hectares of land in the Philippines is presently classified as commercial public forest. These forests are being reduced at a rate of 200 000 ha a year, while reforestation averages only about 17 000 ha a year. About 40 percent of the forest destruction is due to shifting cultivators (kaingineros), illegal logging and accidental fires. On the Island of Mindanao, which has the largest concentration of commercial public forest, the forest resource has been decreasing by about 90 500 ha a year, nearly all of which occurs in the valuable dipterocarp forest.

8. If this trend continues and demand increases as forecast, the Philippines is likely to be a net importer of logs by the year 2000. To offset this situation, the Government has developed policies aimed at conserving the forest resource; principal among these are: (i) the phase-out of log exports, (ii) a reforestation programme, and (iii) stricter control on all forms of forest destruction.

1/ See also Case Study No. 2 - Village Fuelwood Plantations in Korea, for an example of another, but quite different, successful project for rural community development.

Table 1 - Participating Farmers and Area Planted

Year	Number of farm Sub-loans	Year 0	1	2	3	4	5	6
		(hectares planted)						
First	200	400	400	400	400			
Second	300		600	600	600	600		
Third	400			800	800	800	800	
Fourth	400				800	800	800	800
Hectares planted/yr		400	1,000	1,800	2,600	2,200	1,600	800
Cumulative ha planted		400	1,400	3,200	5,800	8,000	9,600	10,400

PICOP

9. The Paper Industries Corporation of the Philippines (PICOP) is the sole domestic producer of newsprint and the major supplier of industrial paper in the country. The Government has granted PICOP a preferred and pioneer industry status under which the company receives a number of incentives to development.

10. PICOP could advantageously meet 100 percent of its groundwood requirements from Albizzia, but insufficient supplies have limited PICOP's consumption of this species to only 15 percent of total requirements. In the late 1960's the Company launched its Agro-forestry Development Plan. Under the plan a participating farmer devotes 20 percent of his land holding to food and livestock production and 80 percent to fast-growing pulpwood trees (mainly Albizzia) grown on an eight-year rotation. At the time of this analysis (1974), 868 tree farms with a total planted area of 1 816 ha have been established and 127 smallholders have received loans from DBP.

11. The present project calls for an expansion of the Plan. Tree farms would be sited within a 100 km radius of the PICOP mill at Bislig, the maximum economic distance for extending technical assistance. The total alienable and disposable land in the project area is estimated at 481 000 ha with about 160 000 ha suitable for tree-farming. Appendix 1 shows the location of the project.

12. To qualify for a loan under the project a farmer must have a signed marketing agreement with PICOP. The typical smallholder would plant 8 ha of Albizzia. The loan is for 15 years at 12 percent interest per annum with the first interest payment due in year 7 and with prinoipal to be repaid in years 9-14.

13. Smallholders would be required to contribute a minimum of 25 percent of project costs in own labour. Smallholders would be eligible if they occupy a minimum of 5 ha, including those who have occupied alienable and disposable land for at least 10 years, but who do not have legal title. There would be no restriction on the annual rate at which the land may be developed.

14. Reliable estimates of the number of farmers who would qualify and apply for DBP loans are not available, but preliminary data from the Bureau of Lands show that over 16 000 smallholders have applied, or will apply, for land titles in the project area.

B. IDENTIFYING COSTS AND BENEFITS

Technical Considerations

15. Albizzia falcataria is indigenous to the Moluccas and was introduced to the Philippines from Java in about 1940. It is a fast-growing tree which develops a clean bole. Response to fertilizers is good and regeneration by seed and coppice is easy. Seeds, which are abundant from the third year, store well and germinate easily. The wood is soft, light in both weight and colour and is satisfactory for veneer, furniture corestock, blockboard and pulp. The most detailed yield figures available come from the Nasipit Lumber Company near Butuan City in northeastern Mindanao, which has Albizzia plantations up to 15 years old (see Appendix 2). These are the most reliable figures available and, although they are considered conservative, they provide the only reasonable basis on which to make yield predictions for this project.

16. Yield estimates for the present project are based on Nasipit site index 30, which shows yields of about 200 m^3/ha after eight years. 1/

17. Individual tree farms would be managed on a sustained yield basis using area control and an eight-year rotation. Farms would be planted initially at any rate a farmer is capable of, but the minimum rate is assumed to be 2 hectares/year. One-eighth of the total area planted would be harvested each year. During the first rotation the first cutting would be advanced to age 7, while some stands would be carried past the rotation age in order that yields can become uniform in the second and subsequent rotation. (See Table 2, Col.5)

18. For tree farms planted at rates greater than 2 hectares/year, annual harvesting of more than 1/8 the total plantation during the first rotation may be desirable. In such cases, uniform annual harvests(by area) are delayed until the second rotation and sustained yields are not reached until the third rotation.

19. A tree farm would first be clear cut of indigenous trees and all other vegetation by hand, with burning if necessary. Lining out and digging of holes are done about a week before planting of seedlings. When fertilizers are available, a few ounces would be worked into the soil two weeks and 7 months after planting. One clear weeding and two spot weedings of about one meter radius would be done during the first year. Further maintenance is not foreseen. The total number of man-days required per hectare through the first rotation is estimated at 110, broken down as follows: land preparation - 37; lining, digging and planting - 19; replanting - 8; fertilizer application - 12.5; and weeding - 34 days. Singling, starting a year after the first harvest, requires 25 man-days per ha.

20. Seedlings would be raised in PICOP's nurseries. Seeds can be obtained locally, and no shortage is likely during the project life. Although some improvement in seed genetic quality (perhaps reflected in improved form and insect resistance) is likely through provenance testing and mass selection, a tree improvement program is not considered essential for this project.

21. Spacing on tree farms would be 4x4 m, with commercial thinnings likely after four years. No estimates of thinning response are available, and thinning costs and returns were n included in this appraisal. No severe pest or disease problems have occurred in Albizzia plantations in the Philippines. However, scattered defoliation by the larvae of a certain yellow butterfly has been noted. Fire risk in the project area is minimal.

22. Farmers would receive free support services from PICOP. The Company maintains a well organized and well-staffed Agro-Forestry Deparment with extension offices throughout the project area. In addition to seedlings, which would be supplied at cost, PICOP would provide the following types of technical assistance to farmers; (i) locating and/or acquiring ownership of vacant alienable and disposable lands, (ii) technical advice in subdividing agro-farms for tree growing and food crops/livestock production, and (iii) technical advice on establishing and managing tree crops. PICOP also plans to continue its program of research on insect control. In addition, DBP has budgeted for a professional forester to assist in project appraisals and to coordinate with PICOP on technical matters. This forester would be responsible for safeguarding the interests of the farmers by (i) studying the development of markets competitive with PICOP and, if necessary, organizing marketing cooperatives; (ii) periodically scaling tree farm harvests to check PICOP volume estimates at mill site;(iii) appraising sites and their suitability for tree farming before loans are approved; and (iv) providing other technical advice that might be required.

1/ Site index is defined as the average total height in meters of dominant and co-dominant trees at 10 years of age. The yield table is reproduced as Appendix 2.

Summary of Inputs and Outputs

23. From the above technical description, a summary of the magnitudes and timing of inputs and outputs (costs and benefits) can be derived. Due to lack of more precise information on variability among project farms, all inputs and outputs and costs and benefits are estimated on an "average" farm basis, assuming an annual planting rate of 2 ha per year for the first four years. All estimates are based on PICOP's planting experience to date. Table 2 shows the number of ha involved each year for an "average" 10 ha farm, and Table 3 shows the magnitudes and the timing of inputs and outputs for such a 10 ha farm.

C. VALUING COSTS AND BENEFITS

Financial Costs and Benefits

24. Unit costs by input type are shown in Col. 3 of Table 4. Combining the cost figures from Table 4 with the information on timing and magnitude of inputs in Table 3, the financial cost figures for tree farming for the typical 10 ha farm are estimated in Table 5. In addition, the cost to the farmer of the DBP loan are also given in Table 5. The loan, given at 12 percent compound interest with a seven-year grace period on repayment of interest (i.e., first repayment in year 7) and nine years on repayment of principal covers 75 percent of the total cost to the farmer. The loan repayments are derived as shown in Appendix 3.

25. On the benefit side, wood produced by project farms would be easily absorbed by PICOP. Market demand for paper and paperboard is expected to grow considerably in the Philippines and in Japan, the principal export market. Total demand in the Philippines is expected to be 800 000 tons in 1985 compared with 420 000 tons in 1975. Production is expected to increase more slowly from 375 000 tons in 1975 to 420 000 tons in 1985. It is estimated that approximately 500 000 m^3 per year of Albizzia wood could be utilized to meet PICOP's present capacity. The first harvest from project tree farms would not take place until 1981 andyield will be about 284 000 m^3 by 1985.

26. PICOP actually pays P60 per cubic metre of wood and is willing to "subsidize" the hauling costs another P10. For the typical farm at a hauling distance of 75 km, total hauling costs are estimated at P27 per cubic metre. Harvesting costs are estimated at P13 per cubic metre. Therefore the resulting average stumpage value is P30/m^3 [i.e.(P60 + P10) - (P27 + P13)].

27. All financial benefits are assumed to materialize at the time of final harvest. Revenues from commercial thinnings and alterations in residual growth as a result of thinnings are excluded from the analysis. Combining outputs given in Table 3 with a unit value equal to P30 per cubic metre, financial benefits can be estimated. They are shown on line 2, Table 5.

Economic Costs and Benefits

28. The economic value of benefits was taken to be equal to the financial value of P30 per m^3, as derived above.[1] The value is based on what PICOP is actually willing to pay for wood at the time of this appraisal. There was no basis on which to estimate the potential real value increase that might take place during the project period. Thus

[1] Ideally, since the paper to be produced with project wood will substitute for imports, the economic value of the benefits should be based on the import substitution value, or the foreign exchange saved, appropriately shadow priced to account for over or under-evaluation of foreign exchange. However, data to derive such a value for the wood component are not available. Thus, benefits were estimated on the basis of PICOP's willingness to pay for the wood, which was taken as an approximation of the real value derived from import substitution. It is considered a conservative figure.

Table 2 - Physical Inputs/Outputs, 10 ha Farm

Years	Activities			
		Second & Later Roatations		
	Establishment Inputs 1/	Singling Input	Weeding Input	Harvest Output 2/
	number of ha			
0	2			
1	2			
2	2			
3	2			
4				
5				
6				
7			1	1 (7)
8		1	1	1 (8)
9		1	1	1 (8)
10		1	1	1 (9)
11		1	1	1 (9)
12		1	1	1 (10)
13		1	1	1 (10)
14		1	1	1 (11)
15 and on 3/				

1/ Planting input includes land preparation, purchase of seedlings, lining, digging, planting, replanting, fertilizing twice, and three first year weedings.

2/ Numbers in parenthesis indicate age of stand being harvested.

3/ The second and third rotations (at least) are based on coppicing.

Table 3 - Timing and Magnitudes of Physical Inputs and Outputs - for Assumed "Average" 10 ha Farm

Item	Units/year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and on
Inputs																	
Land preparation lining, digging and planting	m.d.	74	74	74	74												
labour	m.d.	38	38	38	38												
seedlings[1]	no.	1200	1200	1200	1200												
Replanting																	
labour	m.d.	16	16	16	16												
seedlings[2]	no.	300	300	300	300												
Fertilization																	
labour	m.d.	25	25	25	25												
fertilizer	kg.	4	4	4	4												
Weeding	m.d.	68	68	68	68				34	34	34	34	34	34	34	34	34
Singling	m.d.									25	25	25	25	25	25	25	25
Output																	
Pulpwood stumpage[3]	m^3(r)								184.1	205.8	205.8	227.0	227.0	247.8	247.8	268.2	205.8

[1] Seedling production involves 13 m.d. of labour. Rest of cost is materials.

[2] Assumed that 20 percent would have to be replanted on the average.

[3] Based Appendix 3, using site index 30 and ages of stands harvested as shown in Table 2.

Table 4 - Unit Costs Used in the Financial and Economic Analyses
(pesos/unit)

(1) Item	(2) Units	(3) Financial Value/Unit	(4) Economic Cost
Labour	m.d.	8	4[a]
Fertilizer	kg.	25	25[b]
Seedlings	100	8.7	5.2[c]
Output	m^3(r)	30	30[d]

[a] derived on the basis of estimated production for home consumption and alternative employment given up by a farm family in order to establish and maintain 8 ha of plantations.

[b] Assumed to be the same as the financial cost

[c] Seedling production costs are 80 percent labour and 20 percent materials. Thus, 80 percent of the P8.7 financial cost, i.e. P6.7, was reduced by half to reflect the shadow wage of P4 instead of the financial wage of P8. The shadow price for seedlings was thus calculated as follows: $P8.7(.80)(P4/P8) + P8.7(.20) = P5.22$

[d] The shadow price for output (stumpage) was considered to be close to the financial price, given the information available. Thus the financial price was used.

Table 5 Financial Cash Flow, 10 ha. Plantation

(value in constant pesos)

	YEARS																		
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Cash Receipts																				
1. Bank loans	1500	1500	1500	1500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Sales	-	-	-	-	-	-	-	5523	6174	6174	6810	6810	7434	7434	8046	5174	6174	6174	6174	6174
Total	1500	1500	1500	1500	-	-	-	5523	6174	6174	6810	6810	7434	7434	8046	5174	6174	6174	6174	6174
Cash Disbursements																				
3. Land preparation	590	590	590	590	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Purchase seedlings	130	130	130	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Lining/Dig/Plant	300	300	300	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Replanting	130	130	130	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. Fertilizing	300	300	300	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Weeding	550	550	550	550	-	-	-	275	275	275	275	275	275	275	275	275	275	275	275	275
9. Singling	-	-	-	-	-	-	-	-	100	100	100	100	100	100	100	100	100	100	100	100
Total	2000	2000	2000	2000	-	-	-	275	375	375	375	375	375	375	375	375	375	375	375	375
Loan Payments																				
10. Accum. interest	-	-	-	-	-	-	-	3200	3050	-	-	-	-	-	-	-	-	-	-	-
11. Princ. & interest	-	-	-	-	-	-	-	-	-	1459	1459	1459	1459	1459	1459	-	-	-	-	-
Total	-	-	-	-	-	-	-	3200	3050	1459	1459	1459	1459	1459	1459	-	-	-	-	-
Cash Balance After Loan Payments	(500)	(500)	(500)	(500)	-	-	-	2048	2749	4340	4976	4976	5600	5600	6212	5799	5799	5799	5799	5799

benefits were assumed to remain constant in real terms per unit of output over the project life. Benefits from trees sold from the land clearing were excluded from project benefits, since this value could be obtained with or without the project. Since there was no basis on which to estimate potential net benefits from thinnings, they were not included in the analysis. Thus, the total project benefit figure can be considered as being conservative. Total economic benefits are shown on line 2 of Table 6, which is the basic value flow table for the "average" 10 ha farm.

29. Also, due to the lack of data, all economic costs, except labour costs, are estimated on the basis of their financial values. Labour is shadow-priced at P4/day. Derivation of real labour costs for a 10 ha farm is shown in Table 4.

30. Total economic costs for the average 10 ha farm are shown in Table 6. These include the costs of extension services provided through half-day visits per year per tree farm at P50 per visit.

D. COMPARING COSTS AND BENEFITS

Financial and Economic Rates of Return

31. On the basis of the assumptions above the financial rate of return for a 10 ha tree farm over 20 years would be about 39 percent. The economic rate of return for a period of 16 years is about 32 percent.

Sensitivity Analysis

32. Several of the original assumptions of the financial and the economic analyses were based upon uncertain data or are administratively determined. It is likely that prices and quantities of inputs and outputs will turn out to be different than originally assumed. It is also possible that some of the administrative assumptions (e.g. the fixed loan amount and the four year initial planting schedule) may be changed in the future. In order to test the sensitivity of the financial and economic rates of return to such possibilities, a sensitivity analysis was conducted. Table 7 presents the results of such analysis.

33. First, the period of time used for both financial and economic analyses was lengthened to 31 years, which corresponds to two coppice rotations in addition to the first rotation. 1/ Since the original financial and economic analyses were conducted for different periods of time (19 years and 15 years respectively), the extended period of analysis allows for more meaningful comparisons between financial and economic rates of return for a given set of assumptions. The financial rate of return is only slightly increased by the extended period of analysis (0.4 percent), but the economic rate of return is more significantly increased (by about 1%) since the period of economic analysis was substantially shorter originally (See Table 7). All further sets of assumptions used in the sensitivity analysis are also analyzed for the extended (31 year) period. 2/

34. Second, the four year initial planting period of two hectares per year was changed to an eight year sustained planting period of one hectare per year (Assumption Set 2). The two hectare per year planting rate caused initial costs to be carried over longer periods of time than necessary without providing significant benefits any earlier, which

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1/ The 31 year period of analysis corresponds to two coppice rotations only when harvests begin in the ninth year and continue annually, assuming an eight year rotation. This is the case for all sets of assumptions used in the sensitivity analysis, except for one assuming a six year rotation. Also, for the original set of assumptions, the 31 year period corresponds to one year more than two coppices, since harvesting was advanced to the eighth year.

2/ All calculations were also carried out for 23 years (one coppice rotation), but there was little difference between 23 and 31 years. Therefore the analysis uses only the latter period.

Table 6. Economic Value Flow, 10 ha Plantation (value in constant pesos)

	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Benefits																
1. Thinning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Harvest	-	-	-	-	-	-	-	5523	6174	6174	6810	6810	7434	7434	8046	6174
TOTAL	-	-	-	-	-	-	-	5523	6174	6174	6810	6810	7434	7434	8046	6174
Costs																
3. Land Preparation	295	295	295	295	-	-	-	-	-	-	-	-	-	-	-	-
4. Purchase of seedlings	78	78	78	78	-	-	-	-	-	-	-	-	-	-	-	-
5. Lining/Dig/Plant	150	150	150	150	-	-	-	-	-	-	-	-	-	-	-	-
6. Replanting	65	65	65	65	-	-	-	-	-	-	-	-	-	-	-	-
7. Fertilizing	200	200	200	200	-	-	-	-	-	-	-	-	-	-	-	-
8. Weeding	275	275	275	275	-	-	-	137	137	137	137	137	137	137	137	137
9. Singling	-	-	-	-	-	-	-	-	50	50	50	50	50	50	50	50
10. Administrative	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL	1163	1163	1163	1163	100	100	100	237	287	287	287	287	287	287	287	287
Net Benefits (costs)	(1163)	(1163)	(1163)	(1163)	(100)	(100)	(100)	5286	5881	5881	6522	6522	7147	7147	7559	5887

therefore depressed both the financial and economic rates of return. 1/ Adopting the sustained planting assumption, the financial rate of return increased by about 2% and the economic rate by almost 1%. Since this sustained planting assumption drops the administrative assumption of planting two hectares per year and harvesting only one, it measures the actual rate of return for each hectare assuming an eight year rotation. Therefore, this set of assumptions was used as the base for the sensitivity analysis.

35. In order to assess changes in financial profitability of an average farm induced by different alternative loan policies, the first changes in assumptions were applied to the loan the smallholders received from DBP. In Assumption Set 3 (see Table 7) the loan was assumed to be half as large (to cover 3/8 of establishments costs) as the original loan, which caused the financial rate of return to drop by 10 percent to 31.4 percent. When the loan was assumed to be eliminated entirely in Assumption Set 4, the rate of return dropped by a further 4 percent, to an FRR of 27.1 percent.

36. One factor which by definition must be variable is transportation cost. The economic hauling distance varies from zero to 100 kilometers. The financial and economic rates of return for an "average" plantation would be highest if it was located adjacent to the mill (zero hauling distance) and lowest if it was located 100 kilometers from the mill (the maximum distance considered). To test the maximum sensitivity to hauling cost it was necessary only to calculate the rates of return for the extreme distances. Translated into benefit (revenue) terms, a plantation located adjacent to the mill would have a 23.33% revenue increase in the financial analysis and a 56.67% benefit increase in the economic analysis. 2/ Thus, for a plantation located adjacent to the mill the financial rate of return would increase by 5% over the rate of a plantation located 75 kilometers from the mill, and the economic rate of return would increase by about 7%, (as shown in Assumption Set 5). For a plantation located 100 kilometers from the mill both the financial revenue and economic benefits would be decreased by 9.3%. 3/ In this case, the financial rate of return dropped by 2.3% and the economic rate by 1.5% (see Assumption Set 6).

37. The sensitivity analysis considers two other decreased benefit (revenue) assumptions, which could be caused by one or more of the factors discussed earlier. Assumption Set 7 assumes that benefits (revenues) are 25% lower, which results in a decline in the financial rate of return of 7% and in the economic rate of 4%. Assumption Set 8 assumes that benefits (revenues) are 50% lower. Under this assumption the financial rate of return drops by 18% and the economic rate by 10%.

1/ Under the original two hectare per year planting rate, harvests were begun one year earlier (age 7 or year 8), but this was merely an administrative decision which could also have been made with the sustained (8 year) planting assumption. If it was necessary for PICOP to obtain supplies of Albizzia earlier than in the ninth year, it would perhaps have been better to initially pay higher delivered prices for Albizzia, thereby encouraging earlier planting and shorter initial rotations. In that case it probably would have been necessary for smallholders to plant their entire eight hectares earlier and to vary their first rotation cutting in order to meet PICOP's immediate needs, but higher prices could then justify such planting and harvesting.

2/ Any other single factor or combination of factors (including transportation cost) which would cause benefits (revenue) to increase by these amounts would have the same effect on the rates of return. Thus, this sensitivity analysis could be used to test a number of changes.

3/ An increase in transportation cost of P 2.79/m^3 is a 9.3% increase in a base price of P 30/m^3.

38. Three cost changes were tested for their effects on the rates of return. First, in Assumption Set 9 labor cost was assumed to be 25% higher than originally, which could be due to higher wages (shadow wages) and/or lower productivity. The financial rate of return under this assumption was 10% lower, and the economic rate was 3% lower. Second, in Assumption Set 10 labor cost was assumed to be 50% higher than originally, which lowered the financial rate of return another 5% and lowered the economic rate of return an additional 2%. 1/ And third, it was assumed in Assumption Set 11 that fertilizer cost was twice as high, which decreased the financial rate by 2% and the economic rate by 1%.

39. Even though most of the assumption changes had a large effect on both rates of return, and especially the financial rate, no assumption change reduced either rate below 20%. This apparently suggests that the project is acceptable, both economically to the country and financially to the smallholder, under a wide range of alternative assumptions concerning costs and returns.

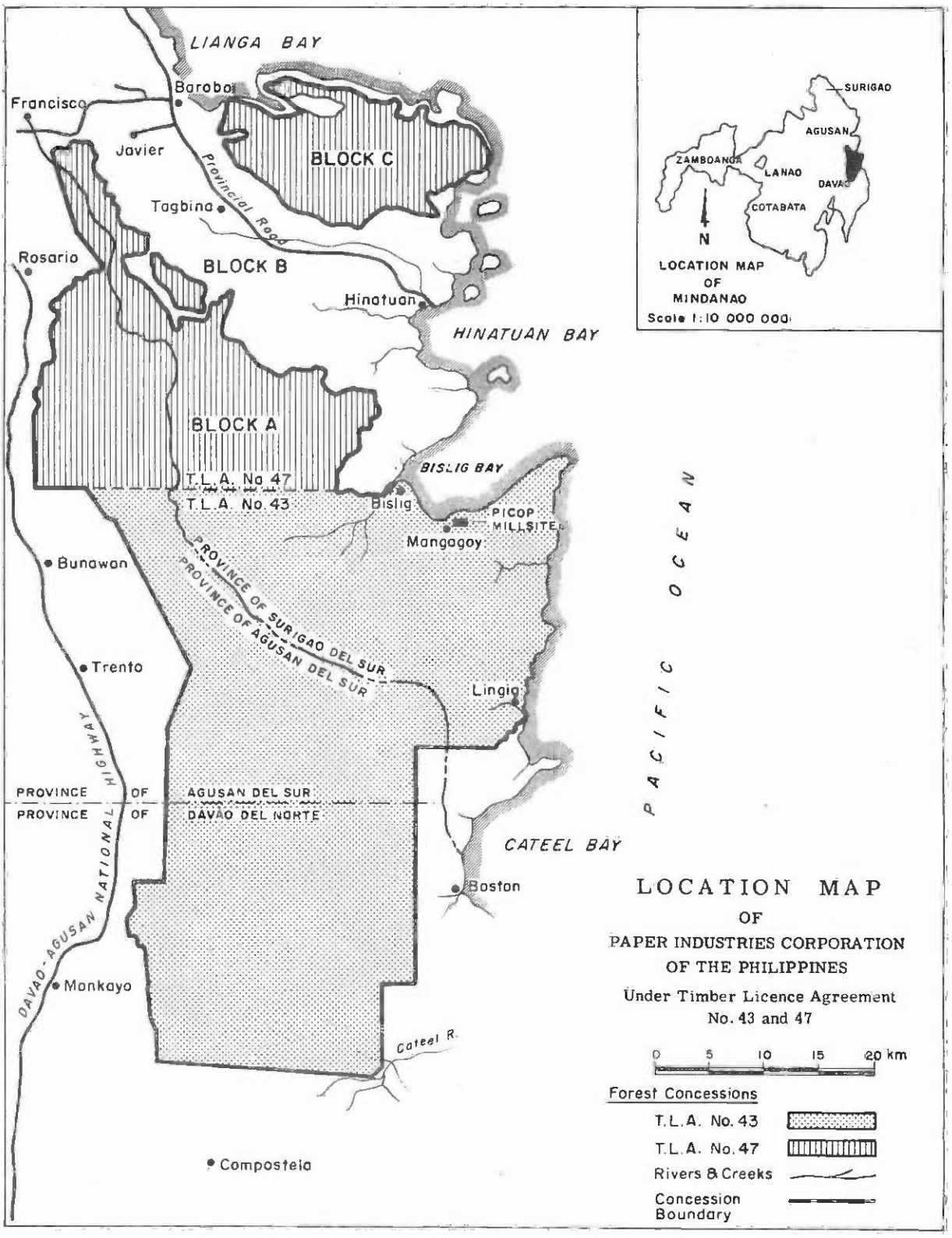
Table 7 - Sensitivity Analysis

	Original assumption	New assumption set	Internal Rate of Return (%) Financial Analysis (31 years)	Economic Analysis (31 years)
1.	Original assumption	Same	39.4	33.2
2.	2 ha per year for 4 years	Sustained Planting (SP) (1 ha/year for 8 years)	41.8	33.9
3.	P 1500 loan for each of first 4 years	Sustained Planting (SP)	31.4	-
4.	Same	SP - no loan	27.1	-
5.	Hauling distance 75 km	SP - hauling distance 0 km	47.2	41.3
6.	Same	SP - hauling distance 100 km	39.5	32.4
7.	Original revenues (benefits)	SP - Revenues (benefits)	34.5	29.5
8.	Same	SP - Revenues (benefits) 50 percent lower	23.7	23.5
9.	Original labour costs	SP - labour costs 25 percent higher	31.8	31.2
10.	Same	SP - labour costs 50 percent higher	26.4	29.1
11.	Original fertilizer cost	SP - fertilizer cost doubled	39.0	32.8

1/ Increased labor cost assumptions had a greater effect on the financial rate of return because financial labor cost was twice as high as the (50% shadow priced) economic labor cost.

APPENDIX 1

Map of Project Area



APPENDIX 2

Yields* by Site Index of Albizzia Falcataria
Nasipit Lumber Co. Plantations (m³/ha)

Age	18	26	28	30	32	34	50
2	22.3	48.0	56.1	64.8	74.2	84.3	189.2
3	31.2	67.3	78.6	90.9	104.0	118.1	265.2
4	39.6	85.6	99.9	115.5	132.2	150.1	337.1
5	47.7	103.0	120.4	139.1	159.3	180.8	406.0
6	55.5	119.9	140.1	161.9	185.4	210.5	472.6
7	63.0	136.4	159.3	184.1	210.8	239.4	537.4
8	70.5	152.4	178.1	205.8	235.6	267.6	600.7
9	77.8	168.2	196.4	227.0	259.9	295.2	662.6
10	84.9	183.6	214.5	247.8	283.7	322.2	723.4
11	91.9	198.8	232.2	268.2	307.2	348.9	783.2
12	98.9	213.7	249.6	288.5	330.3	375.1	842.1
13	105.7	228.5	266.9	308.4	353.1	401.0	900.2
14	112.4	243.0	283.9	328.1	375.6	426.5	957.6
15	119.0	257.4	300.7	347.5	397.9	451.8	1014.0

* up to 10 cm top diameter inside bark not including branches, 2 x 3 m initial spacing, weeded first and second year, no thinning.

APPENDIX 3

Derivation of Farmer Loan Repayments

Year	Loan Amount 1/	Interest Due At End of Year 7 (Beginning of year 8)
0	P 1,500	P 1816
1	P 1,500	P 1461
2	P 1,500	P 1143
3	P 1,500	P 860
	Total	P 5280

Interest due beginning year 7	P 5,280
Amount paid in year 7	P 3,200 2/
Remaining interest due	P 2,080
Principal outstanding (4x$1 500)	P 6,000
Total loan outstanding	P 8,080
One year's interest 12%	P 970
Total interest due 3/ in year 8	P 3,050

The annual repayments of the loan for years 9 - 14 (line 11, Table 5) are derived as follows:

$$A = P\ 6{,}000 \left[\frac{.12(1.12)^6}{(1.12)^6 - 1} \right]$$

$$= P\ 6{,}000\ (0.2432) = P\ 1459$$

The factor in parentheses is called the "capital recovery multiplier", and is given as follows:

$$\left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

The value of this multiplier can be found in most tables of compound and discount factors.

1/ Assuming 2 ha planted per year at a total annual cost equal to P 2000 (Table 2). 75 percent of this amount, or P 1500, is covered by the Bank loan.

2/ Arbitrarily set at this level in order to keep interest payments in years 7 and 8 approximately equal.

3/ P 2080 plus P 970.

ECONOMIC ANALYSIS OF FORESTRY PROJECTS: CASE STUDIES

FAO FORESTRY PAPER 17, SUPPLEMENT 1

CASE STUDY NO. 2

VILLAGE FUELWOOD PLANTATIONS IN KOREA

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

Preface

This is one in a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate methods of preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation for this purpose from the Swedish International Development Authority (SIDA). This case study has been prepared by FAO with the assistance of the College of Forestry at the University of Minnesota.

The project reported on in this case study is a project of the Government of Korea which has been assisted by a loan from the World Bank. The case study is based largely on material contained in an appraisal of the project carried out by the World Bank (Report No. 958a - KO). A field visit to the project provided further information. The case study describes the project as it was perceived at the time of appraisal in late 1975. This material has been released to FAO by the World Bank and the Government of Korea exclusively for the purpose of teaching forestry planning methods. It may not be quoted or reproduced in part or in whole without permission.

ABBREVIATIONS

ERR	=	Economic rate of return
VFA	=	Village Forestry Associations

CURRENCY EQUIVALENTS

US$1.00	=	Won 485
Won 1,000	=	US$2.06

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INTRODUCTION

1. The fuelwood project discussed here is part of an integrated rural development programme in Korea. The overall programme was conceived as a means of improving the living conditions and income earning potentials of some 15 000 villages within the Saemaul Undong (New Community Movement), a community development programme in which villages set their own development priorities and contribute, in kind or cash, to the selected projects.

2. In addition to the fuelwood plantations project analysed here, the integrated rural development programme includes 66 irrigation projects, ranging from 50 to 700 ha in size, 35 upland development areas, 850 km of village roads, 200 bridges, water supplies for 2 000 villages, and 2 400 rural electrification schemes. The programme also includes several supporting research components. The total cost of the fuelwood project discussed here is $14 million, of which an estimated 5 percent would be foreign exchange.

3. The project would significantly reduce local shortage of fuel by establishing about 11 000 village fuelwood blocks, covering about 127 000 ha. Sub-projects would vary from 3 to 50 ha in size and be implemented in all Provinces, but concentrated in those which are more densely populated where fuel shortages are most severe. The project would be an extension of an on-going programme to expand fuelwood plantations in Korea, which in 1975 had already successfully covered more than half a million hectares.

4. Plantations would be established by communal labour, mostly on private land with few alternative uses. Seedlings, fertilizer and technical assistance would be provided by government agencies. Species used would typically contain a mixture of fuelwood and timber-producing species with the proportion of timber species not exceeding 35 percent. The project includes support for fuelwood research (vehicles, equipment and materials). The research would address problems such as species selection, optimum spacing and fertilizer use.

5. The present case study looks in detail at the economic appraisal of the Korean fuelwood project. The case is divided into five sections. Section A provides some general background on the project and the appraisal of it. Section B gives a description of the technical forestry elements of the project and input requirements. Section C analyses project costs, while Section D discusses output and benefits. Finally, Section E provides a comparison of costs and benefits and looks at the sensitivity of the economic analysis and the economic rate of return (ERR) to changes in assumptions.

6. This case study records an example of a successful forestry project designed to involve and benefit the rural poor. One use of the study can thus be to illustrate the conditions and arrangements that helped make it possible and helped to ensure its successful implementation. 1/ Particular issues of substance and concept that the user may wish to consider include local organizational arrangements, coordination of village-level organization with the broader regional and national elements of organization needed to implement the overall project, and the concept of - and problems involved with - the dual purpose (fuelwood and timber) plantations that were made part of the project. Points of technique and organization of the analysis include the development of shadow prices, particularly for labour and fuelwood output, questions of timing and project period (final harvest output assumptions), use of "average" per ha values in the analysis of the entire 127 000 ha included in the project, and use of sensitivity analysis to determine the sensitivity of project results to changes in assumptions regarding input and output values.

A. APPRAISAL BACKGROUND

The Need for Fuelwood

7. Basic to the forestry problem in Korea is the long period of extreme winter cold, when the mean daily temperature is below freezing for almost three months. The heating system commonly in use (the "ondol" system) requires large quantities of fuel (averaging 4.2 tons per annum for a household of 6 persons) and in rural areas has led to the almost total impoverishment of those areas of forest land which are adjacent to agricultural communities. All areas of forest land have traditionally been regarded as freely available for fuelwood gathering and therefore, control of harvest has been almost impossible to

1/ See also Case Study No.1,"Philippine smallholder tree-farming project", for an example of another, but quite different, successful project for rural community development.

impose. The supply of fuelwood is now quite inadequate to meet requirements and thus leaves, grass, and forest litter are raked up for fuel. Rice straw, maize stalks and similar agricultural residues are also used in large quantities. The removal of forest litter has led to serious erosion and flooding problems and also to the lowering of soil fertility levels, whilst the use of agricultural residues as fuel deprive the individual farmers of a potential source of income, and the country of valuable raw materials (for composting, thatching and the manufacture of rope and bags).

8. Recognizing the seriousness of the problem, the Government introduced early in 1973 the following series of measures:

(a) The Office of Forestry was placed under the Ministry of Home Affairs, thus effectively strengthening its authority and ability to enforce forest protection. At the same time, the status of the Provincial and County Forestry Offices was raised and their staffs strengthened;

(b) A strong extension and publicity campaign was mounted, to inform the rural population of the vital necessity of restoring forest cover to the land, and to induce them to adopt the following fuel-saving methods:

(i) Conversion of cooking and heating units to coal burning, where coal supplies are adequate;

(ii) Improvement of the design of cooking stoves, for more efficient conversion of fuel;

(iii) Replacement (under the Saemaul Movement) of thatched roofs by tile, asbestos, and corrugated iron, thereby reducing the consumption of rice straw for thatching;

(iv) Elimination of the practice of cooking all feed for working oxen; and

(v) The introduction of methane gas producers (using animal manure) and kerosene heaters;

(c) Enforcement of regulations forbidding the raking of leaves, grass and litter within forest areas; and

(d) The introduction of a national reforestation scheme to create a well managed fuelwood plantation for each village, the reforestation work to be carried out by the villagers themselves.

9. Due in part to these new measures, standards of forest management in Korea improved in the last years. The annual rate of reforestation with fuelwood plantations built up to more than 30 000 ha per annum, ground vegetation began to develop in the absence of litter-raking, and materials other than thatch for roofing gained widespread use. The forestry plantations were well laid out and survival of trees is high. Silvicultural treatment and logistical facilities were also adequately planned. There do not seem to be any problems of supervision either at the technical advisory level or at the village foreman level.

Forest Land Tenure and Use

10. Of the land classified as forest, 73% is privately owned, 20% is in National Forests, while the remaining 7% is Public Forest (communally owned).

11. The National Forests are located mostly in Gengweon Province, which is the more mountainous and sparsely settled part of Korea. Therefore, the proportion of privately-owned forest land is correspondingly higher in the other, largely agricultural, provinces of the country. The private forest-land holdings are for the most part very small, as shown in Table 1.

12. Private forest-land is used mostly for the gathering of fuel and is therefore usually almost bare of trees or else carries impoverished pines less than 2 or 3 m high. Such land is frequently most valued for its use as a family burial ground. Given the high proportion of privately-owned forest, it is clear that private forest land has to be used for the establishment of village fuelwood plantations. As they are mostly small farmers, the owners are usually not able to bear the cost of planting the land themselves. Under the Forest Development Law of 1973, the Village Forestry Associations (VFA's) are empowered to take over the planting and management of private forest land under an agreement whereby the owner retains the ownership of the land and is entitled to a 10% share of the fuelwood produced from the plantations established upon it. The duration of the contract with the landowner equals the nominal economic life of the species to be planted. This arrangement has resulted in compact blocks of land being available for fuelwood plantations.

Table 1: Ownership Pattern of Private Forest Land

Holding Size (ha)	Number of Holdings	% of Holdings	Total Area (ha)	% of Area
Less than 1.0	985,000	56.0	387,000	8.4
1.0 - 10.0	699,000	39.7	2,275 000	49.2
10.0 - 100.0	74,000	4.2	1,519,000	32.9
More than 100.0	2,000	0.1	441,000	9.5
Total	1,760,000	100.0	4,622,000	100.0

Source: World Bank Report 958a - KO, Feb. 15, 1976.

B. TECHNICAL CONSIDERATIONS

Proposed Project Magnitude and Objectives

13. The establishment of village fuelwood plantations on a total of 127 000 ha in all nine provinces of Korea is proposed for the project (Table 2)

14. Arising out of a recent survey, the fuelwood needs of most villages have been assessed using a standard Fuelwood Forest Record. Based on the number of households and fireplaces in the village, total fuel demand is calculated. The forest resources of the village are assessed and, based on the availability of suitable land and of alternative fuels (such as coal and kerosene), a judgement is made by the district Office of Forestry staff on the size of fuelwood plantation needed. Priority in allocating government staff time and materials to particular villages depends largely on the competence and enthusiasm of the VFA but also on the village's own priorities, as expressed through its Saemaul Committee. Priority is also given to villages with particularly acute shortages of fuel, which is the reason for the concentration of the programme in the more densely populated provinces

Table 2: Provincial Distribution of the Fuelwood Component

Province	No. of sub-projects	Area to be Planted (a)		
		1976	1967	Total
Gyeong-gi	1,220	2,400	7,000	9,400
Gang-weon	943	2,300	7,000	9,300
Chungcheong Bug	897	3,400	5,000	8,400
Chungcheong Nam	1,674	8,100	7,900	16,000
Geonra Bug	1,077	4,400	7,000	11,400
Jeonra Nam	2,240	10,100	15,000	25,100
Gyeongsang Bug	1,796	8,600	14,000	22,600
Gyeongsang Nam	1,231	10,200	13,600	23,800
Jeju	51	500	500	1,000
Total	11,129	50,000	77,000	127,000

Source: World Bank Report 958-KO, Feb. 15, 1976

15. The survey showed that new or supplementary fuelwood blocks are required in about 11 100 villages and this is the basis for the proposed fuelwood project. Sub-projects for each village would vary from 3 ha to about 50 ha, the smaller ones being intended to supplement previously established plantations. The average sub-project size would be 11 ha. While fuelwood production would be the main purpose, about 30% of the trees planted would be intended primarily for timber production (mainly for local house building and, in some cases, for commercial uses), with fuelwood as a by-product. 1/ The main objectives of the fuelwood project are as follows:

(a) To stabilize a sustained supply system of fuelwood for the rural areas by the eventual production of 640 000 tons of additional fuelwood annually;

(b) To supply fuel for both forest owners and non-forest owners;

(c) To protect the forest through self-policing by Village Forestry Association members;

(d) To enrich the national forest resource by the planting of timber-producing species, as an admixture to the fuelwood species;

1/ The percentage for each village block and region would vary depending on needs and location.

(e) To build the productivity of the remaining forest land through the prevention of litter raking; and

(f) To boost the income of farm households through alternative uses for agricultural by-products.

16. In view of the size and success of the 1975 programme (40 000 ha), and the satisfactory establishment and protection of previous years' plantings, the targets of 50 000 ha in 1976 and 77 000 ha in 1977 seem well within practical attainment. Nursery stocks, transport, and technical supervision also appear quite adequate for the proposed project and, most important of all, it appears to have the full understanding and support of the villagers themselves.

Planting sites

17. The sites selected are on moderate to steep land (all other land being given over to agricultural crops), close to the villages. Sites may be either areas classified as "forest", which are preferred for larger plantings, or consist of small pieces of unused "non-forest" land such as roadsides, streambanks, strips adjacent to cultivated land, or risers between bench terraces. As far as possible, communal land is selected for the plantation but, as most forest land is privately owned, arrangements are made for such land to be managed by the Village Forestry Association (VFA), whereby the VFA assumes all management responsibilities (including the organization of planting) and the owner receives 10% of the yield of the plantation. The inclusion of timber-producing species (which have a cash value) eases any problems in obtaining the consent of the landowner and, in nearly all cases, there is no need to resort to the powers of eminent domain provided by the Forest Development Law.

Site preparation

18. In most cases, the areas selected for planting carry only a light growth of shrubs and grass. Clearing is therefore easy and can be carried out with simple hand tools. There is burning before planting and the planting pits, 30 cm in diameter, are made at the time of planting.

Seed supplies and nursery stocks

19. All seeds are produced in Korea. Seed collection is organized by the VFA's. Transplants are produced from a variety of well-organized nurseries, including: (a) state nurseries, (b) VFA nurseries at province, county and village levels, and (c) private commercial nurseries. The largest production is from the VFA nurseries. Stock from these nurseries is sold at a small profit to cover costs and to give a return to the VFA members.

Transport

20. The county has an adequate road network and therefore primary transport of seedlings by truck is no problem, with secondary distribution being carried out by bullock cart and by human portage. There are no serious problems of access to the plantation areas. Project supervision, by the Office of Forestry and the VFA unions, is presently hampered by a lack of suitable vehicles. Under the project, 140 pick-up trucks, one for each county, would be procured.

Planting

21. Planting takes place in March and April. To obtain maximum early yields, planting density is high, with 4 000 plants/ha proposed for "forest" areas, and 10 000 plants/ha for "non-forest" areas, where only low-growing shrubby species are employed, in order to avoid shading of adjacent crops. While research results show that these spacings are optimal from a yield point of view, they may not give sufficient weight to cost factors and to soil and site conditions. There may be additional benefits from less dense spacing

and therefore various spacings would be field tested under the project. Planting is in straight lines up and down the hillsides, to facilitate weeding and later extraction of the produce. Open-rooted planting is used and NPK fertilizer (at a rate which varies from zero to 80 g per plant, with an average of 6 g) is applied at the time of planting.

Species selection

22. The selection of a particular species (or species mixture) for an individual site is governed by its location in the country, soil fertility, and other site characteristics. The main fuelwood species used are Black Locust (Robinia pseudoacacia), Alder (Alnus firma and A. hirsuta) and the leguminous shrubs Bush Clover (Lespedeza spp.) and Indigo Bush (Amorpha sp.). The main timber species are Poplar (Populus alba x glandulosa) and Larch (Larix leptoledis) while Pine (Pinus rigida and P. thunbergii) may be considered dual-purpose. An interesting development is the use of Poplar in alternating lines with Bush Clover on relatively dry mountain sites. This is the so-called "Sunchon" method of fuelwood production. The Lespedeza gives fuelwood in the first year, plus a cash crop from seed production, whilst the Poplar gives fuelwood from the pruning of side branches, and can produce pulpwood at nine years old, or saw timber on longer rotations. Wherever site conditions permit, plantations of mixed timber-producing and fuelwood-producing species are created. For example, Poplar (for pulpwood production) is planted with Lespedeza or Robinia. Pinus rigida (for fuel and timber production) may be planted with Black Locust on low-quality sites, where the nitrogen-fixing capacity of the Black Locust is valuable for site improvement, whilst the Pine is tolerant of the low site quality.

23. While the mixing of fuel and timber-producing species may not be ideal from an economic viewpoint, there are good sociological reasons for its use. The main timber species are well understood by the villagers and produce significant amounts of fuel from pruning and thinning. High-yielding fuel-producing species are more novel and may have problems, such as the thorniness of the Black Locust. Under the project, about 30% of the project area would be planted to dual-purpose species (such as pines), 30% would be devoted to Bush Clover and Indigo Bush in "non-forest" areas, while the remaining areas would grow Black Locust and Alders (Table 3).

Maintenance

24. The plantations are weeded for two or three years after planting, until the trees are free from grass competition. Insect pests pose some problems but control methods are well understood. If necessary, fire breaks are constructed around the plantation. Losses from fire have been low in recent years.

Inputs and outputs

25. The physical inputs required for a typical or "average" ha of fuelwood plantations are shown in Table 4, together with the estimated output (discussed in par.38). A 20-year rotation is assumed for the fuelwood component.

Organization

26. A Village Forestry Association has been formed within every village in the country. The head of each VFA is elected by his fellow villagers for a five-year term. He is directly responsible for activities of the VFA, such as the production of transplants from the village nursery, oak mushroom cultivation, and so on. He obtains technical guidance in his work from the foresters of the VFA Union at county level, and the district officers of the Office of Forestry (see Figure 1).

27. The Office of Forestry and the VFA field organizations are fully staffed at all levels, with the Office of Forestry having approximately 40 technically-trained foresters in each provincial office and 25 in each county office. These numbers are impressive and represent a very adequate forestry organization for carrying out the project.

Table 3 - Fuelwood Component: Species Distribution

Species	% of Area
"Forest" Areas - fuelwood species	
Robinia pseudoacacia	22
Alnus Firmus, Alnus hirsuta	18
- dual-purpose species	
Pinus rigida	29
Pinus thunbergii	2
"Non-Forest" areas - fuelwood species	
Lespedeza sp, Amorpha sp	29
	100

Note: The above distribution is based on preliminary surveys only and has been used for cost estimating purposes only. A more detailed breakdown will be available after final designs are completed and may include additional minor species.

Table 4 - Physical Inputs/Outputs by Years per Ha. (Average) 1/

	Units	YEARS 0	1	2	3	4	5	6	7-19	20
Fuelwood Output	Tons	-	-	-	0.5	1.0	2.0	4.0	5.0	125.0
Inputs										
Labor (local)	Man	48.7	-	-	4.1	8.3	16.7	33.3	41.7	2083.3
Site Prep	Days	3.1	-	-	-	-	-	-	-	-
Planting	"	36.5	-	-	-	-	-	-	-	-
Fertil. Appl.	"	9.1	-	-	-	-	-	-	-	-
Weeding 4/	"	..	..	..	-	-	-	-	-	-
Harvesting	"	-	-	-	4.1	8.3	16.7	33.3	41.7	2083.3
Supervision 2/	"	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Misc. (tools,etc.) 3/		..	-	-	-	-	-	-	-	-
Plants	No.	5944	-	-	-	-	-	-	-	-
Fertilizer	Kg.	42	-	-	-	-	-	-	-	-

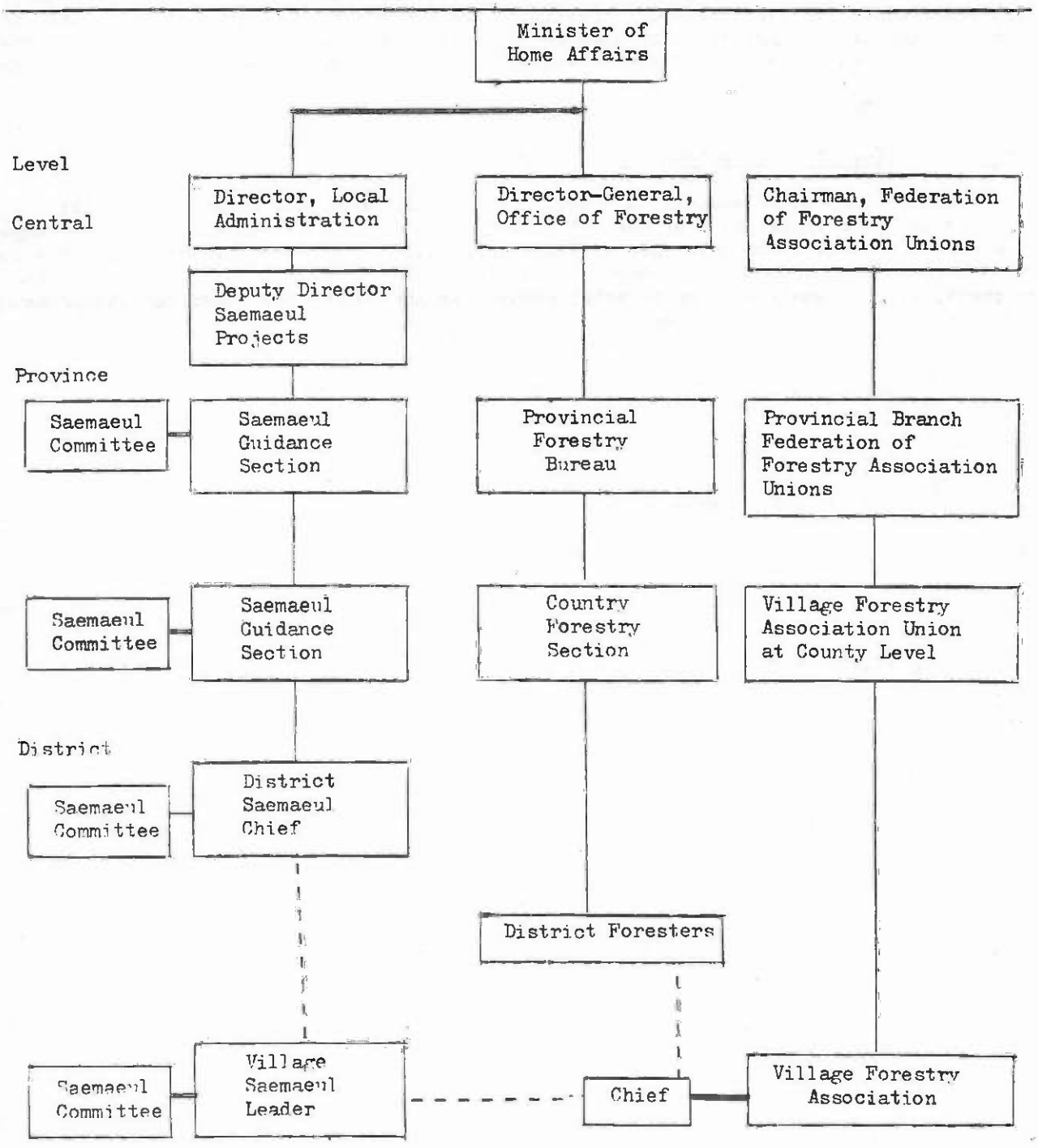
1/ These are weighted averages assumed for 85,836 ha of "forest" land and 41,164 ha of "non-forest" land (Total: 127,000 ha)

2/ Includes only office of Forestry input

3/ Physical breakdown not available

4/ No figures give, but weeding cost is assumed to be offset by fuelwood value of grass collected

Figure 1 - Korea Rural Infrastructure Project
Organization Chart 1/ Fuelwood



1/ Principal project units only shown.

28. For the fuelwood component, the Government would fully subsidize materials (mostly seedlings and fertilizer) and supervision. Labour to establish and maintain the plantations would be provided by the villagers. About 90% of required project funds (for materials) would be allocated to the Office of Forestry, under the Ministry of Home Affairs, then to the Federation of Village Forestry Association Unions at county level, who would pay the suppliers. The remaining 10% (for supervision costs) would come from the Provincial budget.

C. PROJECT COSTS

Shadow prices for foreign exchange and labour costs

29. For the purpose of economic analysis a shadow exchange rate of Won 560 = US$1 (compared to the official rate of Won 485 = US$1) was used to value the foreign exchange component. The shadow exchange rate is based on research undertaken by the Korea Development Institute. In the fuelwood component, it is only applicable to fertilizer and some equipment, i.e., a small portion of total costs. As the demand for unskilled labour is highly seasonal in the rural areas of Korea, seasonal shadow wage rates are appropriate. As the rural labour force is approximately fully employed during the crop season and is also fairly mobile, it is appropriate to use observed wage rates for hired labour as the opportunity cost of labour, that is Won 1,800/day for April, May, July, August and September and Won 1,900/day for the peak months of June and October. During the winter months there is little wage employment. There is, however, some self-employment, notably the weaving of bags from rice straw, for which the net value of production is about Won 450/day - this value has been used to represent the opportunity cost of unskilled labour during the period November to March.

Land cost

30. It is considered that land under the project would have no alternative economic use for the period of the project. Therefore land is valued at zero.

31. Table 5 summarizes the unit cost assumptions used in the analysis. Labour is provided in kind by villagers, while all other economic costs are assumed equal to financial or market costs.

Fuelwood plantation cost components

32. The average costs per ha for all inputs are derived in Table 6. Materials, transport, supervision and overhead are evaluated at their financial cost and total Won 76 376/ha. Planting takes place in March or April, which is on the borderline between the crop season and the off-season. Village volunteer labour has therefore been valued at Won 1 150/man-day, which is approximately a weighted average of the main-season (Won 1 800) and off-season (Won 450) opportunity costs of labour. An average of 48.7 man-days/ha of unskilled labour would be required (see Table 4). The total labour cost of establishment is therefore Won 56 000 (US$115/ha).

33. Recurrent costs include: weeding, management and harvesting. The cost of weeding would be offset by the fuelwood value of the grass collected. Management by Office of Forestry and Union of Village Forestry Associations personnel has been set at 0.1 man-day/ha/yr and valued at Won 2,500/man-day. Other supervision costs (fire prevention, insect control, and so on) would total about Won 2 200/ha/yr. Harvesting would take place in the off-season months and village labour is therefore valued at Won 450/man-day. It is assumed that one man can harvest and transport (by A-frame) 120 kg/day. Thus the harvesting cost would be Won 3 750 (US$7.75)/ton. Final harvest costs (year 20) are equal to Won 937 500 per ha as derived in Table 6, Footnote 2. Costs per ha by years are summarized in Table 7.

Table 5 - Unit Costs

	Units 4/	Cost W/Unit
Labor		
Harvesting 1/	m.d	450
Other 2/	m.d	1,150
Supervision		
OOF Pers.	m.d	2,500
Other	ha/yr	2,200
Transport 3/	ha	2,000
Fertilizer	kg	77.2
Seedlings	plant	11.6

1/ Harvesting takes place during the off months, therefore the minimum shadow wage was used

2/ Establishment starts at the end of the peak season for agricultural activity. Therefore a weighted average of off season and high season labour opportunity costs was used.

3/ Transport of materials (seedlings, fertilizer).

4/ m.d. = man days

Table 6 - Derivation of costs per hectare

	Units	"Forest"	"Non-forest"	Avg. 1/
SEEDLINGS				
Plants	(No./ha)	4,000	10,000	-
cost/plant	(W)	11.6	11.6	
cost/ha	(W/ha)	46,400	116,000	69,000
transport to site	(W/ha)	1,300	3,200	2,000
TOT. (Del)	(W/ha)	47,700	119,200	71,000
FERTILIZER				
Application	(g/plant)	6	6	6
Cost	(W/g)	0.077	0.077	0.077
Cost/Plant	(W/plant)			
plants/ha	(Plants/ha)	4,400	10,000	-
cost/ha	(W/ha)	1,853	4,600	2,743
transport to site	(W/ha)	100	200	133
TOT. (Del)	(W/ha)	1,953	4,800	2,876
ESTABLISHMENT (LABOR)				
Planting				
man-days	(M.D./ha)	24.6	61.5	36.5
value	(W/ha)	28,300	70,700	42,000
Fertilizing				
man-days	(m.d./ha)	6.2	15.4	9.1
value	(W/ha)	7,100	17,700	10,500
Site Prep.				
man-days		4.6		3.1
value		5,300	-	3,600
Weeding		(assumed to be offset by grass fuel collected)		
SUPERVISION				
Office of Forestry (0.1 m.d./ha/yr x W2,500/m.d.				W 250
Other (fire prevent, insect/disease control, etc.)				W 2,200
Total				W 2,450
HARVESTING				
120 kg./m.d or 8.3 m.d/ton and W 450/m.d. (Idle season labor cost)				
Cost/ton = W450 x 8.3 m.d. = W3750				
Cost/ha (by years)				
Years 0-2	Yield (ton/ha) 0			0
3	0.5			1,875
4	1.0			3,750
5	2.0			7,500
6	4.0			15,000
7-19	5			18,700
20	125			937,500 2/
MISCELLANEOUS (tools, etc.)				7,500

1/ Weighted avg. 85,836 ha of "Forest" and 41,164 ha of "non-forest"

2/ 60 Kg/man/day can be harvested. Thus the cost is $\frac{125,000 \text{ kg/ha}}{60 \text{ kg/man day}}$ x W450/man day = W937,500/ha

Table 7 - Economic Analysis of Average Fuelwood Plantation (one ha basis) 1/

W 1000/ha (constant prices)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BENEFITS																					
Fuelwood	-	-	-	6.5	13.0	26.0	52.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	1,625.0
COSTS																					
Establishment:																					
Site Prep.(labor)	3.6																				
Seedlings	71.0																				
Planting (labor)	42.0																				
Fertilizer (del/site)	2.9																				
Fertilizing (labor)	10.5																				
Weeding (labor) 2/	-	-	-																		
Supervision	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Misc. (tools, etc.)	7.5																				
Harvesting				1.9	3.7	7.5	15.0	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	937.5
Total Cost	139.9	2.4	2.4	4.3	6.1	9.9	17.4	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	939.9
NET BENEFIT (cost)	(139.9)	(2.4)	(2.4)	2.2	6.9	16.1	34.6	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	685.1

1/ Original World Bank Appraisal version corrected for consistency

2/ Weeding cost assumed to be offset by grass fuels obtained during operation.

D. PROJECT BENEFITS AND OUTPUT

34. The principal benefits of the fuelwood component would be:

(a) an increase in farmers' incomes, as a reduction in the use of agricultural residues for heating purposes would allow them to be used for composting and other productive purposes;

(b) conservation of Korea's scarce mineral energy resources (principally coal);

(c) creation of permanent timber-producing forests, as a secondary purpose of the fuelwood component;

(d) a reduction in soil erosion and flood damages; and

(e) institution building at the village level, leading to increased self-reliance.

35. At attempt is made to quantify benefits (a) and (b) by shadow pricing fuelwood as shown below. Benefits (c), (d), and (e) will be discussed only in qualitative terms. As discussed earlier, many of the fuelwood plantations would have an admixture of timber species. As the returns from timber production are known to be at least as attractive as those from fuelwood, only the latter type of plantation has been evaluated. This should provide a minimum estimate of the rate of return for the project.

Valuation of fuelwood

36. A precise estimation of the benefits of the fuelwood component is difficult, since at present fuelwood is not traded and therefore there are no data on its market value. Consequently, it is necessary to value the fuelwood in terms of the value of the fuels that it would replace, namely, agricultural residues and coal.

37. Field observations suggest that 80 percent of the additional fuelwood production would replace agricultural residues and 20 percent would replace coal. The calorific value of agricultural residues is about 90 percent that of fuelwood, while that of Korean coal (which is very low grade) is about equal to fuelwood. Thus 1 kg of fuelwood would replace 0.9 kg of agricultural residues plus 0.2 kg of coal. The price of both fuels, taken to represent their opportunity cost, is about Won 12/kg and thus the opportunity cost of fuelwood is about Won 13 000 (US$27)/ton. 1/ There is no foreign exchange effect since both substitute materials are produced and sold locally.

Project output

38. Assuming plantation establishment in Year 0, annual harvest would reach 5.0 ton/ha/y in year seven for a typical fuelwood stand. Yields would build up as follows:

Year	Yield (ton/ha)	% of full development
0-2	0	0
3	0.5	10
4	1.0	20
5	2.0	40
6	4.0	80
7-19	5.0	100

1/ i.e., 1.1 kg of other fuels is worth 1.1 x Won 12/kg or Won 13.20, which is rounded off to Won 13/kg or Won 13 000/ton.

39. It is assumed that the average plantation would be clear-cut in Year 20, yielding 125 tons/ha of fuelwood. Average yield over the rotation would be 9.4 tons/ha/yr. During Years 0 to 2, there would be a certain amount of grass and weeds produced but it is assumed that the economic value of this would be merely equal to the opportunity cost of labour used in collecting it.

Direct project benefits

40. Using the above schedule of outputs and the opportunity cost of fuelwood (estimated above as Won 13 000 per ton) we arrive at the benefit estimates shown in Table 7.

Indirect benefits

41. Besides the direct benefits of the fuelwood component, which are evaluated above, there are several indirect and intangible benefits, for which few data are available. Concentration of fuelwood production close to the village would ease the pressure on the natural "forest" around the village as a source of fuelwood and would enhance its potential for commercial timber production. Leaving forest litter on such areas would retard erosion and help to reduce flood peaks.

42. A major intangible benefit of the fuelwood component would be its contribution to the strengthening of village institutions. That is one reason why fuelwood projects are often among the first to be undertaken by "basic" villages under the Saemaul Movement. Fuelwood plantations, while technologically simple, give a very tangible demonstration to the villagers of the benefits of cooperative action.

E. COMPARING COSTS AND BENEFITS

43. The economic cost and benefit streams are shown in Table 7. The economic rate of return (ERR) is estimated to be 17 percent, which indicates that the investment is attractive.

Sensitivity analysis

44. To test the sensitivity of the ERR to different input and output assumptions, certain changes were tested. These include changes in values for costs such as fertilizer and seedling costs and benefits such as yields and price of fuelwood. In addition, alternative assumptions were tested regarding labour costs. The results are shown in Table 8.

45. As indicated in that table, the ERR is sensitive to an annual change in labour cost and to an annual change in fuelwood value, if introduced separately. In combination, a 4 percent annual increse in labour cost and a 2 percent increase in fuelwood value cancel each other out, giving an ERR of 17 percent, the same as the original ERR. This is because of the different timing of the impacts of these elements.

45. The ERR is also sensitive to other labour cost changes. The original analysis assumed that only half as much fuelwood could be cut per man day in the final harvest (year 21) as in the earlier thinnings. 1/ If it is assumed that the same amount could be cut in the final harvest, the ERR increases by 1.2 percent. The original analysis assumed that the shadow wage rate for off-season labour was Won 450 per man-day, as compared to Won 1800-1900 per man-day during the peak season. If this off-season shadow

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1/ 60 kg/day vs. 120 kg/day

Table 8 - Sensitivity Analysis [1]

Original Assumption	New assumption [2]	New ER (percent)
1. Constant real labour cost for project period.	1. 4 percent annual increase in rural labour cost.	negative
2. Constant shadow price for fuelwood for project period.	2. 2 percent annual increase in real value of fuelwood	21
3. Same as 1 and 2 above.	3. Combination of 1 and 2 above.	17 (no change)
4. Seedling cost of Won 71 000 per ha.	4. Seedling cost of Won 35 500 per ha.	20
5. Fertilizer cost of Won 2 900/ha.	5. Fertilizer cost of Won 6 000/ha.	17 (no change)
6. Final harvest of 125 tons/ha in year 20.	6. Final harvest of 29 tons/ha each in years 20-24.	16.7
7. Final harvest of 125 tons/ha in year 20.	7. No final harvest. Year 20 "thinning" of 5 tons/ha.	14.4
8. Final harvest of 125 tons/ha in year 20.	8. No final harvest. Years 20-25 annual "thinnings" of 5 tons/ha.	15.2
9. Final harvest of 125 tons/ha in year 20.	9. No final harvest. Years 20-30 annual "thinnings" of 5 tons/ha.	15.5
10. Annual thinnings of 5 tons/ha in years 16-19. Final harvest of 125 tons/ha in year 20.	10. No thinnings or harvest beyond year 15.	12.6
11. Annual thinnings of 5 tons/ha in years 13-19. Final harvest of 125 tons/ha in year 24.	11. No thinnings or harvest beyond year 12.	10.0
12. Yields as shown in Table 6.	12. Yields 80% of those shown in Table 6.	14.7
13. Yields as shown in Table 6.	13. Yields 60% of those shown in Table 6.	11.9
14. Final harvest: 60 kg/md.	14. Final harvest: 120 kg/md.	18.2
15. Off-season labour shadow wage = 450W/md.	15. Off-season shadow wage = W600/md.	14.3
16. Off-season labour shadow wage = W450/md.	16. Off-season shadow wage = W675/md.	12.7
17. Fuelwood value of W 13 000/ton.	17. Fuelwood price of W 10 400/ton (80%).	12.9
18. Fuelwood value of W 13 000/ton.	18. Fuelwood price of W 7 800/ton (60%).	5.6

1/ Original ERR was 17 percent.

2/ All other original assumptions remaining the same.

wage is raised to Won 600, the ERR falls nearly 3 percent, and if it is raised to Won 675, it falls by over 4 percent.

46. Reducing seedling cost by 50 percent increases the ERR by 3 percent, while a doubling of fertilizer cost has no effect on the ERR because it is relatively insignificant to begin with.

47. Changes in the yield and timing of output also affected the ERR When yields for each year were assumed to be 80% of the original amounts, the ERR dropped by more than 2%, and when yields were assumed to be only 60%, the ERR decreased by more than 5%. If the final harvest was spread equally over five years, due to demand deficiency or other reasons, the ERR would remain about the same. 1/ To test further for demand deficiency, it was assumed that no more than 5 tons per hectare per year could be used in the community, and that demand would drop to zero after a specified year. For a demand of 5 tons per hectare per year through year 12, the ERR dropped to 10%. For demand cut-offs after years 15, 20, 25, and 30, the ERR were 12.6%, 14.4%, 15.2%, respectively. 2/

48. Finally, if fuelwood values fell to 80% of the originally assumed value, the ERR dropped to 12.9%, and if values decreased to 60%, the ERR fell to 5.6%.

1/ This assumes that instead of harvesting the total volume of 125 tons/ha in year 20, 20 tons/ha/year are harvested from year 20 to year 24, which is a total of 145 tons over 5 years (includes 20 tons of growth over the four years from year 20-24).

2/ For demand assumptions through years 25 and 30, this assumes that the fuelwood plantations established in year 0 continue to yield 5 tons/ha/year (at the same harvest and supervision costs) through that final year of demand.

ECONOMIC ANALYSIS OF FORESTRY PROJECTS:

CASE STUDIES

FAO FORESTRY PAPER 17,

SUPPLEMENT 1

CASE STUDY NO. 3

SOUTH AMERICAN NATURAL FOREST UTILIZATION PROJECT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

Preface

This is one in a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate actual methods used in preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation for this purpose from the Swedish International Development Authority (SIDA). This case study has been prepared by FAO with the assistance of the College of Forestry at the University of Minnesota.

The present case study is based on a real project in a South American country. Certain key data have been changed to avoid disclosure of proprietary information. However, none of the realism of the original project has been lost. The case study describes the project as it was perceived at the time the original project appraisal was carried out, in 1973.

ABBREVIATIONS

ERR	=	Economic rate of return
FOB/f.o.b.	=	Free-on-board
FRR	=	Financial rate of return
HP	=	Horse power
IPT	=	Industrial production tax
NPW	=	Net present worth
TT	=	Trade tax

TABLE OF CONTENTS

INTRODUCTION

1. This is a case study of a project to expand wood supply and processing capabilities for an existing wood processing company. It is an integrated project involving harvest and utilization of natural tropical hardwoods. The proposed project would add plywood, lumber, moulding and sliced veneer capacity and expand significantly the company's ability to supply its raw material needs. The project involves increased commercialization of native species. The proposed project involves an investment of some US$13 million.

2. The Company was founded about 25 years ago as a sawmilling and log export firm. A plywood mill was added about 15 years ago and began operations with a single peeler, which has been added to at intervals so that the mill now has a capacity of about 20 000 m^3 plywood per annum. There is also a small sawmill with a capacity of about 2 800 m^3 per annum.

3. Although the plywood mill started operations almost 15 years ago, it is only in recent years, since the Company received positive incentives to encourage exports, that the mill began to operate under profitable conditions. Log exports have contributed significantly to financing the development of the current mill operation.

4. During the last few years a firm market has been established in Europe for plywood products, based mainly upon one species. From this base other species have been successfully introduced on the market. The present policy is to progressively introduce more native wood species onto the international market. This will broaden the base of raw material supply, which will improve the yield of utilizable timber per hectare.

5. This policy promises to be rewarding, particularly in the longer run, since the region's forests remain one of the few large untouched resources of tropical hardwoods left in the world. In light of growing world demand and limited expansion in other tropical zones, due to physical, economic, and in some cases political constraints, progressively more favourable market conditions for the region's forest products should develop.

6. The present mill is located on a major river, with many tributaries that supply logs to the mill. The mill site is on a small bay out of the main current - which provides a fairly still lagoon for log storage and handling. Undeveloped land on either side of the present mill site could be acquired if future expansion is warranted.

7. While the standing volume of timber in the region is large, much of it is at present inaccessible by water, which is almost the only transport means available. Further, much of the accessible timber has no known commercial market. Thus, while the region certainly could support additional processing capacity, the lack of adequate information on delivered wood cost, availability of presently marketable woods, shortage of skilled labour, infrastructure, etc., has resulted in a slow growth of the wood processing sector.

8. Since the project region is still largely undeveloped, the economic, financial and social conditions which are normally needed for a successful processing operation are not generally available. Therefore, this project raises interesting questions connected with the uncertainty surrounding the proposed operation and its treatment in an economic appraisal. Other issues in this case study include the analytical treatment of separable components, and the differences involved in financial vis-à-vis economic analyses.

9. Section A provides a description of the project, including technical considerations, availability of required inputs, market for outputs and unit prices. Section B provides estimates of project costs and benefits. Costs and benefits are compared in Section C. Finally, Section D explores the sensitivity of the project to changes in key assumptions.

A. THE PROJECT

Outputs and Inputs

10. The project includes a new plywood mill which will be added to the existing one. A new sawmill and moulding plant will also be built and the existing sawmill will be closed down. In addition, high capacity slicing equipment will replace the existing veneer slicer. A logging system new to the region will be introduced.

11. The proposed output mix of the project is structured so as to make use of a variety of species available in the region. Output volumes and types were set at levels that would not overburden the Company's marketing capacity.

Technical Considerations - Processing Components

12. The planned production mix of the industrial complex at full project development (fifth year) is summarized in Table 1. Table 2 shows build-up of production for the main products from year 0 to 4, when full production is reached for all project components.

13. The production of the existing plywood mill will be raised from about 13 000 m^3 per annum to 20 000 m^3 per annum with some minor alterations and additions and improvement in operating skills. (See Appendix 1.)

14. A new plywood mill (plymill) is proposed as the core of the industrial complex. A 3-line mill appears the most appropriate choice to take advantage of the variability of the species that occur in the region, since it greatly increases operational flexibility with no proportional increase in cost over a two-line mill. This is also important for plant maintenance and in case of breakdowns, since the operation is relatively isolated from centres of engineering and spare part supplies. (See Appendix 2 for a description of the plywood mill.)

15. With regard to the proposed sawmill, recommendations about main items of equipment and levels of mechanization have been based on the levels of skilled labour and maintenance and spare parts availabile in the area of the project. A "medium level technology" sawmill is proposed. (Details on plant, equipment and production estimates are shown in Appendix 3.)

16. A pre-drier will be installed to bring all timber for kiln seasoning down to a uniform moisture content of 30 percent. The timber will then be passed to two seasoning kilns for drying to moisture equilibrium (12-14 percent).

17. A moulding plant consists of three 6-cutter planers and moulders and one 4-cutter, together with a 3-saw trimmer. Appropriate bundling equipment is provided for, together with a packaging and covered storage area for the finished products. About 11 000 m^3 of mouldings will be processed per annum. These will be composed of a variety of products in varying proportions according to special orders. Basically two types of mouldings will be produced, i.e. wall panelling and semi-decorative mixed mouldings. (See Appendix 3).

18. The veneer slicer will consist of high capacity equipment, 4 m^3 per hour. Production will be about 500 m^3 per year. Decorative veneer has been included in the production programme in order to optimize local utilization of high grade logs suitable for veneer slicing which in the past have been exported in log form. It is estimated that such logs will not exceed one percent of total supplies.

19. Also a steam plant will be added for the new plywood mill and sawmill. It is estimated that the combined energy requirement of both mills can be adequately satisfied with the available wood waste.

Table 1 - Planned Project Output[1/]

		(m^3 per year)
Old plywood mill	plywood	20 000
New plywood mill	plywood	45 000
New sawmill/moulding plant	green lumber	30 000
	dried lumber	13 000
	mouldings	10 800
New veneer slicing plant	sliced veneer	500
	Total	119 300

Table 2 - Phasing of Output

($1\,000\ m^3$)

	Year				
	0	1	2	3	4-14
Plywood Old Mill (additional)[2/]	4.6	7.0	7.0	7.0	7.0
Plywood New Mill	-	4.4	26.0	45.0	45.0
Green Lumber	-	2.3	15.5	28.5	30.0
Dried Lumber	-	1.0	6.7	12.3	13.0
Mouldings	-	.8	5.9	10.3	10.8
Sliced Veneer	-	-	0.2	0.4	0.5
Total	4.6	15.5	61.3	103.5	106.3

1/ See Appendices 1-3 for additional details.

2/ The old mill will eventually be producing 20 000 m^3, i.e. 7 000 m^3 in addition to 13 000 m^3 being produced now.

Markets for Outputs and Price Assumptions

20. World demand for semi-decorative plywood is growing rapidly. The Company presently has difficulties satisfying foreign orders, and prices on the international market have increased substantially over the last few years. Also, several new species have been successfully tested in export markets. In local markets, prices have been lower on average than for exports but demand is also increasing steadily. It is expected that about 10 percent of the Company's production will be lower grade plywood for local markets.

21. For the purpose of economic evaluation, f.o.b. prices of $\$170/m^3$ and $\$150/m^3$ are assumed for exported and locally marketed plywood respectively.

22. The market for mouldings will be mainly the USA. Market prices vary considerably according to the type of mouldings and wood species used. A conservative average price of US$125 f.o.b. per cubic metre is used for economic calculations. This price reflects the situation on the low price US market for semi-decorative mouldings.

23. In view of the growing sawnwood deficit in Europe, there is no problem expected in placing the small planned volume of 13 000 m^3 kiln dried lumber in this market. In addition, the static but very substantial US market could be approached. The development of sawnwood exports implies the necessity to adopt suitable timber grading and seasoning methods. Given the experience of other companies in the region, no problems are expected in marketing sawnwood output.

24. The principal market for the production of green lumber will be an adjoining wood scarce region. Despite a low per capita consumption of wood products in this region, the absolute size of the market is substantial with an estimated consumption of about 400 000 to 500 000 m^3 per annum. Planned output of 30 000 m^3 should be readily absorbed at full project development in year 4, taking into account the output of competing sawmills. F.o.b. prices assumed in the economic analysis correspond to present levels, i.e., $US\$80/m^3$ for exported and $\$50/m^3$ for locally marketed lumber.

25. With regard to decorative veneer no problems are foreseen in finding markets for the modest output envisaged. An f.o.b. price of $\$300/m^3$ has been assumed as a conservative estimate for sliced veneer.

Raw Material Requirements and Supply

26. Raw material requirements will rise from an estimated 80 000 m^3 per year at present to 325 000 m^3 per year at project maturity: plywood production will require about 162 500 m^3 per year (including some 40 000 m^3 per year for the existing mill operation); sawnwood and mouldings will require 120 000 m^3; veneer will require 2 500 m^3 and log exports will absorb an additional 40 000 m^3 per year. (See Table 3 for phasing of additional requirements.) To secure this volume on a regular year-round basis, a departure from exclusive reliance on the traditional logging system will be necessary. At present logs are obtained entirely from a supply system based on the independent operations of many individual suppliers. Local workers fell the trees by axe on a narrow strip of flood plain land along the river shores upstream from the mill. As water levels rise, the logs are floated out onto the river. The logs are then bought and collected by local operators and are in turn purchased by company agents at recognized collection points. Logs are assembled into larger rafts and floated downstream to the mill, using Company tugboats for guiding the rafts.

27. Some major drawbacks of the traditional wood supply system are the following:

(1) Seasonal fluctuation of supplies as a function of seasonal flooding and the resulting necessity to operate substantial log storage or suffer irregular capacity utilization;

Table 3 - Phasing of Additional Raw Material Requirements
(m^3 (r))

	Year				
	0	1	2	3	4-14
Old Plymill (additional)[1/]	4 000	10 000	10 000	10 000	10 000
New Plymill	-	11 000	65 000	112 500	112 500
Sawmill/Moulding	-	9 000	62 000	114 000	120 000
Veneer Slicing	-	-	1 000	2 000	2 500
Total	4 000	30 000	138 000	238 500	245 000

1/ Wood requirements for the increased output from the old plymill will be covered by greater efficiency in use of the wood already coming into it plus the additional amounts shown here (which are new wood requirements).

(ii) limitation of usable species due to restricted accessible logging areas on low lands along river banks and necessity of floating the logs. This leads to little concentrated exploitation over large catchment areas, difficult logistics and high losses in transit.

28. To secure year-round log supplies, which cannot be provided by the traditional system, it is essential to introduce some form of mechanical logging which does not depend on seasonal water level variations.

29. To determine the logging methods to be adopted and to estimate in detail the investment and operating cost necessary to establish a complete system to guarantee wood supplies, as well as to provide inventories of selected areas to be logged mechanically, a forest inventory/logging survey will be carried out. The system envisioned would include a gradual and selective introduction of mechancial equipment in flood plain logging coupled with optimization of the traditional system, supplemented by dryland logging in particularly suitable areas.

30. Estimates made by the Company indicate that, by perfecting the present labour intensive log supply system, it should be possible to approximately double log supplies to about 155 000 m^3 per annum for the next 10-15 years. This would correspond to roughly one half of the project's total wood requirements at full project development. The means by which this increase is expected are better organization of assembling, improved log barging and use of new collection equipment (tugboats, radio communication). The possibility of providing about 75 000 m^3 per annum of additional logs through the traditional system and the balance (170 000 m^3 per annum) by mechanized logging is taken as the most likely assumption. The mechanized system assumed here will require investments spread over 3 years reaching production capacity of 170 000 m^3 in the fifth year. Other logging system assumptions are tested in the sensitivity analysis.

Labour and Technical Staff

31. With regard to labour, there is an adequate supply to meet project requirements, but it is generally lacking the needed skills. Absenteeism is about 10 percent per day and turnover about 10 percent annually. The lack of skills points to the need to establish in-service training and to improve the general working conditions in the plant so as to attract and retain labour. Although substantial industrial development is taking place in the region, the inflow of people from outlying areas and other parts of the country should be sufficient to ensure a readily available supply of direct production labour.

32. Since the Company's plant management in the past has shown certain deficiencies, particular emphasis will be laid on broadening the management structure and improving its quality. The number of staff in leading and supervisory functions will be increased about threefold and a number of new departments created. Initial inquiries indicate that additional technical, supervisory and executive staff can be attracted from forest industries in other parts of the country.

B. PROJECT COSTS AND BENEFITS

Costs

33. Needed investment to achieve the project's envisaged processing capacity is shown in Table 4, and phasing of the investment is shown in Table 5. Appendices 1-3 show detailed breakdown of investment costs for the processing component of the project.

34. Estimated operating costs for the processing stage at full development are shown in Table 6 and their phasing up to full development (the fifth year) is shown in Table 7. Appendix 4 shows further details for derivation of operating costs.

Table 4 - Summary of Investment Costs for Processing Stage

(US $1,000)

	Equipment	Buildings	Other Civil Works	Engineering Design[1/]	Freight, Insurance[2/]	Installation[3/]	Contingencies[4/]	Total
Existing Plymill	167	-	-	5	25	33	17	247
New Plymill	3,497	1,124	37	140	524	699	466	6,487
Sawmill and Moulding Plant	928	201	28	35	138	185	115	1,630
Veneer Slicing Plant	275	-	-	8	41	55	28	407
Steam Plant	640	60	-	21	96	128	70	1,015
Wood Assembly Equipment[5/]	105	-	-	-	15	-	11	131
Transport Equipment, Plane, Cars	100	-	-	-	15	-	10	125
Sub-Total	5,712	1,385	65	209	854	1,100	717	10,042
Total[6/]	.....7,157.....							

1/ 3% of equipment, buildings and other civil works costs

2/ 15% of equipment cost

3/ 20% of equipment cost including electrical installations

4/ 10% of equipment, buildings and other civil works costs

5/ tugboats, radio communication

6/ details of the totals are shown in Appendices 1-3

Table 5 - Phasing of Investment - Processing Stage

(US $ 1,000)

	Year									
	0	1	2	3/4	5	6-9	10	11	12/13	14
Existing Plymill	247	-	-	-	-	-	-	-	-	-
New Plymill	-	6,487	-	-	-	-	-	-	-	(330)
Sawmill and Moulding	-	1,630	-	-	-	-	-	-	-	(50)
Veneer Slicing Plant	-	-	407	-	-	-	-	-	-	-
Steam Plant	-	1,015	-	-	-	-	-	-	-	(20)
Log Assembly Equipment	131	-	-	-	-	-	131	-	-	-
Transport Equipment	100	25	-	-	80	-	100	25	-	-
Total	478	9,157	407	-	80	-	231	25	-	(400)[1/]

1/ Approximately 25% of civil works and structures used as salvage value and entered as a benefit/revenue in cash flow tables. See Table 3.

Table 6 - A Summary of Annual Operating Cost at full development processing stage[1/]

	Plymill[2/]	Sawmill/Moulding Slicing Plant	Services[3/]	Total
	(US$ '000)			
Direct production labour	678	333	195	1,206
Supervisoty & Administrative labour	144	160	588	893
Auxiliary materials	1,417	200	83	1,700
Repair and maintenance	144	48	31	222
Electricity	485	193	Negligible	678
Sales cost 5%[4/]	439	202	-	641
Reaforestation cost[4/]	31	31	-	61
Total cost[5/] (excluding logs)	3,338	1,166	897	5,400

1/ Details provided in Appendix 4

2/ Including additional costs of existing plymill

3/ Including additional cost of log assembly under traditional supply system

4/ Attributed according to sales and intake volumes

5/ Totals may not add due to rounding

Table 7 - Phasing of Operating Cost During Buildup

(1000 U$)

	Year				
	0	1	2	3	4 2/
Additional Log intake (000 m^3)	4	30	138	239	245
Additional Sales ($ 000)	777	2,221	7,685	12,605	12,828
Direct Production Labor					
- Plymill	-	166.6	500.0	678.3	678.3
- Sawmill	-	83.3	166.6	250	332.8
- Services	-	195.2	195.2	195.2	195.2
Supervisory and Administrative Labor	422.3	666.6	892.5	892.5	892.5
Auxiliary Materials					
- Plymill	125	309.6	896.5	1,416.2	1,416.2
- Sawmill	-	15.3	103.3	190	200
- Services	-	83.3	83.3	83.3	83.3
Repair and Maintenance					
- Existing Plymill	6.2	6.2	6.2	6.2	6.2
- New Plymill	-	137.6	137.6	137.6	137.6
- Sawmill Moulding	-	36.7	36.7	36.7	36.7
- Veneer Slicing	-	-	10.2	10.2	10.2
- Steam Plant	-	24.3	24.3	24.3	24.3
- Log Assembly equipment	3.3	3.3	3.3	3.3	3.3
- Transport Equipment	2.7	3.2	3.2	3.2	3.2
Reforestation	1	5	34.5	59.6	61.3
Electricity					
- Sawmill	-	48	96.2	144.3	192.5
- Plymill	-	121.1	363.6	485	485
Sales Costs	38.8	111	384.3	630.9	646.8
Total cost (excluding logs)	599.3	2,016.8	3,937.8	5,247.0	5,400.6
Service of existing enterprise 1/	(87.5)	(87.5)	(87.5)	(87.5)	(87.5)
Supplementary Cost (rounded)	512	1,929	3,850	5,159	5,313

1/ It represents sunk costs in old mill that can be used in new mill without reducing output of old mill.

2/ Operating costs in years 5-14 are the same as in year 4.

Table 8 - Phasing of Investment and Operating Costs for Logging System

Physical Flows (1000 m^3)	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Traditional system wood supply (1000m^3)[1]	4	30	75	75	75	75	75	75	75	75	75	75	75	75	75
Mechanized logging wood supply	-	-	63	164	170	170	170	170	170	170	170	170	170	170	170
Total	4	30	138	239	245	245	245	245	245	245	245	245	245	245	245
Costs ($US 1000)															
Traditional system[3]	60	450	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125
Mechanized system investment	650[2]	650[2]	1000	-	-	250	250	1000	-	-	250	250	1000	-	-
operation[4]			803	2091	2167	2167	2167	2167	2167	2167	2167	2167	2167	2167	2167
Total	710	1100	2928	3216	3292	3542	3542	4292	3292	3292	3542	3542	4292	3292	3292

[1] Assumed upper limit of 75,000m^3 additional wood per year.

[2] Pilot operation with no significant production. $400,000 of cost is non-recurring development costs; $250,000 are for equipment with five year life

[3] $15/$m^3$(r) delivered

[4] $12.75/$m^3$(r) of operating costs in addition to investment costs.

35. With regard to the cost of raw material supplies it is unlikely that, given increased future demand in the region, the cost of logs at factory gate, supplied through the traditional system, will remain at the present level. A long-term cost of logs supplied by the traditional system of US$15/m^3 at factory site is the estimate used here. This is almost twice the present cost.

36. The mechanized system of logging proposed in the project and its exact cost will depend on the result of the logging/inventory survey. For purposes of this analysis it has been assumed that the system will require an estimated initial investment of $2.3 million. Of the initial investment, $800 000 represents non-recurring development costs. The remaining $1.5 million has a five-year life. Table 8 summarises log cost assumptions using a combination of traditional and mechanized logging.

Benefits

37. Combining data about project output over time shown in Table 2 and unit price assumptions as specified earlier, the total value of output can be derived. Estimates of benefits from year 0 up through full development are shown in Table 9.

C. COMPARING COSTS AND BENEFITS

Economic Analysis

38. For the purposes of this evaluation, market values for all inputs and outputs were taken to reflect economic costs and benefits. Thus, no adjustments were made to market prices.

39. It was considered that wood essentially had an opportunity cost of zero on the stump. Even log exporting is not expected to be affected by the project. There are no apparent structural (long term) unemployment problems in the mill area for the types of labour used in the mill, so the wages and salaries paid were taken to represent economic cost as well. In the case of the labour used in logging and initial transport to collection points, the situation is more difficult to analyse. In the absence of further information on this element (which is not large in any case relative to other input costs), it was assumed that the return to this labour also adequately reflected economic costs. With regard to foreign exchange and capital, shadow prices for both should be established on a macro level. Since none were provided to the analysts by the Government, the market exchange rate and the nominal interest rate were used as measures of economic value. The flow of estimated economic costs and benefits over the life of the project (15 years) is shown in Table 10.[1]

40. Using these value estimates, the economic rate of return (ERR) of the project is 27 percent. Its net present worth (NPW), using a 12 percent discount rate, is US$9 824 000.

41. It is of interest to the Government to know the impact of the project on the balance of payments (i.e., the net foreign exchange effect). This effect is summarized in Tables 11 and 12.

42. Annual net foreign exchange earnings at full project development, taking into account the foreign exchange component of logging costs, would be about $6 million. As indicated in Table 12, the effect will vary from year to year, with a net outflow of some US$ 7.6 million during the first two years.

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[1] The costs and benefits for the log export component were not calculated since log exports were not part of the project, i.e. they did not require project investment, and would have taken place with or without the project.

Table 9 - Phasing of Revenues

($US 1,000)

Product	Price (FOB) US $/m^3	Year				
		0	1	2	3	4 and on
Plywood - Export (90%)	170	704	1,744	5,049	7,956	7,956
- Local (10%)	150	69	171	485	780	780
Green Lumber	50	-	115	775	1,425	1,500
Dried Lumber	80	-	80	536	984	1,040
Mouldings	125	-	100	737	1,288	1,350
Sliced Veneer	300	-	-	60	120	150
Total		773	2,210	7,642	12,553	12,776

Table 10 Economic Analysis of Integrated Operation

(US $1000)

		Year														
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Costs															
1	Processing - investment[1/]	478	9157	407	-	-	80	-	-	-	-	231	25	-	-	-
2	Processing - operations[2/]	512	1929	3850	5159	5313	5313	5313	5313	5313	5313	5313	5313	5313	5313	5313
3	Logging - investment[3/]	783	650	1000	-	-	250	250	1000	-	-	250	250	1000	-	-
4	Logging - operations[4/]	60	450	1928	3216	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292
5	Total	1833	12186	7185	8375	8605	8935	8855	9605	8605	8605	9086	8880	9605	8605	8605
	Benefits															
6	Plywood	773	1915	5534	8736	8736	8736	8736	8736	8736	8736	8736	8736	8736	8736	8736
7	Sawnwood/moulding	-	295	2048	3697	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890
8	Veneer	-	-	60	120	150	150	150	150	150	150	150	150	150	150	150
9	Salvage value[5/]															400
10	Total	773	2210	7642	12553	12776	12776	12776	12776	12776	12776	12776	12776	12776	12776	13176
11	Net Benefits (Costs)	(1060)	(9976)	457	4178	4171	3841	3921	3171	4171	4171	3690	3896	3171	4171	4571

[1/] Details in Table 5 and Appendices 1-3.

[2/] Details in Table 7 and Appendix 4.

[3/] Details in Table 8. Includes logging survey cost of $133,000 in year 1.

[4/] Details in Table 8. Includes cost of logs from traditional supplies.

[5/] Assumed at 25 percent of civil works and structure values

Table 11 - Balance of Payment Effects at Full Development

(US $ 1000)

Estimate of foreign exchange components	Total	Foreign Exchange
Investment[1/]		
existing plymill	247	247
new plymill	6,487	5,176
sawmill and moulding plant	1,630	1,366
veneer slicing plant	407	407
steam plant	1,015	947
transport equipment	256	256
	10,037	8,399
Operating cost at full development[2/]		
direct production labor	1,206	-
supervisory and administrative labor	893	-
auxiliary materials	1,700	1,400
repair and maintenance	222	100
electricity	678	500
sales cost	641	300
reforestation cost	61	-
	5,413	2,300
Logging investment[3/]	2,300	2,070
Logging operating cost at full development[4/]	3,292	1,975
Sales returns[4/]		
plywood	8,736	7,956
lumber	2,540	1,040
mouldings	1,350	1,350
sliced veneer	150	150
	12,776	10,496

1/ See Table 4 3/ See Table 8

2/ See Table 6 4/ See Table 9

Table 12 - Phasing of Balance of Payments Effect

(US $ 1000)

	Years														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Foreign Exchange Outflow[1/]															
Plant - investment	478	7506	407	-	-	80	-	-	-	-	198	-	-	-	-
Plant - operating cost	198	798	1600	2196	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300
Logging - costs	594	715	1903	2090	2139	2302	2302	2789	2139	2139	2302	2302	2789	2139	2139
Sub-total	1270	9019	3910	4286	4439	4682	4602	5089	4439	4439	4800	4602	5089	4439	4439
Foreign Exchange Inflow															
Sales	704	1924	6382	10348	10496	10496	10496	10496	10496	10496	10496	10496	10496	10496	10496
New foreign exchange inflow (outflow)	(566)	(7095)	2472	6062	6057	5814	5894	5407	6057	6057	5696	5894	5407	6057	6057

[1/] Estimates based on detailed analysis of materials, equipment and service requirements

Table 14 - "Rural Fund" Payment Due on Logs

	Years				
	0	1	2	3	4 and on
Total logs purchased ($1000m^3$)	4	30	138	238.5	245.0
Value of logs at point of takeover [1/]	40	300	1380	2385	2450
Rural fund due [2/]	0.8	6.0	27.6	47.7	49.0

1/ Assumed value is $\$10/m^3$ at point of takeover

2/ 2% of value of logs at point of takeover

Table 13 - Expenditures and Receipts Due to Tax Legislation During Buildup Period

(US $ 1000)

	Year				
	0	1	2	3	4 and on
Local Sales 1/					
Plywood	69	171	485	780	780
Sawnwood	-	115	775	1,425	1,500
Export Sales 1/					
Plywood	704	1,744	5,049	7,956	7,956
Sawnwood	-	80	536	984	1,040
Mouldings	-	100	737	1,288	1,350
Veneer	-	-	60	120	150
Industrial Production and Trade Taxes due 2/					
Plywood (local sales)	10.1	24.8	71.8	113.1	113.1
Sawnwood (local sales)	-	3.4	23.2	42.7	45.0
Total Due	10.1	28.2	95.0	115.8	158.1
Industrial Production and Trade Tax Credits 2/					
Plywood export	102.1	252.9	732.1	1,153.6	1,153.6
Sawnwood export	-	2.4	16.1	29.5	31.2
Mouldings export	-	10.0	73.7	128.8	135.0
Veneer export	-	-	8.7	17.4	21.7
Total received	102.1	265.3	830.6	1,329.3	1,341.5
Net amount received 3/	92.0	237.1	735.6	1,173.5	1,183.4

1/ From Table 9.

2/ Tax rates in percent of value:

Sawnwood	3.0
Plywood and veneer	14.5
Mouldings	10.0

paid on local sales/credited to company on export sales.

3/ Total received minus total due.

Table 14 - "Rural Fund" Payment Due on Logs

	Years				
	0	1	2	3	4 and on
Total logs purchased ($1000m^3$)	4	30	138	238.5	245.0
Value of logs at point of takeover [1]	40	300	1380	2385	2450
Rural fund due [2]	0.8	6.0	27.6	47.7	49.0

[1] Assumed value is $\$10/m^3$ at point of takeover

[2] 2% of value of logs at point of takeover

Table 15 - Financial Analysis of Integrated Operation

(US $ 1000)

	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Sources/Comments
Expenditures																
Processing - investment	478	9157	407	-	-	80	-	-	-	-	231	25	-	-	-	Table 10
Processing - operations	512	1929	3850	5159	5313	5313	5313	5313	5313	5313	5313	5313	5313	5313	5313	" "
Wood supply - investment	783	650	1000	-	-	250	250	1000	-	-	250	250	1000	-	-	" "
Wood supply - operations	60	450	1928	3216	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	" "
Loan																
interest due - grace period	-	70	1010	1150	-	-	-	-	-	-	-	-	-	-	-	Appendix 5
principal and interest repay	-	-	-	-	3034	3034	3034	3034	3034	-	-	-	-	-	-	" "
Rural fund payment	1	6	28	48	49	49	49	49	49	49	49	49	49	49	49	Table 14
Total	1834	12262	8223	9573	11688	12018	11938	12688	11688	8654	9135	8929	9654	8654	8654	
Receipts																
Sales																
Domestic	69	286	1260	2205	2280	2280	2280	2280	2280	2280	2280	2280	2280	2280	2280	Tables 9, 12
Export	704	1924	6382	10348	10496	10496	10496	10496	10496	10496	10496	10496	10496	10496	10496	" " "
Salvage value	-	-	-	-	-	-	-	-	-	-	-	-	-	-	400	Text
Loan																
Plant	450	9150	400	-	-	-	-	-	-	-	-	-	-	-	-	Appendix 5
Logging	250	250	1000	-	-	-	-	-	-	-	-	-	-	-	-	" "
Net IPT/TT benefits[1/]	92	237	736	1173	1183	1183	1183	1183	1183	1183	1183	1183	1183	1183	1183	Table 13
Total	1565	11847	9778	13726	13959	13959	13959	13959	13959	13959	13959	13959	13959	13959	13959	
Net Receipts (expenditures) Before taxes	(269)	(415)	1555	4153	2271	1941	2021	1271	2271	5305	4824	5030	4305	5305	5705	-
Corporate taxes	-	-	-	-	-	-	-	-	-	-	1592	1660	1421	1751	1883	Text
Net Receits (expenditures)after taxes	(269)	(415)	1555	4153	2271	1941	2021	1271	2271	5305	3232	3370	2884	3554	3822	-

1/ Benefits not exempt from corporate taxes.

D. SENSITIVITY ANALYSIS

52. The sensitivity of the measures of project economic worth to changes in assumptions concerning values of a number of key parameters is shown in Table 16.

53. It is evident that only one alternative (No. 4) in Table 16 brings the ERR down below 12 percent. This is the case when it is assumed that all costs are 20 percent higher than the original assumption. If all costs were 15 percent higher (No. 5 in Table 16), the project would just break even at 12 percent.

54. Since prices used to value outputs in the analysis were conservative estimates, the sensitivity of the ERR and NPW were also tested for output price increases. In Case No. 2, operating costs were increased by 4 percent and revenues by 2 percent on a compound basis. As shown, this results in a slight increase in the ERR and NPW over results achieved in the original analysis. Similarly, in Case No. 6 all costs and revenues with the exception of salvage value, were increased by 10 percent over the values of the original assumptions. The result is a slight increase in both ERR and NPW. More optimistic changes (increases) in revenues would raise the ERR above 28 percent and the NPW at 12 percent above US$11 million.

55. There is considerable uncertainty surrounding the costs for wood that will result with the new mechanized logging system. Thus the sensitivity of the project's NPW and ERR were analysed for alternative, higher operating costs for the mechanized system. The results are as follows:

Delivered wood cost (excl. investment) (US$/m^3(r))	ERR (percent)	NPW (US$ 1 000)
12.75 (orig. assumption)	27	9 824
25.50 (100% increase)	9	(1 463)
19.13 (50% increase)	19	4 155

56. As indicated, in the unlikely event that operating costs for the mechanized system were twice the expected cost used in the analysis, the ERR would drop to 9 percent and the NPW would become negative at 12 percent. With operating costs one and a half times the original estimate, the ERR would only drop to 19 percent and the NPW would remain positive.

57. In sum, using 12 percent as the relevant discount rate or cutoff rate, the project remains viable under a variety of reasonable potential cost increase assumptions.

58. In connection with the financial sensitivity of the project, the financial cash flow is the same as the economic cash flow, with the exception of the loan, fiscal incentives and tax components. The difference between the ERR and FRR is due entirely to these components. If the loan were halved, the FRR would be 51 percent. If the loan were removed, the FRR would drop to 35 percent. Thus, even if the loan were not secured, the project would appear to be viable for a private enterprise with an alternative rate of return below 35 percent.

Table 16. Sensitivity of Measures of Project Economic Worth to Changes in Assumptions[1/]

No.	New Assumption	New ERR (percent)	New NPW using 12 percent discount rate ($US 1000)
1	operating costs for processing phase increase by 4 percent per year on a compound basis	14	674
2	operating costs and sale revenues increase by 4 and 2 percent per year respectively on a compound basis	28	10,760
3	all costs 10 percent higher than in Table 10	ERR >12%	3,622
4	all costs 20 percent higher than in Table 10	ERR <12%	-2,580
5	all costs 15 percent higher than in Table 10	ERR ≈12%	521
6	all costs and revenues 10 percent higher than in Table 10	ERR >27%	10,797

[1/] Original ERR = 27 percent and NPW = $US 9,824,000. The original value flow data are shown in Table

APPENDIX 1

Present Plywood Plant - Recommended New Equipment

Item	Cost US$
1 Waste hog	21 000
1 Green veneer pneumatic clipper	19 000
1 Torwegge type veneer composer complete with Diehl type jointer and glue applicator	30 000
6 Sets Carboloy sizing saws - 3 Rip 3 Cutoff	3 000
2 8 000 lb loft trucks	25 000
1 Dust extractor system - Cyclone	15 000
1 Plywood pre-press	15 000
1 Dump truck for hog fuel	8 000
2 Lay up hoists for spreaders	6 000
Total	142 000

Other Installations

Item	Cost US$
Lathe waste conveyor to hog	2 000
Infeed and outfeed to hog	1 000
Hog conveyor to fuel storage bin or boilers	1 500
Direct hook up to clippers	7 500
Rebuild transfer infeed to clippers	2 500
Rebuild and extend green chain offbearing tables	2 500
Build hog fuel storage bin	2 000
Relocation of sizing saws	3 000
Plywood pre-press transfer rolls	3 000
Total	25 000
Grand Total	167 000

APPENDIX 2

New Plymill and Veneer Slicing Operations

Plymill - Plant Type, Capacity and Investment Cost

1. The proposed plywood plant would have a productive capacity of 45 000 m^3 of finished plywood per annum on the basis of two ten hour shifts, operating 288 days per annum.

2. The plant is designed to manufacture phenolic and urea resin bonded plywood from four principal species.

3. Increasingly, other species can be utilized with improved log supply.

4. Recovery is based on 40% of cubic input to finished plywood. This is low by international standards but has been taken as a conservative estimate in the light of technical skills at present available.

5. The plywood would have a main building area of 11 - 12 000 m^2. The buildings would be of steel frame and other materials not subject to damage by insect or climatic conditions in the area, and have reinforced concrete floors. Foundations for the major equipment would be on piling.

6. Peeler log diameters would range from 45 cm to 110 cm.

7. Veneer will be peeled on high production lathes fully equipped with dual spindles, block charger and back pressure roll attachment. Veneer from the lathe will go direct to the veneer clippers where usable widths and grades would be sized for further processing.

8. The green veneer would be dried in steam heated veneer dryers; moisture meters would be installed at the outfeed end of the dryers to ensure maximum production and proper moisture content for quality of bond in later process.

9. The veneer preparation department would consist of dry veneer recovery clippers, manually operated, veneer jointers and veneer taping machines to process the random width veneers to full sheet sizes for the gluing operations.

10. Two glue spreaders for each line would be provided for the lay up of veneer prior to pre-pressing and hot pressing in 5 ft by 8 ft 20-opening hot presses, equipped with press loader and unloader. Glue mixing facilities and storage for adhesives and components would be adjacent to the main building at ground level, with the mixed glue being pumped to the spreaders. The finishing department would consist mainly of a panel sizing unit, putty patching facilities, wide belt speed sanders, crating, steel strapping, storage and shipping accommodation. Refuse conveyors would be arranged for the disposal of waste materials and a dust collection system would be installed. Peeler cores would not be fired in the boilers as presently but sawn to produce packaging crates or low grade lumber for local sales. Storage areas for green veneer, dry veneer and finished plywood would be provided. The movement of materials within the plant would be by lift trucks and dollies.

11. Total installed power would be about 4 000 HP.

12. The loading or shipping area would be in line with the storage area for finished products.

13. At this stage the equipment is listed only in such detail that the major equipment items, capital cost and manufacturing cost estimates can be outlined.

14. Detailed equipment comparisons and design development work will be required to make final decisions on such items as plant layout and equipment selection and have been accounted for in the investment cost estimate.

15. Investment costs of new plymill are shown in Appendix 2, Table 1. Table 2 shows equipment needs and capital cost estimates for the veneer slicing operation.

APPENDIX 2

Table 1 - Investment Cost - New Plymill

	Equipment	US$
A.	Debarker	90 000
	Blocksaw	25 000
	Front end loader	135 000
	Bark hog	17 000
	Lathe chargers	195 000
	8' veneer lathes	435 000
	Green veneer clippers	54 000
	Green veneer core saws	30 000
	Veneer waste hog	15 000
	Veneer driers	525 000
	Veneer moisture meters	33 000
	Veneer jointers	90 000
	Veneer tapers	36 000
	Torwegge veneer composer	45 000
	Glue spreaders	60 000
	Lay up scissor hoists	18 000
	Plywood pre-presses	45 000
	20-opening hot presses	375 000
	Hot press loader and unloaders	330 000
	Glue mixers, tanks, scales etc.	30 000
	Sizing and edging saws	105 000
	Sub-total	2 688 000
	2 Drum (1 top and 1 bottom) wide belt speed sanders	150 000
	Cyclone dust collection system	35 000
	Air compressors	45 000
	Veneer carts	9 000
	Waste conveyors, waste hog machines	200 000
	Fork lifts	100 000
	Strapping tools	1 000
	Maintenance equipment	25 000
	Sharpening and grinding equipment	20 000
	Spare parts	75 000
	Total	3 347 000
B.	Buildings including floor, lighting, sprinklers, 11 240 m^2 at 100 $/$m^2$	1 124 000
C.	Logyard 5 000 m^2	17 000
	Hoists, log-lifting equipment	150 000
	Log sorting	20 000
Total investment (excluding freight, installation, etc.)		4 658 000

APPENDIX 2

Table 2 - New Veneer Slicing Operation

Major Equipment and Capital Cost Estimate

	Item	Cost Installed $ US
1	Overhead hoist and monorail	3 000
	Motors, starters, wiring	4 000
1	8 ft vertical type of veneer slicer complete with carriage and controls	85 000
1	Single line endless bed veneer drier	100 000
1	Veneer guillotine jointer	30 000
2	Diehl veneer tapers complete with motors and controls	25 000
1	8 000 lb lift truck	10 000
25	Veneer dollies for transport of veneer within the plant	3 000
2	Sunken steam or hot water vats	10 000
1	20 litre glue mixer and other miscellaneous supplies	5 000
	Total Slicer Operation - Equipment	275 000

APPENDIX 3

Sawmill and Moulding Plant

A. INTRODUCTION

1. The general concept in the design of the sawmill is to provide equipment and a process flow which is to be operated and maintained according to the required high production capacity and to the given special conditions of the raw material and the technological level of the available manpower.

2. The raw material consists of logs of different tropical species (up to 30 and more) with a density range from 400 kg/m^3 to 800 kg/m^3. The diameters vary from 40 cm to about 1.5 m with an average of about 60 cm.

3. The presently available labour force and supervisory staff shows a medium level technological expertise but it seems to be able to advance with the future requirements of the production.

4. Accordingly a band sawmill has been selected having an intermediate level of mechanization but which can be more highly mechanized at a larger stage.

B. SAWMILL AND MOULDING PLANT: OUTLINE OF PRODUCTION PROCESS

5. (i) Basic technical data:

Input	120 000 m^3 logs/yr
Operating period	2 x 10 hr. shifts/day 288 days/yr
Average log size	- diameter : 0.43 m - length : 4.00 m - volume : 0.57 m^3
Recovery	sawn lumber : 55% all products : 45%
Output products	30 000 m^3 green lumber 13 000 m^3 dried lumber 8 640 m^3 net, moulding for panelling walls and ceilings 2 160 m^3 net other mouldings
Total products for sale	53 800 m^3 = 45% net recovery
Waste	62 800 m^3 (600 kg/m^3 density absolutely dry) 32 680 tons absolutely dry All products : 53 800 m^3 Waste : 62 800 m^3 Shrinkage lost : 3 400 m^3 Total 120 000 m^3

6. (ii) Primary log breakdown:

Two log bandsaws with carriages of heavy duty, mechanised with hydraulic clips, log turner ("nigger"), log loader ("flipper") and reception arms.

The log-bandsaws and carriages would remove the outside slabs and cut the centre of the logs into cants and side pieces.

In case of a breakdown at the secondary equipment (re-saws) the log-bandsaws would do more cutting; they would also produce lumber for edging.

7. (iii) Secondary breakdown equipment:

Following the log bandsaws and carriages, the secondary equipment would consist of 3 band re-saws for re-sawing the cant to raw boards for mouldings and 2 twin-edgers for edging the side pieces and the lumber cut for sale.

An undertable crosscut saw should trim the side pieces if it is necessary.

8. (iv) Cutting procedures:

The 3 re-saws should be interconnected by transport facilities in a way that the cants, not having been cut completely in the first passing, can return to the second or to the first re-saw (merry-go-round). The transport of cants, slabs and boards has to be mechanized with longitudinal and transversal conveyors.

9. (v) Impregnation, trimming and grading of green lumber for sale:

At the end of the cross transfer green chain, the green lumber for sale should be classified, impregnated, trimmed and marked.

10. (vi) Drying:

In the pre-drier the lumber should be dried from green to a uniform moisture content of about 30%. In this manner the kiln-drying equipment could be used more effectively and overall costs would be reduced as compared with a system of exclusive kiln drying.

Two kiln-driers should establish the final moisture content of the dried product at about 12%.

At the lumber yard packages sorted by species should be collected to complete loadings for the pre-drier. All transport should be made with fork-lift trucks.

11. (vii) Moulding plant:

The dried lumber should be moulded, trimmed, bundled and packed. The dried lumber for sale should be trimmed and classified in the same plant.

Major Equipment Items

12. Sawmill

		HP	Investment Cost
(1)	**Cutting equipment**		
(a)	2 log bandsaws 20 m/min. each 65 ft/min. each	400	
(b)	3 re-saws 22 m/min. each 72 ft/min. each	300	
(c)	2 twin-edgers 34 m/min. each 110 ft/min. each	100	
(d)	1 undertable cross-cut saw	5	
(e)	1 three-saw trimmer	10	
(2)	**Conveyor equipment**		
(a)	1 log-cutter	15	
(b)	1 log-haul	10	
(c)	3 log-kickers	6	
(d)	2 live log-decks	10	
(e)	153 m. roller conveyor)	100	
(f)	24 m. re-saw feeding c.)		
(g)	54 m. green chain transfer	40	US$ 480 000
(3)	**Other sawmill equipment**		
(a)	saw-dust conveyor)		
(b)	waster transfer)		
(c)	waste hog)	175	
(d)	compressor, etc.)		
(e)	saw sharpening equipment)		
			US$ 115 000
(4)	**Internal transport**		
	2 front-fork lift trucks 3 tons capacity each		US$ 25 000
			US$ 620 000

13. Drying equipment

	HP	Investment Cost
(1) 1 preseasoner 9 x 2 x 40 m^3 = 375 m^3 Board cap.	50	US$ 60 000
(2) 2 drying kilns 7 x 4.5 x 20 m^3 c.o. = 300 m^3	150 each	US$ 200 000

14. Moulding equipment

(1) 3 six cutter planer and moulder 15 m/min. each 50 ft/min. each	135	US$ 35 000
(2) 1 four cutter planer and moulder 11 m/min. 35 ft/min.	16	US$ 7 000
(3) 1 three-saw trimmer	15	US$ 5 000
(4) bundling equipment		US$ 1 000
Total investment for equipment and machinery	1 552 HP	US$ 928 000

Electricity consumption : 1 552 HP = 1 130 kw = 1 614 KVA x 20 hr x 288 days x 0.8 (utilization factor) = 7 436 800 Kwh/year

APPENDIX 4

Estimated Operating Costs - Processing Stage

Estimate of cost of auxiliary materials at full project development, including cost of glues in plywood production

		US$ p.a.
(A) Plymill		
(a) Glues		987 786.60
(b) Other auxiliary material (US$8.30/$m^3$ produced)		433 333.30
	Total	1 421 119.90
	Rounded	1 420 000
(B) Sawmill/Moulding/Slicing Plant		
(a) Knives, chemicals, etc.		
US$ 2 m^3 sawn wood		132 000
US$ 1 m^3 mouldings		10 800
(b) Packaging material		
3% of f.o.b. value of mouldings and sliced veneer		45 000
	Total	187 800
	Rounded	190 000
(C) Services		
- Mainly hooks, cables US$ 0.17/m^3		40 833.30
- Fuel for boats (additional)		22 000.00
- Other		16 666.60
	Total	79 499.90
	Rounded	80 000

Estimate of Costs of Glues in Plywood Production

Ingredient	Quantity Consumed per m^3 of Plywood (kg)	Price (US$)	Total Cost (per m^3)
A. Phenolic Glues			
Phenol Resin	37.0	0.4	14.8
Hardener HP4	15.0	0.215	3.225
Albapin	1.5	1.06	1.59
Flour	1.5	0.206	0.309
		Total	19.924
		Rounded	20

Ingredient	Quantity Consumed per m^3 of Plywood (kg)	Price (US$)	Total Cost (per m^3)
B. Urea Formol Glues			
Urea Resin	27.0	0.235	6.345
Hardener FH-40D	1.0	0.315	0.315
Flour	16.0	0.206	3.296
Emulsion TF	3.0	2.10	6.3
		Total	16.256

Total additional cost of glues at full development:

40 000 m^3 phenolic	x	20	=	800 000
12 000 m^3 urea formol	x	16.25	=	195 000
				US$995 000

Cost of the Reafforestation Programme

Year	1	2	3	4	5
Logs utilized ('000 m^3)	4	20	138	239	245
Annual cost of reafforestation (US$ 1 000)	1	5	34.5	60	61.3

Estimate of Electricity Costs

	Sawmill/ Moulding	Plymill	Total
Installed power (hp)	1 600	4 000	5 600
Installed power (kw)	1 176	2 940	4 116
Installed power (kva)	1 680	4 200	5 880
Operating Hours p.a.	* * * * * * * * * * *	5 760	* * * * * * * * * *
Utilisation factor of installed electrical equipment	-	0.8	-
KWH consumed p.a.	7.7 million	19.4 million	27.1 million
Cost per KWH	-	$0.25	-
Electricity cost p.a.	US$ 192 500	US$ 485 000	US$ 677 500

Estimate of Management and Labour Cost

		Per Month (US$)		Per Annum (US$)
1	Managing Director	1 666.60		20 000
4	Directors	133.30		64 000
14	Managers	833.30		140 000
1	Chief Accountant	833.30		10 000
1	Company Doctor	833.30		10 000
2	Foresters	833.30		20 000
	Total			264 000
	Social Charges 60%			158 400
				422 400
24	Superintendents, supervisors	300		
2	Engineers	300		
1	Saw Doctor	300		97 166.60
1	Staff Nurse	166.60		
12	Buyers	166.60		
5	Lagoon Foremen	166.60		
19	Plymill Foremen	166.60		
6	Sawmilling/Moulding Foremen	166.60		
1	Slicer Plant Foreman	166.60		
8	Maintenance Foremen	166.60		
30	Secretarial Staff, Clerks, Drivers, etc.	166.60		169 000.00
	Total			261 166.60
	Social Charges 80%			208 933.30
				470 099.90
	Workers			
182	Sawmilling/Moulding	66.60		
26	Veneer Slicing	66.60		
20	Lagoon	66.60		
424	Plymill	66.60		
50	Boat Crews	66.60		
20	Power/Boiler	66.60		
12	Maintenance Sawmill	66.60		
20	Maintenance Plymill	66.60		
	Total			603 200
	Social Charges 100%			603 200
				1 206 400
	Total Labour Cost		US$	2 098 899
	Expatriate Staff during Running-in Period (1 year)			
1	Technical Director Plymill	5 000		60 000
1	Technical Director Sawmill	5 000		60 000
1	Production Manager Plymill	4 000		48 000
				168 000

Estimate of Repair and Maintenance Cost

(Supplementary)

	Civil Works and Buildings 1/ (US$ '000)	Equipment 2/ (US$ '000)	Total (US$ '000)
Existing Plymill (new investment)	-	6.2	6.2
New Plymill	13.8	123.9	137.7
Sawmill and Moulding Plant	2.6	34.2	36.8
Veneer Slicing Plant	-	10.2	10.2
Steam Plant	0.7	23.7	24.4
Transport Equipment	-	3.1	3.1
Wood Assembly Equipment	-	3.3	3.3
Total	17.1	204.6	221.7

1/ 1% of investment cost p.a.

2/ 2.5% of investment cost p.a.

APPENDIX 5

Loan: Derivation of Interest and Principal Repayment

Conditions: 3-year grace period on principal repayment and 10% interest with full repayment by year 9.

Year	New Loan Given (beginning year)	End of Year Total Loan Outstanding	Beginning year payments Interest	Principal	Total
		(US$ 1 000)			
1	700	700	-	-	-
2	9 400	10 100	70	-	70
3	1 400	11 500	1 010	-	1 010
4	-	11 500	1 150	-	1 150
5	-	9 616	1 150	1 884	3 034
6	-	7 544	962	2 072	3 034
7	-	5 264	754	2 280	3 034
8	-	2 757	526	2 507	3 034
9	-	-	276	2 757	3 034

Note: Repayment of principal (and interest) for the last five years could also bave been obtained by using the capital recovery multiplier formula, $\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$, where i = 10% and n = 5 years. Looking this factor up in standard tables and multiplying it (0.2638) times the principal outstanding ($11 500 000) we arrive at the annual payment of $3 034. Note also that interest is not paid until the year after the loan is received (see years 1-3).

ECONOMIC ANALYSIS OF FORESTRY PROJECTS: CASE STUDIES

FAO FORESTRY PAPER 17, SUPPLEMENT 1

CASE STUDY NO. 4

KENYA I SAWLOG AND PULPWOOD PLANTATION PROJECT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

Preface

This is one of a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate methods of identifying, preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation to FAO for this purpose from the Swedish International Development Authority (SIDA). This case study has been compiled by FAO with the assistance of the College of Forestry at the University of Minnesota.

The project reported on in this case study is a project of the Government of Kenya which has been supported by a loan from the World Bank. The case study is based largely on material contained in an appraisal of the project carried out by the World Bank (Report No. 706-KE). Additional information was gathered through a visit to the project. The case study describes the project as it was perceived at the time of appraisal in 1974. This material has been released to FAO by the World Bank and the Government of Kenya exclusively for the purpose of teaching forestry planning methods. It may not be quoted or reproduced in part or in whole without permission.

ABBREVIATIONS

ERR	=	Economic rate of return
F.O.B.	=	Free on board
FRR	=	Financial rate of return

CURRENCY EQUIVALENTS

Currency Unit	=	Kenya Shilling (KSh)
US$ 1	=	KSh 7.14
KSh 1	=	US$ 0.14
K£ 1	=	US$ 2.80
	=	KSh 20

TABLE OF CONTENTS

INTRODUCTION

1. This case study is based upon a project which is part of Kenya's continuing industrial sawlog and pulpwood production programme[1]. It is a "time slice" project covering plantation activities during the years 1970-1975. A continuation project, started in 1975, is covered in a separate case study[2].

2. The project involves the establishment and maintenance of about 19 400 ha of sawlog plantations and 9 350 ha of pulpwood plantations located in the Kenyan highlands. The pulpwood plantations will be established near the proposed site of Kenya's first pulpmill. The mill is expected to be built during the first years of the plantation project and will have an annual output of 50 000 metric tons, almost all of which will be consumed domestically. Local sawmills are expected to process all of the sawlog output. Half of the sawnwood produced is expected to be consumed domestically and half exported, mostly to the Middle East and Europe.

3. In addition to plantations, the project includes roads, buildings, vehicles and equipment for Kenya's continuing plantation programme. The project expenditure over the six-year period of plantation establishment totals approximately US$ 4.0 million.

4. The case study is divided into five sections. Section A provides background to the project. Section B gives the specific technical details of the project, including estimates of input requirements and output levels. Section C analyses project costs, while Section D discusses project benefits. Section E provides a comparison of costs and benefits and looks at the sensitivity of the economic analysis and the economic rate of return (ERR) to changes in assumptions concerning input and output values.

5. The present case study raises many of the issues commonly associated with appraising industrial afforestation projects. These issues include a number of shadow pricing points, relating to the value of labour, forest land and the project outputs. It also provides background for discussion of a number of forest management issues (including questions of thinning regimes and separate or joint production of sawlogs and pulpwood)[3]. Finally, in combination with the case study of the followup project, it provides useful insights into how information availability and thinking about a major plantation programme evolved over time.

A. BACKGROUND

6. Kenya's population was estimated to be 9.9 million in 1967. The northern and northeastern parts of the country, comprising three-fifths of the whole, are arid. Northwest from a low-lying tropical coastal plain, the country rises to the Kenya Highlands - a block of alternating plateaux and mountain ranges at elevations of up to 4 000 metres. The principal forest areas are located in these areas of high elevation and favourable rainfall.

7. Forestry and forest industries account currently for less than 2 percent of GDP. Forestry employs between 8 000 and 9 000 permanent workers and forest industries a further 1 500. Kenya's indigenous forest resources cover some 17 275 km^2 over approximately 3 percent of the country's total land area. Over the last 50 years, these forests have been systematically exploited, mainly for the production of sawn timber. The economically accessible reserves of the main commercially valuable species (Podocarpus gracilior, Podocarpus milanjianus, Juniperus procera, Ocotea spp., Olea spp.) have been largely cut out.

1/ Policies and practices described in this case study are not necessarily those actually in force in Kenya, either at present or during the period covered by the project.

2/ See Case Study No. 5 "Kenya II Sawlog and Pulpwood Plantation Project".

3/ A feature of this particular case is that the outlets for its products were well defined, as were nearly all questions about species choice and treatment. For an industrial afforestation project where these aspects presented a much greater degree of uncertainty, see Case Study No. 6 "Zambia Industrial Forestry Project".

8. Regeneration with indigenous species is difficult and growth rates for these species are low. Conversely, regeneration with exotic, fast-growing pine, cypress and eucalypt species has proved very successful. Favourable climatic conditions in the Highlands - a rainfall satisfactory in both amount and distribution, and the lack of any extremes of temperature to cause an annual period of dormancy or slow growth - coupled with fertile deep volcanic soils, make the area comparable with the world's best softwood growing areas. Consequently, since 1945, the Forest Department has been engaged in a systematic reafforestation programme on the cut-over indigenous forest areas using these exotic species. By 1968 nearly 80 000 ha of pine and cypress and 8 000 ha of eucalypt had been planted. The plantations have recently begun to yield substantial volumes of timber (164 000 m^3 of roundwood in 1967 compared to 42 000 m^3 in 1958).

9. Headed by a Chief Conservator of Forests, the Forest Department consists of 35 senior staff (Graduate Forest Officers), 104 intermediate staff (Senior Foresters and Foresters), 142 Rangers and 897 Forest Guards. The total permanent labour force is about 8 200, including miscellaneous staff such as drivers and clerical staff.

10. The Government's 1965-70 Development Plan provided for a continuation of the present planting programme at a yearly rate of about 6 000 ha of sawlog and pulpwood plantations. This would entail Government investment until about 1980; thereafter, the softwood programme should be self-supporting financially. The planting programme is spread over more than 40 Forest Districts in 11 geographic Forest Divisions.

11. On the industrial utilization side the majority of sawmills require modernization, although some improvement for selected mills and associated logging operations has been made in recent years. A factory to produce low-cost prefabricated wooden houses has begun production at Nakuru. An expansion of this activity would foster sawnwood sales. Until 1968, Kenya imported all her plywood and veneer requirements from Uganda, Tanzania and overseas. (See Net Trade Balance in Forest Products, Appendix 1). A new plywood mill at Elburgon in Kenya, using coniferous plantation wood, commenced production in 1968, and another mill at Elgeyo will start operation in early 1969.

12. All Kenya's pulp and paper consumption is presently based on imports. Plans are now under consideration for a pulp and paper mill to be situated on the Nzoia River at Webuye (Broderick Falls) in the Western Province, 300 km west of Nairobi (see map, Appendix 2). The mill would have two paper machines with total rated capacity of 45 000 metric tons of paper per annum. A first expansion to 75 000 metric tons is anticipated by about 1977, but will be dependent upon development of the market. The mill would produce both bleached and unbleached paper products including kraft paper, paperboard, carton board, and uncoated printing and writing paper, but not newsprint.

13. Under current plans, the mill would be commissioned in early 1972 and would be operating at full capacity by 1974/75. The expansion to the 75 000 ton capacity in 1977 would require temporary exports of limited quantities, but by 1982 domestic demand would again catch up with the mill's output. The pulpwood requirements would be of the order of 400 000 m^3 annually by 1982/83, and by that time the first deliveries from the proposed pulpwood plantings could be expected. Until pulpwood plantings are ready for cutting, the mill would obtain its pulpwood requirements from plantations originally established for sawnwood and situated within distances of 100-150 km from the mill.

14. An existing import duty of 15 percent on industrial paper is waived for most imports at the present time. However, to encourage the new mill, the Government of Kenya has agreed to impose a 40 percent ad valorem tariff on all paper products and pulp imports. A financial return of about 19 percent is estimated for the proposed mill, based on estimated prices taking the tariff into account.

B. DESCRIPTION OF THE PLANTATION PROJECT

15. The project consists of the establishment and maintenance of 19 425 ha of sawlog plantations and 9 350 ha of pulpwood plantations. The sawnwood plantations would be located near the road and rail axis of Nairobi-Eldoret-Uganda, (see map, Appendix 2) and would constitute about two-thirds of Kenya's total sawlog plantings during the period 1970-75. The pulpwood plantations would be located close to the proposed Webuye pulpmill. Project plantations would be established in the six years 1970-1975 and output would be used to meet domestic demand for sawn timber and plywood and as raw material for the proposed Webuye pulp and paper mill.

Sawnwood Plantations

16. Cypress (Cupressus lusitanica) and pine (Pinus patula) would be the two principal sawlog species planted. Both would be grown on a 30-year rotation. Cypress has given uniformly successful results in the project areas and its timber is of excellent quality both as sawnwood and as plywood peeler logs. The spacing used would correspond to a stand of 1 680 trees per ha. The average yield of commercial timber for this species in the project area is estimated to be 560 cubic metres per ha over a 30 year rotation. This is made up of approximately 70 cubic metres per ha for each of two thinnings at 15 and 20 years, and about 420 cubic metres per ha when the trees are clear-felled at 30 years (see Table 1 for total sawlog yields). While pine yields are anticipated as being higher, sound and conservative management dictates that within the six years of the planting programme a balance should be maintained between plantings of the well-tried cypress and the more newly-introduced pine. In addition, the plantings of two species will reduce the risk of extensive damage caused to the plantations by possible spreading disease. It is estimated that about 80 percent of sawnwood plantings would be of cypress. Sufficient seeds are available from local seed orchards, and seedlings would be raised at District nurseries. Planting would be made after clearing of indigenous forests, at the beginning of the long rains (March to June). Plantation maintenance would include weeding, pruning and thinning.

17. In all sawlog plantation operations, the "taungya" or "shamba" system would be used. Under this system, after the removal of commercial species of timber, a plot of indigenous forest is temporarily handed over to a resident worker. The resident worker receives a monthly wage, now 50 shs, which is paid only during nine months of each year during which time he works for the Department to do plantation work including nursery work, weeding, pruning, housing and road construction. During the three months in which he is not paid, he is required to clear his plot on which he is then free to grow agricultural crops during that and the following two years. The crops he produces are his recompense for clearing the area. In the third year, the agricultural crops are interplanted with trees.

Pulpwood Plantations

18. Some 3 000 ha of the pulpwood circle have been planted in the last three years at Turbo, near the Webuye pulpmill site. During the project planting period, 1970-1975, the planting rate would reach about 1 600 ha annually, and a total of 9 350 ha would be planted, giving about 12 300 ha of planted pulpwood by 1975 (see Table 5). A total of about 18 500 ha of new plantations would be required to supply the proposed mill on a sustained production basis.

19. In addition to the 3 000 ha already planted about 7 000 plantable hectares of Government owned land are available for use by the Forest Department at Turbo. Some additional 2 350 ha are thus required by the Forest Department for pulpwood plantings during the first five years of the project. The Government foresees no problems in obtaining this area of land by public acquisition and intends to have acquired this land by 31 December 1971.

Table 1. Planting - Harvesting Schedule for Sawlogs

Year Planted	Hectares Planted	Year of Thinnings											Year Harvested					
		1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
1969/70	3,238	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238	-	-	-	-	-
1970/71	3,238	-	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238	-	-	-	-
1971/72	3,238	-	-	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238	-	-	-
1972/73	3,238	-	-	-	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238	-	-
1973/74	3,238	-	-	-	-	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238	-
1974/75	3,238	-	-	-	-	-	3,238	-	-	-	-	3,238	-	-	-	-	-	3,238
Total Hectares	19,425.0	3,238	3,238	3,238	3,238	3,238	6,475.0	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238
Total Volume (m^3) (thousand)		226.5	226.5	226.5	226.5	226.5	453.0	226.5	226.5	226.5	226.5	226.5	1,359	1,359	1,359	1,359	1,359	1,359

Table 2. Planting - Harvesting Schedule for Pulpwood

Year Planted	Year Harvested							
	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Total
	hectares							
1969/70	1,210	40	-	-	-	-	-	1,250
1970/71	-	1,340	280	-	-	-	-	1,620
1971/72	-	-	1,220	400	-	-	-	1,620
1972/73	-	-	-	1,090	530	-	-	1,620
1973/74	-	-	-	-	950	670	-	1,620
1974/75	-	-	-	-	-	790	830	1,620
Total Hectares	1,210	1,380	1,500	1,490	1,480	1,460	830	9,350
(Age 14)	1,210	1,340	1,220	1,090	950	790	-	6,600
(Age 15)	-	40	280	400	530	670	830	2,750
Total Volume (m^3) (thousand)	313.1	359.3	409.9	410.2	410.8	410.5	250.2	2,564.0

20. The areas for planting with pulpwood would be flat and free of forest. The main species planted would be Pinus patula, but during 1970/71-1974/75, about 120 ha annually would be planted with Pinus radiata. P. radiata is higher yielding than P. patula, but is susceptible to Dothistroma Blight (a fungus disease of the needless). More experimentation is needed on the control of this disease before the Forest Department can contemplate large P. radiata plantings. Plantings would be contiguous to facilitate aerial spraying. Pulpwood plantings would be at a density of 1 330 trees per ha and would be grown on a 15-year rotation. Yields at 15 years would be about 290 and 400 cubic metres per ha respectively for P. patula and P. radiata (see Table 2 for expected total pulpwood yields). No thinnings are contemplated.

Future Supply-Demand of Wood Raw Material

21. Projections of requirements for sawnwood from project plantations are developed in Appendix 3. The forecast of sawnwood and plywood requirements equivalent to 2.4 million m3 of roundwood in the year 2000 has been based on an estimate that domestic demand would reach about 1.2 million m3 and on an assumption that a further 1.2 million m3 could be exported mainly to other East African countries and the Near East region. Total requirements would increase yearly five times from the 1967 level of about 0.5 million m3 of production. The expected production from project and earlier plantings, supplemented by thinnings from later plantings and by exploitation of indigenous forests, would meet the estimated sawnwood requirements.

22. The project output of about 400 000 m3 annually of pulpwood would meet the anticipated requirements of the Webuye pulpmill. Since no alternative source of raw material exists for the pulpmill within an economic distance for their transport to Webuye, apart from limited supplies of sawnwood residues and smallwood, it may be confidently assumed that project pulpwood would be used by the proposed mill.

23. In the unlikely event that the pulpmill proposal should fail to materialize, it would be possible to maintain the trees under a longer rotation for use as sawlogs. If this should occur, however, a moderate surplus of sawnwood would probably be created, resulting in some sales being delayed. As a consequence, the return on investment in any pulpwood plantings used in this way would be lower than on regular sawnwood plantings. (See sensitivity analysis, Section E).

C. PROJECT COSTS

24. Project economic costs are assumed to equal the financial costs. Individual cost items are explained in Table 3. The cost estimates are based on Forest Department experience with appropriate modifications in light of experience of plantation developments in other countries.

25. Table 4 describes labour requirement per hectare needed to carry out silvicultural activities. These requirements multiplied by the number of hectares associated with each silvicultural activity (Table 5 and Table 7 for sawlog and pulpwood plantations respectively)

equal total labour requirements. The latter are found in Table 6 (sawlogs) and Table 8 (pulpwood). In order to arrive at total labour costs, labour requirements are then multiplied by the daily labour cost (Table 9) 1/. The schedule of all costs is found in the relevant financial cash flow tables for the sawlog and pulpwood components (Table 10 or Table 12). The cost of the land was assumed to be zero.

26. As it is difficult to establish costs under the present accounting systems, a physical contingency allowance of 15% of total costs has been included in the financial (economic) analysis.

D. PROJECT BENEFITS

Financial Revenue

27. Financial revenue equals the price the Government of Kenya expects to receive for a unit of stumpage multiplied by the volume thinned/harvested. For sawlogs the Ministry of Natural Resources plans to raise stumpage prices by 1975 to KSh 17.66, KSh21.19, and KSh 26.49 per cubic metre measured under bark for the first and second commercial thinnings and final harvest, respectively. These rates are used in the project revenue calculations. Sawlog thinnings occur during years 17 to 27, and final harvests occur during years 32 to 37 (see Table 1). For pulpwood there would be no thinnings, and harvests would occur during years 15 to 21 (see Table 2). Project revenue calculations assume that the pulpwood stumpage price is KSh 21.19 per cubic meter measured under bark. This price has been calculated back from the price that the pulpmill could afford to pay (KSh 106) and at the same time provide a financial return of 19 percent, which is considered sufficient to attract investors.

Economic Benefits

28. For pulpwood the stumpage price of KSh 21.19 per m3 is assumed to be the economic price as well as the financial price, and therefore pulpwood economic benefits are the same as the financial benefits.

29. For sawlogs the output is shadow priced at a higher value. It is assumed that half of the sawlog output will be consumed domestically and substitute for imports, and half will be exported as sawnwood. Both halves of the output are shadow priced based upon the savings/earnings generated, as explained below.

30. The sawnwood value of the 50% of the Kenyan sawlog output which is assumed to substitute for imports is valued at the approximate world F.O.B. sawnwood price of KSh 243.71/m3 (s) in the United Kingdom plus KSh 95.36 for transportation from the United Kingdom to Nairobi, minus KSh 158.94 for the cost of converting standing Kenyan timber to sawnwood delivered to Nairobi, which results in a stumpage price (sawnwood measure) of KSh 180.13/m3. The 50% of the sawlog output which is exported is valued at the approximate world sawnwood price of KSh 247.24/m3 sawn F.O.B. at point of export from Kenya which after netting out KSh 194.26 for logging, sawmilling, and freight to the export point leaves a residual stumpage price (sawnwood measure) of KSh 52.98/m3. An average stumpage price (sawnwood measure) is arrived at as the mean of the import substitution and export values (KSh 110.56). Stumpage prices in roundwood measure are then computed by applying conversion factors (to convert sawnwood measure to roundwood measure) of 3.0, 2.5, and 2.0 for the first thinning, the second thinning, and the final harvest respectively. The average unit economic benefit values calculated in this way are KSh 38.85 and KSh 46.62

1/ In the case of nursery cost only, there is an additional non-labour cost per hectare which must be multiplied by the associated hectares and the result added to the labour cost to get the total nursery cost.

Table 3. Explanation of Costs for Kenya I Analysis

Cost Item	Sawlogs	Pulpwood
Nursery	Labor, plus 10Ksh per ha for fertilizer tools, equipment, and stores.1/	Labor, plus 7.9 KSh per ha for fertilizer, tools, equipment and stores, plus 9.4 KSh per ha for polyethylene sleeves, plus 16.7 KSh for filling sleeves by piecework. (Total cost per ha in addition to labor equals 34.0 KSh.)
Stumping	n.a.	Cost equals KL 5.00, and is applied to 364.2 ha in year 0, 404.7 ha in year 1, and 364.2 ha in yr. 2.
Plowing & Harrowing	n.a.	Cost equals KL 6.2 per ha planted in the year of planting.
Demarcation	All labor	n.a.
Clearing	All labor	n.a.
Pitting	All labor	n.a.
Staking Out	All labor	All labor
Planting	All labor	All labor
Plantation Surveys	All labor	All labor
Beating Up	All labor	All labor
Weeding(s)	All labor	All labor
Pruning(s)	All labor	All labor
Fire Protection	All labor	All labor
Other Protection	All labor	All labor
Dothistroma Control	n.a.	Applies to 121.4 ha of P. radiata planted annually in years 2 - 6.2/ Nursery treatment just prior to planting (age 0) costs KSh 24.7/ha. Field treatment just after planting (also age 0) costs Ksh 37.1/ha. Aerial treatments twice a year at Ksh 49.4/ha each begins at age 1 and are continued annually through age 6 (6 years of 2 treatments each year).
Vehicle (& Tractor) Purchase	Costs given in cash flow table.	Costs given in cash flow table.
Vehicle (& Tractor) Running Cost	Costs given in cash flow table.	Costs given in cash flow table.
Agricultural Equipment	Cost equals Ksh 12.4 per ha planted during the planting period, and 1.03 KSh annually per ha established after the planting period.3/	n.a.
Tools, Stores, (& Other Equipment)	Cost equals 37.1 Ksh per ha planted during the planting period, 3.1 KSh annually per acre established after the planting period up through project year 27, and 1.03 KSh annually per ha established for the remainder of the project.	Cost equals 30.9 Ksh per ha planted during the planting period, and 2.1 KSh annually per ha established after the planting period.
Building Construction	Spread equally over the 6 planting years: 10 forest ranger houses at KL 400 each, 15 forest guard houses at KL 100 each, 425 village houses at KL 75 each, 4 water supply installations at KL 500 each, and six offices and stores at KL 500 each, making a total of KL 42,375 (7.1 Thousand KL per year).	Spread equally over the 6 planting years: 2 forester houses at KL 1000, eight forest ranger houses at KL 400, 10 forest guard houses at KL 100, 200 village houses at KL 100, and 2 water supplies at KL 500, making a total of KL 27,200 (4.5 thousand KL per year.)
Building Maintenance	An annual cost (beginning the year following construction) which equals 10% of the cumulative construction cost during the planting period, and which equals 10% of total construction cost times a factor of (number of cumulative established ha divided by 19,425) after the planting period.	An annual cost (beginning the year following construction) which equals 10% of the cumulative construction cost during the planting period, and which equals 10% of total construction cost times a factor of (number of cumulative established ha divided by 9,350) after the planting period.
Road Construction	One km of access road per 100 ha planted built during the year of planting at KL per km (KL 1.55 per ha planted). Roads are rebuilt at the same cost after 10 years.	One km of access road per 125 ha planted is built during the year of planting at KL 155 per km (KL 1.24 per ha planted).
Road Maintenance	An annual cost (beginning the year following construction) which equals 10% of the cumulative construction cost during the planting period, & which equals 10% of the total construction cost times a factor of (number of cumulative established ha divided by 19,425) after the planting period.	An annual cost (beginning the year following construction which equals 10% of the cumulative construction cost during the planting period, and which equals 10% of the total construction cost times a factor of (number of cumulative established acres divided by 9,350 after the planting period.
Staff Requirements	Costs given in cash flow table.	Costs given in cash flow table.
Office Running Costs	Cost equals 35.21 KSh/ha planted during planting period & 2.93 annually/ ha established after the planting period.	Cost equals Ksh 37.1/ha planted during the planting period and 3.21 KSh annually per ha established after the planting period.
Thinning, Marking Out	All labor	n.a.

1/ Labor requirements outlined in Tables 5 and 6, and compiled in Tables 8 and 10.

2/ See Table 9.

3/ Established ha equal the total number of ha planted minus the total number of ha harvested.

KENYA I PLANTATION PROJECT

Table 4 - Silvicultural Labour Input

	Requires Labour (md/ha)	
	Sawlogs	Pulpwood
Nursery - Planting	18.48	9.34
Nursery - Beating Up	2.77	1.40
Demarcation	3.21	n.a.
Clearing	19.77	n.a.
Pitting	1.23	n.a.
Staking Out	4.94	2.47
Planting	7.41	4.94
Plantation Surveys	2.47	2.47
Beating Up	1.11	0.74
Weeding (s)	4.94	4.94
Pruning - First	9.88	9.88
Pruning - Second	12.36	n.a.
Pruning - Third	14.83	n.a.
Pruning - Fourth	9.88	n.a.
Fire Protection - Initial	4.45	2.47
Fire Protection - Final	2.47	1.24
Other Protection - Initial	1.24	1.24
Other Protection - Final	0.74	0.74
Pre-commercial Thinning	14.83	n.a.
Marking Out (Commercial Thinning)	2.47	n.a.

Table 5. Hectares Associated with Plantation Activities - Sawlogs

Item/Activity	YEARS 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hectares Planted	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Hectares Harvested	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative Established ha.	-	-	3,238	6,475	9,713	12,950	16,188	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425
Nursery-Planting	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-	-
Nursery-Beating Up	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Demarcation	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearing	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitting	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Planting	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-
Weeding	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-
Pruning-First	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-
Pruning-Second	-	-	-	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-
Pruning-Third	-	-	-	-	-	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-
Pruning-Fourth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238
Fire Protec.-Initial	-	-	3,238	6,475	9,713	12,950	16,188	-	-	-	-	-	-	-	-	-	-	-	-
Fire Protec.-Final	-	-	-	-	-	-	-	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425
Other Protec.-Initial	-	-	3,238	6,475	9,713	12,950	16,188	-	-	-	-	-	-	-	-	-	-	-	-
Other Protec.-Final	-	-	-	-	-	-	-	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425
Pre-Commer'l Thinning	-	-	-	-	-	-	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-
Marking Out(Commer'l Thinning)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,238	3,238
Road Construction	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238	-

Item/Activity	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Hectares Planted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hectares Harvested	-	-	-	-	-	-	-	-	-	-	-	-	-	3,238	3,238	3,238	3,238	3,238	3,238
Cumulative Established ha.	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	16,188	12,950	9,713	6,475	3,238	-
Nursery-Planting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nursery-Beating Up	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Demarcation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Planting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weeding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning-First	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning-Second	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning-Third	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning-Fourth	3,238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire Protec.-Initial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire Protec.-Final	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	16,188	12,950	9,713	6,475	3,238	-
Other Protec.-Initial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Protec.-Final	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	19,425	16,188	12,950	9,713	6,475	3,238	-
Pre-Commer'l Thinning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marking Out(Commer'l Thinning)	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238	3,238	-	-	-	-	-	-	-	-	-	-
Road Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Unskilled Labour Requirements - Sawlogs (thousand man days)

Silvicultural Activity	YEARS 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nursery	-	59.8	68.8	68.8	68.8	68.8	68.8	9.0	-	-	-	-	-	-	-	-	-	-	-
Demarcation	10.4	10.4	10.4	10.4	10.4	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearing	64.0	64.0	64.0	64.0	64.0	64.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitting	-	-	4.0	4.0	4.0	4.0	4.0	4.0	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	-	16.0	16.0	16.0	16.0	16.0	16.0	-	-	-	-	-	-	-	-	-	-	-
Planting	-	-	24.0	24.0	24.0	24.0	24.0	24.0	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	-	8.0	8.0	8,0	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	-	3.6	3.6	3.6	3.6	3.6	3.6	-	-	-	-	-	-	-	-	-	-
Weeding	-	-	-	16.0	16.0	16.0	16.0	16.0	16.0	-	-	-	-	-	-	-	-	-	-
Pruning	-	-	-	-	-	-	32.0	32.0	32.0	72.0	72.0	120.0	88.0	88.0	120.0	80.0	80.0	32.0	32.0
Fire Protection	-	-	14.4	28.8	43.2	57.6	72.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Other Protection	-	-	4.0	8.0	12.0	16.0	20.0	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Thinning,Marking Out	-	-	-	-	-	-	-	-	-	-	-	-	48.0	48.0	48.0	48.0	48.0	56.0	8.0
Total Labor Require.	74.4	134.2	213.6	251.6	270.0	288.4	264.4	175.0	114.0	134.4	134.4	182.4	198.4	198.4	230.4	190.4	190.4	150.4	102.4
(Total Labor Cost,KSh/md)	2.354	2.354	2.354	2.9425	3.531	4.1195	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708

Silvicultural Activity	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Nursery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Demarcation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Planting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weeding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire Protection	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	40.0	32.0	24.0	16.0	8.0	-
Other Protection	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	12.0	9.6	7.2	4.8	2.4	-
Thinning,Marking Out	8.0	8.0	8.0	16.0	8.0	8.0	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-
Total Labor Require.	102.4	70.4	70.4	78.4	70.4	70.4	70.4	70.4	70.4	62.4	62.4	62.4	62.4	52.0	41.6	31.2	20.8	10.4	-
(Total Labor Cost,KSh/md)	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708

Table 7. Hectares Associated with Plantation Activities - Pulpwood

Item/Activity	YEAR 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Hectares Planted	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hectares Harvested	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,210	1,380	1,500	1,490	1,480	1,460	830
Cumulative Established	-	1,250	2,870	4,490	6,110	7,730	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	8,140	6,760	5,260	3,770	2,290	830	-
Nursery-Planting	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nursery-Beating Up	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Planting	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weedings	-	1,250	2,870	3,240	3,240	3,240	3,240	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning	-	-	-	-	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-
Fire Protection-Initia	-	1,250	2,870	4,490	6,110	7,730	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire Protection-Final	-	-	-	-	-	-	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	8,140	6,760	5,260	3,770	2,290	830	-
Other Protection-Initi	-	1,250	2,870	4,490	6,110	7,730	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Protection-Final	-	-	-	-	-	-	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	9,350	8,140	6,760	5,260	3,770	2,290	830	-
Stumping	364	405	364	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plowing and Harrowing	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dothistroma Control-Nursery	-	-	121	121	121	121	121	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dothistroma Control-Field	-	-	121	121	121	121	121	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dothistroma Control-Aerial	-	-	-	121	243	364	486	607	607	486	364	243	121	-	-	-	-	-	-	-	-	-
Road Construction	-	1,250	1,620	1,620	1,620	1,620	1,620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8. Unskilled Labour Requirements - Pulpwood
(thousand man days)

Silvicultural Activit	YEAR 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Nursery	11.7	16.9	17.4	17.4	17.4	17.4	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staking Out	-	3.1	4.0	4.0	4.0	4.0	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Planting	-	6.2	8.0	8.0	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plantation Survey	-	3.1	4.0	4.0	4.0	4.0	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beating Up	-	-	0.9	1.2	1.2	1.2	1.2	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weedings	-	6.2	14.2	16.0	16.0	16.0	16.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pruning	-	-	-	-	-	12.4	16.0	16.0	16.0	16.0	16.0	-	-	-	-	-	-	-	-	-	-	-
Fire Protection	-	3.1	7.1	11.1	15.1	19.1	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	10.1	8.3	6.5	4.6	2.8	1.0	-
Other Protection	-	1.6	3.6	5.6	7.6	9.6	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.0	5.0	3.9	2.8	1.7	0.6	-
Total Labor Requirem t	11.7	40.2	59.2	67.3	73.3	91.7	70.0	43.7	34.5	34.5	34.5	18.5	18.5	18.5	18.5	16.1	13.3	10.4	7.4	4.5	1.6	-
(Total Labor Cost, KS nd)	2.354	2.354	2.9425	3.531	4.1195	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708	4.708

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Table 9. Daily Unskilled Labour Cost Schedule

Year	Wage Rate (KSh)	Seven Percent Supervision Cost (KSh)	Daily Labour Cost (KSh)
1967/68-69/70	2.20	0.1540	2.3540
1970/71	2.75	0.1925	2.9425
1971/72	3.30	0.2310	3.5310
1972/73	3.85	0.2695	4.1195
1973/74 and on	4.40	0.3080	4.7080

per m3 of sawlog stumpage for the first and second commercial thinnings, and KSh 58.28 for the final harvest.

Indirect Benefits

31. Indirect benefits were not quantified in either the economic or the financial analyses. Indirect benefits would include the promotion of secondary industries such as logging and sawmills, plywood factories and furniture factories. These would generate additional employment and income. The project itself would employ some 1 500 resident workers. Other indirect benefits would be the maintenance of permanent protective vegetative cover on watershed areas where most of the permanent rivers in Kenya originate.

E. COMPARING COSTS AND BENEFITS

32. The total cost and total benefit/revenue streams are shown in the accompanying cash flow tables. Table 10 is the sawlog financial cash flow, Table 11 is the sawlog economic cash flow, and Table 12 is the pulpwood financial/economic cash flow. 1/ The financial and economic rates of return (FRR and ERR) are as follows:

sawlog financial analysis	7.8% (FRR)
sawlog economic analysis	12.3% (ERR)
pulpwood financial/economic analysis	11.0% (FRR and ERR)

Sensitivity Analysis

33. The sensitivity of the economic rate of return to different input and output assumptions is presented in Table 13.

34. (a) Sawlog sub-project - First, ERR estimates were made separately for each half of the sub-project, i.e. the import substitution and the export components. For the import substitution component the rate of return was 14.8% and for the export component it was 7.8%.

35. Given the expected employment situation in the country, it was estimated that the economic wage for unskilled labour should be somewhat lower than the financial wage rate. Also, it was considered likely that in view of the projected deficits in importing countries, prices of exported Kenyan sawnwood would increase in the future. In order to explore the impact of both changes, results were tested for an increase in the price of the export component equal to 1 percent per year, combined with a shadow wage assumed equal to 75 percent of the financial wage. The economic rate of return for the export component rose from 7.8 percent to 13.5 percent.

36. (b) Pulpwood sub-project. In this case, there was no clear indication of the direction in which prices might move in the future, as pulpwood prices would be heavily influenced by government policies regarding the level of protection granted to the pulp and paper industry. For this reason, results were tested against both increases in pulpwood stumpage prices equal to 1% per year and a total decrease in revenues of 25%. The rate of return respectively increased from 11% to 12.5% and decreased to 8.5%. The results were also tested to determine the effect of shadowpricing unskilled and silvicultural labour at 75% of the original value. This raised the rate of return from 11% to 11.5%.

1/ Pitting cost was assumed not to occur in the economic analysis since it was insignificant and only applied to 25% of the sawlog area. The rate of return is unchanged by its removal.

KENYA I PLANTATION PROJECT

Table 10. Analysis of Financial Return for Sawlog Component

THOUSAND KL/TOT PROJ

COSTS	(YEAR) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	(YEAR) 14	15	16	17	18
1 NURSERY	0	8.00	9.90	12.00	14.00	16.00	16.90	2.40	0	0	0	0	0	0	0	0	0	0	0
2 DEMARCATION	1.20	1.20	1.20	1.50	1.80	2.10	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CLEARING	7.50	7.50	7.50	9.40	11.30	13.20	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PITTING	0	0	.50	.60	.70	.80	.90	.90	0	0	0	0	0	0	0	0	0	0	0
5 STAKING OUT	0	0	1.90	2.40	2.80	3.30	3.80	3.80	0	0	0	0	0	0	0	0	0	0	0
6 PLANTING	0	0	2.80	3.50	4.20	4.90	5.60	5.60	0	0	0	0	0	0	0	0	0	0	0
7 PLANT SUPVEY	0	0	.90	1.20	1.40	1.60	1.90	1.90	0	0	0	0	0	0	0	0	0	0	0
8 BEATING UP	0	0	0	.50	.60	.70	.80	.80	0	0	0	0	0	0	0	0	0	0	0
9 WEEDING	0	0	0	2.40	2.80	3.30	3.80	3.80	3.80	0	0	0	0	0	0	0	0	0	0
10 PRUNING	0	0	0	0	0	0	7.50	7.50	7.50	16.90	16.90	28.20	20.70	20.70	28.20	18.80	18.80	7.50	7.50
11 FIRE PROTECT	0	0	1.70	4.20	7.60	11.90	16.90	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30
12 OTH. PROTECT	0	0	.50	1.20	2.10	3.30	4.70	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40
13 VEH/TRAC PUR	0	0	13.20	10.90	5.50	8.20	6.70	8.20	4.70	2.70	2.30	3.50	3.50	3.50	3.50	2.30	3.50	3.50	8.50
14 VEH/TRAC RUN	0	0	12.90	13.80	14.60	15.20	17.20	18.10	8.50	7.30	7.30	8.10	8.10	8.10	9.00	8.10	8.10	8.10	7.70
15 AGRIC EQUIP	0	0	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16 TOOLS/STORES	0	0	6.00	6.00	6.00	6.00	6.00	6.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
17 BUILD CONSTR	0	0	7.10	7.10	7.10	7.10	7.10	7.10	0	0	0	0	0	0	0	0	0	0	0
18 BUILD MAINT	0	0	0	.70	1.40	2.10	2.80	3.50	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
19 PROD CONSTRU	0	0	5.00	5.00	5.00	5.00	5.00	5.00	0	0	0	0	5.00	5.00	5.00	5.00	5.00	5.00	0
20 ROAD MAINT	0	0	0	.50	1.00	1.50	2.00	2.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21 STAFF REQUIR	0	0	26.10	30.70	35.30	40.00	44.60	51.30	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70
22 OFFICE RUN	0	0	5.70	5.70	5.70	5.70	5.70	5.70	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
23 TWIN/MARKOUT	0	0	0	0	0	0	0	0	0	0	0	0	11.30	11.30	11.30	11.30	11.30	13.20	1.90
24 SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 CONTINGENCY	0	0	15.70	18.20	19.90	23.10	24.40	22.60	12.00	12.20	12.10	14.10	15.40	15.40	16.70	15.00	15.70	13.80	12.00
TOTAL COST	8.70	17.30	140.60	139.90	132.80	171.00	186.80	173.40	91.70	93.50	93.00	108.30	118.40	118.40	128.10	114.90	119.80	105.50	92.80
BENEFITS																			
26 THINNING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200.00	200.00
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL BENEFT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200.00	200.00
NET BENEFITS	-8.70	-17.30	-140.60	-139.90	-132.80	-171.00	-186.80	-173.40	-91.70	-93.50	-93.00	-108.30	-118.40	-118.40	-128.10	-114.90	-119.80	94.50	107.00

COSTS	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1 NURSERY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 DEMARCATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CLEARING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PITTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 STAKING OUT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 PLANTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 PLANT SUPVEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 BEATING UP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 WEEDING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 PRUNING	7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 FIRE PROTECT	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	9.40	7.50	5.60	3.80	1.90	0
12 OTH. PROTECT	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	2.80	2.30	1.70	1.10	.60	0
13 VEH/TRAC PUR	7.30	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.40	2.40	2.40	2.40	2.30	.80	1.20	.60	0	0
14 VEH/TRAC RUN	7.30	6.50	6.50	6.50	6.50	6.50	6.50	6.50	5.70	5.70	5.70	5.70	6.10	5.40	4.20	3.30	2.30	1.40	0
15 AGRIC EQUIP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.80	.60	.40	.20	.10	0
16 TOOLS/STORES	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.90	1.00	1.00	1.00	.80	.60	.40	.20	.10	0
17 BUILD CONSTR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 BUILD MAINT	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	3.50	2.80	2.10	1.40	.70	0
19 PROD CONSTRU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 ROAD MAINT	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.50	2.00	1.50	1.00	.50	0
21 STAFF REQUIR	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	21.40	17.10	12.80	18.60	4.30	0
22 OFFICE RUN	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.30	1.90	1.40	.90	.50	0
23 TWIN/MARKOUT	1.90	1.90	1.90	3.80	1.90	1.90	1.90	1.90	1.90	0	0	0	0	0	0	0	0	0	0
24 SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 CONTINGENCY	11.80	9.80	9.80	10.10	9.80	9.80	9.80	9.80	9.70	9.10	9.10	9.10	9.10	7.70	6.00	4.60	4.50	1.50	0
TOTAL COST	90.20	75.30	75.30	77.50	75.30	75.30	75.30	75.30	74.40	69.60	69.60	69.60	70.00	58.90	45.80	35.00	34.60	11.60	0
BENEFITS																			
26 THINNING	200.00	200.00	200.00	440.00	240.00	240.00	240.00	240.00	240.00	0	0	0	0	0	0	0	0	0	0
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	1800.00	1800.00	1800.00	1800.00	1800.00	1800.00
TOTAL BENEFT	200.00	200.00	200.00	440.00	240.00	240.00	240.00	240.00	240.00	0	0	0	0	1800.00	1800.00	1800.00	1800.00	1800.00	1800.00
NET BENEFITS	109.80	124.70	124.70	362.50	164.70	164.70	164.70	164.70	165.60	-69.60	-69.60	-69.60	-70.00	1741.10	1754.20	1765.00	1765.40	1788.40	1800.00

KENYA I PLANTATION PROJECT

Table 11 - Analysis of Economic Return for Sawlog Component

THOUSAND KL/TOT PROJ

COSTS	(YEAR) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	(YEAR) 14	15	16	17	18
1 NURSERY	0	8.60	9.90	12.00	14.00	19.00	18.00	2.40	0	0	0	0	0	0	0	0	0	0	0
2 DEMARCATION	1.20	1.20	1.20	1.50	1.80	2.10	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CLEARING	7.50	7.50	7.50	9.40	11.30	13.20	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PITTING	0	0	.50	.60	.70	.80	.90	.90	0	0	0	0	0	0	0	0	0	0	0
5 STAKING OUT	0	0	1.90	2.40	2.80	3.30	3.80	3.80	0	0	0	0	0	0	0	0	0	0	0
6 PLANTING	0	0	2.80	3.50	4.20	4.90	5.60	5.60	0	0	0	0	0	0	0	0	0	0	0
7 PLANT SURVEY	0	0	.90	1.20	1.40	1.60	1.90	1.90	0	0	0	0	0	0	0	0	0	0	0
8 BEATING UP	0	0	0	.50	.60	.70	.80	.80	.80	0	0	0	0	0	0	0	0	0	0
9 WEEDING	0	0	0	2.40	2.80	3.30	3.80	3.80	3.80	0	0	0	0	0	0	0	0	0	0
10 PRUNING	0	0	0	0	0	0	7.50	7.50	7.50	16.90	16.90	28.20	20.70	20.70	28.20	18.80	18.80	7.50	7.50
11 FIRE PROTECT	0	0	1.70	4.20	7.60	11.90	16.90	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30
12 OTH. PROTECT	0	0	.50	1.20	2.10	3.30	4.70	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40
13 VEH/TRAC PUR	0	0	13.20	16.90	5.50	8.20	6.70	8.20	4.70	2.70	2.30	3.50	3.50	3.50	3.50	2.30	3.50	3.50	8.50
14 VEH/TRAC RUN	0	0	12.90	13.80	14.60	15.20	17.40	10.10	8.50	7.30	7.30	8.10	8.10	8.10	9.00	8.10	8.10	8.10	7.70
15 AGRIC EQUIP	0	0	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16 TOOLS/STORES	0	0	6.00	6.00	6.00	6.00	6.00	6.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
17 BUILD CONSTR	0	0	7.10	7.10	7.10	7.10	7.10	7.10	0	0	0	0	0	0	0	0	0	0	0
18 BUILD MAINT	0	0	0	.70	1.40	2.10	2.80	3.50	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
19 ROAD CONSTRU	0	0	5.00	5.00	5.00	5.00	5.00	5.00	0	0	0	0	5.00	5.00	5.00	5.00	5.00	5.00	0
20 ROAD MAINT	0	0	0	.50	1.00	1.50	2.00	2.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21 STAFF REQUIR	0	0	25.10	30.70	35.30	40.00	44.00	51.30	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70
22 OFFICE RUN	0	0	5.70	5.70	5.70	5.70	5.70	5.70	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
23 THIN/MARKOUT	0	0	0	0	0	0	0	0	0	0	0	0	11.30	11.30	11.30	11.30	11.30	13.20	1.90
24 SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 CONTINGENCY	0	0	15.70	18.20	19.90	23.10	24.60	22.60	12.00	12.20	12.10	14.10	15.40	15.40	16.70	15.00	15.70	13.80	12.00
TOTAL COST	8.70	17.30	120.60	139.50	152.80	171.00	186.80	173.40	91.70	93.50	93.00	108.30	118.40	118.40	128.10	114.90	119.80	105.50	92.00
BENEFITS																			
26 THINNING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	440.00	440.00
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL BENEFT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	440.00	440.00
NET BENEFITS	-8.70	-17.30	-120.60	-139.50	-152.80	-171.00	-186.80	-173.40	-91.70	-93.50	-93.00	-108.30	-118.40	-118.40	-128.10	-114.90	-119.80	334.50	348.00

COSTS	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1 NURSERY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 DEMARCATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CLEARING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PITTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 STAKING OUT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 PLANTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 PLANT SURVEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 BEATING UP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 WEEDING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 PRUNING	7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 FIRE PROTECT	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	11.30	9.40	7.50	5.60	3.80	1.90	0
12 OTH. PROTECT	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	2.80	2.30	1.70	1.10	.60	0
13 VEH/TRAC PUR	7.30	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.40	2.40	2.40	2.40	2.30	.80	1.20	.80	0	0
14 VEH/TRAC RUN	7.30	6.50	6.50	6.50	6.50	6.50	6.50	6.50	5.70	5.70	5.70	5.70	6.10	5.40	4.20	3.30	2.30	1.40	0
15 AGRIC EQUIP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.80	.60	.40	.20	.10	0
16 TOOLS/STORES	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.00	1.00	1.00	1.00	.80	.60	.40	.20	.10	0
17 BUILD CONSTR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 BUILD MAINT	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	3.50	2.80	2.10	1.40	.70	0
19 ROAD CONSTRU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 ROAD MAINT	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.50	2.00	1.50	1.00	.50	0
21 STAFF REQUIR	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	25.70	21.40	17.10	12.80	8.60	4.30	0
22 OFFICE RUN	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.30	1.90	1.40	.90	.50	0
23 THIN/MARKOUT	1.90	1.90	1.90	3.80	1.90	1.90	1.90	1.90	1.90	0	0	0	0	0	0	0	0	0	0
24 SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 CONTINGENCY	11.80	9.80	9.80	10.10	9.80	9.80	9.80	9.80	9.70	9.10	9.10	9.10	9.10	7.70	6.00	4.60	4.50	1.50	0
TOTAL COST	90.20	75.30	75.30	77.50	75.30	75.30	75.30	75.30	74.40	69.60	69.60	69.60	70.00	58.90	45.80	35.00	34.80	11.90	0
BENEFITS																			
26 THINNING	440.00	440.00	440.00	968.00	528.00	528.00	528.00	528.00	528.00	0	0	0	0	0	0	0	0	0	0
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	3960.00	3960.00	3960.00	3960.00	3960.00	3960.00
TOTAL BENEFT	440.00	440.00	440.00	968.00	528.00	528.00	528.00	528.00	528.00	0	0	0	0	3960.00	3960.00	3960.00	3960.00	3960.00	3960.00
NET BENEFITS	349.80	364.70	364.70	890.50	452.70	452.70	452.70	452.70	453.60	-69.60	-69.60	-69.60	-70.00	3901.10	3914.20	3925.00	3925.20	1948.40	3960.00

KENYA I PLANTATION PROJECT

Table 12. Analysis of Economic and Financial Return for Pulpwood Component

THOUSAND SHILLINGS PER PROJECT

COSTS	(YEAR) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 NURSERY	3.50	5.10	5.70	6.20	6.70	1.30	.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 STUMPING	4.50	5.00	4.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 PLOW/HARROW	0	7.80	10.00	10.00	10.00	10.00	10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 STAKING OUT	0	.40	.60	.70	.80	.90	.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 PLANTING	0	.70	1.20	1.40	1.60	1.90	1.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 PLANT SURVEY	0	.40	.60	.70	.80	.90	.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 BEATING UP	0	0	.10	.20	.20	.30	.30	.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 WEEDING	0	.70	2.10	2.80	3.30	3.80	3.80	1.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 PRUNING	0	0	0	0	0	2.40	3.80	3.80	3.80	3.80	3.80	0	0	0	0	0	0	0	0	0	0	0
10 FIRE PROTECT	0	.40	1.00	2.00	3.10	4.50	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.40	2.00	1.30	1.10	.70	.20	0
11 GEN. PROTECT	0	.20	.50	1.00	1.60	2.20	1.80	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.40	1.20	.90	.70	.40	.10	0
12 DOTH CONTROL	0	0	.40	1.00	1.00	2.20	2.80	3.00	3.00	2.40	1.80	1.20	.60	0	0	0	0	0	0	0	0	0
13 VEHIC. PURCH	0	0.10	0	1.20	3.50	2.70	1.80	2.70	1.20	0	0	2.30	1.20	0	2.10	1.20	0	2.70	.90	0	1.50	0
14 VEH. RUNNING	0	3.80	5.20	5.60	6.10	6.80	7.40	4.10	3.10	3.10	2.70	2.60	2.60	2.60	2.80	2.50	2.20	1.70	1.20	.80	.40	0
15 TOOLS/STORES	0	1.90	2.50	2.50	2.50	2.50	2.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.90	.70	.50	.40	.20	.10	0
16 BUILD CONSTR	0	4.50	4.50	4.50	4.50	4.50	4.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BUILD MAINT.	0	0	.50	.90	1.40	1.80	2.20	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.40	2.00	1.50	1.10	.70	.20	0
18 ROAD CONSTR.	0	1.60	2.00	2.00	2.00	2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 ROAD MAINT.	0	0	.20	.40	.60	.80	1.00	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.00	.80	.70	.50	.30	.10	0
20 STAFF REQUIR	0	11.20	12.70	14.40	16.00	16.80	17.40	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	7.10	5.90	4.80	3.30	2.00	.70	0
21 OFFICE RUN	0	2.50	3.00	3.00	3.00	3.00	3.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.30	1.10	.80	.60	.40	.10	0
22 SUBTOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 CONTINGENCY	0	8.30	8.80	9.10	10.40	11.70	10.70	5.30	4.60	4.30	4.50	3.70	3.40	3.60	3.50	2.80	2.80	1.90	1.30	1.00	.30	0
TOTAL COST	8.00	63.90	66.90	69.80	79.70	87.50	82.20	48.50	35.10	33.00	34.50	28.10	26.00	27.70	28.90	21.00	21.40	14.00	10.20	8.00	2.20	0
BENEFITS																						
24 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	331.80	341.80	434.40	434.70	435.30	435.00	245.20
TOTAL BENEFIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	331.80	341.80	434.40	434.70	435.30	435.00	245.20
NET BENEFITS	-8.00	-63.90	-66.90	-69.80	-79.70	-87.50	-82.20	-48.50	-35.10	-33.00	-34.50	-28.10	-26.00	-27.70	-28.90	310.80	320.40	419.80	424.50	427.30	432.80	245.20

Table 13

Economic Rates of Return for Alternative Assumptions Used in the Sensitivity Analysis

(ERR in percent)

	Sawlog	Pulpwood
1. Half Sawlog Output Substitutes for Imports	14.8	n.a.
2. Half Sawlog Output is Exported	7.8	n.a.
3. Half Sawlog Output is Exported with 1% Annual World Sawnwood Price Increase and 75% Shadow Wage Rate for Unskilled Labour	13.5	n.a.
4. 1% Annual Pulpwood Stumpage Price Increase	n.a.	12.5
5. 2% Annual Pulpwood Stumpage Price Increase	n.a.	14.0
6. 75% Shadow Wage Rate for Unskilled Labour	n.a.	11.5
7. 25% Benefit Reduction	n.a.	8.5

APPENDIX 1

KENYA I

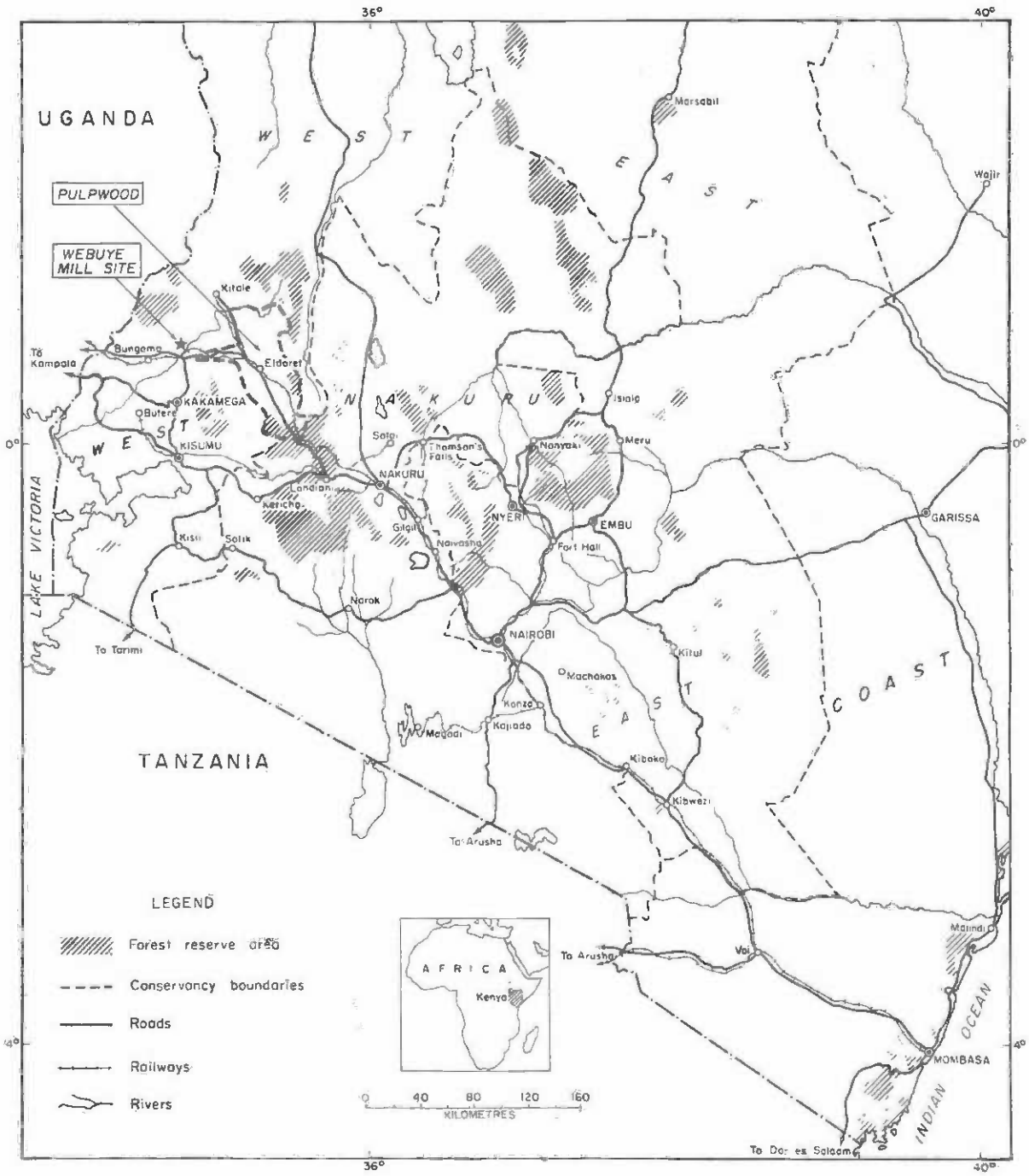
FOREST PLANTATIONS PROJECT

NET TRADE BALANCE IN FOREST PRODUCTS 1963-1967

	1963	1964	1965	1966	1967
			K£ '000		
Fuelwood and Charcoal	+ 77.9	+ 91.8	+ 153.5	+ 134.7	+ 147.6
Sawlogs	- 0.7	- 3.5	+ 2.6	+ 20.7	+ 7.0
Poles and Posts	+ 29.8	+ 23.8	+ 57.9	+ 81.9	+ 78.5
Sawn Timber	+125.9	+218.0	+ 326.8	+ 197.7	+ 173.3
of which: Softwood	(+153.8)	(+204.8)	(+ 273.4)	(+ 193.7)	(+ 246.8)
Hardwood	(- 27.9)	(+ 13.2)	(+ 53.4)	(+ 4.0)	(- 73.5)
Boxes, Crates, etc.	-110.4	-158.9	- 143.2	- 152.5	- 98.5
Builders' Woodwork	+ 85.8	+ 69.7	+ 107.0	+ 59.1	+ 105.8
Wood Carvings	-	+168.9	+ 280.3	+ 341.7	+ 294.5
Plywood	-115.7	-158.9	- 147.7	- 205.2	- 180.6
Matches	+ 3.4	- 18.1	+ 60.8	+ 57.2	+ 34.8
Other	- 2.5	+ 2.3	+ 29.9	- 23.0	- 78.7
Sub-total Wood:	+ 93.4	+235.1	+ 727.9	+ 512.3	+ 483.7
Paper, Paperboard and Manufactures thereof	-2 292.6	-2 163.3	-2 604.0	-2 843.6	-3 046.5
Fibre Board	- 41.7	- 87.9	- 118.2	- 113.6	- 104.1
Sub-total Pulp:	-2 334.3	-2 251.2	-2 722.2	-2 957.2	-3 150.6
Wattle Bark	+ 157.2	+ 197.6	+ 118.3	+ 142.8	+ 66.9
Other	+ 50.0	+ 22.1	+ 34.5	+ 26.7	+ 38.5
Sub-total:	+ 207.2	+ 219.7	+ 152.8	+ 169.5	+ 105.4
NET TRADE BALANCE:	-2 033.7	-1 796.4	-1 841.5	-2 275.4	-2 561.5

APPENDIX 2

KENYA — SAWLOG AND PULPWOOD PLANTATION PROJECT



APPENDIX 3

KENYA I

FOREST PLANTATIONS PROJECT

MARKETING

A. Saw-wood

1. Output from the Saw-wood Circle would be largely of sawlogs, with smaller quantities of peeler logs being supplied to the recently established plywood industry.

2. Domestic demand projections are based on a 1962 FAO study. The FAO data have been amended by the mission in the light of up-to-date information on population growth and income per capita. Thus, in arriving at the medium forecast of demand used in the report it has been assumed that throughout the period 1960-2000, Kenya's population would increase by 3% per annum and per capita income by 3% per annum. The table below shows the projections of demand on these bases, and following this details of the estimates are discussed.

Projected Domestic Saw-wood Requirements

	1960	1967	1980	2000
Sawn Wood (1 000 m^3)	95	131	246	575
Public Sector	22	27	42	80
Commerce and Industry	21	29	57	147
Rural Households	32	47	99	249
Urban Households	20	48	48	99
Plywood (1 000 m^2)	675	835	1 860	5 575
Total Saw-wood Requirements ('000 m^3 roundwood equivalent)	243	337	566	1 217

Public Sector

3. This category includes all government, institutional, and religious buildings as well as private schools and hospitals. Capital expenditure on new buildings will be related to growth in population rather than to incomes. A rate of 3.25% has been taken as the rate of construction necessary to service a population growing at 3%.

Commerce and Industry

4. This sector will develop with the gradual emergence of cash earners in the economy. It has been assumed, however, that since efficiency in the use of wood will increase, the annual growth in commercial and industrial building will be one percentage point less than the annual growth of national income. This will give a rate of increase of about 5% per annum, and an annual consumption of sawn wood of 147 thousand m3 by the year 2000.

Rural Households

5. The use of sawn wood in private residential buildings in rural areas currently represents about a third of total estimated sawn wood consumption. Because of the rapid increase in the number of rural cash earners, it is expected that the growth of this sector will be the fastest. The use of sawn wood in rural households and associated buildings consequently is expected to reach 249 thousand m3 by year 2000, or about 43% of total domestic consumption.

Urban Households

6. This category comprises private residential buildings in all towns, settlements, and trading centres. It is assumed that the future growth rate of urban population will be 5% until 1980, a slower rate than in the past (6%) and thereafter 4% until 2000 as development of commerce and industry becomes spread more widely through the country. With the rates adopted, the use of sawn wood for urban households will reach about 99 thousand m3 in year 2000.

Plywood and Wood-based Board Products

7. Import statistics show an apparent consumption of plywood of 835 thousand m^2 in 1967, or approximately 0.1 m2 per capita per annum. Part of this is re-exported in the form of tea chests. The rate of increase in domestic use is difficult to assess since the uses of plywood overlap with those of other non-wood products and the extent to which substitution would occur is unknown. It is tentatively assumed that annual per capita apparent consumption would rise to 0.25 m2 by the year 2000, resulting in domestic sales of the order of 5.6 million m2 annually.

8. Two privately-owned plywood factories (one at Elgeyo, the other at Sokoro) started operations in 1968/69 with a total annual output capacity of 1.1 million m2. It is assumed that low production costs will permit these factories to compete with imports.

Total Domestic Roundwood Requirements

9. Assuming 2.0, instead of the present 2.5, as the conversion factor of sawn wood to roundwood in the year 2000 (thus anticipating better quality and uniformity of logs and some modernization of sawmill machinery) and a factor of 11.88 m3 of roundwood for each thousand m2 of plywood, total domestic requirements would amount to about 1.2 million m3 of roundwood in the year 2000.

Roundwood Requirements for Exports

10. A comparison of future domestic production (including the production from current planting programmes) with prospective requirements indicates a maximum deficit of about 850 thousand m3 roundwood equivalent in Tanzania and Uganda in 2000. These countries' plans to achieve self-sufficiency have so far been hampered by lack of funds. The scope of Kenyan exports to these countries would depend on the degree and the rapidity of realization of their plans. For a medium forecast, it is assumed that the deficit would be 425 thousand m3, of which 75% would be imported from Kenya. Import requirements in the Middle East are expected to reach about 3.3 million m3 roundwood equivalent of coniferous softwood by the year 2000. It is assumed that Kenya could supply 20% of these requirements. Finally, there is a market in Europe for small quantities of top grade softwood from Kenya, but it is assumed that only about 10% of Kenya's production would meet quality standards for such exports, as at present. In total, this medium forecast assumes total exports equivalent to 1.2 million m3 of roundwood annually in the early 2000's.

Projected Supply/Demand Situation

11. Adopting the preceding forecasts of domestic and export sales, the aggregate demand for roundwood would be about 2.4 million m3 in the year 2000. To assess the range of variation of total requirements, the following additional evaluations were made. In forecasting domestic demand, the income per capita growth rate was assumed to be comprised between 2% and 4.5% per annum. In forecasting exports, it was assumed, first, that Tanzania and Uganda would increase their own plantings, thus reducing their import requirements to between 25% and 75% of the level expected without an expansion of their programmes; and second, that Kenya would succeed in supplying between 15% and 25% of the coniferous wood import requirements in the Middle East. The lower and upper extremes of the range calculated with these assumptions are 1.8 million m3 and 3.0 million m3 of roundwood, respectively.

12. On the basis of conservative yield estimates, about 1.4 million m3 of roundwood annually would be available from the year 2000 from clear felling of project plantings, about 340 thousand m3 from thinning of later plantings, and at least 700 thousand m3 from clear felling of plantings made prior to the project. These sources would provide a total supply sufficient to meet the medium forecast requirement of 2.4 million m3 annually.

13. The supply and demand situation should be revised at regular intervals and planting programmes subsequent to the project adjusted accordingly. In addition, potential markets, both domestic and export, should be investigated and actual market promotion undertaken.

B. Pulpwood

14. It is assumed that, by the time project pulpwood plantings reach maturity, that is after 14-15 years, the Webuye pulp and paper mill would be manufacturing 75 000 m tons of paper, of which 37 500 m tons would be bleached and 37 500 m tons unbleached, requiring about 70 000 m tons of pulp. Assuming recovering rates of 42% and 47% respectively for bleached and unbleached pulp, the annual wood requirements of the pulpmill are estimated at 410 thousand m3, including an emergency reserve of about 5%. Project pulpwood plantings and earlier plantings would supply this demand as shown in the following exploitation schedule.

Projected Annual Exploitation Schedule for Pulpwood

	Plantings Made Prior to the Project		Project Plantings		Total Volume ($000 m^3$)
	Area (ha)	Volume ($000 m^3$)	Area (ha)	Volume ($000 m^3$)	
1981/82	630	165.9	—	—	165.9
1982/83	1 700	443.1	—	—	443.1
1983/84	400	132.2	1 210	313.1	445.3
1984/85	220	82.1	1 380	359.3	441.4
1985/86	—	—	1 500	409.9	409.9
1986/87	—	—	1 490	410.2	410.2
1987/88	—	—	1 480	410.8	410.8
1988/89	—	—	1 460	410.5	410.5
1989/90	—	—	830	250.2	250.2
Total Area Felled:	2 950		9 350		

ECONOMIC ANALYSIS OF FORESTRY PROJECTS: CASE STUDIES

FAO FORESTRY PAPER 17, SUPPLEMENT 1

CASE STUDY NO. 5

KENYA II SAWLOG AND PULPWOOD PLANTATION PROJECT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

Preface

This is one of a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate methods of identifying, preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation to FAO for this purpose from the Swedish International Development Authority (SIDA). This case study has been compiled by FAO with the assistance of the College of Forestry at the University of Minnesota.

The project reported on in this case study is a project of the Government of Kenya which has been supported by a loan from the World Bank. The case study is based largely on material contained in an appraisal of the project carried out by the World Bank (Report No. PA-14a). Additional information was gathered through a visit to the project. The case study describes the project as it was perceived at the time of appraisal in late 1968. This material has been released to FAO by the World Bank and the Government of Kenya exclusively for the purpose of teaching forestry planning methods. It may not be quoted or reproduced in part or in whole without permission.

ABBREVIATIONS

C.I.F./c.i.f.	=	Cost, insurance and freight
ERR	=	Economic rate of return
F.D.	=	Forest Department
F.O.B./f.o.b.	=	Free on board
FRR	=	Financial rate of return
NFW	=	Net Future Worth
NPW	=	Net Present Worth
SEV	=	Soil Expectation Value
SR	=	Soil Rent

CURRENCY EQUIVALENTS

Currency Unit	=	Kenya Shillings (K Sh)
KL	=	K Sh 20
K Sh 1.00	=	US$ 0.14
K Sh Million	=	US$ 140,056
£1.00 Sterling	=	K Sh 17.25

TABLE OF CONTENTS

INTRODUCTION

1. Kenya's forests are of fundamental importance to the country's future development. They provide a valuable economic base for industrial development and also play a crucial role in the preservation of water catchment areas and in the prevention of soil erosion. Forests help protect the country's plant and animal life and offer an important source of tourist revenue. Over the past decades, forests have continually been exploited for sawn timber, charcoal and other forest products. Also, parts of the natural forests have been given over to controlled or spontaneous settlement as a result of intense population pressure in many agricultural areas. As a result the main economically accessible reserves of commercially valuable species have been considerably diminished.

2. The Kenyan Government has over the past thirty years been replacing some of the country's forests with fast-growing exotic softwood plantations. An extensive forest development programme has been designed to meet an increasing domestic demand for forest products and to take advantage of expanding export opportunities, particularly to the Middle East and Europe.

3. Kenya's present long-term industrial forestry programme aims at the establishment of about 136 000 ha of sawlog plantations and 24 000 ha of pulpwood plantations by 1980. To date approximately 104 000 ha of sawlog plantations and 16 500 ha of pulpwood plantations have been established under the programme. In 1970 a project aimed at planting about 19 000 ha of sawlog plantations and 9 000 ha of pulpwood plantations over six years (1970-1975) was launched with the support of the World Bank (the first phase project; see Case Study No. 4). This project was completed one year ahead of schedule in 1974.

4. The project on which this case study is based (the second phase project) will, over six years (1975-1980) continue and expand the first phase project to include the total industrial plantation programme of the Kenyan Forest Department to provide raw material for sawmills and a pulp and paper plant. 1/ The project will complete the Government's target plantation programme to 1980. It will also support further development of plantations already established.

5. When fully established, the plantations would be the primary source of raw material for pulp and paper manufacturing and for the country's sawmills. Of about 46 000 ha planted during the period of implementation of the project, 38 000 ha would be used for sawlogs and the rest for pulpwood.

6. The estimated cost of the project including contingencies for the six-year plantation period is K Sh 396.5 million (US$ 55.5 million with a foreign exchange component of about US$ 12.9 million).

7. This Case Study is divided into five sections. Section A provides background for the project. Section B gives technical details of the project including estimates of input requirements and output levels. Section C analyses project costs and Section D discusses project benefits. Section E provides a comparison of costs and benefits and analyses the sensitivity of expected project performance to changes in input and output assumptions.

8. The Case Study is a self-contained example of a "time slice" project appraisal, including separate analyses of independent project components. In combination with Case Study No. 4, it provides useful insights into the evolution of a major plantation programme, and of the planning of the latter.

1/ Policies and practices described in this case study are not necessarily those actually employed in Kenya, either at present or during the period covered by the case study.

A. BACKGROUND [1/]

9. Forestry contributed about 2 percent of GNP and forest products represented less than 5 percent of total exports in 1973. Kenya remains a net importer of forest products, mainly paper and paperboard products.

10. There are about 180 licensed sawmills in Kenya, and many more unlicensed ones. Most are small operations (only five have an annual capacity of over 3 000 m^3(s)). They are designed primarily to provide sawn timber for the growing rural market, are handicapped by inefficient operations, and produce a low quality product. Total output has averaged about 100 000 m^3(s) annually over the last three years, about 10 percent of which was exported. To meet projected demand, by 1980 sawnwood production capacity would have to be increased to 210 000 m^3(s). This could be realized without major increase in new capacity if significant improvements in the efficiency of existing mills were achieved.

11. Over the past few years the Kenyan government has made increased efforts to assist mills in identifying bottlenecks and improving their efficiency, but only a limited impact has been made thus far. The government in some cases also has designed its industrial plantations in blocks of at least 4 000 ha to encourage the construction of larger, more efficient mills turning out a higher quality product, but this also has failed to produce additional capacity. The project will thus provide further technical assistance to increase the efficiency of sawmilling.

12. There are a number of mills producing plywood. Two mills, one at Elburgon and one at Elgeyo, together produced about 1 million m^2 of plywood in 1972. A third mill with a capacity of 1.5 million m^2 has been constructed at Eldoret, and mills are planned in the Mount Kenya area and the Masai Mau forest.

13. In addition there is the newly constructed pulp and paper mill at Webuye which will eventually be one of the country's largest industrial enterprises. The mill has a capacity of 54 000 air dried metric tons per annum, and its expansion to 75 000 tons by the mid-1980s is being considered. The mill will require about 300 000 m^3 of pulpwood a year at full operation at present capacity, equivalent to the output of about 24 000 ha of plantations; this would need to be increased to some 35 000 ha of plantations to meet expected increases in the mill's capacity.

14. The first phase industrial plantations project was located within four main administrative divisions west of the Rift Valley which account for about 75 percent of the Government's long-term programme. In general, the project has been carried out satisfactorily. In the early years difficulties were experienced in land acquisition, necessitating the relocation of some plantation development and in the establishment of pulpwood plantations in the Turbo area due mainly to soil deficiencies. The planting failures at Turbo had been largely overcome by 1973-1974.

15. The Kenya Government's programme for forestry development has been designed with due regard to environmental considerations. The current system of plantation development and the possible impact of fast-growing plantations on the hydrological balance in forest areas has been studied over a period of fifteen years, and there is sufficient evidence to confirm that there is no adverse impact on the water regime by changing from one form of forest crop (indigenous forest) to another (fast-growing plantations). Also, when the Kenya Government's long-term plantation programme is fully implemented, it will result in the replanting of only about 20 percent of the area of indigenous forests designated as forest reserves, leaving some 1.5 million ha untouched by the programme. Approximately 40 000 ha of this area has already been set aside by the government as Nature Reserves or National Parks.

1/ For additional information on the forest sector of Kenya, see Case Study No.4: Kenya I Sawlog and Pulpwood Plantation Project.

B. DESCRIPTION OF THE SECOND FORESTRY PLANTATION PROJECT

16. The proposed project (analysed here) would be implemented during the six-year period 1975-1980. The project includes:

(a) the afforestation of 32 000 ha for sawlogs and 8 000 ha for pulpwood, and the reforestation of 6 000 ha of clear-felled plantations, mainly for sawlog products (Table 1);

(b) further development of 120 000 ha of existing sawlog and pulpwood plantations;

(c) construction, up-grading and maintenance of forest roads;

(d) construction of staff housing and administration buildings;

(e) studies, technical assistance, and training.

17. The plantation activities include establishment of nurseries, land clearing and preparation, planting and weeding. About 16 million seedlings will be required per year. These will be raised in some 90 existing nurseries in addition to 16 new nurseries to be established by the project.

18. All of the sawlog planting and about 90 percent of the pulpwood planting will take place in already-exploited indigenous forest areas to be cleared using the traditional "shamba" system. 1/ The planting spacing will be 2.5 m x 2.5 m for sawlog crops and 2.7 x 2.0 m for pulpwood crops. The main pulpwood species to be used are pines (Pinus patula and Pinus elliotti) and eucalypts (Eucalyptus saligna) and the primary sawlog species is cypress (Cupressus lusitanica). Planting will be done manually. Past experience indicates that a failure rate of about 10 percent can be expected and replanting will be carried out either in the same or the next planting year.

19. Sawlogs will be grown on a 25-year rotation, with commercial thinnings at age 10 (35 m^3/ha) and age 15 (30 m^3/ha). The final harvest yield is expected to be 360 m^3/ha. Pulpwood will be grown on a 15-year rotation with a final harvest yield of 225 m^3/ha.

20. Project activities include silvicultural and forest management elements such as pruning, thinning, fire control and other services to be provided not only to the project's plantation but also to about 120 000 ha of plantations already established.

21. In addition the project provides for the construction of about 160 km of all-weather forest roads and plantation access tracks per year. Also, 20 km of service roads will be upgraded each year.

22. To meet the requirements of administration and housing, the project will include all direct and indirect administrative overhead expenses in support of the industrial plantation programme and related activities such as forestry protection. The project's staffing will comprise 36 forestry officers, 106 technical level foresters, 165 forest rangers, 164 clerks, 184 drivers and 660 forest guards.

23. To carry out the project, it is necessary to construct one new division headquarters, 4 new stations and 12 new sub-stations. The housing of some 1 300 forest labourers will be improved and some 2 000 new houses constructed at the new stations and sub-stations, making a total housing programme of some 3 300 units.

1/ See Case Study No. 4, page 3, for a description of the shamba system.

24. The project requires investment in equipment for several different project activities including afforestation, road building, administration, buildings and housing. Equipment includes bulldozers, loaders, graders, rollers, lorries, tractors, saloon cars, water pumps, and various other equipment.

25. In connection with studies and technical assistance, the project will provide for a total of 5 man-years of staff time. Staff to be recruited will include a land use planning economist, a forestry specialist, an agronomist, a hydrologist and an ecologist. Funds will also be provided for training skills to interpret data from the Earth Resources Technology Satellite (ERTS) for classifying land use categories and recording changes in land use patterns. Also, in order to improve efficiency and production of the country's sawmills, the project will include the provision of technical assistance comprising three sawmill advisers for three years and the establishment and operation of a small-scale sawmill training centre.

26. Each year 40 ha of trial plantations will be established under the project, and they will provide a basis for an evaluation of forest potential in the Arabuko-Jukoke and the Bone-Lungi semi-arid areas of the Coast Province which appear to have potential for considerable forestry plantation development.

C. PROJECT COSTS

Financial Costs

27. The total project financial cost for the six year plantation period is estimated to be Ksh 396.5 million (US$ 55.5 million). The foreign exchange component is estimated to be about US$ 12.9 million. Appendix 1 presents detailed information about the assumptions relating to physical inputs and the input unit prices which were used in the analysis. Based on these results, Table 2 displays total project financial costs, and a more detailed yearly schedule is presented in Table 3. Three plantation components - sawlog circle, pulpwood circle Eldoret Division and pulpwood circle Turbo Division - are identified and analysed separately because of geographical and/or output differences. The financial costs of the three project components are shown, on a per hectare basis, in Tables 9, 10 and 11. 1/ The cost streams in all cases include all costs of the project components which will be incurred beyond the six-year planting period since they must be incurred in order to receive the benefits. However, the financial costs of studies, technical assistance, training, etc., have been excluded from the cost flows since benefits of these activities are mostly unquantifiable and therefore the analysts preferred to treat these activities and their effects in a purely qualitative manner.

Economic Costs

28. Economic costs are also derived on a per hectare basis for the three plantation components. Individual silvicultural cost items are listed in Table 8 in Appendix 1. Silvicultural labour has been shadow priced at 75 percent of the financial wage of Ksh 12.68 per man day, i.e. at Ksh 9.51 per man day. The silvicultural costs are entered directly into the economic cash flow tables 12, 13 and 14 1/ for the three project components.

29. Non-silvicultural financial costs also have been estimated in Appendix 1 and are listed in text Table 4. 2/ Non-silvicultural economic costs are derived by shadow pricing

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1/ The financial cash and economic value flow tables (tables 9-14) appear on pages 15-20.

2/ Non-silvicultural costs are defined to be those costs which are not directly apportioned on a per hectare basis, such as buildings, vehicles, etc. Non-silvicultural financial costs are determined for the entire plantation programme of 160 000 ha.

the foreign exchange components of these costs at 130 percent of the official foreign exchange rate.

30. These non-silvicultural costs need to be apportioned to each of the three project components on a per hectare basis for inclusion in the per hectare value flow tables. The approach used is as follows:

(a) In Table 4 each non-silvicultural cost is expressed as an average (unweighted) amount, with the foreign exchange component shadow priced as indicated above.

(b) In Table 6 each unweighted cost from Table 4 is adjusted for each project component to reflect the proportion of the total annual unskilled silvicultural labour used in that project component. Unskilled silvicultural labour was used as a basis for weighting non-silvicultural costs since it is likely to be a good indicator of the intensity of project component activity at any given time. The top half of Table 5 shows the yearly requirements of unskilled silvicultural labour for each project component, as well as the weights based on those requirements, which are used to derive the values in Table 6.

(c) Finally, each weighted total from Table 6 is split up into yearly amounts by multiplying it by the percentage of unskilled silvicultural labour used per year in that project component. These yearly percentages are found in the bottom half of Table 5. The yearly weighted non-silvicultural costs are then entered into the economic cash flow table (Tables 12, 13 and 14).

D. PROJECT BENEFITS

Financial Revenue

31. The financial revenue is calculated on the basis of the unit prices the Government of Kenya expects to obtain for stumpage multiplied by the volumes thinned and harvested. Physical yields per hectare are summarized in Table 7.

32. Financial stumpage prices expected for sawlogs are derived from expected sawnwood prices assuming certain conversion factors between sawlogs and sawnwood (which are explained in Table 8). The financial stumpage price for pulpwood is expected to be equal to Ksh 30/m^3. The results of the financial revenue calculations are displayed in Tables 9, 10 and 11.

Economic Direct Benefits

33. In calculating the economic unit value of the pulpwood output, it is assumed that if the project fails to materialize, pulpwood chips would have to be imported to run the Webuye Pulpmill. Therefore, the project's output of pulpwood will save an amount of foreign exchange which is then shadow priced at 130 percent of the financial value of that foreign exchange. The procedure followed is explained in more detail in Appendix 3 and the result is displayed in Table 8.

34. In estimating sawlog values, it is assumed, based on a demand study carried out previously, that 75 percent of the sawlog output will be consumed domestically, substituting for volumes which otherwise would have been imported in the absence of the project. The remaining 25 percent will be exported.

35. The economic benefit streams calculated using the unit values above are displayed in Tables 12, 13 and 14.

36. Inherited values and salvage values were included in the "costs" listed in Tables 4 and 6. Inherited values (costs) are the values at the start of the project of vehicles, equipment, tools, stores, buildings, and road equipment which were purchased or built during the plantation programme preceding the present project. The appropriate inherited value for these items is the value they have, if any, in their next best (highest valued) use other than the present project. Likewise, salvage values (benefits) are the values of the same types of items at the termination of the rotation, valued in terms of their best alternative use or in terms of what they could be sold for. The procedures used to estimate inherited and salvage values are explained in detail in Appendix 2.

37. Both physical and price contingencies were included in the total project costs. However, only the physical contingencies were included in project financial and economic cash flow analyses (see Appendix 1). Price contingencies are important for budgetary purposes, but by definition do not affect real (economic) rates of return.

Indirect Benefits

38. Under the project, benefits would be widely distributed among those to be employed directly in the plantation programme (who would fall within the lower rural income brackets), and in related processing industries, as well as among both rural and urban users of the final product. The project would provide continued employment of about 4 750 person over six years, although this would fall slightly to about 4 500 persons when the main planting programme is completed. However this decrease is expected to be offset by secondary employment opportunities arising from expanding processing industries.

39. As has been mentioned before, there is also a whole array of indirect effects generated by the project which are not quantifiable. One case in point relates to the substantial efforts carried out under the project to train local technicians, and the experience which will be acquired by local project staff during the implementation of the project which could then be favourably extended to other future afforestation programmes. The project will probably provide additional incentives for rural people and will help to distribute the population of Kenya more evenly.

E. COMPARING COSTS AND BENEFITS

40. The financial and economic rates of return for each of these project components were estimated directly from the relevant financial cash and economic value flow tables. The financial and economic value streams differ only in what relates to:

- wages, which in the economic analysis are assumed to be equal to 75 percent of financial values;
- foreign exchange rate, which in the economic analysis is equal to 130 percent of the financial value;
- stumpage values, which are higher in the economic analysis.

41. The estimated financial and economic rates of return for the project components are as follows:

Component	FRR	ERR
Sawlog	6.4 %	15.5 %
Pulpwood Eldoret	2.4 %	21.7 %
Pulpwood Turbo	1.7 %	20.9 %

42. The relative importance of the shadow-priced variables in explaining the discrepancy between financial and economic rates of return was tested (Table 15). The removal of the shadow foreign exchange rate lowers each of the component's original ERR by about 1.0 to 1.4 percent. The removal of the shadow wage rate lowers each original ERR by about one-half of 1 percent. The combined effect of removing simultaneously both the foreign exchange and the wage shadow rates produces a drop of only about 2 percent in the original ERR's.

43. The sensitivity analysis shows that the major reason for the discrepancy between the FRR and ERR is the value of the final output assumed. Thus, if the pulpwood unit economic value is reduced from the original economic value of 475.8 Ksh/m^3 to the very much lower value of 70 Ksh/m^3 - which is still more than double the price assumed in the financial analysis - the ERR falls by about 12 percent.

44. For the sensitivity analysis, the sawlog component was split into its two main elements: import substitution and export. Each was analysed separately as in reality each could be implemented independently. The ERR for the output for import substitution was 16.8 percent and for the export output was 8.2 percent. Further tests of the financial and economic sensitivity of each are shown and discussed in Appendix 4.

KENYA II PLANTATION PROJECT

Table 1, Existing and Projected Planting Areas

(ha)

	Plantations Established as of 31.12.74	Planting Programme						
		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Pulpwood	16 500	2 000	2 000	1 000	1 000	1 000	1 000	8 000
Sawlogs	104 080	4 570	5 540	5 430	5 430	5 430	5 430	31 830
Total	120 580	6 570	7 540	6 430	6 430	6 430	6 430	39 830
Replanting		700	700	1 000	1 200	1 300	1 300	6 200
Total Planting plus Replanting		7 270	8 240	7 430	7 630	7 730	7 730	46 030

KENYA II PLANTATION PROJECT

Table 2, Summary of Total Project Financial Costs
(Ksh million)

	Local	Foreign	Total
Afforestation	120.1	15.3	117.4
Project Management			
Administration	81.6	8.5	90.1
Building Housing	32.9	3.9	36.8
Equipment	5.9	19.7	25.6
Studies and Technical Assistance	6.1	11.1	17.2
Sub-total	239.4	66.5	305.9
Contingencies			
Physical	2.3	2.9	5.2
Price	62.5	22.9	85.4
Sub-total	64.8	25.8	90.6
Total Project Cost	304.2	92.3	396.5

KENYA II PLANTATION PROJECT

Table 3, Project Financial Costs (KSh '000)

	Year 0			Year 1			Year 2			Year 3			Year 4			Year 5		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
AFFORESTATION																		
Labour	16 058	-	16 058	16 160	-	16 160	15 448	-	15 448	15 604	-	15 604	15 610	-	15 610	15 645	-	15 645
Machine Operating Cost	48	113	161	47	109	156	34	80	114	16	38	54	7	18	25	8	18	26
Vehicle Operating Cost	992	2 314	3 306	992	2 315	3 307	992	2 314	3 306	992	2 315	3 307	992	2 314	3 306	992	2 315	3 307
Fertilizer & Tools	248	187	435	248	187	435	224	169	393	230	174	404	233	176	409	233	176	409
Sub-total	17 346	2 614	19 960	14 447	2 611	20 058	16 098	2 563	19 261	16 842	2 527	19 369	14 872	2 508	19 350	16 878	2 509	19 387
FOREST ROADS																		
Road Construction:																		
Staff & Labour	1 063	-	1 063	1 064	-	1 064	1 063	-	1 063	1 064	-	1 064	1 063	-	1 063	1 064	-	1 064
Machine Operating Cost	335	783	1 118	335	783	1 118	335	783	1 118	335	783	1 118	335	783	1 118	335	783	1 118
Workshop Running Cost	33	32	65	32	33	65	33	32	65	32	33	65	33	32	65	32	33	65
Tools & Miscellaneous	11	11	22	11	11	22	11	11	22	11	11	22	11	11	22	11	11	22
Office Running Cost	35	8	43	35	8	43	35	8	43	35	8	43	35	8	43	35	8	43
Bridge & Culvert Material	122	30	152	121	31	152	122	30	152	121	31	152	122	30	152	121	31	152
Road Maintenance	185	432	617	188	439	627	193	450	643	196	458	654	201	469	670	206	480	686
Sub-total	1 784	1 296	3 080	1 786	1 305	3 091	1 792	1 314	3 106	1 794	1 324	3 118	1 800	1 333	3 133	1 804	1 396	3 150
PROJECT MANAGEMENT																		
Administration:																		
Staff & Labour	12 835	-	12 835	12 835	-	12 835	12 835	-	12 835	12 835	-	12 835	12 835	-	12 835	12 835	-	12 835
Office Running Cost	167	39	206	167	39	206	167	39	206	167	39	206	167	39	206	167	39	206
Vehicle Operating Cost	588	1 372	1 960	588	1 372	1 960	599	1 397	1 996	600	1 397	1 997	599	1 397	1 996	600	1 397	1 997
Building & Housing																		
Construction Material	4 124	815	4 939	2 927	578	3 505	2 927	578	3 505	1 109	219	1 328	1 108	219	1 327	1 109	219	1 328
Construction Labour	3 292	-	3 292	2 337	-	2 337	2 337	-	2 337	885	-	885	885	-	885	885	-	885
Maintenance Material	253	206	459	252	207	459	253	206	459	252	207	459	253	206	459	252	207	459
Maintenance Labour	1 248	-	1 248	1 248	-	1 248	1 248	-	1 248	1 248	-	1 248	1 248	-	1 248	1 248	-	1 248
Sub-total	22 507	2 432	24 939	20 354	2 196	22 550	20 366	2 220	22 586	17 096	1 862	18 958	17 095	1 861	18 956	17 096	1 862	18 958
EQUIPMENT	1 541	6 136	7 677	920	3 234	4 154	925	3 358	4 283	950	3 189	4 139	781	1 893	2 674	782	1 893	2 675
STUDIES, TECHNICAL ASSISTANCE & TRIALS																		
Land Use & Catchment Study	353	1 628	1 981	-	786	786	-	786	786	-	786	786	-	786	786	-	785	785
Socio-Economic Study	281	543	824	123	372	495	-	-	-	-	-	-	-	-	-	-	-	-
Technical Assistance:																		
Assistance to Sawmilling Industry	643	1 159	1 802	310	1 007	1 317	308	1 008	1 316	173	41	214	173	41	214	173	41	214
Training Sawmill	660	807	1 467	220	48	268	220	48	268	220	48	268	220	48	268	220	48	268
Coastal Trials:																		
Arabuko Sokoke	32	10	42	191	21	212	192	21	213	191	21	212	192	21	213	191	21	212
Boni & Lungi	256	78	334	83	19	102	120	24	144	121	28	149	121	28	149	121	28	149
Sub-total	2 225	4 225	6 450	927	2 253	3 180	840	1 887	2 727	705	924	1 629	706	924	1 630	705	924	1 629
TOTAL	45 403	16 703	62 106	41 434	11 599	53 033	40 621	11 342	51 963	37 387	9 826	47 213	37 224	8 519	45 743	37 265	8 534	45 799
CONTINGENCIES																		
Physical Contingencies	701	899	1 600	438	467	906	439	480	919	259	428	687	242	298	540	242	298	540
Price Escalation	1 198	1 640	2 838	5 298	2 525	7 823	9 103	3 701	12 804	11 715	4 338	16 043	15 685	4 837	20 522	19 525	5 866	25 391
Sub-total	1 899	2 539	4 438	5 736	2 992	8 728	9 542	4 181	13 723	11 974	4 756	16 730	15 927	5 135	21 062	19 767	6 164	25 931
TOTAL PROJECT COST	47 302	19 242	66 544	47 170	14 591	61 761	50 163	15 523	65 686	49 361	14 582	63 943	53 151	13 654	66 805	57 032	14 698	71 730

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Table 4, Summary of Unweighted Non-Silvicultural Costs and Salvage Benefits for Both Sawlog and Pulpwood Plantations

Item	Single Cost						Annual Cost						Total Amount per ha 130% Shadow F.E. Rate	
	Amount[3] (KL)	Year	Area ('000 ha)	Amount per ha (Ksh/ha)	Foreign Exchange Component (%)	Amount per ha 130% Shadow F.E. Rate (KSh/ha)	Amount[3] (KL)	Year	Area ('000 ha)	Amount per ha (KSh/ha)	Foreign Exchange Component (%)	Amount per ha 130% Shadow F.E. Rate	Sawlog (KSh/ha)	Pulpwood
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Vehicle-Equipment Purchase	-	-	-	-	-	-	135 465	-2/24[1]	160	16.933	100	22.013	594.351	374.221
Vehicle-Equipment Running	-	-	-	-	-	-	301 702	-2/24[1]	160	37.713	70	45.633	1232.091	775.761
Vehicle-Equipment Inherited	406 395	-2	160	50.799	100	66.039	-	-	-	-	-	-	-	-
Tools-Stores	-	-	-	-	-	-	22 000	-2/24[1]	160	2.750	75	3.369	90.963	57.273
Tools-Stores Inherited	33 000	-2	160	4.125	75	5.053	-	-	-	-	-	-	-	-
Building Construction	1 809 406	-2	160	226.176	10	232.961	-	-	-	-	-	-	-	-
Building Maintenance	-	-	-	-	-	-	89 100	-2/24[1]	160	11.138	10	11.472	309.744	195.024
Building Replacement	-	-	-	-	-	-	57 691	-2/24[1]	160	7.211	10	7.428	200.556	126.276
Building Inherited	721 136	-2	160	90.142	10	92.846	-	-	-	-	-	-	-	-
Road Construction-capital	202 620	-1	39.830	101.742	100	132.265	-	-	-	-	-	-	-	-
Road Construction-operating	128 920	-1	6.638	388.411	30	423.368	-	-	-	-	-	-	-	-
Road Maintenance	-	-	-	-	-	-	-	-2/24[1]	-	6.417	60	7.572	189.300	113.580
Road Equipment Inherited	141 625	-1	39.830	71.115	100	92.449	-	-	-	-	-	-	-	-
Staff Requirements	-	-	-	-	-	-	594 140	-2/24[1]	160	74.268	10	76.496	2065.392	1300.432
Office Running	-	-	-	-	-	-	44 825	-2/24[1]	160	5.603	10	5.771	155.817	98.107
Vehicle-Equipment Salvage	406 395	25[2]	160	50.799	100	66.039								
Tools-Stores Salvage	33 000	25[2]	160	4.125	75	5.053								
Buildings salvage (sawlogs only)	1 173 488	25[2]	160	146.686	10	151.087								
Buildings salvage (pulpwood only)	1 354 428	25	160	169.304	10	174.383								

1/ Year 24 is for sawlogs only. For pulpwood the ending year is year 16.

2/ Year 25 is for sawlogs only. For pulpwood the year is year 15.

3/ Columns 1 and 7 are yearly amounts for the total completed plantation area (160 000 ha) or for the total six-year project area (39 830 ha). Columns 3 and 9 give the relevant areas. Per hectare average costs (columns 4 and 10) are the result of dividing column 1 by column 3, and column 7 by column 9, respectively. In the economic analyses, foreign exchange is shadow priced at 130% of the official exchange rate. Columns 5 and 11 indicate the foreign exchange components of each non-silvicultural cost, and columns 6 and 12 give single and annual amounts, respectively, when foreign exchange has been weighted at 130%.

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Table 5, Yearly Unskilled Silvicultural Labour Requirements

	YEAR																													average annual man days per ha	proportion of total plantation area (%)	weighted total cost factor
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total			
Total On-site labour Required (man days/ha)																																
Sawlog	37.7	-	16.62	0.22	27.22	0.22	12.22	7.22	12.22	0.22	12.22	0.22	12.72	0.22	0.22	0.22	0.22	0.72	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	-	142.6	5.281	84.727	1.0203
Pulpwood - Eldoret	37.7	-	16.62	0.22	15.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	-											72.4	4.259	7.637	0.8750
Pulpwood - Turbo	37.7	-	25.02	7.22	7.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	-											79.8	4.929	7.637	0.9523
Yearly Proportion of Total On-site Labour (%)																																
Sawlog	26.44	-	11.65	0.15	19.09	0.15	8.57	5.06	8.57	0.15	8.57	0.15	8.92	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	-	99.92			
Pulpwood - Eldoret	52.07	-	22.96	0.30	21.02	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-											99.95			
Pulpwood - Turbo	47.24	-	31.35	9.05	9.05	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	-											100.05			

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Table 6, Summary of Weighted Non-Silvicultural Costs and Salvage Benefits for Both Sawlog and Pulpwood Plantations

			Sawlogs			Pulpwood - Eldoret			Pulpwood - Turbo		
Cost or Benefit	Type of Cost/Benefit[1]	Year(s)	Unweighted Total Amount - 130% Shadow F.E. Rate (KSh/ha)	Weight	Weighted Total Amount - 130% Shadow F.E. Rate (KSh/ha)	Unweighted Total Amount - 130% Shadow F.E. Rate (KSh/ha)	Weight	Weighted Total Amount - 130% Shadow F.E. Rate (KSh/ha)	Unweighted Total Amount - 130 % Shadow F.E. Rate (KSh/ha)	Weight	Weighted Total Amount - 130% Shadow F.E. Rate (KSh/ha)
Vehicle-Equipment Purchase	AC	d[2]	594.351	1.0203	606.416	374.221	0.8750	327.443	374.221	0.9523	356.371
Vehicle-Equipment Running	AC	d	1232.091	1.0203	1257.102	775.761	0.8750	678.791	775.761	0.9523	738.757
Vehicle-Equipment Inherited	SC	-2	66.039	1.0203	67.380	66.039	0.8750	57.784	66.039	0.9523	62.889
Tools-Stores	AC	d	90.963	1.0203	92.810	57.273	0.8750	50.114	57.273	0.9523	54.541
Tools-Stores Inherited	SC	-2	5.053	1.0203	5.156	5.053	0.8750	4.421	5.053	0.9523	4.812
Building Construction	SC	-2	232.961	1.0203	237.690	232.961	0.8750	203.841	232.961	0.9523	221.849
Building Maintenance	AC	d	309.744	1.0203	316.032	195.024	0.8750	170.646	195.024	0.9523	185.721
Building Replacement	AC	d	200.556	1.0203	204.627	126.276	0.8750	110.492	126.276	0.9523	120.253
Building-Inherited	SC	-2	92.846	1.0203	94.731	92.846	0.8750	81.240	92.846	0.9523	88.417
Road Construction	SC	-1	555.633	1.0000[3]	555.633	555.633	1.0000[3]	555.633	555.633	1.0000[3]	555.633
Road Maintenance	AC	0/24[4]	189.300	1.0000[3]	189.300	113.580	1.0000[3]	113.580	113.580	1.0000[3]	113.580
Road Equipment Inherited	SC	-1	92.449	1.0000[3]	92.449	92.449	1.0000[3]	92.449	92.449	1.0000[3]	92.449
Staff Requirements	AC	d	2065.392	1.0203	2107.319	1300.432	0.8750	1137.878	1300.432	0.9523	1238.401
Office Running	AC	d	155.817	1.0203	158.980	98.107	0.8750	85.844	98.107	0.9523	93.427
Vehicle-Equipment Salvage	SB	25[5]	66.039	1.0203	67.380	66.039	0.8750	57.784	66.039	0.9523	62.889
Tools-Stores Salvage	SB	25[5]	5.053	1.0203	5.156	5.053	0.8750	4.421	5.053	0.9523	4.812
Buildings Salvage	SB	25[5]	151.087	1.0203	154.154	174.383	0.8750	152.585	174.383	0.9523	166.065

1/ AC = annual cost; SC = single cost; SB = single benefit

2/ "d" means that an annual cost is distributed from years minus 2 through 24 for sawlogs (through 14 for pulpwood) according to the proportion of total man days of unskilled silvicultural labour used.

3/ Road costs are unweighted since they are assumed to be equal for all hectares.

4/ Year 24 is the ending year for sawlogs only. For pulpwood the ending year is 14. This annual cost is not distributed according to silvicultural labour distribution. It is equally distributed over the rotation, beginning in year 0, which amounts to KSh 7.6 per hectare per year.

5/ Year 25 for sawlogs only. Year 15 for pulpwood.

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Table 7, Physical output per hectare (m^3)

Year	Sawnwood	Pulpwood
10	35	
15	30	225
25	360	

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Table 8, Output Unit Values

Sawlogs	Sawnwood Ksh/m^3	Conversion Factor	Stumpage Financial Price Ksh/m^3	Economic Unit Value Ksh/m^3
Sawlogs				
1st Thinning	166.67	0.30	50.00	255
2nd Thinning	166.67	0.35	58.33	297
Harvest	166.67	0.42	70.00	357
Pulpwood			30.00	475.8

See Appendix 1 for further details

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Table 9, Financial Cash Flow - Sawlog Component

KEN SHILLINGS/HECTARE

EXPENDIT	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
					(YEAR)										(YEAR)
1 NURSERY	0	601.90	0	0	0	0	0	0	0	0	0	0	0	0	0
2 LAND PREPARE	476.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 PLANTING	0	0	177.50	0	0	0	0	0	0	0	0	0	0	0	0
4 PLANT SUPVEY	0	0	12.76	0	0	0	0	0	0	0	0	0	0	0	0
5 BEATING UP	0	0	17.80	0	0	0	0	0	0	0	0	0	0	0	0
6 WEEDING	0	0	0	0	190.20	0	0	0	0	0	0	0	0	0	0
7 PRUNING	0	0	0	0	152.20	0	152.20	0	152.20	0	152.20	0	152.20	0	0
8 PRE-COM THIN	0	0	0	0	0	0	0	88.88	0	0	0	0	0	0	0
9 MARKING OUT	0	0	0	0	0	0	0	0	0	0	0	0	6.30	0	0
10 FIRE PROTECT	0	0	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
11 OTH. PROTECT	0	0	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
12 VE/EQUIP PUR	123.30	0	54.30	.70	89.00	.70	40.00	23.00	40.00	.70	63.00	.70	61.00	.70	.70
13 VE/EQUIP RUN	276.70	0	121.00	1.60	198.30	1.60	89.00	52.00	89.00	1.60	89.00	1.60	92.70	1.60	1.60
14 VE/EQU INNER	51.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 TOOLS/STORES	20.00	0	8.80	.10	14.50	.10	6.80	3.80	6.50	.10	6.50	.10	6.80	.10	.10
16 TOOLS INNER	4.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BUILD CONSTN	230.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 BUILD MAINT	86.10	0	35.70	.50	58.60	.50	26.30	15.50	26.30	.50	26.30	.50	27.40	.50	.50
19 BUILD REPLAC	52.50	0	23.10	.30	37.60	.30	17.00	10.10	17.00	.30	17.00	.30	17.70	.30	.30
20 BUILD INNER	92.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 ROAD CONSTRU	0	490.20	0	0	0	0	0	0	0	0	0	0	0	0	0
22 ROAD MAINT	0	0	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40
23 ROAD INNER	0	71.10	0	0	0	0	0	0	0	0	0	0	0	0	0
24 STAFF REQUIR	540.90	0	238.40	3.10	390.60	3.10	175.30	103.50	175.30	3.10	175.30	3.10	182.50	3.10	3.10
25 OFFICE RUN	40.80	0	18.00	.20	29.50	.20	13.20	7.80	13.20	.20	13.80	.20	13.80	.20	.20
TOTAL EXPEND	1997.10	1163.20	716.50	15.70	1170.80	15.70	524.70	314.98	528.70	15.70	526.70	15.70	550.20	15.70	15.70
RECEIPTS															
26 THINNINGS	0	0	0	0	0	0	0	0	0	0	0	0	1750.00	0	0
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL RECTS	0	0	0	0	0	0	0	0	0	0	0	0	1750.00	0	0
NET RECEIPTS	-1997.10	-1163.20	-716.50	-15.70	-1170.80	-15.70	-524.70	-314.98	-528.70	-15.70	-526.70	-15.70	1199.80	-15.70	-15.70

EXPENDIT	13	14	15	16	17	18	19	20	21	22	23	24	25	
1 NURSERY	0	0	0	0	0	0	0	0	0	0	0	0	0	601.90
2 LAND PREPARE	0	0	0	0	0	0	0	0	0	0	0	0	0	476.00
3 PLANTING	0	0	0	0	0	0	0	0	0	0	0	0	0	177.50
4 PLANT SUPVEY	0	0	0	0	0	0	0	0	0	0	0	0	0	12.76
5 BEATING UP	0	0	0	0	0	0	0	0	0	0	0	0	0	17.80
6 WEEDING	0	0	0	0	0	0	0	0	0	0	0	0	0	190.20
7 PRUNING	0	0	0	0	0	0	0	0	0	0	0	0	0	761.00
8 PRE-COM THIN	0	0	0	0	0	0	0	0	0	0	0	0	0	88.88
9 MARKING OUT	0	0	6.30	0	0	0	0	0	0	0	0	0	0	12.60
10 FIRE PROTECT	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0	37.50
11 OTH. PROTECT	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	0	32.50
12 VE/EQUIP PUR	.70	.70	2.30	.70	.70	.70	.70	.70	.70	.70	.70	.70	0	406.00
13 VE/EQUIP RUN	1.60	1.60	5.20	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	0	1036.70
14 VE/EQU INNER	0	0	0	0	0	0	0	0	0	0	0	0	0	51.80
15 TOOLS/STORES	.10	.10	.40	.10	.10	.10	.10	.10	.10	.10	.10	.10	0	76.50
16 TOOLS INNER	0	0	0	0	0	0	0	0	0	0	0	0	0	4.20
17 BUILD CONSTN	0	0	0	0	0	0	0	0	0	0	0	0	0	230.80
18 BUILD MAINT	.50	.50	1.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	314.20
19 BUILD REPLAC	.30	.30	1.00	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	144.40
20 BUILD INNER	0	0	0	0	0	0	0	0	0	0	0	0	0	92.00
21 ROAD CONSTRU	0	0	0	0	0	0	0	0	0	0	0	0	0	490.20
22 ROAD MAINT	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	0	160.40
23 ROAD INNER	0	0	0	0	0	0	0	0	0	0	0	0	0	71.10
24 STAFF REQUIR	3.10	3.10	10.20	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	0	2046.70
25 OFFICE RUN	.20	.20	.80	.20	.20	.20	.20	.20	.20	.20	.20	.20	0	153.70
TOTAL EXPEND	15.70	15.70	36.90	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	0	7001.80
RECEIPTS														
26 THINNINGS	0	0	1750.00	0	0	0	0	0	0	0	0	0	0	3500.00
27 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	25200.00	25200.00
28 VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	51.80	51.80
29 TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	4.20	4.20
30 BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	149.70	149.70
TOTAL RECTS	0	0	1750.00	0	0	0	0	0	0	0	0	0	25405.70	28905.70
NET RECEIPTS	-15.70	-15.70	1713.10	-15.70	-15.70	-15.70	-15.70	-15.70	-15.70	-15.70	-15.70	-15.70	25405.70	21143.90

KENYA II PLANTATION PROJECT

Table 10, Financial Cash Flow - Pulpwood Component - Eldoret Division

KEN SHILLING/HECTARE

EXPENDIT	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
				(YEAR)											(YEAR)				
1 NURSERY	0	601.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	601.90
2 LAND PREPARE	478.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	478.00
3 PLANTING	0	0	177.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177.50
4 PLANT SURVEY	0	0	12.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12.70
5 BLAZING UP	0	0	17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17.00
6 WEEDING	0	0	0	0	190.20	0	0	0	0	0	0	0	0	0	0	0	0	0	190.20
7 FIRE PROTECT	0	0	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0	22.50
8 OTH. PROTECT	0	0	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	0	19.50
9 VE/EQUIP PUR	131.20	0	57.80	.80	52.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	0	252.30
10 VE/EQUIP RUN	297.10	0	124.80	1.70	117.90	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	0	560.40
11 VE/EQU INNER	44.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44.40
12 TOOLS/STORES	21.30	0	9.40	.10	8.60	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	0	40.00
13 TOOLS INNER	3.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.60
14 BUILD CONSTR	197.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197.90
15 BUILD MAINT	26.30	0	38.00	.50	34.80	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	165.60
16 BUILD REPLAC	55.90	0	24.80	.30	22.50	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	109.90
17 BUILD INNER	78.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78.90
18 ROAD CONSTRU	0	490.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	490.20
19 ROAD MAINT	0	0	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	0	96.00
20 ROAD INNER	0	71.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71.10
21 STAFF REQUIR	575.20	0	253.00	3.30	232.20	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	0	1103.90
22 OFFICE RUN	43.40	0	19.10	.30	17.50	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	83.90
TOTAL EXPEND	2009.20	1163.20	748.50	16.20	885.80	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	0	4816.30
RECEIPTS																			
23 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6750.00	6750.00
24 VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44.40	44.40
25 TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.60	3.60
26 BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148.10	148.10
TOTAL RECTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6946.10	6946.10
NET RECEIPTS	-2009.20	-1163.20	-748.50	-16.20	-885.80	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	-16.20	6946.10	2129.80

KENYA II PLANTATION PROJECT

Table 11, Financial Cash Flow - Pulpwood Component - Turbo Division

KEN SHILLINGS/HECTARE

	EXPENDIT	12	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		(YEAR)														(YEAR)				
1	NURSERY	0	456.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	456.60
2	LAND PREPARE	478.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	478.00
3	PLANTING	0	0	177.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177.50
4	PLANT SURVEY	0	0	12.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12.70
5	HEATING UP	0	0	35.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35.50
6	WEEDING	0	0	124.60	106.80	128.80	0	0	0	0	0	0	0	0	0	0	0	0	0	420.40
7	FIRE PROTECT	0	0	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0	22.50
8	OTH. PROTECT	0	0	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	0	19.50
9	VE/EQUIP PUR	129.50	0	86.00	24.80	24.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	0	274.70
10	VE/EQUIP RUN	284.40	0	191.50	55.30	55.30	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	0	610.90
11	VE/EQU INTER	44.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44.40
12	TOOLS/STORES	21.00	0	14.00	4.00	4.00	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	0	44.20
13	TOOLS INTER	3.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.90
14	BUILD CONSTR	215.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215.40
15	BUILD MAINT	85.20	0	56.50	10.30	16.30	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	143.30
16	BUILD REPLAC	55.20	0	36.00	10.60	10.60	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	115.00
17	BUILD INTER	85.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85.80
18	ROAD CONSTRU	0	490.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	490.20
19	ROAD MAINT	0	0	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	0	96.00
20	ROAD INTER	0	71.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71.10
21	STAFF REQUIR	568.00	0	377.10	108.80	108.80	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	0	1203.30
22	OFFICE RUN	42.80	0	28.40	8.20	8.20	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	91.20
	TOTAL EXPEND	2021.60	1217.90	1153.80	490.00	366.00	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	0	5360.90
	RECEIPTS																			
23	HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6750.00	6750.00
24	VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48.40	48.40
25	TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.90	3.90
26	BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161.20	161.20
	TOTAL RECTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6963.50	6963.50
	NET RECEIPTS	-2021.60	-1217.90	-1153.80	-490.00	-366.00	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	-16.30	6963.50	1602.60

KENYA II PLANTATION PROJECT

Table 12, Economic Value Flow - Sawlog Component

KEN SHILLING/HECTARE

		(YEAR)														(YEAR)
	COSTS	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
1	NURSERY	0	968.40	0	0	0	0	0	0	0	0	0	0	0	0	0
2	LAND PREPARE	388.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	PLANTING	0	0	133.30	0	0	0	0	0	0	0	0	0	0	0	0
4	PLANT SURVEY	0	0	9.50	0	0	0	0	0	0	0	0	0	0	0	0
5	PLATING UP	0	0	13.30	0	0	0	0	0	0	0	0	0	0	0	0
6	WEEDING	0	0	0	0	142.88	0	0	0	0	0	0	0	0	0	0
7	PRUNING	0	0	0	0	114.10	0	114.10	0	114.10	0	114.10	0	114.10	0	0
8	PRE-COM THIN	0	0	0	0	0	0	0	66.50	0	0	0	0	0	0	0
9	MARKING OUT	0	0	0	0	0	0	0	0	0	0	0	0	4.85	0	0
10	FIRE PROTECT	0	0	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
11	OTH. PROTECT	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	VE/EQUIP RUN	160.30	0	78.60	.98	115.80	.98	82.60	30.70	82.60	.98	82.60	.98	84.10	.98	.98
13	VE/EQUIP RUN	332.40	0	166.50	1.98	240.80	1.98	167.70	63.60	167.70	1.98	167.70	1.98	172.10	1.98	1.98
14	VE/EQU INTER	67.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	TOOLS/STORES	24.50	0	10.80	.10	17.70	.10	8.00	4.70	8.00	.10	8.00	.10	8.30	.10	.10
16	TOOLS INTER	5.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	BUILD CONSTR	237.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	BUILD MAINT	83.60	0	36.00	.50	48.30	.50	27.10	10.00	27.10	.50	27.10	.50	28.20	.50	.50
19	BUILD REPLAC	84.10	0	22.80	.30	30.10	.30	17.50	10.40	17.50	.30	17.50	.30	18.30	.30	.30
20	BUILD INTER	94.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	ROAD CONSTRU	0	555.60	0	0	0	0	0	0	0	0	0	0	0	0	0
22	ROAD MAINT	0	0	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
23	ROAD INTER	0	92.40	0	0	0	0	0	0	0	0	0	0	0	0	0
24	STAFF REQUIR	557.20	0	245.50	3.28	402.30	3.20	180.80	100.60	180.80	3.28	180.80	3.20	188.80	3.28	3.28
25	OFFICE RUN	42.80	0	18.50	.20	30.30	.20	13.80	8.00	13.80	.20	13.80	.20	14.20	.20	.20
	TOTAL COST	2817.60	1116.40	776.18	16.80	1171.90	16.40	930.30	316.30	938.90	16.40	930.30	16.80	954.80	16.80	16.80
	BENEFITS															
26	THINNINGS	0	0	0	0	0	0	0	0	0	0	0	0	8923.70	0	0
27	HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL BENEFT	0	0	0	0	0	0	0	0	0	0	0	0	8923.70	0	0
	NET BENEFITS	-2817.60	-1116.40	-776.18	-16.80	-1171.90	-16.40	-930.30	-316.30	-938.90	-16.40	-930.30	-16.80	8971.90	-16.80	-16.80

	COSTS	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	NURSERY	0	0	0	0	0	0	0	0	0	0	0	0	0	968.40
2	LAND PREPARE	0	0	0	0	0	0	0	0	0	0	0	0	0	388.80
3	PLANTING	0	0	0	0	0	0	0	0	0	0	0	0	0	133.30
4	PLANT SURVEY	0	0	0	0	0	0	0	0	0	0	0	0	0	9.50
5	PLATING UP	0	0	0	0	0	0	0	0	0	0	0	0	0	13.30
6	WEEDING	0	0	0	0	0	0	0	0	0	0	0	0	0	142.88
7	PRUNING	0	0	0	0	0	0	0	0	0	0	0	0	0	570.50
8	PRE-COM THIN	0	0	0	0	0	0	0	0	0	0	0	0	0	66.50
9	MARKING OUT	0	0	4.80	0	0	0	0	0	0	0	0	0	0	9.80
10	FIRE PROTECT	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0	27.50
11	OTH. PROTECT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	25.00
12	VE/EQUIP RUN	.98	.98	3.00	.98	.98	.98	.98	.98	.98	.98	.98	.98	0	605.66
13	VE/EQUIP RUN	1.98	1.98	6.30	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	0	1256.30
14	VE/EQU INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	67.60
15	TOOLS/STORES	.10	.10	.50	.10	.10	.10	.10	.10	.10	.10	.10	.10	0	92.20
16	TOOLS INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	5.20
17	BUILD CONSTR	0	0	0	0	0	0	0	0	0	0	0	0	0	237.70
18	BUILD MAINT	.50	.50	1.60	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	316.30
19	BUILD REPLAC	.30	.30	1.00	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	204.30
20	BUILD INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	94.70
21	ROAD CONSTRU	0	0	0	0	0	0	0	0	0	0	0	0	0	555.60
22	ROAD MAINT	7.60	7.60	9.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	0	190.00
23	ROAD INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	92.40
24	STAFF REQUIR	3.20	3.20	10.50	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	0	2100.30
25	OFFICE RUN	.20	.20	.80	.20	.20	.20	.20	.20	.20	.20	.20	.20	0	156.00
	TOTAL COST	16.80	16.80	38.20	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	0	7600.80
	BENEFITS														
26	THINNINGS	0	0	8923.70	0	0	0	0	0	0	0	0	0	0	17847.40
27	HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	128501.10	128501.10
28	VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	67.40	67.40
29	TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	5.20	5.20
30	BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	154.20	154.20
	TOTAL BENEFT	0	0	8923.70	0	0	0	0	0	0	0	0	0	128727.90	146575.30
	NET BENEFITS	-16.80	-16.80	8885.50	-16.80	-16.80	-16.80	-16.80	-16.80	-16.80	-16.80	-16.80	-16.80	128727.90	138774.50

KENYA II PLANTATION PROJECT

Table 13, Economic Value Flow - Pulpwood Component - Eldoret Division

KEN SHILLING/HECTARE

	COSTS	(YEAR) -2	-1	0	1	2	3	4	5	6	7	8	9	(YEAR) 10	11	12	13	14	15	
1	NURSERY	0	466.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	462.40
2	LAND PREPARE	350.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	350.50
3	PLANTING	0	0	133.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133.10
4	PLANT SURVEY	0	0	9.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.50
5	BEATING UP	0	0	13.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13.30
6	RESEEDS	0	0	0	0	142.60	0	0	0	0	0	0	0	0	0	0	0	0	0	142.60
7	FIRE PROTECT	0	0	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0	16.50
8	OTH. PROTECT	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	15.00
9	VE/EQUIP PUR	170.50	0	75.20	1.00	68.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	327.50
10	VE/EQUIP RUN	353.40	0	155.90	2.00	142.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	0	678.00
11	VE/EQU INNER	57.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57.50
12	TOOLS/STORES	26.10	0	11.50	.20	10.50	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	0	50.70
13	TOOLS INNER	4.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.40
14	BUILD CONSTR	203.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	203.80
15	BUILD MAINT	68.90	0	39.20	.50	35.90	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	170.50
16	BUILD REPLAC	57.50	0	25.40	.30	23.20	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	110.00
17	BUILD INNER	81.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81.20
18	ROAD CONSTRU	0	555.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	555.60
19	ROAD MAINT	0	0	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	0	114.00
20	ROAD INNER	0	92.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92.40
21	STAFF REQUIR	592.50	0	261.30	3.40	239.20	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	0	1137.20
22	OFFICE RUN	44.70	0	19.70	.30	18.00	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	86.30
	TOTAL COST	2039.30	1110.40	753.80	17.40	890.80	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	0	4820.30
	BENEFITS																			
23	HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107055.00	107056.00
24	VE/EQUI SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57.80	57.80
25	TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.40	4.40
26	BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	152.40	152.40
	TOTAL BENEFT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107269.60	107269.60
	NET BENEFITS	-2039.30	-1110.40	-753.80	-17.40	-890.80	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	-17.40	107269.60	102449.30

KENYA II PLANTATION PROJECT

Table 14, Economic Value Flow - Pulpwood Component - Turbo Division

KEN SHILLING/HECTARE

COSTS	(YEAR) -2	-1	0	1	2	3	4	5	6	7	8	9	10	11	(YEAR) 12	13	14	15	
1 NURSERY	0	506.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	506.50
2 LAND PREPARE	358.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	358.50
3 PLANTING	0	0	133.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133.10
4 PLANT SURVEY	0	0	9.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.50
5 BEATING UP	0	0	26.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26.60
6 WEEDING	0	0	106.60	106.60	106.60	0	0	0	0	0	0	0	0	0	0	0	0	0	319.80
7 FIRE PROTECT	0	0	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0	16.50
8 OTH. PROTECT	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	15.00
9 VE/EQUIP RUN	168.30	0	111.70	32.30	32.30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	359.60
10 VE/EQUIP RUN	349.00	0	231.60	66.90	66.90	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	0	739.60
11 VE/EQU INNER	62.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62.90
12 TOOLS/STORES	25.80	0	17.10	4.90	4.90	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	0	55.10
13 TOOLS INNER	4.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.80
14 BUILD CONSTR	221.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	221.80
15 BUILD MAINT	67.70	0	58.20	16.80	16.80	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0	165.50
16 BUILD REPLAC	56.40	0	37.70	10.90	10.90	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	119.40
17 BUILD INNER	28.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68.40
18 ROAD CONSTRU	0	555.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	555.60
19 ROAD MAINT	0	0	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	0	114.00
20 ROAD INNER	0	92.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92.40
21 STAFF REQUIR	585.00	0	368.20	112.10	112.10	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	0	1239.40
22 OFFICE RUN	44.10	0	29.30	8.50	8.50	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	0	94.80
TOTAL COST	2053.10	1152.50	1459.30	408.70	388.70	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	17.60	0	5353.50
BENEFITS																			
23 HARVEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107055.00	107055.00
24 VE/EQU SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62.90	62.90
25 TOOLS SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.80	4.80
26 BUILD SALVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	166.10	166.10
TOTAL BENEFT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107288.80	107288.80
NET BENEFITS	-2053.10	-1152.50	-1459.30	-408.70	-388.70	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	-17.60	107288.80	101935.30

KENYA II PLANTATION PROJECT

Table 15, Sensitivity Analysis

Assumption Set	Sawlog ERR (%)	Pulpwood Eldoret ERR(%)	Pulpwood Turbo ERR(%)
1. Original assumptions	15.5	21.7	20.9
2. No shadow foreign exchange rate	14.4	20.3	19.5
3. No shadow wage rate	15.1	21.1	20.4
4. Combination of 2. and 3.	13.9	19.7	18.9
5. Pulpwood price of Ksh70/m^3	-	9.8	9.0
6. Sawnwood import substitution element	16.8	-	-
7. Sawnwood export element	8.2	-	-
8. No shadow prices	6.4	2.4	1.7

See Appendix 2 for further details

APPENDIX 1

PROJECT COSTS

A. Non-silvicultural physical inputs and costs

Vehicle and Equipment Purchase Costs

1. Vehicles and equipment are assumed to have a six year useful life. A list of the total number of required vehicles and equipment for the entire plantation programme is presented below. It is assumed that equal expenditures for replacements are made each year beginning in the year of planting. This input is composed entirely of foreign exchange.

Item	Number Required	Unit Cost (KL)	Total Cost (KL)
Saloon car	1	2 650	2 650
Station wagon	1	2 450	2 450
Land Rovers	100	2 650	265 000
5-ton lorries	65	3 500	227 500
3-ton lorries	40	2 900	116 000
60-65 hp tractors	10	2 650	26 500
85 hp tractors	8	4 150	33 200
Stationary engines	60 1/	650	39 000
Fire trucks	4	5 300	21 200
Portable water pumps	12	450	5 400
Sub-totals			738 900
10 percent physical contingency			73 890
Total cost (6-year period)			812 790
Total annual cost			135 465
Annual cost per hectare (assuming 160 000 hectares)			0.8467 (KSh 16.9)

Vehicles and Equipment Running Costs

2. The total annual vehicle and equipment running cost for the entire plantation programme is KL 301 702 (see Table 1 in this appendix), which is KSh 37.7 per hectare. The foreign exchange component for running cost is 70 percent.

1/ Stationary engines have a useful life of 12 years. Therefore, only half of the required number were entered in this table.

Tools and Stores Costs

3. Tools and stores costs consist of maintenance and replacement of walkie talkie and VHF radios, uniforms for staff, hand tools and miscellaneous items. The annual cost of the above for the entire plantation programme is KL 22 000 (including a 10 percent physical contingency), which is KSh 2.8 per hectare. The foreign exchange component is 75 percent.

Building Construction Cost

4. It is assumed that one project headquarters office, one new divisional office, four new full accounting stations and 12 sub-stations will be constructed during the project period (1975-1980). Itemized costs for each are presented in Table 2 of this appendix.

5. In addition, some existing staff housing, buildings and water supplies will require replacing. The Department has commenced a programme for the replacement of forest workmen's houses, presently made from mud and wattle, with improved houses. So far about 20 percent of the housing has been replaced; the remainder are being replaced over a ten year period and the project would provide for the replacement of some 3 100 forest workmen's houses phased over the six year period. This would be in addition to some 2 000 new workmen's houses to be constructed in the new stations and sub-stations. The house building programme will be undertaken by the Forest Department using direct labour; costs are based on present day experience.

6. The proposal is to provide during the project disbursement period (1975-1980), an improved house for all permanent forestry workers (working on existing stations and sub-stations) required beyond 1980, i.e., 5 500 forestry families.

7. It is further assumed that building costs associated with each hectare are incurred in the year preceding the planting of that hectare. The foreign exchange component is 10 percent. Total building costs are obtained from the following:

New Stations	Total (KL)
Project Headquarters, Office Block Nairobi	13 650
New Division, Nabkoi	14 795
New Forest Stations (4 at KL 23 150)	92 600
New Forest Sub-Stations (12 at KL 20 250)	243 000
New Forest Workers' Houses for New Stations (2 031 at KL 210)	426 510
Sub-total (New Stations)	790 555
Existing Stations	
Replacement of Existing Forest Workers' Houses 3 116 at KL 210	654 360
Replacement of and Additions to Existing Staff Housing and Buildings	200 000
Sub-total (Existing Stations)	854 360
Sub-total Building Cost	1 644 915
10% Physical Contingency	164 491
Total Building Cost	1 809 406
	(KSh 226.2/hectare)

Building Maintenance Cost

8. Maintenance of existing buildings (see Table 3 in this appendix) and new (project) buildings will be carried out by the Forestry Department with maintenance teams located in the main stations. The foreign exchange component is 10 percent. Maintenance requirements consist of 60 teams of the following:

	KL/year
1 Mason	250
1 Carpenter	250
3 Labourers	540
Materials	310
Sub-total team cost	1 350
10% Physical Contingency	135
Total team cost	1 485
Total Annual Cost of 60 Teams	89 100
	(KSh 11.1/hectare)

Road Construction Cost

9. At the beginning of the project (1975) there was one Forest Department road unit. Under this project two road units will be formed, one West of the Rift and the other East of the Rift. New road construction for both units is summarized below.

	km/year
Primary and secondary roads for new plantations to be established during project period	60
Plantation tracks	100
Service road construction to new stations and upgrading some existing roads	20
Total	180

The total amount of equipment required for both units is shown in Table 4 in this appendix. In addition, KL 3 000 per unit is required for site offices/workshops and housing. Road construction capital costs (equipment plus office/workshop and housing construction) associated with each hectare are assumed to occur in the year preceding the planting of that hectare. Road construction capital costs are composed entirely of foreign exchange.

10. Road construction operating costs consist of (1) machinery operating costs (summarized in Table 5 of this appendix), (2) bridge and culvert construction costs of KL 3 500 per unit, (3) staff and labour (summarized in Table 6 of this appendix), and (4) miscellaneous items. The foreign exchange component equals 30 percent for road construction operating costs.

11. Costs are summarized below.

Capital Costs

Equipment	KL	178 200
Buildings		6 000
Sub-total		184 200
10% Physical Contingency		18 420
Total		202 620
Total Per Hectare	KSh	101.742
	(at 39 830 "new hectares)	

Operating Costs	KL/year
Machine operating costs	54 690
Bridge and culvert materials	7 000
Staff and labour	49 510
Workshop running	3 000
Tools and miscellaneous stores	1 000
Office expenses, supervision, vehicle running costs, administration, etc.	2 000
Sub-total	117 200
10% Physical Contingency	11 720
Total (per hectare, at 6638.33 ha/year)	128 920 (KSh 388.41)
Total Road Construction Cost	KSh 490.2/ha

Road Maintenance Cost

12. Annual road maintenance operating cost per hectare is calculated as follows:

(Average Road Density) x (Machine Hours Required) x (Cost per Machine Hour)

= (.045 km/ha x (1.6 hr/km) x (KSh 50/hr) + 10%

= KSh 3.6/ha + 10% physical contingency = KSh 3.96

13. Capital road maintenance cost is based upon the assumptions that 8 graders are needed and each grader has a useful life of 7 years, which means that an average of 8/7 graders must be purchased (replaced) each year. Each grader costs KL 17 200 (including 10 percent physical contingency). Therefore, the annual capital cost per hectare is:

8/7 (KL 17 200) / (160 000)

= KL 0.12 = KSh 2.46

Total Road Maintenance Cost Per Hectare Per Year = KSh (3.96 + 2.46) = KSh 6.4. The foreign exchange component is 60 percent.

Staff Requirement Costs

14. Annual staff salaries for the entire plantation programme are itemized in Table 7 of this appendix. Ten percent is composed of foreign exchange. A summary by management unit is presented below.

	No.	Unit Cost Per Year	Total KL
Project Headquarters	1	16 000	16 000
Conservancies	3	5 150	15 450
Divisions 1/	14	4 600	64 400
Stations 2/	59	5 530	326 270
Sub-stations 3/	47	3 660	172 020
			594 140

The total annual cost of KL 594 140 is KSh 74.3 per hectare.

Office Running Costs

15. Office running costs are composed of general office expenses of KL 8 825 annually, summarized below, and annual station upkeep of KL 360 for each (100) stations. Ten percent is composed of foreign exchange.

General office expenses	KL/year	KL/year
Project Headquarters	1 000	
Conservancies (KL 300 x 3)	900	
Divisions (KL 200 x 4)	2 800	
Forest Stations (KL 50 x 59)	2 950	
Sub-stations (KL 25 x 47)	1 175	8 825
Station upkeep		36 000
Total Annual Office Running Cost		44 825 (KSh 5.6/ha)

B. Silvicultural physical inputs and costs

16. The afforestation programme will include nurseries, land clearing and preparation, planting and replanting, surveying, weeding, pruning, thinning, protection and road construction.

Nurseries

17. Pulpwood. The Turbo nursery which is capable of holding over three million plants will raise most of the plants for that division, supplemented by the Saboti Nursery.

18. Sawlog. The average annual planting programme in the sawlog area is 5 900 hectares. Twelve million plants would be needed to be met from the existing nurseries. Species to be raised in these nurseries are Cupressus lusitanica (80 percent of the total planting

1/ Includes 1 new Division to be built by project.

2/ Includes 4 new stations to be built by project.

3/ Includes 12 new sub-stations to be built by project.

programme), and Pinus patula and other species, i.e. Eucalyptus and a few hardwoods which will account for the remaining 20 percent. All seeds would be collected from the existing seed orchards. Seedlings are normally raised in the nursery for about six months before planting.

Land Clearing and Preparation

19. Pulpwood. Land is ploughed and harrowed after which maize or wheat is planted for two years before planting of pine trees is commenced.

20. Sawlog Areas. In the sawlog areas and in the pulpwood areas in Eldoret Division the land to be planted is first demarcated into 0.5 hectare plots and allocated to labourers. They clear and burn these plots, plant agricultural crops, i.e. maize, beans and potatoes, for two years, and plant trees in the third year which are intercropped for an additional three years. Felling of small trees in these plots is done by labour, while large trees are felled by the Forestry Department using power saws. Most of these areas are very fertile and therefore no fertilization is required. In the grasslands subsoiling is carried out before pitting out is done.

Planting

21. Pulpwood. Planting in the pulpwood plantations would be done by hand at a space of 2.7 m x 2.0 m (approximately 1 800 plants per hectare). The interval is designed to facilitate easy movement of harvesters while removing the maize interplanted with the trees in the first year. It is also designed to allow free movement of harrows during mechanical weeding. Planting commences immediately after sufficient moisture build-up has been formed during the rainy season (April-May); sometimes when rains are late planting may continue to mid-August. Replacement of failed seedlings (beating up) is done during the same season or the following year depending on the length of the rainy season. Normally an allowance of 10 percent of the seedlings stock is reserved for this purpose. Complete replanting during the following year is done where over 75 percent of the establishment fails. The average planting requirement is 14 man-days per hectare. This includes handling and movement of seedlings from roadside to planting site. Replanting of clearfelled areas takes place one year after felling.

22. Sawlog Areas. In the sawlog areas, planting is carried out by workmen in the allocated plots. Normal spacing is 2.5 m by 2.5 m. An average of 14 man-days is required. Replanting of the clearfelled areas takes place two years after felling. A 10 percent seedling reserve is made to facilitate beating up of failed seedlings after planting. Complete replacement is unusual in the sawlog areas.

Surveying

23. Survey of the planted areas follows immediately after planting has been completed. Survey data from the field is transferred into 1:10 000 survey sheets plotted from 1:25 000 scale aerial photographs. The survey section of the Department keeps a record of all the surveyed areas.

Weeding

24. Pulpwood Area. In the Turbo area, both manual and mechanical weeding are carried out as follows: manual weeding in the first, second and third years at seven man-days per hectare and mechanical weeding in the first, second and third year at two hours per hectare. After the rains in the Turbo area, weed growth is profuse making such heavy weeding necessary.

25. Sawlog Area and Pulpwood Areas Other Than Turbo. Since trees interplanted with agricultural crops are grown in workers' plots for the first three years, weeding is carried out by labour while tending their crops. No mechanical weeding or herbicides application is used. Continual weeding on plantations grown on grasslands is necessary for the first three years, particularly where cypress is established. However, P. patula can survive in grasslands so long as the grass is not taller than the trees. In these areas, weeding is particularly necessary to reduce fire danger and also to minimize rat damage to young seedlings.

Pruning

26. Pulpwood Area. No pruning and thinning is required in the pulpwood area. Where fire danger is considered high in young plantations light pruning may be carried out; otherwise, this is not necessary.

27. Sawlog Area. Pruning of trees intended to provide sawn wood is necessary so as to provide a knot-hole tree timber for better quality. To obtain this high quality timber, it is necessary to carry out pruning schedules as follows:

Cypress - five prunings over ten years

Age 2 - all stems

Age 4 - all stems

Age 6 - 533 stems/hectare to 9.25 metres

Age 8 - 533 stems/hectare to 11.25 metres

Age 10 - 533 stems/hectare to 13.75 metres

No other pruning is necessary after age ten.

Pines - four prunings over ten years at

Age 4 - all the stems

Age 6 - all the stems

Age 8 - 711 stems/hectare to 9 metres

Age 10 - 711 stems/hectare to 12 metres

No further pruning necessary after age ten.

Labour requirement for pruning is based on the country's present average of 12 man-days per hectare. The average annual pruning programme will be 25 000 hectares.

28. Thinning. Thinning is not necessary in pulpwood plantations. It is, however, necessary in sawlog plantations. The purpose of thinning plantations is to increase the value of the final crop. Three thinnings would be carried out on plantations. The first thinning is hygienic and is intended to remove all dying, dead and diseased trees from the plantations. The second and third thinnings are commercial and provide a financial return to the Government while still improving the quality of the final crop. The schedule below shows the remaining crop after thinning in both pine and cypress plantations in the project.

Cypress

Age in Years	Plants Established Per Ha	Crop Remaining After Thinning	Plant Height in Metres
0	1 600	No thinning	-
5	-	533	12
10	-	355	Top height not considered
15	-	250	Top height not considered

Pines

Age in Years	Plants Established Per Ha	Crop Remaining After Thinning	Plant Height in Metres
0	1 600	No thinning	-
5	-	711	12
8	-	533	Top height not considered
13	-	356	Top height not considered

29. The average annual thinning during the project period would be 4 100 ha. Average annual man-day requirement for non-commercial thinning and marking of commercial thinning is eight/ha.

Protection

30. Protection Against Fire. Fire damage in Kenya can be very high, particularly during years of severe drought. In 1971 the country lost 19 000 hectares of forest which included over 2 000 hectares of plantations. It is therefore necessary that adequate fire protection measures are enforced during the project period. In order to ensure strong fire control, the Department established a fire control section to deal with all fire matters.

31. Firebreaks. Firebreaks would be established at a density of 40 m per ha and with a width of 20 m and maintained by early burning and all year round clearing. Firebreak maintenance in both pulpwood and sawlog plantations would be carried out both by labour and tractor with a rotary harrow. An average of 0.12 man-days per hectare would be required.

32. Protection Against Fungal Diseases. Dothistroma pinii has been the worst fungal disease. As a result, the Department has halted any further planting of P. radiata which is particularly susceptible to it while studies continue to find a cheaper method of control. Nursery diseases caused by Rhizoctonia solani Kuhn and pythium spp. still cause problems. Cypress canker caused by Monochaetia unicornis (Cooke and Ellis), Armillaria mellea of both pines and cypress, Diplodia pinea (Desm) have all been present in the Kenya softwood plantations. The Pathology section of the Department carries out a continuous field check on these diseases and controls them where possible. This would continue during the project period.

33. Protection Against Insect Pests. Insect pests of economic importance in Kenya are the woolly aphids of the genera Adelges and Pineus (Homoptera: Adelgidae). P. patula, P. radiata and other pines have been attacked over a wide area. The aphids suck the pine juice and retard growth, and a severe attack can cause death of the trees, although this has not yet been noticed in Kenya.

34. A summary of silvicultural inputs for each of the three project components, together with estimates of total costs per hectare, are displayed in Table 8 of this appendix.

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Table 1 Vehicle and Equipment Running Cost

Location	Type and Number			km/vehicle/year	KSh/km		Annual Cost (KL)
Supervision Vehicles							
Project Headquarters	Saloon Car		1	20,000	1.1		1,100
"	Station Wagon		1	20,000	1.1		1,100
"	Land Rover	1					
Conservancies	" "	3					
Divisions	" "	14					
Main Forest Stations	" "	59					
Sub Forest Stations	" "	23[1]	100	17,000	1.1		93,500
						sub-total	95,700
General Administration Vehicles and Equipment							
Main Forest Stations and Selected Divisions	5/7 ton lorries		65	15,000	1.7		82,875
Sub Forest Stations	3-ton lorries		40[2]	15,000	1.5		45,000
Stations under construction	60-65 hp tractors		10[3][4]	1,000	19.0		9,500
Divisions, Main Station and Sub Stations	Stationary engine (water supplies)		120	1,300 hr/yr	4.0		31,200
(Location not given)	Fire trucks		4	--	--		2,000
" " "	85 hp tractors		8	1,000	20.0		8,000
						sub-total	178,575
				Sub-total all vehicles and equipment			274,275
				10% Physical Contingency			27,427
				Total Annual Cost			301,702
				Total Annual Cost Per Hectare			1.886 (KSh 37.7)

1/ Balance of 24 sub-stations would share transport with main stations and have use of 3-ton trucks.

2/ Allows for replacement of tractor units by trucks in stations where ploughing completed.

3/ Required for general carting over rough terrain during station construction and limited cultivation operations.

4/ Tractor requirements for cultivation operation in Turbo are included in afforestation estimates.

APPENDIX 1

KENYA II PLANTATION PROJECT

Table 2 Schedule of Unit Costs for New Division, Stations and Sub-Stations

	Unit Cost KL	Division No.	Division Cost (KL)	Station No.	Station Cost (KL)	Sub-Station No.	Sub-Station Cost (KL)
Office	-	1	1,300	1	600	1	600
Store, general	330	1	330	1	330	1	330
Store, fuel	110	-	-	1	110	1	110
Garage	-	1	115	1	460	1	460
School	950	-	-	1	950	1	950
Dispensary	330	-	-	1	330	1	330
Shops	290	-	-	2	580	2	580
DFO/Forester House	7,250	1	7,250	1	7,250	1	7,250
Ranger/Clerk/Driver House	1,450	4	5,800	5	7,250	3	4,350
Forest Guard House	550	-	-	3	1,650	3	1,650
Water Supply	1,650	-	-	1	1,650	1	1,650
Nursery	1,450	-	-	1	1,450	1	1,450
Fire Towers	270	-	-	2	540	2	540
Labour houses 1/	210	-	-	-	1/	-	1/
Totals			14,795		23,150		20,250

1/ Calculated on basis of number of employees at cost of KL200/house/employee

KENYA II PLANTATION PROJECT

Table 3 Schedule of Existing Forestry Department Buildings in the Project Area

(Excluding forest workmen's houses)

	HOUSING					OTHER BUILDINGS								
	Senior Staff	Junior Staff	Teachers	Forest Guards	Rest House	Fire Tower	Office	Store	Garage	Dispen.	School	Comm. Hall	Shop	Water Supply
Division														
Elburgon	13	69	40	129	4	11	11	12	8	11	10	5	40	12
Londiani	15	35	12	75	-	3	8	7	3	5	5	-	4	7
Kyahururu	11	66	30	103	-	6	10	13	7	7	7	1	23	11
Baringo	7	35	15	70	-	4	7	7	2	5	5	-	10	6
Eldoret/Nakkoi	11	60	33	78	2	4	11	26	3	11	15	9	39	20
Kitale	6	30	9	63	-	2	6	6	3	5	3	-	4	5
Kisumu	2	9	-	18	-	-	3	4	2	-	-	-	-	1
Turbo	11	21	-	20	-	3	5	6	3	2	-	-	-	7
Nyeri	12	65	23	104	-	5	12	12	8	10	7	3	10	11
Embu	6	28	6	60	-	2	8	6	2	2	2	-	4	6
Nairobi	10	53	21	110	-	4	9	9	4	7	7	-	14	8
Coast	5	25	-	50	-	-	5	5	3	-	-	-	-	4
Southern	3	18	-	40	2	-	3	3	2	-	-	-	-	3
TOTAL	112	514	189	920	8	44	98	116	48	65	60	18	148	101

KENYA II PLANTATION PROJECT

Table 4 Road Construction Equipment Requirement

Item	Estimated Remaining Operational Life Per Unit	Full Operational Life	Replacement Cost or Cost (KL)	Inherited Value (KL)
Existing Equipment				
1 low loader, 20 ton	4 - 5 years	6 years	16,400	12,300
1 Massey Ferguson bulldozer (D6 equiv.)	5,000 hours	10,000 hours	28,400	14,200
1 D.6 Caterpillar	6,000 hours	10,000 hours	22,900	13,740
1 Tevex 32:40 bulldozer (D7.5 equiv.)	6,000 hours	10,000 hours	33,200	19,920
1 Wakefield motor grader (120 hp ")	8,000 hours	10,000 hours	16,000	12,800
1 Champion motor grader (Cat 150 hp ")	8,000 hours	10,000 hours	17,200	13,760
1 Cat 14 motor grader (150 hp)	6,000 hours	10,000 hours	17,200	10,320
1 Front end loader	3,000 hours	10,000 hours	19,600	5,880
1 Bomeg self-propelled road roller 7-ton	10,000 hours	10,000 hours	8,000	8,000
1 Bomeg self-propelled road roller 10-ton	6,000 hours	10,000 hours	10,000	6,000
4 Tipper lorries 5/7 ton	160,000 km	300,000 km	19,200	10,240
2 Land rovers	60,000 km	200,000 km	5,300	1,590
			Total	128,750
New Equipment (per unit)				
1 D.6 (D.7) Bulldozer with ripper & blade				28,000[1/]
1 Cat 955 front end loader 115 hp				24,200
1 Motor grader, 150 hp				17,200
3 7-ton tipper lorries				14,400
2 Land Rovers LWB				5,300
			Total, 1 Unit	89,100
			Total, 2 Units	178,200

KENYA II PLANTATION PROJECT

Table 5 Machinery Operating Costs

Item	Km/hrs/year	Cost/hour or km (KSh)	Annual Cost (KL)
1 bulldozer (D6)	1,500 hours	50	3,750
1 bulldozer (D7)	1,500 hours	60	4,500
1 front end loader	1,400 hours	43	3,010
2 Motor graders	3,000 hours	49	7,350
1 road roller	1,000 hours	16	800
4 tipper lorries	70,000 kms	1.5	5,250
2 Land rovers	35,000 kms	1.1	1,925
1 low loader	4,000 kms	3.8	760
		Total, 1 Unit	27,345
		Total, 2 Units	54,690

[1/] 1 D.7 bulldozer will be required for one unit and one D.6 for the other unit. Cost represents average of D.6 and D.7.

APPENDIX 1

KENYA II PLANTATION PROJECT

Table 6 Staff and Labour Requirements and Costs

Staff/Labour Grade	No.	Annual Cost (KL)	Total Cost (KL)
Headquarters			
Superintending roads engineer	1	1/	-
Cheif Clerk	1	400	400
Clerk/Typists	2	350	700
Driver	1	350	350
Low Loader driver	1	400	400
			1,850
One Unit Requirements			
Road superintendent	1	1,400	1,400
Road foreman	2	850	1,700
Plant operators	7 2/	450	3,150
Plant operators helpers (dozers)	3	180	540
Plant greasers	4	180	720
Drivers	5	350	1,750
Mechanical foreman	1	1,200	1,200
Welder	1	450	450
Mechanics	4	450	1,800
Mechanics' assistants	4	200	800
Bridge building foreman	1	850	850
Bridge labour	10	180	1,800
Masons	2	350	700
Carpenters	2	350	700
Culvert labour	20	180	3,600
Chief clerk	1	400	400
Clerks	1	350	350
Storeman	1	300	300
Watchman/messenger	4	180	720
Road levellers/tracers 3/	2	450	900
		Total 1 unit	23,830
		Total 2 units	47,660
			49,510

1/ Existing post financed by bilateral agreement funds

2/ Spare driver interchangeable with lorry drivers

3/ Major surveys would be undertaken by surveyor seconded from survey branch of F.D.

KENYA II PLANTATION PROJECT

Table 7 Staff Manning Plans and Costs of Management Units

Project Headquarters

	Grade	Annual Cost (KL)
Project Manager	M	2,600
Asst. Manager	L	2,050
Chief Accountant	L	2,050
Acct. Grade I	J	1,400
Acct. Grade III	G	850
Executive Officer	G	850
3 Secretaries	F	1,800
2 Typists	D	700
7 Clerks	D	2,450
2 Drivers	D	700
1 Storeman	D	350
1 Officer Messenger	B	200
	Total	16,000

Conservancies (3)

	Rate	Annual Cost (KL)
1 C of F	2,100	2,100
1 Executive Officer		850
1 Secretary		600
3 Clerk/Typists	350	1,050
1 Driver		350
1 Postman/Messenger		200
	Total	5,150

Divisions (14)

	Rate	Annual Cost (KL)
1 D.F.O.		1,600
1 Asst. D.F.O.		1,400
3 Clerk/Typists	350	1,050
1 Driver		350
1 Postman/Messenger		200
	Total	4,600

Main Forest Stations (59)

	Rate	Annual Cost (KL)
1 Forester		1,140
2 Rangers	500	1,000
1 Clerk/Typist	350	350
2 Drivers	350	700
1 Storeman		300
8 Forest Guards	230	1,840
1 Postman/Messenger		200
	Total	5,530

	Annual Cost (KL)
1 Forester	1,040
1 Ranger	500
1 Clerk	350
1 Driver	350
1 Storeman	300
4 FGs	920
1 Postman/Messenger	200
Total	3,660

KENYA II PLANTATION PROJECT

Table 8, Summary of Silvicultural Costs

Item	Sawlogs					Pulpwood - Eldoret					Pulpwood - Turbo				
	Year(s)	Labour Required (Man days)	Labour Cost[1] (KSh/ha)	Other Cost (KSh/ha)	Total Cost (KSh/ha)	Year(s)	Labour Required (Man days)	Labour Cost[1] (KSh/ha)	Other Cost (KSh/ha)	Total Cost (KSh/ha)	Year(s)	Labour Required (Man days)	Labour Cost[1] (KSh/ha)	Other Cost (KSh/ha)	Total Cost (KSh/ha)
Nursery[2]	-1	44.0	418.440	44	462.440	-1	44.0	418.440	44	462.440	-1	48.0	456.480	48	504.480
Land Preparation	-2	37.7	358.527	-	358.527	-2	37.7	358.527	-	358.527	-2	37.7	358.527	-	358.527
Planting	0	14.0	133.140	-	133.140	0	14.0	133.140	-	133.140	0	14.0	133.140	-	133.140
Plantation Survey	0	1.0	9.510	-	9.510	0	1.0	9.510	-	9.510	0	1.0	9.510	-	9.510
Beating Up	0	1.4	13.314	-	13.314	0	1.4	13.314	-	13.314	0	2.8	26.628	-	26.628
Weeding: First	2	15.0	142.650	-	142.650	2	15.0	142.650	-	142.650	0	7.0	66.570	40[3]	106.570
Second	-	-	-	-	-	-	-	-	-	-	1	7.0	66.570	80[3]	146.570
Third	-	-	-	-	-	-	-	-	-	-	2	7.0	66.570	40[3]	106.570
Pruning	2,4,6,8,10	12.0	114.120	-	114.120	-	-	-	-	-	-	-	-	-	-
Pre Commercial Thinning	5	7.0	66.570	-	66.570	-	-	-	-	-	-	-	-	-	-
Marking Out	10,15	0.5	4.755	-	4.755	-	-	-	-	-	-	-	-	-	-
Fire Protection	0-24	0.12	1.141	-	1.141	0-14	0.12	1.141	-	1.141	0-14	0.12	1.141	-	1.141
Other Protection	0-24	0.1	0.951	-	0.951	0-14	0.1	0.951	-	0.951	0-14	0.1	0.951	-	0.951

1/ Labour Shadow wage rate is KSh 9.51/man day.

2/ Nursery labour required is 40 man days per hectare planted. Ten percent is added for sawlogs (and pulpwood-Eldoret) beating up, and 20 percent is added for pulpwood-Turbo beating up. Two thousand trees need to be grown in the nursery for each hectare planted in the field. (There is a 20% culling loss of seedlings for sawlog and pulpwood-Eldoret nurseries and a 10% culling loss for pulpwood-Turbo nurseries.) It costs KSh 20 per thousand seedlings grown for fertilizer, tools, boxes, etc., which amounts to KSh 44 per hectare for sawlogs (and pulpwood-Eldoret) and KSh 48 per hectare for pulpwood-Turbo.

3/ Cost represents mechanical weeding, which costs KSh 20 per hour.

APPENDIX 2

INHERITED AND SALVAGE VALUES

Both inherited and salvage values derived below are unweighted and have no shadow foreign exchange rate applied to them. Appropriate weighting and shadow pricing has been done in Tables 4 and 6 of the text.

Vehicles and Equipment

The project is assumed to inherit a stock of vehicles and equipment equal to six years of project purchases. The useful lives of vehicles and equipment are six years, so they should be, on the average, half worn out. Therefore, an average of three years of useful life is assumed to remain in the vehicles and equipment inherited. Similarly, at the end of the project the salvage value of vehicles and equipment passed on to the continuing plantation programme is assumed to be six years worth of purchases, again on the average half 'worn out'. The inherited/salvage value is, therefore, equal to the cost of three project years' purchases of vehicles and equipment, which is KSh 50.8 per hectare.

Tools and Stores

The inherited and salvage values for tools and stores are determined in the same manner as the values for vehicles and equipment, above, except that a three year useful life is assumed rather than a six year life. Assuming that the stock of tools and stores is on the average half worn out, 1½ years of useful life are inherited and salvaged, at a value of KSh 4.1 per hectare.

Building Construction

Existing buildings and their replacement costs are given in Table 1 of this appendix. Replacement cost per hectare for all existing buildings is KSh 360.6 per hectare. If on the average the buildings are half worn out, their value (for forestry purposes) is KSh 180.3 per hectare. However, it is doubtful that their value for alternative uses is as high as it is for forestry due to location and design. Assuming that their alternative value is half that of their forestry value, the proper inherited value and salvage value for existing buildings is KSh 90.14 per hectare. In addition, a salvage value of new buildings (capital cost - KSh 226.2) needs to be added. Assuming a 50 year useful life and a non-forestry value equal to half that of forestry, the salvage value of new buildings for the sawlog rotation is 25 percent of the building capital cost (KSh 56.54/ha) and for the pulpwood rotation is 35 percent of the building capital cost (KSh 79.16/ha). The salvage value for existing buildings must be added to the salvage values for new buildings to get the total building salvage values, which are KSh 146.7/ha for sawlogs and KSh 169.3/ha for pulpwood. In addition, the existing buildings, which cost KSh 360.6/ha to rebuild, will have to be replaced. Assuming a 50 year useful life for existing buildings, annual replacement will cost KSh 7.2 per hectare. None of the new buildings will need to be replaced.

Road Construction

Road construction is assumed to occur during the year before planting (year 1). All equipment used for project road construction is expected to be completely used up at the end of the six year construction period. In addition, it is assumed that existing roads and roads constructed during the project have no value other than for forestry (no inherited or salvage values). However, equipment existing at the beginning of the project was used for road construction. Table 4 of Appendix 1 lists that equipment. The inherited value plus 10 percent for physical contingency is KL 141 625, or KSh 71.1 per hectare.

APPENDIX 2

KENYA II PLANTATION PROJECT

Table 1 Replacement Costs of Existing Buildings

Type[1/]	Number[2/]	Unit Replacement Cost (KL)	Total Replacement Cost (KL)
Nurseries	90	1,450	130,500
Fire Towers	44	270	11,880
Division Office	13	1,300	16,900
Station Office	85	600-	51,000
General Stores	116	330	38,280
Fuel Stores	90	110	9,900
Division Garages	13	115	1,495
Station Garages	35	460	16,100
Dispensaries	65	330	21,450
Schools	60	950	57,000
Community Halls	18	330[3/]	5,940
Shops	148	290	42,920
Water Supplies	101	1,650	166,650
DFO/Forester Houses	112	7,250	812,000
Ranger/Clerk/Driver Houses	514	1,450	745,300
Teacher's House	189	1,000[4/]	189,000
Forest Guard House	920	550	506,000
Sub-total			2,822,315
Replacement /Additions to existing staff housing and buildings			200,000
Net			2,622,315
10% Physical contigency			262,231
Total Cost			2,884,546 (KSh 360.6/ha)

1/ All of the types listed in either Table 2 or Table 3 of Appendix 1.

2/ Numbers from Table 3, Appendix 1 (when given). Office and garage numbers split by assuming all 13 divisions had one unit with the remainder located on stations. Numbers for items from Table 8, Appendix 1, assume that each old division/station has same buildings as new division/station.

3/ Community hall cost not given in Table 8, Appendix 1, so assumed equal to store/dispensary cost of KL 330.

4/ Teacher's house cost (not given) is assumed equal to average of junior staff's and forest guards' houses.

APPENDIX 3

ECONOMIC UNIT VALUES OF OUTPUT

The economic price of pulpwood is calculated by determining the cost of importing pulpwood to run the Webuye mill and then shadow pricing it at 130 percent. The price is determined as follows:

	US$
Cost of pulpwood chips from West Coast (North America) f.o.b.	84/BDU [1]
Freight and insurance to Mombasa, Kenya	35/BDU
Cost: C.i.f. Mombasa	119/BDU
Less Chipping costs (including depreciation of equipment)	10/BDU
Equivalent roundwood cost (chip measure)	109/BDU
Equivalent roundwood cost (roundwood measure)	54.5/m^3
Transport to Webuye mill (600 km at KSh 0.178/m^3/km)	10.7/m^3
Handling	1.6/m^3
Cost of pulpwood at mill site	66.7/m^3
Less: Logging costs	13.5/m^3
Transport and handling to mill	2.0/m^3
Economic price of pulpwood stumpage	51.2/m^3
	(KSh 366/m^3)
Economic shadow price of pulpwood stumpage	KSh 475.8/m^3

The economic price of sawlogs which substitute for potential imports is calculated by determining the cost of importing sawnwood to Nairobi. The economic price of sawlogs which are exported is estimated to be KSh 236/m^3. The two prices are averaged (weighted: 75 percent for import substitution output and 25 percent for exported output) and multiplied by 1.30 to reflect the 130 percent shadow pricing of foreign exchange. The average shadow price for sawnwood is then converted to sawlog prices by applying the appropriate conversion factors. These prices are calculated as follows:

	US$/$m^3$
Sawnwood price (lowest grade) in Scandinavia f.o.b.	120
Sea freight to Mombasa	35
Port handling in Mombasa and rail freight to Nairobi	11
Sawnwood import cost in Nairobi	166
Sawmilling cost (less stumpage element plus handling/freight to Nairobi)	55
Economic price (sawnwood measure) of import substitution sawlog stumpage	US$111/$m^3$
	(KSh 793/m^3)
Economic price (sawnwood measure) of export sawlog stumpage	(KSh 236/m^3)
Weighted average economic price (sawnwood measure) of sawlog stumpage	KSh 653.75/m^3
Weighted average shadow price (sawnwood measure) of sawlog stumpage	KSh 849.875/m^3

1/ Bone dry unit of chips. 1 BDU = 2400 lb = 2m^3 roundwood.

APPENDIX 4

SENSITIVITY ANALYSES

1. In Section E of the text the sensitivity of the original ERR to changes in certain assumptions was discussed. The original ERRs are commonly tested by changing an assumption such as the shadow wage rate and then constructing an entirely new cash or value flow table for the new analysis. The new ERR or NPW is then calculated from this new cash flow. This is a complete but somewhat time-consuming method. Much faster computerized methods to test several types of uncertainties are available. One of these was used to carry out the sensitivity analysis of the Kenya II plantation project components. Results are shown in Tables 1 through 6 in this Appendix. These tables show changes in four investment performance measures due to changes in main items of benefits or costs. Changes in benefits/costs are specified in percentage points, in this case 10 percent.

2. If 20 percent had been specified instead, each change in the investment performance measures would have been twice as large. Benefit decreases and cost increases have the effect of lowering the investment performance measures by the amounts listed in these tables, while benefit increases and cost decreases have the effect of raising the measures by the same amounts. For example, if nursery cost increased by 10 percent, in Table 1 the NPW would fall by KSh 42.81 to KSh 16 133.8 and if nursery cost decreased by 10 percent, NPW would rise by KSh 42.81 to KSh 16 219.42. It is evident then, that a change of 10 percent in nursery cost has little effect on NPW, and consequently it is likely to have no effect on the project decision on whether or not to accept the project (assuming that the other costs, the benefits, the discount rate, etc. are as indicated in this analysis).

3. The sensitivity tables also facilitate quick comparisons of the relative sensitivity of the investment performance measures to the various costs and benefits. For example, in Table 1 the largest values in each column are found in row 27, harvest benefit. This means that for a 10 percent change in any cost/benefit all four investment performance measures are most sensitive to a ten percent change in the harvest value. Likewise, the measures are least sensitive to a 10 percent change in the tools salvage value (row 29).

4. Besides indicating the relative sensitivity of investment performance measures to changes in costs and benefits, the tables can be used to directly calculate NPW, NFW, SEV, and SR for changes in one or more benefits or costs. A common test is to check for changes in one or more costs and/or benefits which cause NPW or NFW to become equal to zero at a discount rate equal to the project's alternative rate of return. If such changes were considered likely, the decision whether or not to implement the project could be affected since the profitability of the project would have changed.

5. For example, the figures in Table 1 indicate that a 10 percent benefit decrease or cost increase in any or all benefits and costs would reduce NPW very little. In fact, the complete elimination of the final harvest would reduce NPW by KSh 16 086.6 to KSh 90. In other words, the rate of return on the sawlog sub-project if the only direct benefits were sawlog thinnings would be about 8 percent. Clearly, then, in order for the ERR to drop below 8 percent, very substantial benefit decreases and/or cost increases must occur.

6. The exact changes in prices necessary to reduce NPW to zero can be calculated from Table 1. For example, the average stumpage price reduction which lowers the present value of the thinnings and final harvest benefits by an amount equal to NPW is calculated as follows:

Activity	change in NPW
10 percent thinning value decrease	- 595.55
10 percent harvest value decrease	- 1 608.66
10 percent total removals value decrease (assumed due decrease in stumpage price)	- 2 204.21
NPW	16 176.61

NPW/(10% total removals value decrease) = $\frac{16\ 176.61}{-2\ 204.21}$ = - 7.339

Therefore, a 73.39 percent (i.e. 7.339 x 10) reduction in the average stumpage price would reduce NPW to zero.

APPENDIX 4

Table 1, Economic Analysis for Sawlogs (8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	16 176.61
- net future worth (NFW)	129 219.75
- soil expectation value (SEV)	18 491.50
- soil rent (SR)	1 369.74

SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

DUE TO A 10 PERCENT CHANGE IN	CHANGE IN: NPW	NFW	SEV	SR
1 NURSERY	42.81	342.01	48.94	3.63
2 LAND PREPARE	35.85	286.37	40.98	3.04
3 PLANTING	11.41	91.15	13.04	.97
4 PLANT SURVEY	.81	6.51	.93	.07
5 BEATING UP	1.14	9.11	1.30	.10
6 WEEDING	10.48	83.73	11.98	.89
7 PRUNING	31.56	252.08	36.07	2.67
8 PRE-COM THIN	3.89	31.04	4.44	.33
9 MARKING OUT	.32	2.56	.37	.03
10 FIRE PROTECT	1.09	8.68	1.24	.09
11 OTH. PROTECT	.99	7.90	1.13	.08
12 VE/EQUIP PUR	43.60	348.25	49.84	3.69
13 VE/EQUIP RUN	90.40	722.08	103.33	7.65
14 VE/EQU INHER	6.74	53.84	7.70	.57
15 TOOLS/STORES	6.66	53.16	7.61	.56
16 TOOLS INHER	.52	4.15	.59	.04
17 BUILD CONSTR	23.77	189.88	27.17	2.01
18 BUILD MAINT	22.74	181.66	26.00	1.93
19 BUILD REPLAC	14.71	117.47	16.81	1.25
20 BUILD INHER	9.47	75.65	10.83	.80
21 ROAD CONSTRU	51.44	410.94	58.81	4.36
22 ROAD MAINT	7.51	60.01	8.59	.64
23 ROAD INHER	8.56	68.34	9.78	.72
24 STAFF REQUIR	151.54	1210.52	173.23	12.83
25 OFFICE RUN	11.40	91.03	13.03	.96
26 THINNINGS	595.55	4757.31	680.78	50.43
27 HARVEST	1608.66	12850.11	1838.87	136.21
28 VE/EQU SALVG	.84	6.74	.96	.07
29 TOOLS SALVG	.07	.52	.07	.01
30 BUILD SALVG	1.93	15.42	2.21	.16

APPENDIX 4

Table 2, Economic Analysis for Pulpwood - Eldoret Division
(8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	24 660.18
- net future worth (NFW)	91 243.11
- soil expectation value (SEV)	33 793.52
- soil rent (SR)	2 500.22

SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

		CHANGE IN: NPV	NFV	SEV	S_R
DUE TO A 10 PERCENT CHANGE IN					
1	NURSERY	42.81	158.42	58.67	4.35
2	LAND PREPARE	35.85	132.65	49.13	3.64
3	PLANTING	11.41	42.22	15.64	1.16
4	PLANT SURVEY	.81	3.01	1.12	.08
5	BEATING UP	1.14	4.22	1.56	.12
6	WEEDING	10.48	38.78	14.36	1.06
7	FIRE PROTECT	.87	3.23	1.19	.09
8	OTH. PROTECT	.79	2.93	1.09	.08
9	VE/EQUIP PUR	29.19	107.99	40.00	2.96
10	VE/EQUIP RUN	60.46	223.71	82.85	6.14
11	VE/EQU INHER	5.78	21.39	7.92	.59
12	TOOLS/STORES	4.49	16.63	6.16	.46
13	TOOLS INHER	.44	1.63	.60	.04
14	BUILD CONSTR	20.38	75.41	27.93	2.07
15	BUILD MAINT	15.21	56.26	20.84	1.54
16	BUILD REPLAC	9.82	36.34	13.46	1.00
17	BUILD INHER	8.12	30.04	11.13	.82
18	ROAD CONSTRU	51.44	190.35	70.50	5.22
19	ROAD MAINT	6.02	22.29	8.25	.61
20	ROAD INHER	8.56	31.66	11.72	.87
21	STAFF REQUIR	101.39	375.14	138.94	10.29
22	OFFICE RUN	7.67	28.39	10.51	.78
23	HARVEST	2893.36	10705.50	3964.97	293.70
24	VE/EQU SALVG	1.56	5.78	2.14	.16
25	TOOLS SALVG	.12	.44	.16	.01
26	BUILD SALVG	4.12	15.26	5.65	.42

APPENDIX 4

Table 3. Economic Analysis for Pulpwood - Turbo
(8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	24 189.75
- net future worth (NFW)	89 502.52
- soil expectation value (SEV)	33 148.86
- soil rent (SR)	2 455.47

SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

		CHANGE IN: NPW	NFV	SEV	S_R
DUE TO A 10 PERCENT CHANGE IN					
1	NURSERY	46.71	172.84	64.01	4.74
2	LAND PREPARE	35.85	132.65	49.13	3.64
3	PLANTING	11.41	42.22	15.64	1.16
4	PLANT SUPVEY	.81	3.01	1.12	.08
5	BEATING UP	2.28	8.44	3.13	.23
6	WEEDING	28.61	105.87	39.21	2.90
7	FIRE PROTECT	.87	3.23	1.19	.09
8	OTH. PROTECT	.79	2.93	1.09	.08
9	VE/EQUIP PUR	31.90	118.03	43.71	3.24
10	VE/EQUIP RUN	66.15	244.75	90.65	6.71
11	VE/EQU INHER	6.29	23.27	8.62	.64
12	TOOLS/STORES	4.91	18.15	6.72	.50
13	TOOLS INHER	.48	1.78	.66	.05
14	BUILD CONSTR	22.18	82.07	30.39	2.25
15	BUILD MAINT	16.61	61.44	22.76	1.69
16	BUILD REPLAC	10.74	39.76	14.72	1.09
17	BUILD INHER	8.84	32.71	12.11	.90
18	ROAD CONSTRU	51.44	190.35	70.50	5.22
19	ROAD MAINT	6.02	22.29	8.25	.61
20	ROAD INHER	8.56	31.66	11.72	.87
21	STAFF REQUIR	110.86	410.18	151.92	11.25
22	OFFICE RUN	8.39	31.03	11.49	.85
23	HARVEST	2893.36	10705.50	3964.97	293.70
24	VE/EQU SALVG	1.70	6.29	2.33	.17
25	TOOLS SALVG	.13	.48	.18	.01
26	BUILD SALVG	4.49	16.61	6.15	.46

APPENDIX 4

Table 4. Financial Analysis for Sawlogs (8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	1 560.83
- net future worth (NFW)	12 467.98
- soil expectation value (SEV)	1 784.18
- soil rent (SR)	132.16

SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

		CHANGE IN: NPV	NFW	SEV	SR
DUE TO A 10 PERCENT CHANGE IN					
1	NURSERY	55.73	445.19	63.71	4.72
2	LAND PREPARE	47.80	381.83	54.64	4.05
3	PLANTING	15.22	121.56	17.40	1.29
4	PLANT SURVEY	1.09	8.70	1.24	.09
5	BEATING UP	1.53	12.19	1.74	.13
6	WEEDING	13.98	111.68	15.98	1.18
7	PRUNING	42.10	336.26	48.12	3.56
8	PRE-COM THIN	5.18	41.39	5.92	.44
9	MARKING OUT	.42	3.36	.48	.04
10	FIRE PROTECT	1.48	11.84	1.69	.13
11	OTH. PROTECT	1.28	10.26	1.47	.11
12	VE/EQUIP PUR	33.53	267.85	38.33	2.84
13	VE/EQUIP RUN	74.71	596.83	85.41	6.33
14	VE/EQU INHER	5.18	41.38	5.92	.44
15	TOOLS/STORES	5.44	43.45	6.22	.46
16	TOOLS INHER	.42	3.35	.48	.04
17	BUILD CONSTR	23.08	184.36	26.38	1.95
18	BUILD MAINT	22.78	181.95	26.04	1.93
19	BUILD REPLAC	14.27	114.03	16.32	1.21
20	BUILD INHER	9.20	73.49	10.52	.78
21	ROAD CONSTRU	45.39	362.57	51.88	3.84
22	ROAD MAINT	6.33	50.53	7.23	.54
23	ROAD INHER	6.58	52.59	7.53	.56
24	STAFF REQUIR	147.12	1175.16	168.17	12.46
25	OFFICE RUN	11.08	88.51	12.67	.94
26	THINNINGS	116.79	932.94	133.51	9.89
27	HARVEST	315.47	2520.00	360.62	26.71
28	VE/EQU SALVG	.65	5.18	.74	.05
29	TOOLS SALVG	.05	.42	.06	.00
30	BUILD SALVG	1.87	14.97	2.14	.16

APPENDIX 4

Table 5, Financial Analysis for Pulpwood - Eldoret (8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	2 456.32
- net future worth (NFW)	9 088.43
- soil expectation value (SEV)	3 366.06
- soil rent (SR)	249.34

SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

		CHANGE IN: NPV	NFV	SEV	SR
DUE TO A 10 PERCENT CHANGE IN					
1	NURSERY	55.73	206.21	78.37	5.6%
2	LAND PREPARE	47.80	176.86	65.50	4.85
3	PLANTING	15.22	56.31	20.85	1.54
4	PLANT SURVEY	1.09	4.03	1.49	.11
5	BEATING UP	1.53	5.65	2.09	.15
6	WEEDING	13.98	51.73	19.16	1.42
7	FIRE PROTECT	1.19	4.40	1.63	.12
8	OTH. PROTECT	1.03	3.81	1.41	.10
9	VE/EQUIP PUR	22.47	83.14	30.79	2.28
10	VE/EQUIP RUN	50.00	184.98	68.51	5.07
11	VE/EQU INHER	4.44	16.43	6.08	.45
12	TOOLS/STORES	3.63	13.44	4.98	.37
13	TOOLS INHER	.36	1.33	.49	.04
14	BUILD CONSTR	19.79	73.22	27.12	2.01
15	BUILD MAINT	14.76	54.62	20.23	1.50
16	BUILD REPLAC	9.54	35.31	13.08	.97
17	BUILD INHER	7.89	29.19	10.81	.80
18	ROAD CONSTRU	45.39	167.94	62.20	4.61
19	ROAD MAINT	5.07	18.77	6.95	.51
20	ROAD INHER	6.58	24.36	9.02	.67
21	STAFF REQUIR	98.42	364.15	134.87	9.99
22	OFFICE RUN	7.45	27.58	10.21	.76
23	HARVEST	182.43	675.00	250.00	18.52
24	VE/EQU SALVG	1.20	4.44	1.64	.12
25	TOOLS SALVG	.10	.36	.13	.01
26	BUILD SALVG	4.00	14.81	5.49	.41

APPENDIX 4

Table 6, Financial Analysis for Pulpwood - Turbo
(8% discount rate)

Original analysis	KSh/ha
- net present worth (NPW)	2 938.07
- net future worth (NFW)	10 870.92
- soil expectation value (SEV)	4 026.24
- soil rent (SR)	298.24

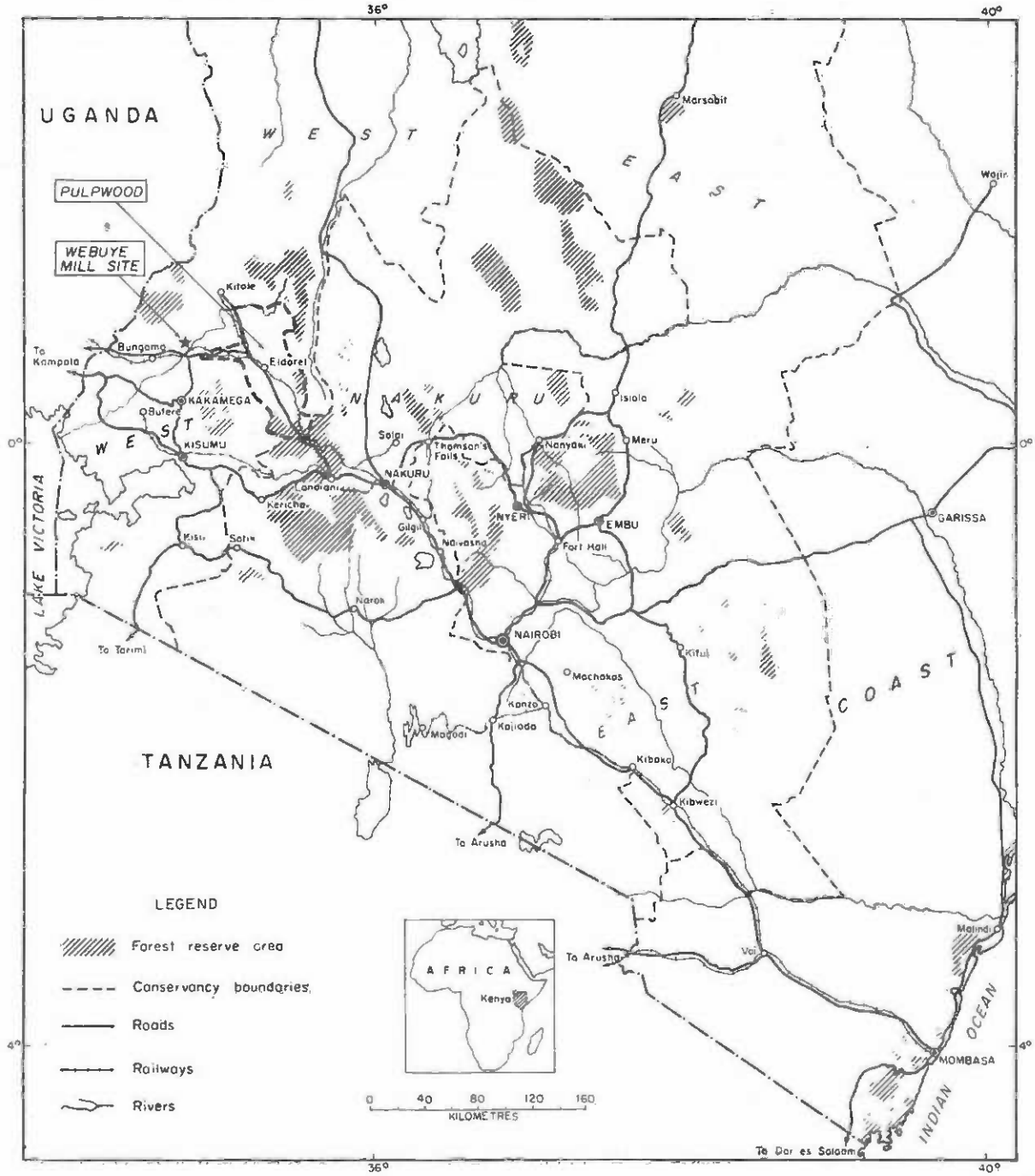
SENSITIVITY ANALYSIS

(8.00 PERCENT DISCOUNT RATE)
KEN SHILLING/HECTARE

		CHANGE IN: NPV	NFV	SEV	SR
DUE TO A 10 PERCENT CHANGE IN					
1	NURSERY	60.80	224.95	83.31	6.17
2	LAND PREPARE	47.80	176.86	65.50	4.85
3	PLANTING	15.22	56.31	20.85	1.54
4	PLANT SURVEY	1.09	4.03	1.49	.11
5	BEATING UP	3.04	11.26	4.17	.31
6	WEEDING	33.91	125.47	46.47	3.44
7	FIRE PROTECT	1.19	4.40	1.63	.12
8	OTH. PROTECT	1.03	3.81	1.41	.10
9	VE/EQUIP PUR	24.56	90.86	33.65	2.49
10	VE/EQUIP RUN	54.65	202.22	74.90	5.55
11	VE/EQU INHER	4.84	17.91	6.63	.49
12	TOOLS/STORES	3.97	14.68	5.44	.40
13	TOOLS INHER	.39	1.44	.53	.04
14	BUILD CONSTR	21.54	79.70	29.52	2.19
15	BUILD MAINT	16.13	59.69	22.11	1.64
16	BUILD REPLAC	10.44	38.65	14.31	1.06
17	BUILD INHER	8.58	31.75	11.76	.87
18	ROAD CONSTRU	45.39	167.94	62.20	4.61
19	ROAD MAINT	5.07	18.77	6.95	.51
20	ROAD INHER	6.58	24.36	9.02	.67
21	STAFF REQUIR	107.65	398.30	147.52	10.93
22	OFFICE RUN	8.13	30.10	11.15	.83
23	HARVEST	182.43	675.00	250.00	18.52
24	VE/EQU SALVG	1.31	4.84	1.79	.13
25	TOOLS SALVG	.11	.39	.14	.01
26	BUILD SALVG	4.36	16.12	5.97	.44

APPENDIX 5

KENYA — SAWLOG AND PULPWOOD PLANTATION PROJECT



ECONOMIC ANALYSIS OF FORESTRY PROJECTS: CASE STUDIES

FAO FORESTRY PAPER 17, SUPPLEMENT 1

CASE STUDY NO. 6

ZAMBIA INDUSTRIAL FORESTRY PROJECT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1979

PREFACE

This is one in a series of case studies of forestry and forest industries projects that has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in order to demonstrate methods of identifying, preparing and appraising projects in the forest sector. The programme of case studies has been made possible by a special allocation to FAO for this purpose from the Swedish International Development Authority (SIDA).

The Project reported on in this case study is a project of the Government of Zambia which has been supported by a loan from the World Bank. The case study is based largely on material contained in an appraisal of the Project carried out by the World Bank (Report No. 1429-ZA, 20 April 1977). Additional information was gathered through a visit to the Project during 1977. The case study therefore describes the Project as it was perceived at that time. This material has been released to FAO by the World Bank and the Government of Zambia exclusively for the purpose of teaching forestry planning methods. It may not be quoted or reproduced in part or in whole without permission.

CURRENCY EQUIVALENTS

Currency Unit = Zambian Kwacha (K)
K1 = US$1.2444
US$1 = K0.8036

ABBREVIATIONS

LNRT	-	Ministry of Land, Natural Resources and Tourism
FD	-	Forest Department
IPD	-	Industrial Plantations Division
KITE	-	Kafubu Industrial Timber Enterprises
ERR	-	Economic rate of return
FRR	-	Financial rate of return
IRR	-	Internal rate of return
f.o.b.	-	Free-on-board
c.i.f.	-	Cost, insurance and freight
p.a.	-	per annum
p.d.	-	per day

TABLE OF CONTENTS

INTRODUCTION

1. This case study is based upon a Project which forms part of Zambia's continuing forestry and forest industry development programme.[1]

2. It is a five-year "time-slice" project, covering planting and maintaining 19 500 ha of industrial forestry plantations during 1978-82, maintaining existing plantations during that period, logging and transporting 120 000 m^3 annually from pre-project plantations, and establishment and operation of a sawmill to produce about 46 000 m^3 of sawnwood annually from pre-project plantations. It is the second such five-year project within the programme, and it is envisaged that it will be followed by further projects. The project costs over the five-year period total approximately US$ 33.7 million.

3. The case study is divided into three parts. Section A gives background information on the country, the forest sector and the industrial forestry programme. Section B provides technical details about the Project, including estimates of input requirements and output levels. Section C contains analyses of Project costs and Project benefits, and a comparison of costs and benefits. This includes an examination of the sensitivity of the economic rate of return (ERR) of the Project, and of some of its component parts, to changes in assumptions about input and output values.

4. This case study provides a basis for discussion of a number of issues that commonly occur in planning and analysing joint forestry and forest industry projects. These centre round the relationship of the different components to each other (e.g., harmonizing the timing and scale of tree growing and processing, the relationship of the species properties to the final product requirements, and valuing the roundwood which constitutes the output of the forestry component of the project and an input into the industries component). The case study also covers other points which often arise in analysing afforestation projects (e.g. the shadow pricing of land, labour and project outputs).[2] It also illustrates issues related to the analysis of "time-slice" projects.

A. BACKGROUND

General

5. Zambia is a land-locked country in central Africa. The total surface area is about 735 000 km^2, and the population is nearly 5 million. Zambia has a sub-tropical climate, with a warm wet season from November to April, a cool dry season from May to September and a hot dry season from September to November. Average annual rainfall decreases from about 1 300 mm in the northwest to about 800 mm in the central region, around the capital, Lusaka.

6. GNP per capita is about $540 (1975). Copper mining dominates the economy, accounting for more than 90 percent of exports and about 25 percent of GDP in 1975. Although manufacturing, services, transport and communications have all been growing rapidly, aggregate growth has been slow due to near stagnation in mining and a low growth rate in agriculture. Agricultural production does not yet adequately reflect the country's huge and usable land resources. The "agriculture, forestry and fishing" group accounts for less than 10 percent of GDP.

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[1] Policies and practices described in this case study are not necessarily those actually employed in Zambia either at present or during the period covered by the Project.

[2] For additional coverage of industrial afforestation project issues see also Case Study No. 4: Kenya I Sawlog and Pulpwood Plantation Project, and Case Study No. 5: Kenya II Sawlog and Pulpwood Plantation Project.

Forest Resources and Wood Utilization

7. About 50 percent of the total area of Zambia is classified as forest land, the greater part of which is open woodland ("miombo"). The natural hardwood forests have so far been providing all the country's requirements of fuelwood, most of its poles and some of its sawnwood, particularly mining timber, while most of the sawn timber and wood-based panels and all the paper products are imported. Accessible productive forests are shrinking, and Zambia's needs for industrial wood of all kinds are rising fast and are being met increasingly from imports. In 1976 imports of forest products amounted to US$ 13 million.

8. The Government of Zambia has accorded high priority to the development of forest resources so that in due course it can become self-sufficient in meeting its timber requirements including the products of wood-based industries. It also recognizes that forests are important in providing protection against soil erosion and in maintaining river flows. To this end, the Government has established a National Forest Estate[1/] of over 8 million ha (some 9 percent of Zambia's total land area).

9. Forest management is the responsibility of the Forest Department (FD) of the Ministry of Land, Natural Resources and Tourism (LNRT). To solve the problems of long gestation periods and difficult commercial exploitation associated with the indigenous species, the Forest Department about 30 years ago began the planting of fast-growing exotic species (mainly Pine and Eucalyptus). This was followed in the 1960's by the creation of an Industrial Plantations Division (IPD) within the Department to handle the then considerably expanded afforestation programme.

10. Roundwood consumption was estimated in 1975 to be about 5 million m^3 of which some 4.5 million m^3 was fuelwood and charcoal. Other uses of roundwood include poles for building and fencing and other domestic purposes. The main industrial uses of roundwood are as poles for the mining industry (pit-props and smelter and refinery poles), transmission poles (power, telegraph and telephone), building poles and fence posts. The current demand for sawnwood is about 100 000 m^3, about half of which is imported.

11. Primary forest industries in Zambia consist essentially of sawmilling and the conversion of Eucalyptus roundwood to transmission poles and posts. Although IPD started sawmilling of exotic species in 1970, more than 80 percent of all sawmilling in Zambia (i.e. all non-IPD sawmilling) is still based on indigenous timber. Excluding pit sawing and a few small local saws, about a dozen sawmills account for over 90 percent of all sawmilling.

12. Many sawmills in Zambia have in the past operated below capacity, but the situation has improved considerably in recent years, as obviously misplaced sawmills went out of business, and those remaining in business have begun to operate at or near full capacity. The only IPD sawmill operating below capacity - Dola Hill - should reach full capacity production in a couple of years when more mature pine will become available.

13. For many years, most of the transmission poles (electricity, telephone, etc.) used in the country were imported. Increasingly, however, locally-grown Eucalyptus poles are being substituted for the imports.

1/ The forest estate or reserves within which exploitation of forest resources is closely supervised by the Forest Department.

14. Zambia's secondary forest industries consist of a blockboard factory, a door manufacturing company, and several joinery and furniture manufacturing enterprises all using mainly imported wood. In the ten years 1964-74, Zambia imported annually on average some 10 000 m^3 of plywood and blockboard, about 800 m^3 of particle board, some 5 200 m^3 of fibreboard, and about 25 000 tons of paper. These imports suggest some scope for import-substitution industries, using the smallwood and sawmill waste in the manufacture of one or more types of wood-based panel with or without a pulp and paper mill.

15. Past studies have indicated that the optimum economic benefit to Zambia would result from a programme which included a pulp and paper mill. This arises mainly because sawmilling alone does not utilise all forest thinnings and results in about 60 percent waste, and wood panel industries are relatively small users of such waste. Moreover, past studies have shown that, by the mid-eighties, domestic demand for kraft and industrial papers would be adequate to justify a pulp mill coming on stream. However, its cost may exceed Zambia's capability to mobilize the necessary finance in the next few years and so far no technical or commercial partner has been firmly identified. Accordingly, the timing of the establishment of a pulp mill is uncertain and investments in afforestation should be justified on the basis of sawmilling and wood-based panel manufacture alone.

The Industrial Forestry Programme

Origin, Concept and Objectives

16. In 1949, the Forest Department started growing Pines on the Copperbelt, at first on an experimental scale near Ndola, and then on an increasingly larger scale around Ndola and west of Kitwe (see map). The Government decided to embark on a long-term industrial forestry programme on the Copperbelt and, in order to implement this programme, the Industrial Plantations Division of the Forest Department was created in 1962. In the sixties, Eucalypts were also tried and from 1967 onwards were planted on a large scale. The main species were P. kesiya for Pines and E. grandis for Eucalypts. The target was the planting of 40 000 ha by 1993, of which approximately 3/4 would be Pine and 1/4 Eucalyptus. The Government is now considering increasing the target to at least 80 000 ha before the turn of the century. The objectives of this planting programme are to supply:

(a) most of Zambia's needs in sawn lumber, using mainly Pine when Pine sawlogs become available in sufficient quantity;

(b) smallwood and sawmill waste, both of Pine and Eucalyptus, for a pulp and paper mill and for various board mills;

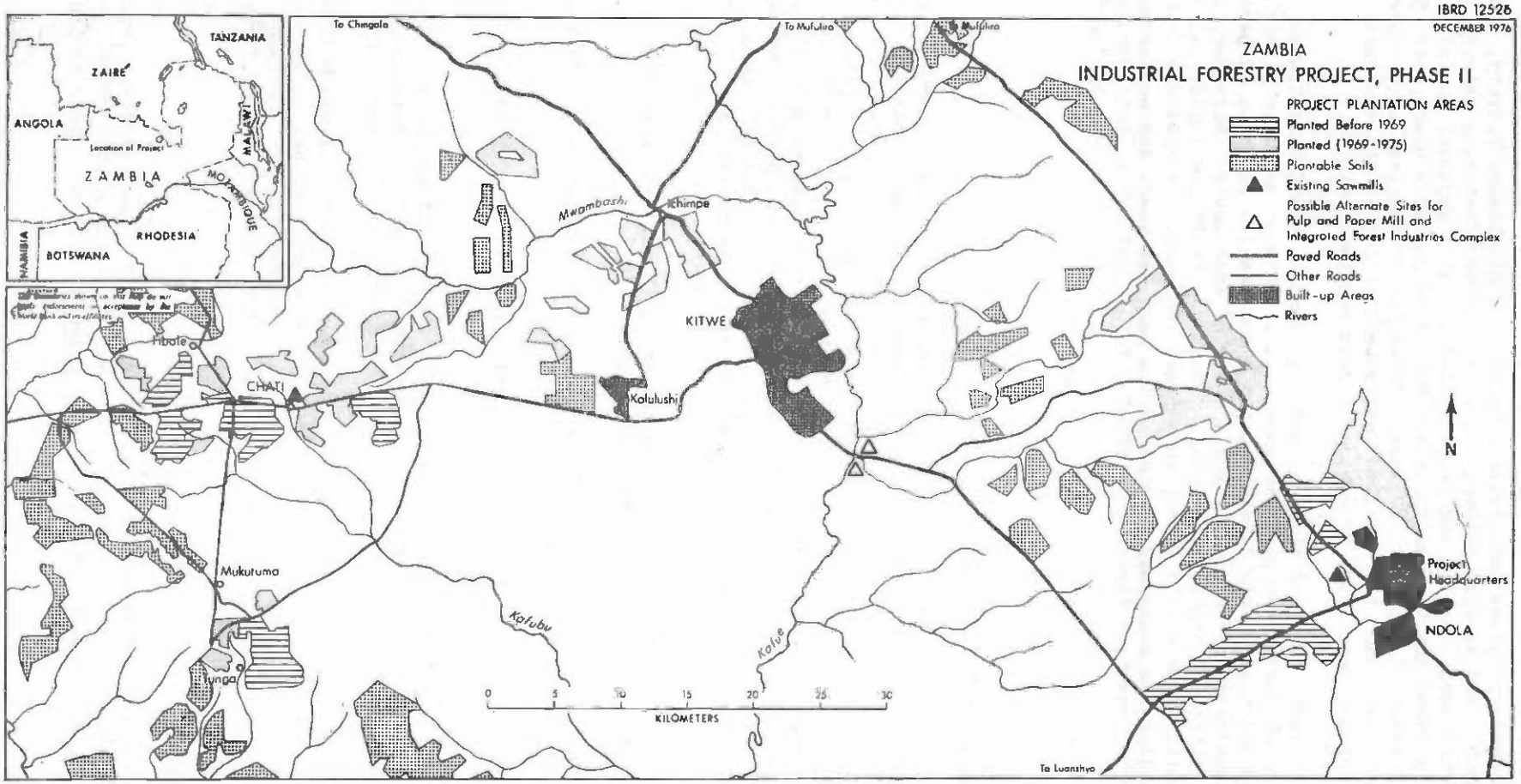
(c) poles (Eucalyptus) of all kinds for smelting, telephone, transmission and other uses.

17. By the year 2000, it is believed that most of these needs can be met from domestic supplies, provided the planting programme is implemented. Regarding sawnwood, however, it is expected that some imports will still be required to supplement domestic production.

18. By 1975 IPD, which had become a virtually independent and entirely self-accounting unit, was employing a total staff of 134, of whom 13 were professional or senior officers, and a total labour force of just over 1 000. Its activities included afforestation, construction and road work, forest exploitation (logging and transport), wood processing and marketing.

Phase I Project

19. The Project, which was managed by IPD, was part of the Zambian Government's Forest Development Programme and provided for the annual planting of 1 000 ha each of Pine (mainly P. kesiya) and Eucalyptus (mainly E. grandis) over an 8-year period (1969-1976).


IBRD 12526
DECEMBER 1976
ZAMBIA
INDUSTRIAL FORESTRY PROJECT, PHASE II
PROJECT PLANTATION AREAS
Planted Before 1969
Planted (1969-1975)
Plantable Soils
Existing Sawmills
Possible Alternate Sites for Pulp and Paper Mill and Integrated Forest Industries Complex
Paved Roads
Other Roads
Built-up Areas
Rivers
TANZANIA
ZAIRE
ANGOLA
Location of Project
ZAMBIA
MALAWI
MOZAMBIQUE
RHODESIA
BOTSWANA
NAMIBIA
To Chingola
To Mufulira
Mwambashi
Chimpe
KITWE
Kalulushi
Hibate
CHATI
Mukuluma
Kafubu
Kafue
Ilunga
0 5 10 15 20 25 30
KILOMETERS
N
Project Headquarters
NDOLA
To Luanshya

The Pine would be grown on a 30-year rotation at a mean annual volume increment rate of approximately 17 m^3/ha, while the Eucalyptus would be grown on a 12-year rotation with a mean annual increment of 18 m^3/ha. It was anticipated that over 90 percent of the Pine production and about half of the Eucalyptus production would be used for sawlogs and construction timber, the balance being for poles of various kinds.

20. The total plantation target of 16 000 ha was reached in 7 years instead of 8, but, based on a reassessment of wood requirements, the ratio of pine to eucalyptus was 72:28 instead of 50:50. The pine management regime was also revised, in order to reduce the quantities of smallwood produced early in the rotation. The mean annual increment of P. kesiya is now considered to be around 14 m^3/ha (3 m^3 less), after due allowance for losses, but that of E. grandis is probably around 25 m^3/ha (7 m^3 more). P. kesiya is now grown on a 25 year rotation.

21. Two new species were introduced into the planting programme on a fairly large scale: Pinus oocarpa and Eucalyptus cloeziana. This was partly to achieve diversification to reduce the risks of disease, poor performance, etc. In addition E. cloeziana has better stem form than E. grandis, which should lead to better recovery in sawmilling, and it is better for transmission poles and mine use. Though it has slower initial growth, it tends to catch up with E. grandis later in the rotation. Similarly, P. oocarpa has better form than P. kesiya (small branches; less susceptible to wind sweep), and is also a slow starter which tends to catch up later.

22. Costs have proved to be high, mainly due to the intensive land clearing and preparation necessary in order to achieve high yields. Research is currently focused on reducing these costs, and on offsetting them to a greater degree by using more of the wood from the cleared woodland for charcoal production and sale.

23. The main issue that plagued the first project was that of uncertainties surrounding development of industries to process the project output. As sufficient processing capacity was not available elsewhere in the country, IPD was obliged to expand the scope of the project to include harvesting and sawmilling. Uncertainty about the timing, scale and technical specifications of the expected panel and pulp industries hindered the planning and management of the plantations.

B. THE PROJECT

General Description

24. The Project would, during the five years 1978 through 1982, continue IPD's long-term planting and maintenance programme, expand IPD's logging and sawmilling capacity, and conduct studies designed to lead to more economical and efficient land clearing and charcoal production. The Project would provide for:

(a) about 3 500 ha of new plantations annually, of which about 3 000 ha would be pine and about 500 ha eucalyptus;

(b) replanting annually with eucalyptus of approximately 400 ha of clear-felled plantations;

(c) maintenance of (a) and (b), together with all existing IPD plantations;

(d) doubling of IPD's logging and transportation capacity from about 60 000 m^3 to about 120 000 m^3 roundwood per year;

(e) construction and equipment of a sawmill of about 46 000 m^3 per year sawnwood capacity;

(f) staff training and fellowships to facilitate (a) to (e) above; and

(g) research, experimentation and studies designed to reduce land clearing costs and to improve charcoal production methods.

25. Plantation maintenance costs have been capitalized in accordance with normal plantation practice and included in Project costs for the plantation development period. All operating costs beyond the five year Project period are excluded from Project costs. The Project would be implemented by IPD.

The Project Area

26. The Project area (see map) is situated on the Copperbelt around the towns of Ndola and Kitwe. The new plantations would be extensions of the existing plantations. There are two main blocks: the first is north and west of Ndola and is generally extending towards Kitwe (this is mostly under Pine); the second is located some 20-50 km west of Kitwe, centred around Chati, with a small forest industrial complex (KITE), and is extending mainly north and south (most of the eucalyptus is planted here, though there is also some pine).

27. Forest plantations are only created inside National Forests. There is, therefore, no land tenure problem. Furthermore, there is an abundant supply of other arable land in the area, and consequently no pressure to use National Forest land for cultivation. The plantations are on good soils, which are readily available on the Copperbelt. Over 500 000 ha of land, or almost 20 percent of the total area of the Copperbelt Province, are reserved under the Forests Act, of which less than 20 000 ha would be planted under the Project. Of some 300 000 ha sampled, about 90 000 ha have been found suitable for tree-planting. The land is generally flat, undulating very gently and varying in altitude from about 1 500 m in the north to about 1 200 m in the south. Average annual rainfall in the Project area is about 1 200 - 1 300 mm, falling mainly from late October to early April. Mean temperatures are 15°C in winter and 23°C in summer. Although violent thunderstorms and torrential rains are common during the wettest months, strong winds are rare, and there are only about three nights of frost a year on the average. In short, conditions inside the Project area are excellent for growing pines and eucalyptus.

28. There is no need within the foreseeable future to plant fuelwood on the Copperbelt, as large areas of woodland are being clearfelled annually for afforestation, and enough firewood and charcoal should be obtained from these areas to supply all the needs of the Copperbelt. This region also contains the greatest concentration of population, industrial development and wealth, hence of potential markets. The area is well served by public roads, forest roads and tracks, and a railway line.

29. Once the choice of a site for the proposed pulp and paper mill has been settled, it would be desirable to locate all future sawmills, the pulp and paper mill, and wood-based panel manufacture within the same complex, in order to minimize wood transport costs and fully utilise the infrastructure within the complex. In the meantime, the Project sawmill will be located at Chati because it is nearest the immediately available roundwood source, and there is already sufficient infrastructure - official buildings, roads, water and electricity - as well as labour and scarce managerial talent there which can be utilized by the new sawmill.

Afforestation, Reforestation and Maintenance (See Annex 1)

30. The detailed planting and replanting would be as follows:

	Area (ha)			
		Eucalyptus		
Year	Pine (new)	New Plantations	Replanting	Total
1	3 000	500	200	3 700
2	3 000	500	300	3 800
3	3 000	500	400	3 900
4	3 000	500	500	4 000
5	3 000	500	600	4 100
Total	15 000	2 500	2 000	19 500

31. It is assumed that about 60 percent of the pine would be Pinus kesiya and 40 percent Pinus oocarpa and other species, and that about 2/3 of the Eucalyptus would be E. grandis and 1/3 E. cloeziana and other species. These proportions ensure good average yields, while providing some diversification, as well as sufficient supplies of wood for specific purposes (e.g. E. cloeziana for poles).

32. "Miombo" woodland would be cleared prior to planting. The soil would then be prepared by disc-harrowing. Both pine and eucalyptus would be raised in polythene tubes. The planting distances would be 2m70 x 2m70 (1 370 plants per ha) for pine and 3m60 x 3m60 (770 plants per ha) for eucalyptus. Borate would be applied to eucalyptus plantations at the time of planting, but no fertilizers would be used for pine. Very intensive weeding would be required during the first 3 years for pine, but for 1-2 years only for eucalyptus.

33. Land clearing for afforestation would continue to be done initially by local contractors but would be gradually taken over by IPD during the Project. This transfer has been necessitated by the decline in competition and high prices charged by the remaining private contracting capacity. Road and other construction and maintenance, as well as the sawmill building, would be carried out by competitive bidding advertised locally or by IPD itself if this proves less expensive.

34. Pine would be pruned at 5, 8 and 11 years, thinned at 11, 14 and 19 years, and clearfelled at 25 years. Eucalyptus would be pruned at about 2 years, thinned at 5 and 8 years, and clearfelled at 12 years.

Road Construction and Maintenance

35. The required road density has been estimated at 10 km of access roads (total 175 km), 3 km of "logging" roads (total 53 km) and 31 km (total 543 km) of compartment roads per 1 000 ha of new plantations. Road maintenance is estimated at 10 percent of capital costs per annum for all categories of roads.

Protection

36. So far pines have been remarkably free from pests and diseases. Nursery techniques are so well developed that losses caused by "damping off" fungi are minimal, and there is no problem of mycorrhiza. Scattered dieback does occur, probably caused by some pathogenic fungi, but this is not a problem.

37. Eucalyptus, on the other hand, particularly E. grandis, are liable to attack by both insects and fungi. The Eucalyptus Longhorn Bark Beetles (Phoracantha spp.) may cause serious losses in some Eucalyptus plantations at Chati, to such an extent that certain areas are no longer planted or replanted with Eucalyptus. Mostly pole crops are affected. Various control measures have been tried, but so far with little or no success. Research is continuing in this field. Concern has also been expressed about the incidence of heart-rot in the lower part of the stem of E. grandis, but this disease does not appear to be serious, especially in view of the relatively short timber rotation adopted for this species (12 years).

38. The fire hazard is high on the Copperbelt, particularly in pine plantations 5 to 8 years old. External firebreaks 15 m wide would be constructed and maintained around all plantations. Internal roads would be used as firebreaks, and 20 m strips would be maintained on either side of main roads. The main fire protection measure would be controlled burning of firebreaks and plantations while there is a serious fire hazard. Finally, fire control would involve maintaining fire-fighting vehicles, equipment and fire towers, as well as manning fire crews.

Project Management

39. Provision would be made for all IPD personnel during the plantation development period. The staff would include a Director, a Financial Controller, 3 Conservators, 3 Auditors and Senior Accounts, 11 Engineers, Managers and Senior Forest Officers, and technical, clerical and an accounting supporting staff. Provision is included for salaries and all the usual civil service allowances. Provision would also be made for the cost of all surveys and for the running of the IPD Training Centre. Baseline project administration and overhead expenses are estimated at K 2.4 million. These costs exclude logging, sawmilling, and other operating costs which should be recovered from annual revenues.

Buildings and Housing

40. Additional housing would be provided for IPD staff and workers. Provision would also be included for normal building maintenance. Total baseline costs of house construction and maintenance are estimated at K 2.7 million. (Details in Annex 1).

Equipment and Vehicles

41. The project would require investment in equipment for afforestation (land clearing, soil preparation, transport of labour and materials, and all fire protection measures), road construction and maintenance, construction of buildings, for workshops and garages, and for administration. (Details in Annex 1). Provision would also be made for tools, office and workshop equipment and an adequate supply of essential spare parts. The project workshops would be responsible for the repair and maintenance of project vehicles and equipment.

Logging and Transport

42. All logging and log transport will be carried out by the Logging Section of IPD. Its logging and transportation operations consist of felling and bucking with chainsaws, bowsaws, and axes; skidding with tractors of various sizes; loading with a front end loader or small hydraulic crane mounted on a tractor; hauling by truck or log trailer; and unloading with a large hydraulic crane. In 1975 the Logging Section felled, extracted and transported about 60 000 m^3 of roundwood, mostly in the Chati-Lamba division. As of June 1976 the Logging Section employed some 120 persons, including six supervisory staff.

43. The Project provides for the logging and transport capacity of IPD's Logging Section to be doubled to enable it to supply the project sawmill, through the phased acquisition of 18 small to medium sized tractors, 4 small hydraulic tractor-mounted loaders, 12 logging trucks of 15-ton and 2 of 35-ton capacity, 2 tippers of the dump truck variety, each of 10 m^3 capacity, two 5-ton trucks and a small grader, 2 four-wheel drive transporters and 3 motorcycles.

Sawmill (See Annex 2)

44. Existing IPD sawmill capacity will be fully utilized by 1978. Log supply projections indicate that thereafter additional capacity will be needed. The project therefore includes provision for a new sawmill capable of producing about 23 000 m^3 sawnwood annually on a single shift of 8 hours, or 46 000 m^3 on a double shift. The sawmill will be located at Chati - the present home of Kafubu Industrial Timber Enterprises (KITE) - to saw mainly IPD's Eucalyptus logs in the first instance, and mainly pine starting from about 1982. The Project provides for the cost of a sawmill building with a concrete slab, and all costs of importing, transporting to Chati, and installing the sawmill and ancillary equipment.

Staff Training and Fellowships

45. The Project would provide for the training costs of Zambians required to replace expatriate staff on short-term contracts now heading many of the units and sections in IPD. The local training of mechanics and artisans will be intensified in order to ensure an adequate supply of this class of workers for IPD.

Trials on Land Clearing and Charcoal Production

46. Land-clearing operations as currently practised on the Copperbelt prior to tree planting are extremely costly. These land-clearing practices are necessary in order to get the high yields achieved. However, in a country in which fuelwood and charcoal are the chief source of fuel, there appears to be scope for using the trees pulled down by bulldozers for these purposes; at present most are simply burnt on the spot. With the twin objectives of reducing the net costs of land clearing and of furthering the development of efficient charcoal production for domestic markets, the Project would provide about K 225 000 for equipment, materials, labour, supervision, and 6 man-months of consultancy, to be spent on land clearing and charcoal production trials.

Future Supply and Demand of Wood Raw Materials

47. Allowing for normal losses at various stages of plantation activity, the mean annual increment is expected to be 14 m^3/ha for Pinus kesiya and 11 m^3/ha for other pines on a 25-year rotation. For Eucalyptus, it is expected to be 25 m^3/ha for E. grandis and 15 m^3/ha for other Eucalyptus species on a 12-year rotation. Sawlogs would represent about 66 percent of the total volume pines, while sawlogs and large poles would represent about 60 percent of the total volume of eucalyptus products. (See Annex 3, Table 1). The remaining volume would represent smallwood which, at the moment, is largely wasted, but which would be the basic raw material for any future pulp and paper mill or wood-based board industries.

48. Under these assumptions, output from the Project should develop as shown in Table 1, and overall IPD wood production is expected to increase as indicated in the table below, where it is compared with projections of national wood demand:

	Volume '000 m^3 Roundwood Equivalent			
	1975	1980	1990	2000
National Demand				
Fuelwood	4 500	5 000	6 000	7 000
Sawnwood	250	325	530	860
Poles	70	90	145	235
Other (paper and wood-based panels)	200	235	415	675
IPD Production				
Sawnwood	80	135	420	465
Poles	25	30	40	45
Smallwood and sawmill waste	100	195	515	700

Table 1

ESTIMATED PROJECT OUTPUT 1/

($1000\ m^3$)

Year	Pine		Eucalyptus		
	Sawlogs	Smallwood	Sawlogs	Poles	Smallwood
1978	-	-	-	-	-
1979	-	-	-	-	-
1980	-	-	-	-	-
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	18.9	14.0	18.9
1986	-	-	21.6	16.0	21.6
1987	-	-	24.3	18.0	24.3
1988	78.0	108.0	27.0	20.0	27.0
1989	78.0	108.0	29.7	22.0	37.9
1990	78.0	78.0	66.4	24.0	21.6
1991	180.0	192.0	74.7	27.0	24.3
1992	180.0	192.0	83.0	30.0	27.0
1993	102.0	84.0	91.3	33.0	29.7
1994	102.0	84.0			
1995	102.0	84.0			
1996	108.0	60.0			
1997	108.0	60.0			
1998	108.0	60.0			
1999	108.0	60.0			
2000	108.0	60.0			
2001 2/	107.63/	28.0			
2002 2/	213.43/	56.0			
2003	326.03/	56.0			
2004	326.03/	56.0			
2005	326.03/	56.0			
2006	326.03/	56.0			

1/ Derived from the average yield figures given in Annex 4, Table 1, and the areas planted annually during 1978-82 (Annex 1)

2/ One third of planting year 1978 felled in year 24 (2001) rather than year 25 (2002)

3/ Loss of 3% of useable volume assumed in clearfelled pine sawlog volume due to logging damage

49. The above figures show that IPD's key output is going to be sawnwood, of which IPD produced about 30 percent of the national consumption in 1975. IPD's proportion is likely to go up to some 50 percent in the year 2000, by which time the output from the rapidly diminishing and virtually irreplaceable natural woodlands would be even less than the 170 000 m^3 of sawlogs those woodlands contributed in 1975. Even if the sawlog output from the indigenous forests were to remain constant at 170 000 m^3, it would still be necessary to import annually some 225 000 m^3 of sawlogs by the year 2000, after allowing for the output from this Project.

50. In theory it is possible to import pine sawn timber from Kenya at a landed price of approximately K 2 per m^3 above the K 126 currently charged by IPD. However, imports of sawn timber or sawlogs from surrounding countries where production costs may be lower than in Zambia are, in practice, not as frequent as might be expected, because overland transport has not been easy to arrange. Coniferous sawnwood from Europe and North America - the traditional sources - costs considerably more than IPD's product and caters for the luxury section of the sawnwood market. There are no known alternative sources of Eucalyptus logs or poles. As long as IPD's prices continue to be below the landed prices of wood from other countries, it is likely to continue to sell all the sawnwood and poles it can produce.

51. As regards the proposed pulp and paper mill, production is expected to be entirely for the domestic market which is protected by high transport costs from external sources of supply. The output is also expected to consist of kraft and other commercial grade papers which are different from types of paper planned for manufacture in most of the surrounding countries

C. PROJECT COSTS AND BENEFITS

52. The Project is a time-slice of a long-term planting, replanting and wood processing programme started in 1949 and intended to extend many years after this Project, and to involve the planting of a total of about 80 000 ha of pine and eucalyptus with their associated processing costs.

53. The heterogeneity of the Project's components, while inevitable in a time-slice project of this nature, is such that they are not directly related to each other, and do not, either together or individually (except possibly for the Project sawmill), contain a complete cost or benefit stream. It is therefore not possible to calculate a rate of return on Project components alone without introducing some costs which were either incurred prior to the Project (e.g. wood from the pre-Project plantations for the sawmill), or costs to be incurred 10 or more years hence and therefore not included in the Project (e.g., sawmills to saw wood from the proposed 19 500 ha of plantations), or components which are still somewhat problematic (e.g., the pulp and paper mill to process smallwood and sawmill waste from the same proposed Project plantations). These costs and benefits which, although outside the Project, have to be brought into any meaningful rate of return calculations, have therefore been introduced and combined with the Project costs and benefits proper in rate of return calculations for the Project and necessary associated investments. (The exact non-Project costs thus introduced into the calculations are identified in Table 3.)

54. The primary direct benefits from the Project would consist of pine and eucalyptus sawnwood, eucalyptus transmission poles and building posts, as well as smallwood and sawmill waste for the proposed pulp and paper mill. The plantations are therefore planned on the assumption that a pulp and paper mill would be built within the next few years, and that all the wood from the plantations would be used by one or other of the wood processing industries. The direct benefits have therefore been measured - both in the financial and economic analysis - at the processed product stage and not at the roundwood production stage. Costs consequently include costs of logging, and costs of roundwood transport and processing.

55. Because of the uncertainties about the pulpmill, Project costs and benefits have been calculated both with the mill and without it. In other words, one set of calculations has been developed on the assumption that there would be no pulpmill, in which case the smallwood would consequently have no value.

Project Costs

Financial Costs

56. The Project is estimated to cost K 27.1 million (US$33.7 million), of which K 13.0 million (US$16.2 million) would be in foreign exchange. Project costs are summarized in Table 2. Project base costs, which do not include any duties or taxes, are estimated as of March 1977. A physical contingency of 10 percent has been added to all costs, and starting from April 1977 price contingencies totalling about 15 percent of baseline costs have been added.[1/]

57. The derivation of the afforestation costs is shown, item by item, in Annex 1. Sawmill costs, and the associated logging and transport costs, are given in Annex 2, and pulpmill costs in Annex 3.

58. The following stumpage costs of wood to be supplied to the Project sawmill and to the pulpmill from plantations established prior to the beginning of the project have been calculated:

Category	Rate (K/m^3)			
	Pine		Eucalyptus	
	I. All produce saleable	II. Smallwood[2/] unsaleable	I. All produce saleable	II. Smallwood[2/] unsaleable
Sawlogs	18	22	6	8
Large poles	-	-	10	13
Smallwood	5	-	3	-

59. These stumpage rates have been calculated as the replacement cost of establishment, maintenance and administration compounded through the length of the rotation at a rate of 10 percent. The details of these calculations are shown in Annex 4. The higher of the two levels of sawlog stumpage (i.e. assuming smallwood unsaleable) was used in the Project sawmill calculation[3/]. The smallwood value was used as the stumpage value of pulpwood.

60. Total annual financial costs are shown in Table 3.

1/ Price contingencies are excluded from the FRR and NPV calculations.

2/ If smallwood could not be sold - i.e., if the pulpmill did not get built, all costs would have to be recovered from sales of sawlog and pole products.

3/ The sawmill would be mainly using sawlogs from plantations from which the smallwood had been thinned out before the pulp mill came on stream.

Table 2

SUMMARY PROJECT COSTS
(K'000)

	1978 Year 1	1979 Year 2	1980 Year 3	1981 Year 4	1982 Year 5	Total Amount	Foreign Exchange Amount	Foreign Exchange %
Plantations 1/	3,679	2,601	3,248	2,738	2,672	14,938	6,248	42
Logging and Transportation 2/	707	281	-	-	-	988	968	98
Sawmilling 3/	2,600	256	533	864	1,212	5,445	3,025	56
Staff Training and Fellowship	20	40	20	-	-	80	64	80
Studies and Trials on Land Clearing and Charcoal Production	66	99	60	-	-	225	99	44
Total Base Costs	7,072	3,277	3,841	3,602	3,884	21,676	10,404	
Physical Contingencies 4/	707	328	385	360	388	2,168	1,040	48
Price Contingencies 5/	1,060	492	576	540	583	3,251	1,560	48
Total Project Costs	8,839	4,097	4,802	4,502	4,855	27,095	13,004	48

1/ Annex 1
2/ Capital Costs only
3/ Annex 2
4/ 10% of Base Costs
5/ 15% of Base Costs

FINANCIAL CASH FLOW FOR THE PROJECT (K. MILLION)

Years	Project Base Costs 1/	Physical Contingencies 2/	Wood Cost for Project Sawmill Using Pre-Project Wood 3/	Total Project Costs Without Pulp Mill	Cost of Pulp Mill 4/	Total Costs Including a Pulp Mill	Revenues from Project Afforestation	Revenues of Project Sawmill Using Pre-Project Wood	Total Project Revenue Without Pulp Mill	Revenues from Pulp and Paper Mill	Total Project Revenue Including Pulp Mill
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1978	7.0	0.7	-	7.7	2.4	10.1	-	-	-	-	-
1979	3.3	0.3	0.4	4.0	15.4	19.4	-	1.0	1.0	-	1.0
1980	3.8	0.4	0.8	5.0	27.3	32.3	-	2.1	2.1	-	2.1
1981	3.6	0.4	1.4	5.4	18.4	23.8	-	3.1	3.1	-	3.1
1982	3.9	0.4	2.0	6.3	12.4	18.7	-	4.5	4.5	11.1	15.6
1983	2.6	0.3	2.0	4.9	9.4	14.3	-	4.5	4.5	14.5	19.0
1984	4.3	0.4	2.0	6.7	9.0	15.7	-	4.5	4.5	16.1	20.6
1985	2.8	0.3	2.0	5.1	8.9	14.0	1.5	4.5	6.0	17.0	23.0
1986	3.3	0.3	2.0	5.6	9.2	14.8	1.7	4.5	6.2	17.9	24.0
1987	3.4	0.3	2.0	5.7	8.8	14.5	1.9	4.5	6.4	18.2	24.6
1988	5.1	0.5	2.0	7.6	7.8	15.4	5.7	4.5	6.2	18.4	24.6
1989	5.8	0.6	2.0	8.4	7.8	16.2	9.3	4.5	13.8	18.6	32.4
1990	4.6	0.4	2.0	7.0	7.8	14.8	8.8	4.5	13.1	18.6	31.7
1991	5.9	0.6	2.0	8.5	7.7	16.2	12.8	4.5	17.3	18.6	35.9
1992	6.1	0.6	2.0	8.7	7.7	16.4	13.3	4.5	17.4	18.6	36.0
1993	4.7	0.5	2.0	7.2	7.9	15.1	9.7	4.5	14.2	18.6	32.8
1994	2.0	0.2	2.0	4.2	7.9	12.1	4.7	4.5	9.2	18.6	28.8
1995	2.0	0.2	-	2.2	7.9	10.1	4.7	-	4.7	18.6	23.3
1996	1.9	0.2	-	2.1	8.1	10.2	5.0	-	5.0	18.6	23.6
1997	1.9	0.2	-	2.1	8.1	10.2	5.0	-	5.0	18.6	23.6
1998	1.9	0.2	-	2.1	8.1	10.2	5.0	-	5.0	18.6	23.6
1999	1.9	0.2	-	2.1	8.1	10.2	5.0	-	5.0	18.6	23.6
2000	1.7	0.1	-	1.8	8.1	9.9	5.0	-	5.0	18.6	23.6
2001	1.9	0.2	-	2.1	8.3	10.4	5.0	-	5.0	18.6	23.6
2002	7.0	0.7	-	7.7	8.1	15.8	10.1	-	10.1	18.6	28.7
2003	6.0	0.6	-	6.6	8.0	14.6	15.1	-	15.1	18.6	33.7
2004	4.5	0.4	-	4.9	8.0	12.9	15.1	-	15.1	18.6	33.7
2005	4.4	0.4	-	4.8	8.0	12.8	15.1	-	15.1	18.6	33.7
2006	4.4	0.4	-	4.8	8.0	12.8	15.1	-	15.1	28.5	45.9

1/ Costs from 1978 to 1982 are from Table 2. Thereafter costs include all operating maintenance and capital replacement expenses of Phase II plantation and project sawmill, as well as logging, pole treatment, and sawmilling costs of all project trees and costs of logging old wood for the single project sawmill.

2/ 10% of base costs.

3/ Based on new recommended IPD stumpages, i.e. K22/m3 for pine and K13/m3 for eucalyptus (see Annex 4).

4/ Pulpwood purchased from the project output is given zero value as the pulpmill's cost would be IPD's revenue and would cancel each other when consolidated as here in one FRR calculation. Pulpwood purchased from pre-project plantations is valued at the recommended IPD stumpage, i.e. K5/m3 for pine and K3/m3 for eucalyptus. (Annex 3).

Table 3

Economic Costs

61. To arrive at costs at economic values, from the financial costs, the costs of traded inputs have been converted from foreign to domestic values by using a shadow foreign exchange conversion factor of US$1 = K 0.9 instead of the official US$1 = K 0.8, as the latter appears to overvalue Zambian currency by this margin. The proportion of the financial costs which is attributable to traded items, and which hence is shadow priced in this way, is shown in Table 2 (in the "Foreign Exchange" column), and in the detailed cost tables.

62. In addition, unskilled labour has been shadow-priced at 60 percent of actual cost to reflect the relative abundance of this class of labour. The labour component of costs is identified separately (under the heading "labour") in each of the cost annexes.

63. No account has been taken in the financial or economic calculations of the cost of land. Actual payments for land used for the plantations have been few, and would not make any difference to the calculations. Also, the alternative cost of the land either in agricultural or charcoal production terms is equally small. However, this aspect would need to be kept under review if planting continues to expand beyond the scope indicated in this Project.

64. Total annual economic costs are shown in Table 4.

Project Benefits

Financial Revenues

65. As has been noted above, revenues/benefits from the Project occur from sales of the products of the industries which will use, or are expected to use, the Project roundwood. The estimates of revenues from the sawnwood and poles produced from roundwood from the Project plantations are based on the prices prevailing at present in Zambia[1] for produce from the existing industrial plantations, as follows:

Eucalyptus lumber, green and rough	K per m^3
Boards longer than 1.5 m (longs)	86
Shorter boards (shorts)	48
Waney edge boards	25
Eucalyptus poles	
from first thinnings	65
from second thinnings	85
Pine lumber, green and rough	
Boards longer than 1.5 m (longs)	126
Shorter boards (shorts)	63

66. It has been assumed that the eucalyptus lumber from the Project sawmill will consist of 65 percent long boards, 25 percent shorts and 10 percent waney edge boards. Similarly, it was assumed that pine lumber from the mill will consist of 75 percent longs and 25 percent shorts.

67. The estimates of quantities of lumber and poles are derived from the estimates of roundwood yields shown in Table 1, and an assumption of a 42 percent yield of sawnwood from sawlog volumes in the course of processing the latter. The resulting annual revenues are shown in column 8 of Table 3.

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[1] This would prove to be a very conservative consumption if local sawnwood prices rose in real terms at the rate predicted for world prices on page 17.

ECONOMIC VALUE FLOW FOR THE PROJECT

(K million)

Year	Financial labour costs 1/	Financial foreign exchange costs 1/	Other project financial costs 2/	Foreign exchange shadow priced 3/	Labour shadow priced 4/	Project economic costs without pulp mill	Pulp mill costs shadow priced 5/	Project economic costs with pulp mill	Project benefits without pulp mill 6/	Pulp mill benefits 3/ 5/	Project benefits with pulp mill
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1978	1.3	5.6	0.8	6.3	0.8	7.9	2.7	10.6	-	-	-
1979	1.3	1.8	0.9	2.0	0.8	3.7	17.2	20.9	1.2	-	1.2
1980	1.6	2.2	1.2	2.5	1.0	4.7	30.2	34.9	2.7	-	2.7
1981	2.2	0.8	2.2	0.9	1.3	4.4	20.5	24.9	4.0	-	4.0
1982	2.0	1.0	3.3	1.1	1.2	5.6	12.7	18.3	5.8	12.5	18.3
1983	1.1	2.1	1.7	2.4	0.7	4.8	9.2	14.0	5.8	16.3	22.1
1984	1.7	3.1	1.9	3.5	1.0	6.4	8.7	15.1	5.8	18.1	23.9
1985	1.2	2.2	1.7	2.5	0.7	4.9	8.5	13.4	8.2	19.1	27.3
1986	1.4	2.5	1.7	2.8	0.8	5.3	8.6	13.9	8.4	20.1	28.5
1987	1.4	2.5	1.8	2.8	0.8	5.4	8.6	14.0	8.8	20.5	29.3
1988	2.0	3.6	2.0	4.0	1.2	3.6	7.8	11.4	8.6	20.7	29.3
1989	2.2	4.1	2.1	4.6	1.3	8.0	7.8	15.8	18.9	20.9	39.8
1990	1.8	3.3	1.9	3.7	1.0	6.6	7.8	14.4	18.0	20.9	38.9
1991	2.3	4.2	2.0	4.7	1.4	8.1	7.8	15.9	23.8	20.9	44.7
1992	2.3	4.2	2.0	4.7	1.4	8.1	7.8	15.9	24.0	20.9	44.9
1993	1.9	3.4	1.9	3.8	1.1	7.8	7.8	15.6	19.6	20.9	40.5
1994	0.9	1.7	1.6	1.9	0.5	4.0	7.8	11.8	6.4	20.9	27.3
1995	0.7	1.3	0.2	1.5	0.4	2.1	7.8	9.9	6.4	20.9	27.3
1996	0.6	1.2	0.3	1.4	0.4	=.1	7.8	9.9	6.9	20.9	27.8
1997	0.6	1.2	0.3	1.4	0.4	2.1	7.8	9.9	6.9	20.9	27.8
1998	0.6	1.2	0.3	1.4	0.4	2.1	7.8	9.9	6.9	20.9	27.8
1999	0.6	1.2	0.3	1.4	0.4	2.1	7.8	9.9	6.9	20.9	27.8
2000	0.6	1.0	0.2	1.1	0.4	1.7	7.8	9.5	6.9	20.9	27.8
2001	0.6	1.2	0.3	1.4	0.4	2.1	7.8	9.9	6.8	20.9	27.7
2002	2.4	4.4	0.9	4.9	1.4	7.2	7.8	15.0	13.8	20.9	34.7
2003	2.0	3.8	0.8	4.3	1.2	6.3	7.8	14.1	20.6	20.9	41.5
2004	1.5	2.8	0.6	3.1	0.9	4.6	7.8	12.4	20.6	20.9	41.5
2005	1.5	2.7	0.6	3.0	0.9	4.5	7.8	12.3	20.6	20.9	41.5
2006	1.5	2.7	0.6	3.0	0.9	4.5	7.8	12.3	20.6	31.6	52.2

1/ See Table 2 and detailed cost tables.
2/ Total financial costs from table 3 net of labour and foreign exchange costs.
3/ Shadow priced at US$1.00=K0.9 instead of the official rate of US$1.00=K0.8
4/ At 60% of financial labour costs.
5/ See Annex 3, page 3.
6/ IPD prices assumed to rise as set out in Annex 2, Table 3, footnote 6.

Table 4

68. Column 9 of the same table shows the additional revenue obtained from sawnwood produced by the Project sawmill using sawlogs obtained from plantations established prior to the Project. These revenues are arrived at from the unit prices shown above and the volumes given in Annex 2.

69. The revenues from the pulpmill (column 11 of Table 3) are derived in Annex 3.

Economic Benefits

70. As the final outputs of the Project will replace imported supplies, in order to arrive at their economic value they need to be valued in terms of world market prices. Kenya seems the most likely source of imports for the kind of pine sawn timber to be produced by the Project. Such timber can be delivered in the Zambian Copperbelt at a total cost of about K 128/m^3 for a 1.5 m length, compared with K 126/m^3 currently charged by IPD. There is no known alternative source of eucalyptus. The parity prices of sawn timber have therefore been assumed to be approximately equal to the current IPD prices.

71. In addition, an allowance has been made for an expected rise in the real value of sawn timber. The World Bank has forecast that the price of sawn timber will rise, at constant 1974 values (US$), as follows:

1978	1979	1980	1985 (and after)
168.1	170.8	174.8	184.1

72. Project sawn timber output prices have therefore been assumed to rise at the same rate, i.e. as follows (1978 = 100):

1978	1979	1980	1985 (and after)
100	102	104	113

73. Paper prices used in the financial analysis were based on world market prices, and therefore no adjustment was needed in this respect in the economic accounts. The value of all importable project outputs - sawnwood, poles and paper - was valued using the shadow price for foreign exchange of US$1 = K 0.9 instead of the official US$1 = K0.8.

74. Annual benefits are shown in Table 4.

Indirect Benefits

75. The Project is expected to be neutral in its environmental impact. The new plantations would help to preserve water catchment areas and prevent soil erosion, but since indigenous forests (which were themselves quite adequate for these purposes) would have to be removed to plant the new trees, there is really no incremental benefit, nor any adverse effects from this source. Similarly, the other components of the Project neither improve nor worsen the environment.

Comparing Costs and Benefits

76. On the basis of the total cost and total revenue/benefit streams shown in Tables 3 and 4, the Project and necessary associated investments would earn an internal financial rate of return (FRR) of 10.5 percent and an internal economic rate of return (ERR) of 14.3 percent.

77. The sawmill to be financed through this Project, together with its associated logging and transport, would process wood from trees planted under previous projects. This group of investments alone would earn a FRR of 15.6 percent and an ERR of 32 percent (Annex 2).

78. The pulp and paper mill, processing sawmill waste and smallwood first from pre-Project plantations and later from Project plantations as well, would earn an FRR of 10.4 percent and an ERR of 11.7 percent[1]. (Annex 3).

Sensitivity Analysis

79. As was noted earlier, consideration has to be given to the possible effects on the Project if, due to lack of funds, lack of technical expertise, or any other reasons, the proposed pulp and paper mill does not materialize. Cash flow statements of the project with and without a pulp and paper mill are shown in Tables 3 and 4. Without the pulpmill, the Project and its necessary associated future investments would earn an FRR of 10.0 percent and an ERR of 20.0 percent, based on sawmilling and pole manufacture alone, but on a much reduced investment and level of activities. The reduced economic impact is shown by the fact that the discounted net value[2] with the pulpmill is K 61 million, and without the pulpmill K 26 million.

80. In addition, the ERR of the Project with a pulp and paper mill has been tested for sensitivity to changes in the cost and benefit streams with the following results:

	ERR
Basic Model	14.3
Costs increased 10%	12.5
Costs increased 20%	10.6
Benefits reduced 10%	12.1

81. It would seem that the ERR is not sensitive to small changes in costs or benefits. A substantial reduction in benefits could result from fires, disease or inadequate production. However, this risk is common to all forestry projects. IPD's fire record has been normal in the past, and the conventional fire preventive measures have been built into the Project.

1/ To calculate the return on the pulp and paper mill as a separate entity, the pulpwood raw material was costed at the cost-price stumpage values calculated in Annex 4 in the financial calculation, and was given a zero stumpage value in the economic calculation because it would have no use other than in the pulpmill (Annex 3).

2/ Discounted at 8.5%, which is the interest rate to be paid on most of the money invested in the project.

ANNEX 1

AFFORESTATION AND REFORESTATION

A. Establishment of Plantations

1. Land Clearing. Afforestation nearly always takes place in "miombo" woodland (see Annex 1) with more or less open canopy and trees 15-20 m high. The land must therefore be completely cleared before planting.

2. The land clearing method which is used on the Copperbelt is very thorough and expensive, but IPD claims that it should not be changed as this would reduce growth and yields. The work has so far been carried out mainly under contract (IPD has recently started undertaking some clearing with direct labour and some land is also cleared by charcoal burners), and the cost per hectare was approximately K200 in 1976. The following operations are included:

(a) Knockdown. A heavy chain, weighing about 50 kg per link and some 200 m long, is pulled by two 300 HP bulldozers moving forward at an average distance of 30 m apart. The chain can easily pull down all small and most medium-sized trees in its path. One or two 200 HP bulldozers follow some 60 m behind the others and help to pull down larger-sized trees.

(b) Windrowing. All the uprooted trees are piled into windrows some 80 m apart by means of bulldozers (200 or 300 HP). When the wood is sufficiently dry it is all burnt in the rows. (It is hoped that during the phase II project the wood will increasingly be converted into charcoal.)

(c) Stumping. Any stumps remaining in the ground after the passage of the bulldozers are removed by hand and piled on to the windrows, and the holes are then filled by hand.

(d) Ploughing. The whole area is ploughed after the stumps have been removed.

3. All these operations have until recently been carried out under contract, except for some of the ploughing which has been done directly by IPD. In order to reduce costs and be less dependent on contractors, IPD would like gradually to take over all the land clearing operations, phased over the Project period. However, in view of the heavy investment involved and of the period of training required, it is assumed that the average cost per ha will be more or less the same throughout the Project period, regardless of who performs the work. Thus, assuming an average total area of 3 500 ha cleared annually at an average cost of K200/ha, the total (base line - 1976) costs are estimated at K 700 000 p.a. or K 3.5 million over the whole Project period.

Equipment

4. A complete unit consists of two 300 HP and at least one 200 HP bulldozers with two sets of chains. IPD already has one such unit, but another unit, with a standby 300 HP dozer, would be purchased during year 1 of the Project, and another replacement unit in year 3 of the Project.

5. The estimated costs are:

Capital Costs

Equipment	Unit Price K'000	Number	Year 1 K'000	Number	Year 3 K'000
300 HP bulldozer, with all attachments	157	3	471	2	314
200 HP bulldozer, with all attachments	114	1	114	1	114
50-60 HP tractor	10	5	50	5	50
Ancillary equipment 1/			70		40
Ploughs, winches, chains, etc.			40		32
TOTAL			745		550

1/ Low bed trailers, tanker, welding sets, etc.

Operating Costs (for one unit during year 1, and 2 units from year 2 to year 5). N.B. 2000 hours per unit p.a.

		Cost per unit p.a. '(K'000)
Materials, spares, maintenance and repairs		45
Fuel - 300 HP: 50 litre/hr 200 HP: 36 litre/hr Tractors: 3.5 litre/hr Ancillary equipment	K0.15/litre	55
Lubricants	K0.81/litre	10
TOTAL		110

Total Operating Costs (K'000)

Year	1	2	3	4	5
	110	220	220	220	220

Salaries and Wages (2 units from year 2)

Category	Number	Annual Salary/wages K	Cost per unit p.a. K
Supervisor	1	3 650	3 650
Dozer drivers	6	1 620	9 720
Tractor drivers	5	1 416	7 080
Labour (incl. Transport)	6	492	2 950
TOTAL			23 400
Ancillary equipment drivers	3	1 416	4 248 (not doubled with second unit)

Total Salaries and Wages (K'000)

Year	1	2	3	4	5
	28	51	51	51	51

Recapitulation of Land Clearing Costs (K'000)

Year	1	2	3	4	5	Total
(a) by IPD						
Equipment	745	-	550	-	-	1 295
Fuel and Lubricants	110	220	220	220	220	990
Salaries & Wages (incl. Transport)	28	51	51	51	51	232
TOTAL	883	271	821	271	271	2 517
(b) by contract	400	300	200	83	-	983
TOTAL (a) + (b)	1 283	571	1 021	354	271	3 500

Soil Preparation

6. Ploughing has been included in the land clearing costs. There only remains pre-planting discing. The unit cost per operation is K7.30/ha (1976), of which labour represents about 25 percent or K1.80/ha. No special equipment need be purchased, apart from disc harrows. (The tractors used in ploughing can also be utilized for discing.) Normally only one discing operation is required, unless planting takes place after too long an interval, when a second discing may be necessary.

Year	1	2	3	4	5	Total
Area (ha)	3 700	3 800	3 900	4 000	4 100	19 500
Costs (K'000)						
Equipment and fuel	20	21	22	23	24	110
Labour (incl. transport)	7	7	7	7	7	35
TOTAL	27	28	29	30	31	145

Nurseries and Seedling Production

7. No new nurseries will be required during the Project, the existing nurseries being conveniently located and adequate. Nursery techniques are well developed and satisfactory. Pine is spot-sown in tubes (1-3 seeds per tube, according to the tested germinating power of the seed stock), while Eucalyptus is transplanted from seedbeds into tubes. The tubes are made of black polythene, 5 cm wide when flat and 12 cm long. Sterilized soil is used to fill the tubes. No special mycorrhizal problem exists as regards Pine. Sowing normally takes place in June-July and the seedlings are ready for planting out as from November-December. Fertilizers are applied diluted in water, one month after germinating (or transplanting) and regularly thereafter, as required. The average task for the filling of tubes is 1 175 p.d. Allowing 20-25 percent for various losses, it is advisable to allow 1 700 Pine or 1 000 Eucalyptus plants per ha, giving a weighted average of 1 500 plants per ha for both Pine and Eucalyptus. The weighted average cost is K10 per thousand seedlings, giving a weighted average cost of K15 per ha, of which approximately one-third or K5 is for materials, and two-thirds or K10 for labour.

Year	1	2	3	4	5	Total
Area (ha)	3 700	3 800	3 900	4 000	4 100	19 500
Costs (K'000)						
Materials	19	19	20	20	21	99
Labour (incl. transport)	37	38	39	40	41	195
TOTAL	56	57	59	60	62	294

Planting and Fertilizing

8. The present planting distances of 2m 70 x 2m 70 (1 370 plants/ha) for Pine and 3m 60 x 3m 60 (770 plants/ha) for Eucalyptus will be maintained. The average cost (all labour) is K15/ha for Pine and K10/ha for Eucalyptus, giving a weighted average of K13/ha, which includes 10 percent for the replacement of failures.

9. No fertilizers are used for Pine, but borate and NPK are applied in Eucalyptus plantations at the time of planting. The cost of this treatment is K20/ha (1976), of which K10 is for the borate and NPK, and K5 is for labour and transport. The planting programme and costs may be summarized as follows:

Year	1	2	3	4	5	Total
Area (ha)						
Pine	3 000	3 000	3 000	3 000	3 000	15 000
Eucalyptus	700	800	900	1 000	1 100	4 500
TOTAL	3 700	3 800	3 900	4 000	4 100	19 500
Costs (K'000)						
(a) Planting						
Labour (incl. transport)	48	49	51	52	53	253
(b) Fertilizing						
Borate & NPK	7	8	9	10	11	45
Labour (incl. transport)	7	8	9	10	11	45
TOTAL	14	16	18	20	22	90
TOTAL (a) + (b)	62	65	69	76	75	343

Weeding

10. Very intensive weeding is required. Most of the weeding is done mechanically, in lines, using a tractor and rotorvator, but hand weeding is sometimes carried out simultaneously around the trees. The following operations are done on the average:

(a) Pine	Operation	Average Cost (K/ha)
1st year	6 mechanical, 4 manual	47
2nd year	4 mechanical, 2 manual	45
3rd year	2 mechanical	23
	Total weeding costs (3 yrs.)	115

(b) Eucalyptus	Operation	Average Cost (K/ha)
1st year	6 mechanical, 4 manual	47
2nd year	0-2 mechanical	7
	Total weeding costs (2 yrs.)	54

Average weighted cost/ha p.a. for Pine and Eucalyptus: K100 (assuming areas at the start and end of the Project balance each other out for the 2-3 years of weeding). This cost includes equipment (33 percent), fuel (17 percent) and labour (50 percent).

Year	1	2	3	4	5	Total
Area (ha)	3 700	3 800	3 900	4 000	4 100	19 500
Costs (K'000)						
Equipment (tractors, etc.)	122	125	128	132	135	642
Fuel & lubricants	63	65	67	68	70	333
Labour (incl.transport)	185	190	195	200	205	975
TOTAL	370	380	390	400	410	1 950

Recapitulation - Total Establishment Costs (K'000)

Operation	Year 1	2	3	4	5	Total
Land clearing	1 283	571	1 021	354	271	3 500
Soil preparation	27	28	29	30	31	145
Nursery production	56	57	59	60	62	294
Planting and fertilizing	62	65	69	72	75	343
Weeding	370	380	390	400	410	1 290
TOTAL	1 798	1 101	1 568	916	849	6 232

Recapitulation - Total Establishment Costs by Categories of Expenditure (K'000)

Category	Year 1	2	3	4	5	Total
Equipment	877	135	688	142	145	1 987
Materials - Local	26	27	29	30	32	144
Fuel and Lubricants	183	296	299	301	304	1 383
Labour (inc. transport)	312	343	352	360	368	1 735
Contract	400	300	200	83	-	983
TOTAL	1 798	1 101	1 568	916	849	6 232

B. Maintenance of Plantations (mainly pre-Project)

11. Pruning

(a) Pine

Operation	Unit Cost (1976) K/ha	Average area (ha) p.a.	Total cost p.a. (K'000)
1st pruning (5 yrs.) (1 000 stems/ha)	10	2 000	20
2nd pruning (8 yrs.) (260 stems/ha)	5	1 500	8
3rd pruning (11 yrs.) (260 stems/ha)	10	1 000	10
		Total cost p.a. Pine	38

(b) Eucalyptus

Pruning (at about 2 yrs.)	5	750	4
Average total cost of pruning p.a. Pine + Eucalyptus			42

12. Thinning. Except in the case of first thinnings for Pine, the only cost involved is for the marking of thinnings as it is assumed that thinnings will be saleable and the felling and logging costs will be borne by logging operations. The first Eucalyptus thinning (at 5 years) is a line thinning and involves no marking costs.

	Pine				Eucalyptus	
	Thin. I (11 yrs.)	Thin.II (14 yrs.)	Thin.III (19 yrs.)	Total P.	Thin. II (8 yrs.)	Total P + E
Cost K/ha	10	3	2	-	1	
Average area (ha) p.a.	1 500	1 000	250	2 750	800	3 550
Total Cost (K'000)	15	3	1	19	1	20

Recapitulation Total Cost of Pruning and Thinning (all labour)

Operation	Year 1	2	3	4	5	Total
Pruning	42	42	42	42	42	210
Thinning	20	20	20	20	20	100
TOTAL (Labour) (including transport)	62	62	62	62	62	310

C. Roads

13. All road construction and maintenance is included here, even of so-called "logging" roads, which are also used for other purposes. However, external firebreaks, which are sometimes used as roads, are dealt with separately under Fire Control.

I. Road Construction (new roads)

Category:	Access Roads (Class B)	"Logging" Roads (Class C)	Compartment Roads (Class D)	Total all roads
Density (km/1 000 ha)	10	3	31	
Average cost 1/ (K/km)	3 125	2 000	280	
Total cost (K/1 000 ha)	31 250	6 000	8.680	
Total cost 2/ (K'000) p.a.	109	21	30	160
Total cost (K'000) - 5 yrs	545	105	150	800
Total length (km) - 5 yrs	175	52.5	542.5	

1/ Mid-1976 costs have been increased by 12 percent to allow for the 20 percent devaluation of the Kwacha in 1976, which affects all imports (55 percent of total road costs).

2/ An average of 3 500 ha of new plantations p.a.

II. Road Maintenance

14. Roads to be maintained annually are as follows:

Category	Access Roads (Class B)	"Logging" Roads (Class C)	Compartment Roads (Class D)	Total all roads
Length (km) of existing roads (1975)	80	90	100	-
Length (km) of new Project roads (total) divided by 2 1/	90	25	270	-
Total length (km) (average)	170	115	370	-
Average cost p.a. (K/km) 2/	312.5	200	28	-
Total cost p.a. (K'000)	53	23	10.4	86.4
Total cost - 5 yrs (K'000)	265	115	52	432

1/ To obtain yearly average over the whole 5-year period

2/ 10 percent of capital costs

15. The total base-line Project costs for road construction and maintenance are K 1 232 000, of which approximately 60 percent (K 470 000) is for equipment and materials, and 40 percent (K 492 000) for labour (including transport).

16. Detailed Project costs are given below:

Equipment (machinery)	Number	Unit Cost (K'000)	Total Cost (K'000)
150 HP motor graders	2 (1 yr. 1 & 1 yr. 4)	80	160
5-ton tipper trucks	4 (2 yr. 1 & 2 yr. 4)	33	132
	Total equipment (machinery)		292
Spares			40
Fuel and lubricants			288
Workshop equipment			40
Materials - imported			40
local			40
Total non-labour			740
Total labour (including transport)			492
Total road costs (construction & maintenance)			1 232

Year	1	2	3	4	5	Total
Machinery and equipment	146	-	-	146	-	292
Spares	20	5	5	5	5	40
Fuel & lubricants	44	52	58	64	70	288
Workshop equipment	20	5	5	5	5	40
Material imported	8	8	8	8	8	40
local	8	8	8	8	8	40
Labour (including transport	80	88	98	108	118	492
TOTAL	326	166	182	344	214	1 232

D. Fire Protection

17. The fire hazard is high in forest plantations on the Copperbelt and losses may sometimes be appreciable despite normal precautions. For example, some 200 ha of Pine were completely lost and another 400 ha of Pine were more or less severely scorched in 1975. Fire damage is worst in Pine stands 5 to 8 years old. External firebreaks 15 m wide are constructed and maintained around all new plantations. Internally, roads are used as firebreaks. 20 m wide breaks are usually maintained on either side of main roads. But essentially fire protection consists of controlled burning of firebreaks and of all plantations while there is a serious fire hazard. Finally, fire control includes maintaining fire-fighting vehicles, equipment and fire towers, as well as fire crews.

18. Fire protection is considered under the following headings:

(i) Construction of external firebreaks (new)

The cost of construction of new external firebreaks is the same as the cost of land clearing, as the same operation is involved. This cost is assumed to be about K200/ha. As the width is 15 m, the average area of external firebreaks is 1½ ha per km and the average cost is K300/km (1976). The average density is 23 km/1000 ha of new plantations, which gives a total of 80.5 km p.a. (3 500 ha of new plantations p.a.). The average annual cost is, therefore, K24 000, divided as follows:

	Cost (K'000)					
Year	1	2	3	4	5	Total
(a) by IPD						
Equipment	8	8	8	8	8	40
Fuel & lub., etc.	7	7	7	7	7	35
Labour (inc. transport)	1	1	1	1	1	5
(b) by contract	8	8	8	8	8	40
TOTAL	24	24	24	24	24	120

(ii) Maintenance of firebreaks

19. All firebreaks are maintained by regular annual strip-ploughing or discing and controlled burning. The average cost is K25/km. The average area of plantations during the project is assumed to be 26 000 + 18 000 = 34 000 ha, and the average length of firebreaks to be maintained (at 23 km/1 000 ha) is assumed to be 34 x 23 = 782 km. The total average cost of firebreak maintenance is K20 000 p.a., made up of:

Equipment	(25%)	-	K 5 000
Fuel & lub., etc.	(50%)	-	K 10 000
Labour (inc. transport)	(25%)	-	K 5 000

Cost (K'000)

Year	1	2	3	4	5	Total
Equipment	2	3	5	7	8	25
Fuel & lub., etc.	8	9	10	11	12	50
Labour (incl. transport)	4	5	5	5	6	25
Total	14	17	20	23	26	100

(iii) Controlled burning

20. Assuming half the total area of plantations is control-burnt annually, the average area involved will be $\frac{34\ 000}{2}$ = 17 000 ha. At an average cost of K 0.5/ha, the annual average cost will be K 9 000, nearly all of it labour.

Cost (K'000)

Year	1	2	3	4	5	Total
Labour (incl. transport)	7	8	9	10	11	45

(iv) Fire Control

21. This includes all fire-fighting equipment and services, and the manning of fire towers and standby crews during periods of high fire hazard.

(a) Fire tenders

There are two types of fire tenders: the light one which consists of a fast, 4WD, 3-ton load-carrying capacity cross-country vehicle, and the heavy one which is a proper fire engine. The requirements are one light tender for 3 500 ha of plantations and one heavy tender for 7 000 ha of plantations. The average total area of plantations during the Project is 34 000 ha (see the two previous headings). The total requirements, including replacements, will therefore be 10 light tenders and 5 heavy tenders.

	Light tenders	Heavy tenders	Total (K'000)
Total requirements (number)	10	5	
No. available in working order	5	2	
Additional no. required (new)	5	3	
Average unit cost (K'000) 1/	30	40	
Total cost (K'000)	150	120	270
Running costs (average)			
(Fuel, lub., etc.	(p.a. K10 000)		50
(Labour	(p.a. K10 000)		50
		Total cost over 5 years	370

1/ Allowing a 20 percent increase over mid-1976 costs (1976 devaluation).

Year	1	2	3	4	5	Total
Equipment	100	-	100	-	70	270
Fuel, lub., etc.	8	9	10	11	12	50
Labour (incl. transport)	8	9	10	11	12	50
Total	116	18	120	22	94	370

(b) Fire towers

22. Requirements - 1 large tower (30 m high) for 1 800 ha.
1 small tower (8 m high) for 4 000 ha.

	Large tower	Small Tower	Total
No. required p.a.	2	1	3
Unit cost (K'000)	7	2	
of which (materials	4	1	5
(labour	3	1	4
Total cost p.a.	14	2	16
of which (materials	8	1	9
(labour	6	1	7

Year	1	2	3	4	5	Total
Materials (incl. transport)	9	9	9	9	9	45
Labour (incl. transport)	7	7	7	7	7	35
Total	16	16	16	16	16	80

23. (c) Fire fighting equipment[1/]

	60 W. radios	25 W. radios	10 W. radios	Other Equipment
No. required (5 years)	6	50	50	
Unit cost (K'000)	2.5	1	0.8	
Total cost (K'000) - 5 yrs.	15	50	40	20
Grand total cost (K'000) - yrs.				125

Year	1	2	3	4	5	Total
Equipment	75	-	-	50	-	125

[1/] Allowing a 20% increase over mid-1976 costs (1976 devaluation).

(d) Fire crews and fire-fighting

Average cost - all labour - (K'000)
p.a. - 20
5 years - 100

Year	1	2	3	4	5	Total
Labour	16	18	20	22	24	100

24. Recapitulation fire control costs (iv) (a-d) (K'000)

Year	1	2	3	4	5	Total
Equipment	175	-	100	50	70	395
Materials	9	9	9	9	9	45
Fuel, lub., etc.	8	9	10	11	12	50
Labour (incl. transport)	31	34	37	40	43	185
TOTAL	223	52	156	110	134	675

25. Recapitulation - all fire protection costs (i) to (iv) (K'000)

Year	1	2	3	4	5	Total
Equipment	185	11	113	65	86	460
Materials local	9	9	9	9	9	45
Fuel, lub., etc.	23	25	27	29	31	135
Labour (incl. transport)	43	48	52	56	61	260
By contract	8	8	8	8	8	40
TOTAL	268	101	209	167	195	940

26. Recapitulation - all afforestation costs (A to D)
Direct costs (K'000)

Year	1	2	3	4	5	Total
1. Establishment of plantations	1 798	1 101	1 568	916	849	6 232
2. Maintenance of plantations	62	62	62	62	62	310
3. Roads - construction and maintenance	326	166	182	344	214	1 232
4. Fire protection	268	101	209	167	195	940
TOTAL	2 454	1 430	2 021	1 489	1 320	8 714

27. Recapitulation - all afforestation costs (Direct costs) (A to D)
By categories of expenditure (K'000)

Category Year	1	2	3	4	5	Total
Equipment	1 256	164	819	371	249	2 859
Materials - local	43	44	46	42	49	229
Fuel and lubricants	250	373	384	394	405	1 806
Labour (incl. transport)	497	544	564	586	609	2 797
Contract	408	308	208	91	8	1 023
TOTAL	2 454	1 430	2 021	1 489	1 320	8 714

E. Non-Afforestation (Indirect) Costs (Project Management)

Administration and Overheads

28. The average IPD establishment (staff) costs during the Project would be as follows:

Posts	No.	Unit cost p.a.[1/] (K'000)	Total cost p.a. (K'000)
Director	1	8.7	8.7
Financial Controller	1	8.7	8.7
Conservators	5	8.2	41.0
Auditors & Senior Accountants	3	6.8	20.4
Engineers, Managers, Senior Forest Officers	11	6.4	70.4
Senior Mechanics & Clerks of Works	6	5.8	34.8
Electrical Officers & Building Officers	5	4.9	24.5
Foresters	10	4.9	49.0
Accountants	4	4.6	18.4
Executive Officers, Surveyors, Transport Officers	13	3.2	41.6
Assistant Accountants	5	3.0	15.0
Stenographers	3	2.7	8.1
Typists	8	2.0	16.0
Senior Officers	10	1.9	19.0
Clerical Officers	15	1.7	25.5
Junior Clerical Officers	8	1.3	10.4
		Total	411.5
+ 12½% housing allowance			51.5
Total cost (salaries and all allowances) p.a.			463
Office expenses (average) p.a.			27
Average Total Cost of Administration and Overheads p.a.			490

1/ Including salary and allowances (excluding housing allowance).

29. Recapitulation - administration and overhead costs

Year	1	2	3	4	5	Total
Salaries and allowances	463	463	463	463	463	2 315
Office expenses (materials and services)	27	27	27	27	27	135
TOTAL	490	490	490	490	490	2 450

F. Housing (additional)

30. The only new buildings required during the project are additional housing for the staff.

Type	Unit cost (K'000) (at 1976 prices)	Year 1 Qty.	1 T. Cost (K'000)	2 Qty.	2 T. Cost (K'000)	3 Qty.	3 T. Cost (K'000)	4 Qty.	4 T. Cost (K'000)	5 Qty.	5 T. Cost (K'000)	Total Qty.	Total T. Cost (K'000)
Low density	16	3	48	2	32	2	32	2	32	3	48	12	192
Medium density	12	4	48	2	24	2	24	3	36	4	48	15	180
High density	4	60	240	60	240	70	280	70	280	90	360	350	1400
Ablution blocks	6	10	60	6	36	7	42	7	42	9	54	39	234
Electricity and Water Services			50		50		50		50		50		250
TOTAL			446		382		428		440		560		2256

31. It is assumed that on the average labour and materials will account for about half the total costs each, and that the foreign exchange component will be about 25 percent of total costs.

Recapitulation - housing costs (K'000)

Year	1	2	3	4	5	Total
Labour (inc. transport)	223	191	214	220	280	1 128
Materials						
local	112	96	107	110	140	565
foreign	111	95	107	110	140	563
TOTAL	446	382	428	440	560	2 256

G. Building Maintenance

32. The average cost of maintaining all Project buildings, old and new, is estimated at K100 000 p.a., of which about half is for labour and half for materials (50 percent foreign).

Building maintenance costs are, therefore, estimated thus:

Costs (K'000)

Year	1	2	3	4	5	Total
Labour (incl. transport)	40	45	50	55	60	250
Materials						
local	20	23	25	28	30	126
foreign	20	22	25	27	30	124
TOTAL	80	90	100	110	120	500

H. Administrative Vehicles & Labour Transport

33. At the end of the Phase I project, the following administrative vehicles were in working order:

Trucks and vans	37
Personnel vehicles	22
Motorcycles	8

34. It is assumed that almost half of these vehicles will be used in afforestation (the other half in logging, forest industries, etc.). Provision is made for the following replacements during the Project period:

Category	Number		Average Unit Cost (1976) (K'000)	Total Cost (5 years) (K'000)
1. 8-ton flat trucks	10)		19.4	194
2. 5-ton trucks or vans	10)	2 p.a.	16	160
3. Personnel vehicles	10)		9	90
4. Motor cycles	10)		2	20
		TOTAL		464

35. The average annual running costs of the existing administrative vehicles and for the transport of labour to the work sites (for afforestation operations only) are:

Item	Number	Unit Cost p.a. (K'000)	Total Cost p.a. (K'000)
Labour - drivers	25	1 416	35 400
skilled workers	10	1 000	10 000
unskilled workers	20	492	9 840
Total labour	55		55 240
Fuel and lubricants (imported)			50 000
Spares (imported)			20 000
TOTAL			125 240

Cost of administrative vehicles, including labour transport

Item	Year 1	2	3	4	5	Total
Vehicles & equipment (new)	100	100	100	100	64	404
Running cost:						
Labour	55	55	55	55	55	275
Fuel and lubricants	50	50	50	50	50	250
Spares	20	20	20	20	20	100
TOTAL	225	225	225	225	189	1 089

The cost of labour transport for all afforestation operations has been included in the cost of labour in each case, and it is assumed that it represents about 10 percent of total labour costs. As the average annual labour costs for afforestation come to K559 400, labour transport represents approximately K56 000 of it. This must be deducted from the totals given above in order to avoid double counting. The actual cost of administrative vehicles and transport under non-afforestation (indirect) costs is therefore K1 089 000 less K280 000 (K55 000 x 5) = K809 000. Labour transport thus represents 25 percent of the total cost of administrative vehicles + labour transport, and by subtracting 25 percent we obtain:

Revised cost of administrative vehicles (excluding labour transport)

Item	Year 1	2	3	4	5	Total
Vehicles & equipment	75	75	75	75	48	348
Labour	41	41	41	41	41	205
Fuel & lubricants	38	38	38	38	38	190
Spares	15	15	15	15	15	75
TOTAL	169	169	169	169	142	818

I. Surveys and Training

36. The average annual cost of surveys is K30 000, made up of labour (K15 000) and materials (K15 000).

IPD has its own training centre, and average annual costs of training are estimated at K10 000 (for materials).

The total costs of surveys and training come to:

Costs (K'000)

Year	1	2	3	4	5	Total
Surveys - labour	15	15	15	15	15	75
materials	15	15	15	15	15	75
Training - materials	10	10	10	10	10	50
TOTAL	40	40	40	40	40	200

Recapitulation - Non-afforestation: (Indirect)Costs (E-I)
(Project Management)

Costs (K'000)

Year	1	2	3	4	5	Total
Salaries & allowances	463	463	463	463	463	2 315
Vehicles & equipment	75	75	75	75	38	348
Fuel & lubricants	38	38	38	38	38	190
Materials - foreign	161	147	162	167	200	837
local	169	156	169	175	207	876
Labour	319	292	320	331	396	1 658
TOTAL	1 225	1 171	1 227	1 249	1 352	6 224

Plantations

Direct and Indirect Costs (K'000)

	1978 Year 1	1979 Year 2	1980 Year 3	1981 Year 4	1982 Year 5	Total 5 Years	Foreign Exchange Amount	Foreign Exchange %
Equipment and vehicles	1 331	239	894	446	297	3 207	3 046	95
Materials: foreign	161	147	162	167	200	837	795	95
local	212	200	215	222	256	1 105	-	-
Fuel and lubricant	288	411	422	432	443	1 996	1 896	95
Labour: afforestation	497	541	564	586	609	2 797	-	-
other	319	292	320	331	396	1 658	-	-
Contract	408	308	208	91	8	1 023	511	50
Salaries & allowances	463	463	463	463	463	2 315	-	30
TOTAL	3 679	2 601	3 248	2 738	2 672	14 938	6 248	46

ANNEX 2

PROJECT SAWMILL

Introduction

1. The conditions in Zambia provide ample justification for the construction of a new sawmill for the production of pine and eucalyptus lumber. The present capacity of existing sawmills at Chati and Dola Hill are not sufficient to handle the increasing volume of pine and eucalyptus sawlogs from IPD after 1978. Log yield projections indicate that an additional sawmill would be required by then.

2. A sawmill would have an estimated capacity of 250 m^3(r) log input per 8-hour shift, corresponding to a lumber output of 113 m^3(s) per 8-hour shift, assuming the average lumber yield to be 45 percent.

3. It has been assumed that the domestic demand for pine and eucalyptus lumber in Zambia will be sufficient to keep the proposed new sawmill at Chati operating on one shift per day in 1980, producing 20 000 m^3(s) per year, and 2 shifts per day in 1982, producing 46 000 m^3(s) in that year.

4. The most economical site for the Project sawmill is at Chati, where there is already sufficient land, labour, water, management and other supporting infrastructure. A future sawmill (probably 1982) would be built at the site of the proposed pulp and paper mill.

5. Proper utilization of sawmill waste should be of particular importance to the sawmills in Zambia which are processing pine and eucalyptus sawlogs from IPD plantations. Since the lumber yield is about 45 percent, the main product of these mills in terms of volume is not lumber but sawmill waste. The production of chips from sawmill waste for production of pulp or panels would require that a suitable chipper be installed at the end of the main waste conveyor, together with chip-conveyor and chip-storage bins for loading of trucks.

Capital Requirement for Sawmill 1/

	Kwacha
Sawmill equipment, crated for export, fob Chattanooga, Tenn., USA (estimated gross weight 180 tons) (estimated total volume 490 m^3)	625 000
Estimated land and sea freight	100 000
Sawmill equipment, cif Chati	725 000

1/ In addition, logging and transport equipment to supply the sawmill is required, at a capital cost of K 990 000.

Installation Cost	175 000
Sawmill Equipment Installed	900 000
Contingencies (including chipping plant)	75 000
Fees paid to Engineering and Contracting firms	75 000
Site preparation (levelling and surfacing)	250 000
Building, 2 storey, on concrete slab foundation	300 000
Moving Equipment	250 000
Machine shop equipment	100 000
Extra spare parts and stores	150 000
Interest during construction	100 000
Total Plant Cost	K 2 200 000
Working Capital	400 000
Total Capital Requirement	K 2 600 000

Manufacturing Cost[1] at Full Capacity (two-shift operation)

Wood Cost		K per year
Eucalyptus sawlog stumpage 29 950 m^3 (r) x K 8		239 200
Pine sawlog stumpage 72 500 m^3 (r) x K 22		1 595 000
Total Wood Cost		1 834 200
Logging and log transport cost 102 400 m^3 (r) x K 6		614 400
Electric energy 40 000 m^3 (s) x 75 kWh x 0.22		60 000
Operating and Maintenance Supplies		120 000
Petroleum products and tires		60 000
Direct Labour:		
20 skilled at K 1 700	34 000	
30 semi-skilled at K 1 000	30 000	
60 unskilled at K 600	36 000	
Total Direct Labour		100 000

[1] Excluding taxes, interest payments and depreciation allowances.

Administration and Mill Supervision	120 000
Allowances and Bonuses:	
45% of wages for direct labour	46 000
35% of salaries	42 000
Miscellaneous Overhead Costs	50 000
Total Conversion Costs	1 212 400
Total Production Costs	3 046 000
Physical Contingencies	304 700
Total Manufacturing Costs	3 351 300

Projected Sales

6. Estimates of sales revenue are based on the following prices and product mix:

Eucalyptus lumber, green and rough	K per m^3 (s)
Boards longer than 1.5 m	86
Shorts	48
Waney edge boards	25
Pine lumber, green and rough	
Boards longer than 1.5 m	126
Shorts	63

7. It has been assumed that the eucalyptus lumber from this mill will consist of 65% long boards, 25% shorts and 10% waney edge boards. Similarly, it was assumed that pine lumber from the mill would consist of 75% longs and 25% shorts.

Projected Sales Volume and Revenue

	Sales Volume			Sales Revenue		
Year	Pine	Eucalyptus ('000 m^3)	Total	Pine	Eucalyptus (K million)	Total
1979	6.5	3.7	10.2	0.72	0.26	0.98
1980	13.1	7.3	20.4	1.44	0.52	1.96
1981	19.9	13.5	33.4	2.19	0.95	3.14
1982-93	32.6	13.5	46.1	3.60	0.95	4.55

Financial Rate of Return

8. Projections of financial cash flow[1] are given, in constant 1977 prices, in Table 2 of this Annex. These projections value sawlogs at the replacement cost unit values calculated in Annex 4 (plus a 10% allowance for physical contingencies). The build-up to full capacity is at the rate indicated in the section above on sales, and costs have been pro-rated accordingly. The financial rate of return computed from these projections is 15.6%.

Economic Rate of Return

9. In order to arrive at projections of economic costs and benefits (Table 3 of this Annex) the following adjustments to the financial accounts have been made:

(1) Imported inputs and outputs which will substitute for imported supplies have been valued at US$1.00 = K 0.9 instead of the official US$1.00 = K 0.8.

(2) The real value of sawnwood outputs has been assumed to rise at the rate set out on p. 17.

(3) Local labour was shadow priced at 60% of the financial cost.

10. On this basis, the economic rate of return has been established to be 32.0%.

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[1] Excluding transfer costs and financial transactions, such as taxes, interest payment and allowances for depreciation.

ANNEX 2
TABLE 1

Project Sawmill

	1978	1979	1980	1981	1982	Foreign Exchange
		(K million)				%
Revenue	-	0.98	1.96	3.14	4.55	100
Capital Costs						
Logging	0.71	0.28	-	-	-	98
Sawmill	-	-	-	-	-	65
Moving equipment	0.25					
Other equipment	1.70					
Other	.25					
Working capital	.40	-	-	-	-	-
Total	2.60	0.28	-	-	-	
Manufacturing Costs						
Wood		0.39	0.77	1.21	1.83	-
Logging and transport 1/		0.14	0.27	0.44	0.61	50
Conversion costs						33
Supplies		0.05	0.10	0.17	0.24	
Labour		0.03	0.06	0.10	0.15	
Other		0.04	0.08	0.15	0.21	
Total		0.65	1.30	2.07	3.04	
Physical contingencies 2/	0.33	0.09	0.13	0.21	0.30	
Total Costs	3.64	1.02	1.43	2.28	3.34	

1/ of which 40% accounted for by labour costs.

2/ at 10% of base costs.

FINANCIAL RATE OF RETURN FOR THE PROJECT SAWMILL (1978-1993)

(K million)

	Wood costs 1/	Other costs 2/	Total costs	Total revenues
1978	-	3.6	3.6	-
1979	0.4	0.6	1.0	1.0
1980	0.8	0.6	1.4	2.0
1981	1.3	1.0	2.3	3.1
1982	2.0	1.3	3.3	4.5
1983	2.0	2.4	4.4	4.5
1984	2.0	1.7	3.7	4.5
1985	2.0	1.3	3.3	4.5
1986	2.0	1.3	3.3	4.5
1987	2.0	2.9	4.9	4.5
1988	2.0	2.4	4.4	4.5
1989	2.0	2.0	4.0	4.5
1990	2.0	1.3	3.3	4.5
1991	2.0	1.3	3.3	4.5
1992	2.0	1.3	3.3	4.5
1993	2.0	1.3	3.3	5.1

1/ Stumpage costs only; using the average unit replacement costs of K22/m^3 for pine and K13/m^3 for eucalyptus (See Annex 4)

2/ Capital costs (including costs of logging equipment acquired by the project to supply the mill (Table1)) and operating costs (including logging and transport operating costs at K6/m^3); excludes depreciation but includes equipment replacement (assuming a life of 5 years for logging equipment and moving sawmill equipment and 10 years for other equipment and structures).

ECONOMIC RATE OF RETURN FOR THE PROJECT SAWMILL (1978-1993)

Year	Wood costs 1/	Foreign exchange costs 2/	Foreign exchange shadow priced 3/	Labour Costs 3/	Labour shadow priced 4/	Other costs 5/	Total economic costs	Total benefits 6/ 3/
1978	-	2.1	2.4	-	-	1.5	3.9	-
1979	0.4	0.4	0.45	0.1	0.05	0.2	1.1	1.1
1980	0.8	0.15	0.15	0.2	0.1	0.25	1.3	2.4
1981	1.4	0.3	0.3	0.25	0.15	0.45	2.3	3.7
1982	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.5
1983	2.0	1.4	1.6	0.4	0.25	0.6	4.3	5.6
1984	2.0	0.8	0.9	0.4	0.25	0.5	3.7	5.6
1985	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.8
1986	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.8
1987	2.0	1.5	1.7	0.4	0.25	1.0	5.0	5.8
1988	2.0	1.4	1.6	0.4	0.25	0.6	4.5	5.8
1989	2.0	1.1	1.25	0.4	0.25	0.5	4.0	5.8
1990	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.8
1991	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.8
1992	2.0	0.5	0.55	0.4	0.25	0.4	3.2	5.8
1993	2.0	0.5	0.55	0.4	0.25	0.4	3.2	6.4

1/ From Annex 2, Table 2

2/ From Annex 2, Table 1

3/ At U.S.$ 1.00 = K 0.9 instead of the official rate of U.S.$ 1.00 = K 0.8

4/ At 60% of actual labour costs

5/ "Other costs" in Annex 2, Table 2, net of foreign exchange and labour costs

6/ Assuming IPD prices rise as follows (1978=100): 1979 = 102, 1980 = 104, 1981 = 106, 1982 = 108, 1983 = 110, 1984 = 112, 1985 and after = 113 (see page 17)

ANNEX 3

PRELIMINARY EVALUATION OF PROPOSED PULP AND PAPER MILL

Introduction

1. The establishment of a pulp and paper mill to utilize part of the wood generated by the industrial plantations has been under consideration by the Government for several years. Conceptual planning for this project is reasonably well advanced. This Annex presents a brief description of the major features of the development as presently conceived, and reviews financial and economic implications.

2. Final exact configuration of the project has not been determined but there now appears to be a concensus with respect to the following features:

(i) the mill would produce linerboard, corrugated medium, sack paper, bag paper and wrapping paper using the kraft pulping process;

(ii) the mill would have a total production capacity of the order of 40 000 tons annually; and

(iii) the mill would start up in about 1982.

3. It has been assumed that fibre furnishes would be 100% pine pulp for all grades except corrugating medium where eucalyptus pulp together with waste paper would be used. The mill would be located on the bank of the Kafue river, close to Kitwe. Earlier studies showed this river to have an adequate flow of water for the mill's requirements. The selected location for the mill eliminates the requirement for any substantial investment in infrastructure. However, some costs may be incurred in extending the railway line into the site, improving the access from the main Kitwe-Ndola road, extending power lines to the site, and providing housing for key staff. For these purposes, a lump sum estimate of K 3 million has been included in the capital cost estimates.

Projected Sales Volume and Revenue

Year	Sales Volume			Sales Revenue		
	Exports	Domestic	Total	Exports	Domestic	Total
	(Thousand tons)			(US$ Million)		
1982	-	24.0	24.0	-	11.1	11.1
1983	3.4	28.6	32.0	1.2	13.3	14.5
1984	5.7	30.3	36.0	2.0	14.1	16.1
1985	5.9	32.1	38.0	2.1	14.9	17.0
1986	6.0	34.0	40.0	2.1	15.8	17.9
1987	3.9	36.1	40.0	1.4	16.8	18.2
1988	1.7	38.3	40.0	0.6	17.8	18.4
1989-2001	-	40.0	40.0	-	18.6	18.6

Project Costs

4. The total project cost, in 1977 prices, is estimated to be K 70.0 million (US$88 million).

5. Projected manufacturing costs per ton of paper produced, excluding depreciation, is summarized in the following table. These costs are based on operation at the full design production rate.

Manufacturing Cost at Full Capacity

Item	Amount (K/ton)	(US$/ton)	(%)
Wood	45.3	56.6	23.5
Chemicals	16.6	20.8	8.6
Other Operating Supplies	24.0	30.0	12.4
Fuel and Power	41.4	51.7	21.4
Labour	19.8	24.8	10.3
Administration & Overhead	45.9	57.4	23.8
Total	193.0	241.3	100.0

6. The wood costs are based on the projected delivered price of the various types of wood used, developed as follows:

Estimated Delivered Wood Cost to Pulp Mill

Type of Wood	Volume (m^3/A)	Price[1] (K/m^3)	Delivery K/m^3)	Total (K/m^3)	(US$/$m^3$)
Pine smallwood	135 000	5.0	6.0	11.0	13.7
Eucalyptus smallwood	20 000	3.0	6.0	9.0	11.3
Sawmill waste	40 000	3.5	-	3.5	4.4
Total	195 000			9.3	11.6

Financial Projections

7. Financial projections for rate of return calculations have been prepared in constant 1977 prices and are attached to this Annex as Table 1. These projections incorporate realistic assumptions concerning the rate of build-up to full production capacity, and for the cost of an expatriate start-up and training crew. The financial rate of return after taxes computed from these projections is 10.4%.

[1] The "price" represents stumpage for the smallwood (see Annex 4), and a transfer price based on fuel equivalent for the sawmill waste. An assumption implicit in this is that a new sawmill will be constructed adjacent to the proposed pulp mill.

Economic Rate of Return

8. In order to get an estimate of the economic internal rate of return of the project, the following adjustments to financial costs and benefits have been made:

(i) Foreign exchange costs[1] and benefits were estimated using a shadow exchange rate of US$ = K 0.9 instead of the official US$1 = K 0.8; and

(ii) Local labour[2] was shadow priced at 60% of the financial cost.

(iii) The pulpwood raw material was given a stumpage value[3] of zero as it has no alternative use.

9. On this basis, the economic rate of return from the pulp and paper mill project has been determined to be 11.7%.

1/ 100% of plant and expatriate assistance costs, 60% of infrastructure and conversion costs and 20% of wood costs.

2/ 13% of conversion costs and 17% of wood costs.

3/ or ex-sawmill value in the case of sawmill waste.

ANNEX 4
TABLE 1

CALCULATIONS OF STUMPAGE RATES - DIRECT COSTS

Basic data for per hectare model calculations

1. Costs

Direct costs (K)		Pine	Eucalyptus
Year 1	Establishment		
	Land clearing	200	200 (18 for replanting)
	Soil preparation	7	7
	Nursery (plant product)	17	10
	Planting	15	10
	Fertilizers	-	20
	Weeding (first year)	47	47
Total establishment (direct) costs		286	294 (112 for replanting)
Year 2	Weeding	45	11 (including a light pruning)
Year 3	Weeding	23	-
Year 5	Pruning I	10	- (see year 2)
Year 8	Pruning II	5	-
Year 11	Pruning III	10	-
Year 11	Thinning I	4(10)[1/]	-(10)[1/] (line thinning at year 5)
Year 14	Marking of Thinning II	3	1 (at year 8, not 14)
Year 19	Marking of Thinning III	2	-
Clearfelling at		year 25	12

1/ If smallwood is unsaleable.

ANNEX 4
TABLE 2

Stumpage rates - indirect costs may be divided into two categories:

(a) New (i.e. referring to new plantations only: 17.5 ha over whole 5-year Project period).

Item		Total Project cost (K'000)	Total average area involved (ha'000)	Average cost per ha p.a. during Project (K)
1.	Road construction	800	17.5	9
2.	Fire protection (new firebreaks and fire towers)	200	17.5	2
3.	Housing (additional)	2 256	17.5	26
			TOTAL	37

(b) Recurrent (i.e. referring to whole area of plantations: 23 000 + 3 500 = 26 500 ha before Project and 44 000 ha at end of Project, giving an average area of 35 000 ha over the whole Project period).

Item		Total Project cost (K'000)	Total average area involved (ha'000)	Average cost per ha p.a. during Project (K)
1.	Road maintenance	432	35	3
2.	Fire protection (recurrent)	740	35	4
3.	Administration	2 450	35	14
4.	Building maintenance	500	35	3
5.	Administrative vehicles and transport	818	35	5
6.	Surveys and training	200	35	1
			TOTAL	30

Indirect costs would be charged at the rate of K37 (for new plantations only) and K30 (for recurrent expenses for all plantations), i.e. a total of K67 per annum during the first five years (Project period), and at the rate of only K30 (recurrent) per annum thereafter.

ANNEX 4
TABLE 3

2. Yields (m^3/ha)

The following yields have been assumed:

(a) Pine

Operation	Age	*P. kesiya* Sawlogs	*P. kesiya* Smallwood	*P. kesiya* Total	*P. oocarpa* and others Sawlogs	*P. oocarpa* and others Smallwood	*P. oocarpa* and others Total	(60% P.K., 40% P.O.) Weighted average for Pine (all species) Sawlogs	Smallwood	Total
Thin I	11	30	40	70	20	30	50	26	36	62
Thin II	14	40	30	70	25	25	50	34	28	62
Thin III	19	40	20	60	30	20	50	36	20	56
Clearfell	25	120	30	150	100	25	125	112	28	140
TOTAL		230	120	350	175	100	275	208	112	320
MAI		(9.2)	(4.8)	14	(7)	(4)	11	(8.3)	(4.5)	12.8

(b) Eucalyptus

Operation	Age	*E. grandis* Sawlogs	*E. grandis* L.poles	*E. grandis* Smallw.	*E. grandis* Total	*E. cloeziana* and others Sawlogs	*E. cloeziana* and others L. poles	*E. cloeziana* and others Smallw.	*E. cloeziana* and others Total	(2/3 E.g., 1/3 E.c.) weighted average for Eucalyptus(all species) Sawlogs	L.poles	Smallw.	Total
Thin I	5	-	-	60	60	-	-	20	20	-	-	47	47
Thin II	8	30	20	30	80	20	20	20	60	27	20	27	74
Clearfell	12	100	30	30	160	50	30	20	100	83	30	27	140
TOTAL		130	50	120	300	70	50	60	180	110	50	101	261
MAI		(10.8)	(4.2)	(10)	25	(5.8)	(4.2)	(9.0)	15	(9.0)	(4.2)	(8.6)	21.8

ANNEX 4
TABLE 4

3. Stumpage rates

On the basis of the assumptions given above for costs and yields, the following stumpage rates have been calculated in order to give an IRR of 10 percent.

Rate (K/m^3)

Category	Pine		Eucalyptus	
	I. All produce saleable	II. Smallwood unsaleable	I. All produce saleable	II. Smallwood unsaleable
Sawlogs	18	22	6	8
Large poles	-	-	10	13
Smallwood	5	-	3	-

ANNEX 4
TABLE 5

STUMPAGE RATES - PINE, SAWLOGS AND SMALLWOOD (PER HECTARE - K)

Year		Direct Costs-K	Indirect Costs-K	Total Costs-K	Volume (m^3/ha) Sawlogs	Volume (m^3/ha) Smallwood	Revenue Sawlogs @K18/m^3	Revenue Smallwood @K5/m^3	Total Benefits	Net Benefits	FIRR -	FIRR 10% +
1	Establishment	286	67	353						(353)	353	
2	Weeding	45	67	112						(112)	101	
3		23	67	90						(90)	74	
4			67	67						(67)	50	
5	Pruning I	10	67	77						(77)	53	
6			30	30						(30)	19	
7			30	30						(30)	17	
8	Pruning II	5	30	35						(35)	18	
9			30	30						(30)	14	
10			30	30						(30)	13	
11	Thinning I and Pruning III	14	30	44	26	36	468	180	648	604		232
12			30	30						(30)	10	
13			30	30						(30)	10	
14	Thinning II	3	30	33	34	28	612	140	752	719		208
15			30	30						(30)	8	
16			30	30						(30)	7	
17			30	30						(30)	6	
18			30	30						(30)	6	
19	Thinning III	2	30	32	36	20	648	100	748	716		129
20			30	30						(30)	5	
21			30	30						(30)	4	
22			30	30						(30)	4	
23			30	30						(30)	4	
24			30	30						(30)	3	
25	Clearfelling		30	30	112	28	2 016	140	2 156	2 126		215
										TOTALS:	779	784

Conclusions: The stumpage rates for Pine should be about K18/m^3 for sawlogs and about K5/m^3 for smallwood assuming both are saleable.

STUMPAGE RATES - EUCALYPTUS (2/3 E.G., 1/3 E.C. & OTHERS.) - SAWLOGS, LARGE POLES AND SMALLWOOD

(per hectare - K)

Year		Direct Costs	Indirect Costs	Total Costs	Volume (m^3/ha) Sawlogs	L. poles	Smallwood	Revenue Sawlogs @K6/m^3	L. poles @K10/m^3	Smallwood @K3/km^3	Total Revenue	Net Benefits	FIRR 10% −	+
1	Establishment	304	67	371								(371)	371	
2	Weeding & Pruning	11	67	78								(78)	71	
3			67	67								(67)	55	
4			67	67								(67)	50	
5	Thinning I	-	67	67	-	-	47	-	-	141	141	74		51
6			30	30								(30)	19	
7			30	30								(30)	17	
8	Thinning II	1	30	31	27	20	27	162	200	81	443	412		211
9			30	30								(30)	14	
10			30	30								(30)	13	
11			30	30								(30)	12	
12	Clearfelling	-	30	30	83	30	27	498	300	81	879	849		297
13	Reestablishment	112	30	142								(142)	45	
14	Weeding & Pruning	11	30	41								(41)	12	
15			30	30								(30)	8	
16			30	30								(30)	7	
17	Thinning I	-	30	30	-	-	47	-	-	141	141	111		24
18			30	30								(30)	6	
19			30	30								(30)	5	
20	Thinning II	1	30	31	27	20	27	162	200	81	443	412		67
21			30	30								(30)	4	
22			30	30								(30)	4	
23			30	30								(30)	3	
24	Clearfelling	-	30	30	83	30	27	498	300	81	879	849		86
												TOTALS:	716	736

Conclusion: The stumpage rates for Eucalyptus should be about K6/m^3 for sawlogs, K10/m^3 for large poles and K3/m^3 for smallwood assuming all are saleable.

ANNEX 4
TABLE 6

ANNEX 4
TABLE 1

STUMPAGE RATE - PINE (60% P.K., 40% P.O. & OTHERS) - SAWLOG UTILIZATION ONLY

(Per hectare - K)

Year	Operation	Direct Costs	Indirect Costs	Total Costs	Volume of sawlogs m^3/ha	Revenue at K22/m^3	Net Benefits	FIRR - 10%	FIRR +
1	Establishment	286	67	353			(353)	353	
2	Weeding	45	67	112			(112)	102	
3		23	67	90			(90)	79	
4			67	67			(67)	50	
5	Pruning I	10	67	77			(77)	53	
6			30	30			(30)	19	
7			30	30			(30)	17	
8	Pruning II	5	30	35			(35)	18	
9			30	30			(30)	14	
10			30	30			(30)	13	
11	Thinning I & Pruning III	20	30	50	26	572	522		201
12			30	30			(30)	10	
13			30	30			(30)	10	
14	Thinning II	3	30	33	34	748	715		207
15			30	30			(30)	8	
16			30	30			(30)	7	
17			30	30			(30)	6	
18			30	30			(30)	6	
19	Thinning III	2	30	32	36	792	760		137
20			30	30			(30)	5	
21			30	30			(30)	4	
22			30	30			(30)	4	
23			30	30			(30)	4	
24			30	30			(30)	3	
25	Clearfelling		30	30	112	2464	2434		246
							TOTALS	785	791

Conclusion: The stumpage rate for pine sawlogs should be about K22/m^3 to produce an IRR of 10%, assuming smallwood is not saleable, but thinnings must be done as scheduled.

STUMPAGE RATE - EUCALYPTUS (2/3 E.G., 1/3 E.C. & OTHERS) - SAWLOG AND POLE UTILIZATION ONLY

(Per hectare - K)

Year		Direct Costs	Indirect Costs	Total Costs	Volume (m^3/ha) Sawlogs	Volume (m^3/ha) Large Poles	Revenue Sawlogs at K8/m^3	Revenue Large poles at K13/m^3	Total Revenue	Net Benefits	FIRR - 10%	FIRR +
1	Establishment	304	67	371						(371)	371	
2	Weeding & Pruning	11	67	78						(78)	71	
3			67	67						(67)	55	
4			67	67						(67)	59	
5	Thinning I	10	67	77						(77)	46	
6			30	30						(30)	19	
7			30	30						(30)	17	
8	Thinning II	1	30	31	27	20	216	260	476	445		228
9			30	30						(30)	14	
10			30	30						(30)	13	
11			30	30						(30)	12	
12	Clearfelling		30	30	83	30	664	390	1054	1024		358
13	Reestablishment		30	142						(142)	45	
14	Weeding & Pruning	11	30	41						(41)	12	
15			30	30						(30)	8	
16			30	30						(30)	7	
17	Thinning I	10	30	40						(40)	9	
18			30	30						(30)	6	
19			30	30						(30)	5	
20	Thinning II	1	30	31	27	20	216	260	476	445		73
21			30	30						(30)	4	
22			30	30						(30)	4	
23			30	30						(30)	3	
24	Clearfelling		30	30	83	30	664	390	1054	1024		114
										TOTAL	771	773

Conclusion: The stumpage rate for eucalyptus should be about K8/m^3 for sawlogs and K13/m^3 for large poles, to produce an IRR of 10%, assuming smallwood is not saleable, but thinnings must be done as scheduled.

ANNEX 4
TABLE 8