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**Report No. 7759**

**PROJECT COMPLETION REPORT**

**MALAWI**

**PHASE II OF NATIONAL RURAL DEVELOPMENT PROGRAM  
(WOOD ENERGY PROJECT)  
(CR. 992-MAI)**

**MAY 16, 1989**

**Agriculture Operations Division  
Southern Africa Department**

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## ABBREVIATIONS

CCDC	Capital City Development Corporation
CG	Central Government
ERR	Economic Rate of Return
ESU	Energy Studies Unit
FAO/CP	Food and Agricultural Organization/Cooperative Program
FD	Forestry Department
FRIM	Forestry Research Institute of Malawi
FRR	Financial Rate of Return
GOM	Government of Malawi
IDA	International Development Association
LA	Local Authority
MAI	Mean Annual Increment
MANR	Ministry of Agriculture and Natural Resources
MFNR	Ministry of Forestry and Natural Resources
MOWS	Ministry of Works and Supplies
NRDP	National Rural Development Program
RMEA	Regional Mission in Eastern Africa
WED	Wood Energy Division
SAR	Staff Appraisal Report
ICB	International Competitive Bidding
LCB	Local Competitive Bidding

THE WORLD BANK  
Washington, D.C. 20433  
U.S.A.

Office of Director-General  
Operations Evaluation

May 16, 1989

**MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT**

**SUBJECT: Project Completion Report on Malawi -- Wood Energy Project  
(Credit 992-MAL)**

Attached, for information, is a copy of the report entitled "Project Completion Report: Malawi--Phase II of National Rural Development Program (Wood Energy Project) (Credit 992-MAI)" prepared by the Africa Regional Office. No further evaluation of this project by the Operations Evaluation Department has been made.

Attachment

A handwritten signature in black ink, appearing to be 'R. P. ...', is written over the word 'Attachment'.

## PROJECT COMPLETION REPORT

## MALAWI

PHASE II OF NATIONAL RURAL DEVELOPMENT PROGRAM  
(WOOD ENERGY PROJECT)  
(Cr. 992-MAI)

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MAP : IBRD 14336R

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(Cr. 992-MAI)

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PREFACE

This is the Project Completion Report (PCR) for the NRDP II Wood Energy Project in Malawi, for which IDA approved on January 15, 1980 a Credit in the amount of US\$13.8 million. The Credit was declared effective on June 9, 1980. It closed on December 31, 1987 after three extensions totalling 24 months.

The PCR was prepared by FAO/CP and AF6AG staff, and is based on material prepared by the Wood Energy Division in Malawi, a study of project related documents and files, a two week field visit in April 1987, followed by a further one week field visit in January 1988.

The Project is the first Bank Group operation in the sector. Further Bank involvement in the wood energy sector in Malawi continues with the Second Wood Energy Project which was approved by the Board in March 1986.

The draft report has been read by the Operations Evaluation Department (OED), and copies were sent to the Borrower and its agencies for comment in February 1989. No comments were received.

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BASIC DATA SHEET

<u>Key Project Data</u>	<u>Appraisal Estimate</u>	<u>Actual</u>	<u>Actual as a % of Estimate</u>
Total Project Cost (US\$M)	16.3	16.4	101
Credit Amount	13.8	13.8	100
Amount Disbursed	13.8	13.8	100
Amount Cancelled		-	
Date Physical Components completed	06/30/85	06/30/85	
Proportion then completed	100%	100%	
Economic rate of return	14%	9.4%	
Financial rate of return	9.7%	7.4%	
Financial performance		Fair	
Institutional performance		Good	

Important Dates

First mention in Files	-	02/78
Appraisal	03/79	03-04/79
Negotiations	01/80	01/80
Board Approval	03/80	03/13/80
Signing of credit agreement	04/80	04/25/80
Effectiveness	07/25/80	06/09/80
Closing	12/31/85	12/31/87

Other Project Data

Borrower	:	Government of Malawi
Executing Agency	:	WED, MFNR
Fiscal Year GOM	:	April 1 - March 31
Name of Currency	:	Kwacha
Currency Exchange Rates	:	

1980 (Appraisal)	US\$1.00 = MK 0.812
1981	US\$1.00 = MK 0.895
1982	US\$1.00 = MK 1.055
1983	US\$1.00 = MK 1.175
1984	US\$1.00 = MK 1.413
1985	US\$1.00 = MK 1.172
1986	US\$1.00 = MK 1.861
1987	US\$1.00 = MK 2.243

Average for IDA disbursements US\$ 1.00 = MK 1.432

Follow-on Project : Second Wood Energy  
 Loan Number : Ln. 2570-MAI  
 Loan Amount : US\$M16.7  
 Date of Board Approval : 03/25/86

Cumulative Disbursements

	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Appraisal Estimate (US\$M)	2,400	5,800	9,000	11,400	13,200	13,800	13,800	13,800
Actual (US\$M)	925	3,254	6,109	7,699	9,085	9,883	11,162	13,800
Actual as % of Estimate	39	56	68	68	69	72	81	100

Date of final disbursement: 06/30/88

STAFF INPUTS  
(staff weeks)

	<u>FY74</u>	<u>FY75</u>	<u>FY76</u>	<u>FY77</u>	<u>FY78</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>	<u>TOTAL</u>
Preappraisal			.3		3.9	18.6	.9									21.7
Appraisal						28.2	18.2									46.4
Negotiations						.1	7.6									7.7
Supervision							5.5	12.1	8.0	9.3	6.9	2.1	4.9	15.1	7.5	69.3
Other					.1	3.4	.0	.8								4.3
Subtotal	.0	.0	.3	.0	4.0	48.2	32.2	12.9	8.0	9.3	6.9	2.1	4.9	15.1	7.5	149.4

Mission Data

	<u>Date (Mo/Yr)</u>	<u>No. of Persons</u>	<u>Mandays in Field</u>	<u>Specialization Represented (1)</u>	<u>Report Date</u>	<u>Performance Rating</u>
Ident.	02/78	1	4	d	02/03/78	-
Prep.	09/78	1	60	b	01/08/79	-
App.	03/79	3	63	a,a,b	02/08/80	-
Sup. I	06/80	2	14	a,b	07/10/80	1
Sup. II	10/80	2	18	a,b	11/21/80	2
Sup. III	06/81	2	20	a,b	09/02/81	2
Sup. IV	10/81	1	2	a	11/24/81	(2)
Sup. V	05/82	2	18	a,b	06/02/82	2
Sup. VI	11/82	2	14	a,b	12/15/82	2
Sup. VII	05/83	2	14	b,c	06/16/83	2
Sup. VIII	11/83	2	14	b,d	12/23/83	2
Sup. IX	04/84	1	3(3)	b	05/23/84	2
Sup. X	12/84	1	5(3)	b	02/12/85	1
Sup. XI	11/85	1	1(3)	b	01/29/86	1
Sup. XII	10/86	2	8(3)	a,b	12/08/86	2
Sup. (PCR)	04/87	2	17	a,a	04/27/87	2
Sup. (PCR)	02/88	1	7	a	02/26/88	2

- (1) a = economist; b = forester; c = agriculturalist; d = agric. economist  
 (2) Micro supervision while on other work; mission issued only BTO.  
 (3) Partial supervision combined with other mission work.

PROJECT COMPLETION REPORT

MALAWI

PHASE II OF NATIONAL RURAL DEVELOPMENT PROGRAM  
(WOOD ENERGY PROJECT)  
(Cr. 992-MAI)

EVALUATION SUMMARY

Objectives

1. The NRDP II (Wood Energy) Project was the first operation in the Malawi forestry sub-sector assisted by the Bank Group. The principal goals of the project were (a) to assist in the development of Malawi's forestry resource so as to permit a sustainable energy supply in the future without damaging the environment; (b) to improve forest management and conservation; and (c) to improve the institutional and economic framework required for forestry development. Major components of the project consisted of the establishment of retail nurseries and fuelwood/pole plantations, strengthening of the Wood Energy Division, and establishment of an Energy Studies Unit. The principal policy measure was an agreement by the Government to increase wood prices gradually, so that by the time project output was marketed wood prices would be at a level to ensure full cost recovery in project plantations.

Implementation Experience

2. The project's objectives have been partially achieved. The physical infrastructure of the nurseries was set up very rapidly and all the nurserymen were in post by the first year of the project. However, production and sales of seedlings lagged considerably behind the appraisal targets, which were highly unrealistic in view of the fact that retail nurseries were a new concept in Malawi. Although production in the nurseries improved steadily, and by the end of the project average production levels had reached the original estimates, seedling sales remained rather low. This was largely because the agreed increases in wood prices did not take place. Farmers proved to be reluctant to purchase seedlings because the low stumpage rate for fuelwood, combined with the easy access to free wood in the virtually unprotected and uncontrolled indigenous forest, greatly reduced their financial incentives to grow their own wood supply. The lack of extension services for the farmers compounded this problem. As a result, the total area planted under woodlots and volume of wood produced during the project is less than half that foreseen at appraisal.

## Results

3. The number of hectares established under the plantation component actually exceeded the appraisal target. However, wood yields are likely to be substantially lower than expected -- the average mean annual increment is about 4.7 m<sup>3</sup>/ha against a potential 10-14 m<sup>3</sup>/ha. This is partly due to poor planning - this was the first time that the Forestry Department had undertaken such a large fuelwood plantation program- which resulted in the establishment of plantations in unsuitable locations and with inappropriate species and provenances. In addition, insufficient attention was paid to tending and weeding in the first years after planting and inadequate fire protection was provided. While wood yields are low, the per hectare costs of establishing the Government plantations are high, due to heavy outlays on vehicles, staff housing, offices, roads and other infrastructure. The ultimate financial cost per cubic meter of wood produced by the FD is therefore very high - current data suggest a cost recovery stumpage rate about 8 times higher than the present stumpage rate. In addition to being a high cost producer, it is clear that the FD does not have the financial, managerial and staffing capacity to plant on the scale necessary to deal with the fuelwood deficit.

## Findings and Sustainability

4. In retrospect, given the inexperience of both the Bank and the Government in social forestry and fuelwood plantations it would have been better to have started with a pilot project. This might have avoided some of the mistakes such as establishment of nurseries and plantations in unsuitable locations, inappropriate seeds and provenances and inadequate maintenance of plantations. However, the project was successful in establishing institutions, preparing staff and developing public and political support for tree planting. The project created the WED and the ESU. A well trained, competent, experienced and dedicated staff is now in place. The project team managed to launch planting activities throughout the country, by motivating schools, villages and area action groups to plant trees. More generally, the project had an important impact on raising, nationwide, the consciousness for the emerging fuelwood crisis. The WED now has the capacity to conceive, prepare and implement the Second Wood Energy project with only marginal foreign assistance.

5. The project was not designed to deal with issues such as wood conservation, revenue collection and protection and management of natural forest. Although agreements on wood pricing were incorporated into the project design, in practice the Government did not implement this critical reform. However, throughout project implementation there was an on-going policy dialogue between the Bank and the FD, from which developed the long run strategy for the sub-sector. A gradual redefinition of the appropriate role of the Government in the forestry sub-sector has taken place, with more emphasis on creating a policy environment that encourages private production and conservation and less on direct production of wood by the FD. The lessons learned from the project have been incorporated into the design of the Second Wood Energy Project which aims to implement a comprehensive policy package designed to create incentives for private tree planting and wood conservation. Its most significant features are increases in fuelwood prices, expanded forest protection and revenue collection activities, and provision of incentive payments to small farmers for tree planting. Provision is made for only a limited amount of Government plantations in environmentally fragile areas.

# PROJECT COMPLETION REPORT

## MALAWI

### PHASE II OF NATIONAL RURAL DEVELOPMENT PROGRAM (WOOD ENERGY PROJECT) (Cr. 992-MAI)

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#### I. INTRODUCTION

1.01 The forestry sub-sector plays a vital role in the Malawian economy. The indigenous forest provides the rural population with poles for building and fuelwood for heating and cooking; the principal source of energy for urban households is fuelwood or charcoal, and, finally, the tobacco and tea industries, which represent Malawi's chief source of foreign exchange earnings, are critically dependent on large supplies of fuelwood for curing. Overall, firewood for domestic and industrial purposes represents over 85% of total energy consumed in the country. However, official statistics on the value of forestry products do not adequately reflect this contribution, because wood consumed for domestic purposes is free of charge, while the stumpage rate on commercial wood is extremely low and, in any case, rarely enforced.

1.02 Partly as a result of increasing population pressure, there is now a substantial gap between the demand for fuelwood and its sustainable supply. The deficit is being met by depletion of the natural forest which, if it continues unabated, would have major repercussions for the future wood supply and environmental balance of the country. At present it is unlikely that alternative energy sources would become available at prices the population in general could afford. There are no known deposits of oil or natural gas in Malawi. Imported fossil fuels are prohibitively expensive and a drain on scarce foreign exchange. Rural electrification is unlikely to materialise in the near future because of the high establishment costs, while solar energy and biogas are still at the experimental stage. Limited coal deposits of poor quality occur in the north of the country, but exploitation is at an early stage and transportation costs are likely to be excessive. Malawi can therefore be expected to remain dependent on the forestry sub-sector for much of its energy supply for the foreseeable future. In view of the current rapid depletion rate of the natural forest, the Government has placed priority on the development of a sustainable wood energy program to meet the future demand for fuelwood and building poles while at the same time conserving the indigenous forest and environment. Since the late seventies, the Government has sought assistance from the Bank in development of its forestry/wood energy strategy and financing of the investments needed to support the program.

1.03 The National Rural Development Program, Phase II (First Wood Energy) Project (Cr.992-MAI) was the first Bank Group assistance in the

Malawi forestry sub-sector. Since then, as part of SAL III, the Bank has also financed a Technical Assistance Project (Cr.1428-MAI, signed in January 1984), which included a provision (US\$1.4 million) for technical assistance to help improve the efficiency of tobacco curing technology and thereby reduce fuelwood consumption. In 1984, the Bank financed the Wood Industries Restructuring Project (Loan 2486-MAI US\$6.4 million) which is designed to further the rehabilitation of the wood processing industry and the conversion of the Forest Industries Department into a Wood Industries Corporation. In 1984, the Bank, together with the Forestry Department, prepared a forestry sub-sector study (Report No.4927-MAI) to assist the Malawi Government in laying the groundwork for the development of a forestry strategy and to identify the necessary policy actions and possible investments. In 1986, the Bank financed the Second Wood Energy Project (Ln.1670-MAI) as the second phase in the long term forestry-wood energy program. The experience and lessons learned from the first Wood Energy Project and the findings of the forestry sub-sector study were directly incorporated into the design of the second project. In 1987, IFC made a loan to the Vipha Plywoods and Allied Industries Ltd. (IFC Loan 872-MAI, US\$3.6 million).

1.04 The current project became effective on June 6, 1980. The Borrower was the Government of Malawi and the implementing agency was the Wood Energy Division (WED) in the Forestry Department (FD) of the then Ministry of Agriculture and Natural Resources (MANR). The Ministry was subsequently divided into the Ministry of Agriculture and the Ministry of Forestry and Natural Resources (MFNR). The principal objectives of the project were (a) to assist in the development of Malawi's forestry resource so as to strengthen its permanent energy resource base; (b) to improve forest management and conservation; and (c) to improve the institutional and economic framework required for forestry development. Major components of the project consisted of the establishment of retail nurseries and fuelwood and pole plantations, strengthening of the Wood Energy Division, establishment of an Energy Unit and pre-investment activities for NRDP III. Although the project got off to a somewhat slow start, the physical components were all completed satisfactorily by the original closing date, December 31, 1985. However, substantial funds remained undisbursed due to the marked appreciation of the dollar over the project period. At the request of the GOM, the closing date of the project was extended, first for a year, and then subsequently twice more, for six months each, to finance maintenance of the plantations, operation of the nurseries and the Wood Energy Division, replacement of vehicles, preparation for Phase II of the Wood Energy program and extension of the successful Pilot Energy Efficiency Project in tobacco curing. The project finally closed in December 1987, 24 months after the original closing date.

## II. PROJECT IDENTIFICATION, PREPARATION, APPRAISAL AND NEGOTIATIONS

2.01 In 1978, the Government of Malawi requested that the Bank consider financing the first phase of a long term forestry-wood energy program, aimed at reducing the imbalance between wood supply and demand, and hence reversing the trend toward the destruction of Malawi's forest resource. The potential for a wood energy project was first identified in February

1978, when a Bank mission visited Malawi to discuss with the Ministry of Agriculture and Natural Resources a rural forestry component of an unidentified agricultural project. The component, an energy project including fuelwood/pole plantations and a farmer tree grower program based on establishment of nurseries, along with various studies and strengthening of the Forestry Department, was initially conceived as an integral part of the ongoing National Rural Development Program. However, in view of the innovative nature of the proposals and consequent high risk, together with the probable size of the component, it was subsequently agreed between the Government and the Bank to have a separate wood energy project rather than a forestry component of a larger agricultural project. Following the Bank mission, a national team of senior officers from the MANR was convened to prepare a Forestry Sector Background report with emphasis on the supply/demand for fuelwood and poles, in accordance with terms of reference left by the Bank. A forestry consultant with the FAO/World Bank Cooperative Program visited Malawi in May and June 1978, to assist in the preparation of the report, which served as the basis to prepare the project. The FAO/CP consultant returned to Malawi in September/October 1978 to assist the MANR in the completion of the Project Preparation Report which was finalized in January 1979. The World Bank's Regional Mission in Eastern Africa (RMEA) provided support and guidance to the MANR during identification and preparation of the project.

2.02 The appraisal mission took place in March/April 1979, when a three man mission spent about three weeks in the field. While the overall design of the project remained essentially the same, the appraisal team did introduce a few modifications. The preparation report had recommended that Gmelina species should be planted in all the individual woodlots since this species is more resistant to termite attacks than Eucalyptus and treatment of planted Eucalyptus with aldrin was believed to pose a health risk. However, the mission recommended the planting of Eucalyptus, since Gmelina has a much lower growth rate and a much lower heating value. The mission also recommended that treatment with aldrin be confined to the nurseries, which is a method widely used in other countries. The Government accepted these recommendations.

2.03 The area for the fuelwood and pole plantations (11,400 ha) was accepted as presented in the preparation report. However, the figure for the total area to be planted under individual woodlots (31,600 ha) was found to be too ambitious, as it was based on an assumed planting density of 1500 trees/ha, while the mission believed that a planting density of 2,500 trees/ha would be more likely. The mission estimated that around 15,000 ha of individual woodlots would be established over the five year period. While the plantation component represented the bulk of project costs, the appraisal mission emphasized that the long run achievement of the project depended largely on its success in encouraging households, who are the largest consumers of wood, to grow their own wood. The vast majority of households are too poor to pay the full cost of plantation wood (which would therefore have to be mainly for commercial purposes) nor are there other cheap energy sources available to them. The mission concluded that the most important contribution of the project would be in promoting the establishment of wood lots by small farmers so that they could be self-sufficient in fuelwood in the future.

2.04 The mission also recommended the inclusion under the project of an Energy Studies Unit that would investigate not only more efficient use of wood energy but also alternative sources of energy such as bio-gas and solar energy. An energy economist from the Bank visited Malawi briefly in May 1979 to appraise in detail this component. A final change in the project resulting from the appraisal was the decision to include funds to finance about 1,500 ha of fuelwood plantations by the Capital City Development Corporation (CCDC).

2.05 The project was negotiated in January 1980 and with only minor modifications was accepted as presented by the appraisal mission. Three main issues had emerged during appraisal of the project. First, the mission was concerned about the availability of land for the FD and urban and rural council plantations. It was agreed at negotiations that the written approval of the traditional authorities, and the payment of compensation where applicable, should be a condition of disbursement for each plantation component. Second, calculations by the mission suggested that the current stumpage rate was considerably below the level required for full cost recovery. Assurances were obtained during negotiations that a charge system reflecting the principle of cost recovery would be enforced gradually so that, by the time the project output was marketed, a price level that ensured the full recovery of production costs would have been reached. Assurances were also obtained that the Government and IDA would consult annually on the general pricing policy affecting the forestry sub-sector, giving due regard to social considerations and the impact a price increase would have on the major users of fuelwood. The third issue concerned the revenue from the district and town council plantations. It was agreed that the revenue would be remitted by the respective councils to the Central Government and thus accrue to the national budget. However, assurances were obtained during negotiations that the Government would provide, following consultation with the Bank, financial incentives to the councils, by remitting to them a percentage of the revenues.

2.06 The principal goal of the project is to assist in the development of Malawi's forestry resource so as to permit a sustainable energy supply in the future while conserving Malawi's natural forests and the environment. The project as negotiated consisted of:

- (a) establishment and management by the Wood Energy Division of a national network of 88 nurseries which would produce seedlings for sale to the public who would be encouraged to grow woodlots to meet their domestic needs for fuelwood and poles;
- (b) establishment and operation of plantations to produce and sell fuelwood and poles for commercial and industrial use; specifically (i) about 3,000 hectares by the Forestry Department; (ii) about 1,500 hectares by CCDC and (iii) about 300 hectares by each of five District Councils and three Town Councils;
- (c) strengthening of the Wood Energy Division within the Forestry Department through the appointment of key staff;

- (d) studies of improved methods of charcoal production and marketing to be carried out by the WED;
- (e) establishment and staffing of the Energy Studies Unit within the Planning Department of MANR to carry out studies of possibilities to reduce wood consumption through more efficient utilization and development of alternative energy sources; and
- (f) financing of pre-investment activities for NRDP III.

2.07 The estimated total cost of the Project was US\$16.3 million, comprising US\$1.5 million for nurseries, US\$6.8 million for Government plantations, US\$1.1 million for local authority plantations, US\$1.2 million for CCDC plantations, US\$3.7 million for the WED, US\$0.2 for charcoal trials, US\$1.3 for the Energy Studies Unit and US\$0.5 for the NRDP III Pre-Investment Study. The IDA credit of US\$13.8 million financed 85 percent of project costs, with the remaining 15 percent financed by the GOM.

2.08 Processing of the credit proceeded smoothly and rapidly as there were no special conditions for board presentation or project effectiveness. The credit was approved by the Board on March 13, 1980; the credit agreement was signed on April 25, 1980 and the project became effective on June 9, 1980.

### III. IMPLEMENTATION AND OPERATING PERFORMANCE

#### A. Implementation and Performance of Project Components

##### a. Retail Nurseries

3.01 The Project provided for the establishment of 88 permanent retail nurseries. Details on nursery establishment, seedling production and distribution are given in Annex 1, Table 1. Construction of 80 of the permanent nurseries was achieved during the first year of the project and the remainder completed in financial year 1984/85. In addition, 10 temporary nurseries were set up during the 1982/83 planting season. <sup>1</sup>

3.02 While the physical infrastructure of the nurseries was set up very rapidly and all the nurserymen were in post by the first year of the project, production and sales lagged considerably behind appraisal targets. During successive supervisions, it became apparent that the

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<sup>1</sup>/These were not originally contemplated in the SAR as it was expected that hired transport from the Plant Vehicle Hire Organization (PVHO) would solve the problem of seedling distribution to remoter areas. However, during the project it was realized that PVHO vehicles were not always available at the time of the seedling distribution campaign, and it was therefore decided to establish 10 temporary nurseries to meet the growing demand for seedlings in areas away from the existing permanent nurseries.

original estimate of 100,000 seedlings produced per nursery, per annum, from year one of the project, was much too ambitious, and the targets were revised accordingly. Specific problems identified during supervisions included lack of adequate transportation, and late procurement of inputs such as seed, polythene tubes and fertilizers. In fact, production improved steadily during the project as the FD gained experience and, by 1985/86, average annual production from the nurseries had reached the appraisal targets. A total of about 13.4 million seedlings were produced for the 1986/87 planting season, exceeding the targets by 68%. A further positive development was the gradual decline in the seedling death rate during the project, from around 20% at the beginning to 7.5% by 1986/87. Reflecting both these factors, the average production cost of seedlings declined drastically over the project period, from 35.5 tambala per seedling in 1980/81 to 3.3 tambala in 1986/87 (see Annex I, Table 2).

3.03 A more fundamental issue, however, was the low percentage of seedlings produced that was actually sold, resulting in substantial carry-over of stock from one year to the next. Part of the explanation again relates to the inexperience of the WED in this type of operation, which led to a host of minor teething problems, such as inadequate publicity, particularly at the beginning, delayed seedling distribution due to lack or breakdown of vehicles, distribution of seedlings to selling points where demand had been poorly assessed and experiments with new species not yet accepted by farmers. However, although sales did improve substantially over the life of the project, as many of these minor problems were ironed out, sales were still at only 69% of production by the seventh year of the project. During the course of Bank supervision, several more fundamental design flaws underlying the disappointing sales rate were identified:

- (i) Inappropriate Location of Nurseries. The location of nurseries was not based on a thorough supply and demand analysis that identified wood deficiency areas, nor was any prior assessment of the accessibility of the sites made. Consequently there was very substantial variation in sales levels across nurseries, with some nurseries selling less than 5,000 seedlings per annum. Closing such nurseries proved to be impossible in the face of major local political resistance.
- (ii) Lack of Extension Services. As originally conceived in the SAR, the bulk of the extension work was to be carried out by the nurserymen, together with some support from the WED and the agricultural extension service of MANR. It was envisaged that the nurserymen would devote about half of their time to advising farmers on planting and tending techniques, with special attention to choice of species, site preparation, planting distance, planting seasons, protection against termites, browsing animals and fire, and weeding. In practice, the nurserymen had neither the time nor the training to provide extension

services to the farmers. At the suggestion of a Bank supervision mission, a committee was formed in late 1982 to work on the design of an extension system for treeplanting. Detailed terms of reference were left for the committee by the mission. On subsequent supervision missions, a fair amount of technical assistance was provided by discussing with the Project management, in some depth, organizational options in extension. However, despite these initiatives, there was little or no progress during the project in setting up a system for forestry extension services, largely because there was no agreement on whether foresters should be fully integrated into the existing Agricultural Extension Service or whether a separate parallel system should be set up for forestry.

- (iii) Lack of Incentives for Tree-Planting. Earlier supervision missions placed a great deal of emphasis on the issue of inadequate extension. Later supervision missions, drawing also on the findings of the sub-sector study, concluded that planting for fuelwood was unpopular with small farmers largely because of low producer prices for fuelwood and the availability of free wood in the virtually uncontrolled and unprotected natural forests. Planting trees was found to be well accepted and practiced where there existed a nearby cash market for poles, suggesting that the problem was not that farmers did not know how to grow trees, but that they did not find it financially attractive to grow trees for fuelwood. Raising the stumpage rate alone would not help as the stumpage rates could not be enforced under the existing very weak revenue collection system.

3.04 An issue that surfaced repeatedly during supervisions was the appropriate price level for sale of the seedlings. The intention in the SAR was that there should be full cost recovery through sales. This was soon realised to be impossible, as during the 1980/81 planting season production cost was 35.5 tambala per seedling as against a selling price of 2.5 tambala and, even so, sales were poor. In the second and subsequent years, the concept of cost recovery was dropped in favour of low prices to encourage farmers' demand and the price of seedlings was lowered to 1 tambala. In 1982/83, differential pricing was introduced, with the price set at 1 tambala for smallholders and 3 tambala for estates, the objective being to reduce unnecessary subsidies to estates. This differential continued and increased in 1983/84 when the price to estates reached 10 tambala per seedling. However, the experiment was not a success as it caused considerable confusion to the nurserymen and apparently was evaded by many estates who sent their tenants to collect seedlings at the lower rate. The price differentiation was abandoned in the 1984/85 campaign and a uniform selling price of 1 tambala per seedling was established. As a consequence of the increasing productivity of the nurseries, and increasing sales rate, the unit cost of sales has gradually declined during the

project period, reaching 3.3 tambala during the 1985/87 selling campaign (see Annex I, Table 2). This suggests that, given further improvement in the sales rate, it should be possible to sell seedlings at a price small farmers can afford and yet keep subsidies to a minimum.

3.05 Record keeping by the nurserymen has generally been rather poor. Records on seedlings distribution by users were maintained only during the 1981/82 and 1982/83 planting seasons and then were discontinued. According to this early data, it seems that, on average, small farmers represented about 50%, followed by estates (24%), communities and institutions (12%), large scale private farmers (8%), and Government (6%). Monitoring of the seedling survival rate after sales was carried out only to a very limited extent. The FD had produced standard forms for reporting survival rates, but the use of these forms by nurserymen never caught on and has been discontinued. Monitoring appeared to be on an ad hoc basis, according to the interest and time available by ADD staff involved. The Forestry Extension Officer from Salima ADD estimated mortality at 14% in 1982 and 20% in 1983. Blantyre and Karonga ADDs produced mortality figures of 20-30% for 1984. Finally, Chipita reported a good survival rate with only 15% mortality. Failures were attributed to moisture, stress, termites, fire and livestock.

3.06 In retrospect, given the innovative character of the nursery component, a pilot operation would have been more appropriate. This would have allowed the FD to gain experience in operating this type of component and permitted greater flexibility. Under a pilot scheme, it would have been possible to test different ways to provide extension services. Also, surveys should have been carried out to identify key wood deficit areas and farmer attitudes to tree planting so that nurseries would be located in the most receptive areas. More fundamentally, the disappointing experience with respect to sales demonstrated that the success of the nursery program is critically dependent on changes in the policy environment to create financial incentives for small farmers to plant trees.

#### b. Forestry Department Plantations

3.07 A total of 9,000 ha of fuelwood and pole Eucalyptus plantations, equally distributed among the three districts of Blantyre, Lilongwe and Zomba, were to be established under the Project. This target was actually exceeded, as a total of about 9,300 ha of plantations were actually established by the end of the 1985/86 seasons. Furthermore, as mentioned in paragraph 3.12, some additional 1,580 ha in Dowa district that were to have been planted by CDCC were also established under the Central Government plantation program. Details concerning the location and phasing of implementation of this component are given in Annex I, Table 4. Details on the various species planted are presented in Annex I, Table 5.

3.08 Apart from some minor changes during project implementation, construction work and purchases of plant and vehicles were executed as foreseen at appraisal. As indicated in Annex I, Table 6, 51 houses (11 type D, 26 type E and 14 Type F) were built, as well as 301 traditional houses, 5 office blocks, 8 store-rooms, 3 workshop/garages and 10 other small buildings housing generators, water tanks and/or water pumps. Purchases of plant and vehicles, before replacement, included 4 pickups, 4

seven-ton lorries, 4 tractors with trailers, 12 motorcycles and 4 generators (Table 7). As indicated in Table 8, a total of 228 km of roads have also been constructed under the project.

3.09 Although the Government plantation component got off to a somewhat slow start, largely because of delays in the civil works constructed by the Ministry of Works and Supplies, the appraisal target for hectares established was slightly exceeded by the original closing date of the project (December 1985). However, yields from the plantations are very low. A survey carried out in 1987 by the Forestry Department and the Forestry Research Institute of Malawi suggest that the average mean annual increment is around 4.7 m<sup>3</sup>/hectare/annum, compared to a potential 10-15 m<sup>3</sup>/ha/annum estimated in the SAR (see Annex V). In some extreme cases the MAI of the plantations is lower than that of the unimproved miombo woodland cleared from the site. This was partly due to poor planning - this was the first time that the Forestry Department had undertaken such a large fuelwood plantation program - which resulted in the establishment of plantations in unsuitable locations and with inappropriate species and provenances. However, bad management also played a role. Several supervision missions drew attention to the rather low quality of maintenance of the plantations, especially those established in the latter years of the project. The primary maintenance operations, after establishment, include fire protection measures, line screenings, grass cutting and weeding. These operations were not always accomplished at the right time, and in some cases were completely neglected. As a result there is a high fire risk in some of the plantations. Clearly, the low wood yields have a detrimental effect on the financial and economic returns to the plantations (see paras 4.06 and 4.07).

3.10 While wood yields are low, the per hectare costs of establishing the Government plantations are high, due to heavy outlays on vehicles, staff housing, offices, roads and other infrastructure. The ultimate cost of the wood produced by the Forestry Department is therefore extremely high. The cost for Eucalyptus wood from the project is estimated to be about MK21.9 per stacked cubic metre of wood, in 1986/87 prices, (see Chapter IV and tables 1 and 2 in Annex III for calculation details). This cost is about 8 times higher than the 1987 stumpage rate of MK2.70 per stacked cubic metre, despite the pricing covenant agreed in the Credit Agreement. An additional problem identified during supervision was the very high variation in the establishment costs of plantations between the regions that appeared to be largely due to differences in the quality of management and supervision.

#### c. CCDC plantations

3.11 It was envisaged at appraisal that CCDC would utilise some of the land within the designated boundaries of the Capital City for the establishment of 1,500 ha of plantations for fuelwood and pole production. This was intended to meet the ever increasing demand for wood from the commercial and industrial sectors, as well as from urban dwellers. It was agreed at negotiations that the funds would be lent by the Government to CCDC at an interest rate of not less than 10% repayable over 30 years, including a grace period of nine years. The execution of a subsidiary loan agreement, acceptable to IDA, between the Government and CCDC, was a

condition of disbursement for the CCDC plantations. However, CCDC and the Government were unable to agree on the terms of a subsidiary loan agreement. CCDC claimed not to have been fully consulted before the negotiation of the project between GOM and IDA, and decided that it could not afford to participate in the project on the terms originally agreed to at negotiations (i.e., by borrowing funds at 10% interest). An additional problem was that the land to be used was fairly heavily settled. The costs of compensation and resettlement had been substantially underestimated and CCDC did not feel able to bear these costs which had not been included in the loan package.

3.12 As a consequence, GOM requested the World Bank to approve utilising the funds available for this component to finance the establishment, by the FD, of a fuelwood and pole plantation about 60 miles outside Lilongwe in forest reserves in the Dowa district. After the Bank's approval in 1981, the establishment of this plantation started with the 1982/83 planting season, and was completed by 1984/85 (see Annex I, Table 4).

#### d. Local Authority Plantations

3.13 The project provided for the establishment of 8 plantations of 300 ha each for fuelwood and pole production (5 in rural areas in Karonga, Lilongwe, Kasungu, Blantyre and Zomba; and 3 in urban areas of Karonga, Kasungu and Zomba). In physical terms, all have been successfully implemented, reaching a total coverage of about 2,710 ha by 1985/86, as against 2,400 ha estimated at appraisal. <sup>2</sup> Details of regional and district distribution, as well as phasing of implementation of this component, are given in Annex I, Table 3.

3.14 During implementation of the project, building construction and purchase of plant and vehicles were executed as foreseen at appraisal. As indicated in Annex I, Tables 6 and 7, 12 houses (3 type D and 9 type E), 54 traditional houses and 21 store-rooms were built, and a total of 13 motorcycles (before replacement) purchased. Furthermore, 47.5 km of roads were also constructed under the project (see Annex I, Table 8).

3.15 The original plan in the SAR was that the respective District and Town Councils would be responsible for the implementation of this component and the FD would allocate funds to them for that purpose. However, in view of the fact that Local Authorities had no expertise or desire to carry out the necessary implementation program, and also because the WED felt that control of funds allocated to the councils would be difficult and disbursement and accounting procedures complicated by council's use of funds, it was agreed to transfer responsibility for project execution to the FD. The intent was that the Local Authorities would take back the responsibility for maintenance and operation of the plantation later on. To date, this has not happened and the LA plantations still remain under the responsibility of the FD. However, the Forestry Support Services Division within the FD is currently preparing a management plan and cost

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<sup>2/</sup> As mentioned in Para 3.16, this figure includes 147 ha in Nkata Bay District which was added during the project.

estimates to maintain the plantations. This will be sent to the Ministry of Local Government for review and a final decision is expected before the end of 1988.

3.16 Likoma and Chizumulu Plantation. In 1981/82, GOM asked the FD to carry out a survey on fuelwood availability and needs on the two islands of Likoma and Chizumulu within the district of Nkata Bay. The survey found a severe fuelwood shortage in the islands which was met by importation of wood from adjacent Mozambique. The matter was discussed during a World Bank supervision mission in November 1982 and the FD was asked to formulate a proposal to be included under the project. The proposal for the establishment of 147 hectares of fuelwood and pole plantation was accepted by the Bank and planting started in 1983/84 and was completed in 1985/86.

e. Wood Energy Division

3.17 The Wood Energy Division was established within the FD to be directly responsible for Project implementation and to direct, coordinate and control all matters relating to wood energy. Adequate staffing was a serious problem in the first few years of the project both at headquarters and in the field. Although at headquarters most vacancies were in middle-level administrative positions, vacancies at the managerial level, such as the key position of the Senior Planning and Extension Officer, hampered efficient implementation of the project. In the field, there were large numbers of vacancies at the forester and forest ranger levels. However, by the end of the project substantial progress on staffing had been made, with most of the posts foreseen at appraisal filled (see Annex I, Table 9).

f. Energy Studies Unit

3.18 The Energy Studies Unit, like the WED, was in the MANR at the beginning of the project. When the MANR split into two ministries, the Energy Studies Unit initially remained in the Planning Division of the MOA, while the WED went to MNFR. Later, however, the ESU was moved to the WED to promote close coordination between the ESU work program and other project activities. Expenditures under this component were higher than those estimated at appraisal, mainly because of the costs of the expatriate consultant who headed the Unit for the first four years. Overall, the performance of the Unit was mixed. Early supervision missions found the initial work program overly oriented towards theoretical and exploratory work (such as in-depth surveys on selected topics) rather than toward carrying out practical experiments, as was also originally intended. Another problem was that staffing of the unit with Malawians was rather slow.

3.19 In the first few years, the Unit carried out a survey of small farmers' use of energy, followed by a national survey of smallholder knowledge, attitudes and practise with respect to tree planting. The latter found that, in general, farmers do know how to grow trees and do so when it is financially attractive, for example, where there is a good market for poles. By the time of the mid-term review of the Project (June 1983), the supervision mission had some concerns about the role of the Unit. As stated in the SAR, the ESU was assigned to carry out a variety of studies required for planning of possible future wood energy projects,

including (i) investigating the reduction of wood consumption through developing designs and fabrication techniques for cooking stoves, large scale wood combustion devices such as tobacco curing barns, biogas units and solar heaters, and (ii) collecting data on traditional tree harvesting systems and their effects on forest yields, on the relationship between deforestation and agricultural productivity, and on traditional cooking practices. While the mission recognized this list probably exceeded the capacity of such a unit, it felt the actual activities - essentially the carrying out of studies based on rural household surveys - were too limited. The mission recommended that the ESU play a more important role in formulating a wood based energy policy, and providing the necessary data for wood energy related investments. Based on the mission's suggestions, the ESU prepared a work program which was reviewed and approved by the Bank. Subsequent supervision missions found the work of the Unit more focused and relevant.

3.20 In retrospect, it is clear that the catalogue of activities planned in the SAR was too ambitious for a small new unit. However, by the end of the project period, the ESU was fully staffed with Malawians (including the head of the unit), several of whom had been on study leave overseas and who represented a well trained and competent group. The ESU is now capable of contributing to the formulation of a wood based energy policy, and carrying out studies, surveys and data collection as necessary to support wood energy related investments such as the Second Wood Project.

g. Charcoal trials

3.21 Provision was made available under the credit for the Wood Energy Division to carry out charcoal trials to identify more efficient methods of charcoal production and investigations into marketing and consumer acceptance of charcoal. The WED, together with the ESU, undertook trials on a small scale comparing the efficiency of three kiln technologies - traditional earth pit kilns, imported portable steel kilns and locally made brick kilns. They found that the traditional earth kilns were very wasteful while the steel kilns were very expensive, and required fairly intensive and sophisticated management that was unlikely to be widely available in Malawi. Brick kilns appeared to offer the best solution, being more efficient than the earth pits and cheaper and simpler to operate than the steel kilns. These results, and some preliminary findings concerning the potential industrial and urban household markets for charcoal, formed the basis for the design of the Pilot Charcoal Production Component of the Second Wood Energy Project.

h. NRDP III Pre-investment

3.22 The purpose of this component was to ensure the uninterrupted execution of successive rural development projects within the National Rural Development Program through creating continuity between project planning and project implementation by appointing key project staff, collecting additional base-line data and providing in-service training of planning and management staff. Of the US\$400,000 allocated to this component under the credit agreement, about US\$260,000 was spent, mostly on housing and office construction in Lilongwe Northeast and Dedza Hills.

## B. Costs, Financing and Disbursements

3.23 Costs. Total project costs were estimated at US\$ 16.3 million. By the original closing date of the project (December 1985), all the physical components of the project had been completed satisfactorily but at a total cost of only around US\$ 11.5 million (70% of SAR estimate). This substantial cost underrun was primarily due to currency realignments over the project period, specifically the dramatic appreciation of the dollar against all major currencies. At the request of the Government, the closing date of the project was extended, first for a year, and then subsequently twice more, for six months each. During the extension, project funds were used to finance maintenance of the plantations, operation of the nurseries and the WED, construction of new headquarters for the Forestry Department, replacement of vehicles, preparation for Phase II of the Wood Energy Program (including procurement of vehicles, studies, short term consultancies and a project implementation workshop) and extension of the successful Pilot Energy Efficiency Project in tobacco curing.<sup>3</sup> The Credit closed on December 31, 1987, with total costs of US\$16.4 million. Summary cost data are presented in Annex II, Tables 1 and 3; detailed cost tables can be found in Annex IV.

3.24 Financing. According to the SAR, the Government would finance 15% of project costs and IDA 85%. Actual financing by the GOM represented 14.9% of total costs (Annex II, Table 4b).

3.25 Disbursements. Disbursements averaged around 68% of appraisal estimates for most of the project period. Disbursements were initially slower than expected because of delays in civil works constructed by the MOWS and the delay in establishing some plantations caused by the withdrawal of CCDC. By the original closing date (December 1985) of the project, all the physical components of the project had been completed on schedule but only 72% of the credit had been disbursed, mainly because of the very marked appreciation of the dollar during the project period. The Credit was extended three times for a total of two years, finally closing on December 31, 1987. The entire credit of US\$13.3 million was disbursed by June 30, 1988. Details on disbursements are in Annex II, Tables 4 & 5.

## C. Procurement

3.26 Procurement for goods and services has been in accordance with Bank Group procurement guidelines. Plant and vehicles were procured under ICB during the first year of the project. Preparation of bidding documents and evaluation of the bids were undertaken by the WED in a competent and timely manner with no significant problems or delays. A comparison between appraisal estimates of unit costs and the actual unit costs shows that,

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<sup>3</sup>/Research trials under the Tobacco Energy Conservation Project have demonstrated that wood consumption can be reduced from an average of 42 stacked m<sup>3</sup> per ton of tobacco cured to between 10-15 stacked m<sup>3</sup> per ton by utilizing an improved furnace and better management and curing techniques. The main focus of the program is now directed to disseminating the research findings and training estate managers, furnace builders and furnace stokers/operators in the new techniques.

with one or two exceptions, the bids were close to estimates. Overall, averaging out under and over estimates, total expenditure for vehicles and equipment was within appraisal estimates. Small items of machinery and equipment, as well as material (such as seed and fertilizer) were procured under LCB, using procedures acceptable to the Bank. Building construction works in areas such as Lilongwe were tendered on the basis of LCB and successfully executed. Other buildings which, due to their small size and scattered locations, were not suitable for LCB were constructed under force account of the Ministry of Works and Supplies (MOWS), or the FD. While the housing constructed by the FD was accomplished without problems, delays in completion were experienced in some areas for buildings constructed by the MOWS. These delays were partly due to tardiness in preparation of site plans by the FD and partly because the MOWS was thoroughly overburdened with commitments. In 1987, additional vehicles required to replace worn out vehicles under Wood Energy I and start-up vehicles for Wood Energy II were procured successfully through ICB.

#### D. Adherence to Covenants

3.27 Stumpage Rates: As stated in the credit agreement, the Government recognized that wood prices, to the extent that they are determined by the Government, should be fixed at such levels as would promote a more efficient use of wood, stimulate further forestry development and preserve forests on public and customary lands, while giving due regard to social considerations and to the impact that prices would have on the major users of fuelwood. Consistent with these objectives, the Government agreed to take action to increase wood prices gradually so that by the time the wood produced under the project is marketed, wood prices would be at a level to ensure full cost recovery in project plantations. It was further agreed that the Government and IDA would consult annually on general pricing policy affecting forestry products.

3.28 In practice, there was little attempt by the Government to comply with this covenant. At the beginning of the project, the stumpage rate was MK 0.25/stacked cubic yard (equivalent to MK 0.33/stacked cubic meter). During the project period the stumpage rate was raised twice, first to MK 0.50/stacked cubic yard, (MK 0.66/stacked cubic meter) and then to MK1.80/stacked cubic meter. In March 1986, the stumpage rate was raised 50%, to MK2.70/stacked cubic meter, to comply with the conditions for board presentation of the Second Wood Energy Project. However, actual costs data from the plantations imply a cost recovery stumpage rate of about MK21.9/stacked cubic meter in 1986/87 prices (see Annex III, Table 2). Hence wood prices are still very far from full cost recovery levels.

3.29 In retrospect, the clause about giving due regard to social considerations and the impact of price increase on users allowed the Government to put off taking action with respect to wood prices which would clearly be unpopular and painful in the short run but which is absolutely critical for the success of the future wood energy program. Wood pricing was a major issue during negotiations of the Second Wood Energy Project and, in this case, the covenant was made stronger and more specific in terms of timing and did not include a "let-out" clause on social grounds.

3.30 Revenue Sharing with Local Authorities: It was agreed at negotiations that an agreement would be made between the Local Authorities and FD on sharing of revenues from forestry products, by not later than December 31, 1980. This agreement proved difficult to reach. The Ministry of Local Government apparently felt that if the plantations are to be considered town and district council plantations, most, if not all, of the revenues should accrue to these councils. However, the intention of Treasury and the Bank had always been that the bulk of the revenue would accrue to the central budget, while allowing the local authorities to keep a small portion as a financial incentive to maintain the plantations. Although this issue was raised repeatedly by early supervision missions, it was decided only recently that the revenue share to be allocated to the Local Authorities would be set at 20%.

3.31 All other covenants were complied with satisfactorily.

#### E. Auditing and Reporting

3.32 The WED prepared progress reports on the Project every six months, based on an outline suggested by the first supervision mission. These reports were generally thorough and satisfactory, although occasionally not actually completed until some months after the period covered. Assurances were obtained at negotiations that all Project accounts, including statements of expenditures, would be audited by independent auditors and that the audited accounts, together with the auditors report, would be submitted to IDA not later than six months following the end of the fiscal year. In practice, although the accounts and the audit report were always satisfactory, they were sometimes overdue by up to as much as nine months. However, the trend would appear to be towards improvement, with the latest audit, for the 1986/87 fiscal year, submitted on time.

### IV. PROJECT IMPACT

#### A. Wood Production

4.01 The total area planted and estimates of wood produced under the project are summarized below; details can be found in Annex III, Table 1.

<u>Component</u>	<u>Area planted (ha)</u>	<u>SAR estimate (ha)</u>	<u>Output ('000 m<sup>3</sup> solid)</u>	<u>SAR estimate ('000 m<sup>3</sup> solid)</u>
LA plantations	2,710	2,400	401.6	998
CG plantations	10,900	10,500**	1,615.4	4,368
Woodlots	<u>7,218*</u>	<u>15,000</u>	<u>1,028.3</u>	<u>4,320</u>
<b>TOTAL</b>	<b>20,828</b>	<b>27,900</b>	<b>3,045.3</b>	<b>9,686</b>

\* Hectares of woodlots planted estimated by dividing the number of seedlings sold or issued free (see Annex I, Table 2) by 2,500, the assumed planting density per hectare.

\*\* 9,000 ha of central Government plantations plus 1,500 ha of CCDC plantations actually established by central Government.

4.02 Plantations. The areas planted under the LA and CG plantation components slightly exceeded the SAR estimates. However, ultimate output of wood, in solid cubic metres, is estimated at only just over one-third of appraisal estimates. The SAR assumed four coppice rotations of eight years each, with an MAI of 15 m<sup>3</sup>/ha during the first two rotations, 12 m<sup>3</sup>/ha during the third and 10 m<sup>3</sup>/ha during the last rotation. The SAR emphasized that these expected yields were tentative and would have to be revised, when more accurate information became available. A preliminary evaluation of yields in the plantations was undertaken during the appraisal of the WEII project and concluded that the SAR estimates were overly optimistic.<sup>4</sup> This was confirmed by the results of a survey carried out by the FD and FRIM in different ecological sites to obtain more reliable data on wood yields (see Annex V). The survey, which terminated in September 1987 and covered an area of about 9,500 hectares (almost 70 % of the total project area), found average wood yields over 50 % lower than those forecast at appraisal. Based on the survey, the following MAI forecasts have been used to estimate total project output: 4.7 m<sup>3</sup>/ha in the first rotation, 7.5 m<sup>3</sup>/ha in the second, 6.5 m<sup>3</sup>/ha in the third and 6.0 m<sup>3</sup> in the final rotation. Assuming four six-year rotation, these yields forecasts lead to an estimated total output of about 2 million solid m<sup>3</sup> over a period of 30 years (see Annex III, Table 1).

4.03 Woodlots. As noted earlier, the production and sales targets for the nursery program were much too ambitious. The SAR assumed that each nursery would produce and sell about 100,000 seedlings per annum, from year one, leading to an estimate of around 15,000 ha of woodlots to be established during the project period. In practice, it took five years for production to reach the original target, and sales lagged considerably behind production. As a result, the estimated number of hectares planted as woodlots is less than half the SAR estimate. Based on the field work for the WEII appraisal, yields from the woodlots are assumed to be slightly higher than those used to estimate output from both CG and LA plantations. It is further assumed that wood will be cut by smallholders on the equivalent of a 5-year rotation. This implies a total output of about 1.0 million solid m<sup>3</sup> of wood from the woodlots over a 20 year period. (Annex III, Table 1).

4.04 According to estimates made during the appraisal of WEII, there was an apparent annual wood deficit of about 4 million m<sup>3</sup> in 1984, which is projected to rise to an annual deficit of 5.6 million m<sup>3</sup> over the next ten years. The entire 30 year output of the project is thus only equivalent to roughly 50% of one year's wood deficit. In terms of production, therefore, the impact of the project is very small. Clearly, the central Government does not have the financial or manpower resources to plant on a scale to fill the gap between supply and demand. During project implementation, the Bank and the GOM worked together to develop a strategy for wood energy,

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<sup>4</sup>/The mission also recommended that the wood from the plantations be cut on a 6 year rotation basis.

which emphasizes the role of Government in creating a policy environment that would promote private production and conservation of wood rather than in producing wood directly.

## B. Production Costs and Financial Returns

4.05 Stumpage Rate. In the SAR calculations of the cost recovery stumpage rate and FRR were made separately for the LA, the CCDC and the CG plantations. However, as in practice, all plantations under the project were established and maintained by the Forestry Department, separate calculations would be meaningless and have not been made. Based on the actual costs for the plantations (LA plus CG) for the first eight years of the Project and projections of costs and of wood output thereafter, and using a discount rate of 12%, the stumpage rate that would ensure full recovery of costs would be around MK 31.3/solid m<sup>3</sup> (MK 21.9/stacked m<sup>3</sup>) in 1986/87 prices. (Annex III, Table 2 presents the details of the calculation).<sup>5</sup> The 1987 stumpage rate of MK 2.70/stacked m<sup>3</sup> highlights the failure of the Government to adhere to the covenant on wood pricing in the DCA.

4.06 Financial Returns. Details for the calculation of the FRR for the plantations component are presented in Annex III, Tables 3 and 4. Based on information from the FD, it is assumed that output from about 40% of the area planted would be sold as poles, with the remainder sold as fuelwood. Projected real stumpage rates for fuelwood are taken from the appraisal report for the Second Wood Energy Project (Report No.5914-MAI, Para 4.05). Using these assumptions, the FRR for the plantations is estimated at about 7.4%. Following the example in the SAR, no calculation of financial benefits has been made for the farmers woodlots as virtually all wood produced under this program would be utilised by the farmers themselves to meet their domestic requirements. The original aim for the nurseries, as stated in the SAR, was that the seedlings would be sold to farmers at cost, and hence no separate financial rate of return was calculated for the nursery component. In practice, in the initial years of the project, seedlings were sold at prices substantially below costs, implying heavy subsidization of the nursery component (see Annex I, Table 2). However, as production and sales levels improve, it should be possible to achieve full cost recovery at prices farmers can afford.

## C. Economic Returns

4.07 A major problem in estimating the economic returns to the project is how to value fuelwood production. The existing local market is distorted; the price of fuelwood reflects the low private costs of clearing forests at present rather than the considerable long-term costs of

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<sup>5</sup>/The SAR estimated the cost recovery stumpage rate in the Forestry Department plantations as MK 7.30/m<sup>3</sup> solid (1979 prices), using a 10% discount rate. Using the inflation rates shown in Annex II, Table 2a, this would imply a stumpage rate of MK 18.0/solid m<sup>3</sup> in 1986/87 prices. At a 10% discount rate, the stumpage rate based on actual costs and revised projections, would be MK 25.9/solid m<sup>3</sup> in 1986/87 prices - almost 45 % above the SAR estimate.

replacement, not to mention environmental degradation. Following the approach taken in the SAR for the Second Wood Energy Project, the wood output from the project is valued at the economic cost of supplying the same quantity of fuel (in energy equivalent units) through the next best alternative. The choices include: (a) use of alternative sources of energy such as kerosene; (b) production of charcoal from exploitation of existing forestry resources such as Viphya; and (c) continuation of unrestricted exploitation of existing natural forests. <sup>6</sup> Details of the calculations for the alternative measures of valuing fuelwood are presented in the WEII SAR (Report No.5914-MAI, Annex 2, Tables 14-16). The economic returns to the plantation component are calculated imputing in turn the economic value of fuelwood implied by these three alternatives. Costs are adjusted to include the current rental cost as a proxy for the opportunity cost of land. The ERR to the plantations varies from 9 to 16%. (See Annex III, Table 5 for details.).

Economic Rates of Return to Plantations  
Associated with Alternative Ways to Value Fuelwood

	<u>Economic Value of Wood MK/Solid m<sup>3</sup></u>	<u>ERR estimate %</u>
<u>Alternative Energy Sources:</u>		
Imported Kerosene	58.3	16.3
Viphya Charcoal	26.7	10.4
Depletion of Indigenous Forest	22.8	9.4

4.08 Analysis done during the appraisal of the Second Wood Energy Project suggests that small farmers would produce fuelwood at approximately one-third of the cost of Forestry Department plantations (see Report No.5914-MAI, para 4.06). Hence, the economic returns to the woodlots are likely to be substantially higher than the economic returns to the plantations, reflecting the much lower total economic costs of tree planting by smallholders.

V. INSTITUTIONAL PERFORMANCE

A. Bank Performance

5.01 Project Design. In retrospect, there appear to be some flaws in the project as originally designed by the appraisal team. The establishment of a large nationwide network of nurseries in the first year of the project

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<sup>6</sup>/This alternative involves substantial transport costs, as the distance required to fetch wood is likely to be large. In addition, there are environmental costs associated with destruction of the natural forest. While these are difficult to quantify, a rough estimate is made in terms of the possible losses in agricultural productivity.

was premature. Although almost all the nurseries were physically established in year one, production and sales of seedlings were considerably below the very ambitious appraisal estimates. A pilot nursery scheme which would have allowed the FD to gain experience in operating a very innovative and unfamiliar type of component would have been more appropriate. Another problem was that no survey had been carried out to identify key wood deficit areas, and, as a result, some nurseries were located in areas with no shortage of wood and consequently little demand for seedlings; in other cases, nurseries were located in sites with poor accessibility. As conceived by the appraisal team, extension was supposed to be carried out by the nurserymen. In practice, this proved impossible as the nurserymen had neither the time nor the capability to do extension. A pilot scheme would ideally have included provision for testing different ways of providing extension to farmers on treeplanting. The most fundamental problem with the nursery component, however, was the lack of incentive for small farmers to plant trees, given the prevailing policy environment. The scope of the project was basically too narrow, focusing as it did on production of seedlings, but failing to address policy issues such as low producer prices for fuelwood and availability of free wood in the natural forests, which greatly reduced the incentives for tree planting.

5.02 With respect to the plantation components, the appraisal mission appears to have totally misjudged the willingness or capability of both CCDC and the local authorities to establish and maintain plantations. Although the overall number of hectares planted actually exceeded the number foreseen at appraisal, all the plantations were ultimately established by the FD who, at least according to the SAR estimates, had higher costs than either CCDC or the local authorities. Given the very high costs of central Government plantations and the fact that the FD does not have the capacity or resources to plant on the scale necessary to deal with the fuelwood deficit, it would have been desirable to have devoted more attention to identifying ways to get agents, other than the civil service, to plant trees. A further problem with the plantation component is that preliminary evidence suggests that the appraisal team overestimated wood yields by over 50%.

5.03 Project Supervision. Bank supervision has, overall, been satisfactory. Thirteen missions, comprising foresters and economists/ agricultural economists, spent a total of about 130 man days in Malawi to supervise the Project. Continuity of staff on supervision was good; the missions generally consisted of two persons, of whom at least one had been on a previous supervision. Bank missions helped project management identify specific implementation problems such as transportation bottlenecks in seedling distribution, lack of publicity, late delivery of inputs, poor maintenance in the plantations and so on; and also provided advice on issues such as the design of an extension system, methods of termite control, and seedling prices. More importantly, throughout project implementation, there was an on-going policy dialogue between the Bank and FD, based on the findings of the supervision missions and the forestry sub-sector study, from which developed the long run strategy for the subsector and the design of the second Wood Energy Project.

## B. Implementing Agencies

5.04 The Wood Energy Division was created in the Forestry Department to be directly responsible for Project implementation and to direct, coordinate and control all matters relating to wood energy. One problem that surfaced during project implementation and which undermined management effectiveness to some extent was the frequent absence of the more senior members of the WED, who travelled extensively both within Malawi and abroad. Another issue was that the project manager was sometimes overburdened with other responsibilities within the Ministry and unable to devote sufficient time to details of project implementation. Overall, however, the management of the project was satisfactory. All the physical components of the project were completed on time. Although the appraisal targets for the nurseries were not achieved, these were highly unrealistic given the lack of experience of the Bank and the country in social forestry operations. However, the project team did increase the national awareness of the emerging fuelwood crisis and developed public and political support for tree-planting. The project team managed to launch planting activities throughout the country by motivating schools, villages and area action groups to plant trees. Throughout implementation, staff from the WED worked closely with the Bank in the development of the forestry/wood energy strategy and policies.

5.05 One of the conditions in the DCA was the appointment of a suitably qualified and experienced financial controller. An expatriate financial controller was recruited whose work was very satisfactory, and who established excellent working relations with staff in the FD. However, the training of Malawian counterparts has been less satisfactory despite the best efforts of the controller, largely because of the rather low calibre and high turnover of the counterparts. This in turn stems from the more general problem that the salaries for accountants in the civil service are much less attractive than salaries in the private sector.

## VI. CONCLUSIONS AND LESSONS TO BE LEARNED

6.01 The project achieved most of its physical targets by the original closing date. In addition, the project was successful in establishing institutions, educating staff, and developing public and political support for tree planting. The project had an important impact on raising, nationwide, the consciousness for the emerging fuelwood crisis which is now drawing attention on the highest political level and establishing firmly the concept of social forestry in Malawi. The project created the WED and the ESU. A well trained, competent, experienced and dedicated staff is now in place with the capacity to conceive, prepare and implement the much more complex second phase Wood Energy project with only marginal foreign assistance.

6.02 The plantation component was successful in purely physical terms - the numbers of hectares established actually exceeded the appraisal target. However, the wood yields from the plantations are substantially lower than had been anticipated. This is partly due to the establishment of

plantations in unsuitable locations and with inappropriate species and provenances. In addition, insufficient attention was paid to tending and weeding in the first years after planting and inadequate fire protection was provided. While wood yields are low, the per hectare costs of establishing the Government plantations are high, due to heavy outlays on vehicles, staff housing, offices, roads and other infrastructure. The ultimate financial cost per cubic meter of wood produced is therefore extremely high -- around MK21.9/cubic meter stacked (in 1986/87 prices) for the project plantations, which is about 8 times higher than the present stumpage rate. It is also clear that the Forestry Department does not have the financial, managerial and staffing capacity to plant on the scale necessary to deal with the fuelwood crisis. Instead, the Government needs to concentrate on establishing the right environment to induce private production and conservation of wood, through its policies on wood pricing, revenue collection and indigenous forest protection. In the medium term, Government planting should be restricted to environmentally fragile areas where private planting would not occur.

6.03 The project did not initially meet the targets set in the SAR for the nursery component. Production and sales targets were highly unrealistic given the lack of experience of the Bank and the country in social forestry. A further problem was that the selection of nursery sites was arbitrary and not based on attitude or wood deficit surveys. As a result, nurseries were often not located in the most receptive or accessible areas. A pilot project would have provided more flexibility than a production-oriented project, and would have allowed the FD to build up experience in operating this type of component. The establishment of a large nationwide network of nurseries in year one overloaded the managerial and supervisory capabilities of the WED and regional forestry offices. It would have been better to establish the nurseries gradually, with locations based on results obtained in surveys of wood deficiency areas and on small farmers' attitudes towards tree planting. In addition, a pilot project could have provided the framework for testing alternative extension systems.

6.04 By the end of the project period, average production levels from the nurseries had reached the original appraisal estimates, but seedlings sales remained rather low. Despite the disappointing sales performance of the nurseries, however, analysis undertaken for the Second Wood Energy Project clearly demonstrates that tree planting by rural households is by far the lowest cost way to deal with the fuelwood crisis. Supplying farmers with subsidized seedlings through retail nurseries is a highly cost effective way for the Government to promote tree planting. However, for this approach to be successful, it is necessary to ensure that financial incentives exist for farmers to plant trees. The experience under the Project demonstrates that merely providing subsidized seedlings is not enough. The main reasons why tree planting is not popular with small farmers are the low producer prices for wood and availability of free wood in the natural forest.

6.05 The project was not designed to deal with issues such as wood pricing, revenue collection, and protection and management of natural forests, but did create the basis for dealing with these wider issues in the second phase. The lessons learned have been incorporated into the

design of the second phase. The major thrust of the Second Wood Energy project is to implement a comprehensive policy package designed to create incentives for private tree planting and wood conservation. Its most significant features are increases in fuelwood prices, expanded forest protection and revenue collection activities, and provision of incentive payments to small farmers for tree planting. The Project aims to encourage private tree planting directly by providing investment incentives, subsidized seedlings and extension services, and indirectly by increasing the stumpage fees to cost recovery levels plus a margin for the producer. Access to free wood in the indigenous forests will be restricted. The actions on wood pricing and revenue collection indirectly create incentives for greater wood conservation. In addition, the Project is introducing more fuel-efficient technologies in tobacco curing, charcoal making and domestic cooking stoves. In line with the redefinition of the Government's role in fuelwood production, namely creation of a policy environment that encourages private production and conservation rather than direct production by the FD, provision is made for only a limited number of Government plantations in environmentally fragile areas.

6.06 Under the new project, nurseries initially would be established on a temporary basis until the farmers' response is sufficient to justify their upgrading to permanent nurseries. Establishment of temporary nurseries requires only low cost traditional bush-material houses for the nurserymen, a shed for tools, and materials and fencing. Thereafter, upgrading would entail additional investments in more permanent houses for nurserymen, improved storage facilities, and water tanks. The new nurseries are phased in gradually over a period of three years and the initial production target is relatively modest, around 50,000 seedlings per nursery in the first year of operation. A pilot extension scheme is included to try to determine whether a workable arrangement with the Agricultural Extension Service can eventually be developed. This provides for six pilot extension units to be set up in areas with acute fuelwood shortage. In addition, provision is made for a small unit at the FD headquarters to develop training materials for farmers and extension staff and to strengthen the existing publicity unit and existing Forestry Extension Unit.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 1: Nurseries - Seedlings Production and Distribution

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
Number of nurseries	80	82	84	87	88	88	88
	'000 seedlings						
Target production	8,000 <sup>2/</sup>	3,700 <sup>3/</sup>	2,700 <sup>3/</sup>	3,000 <sup>3/</sup>	5,900 <sup>3/</sup>	7,500 <sup>3/</sup>	8,000 <sup>3/</sup>
<u>Production 1/</u>	2,605	1,747	2,044	2,658	5,089	8,539	13,439
Production as a % of target	32%	47%	75%	89%	86%	114%	168%
<u>Carry over</u>	-	1,749	919	574	112	574	1,579
Total before deaths	2,605	3,496	2,963	3,232	5,201	9,113	15,018
Deaths/culls - Number	470	700	40 <sup>a</sup>	342	503	640	1,139
- Percentage	(18)	(20)	(14)	(11)	(10)	(7)	8
Total available	2,135	2,796	2,560	2,890	4,698	8,473	13,879
Sales - Number	386	1,783	1,813	2,443	3,672	6,035	10,402
- Percentage	(15)	(51)	(61)	(76)	(71)	(66)	(69)
<u>Free issues and demonstrations</u>	-	94	173	335	452	859	1,405
<u>Stock left in nurseries</u>	1,749	919	574	112	574	1,579	2,072

1/ Including, from 1982/83 onwards, production from additional 10 temporary nurseries.

2/ Original appraisal target of 100,000 seedlings per nursery per annum.

3/ Revised targets following Bank supervision missions.

NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

PROJECT COMPLETION REPORT

Table 2: Seedling Production Cost

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
	(MK 000)						
<b>I. Expenses</b>							
Direct expenses	81.0	110.7	92.7	95.0	144.7	193.7	287.7
Depreciation - Fixed Assets	13.5	34.7	26.6	40.0	27.7	15.2	14.2
- Nursery Sites	2.0	3.1	2.8	3.0	3.3	2.5	-
- Overhead Allocation	<u>42.5</u>	<u>41.3</u>	<u>25.8</u>	<u>30.0</u>	<u>48.3</u>	<u>60.1</u>	<u>93.8</u>
Total Expenses	139.0	189.8	147.9	168.0	224.0	271.5	395.7
<b>II. Revenues (seedlings)</b>	6.4	19.0	18.8	25.0	35.6	56.2	145.1
<b>III. Profit (loss)</b>	(132.6)	(170.8)	(129.1)	(143.0)	(188.4)	(215.3)	(250.6)
	(Number in 000)						
<b>IV. Plants Sold/Issues</b>							
Plants sold	386	1,782	1,813	2,444	3,672	6,035	10,402
Free issues	-	-	-	<u>335</u>	<u>452</u>	<u>859</u>	<u>1,405</u>
Total	386	1,782	1,813	2,779	4,124	6,894	11,807
	(Tambala/Seedling)						
<b>V. Unit Cost of Sales plus Issues</b>							
Direct expenses	21.0	6.2	5.1	3.4	3.5	2.8	2.4
Depreciation and Overhead	<u>14.5</u>	<u>4.4</u>	<u>3.0</u>	<u>2.6</u>	<u>1.9</u>	<u>1.1</u>	<u>0.9</u>
Total Unit Cost	35.5	10.6	8.1	6.0	5.4	3.9	3.3

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 3: Local Authority Plantations - Location and Phasing of Implementation

Location of Plantations	Planting Season					Total	Appraisal * Estimates
	1981/82	1982/83	1983/84	1984/85	1985/86		
	(ha)						
<b>I. Urban Plantation</b>							
Northern region (Karonga, 3 sites)	24.2	27.4	77.5	140.8	-	269.9	300
Central region (Kasungu, 3 sites)	78.7	89.9	80.9	107.0	-	356.5	300
Southern region (Zomba, 6 sites)	<u>71.3</u>	<u>79.0</u>	<u>109.0</u>	<u>75.0</u>	-	<u>334.3</u>	<u>300</u>
Sub-total (12 sites)	174.2	196.3	267.4	322.8	-	960.7	900
<b>II. Rural Plantation</b>							
Northern region (Karonga, 4 sites)	51.4	61.0	99.5	113.6	-	325.5	300
(Nkhata Bay, 2 sites)	-	-	12.3	64.3	70.4	147.0	-
Central region (Lilongwe, 4 sites)	87.0	81.0	83.5	72.0	-	323.5	300
(Kasungu, 4 sites)	72.4	65.5	80.2	86.0	-	304.1	300
Southern region (Blantyre, 5 sites)	60.2	100.0	82.3	100.0	-	342.5	300
(Zomba, 5 sites)	<u>59.2</u>	<u>79.0</u>	<u>75.0</u>	<u>94.0</u>	-	<u>307.2</u>	<u>300</u>
Sub-total (24 sites)	330.2	386.5	432.8	529.9	70.4	1,749.8	1,500
TOTAL (36 sites)	<u>504.4</u>	<u>582.8</u>	<u>700.2</u>	<u>852.7</u>	<u>70.4</u>	<u>2,710.5</u>	<u>2,400</u>
<b>TOTAL BY REGION</b>							
- Northern region	75.6	88.4	189.3	318.7	70.4	742.4	600
- Central region	238.1	236.4	244.6	265.0	-	984.1	900
- Southern region	<u>190.7</u>	<u>258.0</u>	<u>266.3</u>	<u>269.0</u>	-	<u>984.0</u>	<u>900</u>
TOTAL	504.4	582.8	700.2	852.7	70.4	2,710.5	2,400

\* SAR foresaw annual planting for each plantation would be at the rate of 75 ha per annum from the second through the fifth year of the Project.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 4: Central Government Plantations - Location and Phasing of Implementation

Location of Plantations	Planting Season					Total	Appraisal <sup>2/</sup> Estimates
	1981/82	1982/83	1983/84	1984/85	1985/86		
	(ha)						
<u>I. Northern Region</u>	-	-	-	-	-	-	-
<u>II. Central Region</u>							
Lilongwe (1 site)	379.8	708.4	812.3	1,179.3	-	3,079.8	3,000
Dowa (2 sites) <sup>1/</sup>	-	230.8	652.0	694.5	-	1,577.3	-
Sub-total (3 sites)	379.8	939.2	1,464.3	1,873.8	-	4,657.1	3,000
<u>III. Southern Region</u>							
Blantyre (7 sites)	271.1	645.8	875.2	1,163.7	117.0	3,072.8	3,000
Zomba/Machinga (11 sites)	450.0	850.0	1,030.0	770.0	70.0	3,170.0	3,000
Sub-total (18 sites)	721.1	1,495.8	1,905.2	1,933.7	187.0	6,242.8	6,000
<b>TOTAL (21 sites)</b>	<b>1,100.9</b>	<b>2,435.0</b>	<b>3,369.5</b>	<b>3,807.5</b>	<b>187.0</b>	<b>10,899.9</b>	<b>9,000</b>

<sup>1/</sup> Replacing CCDC plantations.

<sup>2/</sup> SAR foresaw annual planting rate of 450 ha in the second year and 850 ha in each subsequent year, in each plantation.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MW)PROJECT COMPLETION REPORTTable 5: Plantation Establishment by Species

Species	Central Government Plantations		Local Authority Plantations		Total	
	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
<i>Bucalyptus Camaldulensis</i>	6,483	59	1,752	64	8,235	60
<i>Bucalyptus Terticlaonis</i>	3,240	30	678	25	3,918	29
<i>Bucalyptus Saligna</i>	155	2	55	2	210	2
<i>Bucalyptus Grandis</i>	1,022	9	208	8	1,230	9
Others <sup>1/</sup>	-	-	18	1		
<b>TOTAL</b>	<b>10,900</b>	<b>100</b>	<b>2,711</b>	<b>100</b>	<b>13,611</b>	<b>100</b>

<sup>1/</sup> Including *Bucalyptus Pellita*, *Amelina* and *Caseta*.

ANNEX I  
Table 6

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NROP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

PROJECT COMPLETION REPORT

Table 6: Buildings by Type Constructed under the Project

Buildings	Wood Energy Division	Energy Study Unit	Forestry Department Plantations	Local Authority Plantations	Regular Forestry Offices	Agricultural Development Divisions	Retail Nurseries	Total
Houses: Type B	4	-	-	-	-	-	-	4
C	2	2	-	-	3	3	-	10
D	4	3	11	3	3	3	-	27
E	4	5	26	9	20	3	-	67
F	<u>3</u>	<u>1</u>	<u>14</u>	<u>-</u>	<u>5</u>	<u>1</u>	<u>-</u>	<u>24</u>
Total	17	11	51	12	31	10	-	132
Traditional Houses	-	-	301	54	8	-	83	446
Office Blocks	1	1	5	-	3	-	-	10
Store Rooms <u>1/</u>	-	-	8	21	1	-	81	111
Generator House	-	-	4	-	-	-	-	4
Workshops/Garages	-	2	3	-	-	-	-	5
Water Tanks	-	-	4	-	-	-	-	4
Water Pump House	-	-	2	-	-	-	-	2

1/ Including small seed, large store-rooms and fuel stores.

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NDP II WOOD ENERGY PROJECT (CREDIT 992-MAL)

PROJECT COMPLETION REPORT

Table 7: Plant and Vehicles Purchased under the Project

Type	Wood Energy Division	Energy Study Unit	Forestry Department Plantations	Local Authority Plantations	Regular Forestry Offices	Agricultural Development Divisions	Retail Nurseries	Total Initial Purchase	Replacement NDP II	Start-up WELL
Four-wheel drive station wagon	1	1	-	-	2	-	-	4	9	4
Four-wheel drive hard top	-	-	-	-	3	-	-	3	-	-
Four-wheel pick-up	1	-	4	-	3	-	-	8	9	22
Pick-up	1	-	-	-	-	6	-	7	-	-
Saloon vehicles	1	1	-	-	-	-	-	2	-	3
Lorries (7 ton)	-	-	4	-	-	-	-	4	-	10
Tractors (35 hp)	-	-	3	-	-	-	-	3	-	-
Tractors (65 hp)	-	-	1	-	-	-	-	1	-	6
Trailers	-	-	4	-	-	-	-	4	-	6
Motorcycles	1	-	12	13	1	-	-	27	29	75
Bicycles	-	-	-	-	-	-	169	169	100	225
Generators	-	-	4	-	3 1/	-	-	7	-	1
Cinema van trailer	-	-	-	-	3	-	-	3	-	-
Mini bus	-	-	-	-	-	-	-	-	-	2

1/ Portable Potter generators.

ANNEX I  
Table 8

MALAWI

NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

PROJECT COMPLETION REPORT

Table 8: Road Construction

<u>Local Authority Plantations</u>	<u>District</u>	<u>km</u>
- Rural	Blantyre	5.0
	Kasungu	4.7
	Lilongwe	2.0
	Karonga	11.3
	Zomba	<u>3.0</u>
	Sub-total	
- Urban	Kasungu	12.1
	Karonga	3.0
	Zomba	<u>6.4</u>
	Sub-total	
	Total L.A.P.	47.5
<u>Central Government Plantations</u>	Lilongwe	35.0
	Blantyre	79.7
	Zomba	90.5
	Dowa	<u>23.1</u>
	Total C.G.P.	228.3
	TOTAL	<u>275.8</u>

ANNEX I  
Table 9

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NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

PROJECT COMPLETION REPORT

Table 9: Wood Energy Division - Number of Posts Filled

	Grade	Number of Posts		
		SAR	Filled	Vacant
Assistant Chief Forestry Officer	P6	1	1	-
Senior Forestry Officer	P8	3	3	-
Senior Accountant	P8	1	1	-
Planning Officer	PO	1	1	-
Personnel Officer	PO/CEO	1	1	-
Chief Forester	CTO	3	3	-
Senior Forester	STO	7	7	-
Senior Executive Officer	SEO	1	1	-
Senior Assistant Accountant	SEO/acc.	2	1	1
Forester	TO	26	24	2
Building Supervisor	TO	3	2	1
Executive Officer	EO	3	3	-
Building Foremen	STA	3	3	-
Clerical Officer	CO	29	24	5
Clerical Officer Accountant	CO/acc.	1	18	1
Forestry Assistant	TA	55	55	-
Copy Typist	D6	2	2	-

## MALAWI

## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 1: Total Project Costs in Current Terms 1/

	1980/81	1981/82	1982/83	1983/84	1984/85 (MK'000)	1985/86	1986/87	1987/88 <sup>2/</sup>	Total
<u>Investment Costs</u>									
Retail Nurseries	155.7	33.3	6.0	21.2	4.2	0.6	1.6	47.6	270.2
Local Authority Plantations	17.3	175.1	77.3	3.1	3.4	2.3	17.9	76.4	372.8
Central Government Plantations	141.2	561.5	651.9	318.3	130.1	17.7	10.5	310.8	2,142.0
Wood Energy Division	304.5	737.8	478.0	121.5	61.3	15.4	65.5	302.0	2,086.0
Charcoal Trials	-	3.7	0.5	-	-	-	-	-	4.2
Energy Studies	24.3	4.4	308.8	11.4	72.0	26.5	42.7	89.1	579.2
<b>Total Wood Energy Investment Costs</b>	<b>643.0</b>	<b>1,515.8</b>	<b>1,522.5</b>	<b>475.5</b>	<b>271.0</b>	<b>62.5</b>	<b>138.2</b>	<b>825.9</b>	<b>5,454.4</b>
<u>Operating Costs</u>									
Retail Nurseries	94.4	101.9	90.2	96.6	165.6	213.4	287.7	248.0	1,297.8
Local Authority Plantations	4.0	115.3	289.2	187.3	288.2	213.3	281.8	289.8	1,668.9
Central Government Plantations	58.3	378.9	783.0	785.0	960.9	663.8	1,020.1	858.5	5,508.5
Wood Energy Division	96.9	380.6	567.7	658.5	749.4	751.4	839.8	542.7	4,587.0
Charcoal Trials	-	3.6	3.5	0.1	-	-	-	-	7.2
Energy Study Unit	-	107.0	180.7	176.5	92.5	57.8	103.5	50.7	768.7
<b>Total Project Operating Costs</b>	<b>253.6</b>	<b>1,087.3</b>	<b>1,914.3</b>	<b>1,904.0</b>	<b>2,256.6</b>	<b>1,899.7</b>	<b>2,532.9</b>	<b>1,989.7</b>	<b>13,838.1</b>
<u>Other Costs</u>									
NRDP III Pre-Investment	-	-	248.2	83.8	-	-	-	-	332.0
WE II Start-up <sup>3/</sup>	-	-	-	-	-	-	197.1	2,445.6	2,642.7
Tobacco Fuel Efficiency Project Ext.	-	-	-	-	-	-	-	635.9	635.9
Forestry HQ Office Block	-	-	-	-	-	-	560.0	-	560.0
<b>Total Other Costs</b>	<b>-</b>	<b>-</b>	<b>248.2</b>	<b>83.8</b>	<b>-</b>	<b>-</b>	<b>757.1</b>	<b>3,081.5</b>	<b>4,170.6</b>
<b>TOTAL PROJECT COSTS (MK'000):</b>	<b>896.6</b>	<b>2,603.1</b>	<b>3,685.0</b>	<b>2,463.3</b>	<b>2,527.6</b>	<b>1,962.2</b>	<b>3,428.2</b>	<b>5,897.1</b>	<b>23,463.1</b>
<b>TOTAL PROJECT COST (US\$'000):<sup>3/</sup></b>	<b>1,067.7</b>	<b>2,769.3</b>	<b>3,380.7</b>	<b>2,002.7</b>	<b>1,696.4</b>	<b>1,121.3</b>	<b>1,749.1</b>	<b>2,597.8</b>	<b>16,385.0</b>

1/ Details are given in Annex IV, Tables 1 to 6.

2/ Estimates in 86/87 prices.

3/ Vehicles, Workshop, Short-term Consultancies, Studies.

4/ Exchange rates for relevant fiscal year are given in Table 2.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 2a: MK/US\$ Exchange Rates

Year	Exchange Rate <sup>1/</sup> (MK to US\$)	Fiscal Year <sup>2/</sup>	Exchange Rate (MK to US\$)
1980	0.8121	1980/81	0.84
1981	0.8953	1981/82	0.94
1982	1.0555	1982/83	1.09
1983	1.1748	1983/84	1.23
1984	1.4134	1984/85	1.49
1985	1.7191	1985/86	1.75
1986	1.8611	1986/87	1.96
1987	2.2431	1987/88	2.27
1988 (January)	2.4700		

Table 2b: Inflators/Deflators, 1979/80 - 1986/87

Year	Consumer Price Index <sup>1/</sup> (1980 = 100)	Financial Year <sup>2/</sup>	Consumer Price Index	Inflators	Deflators
1979	84.0	1979/80	88.0	2.47	1.00
1980	100.0	1980/81	102.9	2.11	1.17
1981	111.8	1981/82	114.6	1.90	1.30
1982	122.8	1982/83	127.0	1.71	1.44
1983	139.4	1983/84	146.4	1.48	1.67
1984	167.3	1984/85	171.7	1.26	1.96
1985	184.9	1985/86	191.4	1.13	2.19
1986	210.9	1986/87	217.2	1.00	2.47
1987 (Jan - April)	236.1				

<sup>1/</sup> Source: International Financial Statistics (IMF- Jan. 1988)

<sup>2/</sup> From April 1 - March 31.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAL)PROJECT COMPLETION REPORTTable 3: Total Project Cost in Constant 1986/87 Prices 1/

Components	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	Total
(MK'000)									
<b>I. Investment Costs 2/</b>									
- Retail Nurseries	328.5	63.3	10.3	31.4	5.3	0.7	1.6	47.6	488.7
- Local Authority Plantations	36.5	332.7	132.2	4.6	4.3	2.6	17.9	76.4	607.2
- Central Government Plantations	297.9	1,066.8	1,114.7	471.1	163.9	20.0	10.5	310.8	3,455.7
- Wood Energy Division	642.5	1,401.8	817.4	179.8	77.3	17.4	65.5	302.0	3,503.7
- Charcoal Trials	-	7.0	0.8	-	-	-	-	-	7.8
- Energy Studies	51.3	8.4	528.1	16.9	90.7	29.9	42.7	89.1	857.1
Sub-total:	1,356.7	2,880.0	2,603.5	703.8	341.5	70.6	138.2	825.9	8,920.2
<b>II. Operating Costs 2/</b>									
- Retail Nurseries	199.2	193.6	154.3	143.0	208.7	241.2	287.7	248.0	1,675.7
- Local Authority Plantations	8.4	219.2	494.5	277.2	363.1	241.0	281.8	289.8	2,175.0
- Central Government Plantations	123.0	719.9	1,338.9	1,161.8	1,210.7	750.1	1,020.1	858.5	7,183.0
- Wood Energy Division	204.5	723.1	970.8	974.6	944.2	849.1	839.8	542.7	6,048.8
- Charcoal Trials	-	6.8	6.0	0.1	-	-	-	-	12.9
- Energy Studies	-	203.3	309.0	261.2	116.6	65.3	103.5	50.7	1,109.6
Sub-total:	535.1	2,065.9	3,273.5	2,817.9	2,843.3	2,146.7	2,532.9	1,989.7	18,205.0
<b>III. Other Costs 2/</b>									
- NRDP II Pre-Investment	-	-	424.4	124.0	-	-	-	-	548.4
- WE II Start-up	-	-	-	-	-	-	197.1	2,445.6	2,642.7
- Tobacco Fuel Efficiency Project	-	-	-	-	-	-	-	635.9	635.9
- Forestry HQ Office Block	-	-	-	-	-	-	560.0	-	560.0
<b>TOTAL PROJECT COSTS:</b>	<b>1,891.8</b>	<b>4,945.9</b>	<b>6,301.4</b>	<b>3,645.7</b>	<b>3,184.8</b>	<b>2,217.3</b>	<b>3,428.2</b>	<b>5,897.1</b>	<b>31,512.2</b>

1/ Factors to convert figures in current terms into 1986-87 constant prices are given in Table 2b.

2/ Corresponding figures in current terms are given in Table 1.

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## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAL)

## PROJECT COMPLETION REPORT

Table 4a: Schedule of Estimated versus Actual Disbursements 1/

IDA Fiscal Year	Quarter Ending	Estimated Disbursements			Actual Disbursements			Balance	Actual as a % of Estimate
		Quarter	Annual	Cumulative	Quarter	Annual	Cumulative		
	(US\$'000)		(US\$'000)			(US\$'000)		(US\$'000)	
1980/81	September 1980	400			-				
	December 1980	400			-				
	March 1981	800			323.2				
	June 1981	800	2,400	2,400	601.9	925.1	925.1	(1,474.9)	39
1981/82	September 1981	800			620.4				
	December 1981	800			176.9				
	March 1982	900			868.6				
	June 1982	900	3,400	5,800	663.0	2,328.9	3,254.0	(2,546.0)	56
1982/83	September 1982	800			781.9				
	December 1982	800			814.8				
	March 1983	800			463.6				
	June 1983	800	3,200	9,000	794.3	2,854.6	6,108.6	(2,891.4)	68
1983/84	September 1983	600			701.6				
	December 1983	600			315.1				
	March 1984	600			368.4				
	June 1984	600	2,400	11,400	205.4	1,590.5	7,699.1	(3,700.9)	68
1984/85	September 1984	500			349.2				
	December 1984	500			377.6				
	March 1985	400			283.8				
	June 1985	400	1,800	13,200	375.4	1,386.0	9,085.1	(4,114.9)	69
1985/86	September 1985	300			241.0				
	December 1985	300			159.6				
	March 1986	-			293.1				
	June 1986	-	600	13,800	104.7	798.4	9,883.5	(3,916.5)	72
1986/87	September 1986	-			205.0				
	December 1986	-			467.2				
	March 1987	-			282.6				
	June 1987	-	-	13,800	323.6	1,278.4	11,161.9	(2,638.1)	81
1987/88	September 1987	-			446.3				
	December 1987	-		13,800	1,612.8	2,095.1	13,221.0	(579.0)	96
	March 1988 <sup>1/</sup>	-			347.4				
	June 1988 <sup>1/</sup>	-		13,800	231.6	2,638.1	13,800.0	-	100

1/ Estimates

Table 4b: Project Financing

<u>Total</u> <u>Expenditure</u> MK (000)	<u>Total</u> <u>Claim</u> <u>(IDA)</u> MK (000)	<u>Local</u> <u>Contribution</u> <u>(GCM)</u> MK (000)	<u>%</u> <u>Contribution</u> <u>(GCM)</u>
23,463.1	19,967.1	3,496.0	14.9

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NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

PROJECT COMPLETION REPORT

Table 5: Credit Disbursement by Category

Category	Original DCA	Amount of Credit Allocated		Up to 31/12/87	Disbursement Jan. June 88	Total	Actual as a % Allocation
		1st 1/ Revision	2nd 2/ Revision				
(US\$'000)							
<b>I. Nursery Development</b>							
A. Civil Works	160	160	170	155	-	155	91
B. Vehicles & Equipment	80	80	95	68	5	73	77
C. Operating Costs	890	890	710	643	37	680	96
<b>II. District &amp; Town Council Plantations</b>							
A. Civil Works	200	200	270	243	-	243	50
B. Vehicles & Equipment	25	25	50	39	8	47	94
C. Operating Costs	555	555	650	587	44	631	108
<b>III. Forestry Dept. Plantations</b>							
A. Civil Works	1,900	1,915	1,210	1,170	-	1,170	97
B. Vehicles & Equipment	260	300	815	499	33	532	65
C. Operating Costs	2,850	3,655	2,850	2,675	129	2,804	98
<b>IV. CCDC Plantations</b>							
A. Civil Works	15	-	-	-	-	-	-
B. Vehicles & Equipment	40	-	-	-	-	-	-
C. Operating Costs	805	-	-	-	-	-	-
<b>V. Wood Energy Division</b>							
A. Civil Works	1,000	1,000	1,300	1,198	-	1,198	92
B. Vehicles & Equipment	210	210	840	1,403	124	1,527	182
C. Operating Costs	530	530	2,030	1,504	90	1,594	78
D. Staff Salaries	1,120	1,120	795	585	30	615	77
<b>VI. Charcoal Trials Studies</b>	130	130	20	7	-	7	35
<b>VII. Energy Unit</b>							
A. Civil Works	200	200	530	322	2	324	98
B. Vehicles & Equipment	100	100	70	87	7	94	134
C. Operating Costs	500	500	250	245	9	255	102
D. Consultant Services	260	260	875	1,231	61	1,292	147
<b>VIII. NRDP III Pre-Investment</b>	400	400	260	259	-	259	100
<b>IX. Unallocated</b>	1,560	1,560	-	-	-	-	-
<b>GRAND TOTAL</b>	<b>13,800</b>	<b>13,800</b>	<b>13,800</b>	<b>13,221</b>	<b>579</b>	<b>13,800</b>	<b>100</b>

1/ After CCDC withdrawal.

2/ Unallocated credit amount of US\$1,560,000 has been distributed proportionately to various categories.

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## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 1: Estimated Wood Production

Project Year	CG Plantations <sup>1/</sup>		LA Plantations <sup>1/</sup>		Woodlots		Total Production '000 m <sup>3</sup>
	Area Planted ha	Production '000 m <sup>3</sup> Solid	Area Planted ha	Production '000 m <sup>3</sup> Solid	Area <sup>2/</sup> Planted ha	Production <sup>3/</sup> '000 m <sup>3</sup>	
1	0	0	0	0	154	0	0
2	1,101	0	504	0	751	0	0
3	2,435	0	583	0	794	0	0
4	3,369	0	700	0	1,111	0	0
5	3,808	0	853	0	1,650	0	0
6	187	0	70	0	2,758	5.0	5.0
7		0		0		24.4	24.4
8		31.0		14.2		25.8	71.0
9		68.7		16.4		36.1	121.2
10		95.0		19.7		53.6	168.3
11		107.4		24.1		96.1	227.6
12		5.3		2.0		31.9	39.2
13		0		0		33.7	33.7
14		49.5		22.7		47.2	119.4
15		109.6		26.2		70.1	205.9
16		151.6		31.5		122.6	305.7
17		171.4		38.4		26.3	236.1
18		8.4		3.2		27.8	39.4
19		0		0		38.9	38.9
20		42.9		19.7		57.8	120.4
21		95.0		22.7		101.5	219.2
22		131.4		27.3		24.4	183.1
23		148.5		33.3		25.8	207.6
24		7.3		2.7		36.1	46.1
25		0		0		53.6	53.6
26		39.6		18.1		89.6	147.3
27		87.7		21.0		0	108.7
28		121.3		25.2		0	146.5
29		137.1		30.7		0	167.8
30		6.7		2.5		0	9.2
TOTAL	10,900	1,615.4	2,710	401.6	7,218	1,028.3	3,045.3

<sup>1/</sup> Assumptions for calculation of wood production from CG and LA plantations: rotation of six years with one seedling and three coppice rotations. A MAI of 4.7 m<sup>3</sup>/ha is assumed in the first rotation. Subsequent rotations are assumed to have MAIs of 7.5 m<sup>3</sup>/ha, 6.5 m<sup>3</sup>/ha and finally 6 m<sup>3</sup>/ha.

<sup>2/</sup> Assumption for estimation of hectares planted in woodlots: 2,500 seedlings per hectare.

<sup>3/</sup> Assumptions for calculation of wood production from woodlots: rotation of five years with one seedling and three coppice rotations. MAI as follows:

First rotation	: 6.5 m <sup>3</sup> /yr/ha
Second rotation	: 8.5 m <sup>3</sup> /yr/ha
Third rotation	: 7.0 m <sup>3</sup> /yr/ha
Fourth rotation	: 6.5 m <sup>3</sup> /yr/ha

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## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 2: Stumpage Fee Calculations: IA and OG Plantations

Planting Season	Project Year	Investment <sup>1/</sup> Costs	Operating <sup>1/</sup> Costs	Total Costs	Costs		Discounted Yield <sup>2/ 3/</sup> at 12%
					Discounted at 12%	Yield <sup>2/ 3/</sup>	
				(MK'000)	(m <sup>3</sup> 000)		
1980/81	1	334	131	465			-
1981/82	2	1,399	939	2,338			-
1982/83	3	1,247	1,833	3,080			-
1983/84	4	476	1,439	1,915			-
1984/85	5	168	1,574	1,742			-
1985/86	6	23	991	1,014			-
1986/87	7	28	1,301	1,330			-
1987/88	8	386	1,148	1,534			45.3
	9	-	230	230			85.1
	10	-	230	230			114.8
	11	-	230	230			131.4
	12	-	230	230			7.3
	13	-	230	230			-
	14	77	230	307			72.2
	15	-	230	230			135.8
	16	-	230	230			183.1
	17	-	230	230			209.7
	18	-	230	230			11.6
	19	-	230	230			-
	20	77	230	307			62.6
	21	-	230	230			117.7
	22	-	230	230			158.7
	23	-	230	230			181.7
	24	-	230	230			10.0
	25	-	230	230			-
	26	77	230	307			57.8
	27	-	230	230			108.6
	28	-	230	230			146.5
	29	-	230	230			167.8
	30	-	230	230			9.3
<b>TOTAL</b>					9,151	2,017.0	292.8

Stumpage fee:  $9,151/292.8 = \text{MK}31.3/\text{m}^3$  solid (equivalent to  $\text{MK}21.9/\text{m}^3$  stacked)

<sup>1/</sup> Details are given in Table 3, Annex II. Note replacement of vehicles in Yr 8 and every 6 years thereafter but only 20% applicable to the project. Operating costs from year 9 onwards are estimated to run at 20% of previous figure.

<sup>2/</sup> Yield assumptions are as follows:  
 First rotation -  $4.7 \text{ m}^3/\text{ha}/\text{year}$   
 Second rotation -  $7.5 \text{ m}^3/\text{ha}/\text{year}$   
 Third rotation -  $6.5 \text{ m}^3/\text{ha}/\text{year}$   
 Fourth rotation -  $6.0 \text{ m}^3/\text{ha}/\text{year}$

<sup>3/</sup> Assuming a six-year rotation. Planting started during the 1981/82 season.

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## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 3: Estimated Fuelwood and Pole Production and Value

## IA and OG Plantations

Planting Season	Project Year	Area Planted 1/		Total	Production		Unit Price		Gross Value of Production		
		Fuelwood	Poles		Fuelwood 2/	Poles 3/	Fuelwood 4/	Poles 5/	Fuelwood	Poles	Total
		(ha)		(m <sup>2</sup> 000)		(000)	(MK/m <sup>3</sup> solid)	(MK/unit)	(MK 000)		
1980/81	1	-	-	-	-	-	-	-	-	-	-
1981/82	2	963.0	642.0	1,605	-	-	-	-	-	-	-
1982/83	3	1,810.8	1,207.2	3,018	-	-	-	-	-	-	-
1983/84	4	2,441.4	1,627.6	4,069	-	-	-	-	-	-	-
1984/85	5	2,796.6	1,864.4	4,661	-	-	-	-	-	-	-
1985/86	6	154.3	102.8	257	-	-	-	-	-	-	-
	7	-	-	-	-	-	3.9	1.0	-	-	-
	8	-	-	-	27.2	578	4.1	1.0	112	578	690
	9	-	-	-	51.1	1,086	5.1	1.0	261	1,086	1,347
	10	-	-	-	68.8	1,465	5.9	1.0	406	1,465	1,871
	11	-	-	-	78.9	1,678	6.7	1.0	529	1,678	2,207
	12	-	-	-	4.4	93	7.7	1.0	34	93	127
	13	-	-	-	-	-	8.9	1.0	-	-	-
	14	-	-	-	43.3	1,156	10.3	1.0	446	1,156	1,602
	15	-	-	-	81.5	2,173	11.9	1.0	970	2,173	3,143
	16	-	-	-	109.9	2,930	13.6	1.0	1,495	2,930	4,425
	17	-	-	-	125.8	3,356	15.3	1.0	1,925	3,356	5,281
	18	-	-	-	6.9	185	15.3	1.0	106	185	291
	19	-	-	-	-	-	15.3	1.0	-	-	-
	20	-	-	-	37.6	642	15.3	1.0	575	642	1,217
	21	-	-	-	70.6	1,207	15.3	1.0	1,080	1,207	2,287
	22	-	-	-	95.2	1,628	15.3	1.0	1,457	1,628	3,085
	23	-	-	-	109.1	1,864	15.3	1.0	1,669	1,864	3,533
	24	-	-	-	6.0	103	15.3	1.0	92	103	195
	25	-	-	-	-	-	15.3	1.0	-	-	-
	26	-	-	-	34.7	642	15.3	1.0	531	642	1,173
	27	-	-	-	65.2	1,207	15.3	1.0	998	1,207	2,205
	28	-	-	-	87.9	1,628	15.3	1.0	1,345	1,628	2,973
	29	-	-	-	100.7	1,864	15.3	1.0	1,541	1,864	3,405
	30	-	-	-	5.6	103	15.3	1.0	86	103	189

1/ It is assumed that 40% of the total planted area would be for pole production.

2/ 60% of fuelwood production as calculated in Tables 1 and 2

3/ Yield assumptions as follows:

First rotation - 900 poles/ha

Second rotation - 1,800 poles/ha

Third rotation - 1,000 poles/ha

Fourth rotation - 1,000 poles/ha

4/ SAR Second Wood Energy Project - projected stumpage rates in 1986 prices.

5/ Weighted average price calculated as follows:

	Price of poles	Prod. (%)
6 cm diameter	0.14	10
6-8 cm "	0.21	10
12-14 cm "	0.58	30
18-20 cm "	1.15	20
22-24 cm "	1.84	20
24 cm "	2.00	10



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## NDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 5: Economic Returns to Plantations

Project Year	Economic Costs <sup>1/</sup>	Kerosene			Charcoal			Depletion of Indigenous Forest		
		Fuelwood Valued at Cost of Kerosene <sup>2/</sup>	Total EC Value <sup>3/</sup>	Net Benefits	Fuelwood Valued at Cost of Charcoal <sup>4/</sup>	Total EC Value <sup>3/</sup>	Net Benefits	Fuelwood Depletion <sup>5/</sup>	Total EC Value <sup>3/</sup>	Net Benefits
1	465	-	-	(465)	-	-	(465)	-	-	(465)
2	2,354	-	-	(2,354)	-	-	(2,354)	-	-	(2,354)
3	3,126	-	-	(3,126)	-	-	(3,126)	-	-	(3,126)
4	2,002	-	-	(2,002)	-	-	(2,002)	-	-	(2,002)
5	1,876	-	-	(1,876)	-	-	(1,876)	-	-	(1,876)
6	1,150	-	-	(1,150)	-	-	(1,150)	-	-	(1,150)
7	1,466	-	-	(1,466)	-	-	(1,466)	-	-	(1,466)
8	1,670	1,586	2,164	494	726	1,304	(366)	620	1,198	(578)
9	366	2,979	4,065	3,699	1,369	2,455	2,089	1,165	2,251	(1,162)
10	366	4,011	5,476	5,110	1,837	3,302	2,936	1,569	3,034	(2,227)
11	366	4,600	6,278	5,912	2,107	3,785	3,419	1,799	3,477	(2,565)
12	366	257	350	(16)	117	120	(156)	100	193	(83)
13	366	-	-	(366)	-	-	(366)	-	-	(366)
14	443	2,524	3,680	3,237	1,156	2,312	1,869	987	2,143	(1,869)
15	366	4,751	6,924	6,558	2,176	4,349	3,983	1,858	4,031	(2,073)
16	366	6,407	9,337	8,971	2,934	5,864	5,498	2,506	5,436	(2,934)
17	366	7,334	10,690	10,324	3,359	6,715	6,349	2,868	6,224	(3,359)
18	366	402	587	221	184	369	3	157	342	(165)
19	366	-	-	(366)	0	-	(366)	-	-	(366)
20	443	2,192	2,834	2,361	1,004	1,646	1,203	857	1,499	(1,004)
21	366	4,116	5,323	4,957	1,885	3,092	2,726	1,610	2,817	(1,885)
22	366	5,550	7,178	6,812	2,542	4,170	3,804	2,171	3,799	(2,542)
23	366	6,361	8,225	7,859	2,913	4,777	4,411	2,487	4,351	(2,913)
24	366	350	453	87	160	263	(103)	137	240	(103)
25	366	-	-	(366)	-	-	(366)	-	-	(366)
26	443	2,023	2,665	2,222	926	1,568	1,125	791	1,433	(926)
27	366	3,801	5,008	4,642	1,741	2,948	2,582	1,487	2,694	(1,741)
28	366	5,125	6,753	6,387	2,347	3,975	3,609	2,004	3,632	(2,347)
29	366	5,871	7,735	7,379	2,689	4,553	4,187	2,296	4,160	(2,689)
30	366	326	429	63	150	253	(113)	128	231	(113)

ERR: 16.3%

ERR: 10.4%

ERR: 9.4%

<sup>1/</sup> Financial Costs + Rental Cost (Mk 10/ha) as proxy for opportunity cost of land.<sup>2/</sup> Fuelwood valued at cost of kerosene: MK 58.3/m<sup>3</sup>.<sup>3/</sup> Including value of poles (from Table 3).<sup>4/</sup> Fuelwood valued at cost of charcoal: MK 26.7/m<sup>3</sup>.<sup>5/</sup> Fuelwood valued at cost of depletion of indigenous forest: MK 22.8/m<sup>3</sup>.

## MALAWI

## NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 1: Nurseries Component - Costs in Current Terms

Category	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88 <sup>1/</sup>	Total
	(MK'000)								
<b>Investment Costs</b>									
Roads	-	0.6	-	-	-	-	-	-	0.6
Bridges	-	0.6	-	-	-	-	-	-	0.6
Water Supply	-	-	1.2	-	-	-	-	-	1.2
Housing	98.7	24.7	3.2	(0.3)	3.6	-	-	-	129.9
Store Buildings	-	0.2	-	0.6	-	-	-	-	0.8
Workshops and Garages	-	1.0	0.2	-	-	-	-	-	1.2
Other Buildings	-	1.2	-	1.8	0.6	-	-	-	3.6
Vehicles	11.0	-	-	19.0	-	-	-	47.6	77.6
Office Equipment	9.6	-	-	-	-	-	-	-	9.6
Field Equipment	36.4	0.8	0.3	0.1	-	0.6	1.6	-	38.9
Extension Aids	-	4.2	1.1	-	-	-	-	-	5.3
<b>Total Investment Costs</b>	<b>155.7</b>	<b>33.3</b>	<b>6.0</b>	<b>21.2</b>	<b>4.2</b>	<b>0.6</b>	<b>1.6</b>	<b>47.6</b>	<b>270.2</b>
	(MK'000)								
<b>Operating Costs</b>									
Forestry Operation - Labor	94.4	65.7	41.1	36.6	102.6	141.5	165.7	176.9	824.5
Overhead - Personnel	-	9.1	25.1	32.6	13.1	2.8	23.0	16.6	122.3
- Office	-	0.1	0.1	0.1	0.3	0.2	0.4	2.7	3.9
Maintenance Costs	-	0.4	-	0.3	1.7	0.4	14.5	7.2	24.5
Motor Vehicles Expenses	-	19.8	14.8	17.8	31.3	17.0	54.4	37.7	192.8
Field Inputs	-	6.8	9.1	9.2	16.6	51.5	29.7	6.9	129.8
<b>Total Operating Costs</b>	<b>94.4</b>	<b>101.9</b>	<b>90.2</b>	<b>96.6</b>	<b>165.6</b>	<b>213.4</b>	<b>287.7</b>	<b>248.0</b>	<b>1297.8</b>
<b>TOTAL NURSERIES COSTS</b>	<b>250.1</b>	<b>132.2</b>	<b>96.2</b>	<b>117.8</b>	<b>169.8</b>	<b>214.0</b>	<b>289.3</b>	<b>295.6</b>	<b>1568.0</b>

<sup>1/</sup> Estimated.

MALAWINRP II WOOD ENERGY PROJECT (CREDIT 992-MAL)PROJECT COMPLETION REPORTTable 2: Local Authority Plantation Component - Costs in Current Terms

Category	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88 <sup>1/</sup>	Total
	(MK'000)								
<u>Investment Costs</u>									
Roads	0.5	2.6	9.1	4.0	1.3	1.1	-	3.4	22.0
Bridges	-	8.1	-	0.4	0.1	-	-	-	8.6
Boreholes	-	0.2	(0.1)	-	-	-	-	-	0.1
Water Supply	-	2.7	0.1	-	-	-	-	-	2.8
Electricity	0.2	-	-	-	-	-	-	-	0.2
Housing	-	145.8	56.8	(3.2)	0.9	-	-	-	199.4
Offices	-	0.8	-	-	-	-	0.4	-	2.1
Store Buildings	-	1.0	0.9	-	-	-	0.6	-	2.5
Workshops and Garages	-	-	0.9	-	-	-	-	-	0.9
Other Buildings	-	4.2	3.3	1.5	0.5	1.2	0.2	-	10.9
Fences, Beacons & Demarcation	-	0.5	-	-	-	-	9.8	-	10.3
Firebreaks	-	-	2.3	0.4	-	-	0.2	-	2.9
Vehicles	13.0	1.8	-	-	-	-	-	70.0	84.8
Office Equipment	-	-	0.1	-	0.1	-	2.6	-	2.8
Field Equipment	3.6	6.5	0.3	-	0.5	-	-	3.0	13.9
Fire Control Equipment	-	-	2.5	-	-	-	-	-	2.5
Extension Aids	-	-	0.3	-	-	-	-	-	0.3
Household Furniture	-	0.6	0.5	-	-	-	-	-	1.1
Office Furniture	-	0.3	0.3	-	-	-	4.1	-	4.7
<b>Total Investment Costs</b>	<b>17.3</b>	<b>175.1</b>	<b>77.3</b>	<b>3.1</b>	<b>3.4</b>	<b>2.3</b>	<b>17.9</b>	<b>76.4</b>	<b>372.8</b>
<u>Operating Costs</u>									
Forestry Operation - Labor	3.2	85.3	197.6	140.2	216.0	168.5	194.4	200.5	1,205.7
Overhead - Personnel	-	14.3	18.4	8.0	14.5	21.0	28.4	27.9	132.5
- Office	-	-	0.4	2.0	1.8	5.0	9.1	15.4	33.7
Maintenance Costs	0.4	0.5	2.0	0.5	0.9	2.9	11.4	12.8	31.4
Motor Vehicles Expenses	0.1	10.4	15.5	22.9	19.9	13.6	25.7	17.6	125.7
Field Inputs	0.3	4.8	55.3	13.7	35.1	2.3	12.8	15.6	139.9
<b>Total Operating Costs</b>	<b>4.0</b>	<b>115.3</b>	<b>289.2</b>	<b>187.3</b>	<b>288.2</b>	<b>213.3</b>	<b>281.8</b>	<b>289.8</b>	<b>1,668.9</b>
<b>TOTAL IA PLANTATION COSTS</b>	<b>213</b>	<b>290.4</b>	<b>366.5</b>	<b>190.4</b>	<b>291.6</b>	<b>215.6</b>	<b>299.7</b>	<b>366.2</b>	<b>2,041.7</b>

<sup>1/</sup> Estimated

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## NDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)

## PROJECT COMPLETION REPORT

Table 3: Central Government Plantation Component - Costs in Current Terms

Category	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88 <sup>1/</sup>	Total
	(MK'000)								
<u>Investment Costs</u>									
Roads	0.1	17.8	26.4	38.1	30.0	0.1	-	-	112.5
Bridges	-	11.9	3.8	5.3	3.0	1.9	0.3	-	26.2
Boreholes	-	2.3	-	8.8	5.5	-	-	-	16.6
Water Supply	-	14.1	22.5	32.9	14.7	0.1	-	1.6	85.9
Electricity	-	1.0	1.3	16.0	0.5	1.2	1.5	3.6	25.1
Housing	-	420.3	383.1	193.6	55.1	8.1	-	-	1,060.2
Offices	-	10.9	64.2	10.2	12.1	-	0.5	-	97.4
Store Buildings	-	3.3	18.1	6.8	2.2	-	-	1.3	31.7
Workshops and Garages	-	17.0	17.3	3.5	1.7	-	-	-	39.5
Other Buildings	-	0.6	1.6	2.5	0.4	0.8	3.3	1.7	10.9
Fences, Beacons & Demarcation	0.4	-	0.2	0.2	0.6	0.5	1.6	-	3.5
Firebreaks	-	3.7	(2.3)	1.2	-	1.6	-	-	4.2
Vehicles	89.2	-	48.3	0.2	0.2	-	-	300.6	438.5
Mobile Plants	37.4	15.7	15.9	-	-	-	-	-	69.0
General Stationary	-	35.3	-	-	-	-	-	-	35.3
Office Equipment	-	-	2.6	0.4	0.4	2.1	-	-	5.5
Field Equipment	14.1	4.1	6.1	0.3	-	0.3	2.4	1.1	28.4
Fire Control Equipment	-	-	27.1	-	-	-	-	-	27.1
Household Furniture	-	2.1	1.9	0.2	-	-	-	-	4.2
Office Furniture	-	1.4	13.8	(1.9)	3.7	1.0	0.9	0.9	19.8
<b>Total Investment Costs</b>	<b>141.2</b>	<b>561.5</b>	<b>651.9</b>	<b>318.3</b>	<b>130.1</b>	<b>17.7</b>	<b>10.5</b>	<b>310.8</b>	<b>2,142.0</b>
<u>Operating Costs</u>									
Forestry Operation - Labor	56.1	138.1	403.7	523.5	671.4	426.8	608.2	554.9	3,382.7
Overhead - Personnel	0.5	18.3	90.2	63.9	98.1	105.8	126.2	102.7	600.7
- Office	-	-	1.8	6.4	12.6	7.7	17.3	11.9	57.7
Maintenance Costs	-	-	0.6	2.6	12.4	15.0	93.5	65.8	189.9
Motor Vehicles Expenses	1.7	50.7	64.2	100.2	149.9	106.7	141.9	103.8	719.1
Field Inputs	-	171.8	222.5	88.4	21.5	1.8	33.0	19.4	558.4
<b>Total Operating Costs</b>	<b>58.3</b>	<b>378.9</b>	<b>783.0</b>	<b>785.0</b>	<b>960.9</b>	<b>663.8</b>	<b>1,020.1</b>	<b>858.5</b>	<b>5,508.5</b>
<b>TOTAL GOV. PLANTATION COSTS</b>	<b>199.5</b>	<b>940.4</b>	<b>1,435.3</b>	<b>1,103.3</b>	<b>1,091.0</b>	<b>681.5</b>	<b>1,030.6</b>	<b>1,169.3</b>	<b>7,650.5</b>

<sup>1/</sup> Estimated

MALAWINDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 4: Wood Energy Division Component - Costain Current Terms

Category	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88 <sup>1/</sup>	Total
	(K'000)								
<u>Investment Costs</u>									
Water Suppl.	0.4	4.1	0.2	-	-	-	-	2.0	6.7
Electricity	-	0.6	5.0	0.3	-	-	-	21.2	27.1
Housing	66.7	634.6	443.2	58.9	1.4	5.8	-	-	1,210.6
Offices	-	32.5	1.8	22.0	10.5	-	-	-	66.8
Store Buildings	-	3.6	3.0	0.5	-	-	-	5.4	12.5
Workshops/Garages	-	-	0.8	-	-	-	2.3	-	3.1
Other Buildings	-	2.1	0.2	0.2	-	-	0.6	-	3.1
Fences and Beacons	-	-	-	-	-	4.0	-	-	4.0
Vehicles	228.0	3.4	0.3	17.8	-	1.3	-	229.6	480.4
Mobile Plants	-	26.8	0.2	-	-	-	-	-	27.0
Office Equipment	2.6	7.6	6.0	5.0	42.7	2.0	54.6	29.2	149.7
Field Equipment	0.3	2.0	2.3	-	-	-	5.4	6.8	16.8
Fire Control Equipment	-	0.3	-	-	-	-	-	-	0.3
Extension Aids	-	0.2	0.5	15.5	0.2	-	0.7	-	17.1
Household Furniture	-	10.2	10.3	0.2	0.2	-	-	-	20.9
Office Furniture	6.5	9.7	4.2	0.6	5.0	0.8	1.9	7.8	36.5
Library and Publications	-	0.1	-	0.5	1.3	1.5	-	-	3.4
<b>Total</b>	<b>304.5</b>	<b>737.8</b>	<b>478.0</b>	<b>121.5</b>	<b>61.3</b>	<b>15.4</b>	<b>65.5</b>	<b>302.0</b>	<b>2,086.0</b>
<u>Operating Costs</u>									
Overhead - Personnel	80.1	266.4	397.9	466.9	523.8	555.3	515.8	295.7	3,101.9
- Office	6.4	18.2	34.4	61.9	49.1	59.8	82.6	68.9	381.3
Maintenance Costs	-	0.5	1.2	2.2	11.9	6.3	35.8	20.9	78.8
Motor Vehicles Expenses	10.4	87.8	125.8	125.9	162.6	129.3	174.6	150.4	966.8
Field Inputs	-	7.7	8.4	1.6	2.0	0.7	31.0	6.8	58.2
<b>Total Operating Costs</b>	<b>96.9</b>	<b>380.6</b>	<b>567.7</b>	<b>658.5</b>	<b>749.4</b>	<b>751.4</b>	<b>839.8</b>	<b>542.7</b>	<b>4,587.0</b>
<b>TOTAL WE DIVISION COSTS</b>	<b>401.4</b>	<b>1,118.4</b>	<b>1,045.7</b>	<b>780.0</b>	<b>810.7</b>	<b>766.8</b>	<b>905.3</b>	<b>844.7</b>	<b>6,673.0</b>

<sup>1/</sup> Estimated.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 5: Energy Studies Components - Costs in Current Terms

Category	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88 <sup>1/</sup>	Total
	(K'000)								
<u>Investment Costs</u>									
Electricity	-	-	0.1	0.4	-	0.8	-	-	1.3
Housing	-	-	294.7	7.7	65.3	19.6	-	-	387.3
Offices	-	-	-	0.5	0.7	(0.6)	12.3	17.4	30.3
Workshops/Garages	-	-	0.5	0.1	0.1	0.9	15.6	5.5	22.7
Fences, Beacons & Demarcation	-	-	-	-	0.2	3.3	-	-	3.5
Charcoal Kilns	-	-	0.6	-	-	-	-	-	0.6
Vehicles	-	-	-	-	-	0.5	-	30.9	31.4
Mobile Plant	24.1	-	-	-	-	-	-	-	24.1
Office Equipment	0.2	2.1	3.3	1.5	0.5	1.9	9.1	-	18.6
Field Equipment	-	0.1	2.5	-	-	-	5.7	29.5	37.8
Extension Aids	-	-	-	-	0.8	-	-	-	0.8
Household Furniture	-	2.0	2.0	0.2	2.1	-	-	-	6.3
Office Furniture	-	0.2	5.1	1.0	2.0	0.1	-	14.2	14.2
Library and Publications	-	-	-	-	0.3	-	-	-	0.3
<b>Total Investment Costs</b>	<b>24.3</b>	<b>4.4</b>	<b>308.8</b>	<b>11.4</b>	<b>72.0</b>	<b>26.5</b>	<b>42.7</b>	<b>89.1</b>	<b>579.2</b>
<u>Operating Costs</u>									
Overhead - Personnel	-	100.2	160.8	153.3	45.0	36.4	56.9	27.9	580.5
- Office	-	3.6	6.6	11.0	20.3	8.9	15.7	3.5	69.6
Maintenance Costs	-	-	-	-	2.2	0.4	3.4	3.2	9.2
Motor Vehicles Expenses	-	2.5	8.3	11.7	23.8	12.0	21.9	6.1	86.3
Field Inputs	-	0.7	5.0	0.5	1.2	0.1	5.6	10.0	23.1
<b>Total Operating Costs</b>	<b>-</b>	<b>107.0</b>	<b>180.7</b>	<b>176.5</b>	<b>92.5</b>	<b>57.8</b>	<b>103.5</b>	<b>50.7</b>	<b>768.7</b>
<b>TOTAL ESU COSTS</b>	<b>24.3</b>	<b>111.4</b>	<b>489.5</b>	<b>187.9</b>	<b>164.5</b>	<b>84.3</b>	<b>146.2</b>	<b>139.8</b>	<b>1,347.9</b>

<sup>1/</sup> Estimated.

MALAWINRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)PROJECT COMPLETION REPORTTable 6: Charcoal Trials - Operating Cost in Current Terms

Components	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	Total
	(MK'000)								
<u>Investment Costs</u>									
Charcoal Kilns	-	3.3	-	-	-	-	-	-	3.3
Field Equipment	-	0.4	0.5	-	-	-	-	-	0.9
<b>Total Investment Costs</b>	-	3.7	0.5	-	-	-	-	-	4.2
<u>Operating Costs</u>									
Forestry Operation - Labor	-	-	0.2	0.1	-	-	-	-	0.3
Overhead - Personnel	-	0.2	0.7	-	-	-	-	-	0.9
- Office	-	-	-	-	-	-	-	-	-
Maintenance Costs	-	-	-	-	-	-	-	-	-
Motor Vehicles Expenses	-	3.0	2.4	-	-	-	-	-	5.4
Field Inputs	-	0.4	0.2	-	-	-	-	-	0.6
<b>Total Operating Costs</b>	-	3.6	3.5	0.1	-	-	-	-	7.2
<b>TOTAL CHARCOAL TRIALS COSTS</b>	-	7.3	4.0	0.1	-	-	-	-	11.4

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NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAL)

PROJECT COMPLETION REPORT

A SUMMARY OF THE WOOD YIELD SURVEY FOR NRDP II - WOOD ENERGY I PROJECT

Introduction

1. This paper summarizes the results of a yield forecast survey carried out by the Forestry Department (FD) and Forestry Research Institute of Malawi (FRIM) in September 1987. The survey concentrated on a number of areas, both in Central Government and Local Authority plantations, of varying ecological characteristics. A total of about 9,500 ha (70% of total project area) have been surveyed. The results, however, indicated a much lower Average Mean Annual Increment (MAI) than had been envisaged at appraisal, 4.7 m<sup>3</sup>/ha against an estimated 10-14 m<sup>3</sup>/ha.

2. Several reasons appear to have contributed to this low productivity, some of which are highlighted in the survey report. In addition, some problems arose due to lack of proper planning, since this was the first time that the Department of Forestry had undertaken such a large fuelwood/pole plantation program.

Problems Contributing to Lower Yields

3. Listed below are the main problems affecting each plantation unit surveyed and probably affecting plantation units within similar ecological sites.

a) Local Authority Plantations. These plantations were mostly situated on marginal lands such as bare hills and areas of low fertility, as indicated by low farming activities when they were acquired. This was the only land available for tree planting in the five districts of Karonga, Kasungu, Lilongwe, Zomba and Blantyre. The principal problems contributing to the low productivity of the plantations are considered to be the following:

i) Mpemba (159 ha) (Blantyre): The low MAI for this plantation of 4.2 m<sup>3</sup>/ha was blamed on an inappropriate choice of species and on the droughts experienced in 1983 and 1986/87;

- ii) Namisu (112 ha) (Blantyre): This plantation is located in a dry area with low rainfall, which is an important factor contributing to the below average MAI of 3.8 m<sup>3</sup>/ha, although poor management is thought to be the principal cause;
- iii) Likangala, Naisi and Mulinda (218 ha) (Zomba): These three areas had MAIs of 8.7 m<sup>3</sup>/ha, 10.2 m<sup>3</sup>/ha and 6.2 m<sup>3</sup>/ha respectively which, although above the overall average of 4.7 m<sup>3</sup>/ha, are nevertheless below the project appraisal target of 10-14 m<sup>3</sup>/ha. This is attributed mainly to management problems, especially during the first year after establishment;
- iv) Namilongo (99 ha) (Zomba): The poor MAI of 3.4 m<sup>3</sup>/ha achieved on this plantation is due to the difficult physical characteristics of the terrain, i.e. a high incidence of rocky outcrops and thin soil in some areas, which permanently affect tree growth;
- v) Mbalame and Chimvuwo (242 ha) (Lilongwe): The problems associated with low MAIs for these plantations of 3.6 m<sup>3</sup>/ha and 5.4 m<sup>3</sup>/ha respectively were mainly poor tending and, at Chimvuwo, inappropriate choice of species. Gmelina arborea, near Chimvuwo, is doing very well;
- vi) Chipokosa and Mchezi/Chiuta (338 ha) (Kasungu): The major problems on these plantations are associated with poor tending and soil of low productivity: laterite in the soil hinders root penetration. The MAIs were found to be 1.1 m<sup>3</sup>/ha and 4.2 m<sup>3</sup>/ha respectively;
- vii) Ngara and Ighembe (281 ha) Karonga): The productivity of Ngara is low due to waterlogging in low lying areas and termite attacks in the upland. These problems, together with poor tending, contributed to a low MAI of 2.2 m<sup>3</sup>/ha. In the case of Ighembe, the terrain is more favourable and there is potential to reach an MAI above 8.7 m<sup>3</sup>/ha. On both sites, part of their areas has suffered damage by fire.

b) Central Government Plantations

- i) Thuchila (1,944 ha) (Blantyre): The potential at Thuchila is high and it is felt that an MAI above 9.5 m<sup>3</sup>/ha could have been achieved, particularly if the area were planted to E. tereticornis and E. saligna.

- ii) Bangwe (275 ha) (Blantyre): The main problems associated with the low MAI of  $6.8 \text{ m}^3/\text{ha}$  at this site are inappropriate choice of species in some parts of Bangwe, and inadequate tending operations in the first years after planting;
- iii) Matukuta; Naminyanga and Nsuluzi (1,625 ha) (Zomba): The above sites are located in drier parts of Machinga and Malosa forest reserve. The MAIs of  $4.8 \text{ m}^3/\text{ha}$  and  $3.2 \text{ m}^3/\text{ha}$  respectively were due to inadequate tending operations because of the ambitious planting target, and fire damage, especially at Naminyanga and Matukuta;
- iv) Katete (3,053 ha) Lilongwe: This plantation was found to have an MAI of  $3.0 \text{ m}^3/\text{ha}$ , the main reasons apparently lack of weeding and lack of fertilizer application particularly on the area planted in the 1984/85 season, which represented 1/3 of the total area planted. Eucalyptus camaldulensis has also been found to have a lower MAI than E. tereticornis;
- v) Ngara (1,129 ha) (Dowa): This plantation had the lowest MAI, at  $0.8 \text{ m}^3/\text{ha}$ , which was attributed mainly to poor management. The area was not weeded properly and there have been frequent outbreaks of fire. In some areas, laterite in the soil hinders root penetration.

MALAWI  
NRDP II WOOD ENERGY PROJECT (CREDIT 992-MAI)  
PROJECT COMPLETION REPORT

Central Government Plantations - Present Wood Yields and Forecasts 1/

		Area (ha)	Density (trees/ha)	-----MAI (m <sup>3</sup> )-----		-----Remarks-----
				Survey 1987	Forecasts	
<u>Central Region:</u>	Katete	3,053	1,237	3.0	6.0	Some plots not fertilized, heavy planting targets during establishment. Weeds.
	Ngara	1,129	1,316	0.8	1.0	Soil (laterite), fire, poor management.
<u>Southern Region:</u>	Naminyanga	925	1,233	4.9	5.5	(Eucalyptus C and T were the correct choice. Management is the main problem. Due to weeds (some plots were damaged by fire.
	Matukuta	250	1,342	4.8	5.5	
	Nsaluzi	450	1,207	3.2	4.0	
	Thuchila	1,944	1,380	9.5	12.0	Cultivated and fertilized. Controlled burning done.
	Bangwe	275	n.s.	6.8	8.5	n.s.
<u>Total Area:</u>		<u>8,026</u>				
MAI Weighted Average (m <sup>3</sup> )				4.7	6.7	

1/ Based on yield survey carried out by the Department of Forestry and FRIM in 1987.

MALAWI  
NROP II WOOD ENERGY PROJECT (CREDIT 992-MAI)  
PROJECT COMPLETION REPORT

Local Authority Plantations - Present Wood Yields and Forecasts 1/

	Area (ha)	Density (trees/ha)	-----MAI (m <sup>3</sup> )-----		-----Remarks-----	
			Survey 1987	Forecasts		
<u>Northern Region:</u>						
	Ngala	98	1,165	2.2	3.0	Termites, fire, poor tending, water logging.
	Lhembe	163	1,498	8.7	12.0	Overgrow of weeds.
<u>Central Region:</u>						
	Chipokosa	238	1,548	1.1	2.5	Soil (laterite). Some plots not fertilized.
	Mchezi/Chiuta	130	1,533	4.2	5.0	Plots not fertilized in the first year.
	Mbalane	134	1,409	3.6	5.0	Poor management, eucalyptus Cam. not very productive.
	Chivuvu	108	1,418	5.4	7.0	----
<u>Southern Region:</u>						
	Nanisu	112	1,282	3.8	5.0	Management, weeds, fire, P85 not fertilized.
	Likangala	88	1,332	8.7	12.0	(Eucalyptus T. satisfactory. The plots were cultivated and fertilized during establishment, Naisi already filled.
	Naisi	56	1,128	10.2	12.5	
	Mulinda	74	1,359	6.2	7.5	
	Namilongo	90	1,437	3.4	4.0	Eucalyptus C. not very productive. Some blocks not fertilized.
	Mpesha	159	n.s.	4.2	5.5	n.s.
<u>Total Area:</u>	<u>1,449</u>					
MAI Weighted Average (m <sup>3</sup> )				4.7	6.4	

1/ Based on yield survey carried out by the Department of Forestry and FRIM in 1987.

