Land Resources Development Centre

FOREST DEVELOPMENT IN RELATION TO THE NORTHERN REGION IRRIGATION REHABILITATION PROJECT IN THE NILE PROVINCE OF SUDAN

R J WEDDERBURN & M ERRINGTON

P 158

LRDC
Land Resources Development Centre
Overseas Development Administration

FOREST DEVELOPMENT IN RELATION TO THE NORTHERN REGION IRRIGATION REHABILITATION PROJECT IN THE NILE PROVINCE OF SUDAN

R J WEDDERBURN & M ERRINGTON

Land Resources Development Centre
Tolworth Tower, Surbiton, Surrey KT6 7DY, England.

1985

CONTENTS

ABBREVIATIONS

NRIRP	Northern Regions Irrigation Rehabilitation Project (supported by ODA)
NAPC	Northern Agricultural Production Corporation
GOS	Government of Sudan
ODA	Overseas Development Administration (UK)
JAP	Joint Afforestation Project
SCC	Sudan Council of Churches
CFA	Central Forest Administration
RFS	Regional Forest Service
NGO	Non Governmental Organistion

SUMMARY

The report examines the present state of the forestry sector in the Nile Province, as well as forest products currently traded, and makes recommendations for possible ODA assistance for a small-scale forestry development which would serve to protect the already established agricultural irrigation schemes run by NAPC.

Parts 1-3 cover the Terms of Reference and the physical and social environment of the area; in Part 4 the present Government Forest Organisation and Policy is described, while Part 5 looks at the marketing aspects and prices of forest products - fuelwood, charcoal, building poles, fruit, rope, mats.

Part 6 describes forest activities currently taking place in the Nile Province.

Proposals and recommendations (Part 7), are largely of an investigatory/ demonstration nature designed to point the way for further forest developments in the Nile Province. A financial analysis of the overall project proposals is included in Part 7.

PART 1 INTRODUCTION

1.1 ORIGIN AND OBJECTIVES OF PRESENT STUDY

This Report examines certain aspects of the forestry sector in the Nile Province of Sudan. It follows the agreement between the Government of Sudan (GOS) and the British Overseas Development Administration (ODA) to set up the Northern Region Irrigation Rehabilitation Project (NRIRP), a programme of assistance to the irrigated farming sector in the Northern Region, focussed initially on the Northern Agricultural Production Corporation (NAPC) in the Nile Province.

British Missions visited the NRIRP area during 1982 and 1983 and discussions held with Sudanese officials covering a range of subjects including the Joint Afforestation Project (JAP) implemented by the Central Forest Administration (CFA) of the GOS and the Sudanese Council of Churches (SCC). One conclusion was that a clearer idea was required of the ultimate objectives of forestry work in the Nile Province, and a study was recommended to identify the present and future demand and supply patterns for forest products. The study would ascertain key areas (in terms of location and forest product characteristics) where investment is required to help meet expected future supply shortfalls.

1.2 TERMS OF REFERENCE

A two-man team, comprising a forester and an agricultural/socio-economist visited Sudan during March-May 1985 (see Appendix 8 for programme of work) to undertake the proposed study. Terms of Reference are set out below:

1.2.1 Forester

ODA are embarking on a programme of assistance to the irrigated farming sector in Northern Region focussed initially on the Northern Agriculture Production Corporation schemes in Nile Province. The project is called the Northern Region Irrigation Rehabilitation Project (NRIRP). As part of NRIRP ODA wish to assist in the forestry sector in view of the growing pressure of human and animal populations on Nile Province forest resources.

To help define the objectives of a NRIRP forestry component, a study is required to investigate:

a. the demand for forest products (including but not restricted to fuel wood, charcoal, fodder and building poles) by the town dwellers, farmers and nomads and by their animals within a few miles of the River Nile between the Fifth and Sixth Cataracts;

b. the supply to meet the above demand;

c. the possibility of developing plantations to meet the demands identified at a.

The forester will have discussion with the Forestry Department staff at Regional and Central level, draw on past records and look at existing irrigated and dry land plantations in Sudan. The forester will also have discussions with farmers, nomads and local officials to come to an understanding of the forestry problems from the consumer's point of view.

The forester's terms of reference are as follows:

1. Make recommendations as to how to grow the various products identified by the socio-economist focussing particularly on:

   firewood and poles
   browse
   other requirements, fruit, medicine.

   The recommendations should include areas required, species recommended and growth rates assumed. Assuming irrigation water will be necessary, the amount required should be estimated.

2. Recommend measures needed to provide the indirect benefits from forestry:

   measures and species to halt encroaching sand
   windbreaks to reduce the dessicating winds.

3. Indicate the number, location and size of forest nurseries.

4. Liaise with the socio-economist and recommend how the local people are to be involved in establishment, maintenance and harvesting phases of the plantations.

5. In collaboration with the socio-economist draw up an outline forestry project proposal. The project should be located on those NAPC schemes where irrigation water is most likely to be made available for forestry work in the next few years. The proposal should indicate staff requirements (both Sudanese and expatriate), costs by year (showing local and offshore costs separately), and expected outputs by year (projecting production volumes of different forestry products and areas of land protected from sand encroachment and dessicating wind).

1.2.2 Agricultural/socio-economist

ODA are embarking on a programme of assistance to the irrigated farming sector in Northern Region focussed initially on the Northern Agriculture Production Corporation schemes in Nile Province. The project is called the Northern Region Irrigation Rehabilitation Project (NRIRP). As part of NRIRP ODA wish to assist in the forestry sector in view of the growing pressure of human and animal populations on Nile Province forest resources.

To help define the objectives of a NRIRP forestry component, a study is required to investigate:

a. the demand for forest products (including but not restricted to fuel wood, charcoal, fodder and building poles) by the town dwellers, farmers and nomads and by their animals within a few miles of the River Nile between the Fifth and Sixth Cataracts;

b. the supply to meet the above demand;

c. the possibility of developing plantations to meet the demands identified at a.

It is envisaged that the study findings would be based on market surveys, review of relevant official records, and discussions with farmers, towns-people, nomads, traders, officials and others in Nile Province. The terms of reference are as follows:

1. Provide rough quantification wherever possible, describe

   a. the spatial and seasonal patterns of demand and supply flows for different forest products;

   b. the institutional arrangements underlying these flows, highlighting the roles of family-gatherers, commercial gatherers/producers, middlemen, retailers and others, and the methods by which prices are set.

2. For the more important forest products demanded and highlighting spatial variation, present data on

   a. prices over the past two or three years, highlighting important seasonal variations and providing conversion factors between local measurements and SI units;

   b. preferred and most common varieties, providing local and botanical names;

   c. preferred specifications and sizes for building poles etc.

3. Highlight any recent changes in the spatial, seasonal or institutional patterns of demand and supply flows as might be indicated by growing shortages and rising real prices. Taking into account the likely effect of existing forestry programmes, and providing rough quantification wherever possible, project demand and supply for different forestry products in different demand zones to identify areas of prospective serious shortfall.

4. Draw attention to the implication for disadvantaged groups of present trends and possible future forestry policies.

5. Make recommendations about where ODA forestry assistance should be concentrated geographically and in terms of choice of forest product characteristics, establishing if possible a priority ranking of different areas/NAPC schemes and of different forest production characteristics.

6. In collaboration with the forester draw up an outline forestry project proposal on a limited scale. The Project should be located on those NAPC schemes where irrigation water is most likely to be made available for forestry work in the next few years. The proposal should indicate staff requirements (both Sudanese and expatriate), costs by year (showing local and offshore costs separately), and expected outputs by year (projecting production volumes of different forestry products and areas of land protected from sand encroachment and dessicating wind).

7. Liaise with the forester and indicate how the people can be involved at the establishment, maintenance and harvesting phases of the project.

1.3 ACKNOWLEDGEMENTS

The authors would like to express their gratitude to all those both within the Government of Sudan and elsewhere who helped to make their assignment so enjoyable. Hospitality and friendliness, despite very trying times, were second to none and will be long remembered.

PART 2 THE NRIRP PROJECT AREA

2.1 NRIRP

Following preliminary appraisal studies, the Sudanese Government and the British Overseas Development Administration (ODA) signed an agreement and memorandum in 1983 to initiate the Northern Region Irrigation Rehabilitation Project (NRIRP).

The main aims of NRIRP are to assist NAPC to provide a more secure supply of inputs to its farmers in order to improve agricultural production; to ensure a more cost effective use of resources and to enable NAPC to function independently of government subsidy.

Phase 1 of the project, which is scheduled to run from 18 January 1984 to 31 March 1986, has already included a study undertaken by Sir M. MacDonald and Partners and associated firms. An interim report has been produced and recommendations put forward for consideration by ODA and the NAPC Board of Management during early 1985.

Phase 1 aimed to overcome NAPC's shortage of spares, provide some essential items of capital equipment and begin to tackle its institutional problems. In addition to the study referred to above, Phase 1 also includes the provision of expatriate TCO inputs (Workshops, Supplies and Civil Engineering Advisers) and as the project recognises the importance of afforestation, a short-term study designed to assist in the forestry sector. This study is the subject of the present report, (see Terms of Reference in Section 1.2).

2.2 LOCATION

The overall NRIRP project area is located within the two provinces, the Nile and the Northern which together form the Northern Region of Sudan. It lies between latitudes 16° and 20° N and longitudes 32° and 35° E (Text Map 1). The total area of the Northern Region is about 477,074 km^2; within the region the Nile Province covers an area of 120,807 km^2 and the Northern Province 356,267 km^2.

2.3 PHYSICAL ENVIRONMENT

2.3.1 Climate

The Northern Region lies within desert and semi-desert areas and has an annual rainfall varying between 0 and 300 mm. Rainfall in the Nile Province (which normally falls during the months June to September) has not exceeded 100 mm (4") a year since 1973.

The summer season with high temperatures and low humidity extends from April to October. May and June are the hottest months with mean daily maximum temperatures around 42°C and relative humidity of about 25%. The coldest month in the Nile Province is January with a mean daily minimum temperature of 22°C.

Winds are usually north or north-east during October to May. During the time of the year when rain can occur, the prevailing wind tends to be from the south-west. Blowing from the desert, the winds are hot and dry in summer and cool and dry in winter. Wind velocity rarely exceeds 14 kph (8 mph), except during the frequent dust storms that build up over the desert.

Climatological data for two areas, Atbara and Shendi are shown in Tables 1 and 2, while more recent rainfall data for Atbara, presented in Table 3, exemplifies its erratic nature which has resulted in severe drought over recent years throughout Nile Province.

2.3.2 Geology and Soils

A detailed account of the geology and soils of the area was provided in the Roseires Soil Survey Report No 5 (Sir M. MacDonald, 1964) and summarised by Berry (1978):

'The underlying bedrock consists of Pre-cambrian granites, gneiss and mica schists with quartzite. The granite, where outcrops appear as small hills, weathers to give quantitives of waterborne sand.

Later deposits of Cretaceous Nubian sandstones are widespread, particularly occurring near the Nile, and consists of flat-bedded sandstones, mudstones and conglomerates, giving rise to lowlying rock outcrops and gravel ridges. The surface soil deposits overlying these formations are the qoz sands (deposited by wind under arid conditions), clay plains and laterites. Along the banks of the Rivers Nile and Atbara are the narrow beds of silty alluvia varying from 50 to 1000 m in width. In general, the area is dominated by shifting sands in sheets and dunes, with occasional alluvial depressions with loams and clays associated with dry watercourses (wadis).

2.3.3 Natural Vegetation

In the Nile Province where annual rainfall can approach 300 mm per year in the southern part, the vegetation is typically semi-arid with *Acacia tortilis - Maerua crassifolia* scrub association, (Berry 1978).

Tree species, characteristics of the area include *Acacia tortilis* sub species *raddiana*, *Acacia ehrenbergiana*, *Acacia seyal*, *Balanites aegyptiaca* and *Ziziphus spinachristi*.

Shrub species commonly reported (Berry, 1978) were *Calotropis procera*, *Capparis decidua* and the zerophyte *Leptadenia pyrotechnica*.

Berry (1978) also reported infrequent occurrence of grass species: Aristida mutabilis, Cymbogon nervatus and Panicum sp. Outside the NAPC schemes virtually no grass cover was observed during the present study.

TABLE 1 Climatological data - Atbara, 1951-1980

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Rainfall (mm)	-	-	-	TR	4	1	24	30	6	2	-	-	67
Daily minimum temperature °C	14.4	15.7	18.7	22.3	26.1	28.2	27.3	26.8	27.3	24.7	20.4	16.0	-
Daily maximum temperature °C	30.2	32.5	36.2	39.6	42.4	42.9	40.4	39.5	41.0	39.3	34.8	31.0	-
Daily mean temperature °C	22.3	24.1	27.5	31.1	34.3	35.5	33.9	33.1	34.1	32.0	27.6	23.5	-
Relative humidity %	34	28	21	19	19	21	34	40	29	27	35	37	-
Mean wind speed (kph)*	9.7	11.3	9.7	8.1	6.4	8.1	8.1	8.1	6.4	6.4	8.1	9.7	-
Prevailing wind direction*	N	N	N	N	N	N	SW	SSW	SSW	N	N	N	-

* 10 year average

Source: Sudan Meteorological Department, Khartoum

TABLE 2 Climatological data - Shendi, 1951-1980

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Rainfall (mm)	TR	TR	0	TR	2	4	27	51	16	1	0	0	101
Daily minimum temperature °C	14.4	16.0	19.1	22.2	26.1	27.9	25.9	25.1	26.6	24.9	19.6	15.4	-
Daily maximum temperature °C	30.7	32.9	36.5	39.8	42.1	42.2	39.3	38.1	38.4	39.1	33.9	30.3	-
Daily mean temperature °C	22.7	24.5	27.8	31.0	34.1	35.0	32.6	31.6	32.5	32.0	26.7	22.9	-
Relative humidity %	34	27	22	19	19	20	32	40	32	28	29	32	-
Mean wind speed (kph)*	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	-
Prevailing wind direction*	NE	NE	NE	NE	NE	SW	SW	SW	SW	NE	NE	NE	-

* 9 year average

Source: Sudan Meteorological Department, Khartoum

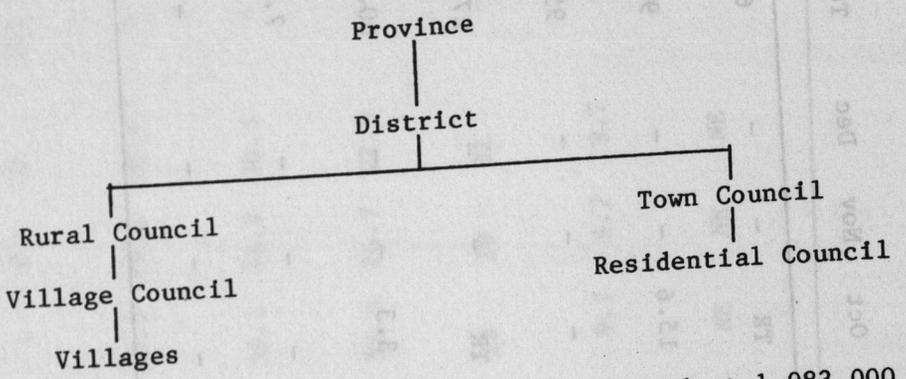
TABLE 3 Rainfall (mm) in recent years (1978 - 1984). Atbara, Nile Province

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1978	-	-	-	-	-	-	56.8	29.2	4.8	TR	-	-	69.0
1979	TR	-	-	-	TR	-	0.1	14.2	65.6	15.6	-	-	90.8
1980	-	-	TR	-	7.7	3.3	28.6	6.5	-	-	-	-	95.5
1981	TR	-	-	1.5	-	TR	10.7	2.0	12.8	TR	-	-	27.0
1982	TR	-	TR	0.5	1.5	1.7	19.3	16.6	17.6	3.3	-	-	60.5
1983	0.8	-	-	-	-	-	6.4	-	TR	-	-	-	7.2
1984	-	-	TR	-	-	-	TR	TR	TR	-	-	-	-

Source: Forest Office, Ed Damer

2.4 POPULATION AND THE LOCAL ADMINISTRATIVE STRUCTURE

The Northern Region of Sudan is made up of two provinces, the Northern Province and the Nile Province. Within each province, administrative units are successively sub-divided down to village (in the rural areas) or to residential area (in the towns) as illustrated below:



Total population of the Northern Region was estimated at 1,083,000 (1983 Census) representing 5.3% of Sudan's total population of 20,564 000.

Population within the Nile Province by administrative unit is presented in Table 4, while population data by selected villages in the Southern District of the Nile Province are to be found in Appendix 1.

1973 Census data show settled population of the main towns of the Nile Province to have been:

	1973	1983	Average % annual increase
Berber	11,300	14,425	2.77
Atbara	66,110	73,009	1.04
Ed Damer	17,080	25,345	4.84
Shendi	24,160	34,505	4.28

Comparing the 1973 levels with the latest 1983 figures taken from Table 4, allows average annual increases to be calculated.

The lower annual increase in the case of Atbara may be explained by it being a more industrial town - Atbara is a Sudanese Railway town - and hence more influenced by "modern" ideas.

The figures for Ed Damer and Shendi, both more 'rural' towns, are well above the UN estimate of annual population increase in the whole of Sudan of 2.9%.

TABLE 4 Population in the Nile Province by administrative unit, 1983

Administrative Unit	Headquarters	Settled Population				Nomadic Population			
		Households heads	Male	Female	Total	Households heads	Male	Female	Total
NORTHERN DISTRICT (AREA) COUNCIL	Berber								
Urban Councils:									
Berber Town Council	Berber	2,305	6,363	8,062	14,425	-	-	-	-
El Bauga Town Council	El Bauga	662	2,073	1,902	3,975	8	35	10	45
Abu Hamad Town Council	Abu Hamad	1,982	5,799	6,485	12,284	-	-	-	-
Rural councils:									
Abu Hamad Rural Council	Abu Hamad	3,574	8,805	10,947	19,752	-	-	-	-
Shirri Rural Council		3,610	10,205	11,250	21,495	739	2,100	1,981	4,081
El Shirake Rural Council		2,498	6,629	7,633	14,262	-	-	-	-
El Bauga Rural Council		1,608	3,807	4,753	8,560	193	469	400	869
Berber Rural Council		13,123	34,958	39,984	74,942	239	1,101	983	2,084
TOTAL Northern District Council		29,362	78,639	91,016	169,655	1,179	3,705	3,374	7,079
CENTRAL DISTRICT (AREA) COUNCIL	Ed Damer								
Urban Councils:									
Atbara Town Council	Atbara	11,371	38,768	34,241	73,009	-	-	-	-
Damer Town Council	Ed Damer	3,433	12,785	12,560	25,345	-	-	-	-
Ed Damer Rural Council	Ed Damer	8,561	24,702	25,624	50,326	-	-	-	-
Zeidab Rural Council	Zeidab	12,093	23,287	27,531	50,818	1,444	4,065	3,633	7,698
Sidoun Rural Council	Sidoun	5,462	14,120	12,734	26,854	-	-	-	-
TOTAL Central District Council		40,920	113,662	12,690	226,352	1,444	4,064	3,633	7,698
SOUTHERN DISTRICT (AREA) COUNCIL									
Urban Councils:									
Shendi Town Council	Shendi	5,162	17,768	16,737	34,505	-	-	-	-
Kaboushia Town Council	Kabushiya	1,134	2,703	3,531	6,234	-	-	-	-
El Matama Town Council	El Matama	954	3,511	3,810	7,321	-	-	-	-
Rural Councils:									
Shendi Rural Council	Shendi	14,637	39,137	42,835	81,972	3,424	9,282	9,677	18,959
Wad Hamid Rural Council	Wad Hamid	4,598	12,773	13,719	26,492	479	1,291	1,149	2,440
El Matama Rural Council	El Mata	9,138	22,624	27,793	50,417	688	1,861	1,704	3,565
TOTAL Southern District Council		35,623	98,516	108,425	206,941	4,590	12,434	12,530	24,964
GRAND TOTAL: Nile Province		105,905	290,817	312,131	602,948	7,213	20,204	19,537	39,741

2.5 NAPC AGRICULTURAL SCHEMES IN NILE PROVINCE

The Northern Agricultural Production Corporation (NAPC) is a government corporation, responsible to the Central Ministry of Agriculture, and operates 13 agricultural irrigation schemes in the Northern Region along the narrow strip of land bordering the banks of the River Nile.

In the Nile Province, NAPC has nine schemes; from north to south they are:

El Bauga
Fadlab
Zeidab
Aliab
Kitiab
Kelli
Kaboushia
Seyal
Gandato

Their location is shown in Text Map 1 and their more important statistical information in Table 5.

NAPC's role, financial position, management and staffing have already been reported upon in previous components of the NRIRP (Sir M. Macdonald, 1984).

For administration purposes, NAPC's schemes are sub-divided into four zones each of which has a Zone Manager:

Northern Zone, coincident with the Northern Province and administered from Gureir (outside the present study area);

Central Zone, in Nile Province and administered from Atbara; it includes El Bauga, Fadlab, Aliab and Kitiab schemes;

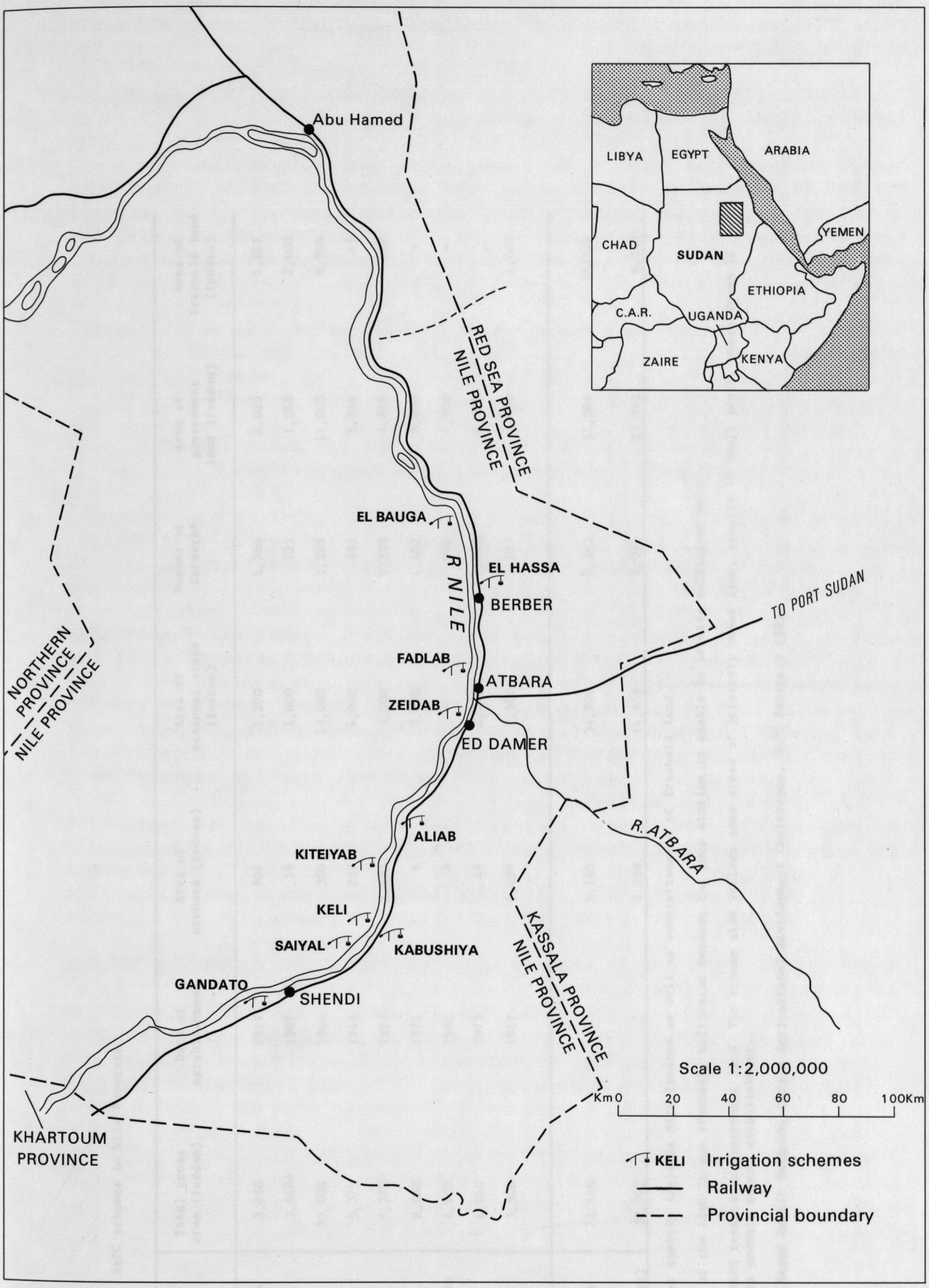
Southern Zone, also in the Nile Province and administered from Shendi; included are the Kelli, Kaboushia, Seyal and Gandato schemes.

The fourth zone, Zeidab Zone, is a single scheme Zeidab, which because of its large size and unique cropping pattern, is administered separately.

Overall NAPC headquarters is located at Ed Damer.

2.6 AGRICULTURE IN THE NILE PROVINCE

As well as the Government NAPC schemes, the agricultural sector is characterised by a diversity of production methods covering private, cooperative and company irrigation pump schemes as well as traditional irrigation schemes, some rainfed agriculture and the widespread keeping of livestock in sedentary, semi-nomadic and nomadic systems.



TEXT MAP 1 Irrigated agricultural schemes - Nile Province

P158/SUD/ME/1

Prepared by Land Resources Development Centre 1985

TABLE 5 NAPC schemes in Nile Province

Name of scheme	Total gross area (feddan)	Date of establishment	Area of orchard (feddan)	Area of seasonal crops (feddan)	Number of farmers*	Area of government land (feddan)	Area of freehold land (feddan)
El Bauga	3,650	1917	906	1,200	1,560	2,023	1,627
Fadlab	3,668+	1907	19	1,000	225	1,068	2,600
Zeidab	30,000	1904	300	18,000	1,269	21,000	9,000
Aliab	5,375	1943	287	4,000	483	5,356	19
Kitiab	5,775	1927	2,101	3,000	1,338	4,878	897
Kelli	9,000	1971	4	3,000	1,653	9,000	-
Kaboushia	4,500	1981	4	-	800	4,500	-
Seyal	6,680	1973	47	2,200	1,190	6,680	-
Gandato	3,500	1917	1,497	2,500	1,127	2,499	1,001
Total (feddan)	72,148		5,165	34,900	9,645	57,004	15,144
Total (hectares)	30,302		2,169	14,658	4,051	23,942	6,360

* Farmer numbers includes NAPC tenants as well as owners/tenants of freehold land.

\+ Most of the land is not presently cultivated because the pump station is unable to provide sufficient water.

x For NAPC tenants on Government land. The scheme also include some areas of privately owned land, usually in small plots, where freehold rights predate scheme establishment.

Source: Sayed Beshir Mahgoub, Dongla Agricultural Development Conference, NAPC February 1985.

The agricultural sector is dominated by irrigated agriculture which takes place in alluvial basins on the flood plain and a narrow alluvial strip adjacent to the Nile.

The farming year is traditionally divided into three seasons, summer (seifi), flood season (damira) and winter (shitwe).

Summer extends from April to July and, being extremely hot and dry, results in working conditions being very unpleasant. Damira, from August to October is less hot and more humid since the small amount of rainfall that can occur falls during this period. The winter season extending from late October to April is much cooler allowing relatively tolerant conditions.

Berry (1978) reported that three main cultivable practices were locally recognised:

1. Gezira or seluka:

   flood season (damira) - sorghum - irrigation not usually required because of temporary high water table.

2. Saqiya:

   flood season (damira) - sorghum, maize, 'Lubia' (Dolichos lablab)

   winter season (shitwe) - wheat, barley, tick beans (Vicia faba or 'ful masri') haricot beans (Phaseolus vulgaris or fasulia) and Dolichos lablab.

   summer season (seifi) - sorghum, lucerne (Medicayo sativa) and fruit from orchards harvested.

3. Basin cultivation:

   flood season (damira) - sorghum, Dolichos lablab, maize

   winter season (shitwe) - tick beans, haricot beans, wheat, onions, chuck peas (Cicer arietinum or hummus)

Cotton (on the NAPC Zeidab scheme) is grown during the summer season and harvested in September.

Typical yields quoted for the Nile Province are:

	Average yield kg/feddan
Summer season	
Sorghum	700
Winter season	
Faba bean	750
Haricot bean	650
Chick pea	450
Lubia	750
Wheat	750
Onion	6,000
Maize	650
Permanent crops	Yield/tree*
Dates	80 kg
Mangoes	200 - 300 fruits
Citrus	300 - 500 fruits

* Planting density of 66 trees per feddan.

Livestock are an integral part of the farming system common to most of the irrigated areas in Nile Province. They are kept for the provision of draught power, transport, milk, meat and by-products. The need for working oxen is an important consideration in the overall farm power requirements. Camels and donkeys are basic to local transport and marketing whilst sheep,goats and cows provide a valuable source of meat and milk. Farmers consider livestock to be an important part of their livelihood judging by the significant areas of irrigated land that are devoted to fodder production both in pure stand and as an orchard intercrop. Sorghum has remained the main green fodder supplemented by lubia though this pattern is changing with increasing areas of lucerne. Crop residues are also important sources of livestock feed.

Details of agriculture in the Nile Province, and on the NAPC schemes on Kelli, Seyal and Kaboushia schemes (KSK) in particular have already been discussed by Sir M. MacDonald (1984). This report also provides indications of scheme crop yields (for KSK), crop returns and farm incomes.

2.7 ENVIRONMENTAL DETERIORATION

Over large areas in the north deserts already exist, and have done for a very long time. In themselves they are unwelcome, inevitable and generally to be avoided. Desert conditions however are quick to spread whenever climatic or biotic influences adversely affect neighbouring lands which enjoy more favourable conditions.

According to a GOS/SC/SCC proposal in 1982 for extension of the Joint Afforestation Project to the Northern Province -

"Desert encroachment is endangering all valuable agricultural land of the Northern Province. The seriousness of the problem could be indicated by the present situation of Kerma Basin. This basin lies on the east bank of the Nile 4 km from Dongola. When it was opened in 1903 (to irrigated farming) it had an area of 90,000 acres which diminished to 50,000 in 1973."

Commenting on conditions in this Basin Musnad (undated) says -

"Although at the beginning the area is free from sand, once cropped it becomes duny and keeps shrinking until the farmer finds it uneconomic to continue, and so he either pulls out or shifts to another area. In fact farmers have created and still create these dunes and hummocks of sand by cropping in the face of exposure to sand-laden winds. By so doing they create roughness that reduces wind speed to deposit sands on their farms."

Recent studies (1983) on the rate of desert encroachment in the Northern Province show that dunes are creeping at a rate of 7 - 15 mm/annum and are now threatening at several places (Dongola and Affad) the Nile Course itself, (GOS/UNDP project proposal SUD/84/009).

In Nile Province, southwards from about latitude 18°N, conditions progress from arid to semi-arid. Whilst there is less true desert, rain-fed agriculture is not possible over most of the area, but rainfall and vegetation are generally sufficient to support nomadic pastoralists with camels, goats and sheep. However severe and widespread droughts over the past decade, aggravated by increasing population, over-stocking and excessive destruction of already sparse vegetation have disturbed the delicate balance of nature and desertification is spreading also in these zones. Because the rangelands affected are extensive, dune formation appears less dramatic than, say, in the Kerma Basin but depletion of herds and the reluctant migration of nomads in ever increasing numbers to the riverine areas are clear evidence of the deterioration taking place.

In the region as a whole settled agriculture is confined almost entirely to a narrow belt of alluvial basins and strips along the Nile and, to a limited extent, along the Atbara river. Even here however, some desertification is occurring, partly by encroaching sand carried by prevailing winds from the deserts to the north, but also as the result of conditions created within irrigated schemes themselves. Most schemes suffer at one time or another and to varying extent from pump failure, fuel shortage, water intake problems, or inefficient water distribution. When this happens and water fails to reach the fields, cultivated soils dry out and are blown away to block canals, form dunes and, in fact, create miniature deserts within the scheme. This situation is clearly to be seen in the Kelli scheme which, owing to intake problems, has for some time been able to provide irrigation water for only one out of the three farming seasons each year. It also occurs over parts of many other schemes during the irrigation gap commonly left from April to July each year in the least intensive hot, dry, summer ('Seifi') farming season.

PART 3 SOCIOECONOMIC ASPECTS

3.1 COST OF LIVING

Recent years have seen dramatic increases in the cost of living in Sudan, especially in basic foodstuffs. Figures published in the March 1985 edition of Sudanow show the following price indices:

	February 1983	February 1984	% Change
Low income group food	997.8	1291.0	29.4
Low income group general	928.1	1191.9	28.4
High income group	988.5	1269.1	28.4
High income group general	895.5	1140.6	27.4

Further price rises have taken place since February 1984. If these price increases have affected most income groups within Sudanese society, the consequences for the nomadic groups who have become virtually destitute as a consequence of the current drought, are particularly alarming.

In the study area towns of Atbara, Damer and Shendi, examples of recent price increases were observed. The small round flat loaves, universally eaten within towns, now cost an average of 13 pt each, representing a 160% increase from the position five years ago.

Dura, the staple of the rural areas and used to make kisera now costs LS130 /sack (95 kg) even for poor quality grain. One sack of dura can feed an average family for about 2 months. To put these figures in perspective it can be noted that an agricultural labourer's wage is presently LS2.00 per day, (official government rate).

3.2 SOCIAL GROUPS

Among the rural people of the study area, two main groups are recognisable; the 'river' Sudanese who engage largely in irrigated agriculture on or close to the Rivers Nile and Atbara, and the nomadic pastoralists of the desert and semi-desert areas to the east and west of the Nile.

If the rising trend in food prices has affected most Sudanese, the hardships imposed on the nomadic peoples has been particularly severe, accentuating those difficulties already resulting from the present persistent drought.

As drought has prevailed and grazing in the traditional areas declined, nomads moved their livestock to the riverine areas where crop residues and limited grazing and browse is available. Some families do still have animals and a number of pregnant females were observed; in these cases they are hoping to rebuild their herds once the rains start. But in other cases, over time, nomads have been forced to sell their livestock to obtain money for food; many having sold all their stock are now close to destitution and are seeking other sources of income.

Nomads and their families can now be observed 'camping' in River towns and villages where they have been employed as nightguards. Others have obtained work as agricultural labourers, sometimes on the NAPC schemes and with the JAP. But in the desert areas, where many destitute nomads are still living, some have become engaged in illegal charcoal production. During the authors visit to the Hasaniya area small amounts of bagged charcoal were seen at four places awaiting transport to the river towns for sale.

The small-scale forestry projects now being run by the Green Deserts NGO (see Section 6.3.1) in the Hasaniya area have provided a valuable alternative income source for a small number of nomadic families.

3.3 LAND OWNERSHIP

The land tenure pattern in the private agricultural sector is complex and has been the subject of a number of legislative ordinances described by Sir M. MacDonald et al (1979). Land is inherited through the traditional Muslim system according to Sharia Law. A wide variation in holding size occurs on private and cooperative land and share cropping is common.

Within the public irrigation schemes land is privately owned but most belongs to government. Farmers on government land are the tenants of NAPC and there is no right of succession. On the death of a tenant the Coporation selects a successor who has to compensate the legatees of the deceased for any permanent improvement that may have been made. It is the custom of NAPC to select new tenants from the family of the deceased where this is feasible.

Holding sizes for NAPC tenants vary between 15 feddans at Zeidab to 5 feddans on the most recently established schemes, Kelli, Kaboushia and Seyal. On the other schemes the standard holding size is 10 feddan but 5 feddan plots are to be found as a result of plots being split on the death of a previous tenant. Within the NAPC schemes there are sometimes some private farmers retaining their original holdings usually along the banks of the Nile and these because of traditional inheritance systems, are frequently very small in size, often only a fraction of a feddan.

Should NAPC wish to increase the area presently under cultivation, it has the entitlement to move into the "reserve extension" land immediately adjacent to its present boundaries.

3.4 IRRIGATION PRACTICES

3.4.1 Irrigation Technology

The traditional system of irrigation in the Nile Province, open channels, is deeply engrained into the psyche of the River Sudanese. The implications of this are discussed later. In efficiency terms, the system is somewhat wasteful of water, as has been described by MacDonalds and Partners (1984), largely on account of conveyance losses. MacDonalds estimated that about half of the water pumped is lost in seepage and evaporation.

In one sense the excessive use of water is acceptable. Water is after all 'freely available' even after several years of poor rains in the Nile catchment areas. There are even beneficial socio-economic aspects which should not be lightly disregarded. The present irrigation system encourages considerable vegetative growth along the canal banks, much of which is cut for fodder or grazed directly by a range of stock. It is likely that this is an extremely valuable 'free' source of fodder for a number of poorer people within the community.

Of course in stricter economic terms, water is not freely available; raising it from the river or well, invariably using a diesel (referred to in Sudan as gas oil) engine pump requires fuel which is costly and not always readily available at the official retail price of LS4.50/ gallon (LS 0.99/litre). It was observed that some private farmers used small electric motor driven pumps to extract water from the river, but this was possible only where electricity transmission lines passed close to the river bank. This was the case only on the edge of towns.

The supply of fuel to both NAPC schemes and the private agricultural sector is of course dependent on factors outside their control namely the availability of foreign currency within Sudan as a whole. Though agricultural uses of fuel are recognised as being of high priority and NAPC has an individual quota, its fuel requirements are rarely fully supplied. On several occasions during the present visit to NAPC schemes it was observed that pumping was reduced or suspended because of shortage of fuel.

Reduced dependence on diesel fuel would be a great asset; this theme and its practical possibilities are developed in subsequent sections of this report.

3.4.2 Irrigation Water Requirements for Tree Seedlings

3.4.2.1 Open canals

Bayoumi (1976) has stated that the irrigation water requirements of 1 feddan of planatation is 400 m^3 per month (this is equivalent to an effective rainfall of 45mm assuming an approximate 50% loss).

3.4.2.2 Spot irrigation

Spot irrigation involves the individual watering of tree seedlings and is not commonly practiced in the study area. Where spot watering is known to be used in the Hasaniya area by the Green Deserts Project, the Forest Department has advised two waterings per week with two gallons per seedling at each watering. Assuming the current spacing of 2m apart within rows each 3m apart, seedling population is 700 per feddan.

Total water requirements per feddan per year would be:

700 seedlings x 4 gallons/week x 52 weeks
= 145,600 gallons
= 662 m^3

With spot irrigation, demand for water is only 14% of that required by the open channel method, assuming no losses from source to point of use. It is however more labour intensive; whereas watering by open canal was assumed to take 1 manday per inundation per feddan (required to open and close canals) (Berry, 1978), spot irrigation of 1 feddan is estimated to take 3-5 mandays depending on the exact method used and how water is brought to the site.

Spot irrigation involves more physical effort and greater supervision but it does mean that the amount of water given is accurately known. It is moreover, a new concept presently unfamiliar to unskilled labour, though given adequate demonstration and supervision there is no reason to expect that the technique could not be implemented.

Labour for farm work is reported to be readily available (MacDonalds and Partners, 1984) with wages for a 5-6 hour day being LS4.00-5.00 in the private sector or LS2.00 within the public sector.

A further advantage of spot irrigation is that land preparation and levelling need not be so critical, if necessary at all.

PART 4 GOVERNMENT FORESTRY ORGANISATION AND POLICY

4.1 CENTRAL FOREST ADMINISTRATION (CFA)

Organised forestry in the Sudan began in 1902 and for many years responsibility for all forest affairs throughout the country was in the hands of a centralised and efficient Sudan Forest Service with its headquarters in Khartoum.

Decentralisation commenced in 1960 with the passing of the Provincial Administration Act. As a result of this provincial forest operations had to be funded from provincial revenue, but the Central Forest Administration (CFA) still retained a measure of expenditure control through monthly returns and annual reports. It also retained responsibility under the Forestry Ordinance enacted in 1932, for the control and management of all Forest Reserves and all lands not used for cultivation.

Consequent upon the Local Peoples Government Act of 1971 full budgetary control of their own affairs, without reference to Central Government, was given to Provincial authorities. In the case of Forestry both forest royalty and revenue from the sale of produce sold by Provincial Forestry staff became part of the provincial budget. The CFA only retained responsibility for overall Forest Policy, central planning, major inventories, working plans, development schemes involving external assistance and the secondment of staff to the provinces. For a while it also continued to control technical training, higher education and research, but these responsibilities were also soon taken away. In 1973 training of Forest Rangers was taken over by the Institute of Technological Colleges, under the Ministry of Higher Education. In 1974 higher education to Forestry degree level, previously undertaken overseas, was incorporated as a department in the Faculty of Agriculture at the University of Khartoum (and later also at the University in Juba). In 1975 Forest Research also passed from the control of the CFA and became an Institute under the Agricultural Research Corporation.

Today the CFA, much reduced in its powers and range of influence, is a part of the Ministry of Agriculture, Food and Natural Resources and is made up of five Sections (see Appendix 3.1), dealing with -

Administration and Finance
Management, Inventory and Reservation
Afforestation
Utilisation
Gum Arabic

It is nominally responsible for management and development of national forestry resources but recent regionalisation legislation* has left

*The Regionalistion Act of 1981 divided North Sudan into five Regions (Northern, Eastern, Central, Kordofan and Darfur) in addition to Khartoum and the South which enjoyed special status and administrative structures. The South was sub-divided in 1983).

many uncertainties as to the division of responsibilities between Regional Forest Departments and the CFA. Conflicting mandates and responsibilities have resulted in a lack of direction and leadership in the forestry sector as a whole and a proliferation of agencies and departments involved in forestry and renewable energy. Financially the effective capacity of the CFA is also strictly limited as support for forestry in Sudan has long been neglected. Out of a total development budget of LS. 2,300 million over the last Plan period Agriculture received LS. 754 million (about LS. 274 million annually). Forestry was not mentioned in the Plan, but it appears that actual budgetary allocations for the years 1981/82 to 1983/84 amounted to only 0.6, 0.7 and 1.1% of the total allocation for agricultural development.

As far as the Northern Region (at any rate) is concerned it appears that the CFA is presently able only to offer advice on policy and legal matters, to make occasional modest disbursements of development funds, to liaise with donors and potential donors and to arrange secondment of staff to the Region. Even in this last respect however the Director of Forests has intimated that, owing to the low level of salaries paid by Government and the high cost of finding accommodation at a new station, he is having increasing difficulty when trying to move staff on secondment. Already he has lost many of his best officers, attracted away by higher salaries in the Arab States (and even Mauritania), so that he now prefers to leave staff where they are in the hope that continuity of posting many compensate for his inability to offer more positive financial incentives.

4.2 REGIONAL FORESTRY ADMINISTRATION IN NILE PROVINCE

The Forestry Division in the Northern Region is within the Department of Natural Resources under the Regional Ministry of Agriculture and Natural Resources, with headquarters at Ed Damer (see Appendix 3.2). The Division is headed by a Conservator of Forests who is responsible administratively and technically to the Director of Natural Resources for all forestry activities in the Region. Administration includes the organisation of divisional activities and liaison with other Regional Government departments and corporations, particularly with regard to the supply of forest produce. Technical responsibilities involve the control of forests in the provinces, supervision of nursery work, protection and utilisation of forest reserves and their regeneration. Major forestry development projects are planned and financed through the CFA, but implementation is executed by Regional staff (who are mostly indigenes of the Region and on secondment to the Region from the CFA).

In Nile Province, as well as the Conservator at headquarters, there are (see Appendix 3.2) one Conservator and one Assistant Conservator stationed at Shendi, one Assistant Conservator stationed at Berber and two Assistant Conservators at Ed Damer engaged on provincial duties. In addition, and specifically for the Joint Afforestation Project (see section 6.2), Shendi and Ed Damer each have one Conservator and one Assistant Conservator of Forests. All four Conservators presently stationed in Nile Province have considerable experience, and received their training at the Forestry Institute, Soba (just outside Khartoum).

4.3 FOREST POLICY

National Forest Policy, supported by the Forestry Ordinance of 1932, provided for the creation, protection and regeneration of forest reserves but conditions prevailing in the Northern Region have initiated formulation of an expanded policy to meet local needs whilst remaining within the framework of the general agricultural policy of the Region. The following are the most important items of the expanded forest policy:

1. Protection of existing tree vegetation and creation of irrigated forests by canal planting, shelterbelts and forestry production blocks.

2. Five percent of all new agricultural schemes shall be retained for afforestation in the form of shelterbelts and forestry production blocks to provide protection and meet local requirements for fuel and poles.

   The renewal of licences for existing agricultural schemes is to be conditional upon allotment of a certain percentage of the area for shelterbelts.

3. Linear canal planting in all agricultural schemes will be the guided policy for forestry plantations in the Northern Region.

PART 5 FOREST PRODUCTS

In this part of the report spatial and seasonal patterns of supply and demand for forest products are discussed. As well as the main forest products, fuelwood, charcoal and building poles, the uses of several other less important products are described.

Forest products studied in more detail in the following sections include:

- fuelwood
- charcoal
- building poles
- edible and other fruit
- other products

Before examining individual products, the overall forest resource in Sudan will be briefly examined. A recent World Bank report (1983) has commented -

"The growing stock volume of forest resource in the whole of Sudan was estimated to be in the order of 1994 million m^3 in 1980. The annual allowable cut from this resource was estimated at 44.4 million m^3, ie a growth rate of approximately 2.2%. This level of anual allowable cut was insufficient to meet estimated consumption of 72.4 million m^3 of growing stock equivalent, inclusive of all fuelwood consumption for domestic, commercial and industrial purposes.

The annual allowable cut was only 61% of estimated consumption, the balance representing overcutting of the resource. There is a further loss of growing stock due to clearance for mechanized farming schemes, which is estimated at 3.4 million m^3. Total consumption losses add up to 75.8 million m^3, exceeding the annual allowable cut by 31.4 million m^3 and resulting in a loss of capital growing stock. Such a loss effectively reduces the total growing stock volume and the annual allowable cut in subsequent years (assuming a constant mean annual increment).

Population growth and sectoral growth lead to increased demand for fuelwood in the form of firewood and charcoal, while agricultural expansion increases losses in growing stock. Thus total removals increase while annual allowable cut decreases. This progressive reduction in growing stock and annual allowable cut as a result of increasing consumption has been determined for the total national forest resource.

Projections of supply, losses and consumption balances from 1980 indicate that by the year 2000, the forest resource and the annual allowable cut will have been reduced by 69.6% of the 1980 base year figure, while consumption is expected to rise by 86%. The forest resource will become a wasting asset at an increased rate. These projections indicate that the total area of forest could be reduced from its present level of 112.5 million hectares to only 33.8 million hectares."

Though necessarily imprecise, since no distinction between wood-scarce and wood-rich provinces and regions has been made, the figures indicate a series depletion of the resource under present regimes of supply and consumption, (World Bank, 1983).

Observations in the study area generally support the above scenario. Areas of natural forest vegetation are limited to the immediate area of the Rivers Nile and Atbara. Once one travels through the narrow irrigated strip bounding either side of the river, forest cover quickly declines as the desert takes over, only to reoccur in isolated pockets in and around localised wadis.

5.1 FUELWOOD

5.1.1 Previous Studies

The World Bank study (1983) included projections of household fuelwood consumption for all the Provinces of Sudan based on previous Sudanese work, (SNEA surveys, Mukhtar 1978, Mukhtar 1982). Per capita consumption in the Northern and Nile Provinces is shown in Table 6, while total demand is presented in Table 7.

TABLE 6 Per capita consumption of household fuelwood in roundwood equivalents in Nile and Northern Provinces, 1980

Province	Areas	Consumption, m^3 per annum
Nile	Urban	0.43
	Rural	0.64
Northern	Urban	0.35
	Rural	0.50

TABLE 7 Projections of household demand for fuelwood 1980-1995 ('000 m^3 roundwood growing stock equivalent)

Province	1980	1985	1990	1995
Nile	348	366	384	403
Northern	195	206	219	233

If the per capita consumption figures in Table 6 are taken, together with the urban, rural and nomadic populations given in Table 4 (Section 2.4), a total consumption figure of 374,000 m^3 fuelwood (roundwood equivalent) for the Nile Province in 1983 is obtained:

	Nile Province population, 1983				m^3 Consumption, roundwood growing stock equivalent
Urban	177,098	x	0.43	=	76,152
Rural	425,850	x	0.64	=	272,544
Nomadic	39,741	x	0.64	=	25,434
					374,130

This figure is reasonably in agreement with the 1980-1995 trend shown in Table 7.

The estimated volume of fuelwood consumption in 1985 is estimated at 366,000 m^3 roundwood equivalent, (Table 7). To obtain this amount from natural forest in the Nile Province, assuming a minimum yield of 0.2 m^3 per feddan/annum (0.48 m^3/ha) for Acacia tortilis - Balanites aegyptriaca scrub (Berry, 1978) would require 1,830,000 feddan (768,600 ha). The register of Forest Reserves in the Nile Province was given as 85,310 feddan in 1984 (SREP, 1984): this was equivalent to 35,830 ha.

Clearly available reserves are only a fraction of the area required and these estimates do not take into account charcoal and pole requirements.

Earl (1984) quotes a number of previous studies which give estimates of measures and conversion factors for fuelwood and charcoal; these are presented in Appendix 4.

Berry (1978) used a figure of per capita fuelwood consumption in rural areas of 0.327 m^3 (expressed in round overbark measurement). Using the conversion factors presented in Appendix 4, the rural per capita consumption figure shown for the Nile Province in Table 6 converts to 0.35 m^3 per capita (expressed similarly in round overbark measurement). This is in broad agreement with Berry's figure.

The steps in the conversion are:

1. Calculate weighted average per capita fuelwood consumption m^3 roundwood growing stock equivalent (rural areas)

$$\left(\frac{425,850}{642,689} \times 0.64\right) + \left(\frac{39,741}{642,689} \times 0.64\right)$$

$$0.42 + 0.04$$

$$= \underline{0.46\ m^3 \text{ roundwood growing stock equivalent}}$$

2. Calculate equivalent in terms of metric tonnes dry fuelwood

3 m^3 growing stock = 1 metric tonne dry fuelwood

0.46 m^3 " " = 0.15 " " " "

3. Calculate equivalent in terms of stacked volume fuelwood

1 ton fuelwood = 3.3 m^3 stacked fuelwood

0.15 metric tonnes = 0.49 " "

4. Calculate equivalent in terms of round overbark measurement

1 m^3 stacked fuelwood = 0.71 m^3 round overbark

0.49 " " = 0.35 " "

Repeating the above exercise to include estimates of urban per capita fuelwood consumption increases the 0.35 to 0.44 m^3 per capita (round overbark measurement) for the Nile Province as a whole.

The above estimates are of household requirements: there are however other industrial uses for fuelwood in Sudan and this will be examined in the following section.

5.1.2 Surveys in the Study Area

Time did not allow detailed market surveys: instead a number of random interviews were conducted with traders in Atbara, Ed Damer and Shendi, the main towns in the study area. No interviews were undertaken in the town of Berber outside the area of immediate interest.

Small bundles of fuelwood were being sold in the local markets in all towns. At Atbara and Ed Damer, among the smaller traders, the average amount sold per week was 6 to 7 kantars (7-8 m^3): fuelwood was purchased from middlemen who arranged transport to town (1 lorry-load was said to consist of 400 bundles approximately or a volume of 15 m^3). Middlemen purchased from local collectors mainly in the Atbara River area. In Ed Damer traders paid 60 pt/bundle and sold in the Damer market at 80 pt per bundle. Prices, they remarked, had increased from 30 pt per bundle in 1981 to the present 60 pt, a 100% increase.

In the Shendi market women were selling small quantities of fuelwood, as little as 2-3 bundles a day. They bought from other people who did the actual collection (around near-by villages) at a price of LS 1.25/bundle and sold at LS 1.50/bundle, a remarkably low margin. One women claimed that in 20 years of trading in Shendi market, she had never known the low volume of fuelwood currently being traded.

Once a viable energy source, continuous firewood collection, exacerbated by population increases and rising demand, have led to progressive deforestation and desertification. Fuelwood has now become less available as distances to forested areas and time taken to collect have increased. Whereas once collected by women and children for home use, a small fuelwood collection and distribution enterprise has evolved.

Also, as forests retreat from populated areas, the demand for fuelwood has declined (now used more for kindling), and the use of charcoal (which is easier to transport than fuelwood, but whose production consumes forests even more quickly than does fuelwood collection) is increasing.

Industry also makes its own demands for fuelwood. In addition to traders, several bakers and brickmakers were interviewed in Atbara, Ed Damer and Shendi.

Small-scale bakers make an average of 4,000 to 5,000 (say 4,500) round flat loaves per day from their controlled allocation of flour. This level of production requires 20-25 bundles fuelwood/day or 1 lorry-load over approximately a 2½ week period.

Atbara is estimated to have a population of 74,535 in 1985; if the average family size is 6.4 and some 10-15 (say 12) loaves per family are required each day, then total consumption is in the order of 140,000 loaves per day. This level of bread production requires 622 bundles of fuelwood or 1.6 lorry-loads (23 m^3) /day. This is equivalent to 8,400 m^3 stacked fuelwood or 7,500 m^3 growing stock equivalent for breadmaking alone.

Whether this amount of bread is actually baked is uncertain without more detailed survey work. Certainly in Atbara and Shendi there are at least six modern bakeries which do not use fuelwood. The essential point to note is that the data given in Table 7 may well underestimate total fuelwood need in the Nile Province.

Further suggestions of underestimation arise from discussions with brickmakers in Damer and Shendi. Typically 100,000 bricks are produced each burn (about once a month), requiring 45 m^3 fuelwood or three lorry-loads (equivalent to approximately 500 m^3 roundwood growing stock equivalent). The total brick production in the Nile Province was not known: in the Ed Damer area it was claimed that the increasing demand during the last year had not been supplied because of the unavailability of fuelwood. In Shendi however, one brickmaker commented that demand recently had fallen and that bricks were now being stockpiled.

Fuelwood hought by the lorry-load varied from LS 200 to LS 235. Brickmakers obtained supplies via the local markets or via the Forest Department.

A few traders 'specialised' in supplying fuelwood to bakers and brickmakers. Though presently any type of fuelwood was used, preferences were expressed for -

Gemiza	Ficus sp
Turfa	Tamarix articulata
Sunt	Acacia nilotica

Generally, the preferred fuelwoods were -

Talah	Acacia seyal
Sumr	Acacia tortilis var. radianna
Sunt	Acacia nilotica

5.1.3 Projections of Future Fuelwood Demand and Supply

In the medium term demand for fuelwood for both bread and brickmaking is likely to remain firm. Bread is now a basic component of the urban diet and though more modern bakeries are likely to be established, wood will remain the desired form of fuel of many of the older bakeries in the foreseeable future.

Neither is any reduced demand for bricks envisaged. The traditional housing style with extensive high-walled compounds is not at all frugal in the use of bricks and new construction was widely observed in all the major towns, though in the villages, unburnt sun-dried bricks were often used.

Projections of household fuelwood demand can be related to future population estimates. Using the per capita consumption data described above in Table 6 and the population data from Table 4, enables projections of fuelwood demand to be calculated, illustrative of the spatial variation within the Nile Province. These are set out in Table 8.

Managed plantation and forest reserves are unable to supply present-day requirements for fuelwood in the Nile Province, and the low level of reafforestation in recent years suggests that this situation is likely to continue well into the foreseeable future.

Table 9 shows Forest Reserves in Nile Province (Bayoumi et al, 1984) to be some 85,000 feddan in extent; this is the same figure quoted by Berry in 1978. How much of this area is still productive or how much has been subject to illegal cutting in these intervening years is uncertain. Certainly some sections of some reserves eg Abu Saleem have been replanted.

The Forest Department in Damer commented that there had been no new forest reserves gazetted since 1965.

Data sheets prepared for use with the World Bank Forest Sector Study provided details of Government forestry activity in Sudan during 1979 to 1984.

TABLE 8 Projections of fuelwood demand 1985-1995 by urban and rural areas, m^3 roundwood growing stock equivalent

Area	1983	1985		1990		1995	
	Population	Population	Consumption m^3	Population	Consumption m^3	Population	Consumption m^3
Berber Town	14,425	15,274	6,567	17,621	7,577	20,328	8,741
El Bauga Town	3,975	4,209	1,810	4,856	2,088	5,602	2,409
Abu Hamad Town	12,284	13,007	5,593	15,005	6,452	17,311	7,444
Abu Hamad Rural Council	19,752	20,914	13,385	24,128	15,442	27,835	17,814
Shirri Rural Council	25,536	27,039	17,305	31,193	19,964	35,986	23,031
El Shirake Rural Council	14,262	15,101	9,665	17,422	11,150	20,099	12,863
El Bauga Rural Council	9,429	9,984	6,390	11,518	7,372	13,288	8,504
Berber Rural Council	77,026	81,558	52,197	94,090	60,218	108,548	69,471
Atbara Town	73,009	77,305	33,241	89,183	38,349	102,887	44,241
Damer Town	25,345	26,836	11,539	30,960	13,313	35,717	15,358
Ed Damer Rural Council	50,326	53,287	34,104	61,475	39,344	70,921	45,389
Zeidab Rural Council	58,516	61,959	39,654	71,480	45,747	82,463	52,776
Sidon Rural Council	26,854	28,434	18,198	32,803	20,994	37,844	24,220
Shendi Town	34,505	36,535	15,710	42,149	18,124	48,626	20,909
Kaboushia Town	6,234	6,601	2,838	7,615	3,274	8,785	3,778
El Matama Town	7,321	7,752	3,333	8,943	3,845	10,317	4,436
Shendi Rural Council	100,931	106,870	68,397	123,291	78,906	142,236	91,031
Wad Hamid Rural Council	28,932	30,634	19,606	35,342	22,619	40,772	26,094
El Mata Rural Council	53,982	57,158	36,581	65,941	42,202	76,074	48,687

TABLE 9 Forest Reserve Estate in the Nile Province

Name of reserve	District	Area, feddans	Remark
Kaoli and Um Rouce	Sidon	719	Under settlement (Central)
Kalalab and Salalab	"	964	" "
El Shababeit	"	360	"
Um Ba'Asheem and Um Handal	"	1,428	" "
Khor El Frel	"	1,738	" "
Abu El Kheil	"	1,809	" "
Talsham	"	2,000	" "
Um Bairbir	"	3,000	" "
Tamsharaf	"	3,000	" "
El Geir	"	1,500	" "
El Sowana	"	800	"
North Atbara	Atbara	980	Provincial
Sout Atbara	Atbara	2,700	"
Um Sayala	"	850	"
El Makabrab	Ed Damer	812	"
Wad El Nar	Shendi	56	Gazetted (Central)
Abu Higilig	"	318	" "
Dolo'a	"	1,032	" "
El Hawad	"	1,738	" "
El Hilgi	"	1,745	" "
Gozel Halag	"	1,125	" "
Um Dubei'a	"	1,751	" "
Es Salama	"	796	Provincial
El Awateib	"	836	"
Wadi El Arous	"	2,570	Under settlement (Central)
Wadi El Kirbikan	"	1,748	" "
Wadi Banaga	"	492	" "
Wadi Golai	"	3,720	" "
Wadi El Banat	"	2,200	" "
Wadi El Fazara	"	900	" "
Kaboushia	"	284	" "
Um Gurad	"	4,047	" "
Abu Saleem	"	700	" "
Abu Karamat	"	2,700	" "
Wadi El Shakkaia	"	730	" "
Wadi El Sheik	"	1,200	" "
Wadi El Dabi	"	1,500	" "
El Moghaweir	"	1,100	" "
Wadi El A'agir	"	1,600	" "
Wadi Hallouf	"	1,300	" "
Wadi Kassala	"	1,400	" "
Wadi Bihairriya	"	1,500	" "
Erat	Girsi	500	Under settlement (Central)
El Baroneit	"	450	" "
Ashoul	"	400	" "
El Sahagi	"	600	" "
El Shigil	"	1,000	" "
El Toan	"	1,500	" "
El Marzouga	"	1,500	" "
Gaili	"	2,000	" "
El Shinkeinta	"	1,200	" "
Booria	"	500	" "
Kalhada	"	2,000	" "
Shangareit	"	3,000	" "
El Dagag	"	2,500	" "
Um Guroud	"	2,500	" "
Tomri	"	2,000	" "
Ambloreib	"	1,500	" "
Total		85,398	

In the Nile Province production levels were shown as:

1979-80	No production except a few telephone poles. Fuelwood and charcoal imported from Blue Nile and Kassala Provinces
1980-81	35 m^3 fuelwood
1981-82	24 m^3 fuelwood
1982-83	4010 m^3 fuelwood 532 roofing poles
1983-84	No production.

5.2 CHARCOAL

5.2.1 Previous Studies

Earl (1984) has described the well organised nature of the charcoal industry in Sudan. Salient points from his study are reported in the following sections.

While the charcoal market is largely based in the urban centres of Sudan, most charcoal is produced from trees removed from land required for mechanised agriculture in the Blue Nile, Kassala, South Kordofan and Upper Nile Provinces.

The industry is generally owned and managed by enterpreneurs. Those operating legally pay the Forest Administration for a licence to make charcoal, in defined areas, in advance of land clearing operations.

Illegal charcoal-making occurs on a small-scale but is widespread and generally takes place wherever trees can be cut down surreptitiously. Mukhtar (1982) estimated that illegal charcoal production amounted to approximately 92% of the recorded total in 1978-79.

Earl (1984) also provided details of average production costs showing break-down by the various contributing components. These were:

	Cost per sack, LS
Labour	1.50
Agent	0.25
Water	0.40
Sacks	0.70
Transport production site to depot	0.40
Loading/unloading	0.20
Royalty	0.27
Transport to Khartoum	1.87
Total production cost	5.59

In Khartoum, the wholesale price per sack was LS 6.00 to 6.50 and the controlled retail price LS 7.00 per sack, (Earl 1984). As will be seen later prices appear to have risen considerably since these data were obtained.

As well as estimating household fuelwood consumption, the World Bank (1983) gave data on charcoal consumption in the Nile and Northern Provinces. Per capita data is presented in Table 10 and total consumption in Table 11.

TABLE 10 Per capita consumption of household charcoal in roundwood equivalents in Nile and Northern Provinces, 1980.

Province	Areas	Consumption, m^3 roundwood growing stock equivalent per capita per annum
Nile	Urban	2.6
	Rural	2.2
Northern	Urban	2.5
	Rural	2.2

TABLE 11 Projections of household demand for charcoal 1980-1995 ('000 m^3 roundwood growing stock equivalent).

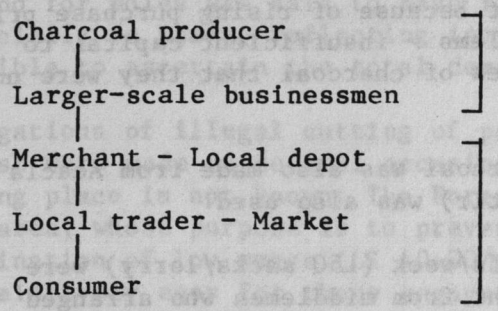
Province	1980	1985	1990	1995
Nile	1,386	1,511	1,631	1,762
Northern	900	967	1,035	1,112

If it is assumed that nomads probably tend not to use charcoal, then consumption in the Nile Province in 1983 was 1397,000 m^3 roundwood equivalent (calculated from population data in Table 4 and per capita consumption data in Table 10). This figure follows the above trend reasonably well.

Berry's figure (1978) of per capita consumption of charcoal in rural areas of 0.486 m^3 (round overbark measurement) may be too low. Using the conversion data from Appendix 1, the per capita consumption figure of 2.2 m^3 (Table 10) is equivalent to 1.47 m^3 (solid, overbark measurement), 3 x Berry's figure.

5.2.2 Surveys in the Study Area

As at the national level, there is a well organised regional charcoal marketing system. Information obtained from interviews with merchants and traders in Atbara, Ed Damer and Shendi gave a good insight into the local charcoal industry. In general terms the structure can be represented diagramatically as shown -



In Atbara, on the edge of town is a local charcoal depot to which lorry-loads of charcoal are delivered, for distribution to waiting merchants. At the time of the visit, a seven-ton lorry-load of charcoal was being unloaded and some 500 sacks were already stacked in the depot.

Charcoal is produced locally in the Atbara River area, in fact the lorry seen unloading came from this area; but it was stated that approximately 96% of deliveries came from El Gedaref area in Kassala Province some 450-500 km distant from Atbara.

Charcoal is stored in central depots in Kassala Province from where it is distributed throughout the year, though production takes place generally in the dry season, between December and May. During the early part of the season (January - February) arrangements are made to take the charcoal direct to markets. As the season progresses and the market becomes saturated, the charcoal is taken to nearby depots, sacks emptied and charcoal made into large heaps. The charcoal is rebagged by hand at the end of the rainy season (October - December) and then sent to the market as demand rises.

Merchants at the Atbara depot jointly purchase delivered loads each containing some 200 sacks. They generally prefer charcoal made from Talah (Acacia seyal) and typically trade some 200-300 sacks/month. Buying prices, quoted as being between LS 11.50 - 12.00 per sack, have increased markedly during the last five years, LS 6.00 - 7.00 in 1981, LS 9.00 in 1983. All charcoal stock was sold in Atbara, either direct to the consumer or to local traders who resold in the Atbara market. Selling price was said to be LS 12.50 /sack.

In the Atbara market, local traders sold an average of 10-20 sacks of charcoal per week. Purchasing from the Atbara depot at LS 12.25/sack, the retail price was LS 13.00/sack or LS 3.00 per 4 gallon tin. It was claimed that one sack gave 3-4 tins, but this seems low (probably at least 5 tins are obtained).

In Ed Damer, with a similar marketing system, local traders said they purchased charcoal for LS 10.00 per sack and sold for LS 11.00 per sack or for 50 pt per kala (a small heap weighing about 2 kg). One sack gave about 20 kala (low?). Damer traders sold 20-25 sacks/week.

Several local traders commented that because of rising purchase prices they had experienced cash flow problems - insufficient capital to purchase stock - hence the quantities of charcoal that they were now selling had declined.

At Shendi the preferred type of charcoal was also made from Acacia seyal (Talah) though Acacia mellifera (Kitir) was also used.

An average of about three lorry-loads/week (150 sacks/lorry) were currently being sold, and were bought from middlemen who arranged transport from El Gedaref in Kassala Province. Prices paid were LS 10.50/sack up to the previous week, but presently (late April 1985) had declined to LS 9.00 as increased quantities here come to the market. Buying prices have risen from LS 2.50/sack in 1981 to the LS 10.50 in 1985. Demand for charcoal is now increasing even in the smaller villages outside Shendi on account of the reduced availability of fuelwood in the area.

All charcoal was sold to consumers in the Shendi market. Retail price was stated as LS 11.00/sack (recently reduced to LS 10.00) or LS 2.00/ ruba (approximately 6.7 rubas obtained from 1 sack).

One sack of charcoal is consumed by the average family in 10-20 days.

Regionally, there is also the problem of illegal charcoal making. Several reports of illegal charcoal production in the Atbara River and Hasaniya areas were made during the visit, largely attributed to destitute nomads. Though still on a relatively small-scale at present the longer term danger is that if the drought continues, this form of illegal exploitation will increase, as it is one of the few alternatives open to destitute nomads with no other means of generating income.

5.3 BUILDING POLES

Traders were interviewed in the Ed Damer and the Atbara 'pole market' close to the bank of the Atbara River. Virtually all building poles are obtained from Shagiya (Dom Palm - Hyphaene thebaica) cut in the Atbara River area; Neem is also a source of poles.

Middlemen bring uncut palms to Atbara where each palm, about 2-3m in length is cut into about 8-12 poles. Each uncut palm was bought at between LS 25.00 - 35.00 each and sold at LS 5.00 - 7.00 per pole depending on class. First class poles, showing a black grain are from older palms, whereas second and third class poles originate from younger palms. Larger quantities of second and third class poles were reported to be currently traded implying that the more mature palms may have already been cut down.

Traders in Ed Damer sold an average of 500 - 600 poles per year; purchase prices were LS 3.00 - 5.00 per pole and selling prices LS 5.00 - 7.00 depending on quality. Traders commented that buying prices had risen from LS 2.00/pole in 1981 to the present LS 5.00.

Demand for poles was said to have risen in the last two years, especially in Damer, reflecting increased building activity. It was not possible to ascertain the total demand level for poles.

Allegations of illegal cutting of palms in the Atbara River Dom Palm forest were made on several occasions, though on what scale this is taking place is not known. The Forest Department does have employees in the area, whose purpose is to prevent these illegal activities: but a combination of low wages (LS 40.00/month) and rising food prices makes it relatively easy for those engaged in the illegal trade to ensure that Forest Guards are 'looking the other way'. There appears to be no way of resolving this problem in the immediate future.

In the Shendi market a greater variety of poles was observed - Dom Palm, Delib (Borassus aethiopium) and Sunt (Acacia nilotica) - brought by middlemen from Kassala, Blue Nile or from the El Obeid area in the west. Buying prices were given as:

Dom	6m	LS 14.00/pole
	3½m	LS 10.00/pole
Delib	6m	LS 150.00/pole,

whereas selling prices allowed a LS 2 margin per pole. Generally, prices have risen in recent years reflecting increased transport costs and increased demand for poles due to an upswing in building activity.

5.4 EDIBLE AND OTHER FRUITS

While charcoal, building poles and fuelwood are undoubtedly the major forest products in the Nile Province, minor forest products do have their place in the local economy.

In the markets of Atbara and Ed Damer the following tree edible fruits were observed:

Nabig obtained from Sider (Zizyphus spinachristi)

Lalobi obtained from Higlig (Balanites aegyptiaca)

Gongoleza obtained from Tabaldi (Adansonia digitata)

Garad obtained from Sunt (Acacia nilotica) and used for tanning.

Traders selling these fruits seemingly specialised in dry commodities - grain (dura, wheat, millet); dried chopped okra and tomatoes; chillies, groundnuts and dates, with the edible fruits representing only a small part of total stock.

Regarded as 'local sweets', the fruit are usually purchased by or for young people and children. Though traded in relatively small quantities, they are nevertheless a reasonably high value product. Details of

average volumes traded, prices and origins are presented in Table 12. A ruba is a measure of volume (8¼ litres); approximately 14 ruba are obtained from one sack.

A range of edible and other fruit were observed also at Shendi:

Nabig
Gongoleza
Dom Fruit
Lalobi
Tamarindus indica
Garad

Most of the fruit is supplied seasonally, brought to Shendi by middlemen, and originates largely from western Sudan. Nabig and Garad are obtained locally within the Nile Province.

Buying prices were reported as:

Nabig	LS 50/sack
Gongoleza	LS 80/sack
Dom Fruit	LS 25-30/sack
Lalobi	LS 30-35/sack
Tamarindus	LS 120/quntar
Garad	LS 15-20/sack

Most buying prices have doubled since 1981, and their availability is declining. Cash flow problems were again stated as reasons for traders reduced purchases.

Selling prices were given as:

	LS/ruba
Nabig	6.00
Gongoleza	10.00
Dom Fruit	5 pt/fruit
Lalobi	3.50
Tamarindus	1.00 - 1.50
Garad	2.00

Where tracts of mesquite have been established boardering the NAPC schemes, pods are collected by local people for stock feeding. These pods were not observed on sale in any of the local markets.

5.5 OTHER PRODUCTS

5.5.1 Rope

Locally made rope was widely observed in the markets of Atbara, Damer and Shendi. Manufactured from the leaves of the Dom Palm (Hyphaene thebaica), each rope is made to a 'standard length' of about 30 metres. Volumes traded per week varied between 400 - 500: middlemen purchased from the local producers in eg the Atbara River area and transported the ropes to the town markets.

TABLE 12 Details of volumes traded, prices and origins of edible and other fruits, Atbara and Ed Demer

Product	Average volume traded sacks/month	Buying price, LS/sack	Selling price, LS/ruba	Origin	How obtained
Nabig	2½	45.00	5.50	Kassala El Obeid	Via Middlemen to Atbara/Damer Bought in Omdurman
Lalobi	1	40.00	3.00	Kassala	Via Middlemen to Atbara/Damer
Gongoleza	2½	65.00	8.00–9.00	El Obeid	Bought in Omdurman
Garad		6.00–15.00	2.00		

Buying prices were given as 40 pt per rope, a price which had increased from 7-8 pt in 1981, and 15 pt in 1983. Selling prices varied between 45 -60 pt.

Ropes are an essential component of locally-made beds, approximately ten ropes being needed for each bed.

5.5.2 Mats

Dom palm leaf mats are another locally made product traded widely. Depending on size, buying prices are in the order of 60 pt for small mats and LS 2.00 for larger size; the latter has increased from 80 pt in 1983. Selling prices are 70 pt for small mats, LS 2.10 for larger ones.

As well as the finished products, the raw material is also traded, and used for mat or broom making. Bundles of leaves were bought for LS 1.25 each and sold at LS 1.50. Buying prices had risen from 45 pt in 1981. Traders claimed to sell between 70 - 100 bundles per week.

5.6 PRIORITY NEEDS

While the forest products discussed above all have their place in the economy of the Nile Province, and can rightly claim importance, those whose supply position is presently reaching critical proportions are undoubtedly charcoal, building poles and fuelwood.

Charcoal is important because it is the main cooking fuel for the majority of urban Sudanese, with the main supply source 400 - 500 km distant necessitating high transport costs. The transport cost component in the charcoal production costs shown in Section 5.2.1 represents 33% of the total.

Increasing charcoal prices due to scarcity will impose a further limit on consumer realisable demand, a situation which is already causing economic hardship among the poorer sections of the community. At the same time the rising population will increase nominal demand.

The Nile Province is an area of limited forest reserves, and probably has never been able to supply its own needs for many years. But what forest estate there is, has been sadly depleted in recent years by drought and now the little that remains is under further threat from the activities of illegal charcoal producers.

With building poles, though local needs appear to be largely met from within the Nile Province - few traders claimed that poles originated from outside the province - indications were that the resource is being exploited on a significant scale at present (enhanced by illegal cutting). Dom Palms are very slow growing and there is no replanting programme (either Doms or any other suitable pole-producing trees) at the moment on a scale sufficient to safeguard future supply.

Fuelwood is also the cooking fuel of many Sudanese, especially among the low-income groups who are unable to afford charcoal and in the rural areas. Again there is an indication that most fuelwood supplied comes from within the Province, though it does appear to be a case of utilising anything that comes to hand (one baker had recently purchased old railway sleepers from Sudan Railways in Atbara).

What is certain is that present forest resources in the province are unable to meet overall demand, and that this scarcity has forced up prices (Section 5.1.2).

PART 6 FORESTRY ACTIVITIES IN NILE PROVINCE

6.1 GOVERNMENT FORESTRY

Most significant Government achievements in the Forestry sector date back before 1971 and were implemented by the Central Forest Administration. Since that time, and especially after regionalisation the CFA's role has been restricted to the supply of supervisory staff and the allocation of development grants, rather than direct participation. It should be noted however that, without such staff and funding there could have been little, if any, forestry activity at all.

6.1.1 The Forest Estate

Out of 58 Reserves, totalling 85,398 feddans, which comprise the Forest Estate only eight (8,257 feddan) are gazetted and fully constituted (see Table 9). No new Reserves have been established since 1965 and this is attributed by forestry officials to lack of interest by political administrations, which have favoured exploitation to generate revenue rather than conservation and management. This has been particularly noticeable since regionalisation and is reflected in the decrease in expenditure allocations and the increase in revenue since 1981 (see Appendix 5.1); though the source of revenues is not clear when they are compared with figures for production (see Appendix 5.2).

6.1.2 Afforestation

There is a long history of forest tree planting in the Province, though reliable records are difficult to find. Many exotic species including Azadirachta indica (Neem), Khaya senegalensis, Eucalyptus microtheca and E. camaldulensis, Dalbergia sissoo and Conocarpus lancifolia have been used, mostly for amenity purposes. Prosopis chilensis (Mesquite), introduced to Sudan in 1917, has however been by far the most successful; it has been planted as shelterbelts in Nile Province since the 1930s, and extensively used for this purpose from 1969 onwards (Musnad & El Mak, 1983).

In recent years, whilst the extent of planting by the Forestry Division itself has not been great (see Appendix 5.2) increasing attention has been given to the production of tree seedlings (see Appendix 5.3). Presently there are eight nurseries in the Province with a total capacity of just over ½ million plants, which it is hoped to increase to 1 million during 1985. Finance is the limiting factor and the Forestry Division is well aware of the need to produce much greater numbers of plants. If the existing policy to afforest 5% of all agricultural schemes, and to make the issue of farming licences conditional upon the planting of trees, is to be implemented then the Division estimates that 10 million plants would be required each year over the Region as a whole.

6.1.3 Research

No research project has been carried out in Nile Province, but there is one currently being implemented in Northern Province. This project was started in 1975 at Khoway, east of Dongola and adjacent to the desert. It has the objective to find out the best design of shelterbelts to protect agricultural crops and its effect on their yield. The project is financially supported by the IDRC (International Development Research Centre) and is being implemented by the Forestry Research Centre of the Agricultural Research Corporation. The first phase, which involved establishment of shelterbelts, has been completed and experimental data are being analysed. The second phase, which involves cultivation of agricultural crops, began in 1984. The results of this project, when published, should be of relevance in Nile Province.

6.2 JOINT AFFORESTATION PROJECT (JAP)

6.2.1 General Description

This project, the main planned activity in the Forestry sector within Nile Province, is a joint effort by the Government of Sudan (GOS) and the Sudan Council of Churches (SCC) to establish shelterbelts and production blocks within existing irrigated agricultural schemes. The GOS provides supervisory staff by secondment from the CFA, carries out physical ground levelling and preparation through the Earth Moving Corporation (EMC), on contract. Overseas donors have provided, through the SCC, the major part of both capital and operating costs. The Project Manager (Sd. Kamal Osman Khalifa), a former Director of the CFA, is provided by the SCC and is based in Khartoum.

The shelterbelts are 25 metre wide strips planted with Prosopis chilensis (Mesquite) and are to protect irrigation schemes from wind and windblown sand, and at the same time the pods of Mesquite provide a considerable amount of useful fodder.

Production blocks are widened shelterbelts, usually 50 m. wide, intended to provide fuelwood and poles. Initially they were planted mostly with Eucalyptus microtheca and some Mesquite, but in recent years E. camaldulensis has been favoured because of its greater height and straighter form.

In all plantations spacing between rows is 3 m., a convenient distance for mechanical ploughing. Trees are planted 2 m. apart along one side of the ridges and flood irrigated along the furrows. Water has to be pumped, as it cannot be syphoned, from a scheme canal into a specially prepared irrigation channel (Abuishrin) from which it is directed at intervals to the tree rows (see Figure 1 and Plates 1-6). Water cooled, diesel engined pumps, mostly with 4" delivery outlet are used for this purpose; although portable they are not easily moved (see Plate 2).

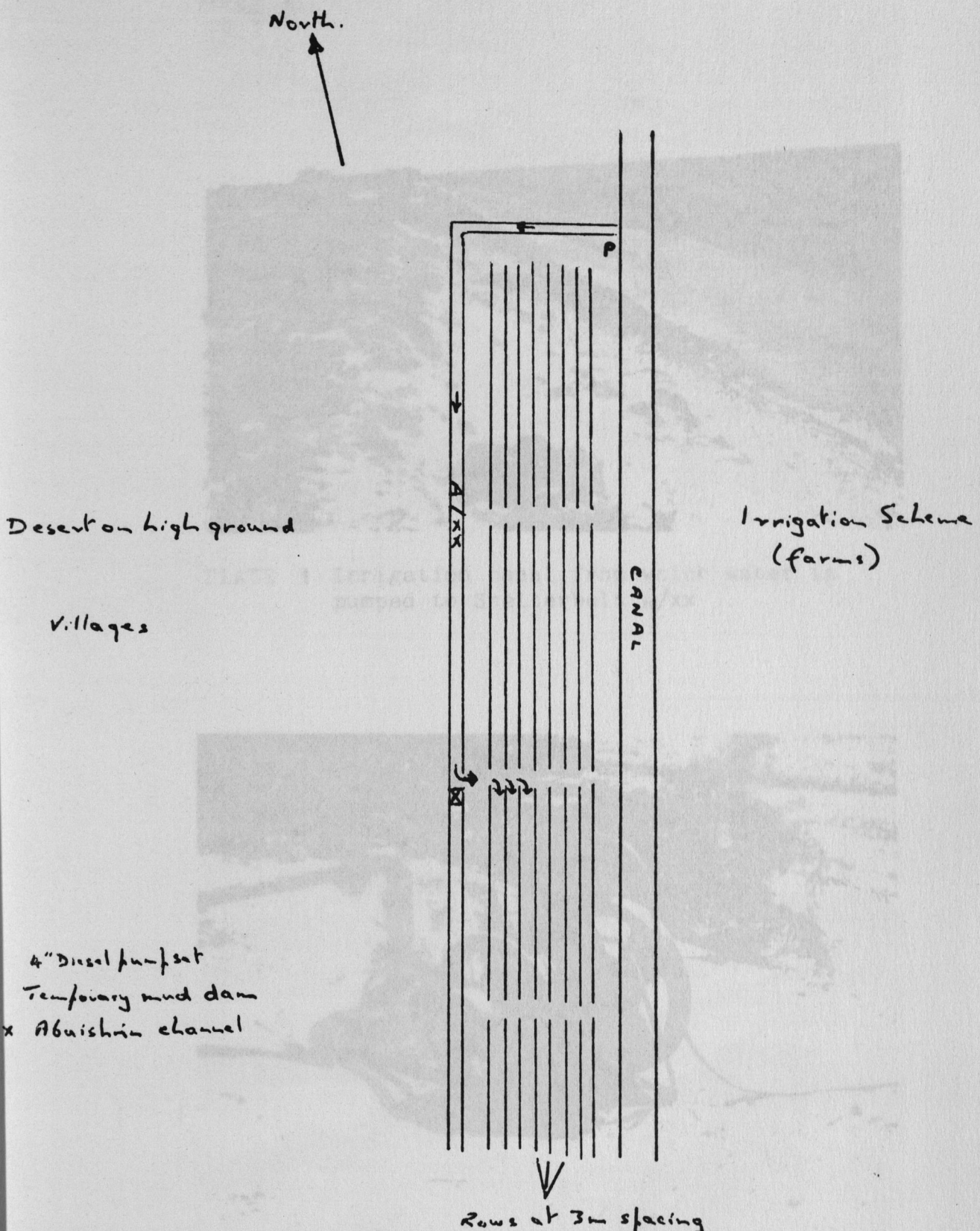


FIGURE 1 Diagramatic plan of a typical Shelterbelt on the West side of the river (not to scale)

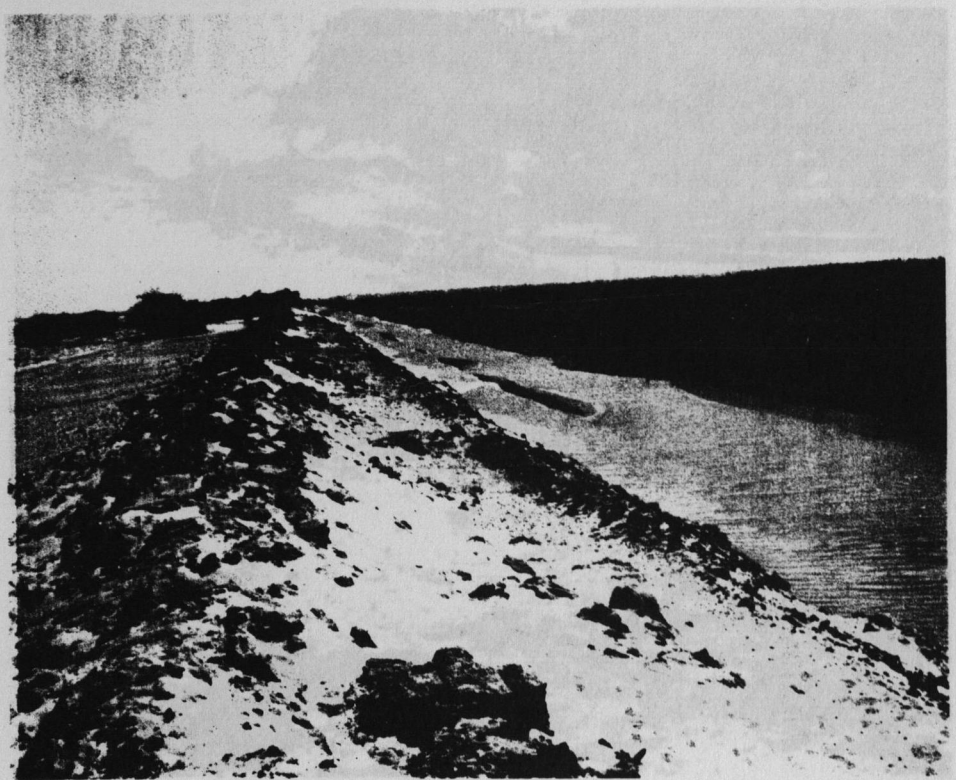


PLATE 1 Irrigation canal from which water is pumped to Shelterbelt A/xx

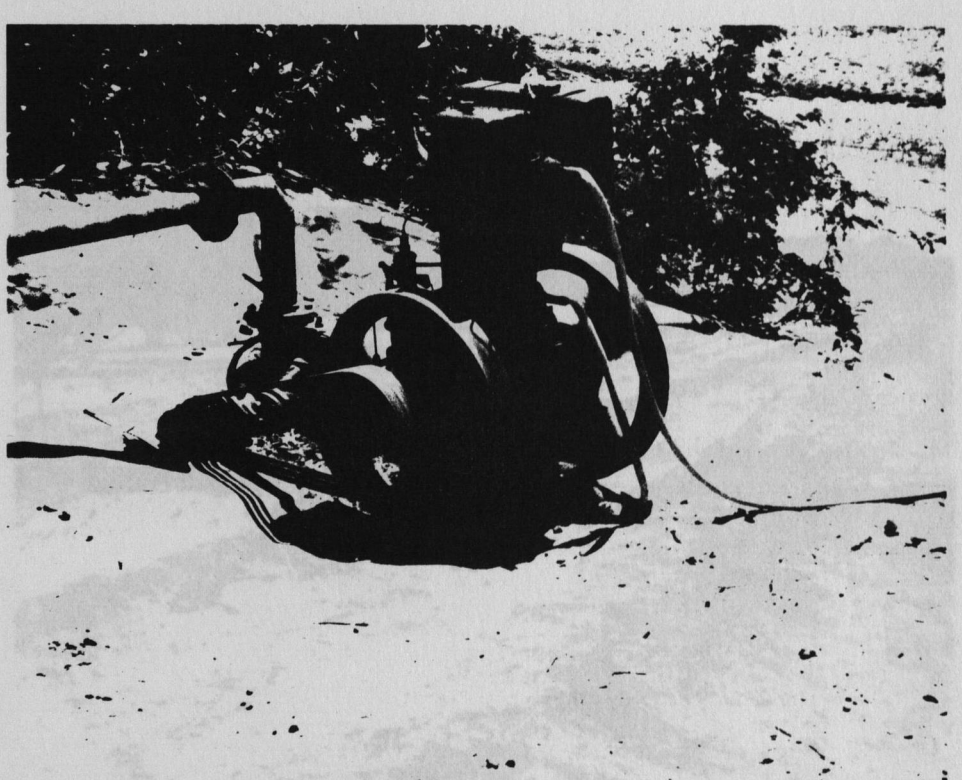


PLATE 2 A typical diesel pumpset as used for shelterbelts and on private farms

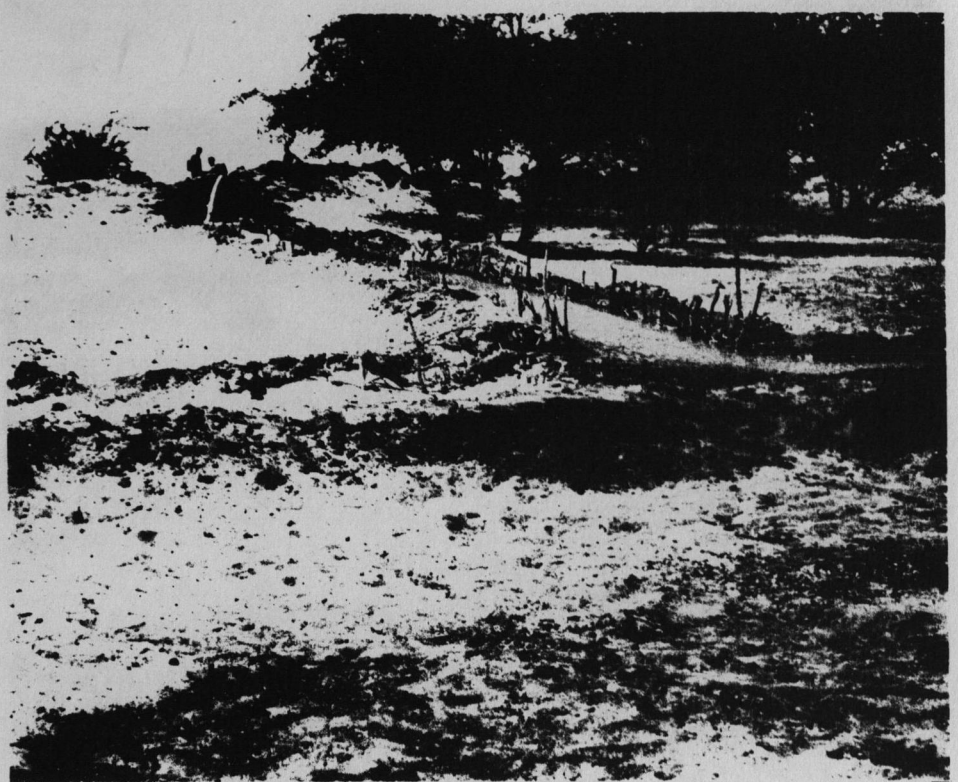


PLATE 3 Water being pumped from canal into the shelterbelt A/xx

PLATE 4 The shelterbelt A/xx with water flowing to more distant irrigation furrows

PLATE 5 Planting a gap in the Zeidab shelterbelt. March 1985

PLATE 6 Furrows receiving irrigation water. Mesquite newly planted on side of ridge. More of Zeidab Shelterbelt (north end) in the background

Standard procedure is to irrigate all species twice a month for the first three months, then monthly up to 3 years for Mesquite and up to 10 years for the Eucalypts. In theory each feddan of plantation should receive 400 m^3 per month, but no measurement is made and in practice water is supplied as and when it (and diesel for the pumps,) is available. Except in schemes where horticultural tree crops are grown irrigation water is seldom available at all in April, May and June during the hot summer (Seifi) season when the river level is low and farming intensity at its minimum.

Depending on the availability of funds, and of polythene seedling bags (from a supplier in Khartoum), nurseries are sown between November and March each year. Planting should be during the season when rain may be expected (July and August) but Berry (1978) commented that much had in fact been carried out in January and February, whilst the present Mission noted some planting being continued in March and April 1985. Bosshard (1966) found that the length of the period between planting and the beginning of interruptions in irrigation has a distinct effect on the drought resistance of trees during their first irrigation gap (April - July); those planted earliest having the greatest resistance.

6.2.2 Project Achievements

At the outset the project was planned to last 5 years (July 1977 to June 1982) and to plant 1,071 feddans. In fact only 683 feddan (64%) were achieved during that period, the shortfall being attributed mainly to factors beyond project control. In the first place there were delays in land preparation by the EMC which had plant maintenance and availability problems, and rated forestry work as of low priority. Secondly there were frequent shortages of irrigation water due to problems of pumphouse inlet siltation, pump breakdowns and acute fuel shortages.

In a 3 year extension of the project (July 1982 to June 1985) it was intended to plant 543 feddan - ie. the 388 fed. outstanding from Phase 1 plus a further 155 fed. of production blocks. To date however, and apparently due to inadequate flow of funds from the donor agency, it has been possible to plant only 166 fed. (30% of the Phase 2 target).

Thus, over the entire 8 years of the project a total of 849 feddan have been planted, representing 79% of the original target. This is made up of 589 feddan of shelterbelts and 260 fed. of production blocks (see Table 13). However, whilst this is an appreciable planting achievement, it is unfortunate that project staff have not carried out any enumerations and that records do not reveal the extent of successful plantation establishment. The only stocktaking information available concerns four of the Phase 1 shelterbelts surveyed late in 1982, which reveals 15% failure in Mesquite and 75% failure in the Eucalypts. On the basis of brief visits during the present Mission to parts of all the sites planted it would seem that these figures may still be indicative of the general situation, and that failures have mostly been due to water supply problems and the relative drought resistance of the species used.

TABLE 13 Areas planted under the JAP (feddan)

Site		1977 - 1982		1982 - 85	1977 - 1985
		Area to be planted	Area actually planted	Area to be planted	Total area actually planted
Zeidab	SB	202	202	-	202
Kelli	SB	150	-	150	-
Makniya	PB	25	25	-	25
Seyal	SB	80	-	80	80
Seyal	PB	125	125	-	125
El Hassa	SB	64	64	-	64
Gandato	SB	75	-	75	-
Kaboushia	SB	350	267	83	213
Kaboushia	PB	-	-	155	60
Aliab	SB	-	-	-	11
Um El Toyur	SB	-	-	-	19
Aby Saleem	PB	-	-	-	50
Total		1,071	683	543	849

Note:-

1. SB - Shelterbelt
2. PB - Production Block
3. Makniya PB is within Kelli Scheme
4. Um El Toyur is part of Zeidab Scheme
5. Abu Saleem PB is in a Forest Reserve adjacent to Zeidab Scheme
6. JAP figures for area of Kaboushia SB planted in the first phase and that achieved by the end of the project conflict.

(Source : JAP reports)

Prosopis chilensis has very high resistance to drought and grows well almost everywhere it has been used, even establishing itself naturally by seed into some non-irrigated areas. Extensive failures were seen only where water has been insufficient to permit initial establishment (eg. parts of Aliab and Kaboushiya shelterbelts - see Plate 7) and on higher terrace sites (eg. El Hassa shelterbelt) (Plate 8) where irrigation has not been possible for several years and where perhaps roots have not yet reached groundwater (at 8 m).

No well stocked stands of Eucalyptus were seen in any of the JAP areas other than the 1984 planted area in Abu Saleem production block, where irrigation water is plentiful.

6.2.3 The Future of the JAP

The project is due to end on 30 June 1985 and, there being little possibility of further funding through the SCC, it will then become the responsibility of the GOS to take over maintenance and extension of the plantations. Under the Nimeiri regime (ousted on 6 April 1985,) it had been decided that the task should be given to the Northern Agricultural Production Corporation (NAPC) since it is responsible for the irrigation schemes within which most of the plantations are sited, and such action is still favoured by all parties concerned. However the General Manager of the NPAC rightly maintains that, before his Corporation can take over, he must be provided with adequate funds and trained Forestry staff. Staffing, on secondment, is not considered likely to be a problem since NAPC salary scales are slightly higher than those of Ministries; but as at early May no special budget had yet been approved.

If the NAPC does take over from the JAP the following views expressed by the General Manager (Sd. Bashir Mahgoub) will be likely to influence forestry activities -

- Within Agricultural Schemes there should be a single overall management, but Scheme Inspectors (Managers) would be expected to become more involved than hitherto in Forestry matters.

- Greater priority should be given to the protective rather than the productive aspects of afforestation since agricultural crops are the main objective of the Corporation.

- Tree planting along canals and Abuishrin channels should be encouraged, but not along the final field channels (Abusitta) which would need to be demolished each season if larger scale mechanical cultivation becomes possible.

- Whilst doubtful whether voluntary planting by individuals or communities will be successful on a significant scale, the General Manager would like to see it encouraged, whether by the NAPC itself, or the Forestry Division or any non-Government organisation.

Trees planted by farmers on their own tenancies will be their own property, subject only to technical supervision and control of felling by NAPC staff (as is the case with fruit trees).

No extra water charges would be levied on farmers who plant trees on their own farm boundaries. But if they establish irrigated planatations water would be charged at the same rate as for horticultural tree crops (presently LS.120/fed./year).

6.3 NON-GOVERNMENT ORGANISATIONS (NGOs)

6.3.1 Green Deserts Ltd

This small British-based charity established in 1976, "involved in ecological arid land recovery and afforestation," initiated the Forestry and Nomadic Pastoralism Project in Nile Province in 1981. Particular emphasis is on promoting community forestry among traditionally pastoral peoples of the Jebel Hasaniya, a hilly area in the Bayuda Desert to the west of Ed Damer, and to foster an awareness of the reasons for desertification with the long term objective of slowing down/reversing expansion of desert areas and the ever increasing movement of nomadic pastoralists to a more or less permanent but precarious life on the fringes of agricultural riverine communities, where pressure on resources is already at an unprecedented level.

Initially work concentrated on the construction, using local (paid) labour and materials, of low walls across dry wadis and the sowing of Mesquite seeds in the hope that the walls would retain sufficient moisture after rains had fallen to enable the seeds to germinate and establish themselves. However, this hope provided too optimistic in an area of less than 150 mm. p.a. rainfall, where there has been total rain failure in most parts since 1978.

Following arrival of the present Project Manager (Stephen Bristow) in late December 1983, the practice of direct sowing was replaced by planting and hand watering. Sites were selected with socio-economic as well as silvicultural reasons in mind. All are in wadis where water may be expected to flow when rain eventually falls, and microcatchments have been constructed to trap water after rain. The species used is mostly Mesquite (Prosopis chilensis), although trial plantings with indigenous species are commencing. In all cases emphasis is placed on community involvement and participation in decision making. Local people are however employed to plant, protect and irrigate trees with water drawn from wells. To date establishment has been encouraging (see Table 14), but it remains to be seen how long the trees will have to be irrigated before their roots penetrate sufficiently to tap groundwater; which varies in depth from about 10 metres at the Zeidab site, 25 m. at Umm Merwa, 35 m. at El Fura to 90 m. at El Khilella.

PLATE 7 Mesquite at Kaboushia Shelterbelt in March 1985. Water supply failed soon after planting

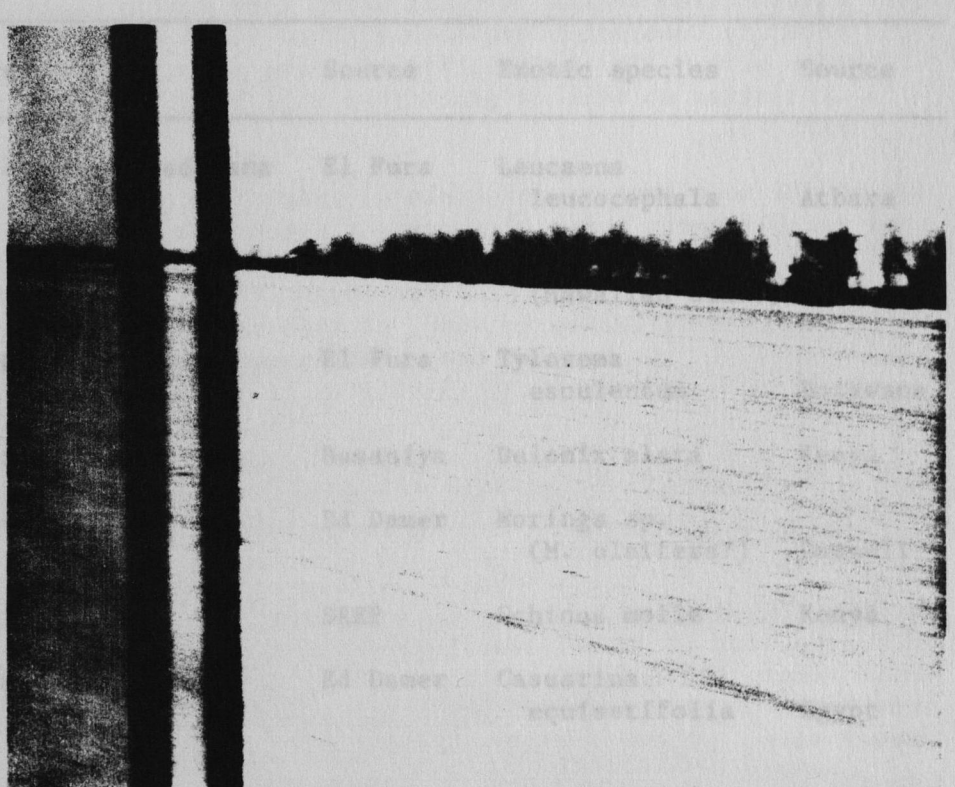


PLATE 8 El Hassa Shelterbelt, March 1985. There has been no water for several years and the Mesquite is dying

TABLE 14 Survival rates of Mesquite on desert sites planted by Green Deserts

Site	Date Planted	No. Planted	Survival
El Khilella	9/1/84	110	70% (late June 1984)
Zeudab	29/1/84	50	74% (late June 1984)
School	20/2/84	32	100% (late June 1984)
Umm Merwa			
Abu Dom wadi	mid May 1984	110	95% (July 1984)
El Fura	July 1984	400	98% (Dec. 1984)

Source: Green Deserts report

TABLE 15 Species planted (1984) by Green Deserts in the Arboretum at Abu Saleem Forest Reserve

Native species	Source	Exotic species	Source
Acacia tortilis ssp. raddiana	El Fura	Leucaena leucocephala	Atbara
" " " "	Girsi	" " (Hawaiian Giant)	SREP
Balanites aegyptiaca	El Fura	Tylosema esculentum	Botswana
Maerua crassifolia	Hasaniya	Delonix elata	Kenya
Zizyphus spina-christi	Ed Damer	Moringa sp. (M. oleifera?)	Darmali
Capparis decidua	SREP	Schinus molle	Kenya
Acacia albida	Ed Damer	Casuarina equisetifolia	Egypt

Source: Green Deserts report

Apart from sites with paid labour, there are many individuals and family communities now growing trees by their homes. These trees are provided by the project for those who request them, and the people concerned are thereafter visited periodically to discuss any problems that have arisen. Some families have started to raise vegetables and sorghum next to the trees.

Other works carried out under this project, and of particular interest to Forestry in the province as a whole, include -

1. Arboretum. 2/3 feddan at Abu Saleem Forest near Zeidab has been planted with 6 indigenous and 6 exotic tree species (see Table 15), and more are to be planted. An area of 1 feddan in the same Forest has also been fenced against animals, and growth studies of the protected trees and shrubs are being made.

2. Calotropis procera. Samples of this widely distributed shrub have been sent to the UK for analysis following observation that, whilst unpalatable to livestock in the fresh state, goats will readily eat the dried leaves. A number of goats have been purchased for experimental feeding.

3. Mesquite fencing units. (see Plate 9). Fencing units making use of thinnings from Mesquite shelterbelts have been produced at low cost (see Appendix 6). Such fencing seems more appropriate for forestry purposes than barbed wire, which seldom keeps out goats and, if repaired at all is frequently just patched with thorns.

4. Plastic Tree Guards. A trial using tree guards donated by the UK Forestry Commission has been started to investigate their effect on tree growth. The possibility of using guards of this type for tree irrigation as well as protection will be discussed later (see Part 7).

One of the most serious constraints, apart from water, to successful tree establishment under this project appears to have been blown sand - "the sand collects in the planting pits, and several centimetres can accumulate in a wind blow of a few hours. Plant death is not caused entirely by being buried in sand, as this can be removed daily, but hot sand in direct contact with the young leaves and shoots dessicates the plant and those affected make little or no growth". (Project Report, February to June 1984).

Presently project funding comes largely from Oxfam, and is expected to end in November 1985. It will be a pity if the project has to end then, without having experienced even one season of 'normal' rainfall. According to the Project Manager it requires only an additional Sterling £15,000 to enable existing tasks to be completed and, if rain does at last come, for it to be seen whether the nomads who have been involved would retain the sensitivity they appear to have acquired regarding the importance of tree conservation and planting, or simply resume their former ways.

PLATE 9 Mesquite fencing units around Green Deserts plot near Zeidab. March 1985

PLATE 10 Sand blowing from the north-east (bottom left of photo.) March 1985

6.3.2 SOS Sahel International: British Committee

SOS Sahel International was founded in 1976 by a group of Sahelian countries as a non-governmental and non-denominational organisation to assist in a range of development projects including afforestation. European committees have been set up in France, Belgium, Germany and the UK, each committee being autonomous but operating under the umbrella of an executive committee with headquarters in Paris. The British Committee was established in 1982, and its aim is to give priority to afforestation and water management projects which seek to increase agricultural production.

As part of its policy to work closely with other agencies SOS Sahel has taken over responsibility for implementation of a "Village Extension Scheme" (VES) which had been researched and designed by Green Deserts in 1981/82. This project aims to encourage and assist villagers in Government agricultural schemes in the Nile Province to plant tree windbreaks along irrigation channels and to establish village woodlots in order to "protect the environment and improve the quality of life among the less advantaged sectors of the community." The core of the project is to be an extension programme which combines non-formal education and entertainment, through a puppet theatre, with more formal extension techniques. Labour is to be provided by the villagers themselves. The project, which will receive financial support from the ODA, is schedule to commence in October 1985 and is expected to have Stephen Bristow, presently working for Green Deserts, as its Field Director.

The following statements, quoted from a report made by the Director, British Committee SOS Sahel International, following a visit he made to Nile Province in February 1985, are particularly relevant:

> "Up to now tree planting has rarely taken place at village level. The emphasis has been on paying labour to plant shelterbelts. Experience throughout the Sudan has shown that when payment ceases, so does effective maintenance. It is vital for the long-term success of the VES that labour is voluntary and is seen as a personal investment. The link between tree planting and ensuing economic benefits needs to be very clearly stressed. The General Manager of the NAPC (Mr. M. Bashir) doubts whether, in the initial stages, people will be prepared to plant trees without payment. However, none of the (7) farmers interviewed raised the issue of payment, or mentioned the lack of payment as a possible constraint."
>
> "Recent experience suggests that what village communities want is technical assistance and access to seeds and seedlings."

The "widespread perception that shelterbelts are the property and responsibility of the goverment" is recognised, but it is hoped that voluntary support will be given by farmers if they can be convinced that, in the VES, trees planted will belong to them and will provide private supplies of fuelwood and fodder.

The project is expected to start in villages within the Seyal Scheme, and it is to be hoped that it will succeed in its aims for it is only through voluntary efforts that tree planting on the scale necessary in Nile Province can possibly be accomplished. Implementation through a NGO should help to free it from fears of interference by Government and, as long as the project continues, it will not be appropriate for similar works to be carried out in the same area using paid labour.

6.3.3 The Private Sector

After travelling through Nile Province it is obvious, without any recorded statistics, that a considerable amount of private tree planting has been done over the years, and is still continuing, around dwellings and farms. This is particularly the case in and around the older established agricultural schemes such as those at Zeidab and Gandatto. On the other hand, on arriving by air at Atbara, one of the larger towns in Sudan and long established as the Railway headquarters town, it is noticeable that whereas the Railway Quarters area is well treed the rest of the town seems remarkably bare of vegetation. Hopefully it is true that all the people need is technical assistance and access to seeds and seedlings. If this is the case the Government Forest Service should concentrate on tree seedling production coupled with extension work and practical demonstration areas. The public, and especially farmers, seldom believe words alone; they want to see what is intended and to judge the benefits for themselves. It will be impossible by any account for Government itself to undertake all the tree planting necessary to meet fuelwood requirements alone, apart from needs for amenity or protective purposes.

PART 7 DEVELOPMENT PROPOSALS AND RECOMMENDATIONS

7.1 GENERAL RECOMMENDATIONS (for the Forestry sector as a whole in Nile Province)

7.1.1 Production Forestry

82% of domestic energy requirements in Sudan are derived from wood but whereas 74% of the population (estimated at 21.6 million in 1984,) is concentrated in the 12 northern Provinces these provinces contain only 33% of the country's forests; and, to make matters even worse, 93% of the northern forests occur in the southern parts of Darfur and Kordofan.

In Nile Province it is estimated(1) that annual consumption of fuelwood presently totals 374,130 m^3 whilst that of charcoal (mainly imported from Kassala Province,) totals 1,484,755 m^3 roundwood equivalent. On the basis of potential yields(2) existing Forest Reserves could, in theory, supply only 17,000 m^3 p.a. and it would therefore need a further 614,000 feddans of plantations (equivalent to an area 300 km. long and 8.6 km. wide - ie. approximately the whole area along the Nile valley between the 5th and 6th Cataracts,) to supply the balance. This is clearly impossible, but it does emphasise the importance of increasing tree planting wherever possible; and on the inside as well as around existing agricultural schemes. Whilst enough trees could perhaps be grown in the province to meet present fuelwood requirements it seems inevitable that the much greater charcoal needs will always have to be met by importation and that this will be from an every increasing distance, at proportionately higher costs.

7.1.2 Protection Forestry

Within the farming community the need to protect crops from the effects of dessicating winds and desert encroachment has long been recognised. The potential of trees in providing such protection is also becoming increasingly realised, but what has not been sufficiently appreciated yet by both Government officials and farmers is that, to be effective, tree windbreaks must be planted as nearly at right angles to the prevailing wind direction as possible. Throughout most of the year winds come from the north and north-east, and in the remaining ('Rainy'

---

(1) Total population 642,689 (1983 Census. See Table 8)
Per capita annual consumption in m^3 roundwood growing stock equivalent. (World Bank, 1983)

	Urban	Rural
Fuelwood	0.43 m^3	0.64 m^3
Charcoal	2.6 m^3	2.2 m^3

(2) Potential yields (Berry, 1978):
Natural Forest Reserves 0.2 m^3/fe/yr.
Eucalyptus plantation 3 m^3/fe/yr.

Apart from securing a reliable source of water the method, quantity and frequency, of application need further study. Customarily it is delivered to the trees along open furrows, which can only be prepared after site levelling by heavy mechanical equipment, and thereafter need frequent clearing of windblown sand. Plantations so irrigated receive, in theory, 400 m^3 of water per feddan containing 700 trees, per month (ie. about 88,000 gallons). Trials should be made with various methods of spot irrigation, which can obviate the need for expensive and time consuming site levelling and be more economical in the use of water. Trees can be established using 4 gals. or less of water per week; this is only about 12,000 gals. or 54 m^3 per feddan of 700 trees each month, and would be most realistic if shallow wells are being utilised. Although spot irrigation would be more labour intensive than furrow irrigation the number of workers can be reduced by making use of PVC piping, available from Khartoum in sizes up to 100 mm. (4") diameter, instead of an abuishirin to deliver water to appropriate offtakes. In any case, with increasing numbers of nomads settling in the riverine areas after losing their normal means of livelihood, labour should not be difficult to obtain.

Another factor affecting the supply of water to trees is the method by which it is drawn from its source, be it a canal or a well. Presently pumps are used which require diesel fuel, and both fuel and spare parts are difficult to obtain. The feasibility of harnessing wind and/or solar power to pump water is a subject which could most usefully be investigated through an external programme of assistance.

Whilst the availability and efficient application of water have been the most important factors affecting afforestation in the province it is considered that more attention needs to be given to the selection of tree species appropriate both to growing conditions and to the purposes for which they are required. Prosopis chilensis, a useful fodder and fuel species outstanding in its ability to survive, and even thrive, under conditions of minimal irrigation in the JAP shelterbelts, is not a good choice for windbreaks across agricultural schemes as it is too low growing and may invade farmlands if not weeded out at an early stage (Plates 11 to 14). Eucalyptus camaldulensis on the other hand, though ideal because of its height and narrow crown form for windbreaks inside schemes with plentiful water, has largely failed in the JAP production blocks along the boundary. It is difficult to understand why other tree species, both exotic and indigenous, which are already well known have not been used more extensively in the shelterbelts and production blocks in Nile Province. A list of species recommended for further consideration is given in Table 16. In addition to trials using more species it will be necessary to study the silvicultural techniques and practices (eg. size of plant, time of planting, etc.,) best suited to each.

Even if water problems can be solved and the correct tree species and silvicultural techniques are used, plantations may still fail in places where damage by animals is a hazard unless they are adequately protected. Under the JAP normal practice has been to fence areas using 5 or 6 strands of barbed wire (imported from overseas,) hung between squared posts of Acacia nilotica (imported from Gezira province,). But, during six weeks spent in the province, only two plantations were seen

TABLE 16 Tree species recommended for trials within and around irrigated agricultural schemes in Nile Province

Species	Uses
Acacia albida	Soil improvement (Nitrogen fixation); fodder (leaves and pods); fuelwood. Best planted at wide spacing
Acacia nilotica	Charcoal; fuelwood; tannin (pods); piles; timber
Acacia seyal	Charcoal; fuelwood; poles
Acacia tortilis (raddiana)	Fuelwood; charcoal; tannin (bark)
Albizia lebbek	Poles; fuelwood; windbreaks
Azadirachta indica (Neem)	Fuelwood; poles; timber
Cassia siamea	Poles; fuelwood; windbreaks
Casuarina equisetifolia	Windbreaks; poles; fuelwood; timber
Conocarpus lancifolius	Windbreakes; poles; timber; fuelwood
Dalbergia sissoo	Fuelwood; poles
Eucalyptus camaldulensis	Windbreaks; poles; fuelwood. Trials using seed of Petford and of Katharina provenances, imported from Australia (not Nigeria,) should be made
Eucalyptus microtheca	Fuelwood; poles
Khaya senegalensis	Fuelwood; poles; timber
Leucaena leucocephala	Windbreaks; soil improvement (Nitrogen fixation); fuelwood; poles
Prosopis chilensis	Fodder (pods); fuelwood
Prosopis cineraria	Poles, fuelwood. Seed should be obtained from the Sultanate of Oman
Zizyphus mauritiana	Edible fruits, larger than those of Z. spinachristi; fuelwood; poles. Seed may be obtained from Pakistan

PLATE 11 A well established shelterbelt (p.73) at Aliab Scheme, but it runs parallel to the prevailing wind direction

PLATE 12 Eucalyptus microtheca (p.73) at the Aliab Scheme. It is more drought resistent than E. camaldulensis but has poor stem form

season) months they come from the south-west. However most of the land made available for shelterbelts so far has been along the boundary of agricultural schemes furthest from the Nile, which itself flows in a general northerly direction. Thus most existing shelterbelts are aligned more or less parallel to prevailing winds, and exert a minimal influence as windbreaks. To secure the protection needed much greater attention will have to be devoted to overcoming real and imagined prejudices and to the planting of lines of trees along every road, canal and abuishirin channel which runs in an approximately east - west direction. Those which run south-north can also be planted, to establish a network pattern and thereby increase the degree of protection. By careful management and controlled exploitation these windbreaks could also help towards meeting production needs.

7.1.3 Extension

Afforestation on the scale and at the tempo necessary cannot possibly be achieved solely by the official Forestry services. The cost alone would be prohibitive. What is needed is to mobilise public support and stimulate the widespread planting of trees by individuals and communities on the boundaries of their farms and around their homes. One tree planted per head of population would be equivalent to over 9,000 feddans of plantation which could yield 27,000 m^3 of fuelwood a year, so the potential is enormous. The Forestry Services should concentrate on extension work to give greater publicity to the seriousness of the problem and indicate how individual participation in an overall effort could help to improve the situation. As part of the campaign production of tree seedling should be substantially increased, and practical demonstrations of how to plan and subsequently tend the trees should be given, frequently, at as many locations as possible throughout the province.

7.1 4 Investigation and Demonstration

From the study of project reports, and visits made to many sites in the province it is apparent that many matters concerning afforestation still require investigation with a view to effecting improvements.

Under climatic conditions existing in the province it is virtually impossible, even in favourable years, to establish trees successfully on a significant scale without watering. As most of the land made available for planting so far has been on the periphery of agricultural schemes the water for trees has been obtained, as and when available, from the irrigation systems of those schemes and it is because of frequent and often prolonged failures in such supply that most tree mortality, especially of eucalypts, has occurred. The potential for using groundwater as an alternative source of supply, at least to cover periods when water is not available from irrigation canals, requires practical investigation. Groundwater can be obtained from shallow (6-8 m.) wells and from sub-artesian ('matara') tube wells in which it rises to within 10 - 15 m. of the surface, and both types of well can be readily constructed locally.

Apart from securing a reliable source of water the method, quantity and frequency, of application need further study. Customarily it is delivered to the trees along open furrows, which can only be prepared after site levelling by heavy mechanical equipment, and thereafter need frequent clearing of windblown sand. Plantations so irrigated receive, in theory, 400 m^3 of water per feddan containing 700 trees, per month (ie. about 88,000 gallons). Trials should be made with various methods of spot irrigation, which can obviate the need for expensive and time consuming site levelling and be more economical in the use of water. Trees can be established using 4 gals. or less of water per week; this is only about 12,000 gals. or 54 m^3 per feddan of 700 trees each month, and would be most realistic if shallow wells are being utilised. Although spot irrigation would be more labour intensive than furrow irrigation the number of workers can be reduced by making use of PVC piping, available from Khartoum in sizes up to 100 mm. (4") diameter, instead of an abuishirin to deliver water to appropriate offtakes. In any case, with increasing numbers of nomads settling in the riverine areas after losing their normal means of livelihood, labour should not be difficult to obtain.

Another factor affecting the supply of water to trees is the method by which it is drawn from its source, be it a canal or a well. Presently pumps are used which require diesel fuel, and both fuel and spare parts are difficult to obtain. The feasibility of harnessing wind and/or solar power to pump water is a subject which could most usefully be investigated through an external programme of assistance.

Whilst the availability and efficient application of water have been the most important factors affecting afforestation in the province it is considered that more attention needs to be given to the selection of tree species appropriate both to growing conditions and to the purposes for which they are required. Prosopis chilensis, a useful fodder and fuel species outstanding in its ability to survive, and even thrive, under conditions of minimal irrigation in the JAP shelterbelts, is not a good choice for windbreaks across agricultural schemes as it is too low growing and may invade farmlands if not weeded out at an early stage (Plates 11 to 14). Eucalyptus camaldulensis on the other hand, though ideal because of its height and narrow crown form for windbreaks inside schemes with plentiful water, has largely failed in the JAP production blocks along the boundary. It is difficult to understand why other tree species, both exotic and indigenous, which are already well known have not been used more extensively in the shelterbelts and production blocks in Nile Province. A list of species recommended for further consideration is given in Table 16. In addition to trials using more species it will be necessary to study the silvicultural techniques and practices (eg. size of plant, time of planting, etc.,) best suited to each.

Even if water problems can be solved and the correct tree species and silvicultural techniques are used, plantations may still fail in places where damage by animals is a hazard unless they are adequately protected. Under the JAP normal practice has been to fence areas using 5 or 6 strands of barbed wire (imported from overseas,) hung between squared posts of Acacia nilotica (imported from Gezira province,). But, during six weeks spent in the province, only two plantations were seen

PLATE 13 Mesquite thriving (background) and invading a poor stand of Eucalyptus. Zeidab Shelterbelt, March 1985

PLATE 14 Eucalyptus camaldulensis p.84 in Abu Saleem Production Block. March 1985

with their fences still intact (at Abu Saleem and Kabushiya Production Blocks, both recently planted). Now that Mesquite is to be found throughout the riverine parts of the province, and especially at those places where it has spread naturally into areas where it is not desired (eg. at Makniya in the Kelli Scheme,) it is recommended that it be used for fencing in the manner developed by Green Deserts (see Appendix 6), rather than continue with the use of expensive imported materials.

It must be emphasised that practicing foresters should at all times be at pains to explain what they are doing, and demonstrate the results to the local people wherever they are working. Unless people are well-informed there will be little support for, and possibly even hostility against any future large-scale afforestation programmes. However, if public support can be gained and brought to realise that there are considerable benefits, both direct and indirect, to be obtained at the individual level then a high degree of voluntary participation in tree planting will be assured.

7.2 PROPOSED ASSISTANCE

Reference has already been made in Section 6.3.2 to the "Village Extension Scheme" (VES), to be implemented by the British Committee of SOS Sahel International. Initially to be based on villages of the Seyal Agricultural Scheme, part of NAPC, it will be concerned with the planting by voluntary efforts of windbreaks along irrigation channels and the establishment of village woodlots. The VES will be partly financed by ODA.

The additional assistance which ODA would provide and which is described in detail below is seen as complementing the VES project as well as providing, by means of investigations and demonstration, additional technology and improved practices of value to forestry development in other areas of Nile Province. A situation is envisaged whereby the NAPC would plant trees on the strips of land which separate its schemes from the desert and along roads and canals within the schemes, whilst the farmers would plant trees for themselves on the land that they are irrigating and at their villages.

It is proposed that ODA assistance, for three years at this stage, be centred on the Kelli Agricultural Scheme, also part of the NAPC and just a short distance north of the Seyal Scheme, where 150 feddans of land allocated to but not planted by the JAP is available (see Text Map 1 and separate Map 1). This land is contained in eight strips in which a total of 133 fed. has already been provided with 'abuishrin' delivery channels (see Table 17). It is understood that additional land on the desert side of these strips could be made available by the NAPC under its "reserve extension" powers. The main components of the proposals are:

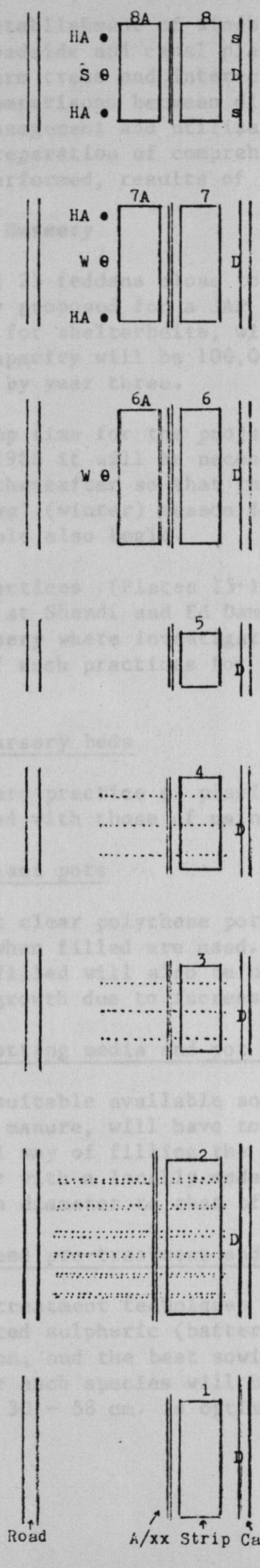
i. Establishment of a tree nursery, including studies to develop improved techniques for raising seedlings
ii. Investigations on the use of alternative water and energy sources and of methods of irrigation and quantities
iii. Trials with a wider range of species which may be suitable for wood and fodder production and for wind protection

TABLE 17 Sites provided with Abishrin (A/xx channels but still not planted at the end of the JAP

Sprip No.	Start of A/xx and direction	Length (m.)	Width (m.)	Area (fed.)	Remarks
1	Minor Canal No.1 northwards from K 3.216	1,400	50	16.7	East of Kelli
2	Minor Canal No.1 from K 4.616	1,860	70	31.0	East of Farahsine
3	Double A/xx No.14 from K. 616	1,040	50	12.4	East of El Obidab
4	Minor Canal No.2 from K. 624	1,040	50	12.4	North of El Obidab
5	Minor Canal No. north from K.600	700	50	8.3	West of El Obidab
6	Minor Canal No.2 north from K3.018	1,680	50	20.0	East of El Hadahid
7	Minor Canal No.2 north from K5.588	1,460	50	17.4	East of El Komor
8	Minor Canal No.2 north from K8.218	1,220	50	14.5	East of El Komor and up to Sagadi
	Total			132.7	feddans

FIGURE 2

Diagramatic representation of planting areas along Strips, A/xx, canals and roads (not to scale)



- Each Strip 1220 m. x 50 m. (14.5 fed.)
  Trials with 16 species
  16 rows x 610 trees in each Strip
  Strip 8 irrigated by method (i)
  Strip 8A by method (v)

- Each Strip 1460 m. x 50 m. (17.4 fed.)
  Trials with 16 species
  16 rows x 730 trees in each Strip
  Half of each Strip irrigated by method (ii)
  and the other half of each by method (iii)

- Each Strip 1680 m. x 50 m. (20 fed.)
  Trials with 16 species
  16 rows x 840 trees in each Strip
  Strip 6 irrigated by method (i)
  Strip 6A by method (iv)

- Strip 700 m. x 50 m. (8.3 fed.)
  Acacia albida spacing trials and farming
  Irrigation method (i)

- Strip 1040 m. x 50 m. (12.4 fed.)
  3 x 1-row windbreaks each 150 m. long and each of a different species
  Irrigation method (i)

Strip 1040 m. x 50m. (12.4 fed.)
3 x 1-row windbreaks each 150 m. long and each of a different species
Irrigation method (i)

Strip 1860 m. x 70 m. (31 fed.)
6 x 2-row windbreaks each 210 m. long and each of a different species
Irrigation method (i)

Strip 1400 m. x 50 m. (16.7 fed.)
Trials with 16 species
16 rows x 700 trees
Irrigation method (i)

- • Shallow well
- θ Matara well
- D Diesel pump
- W Windpump
- HA Hand/animal pump
- S Solar pumps
- s

iv. Establishment of windbreaks
v. Roadside and canal planting
vi. Farm trees and inter-cropping
vii. Comparisons between different methods of fencing
viii. Management and utilisation
ix. Preparation of comprehensive records on all aspects of works performed, results of investigations and costs.

7.2.1 The Nursery

An area of 25 feddans close to and just south of Kelli village, originally proposed for a JAP nursery and additional to the 150 feddans allocated for shelterbelts, will be developed as the ODA nursery. Planned capacity will be 100,000 plants in the first year, rising to ¼ million by year three.

As start up time for the project (under NRIRP Phase II) is expected to be April 1986 it will be necessary to commence operations as soon as possible thereafter so that the nursery can be ready by November, when the 'Shitwe' (winter) season irrigation begins and the sowing of tree seeds should also begin.

Normal practices (Plates 15-17) as used in the Forestry Division's nurseries at Shendi and Ed Damer, will be studied and replicated in the Kelli nursery where investigations will also be carried out on various aspects of such practices for comparison. Such investigations will include -

7.2.1.1 Nursery beds

The standard practice of placing pots in sunken, brick-lined, beds will be compared with those of using surface and even raised beds.

7.2.1.2 Plant pots

At present clear polythene pots (bags) 200 mm. long and 50-65 mm. in diameter when filled are used. Black pots 250 mm. long and 75 mm. diameter filled will also be used, to compare durability and differences in plant growth due to increased rooting space.

7.2.1.3 Potting media and pot filling

The most suitable available soil or soil mixture, including the addition of animal manure, will have to be found. Also, the most efficient and economical way of filling the pots (eg. with hands only, with a small trowel, or with a locally made scoop funnel having a spout just a little smaller in diameter to that of the pots).

7.2.1.4 Seed pre-treatment and sowing dates

Seed pre-treatment techniques such as scarification, soaking in water or concentrated sulphuric (battery) acid, etc., to promote rapid germination, and the best sowing dates to produce the optimum size of plants for each species will be studied. Berry (1978) reported that a height of 30 - 58 cm. is optimal for Eucalyptus and 40 cm. for Prosopis.

7.2.1.5 Watering

The quantity, frequency, time and method of applying water to the pots at different stages of seedling development will be studied. In sunken beds the relative merits of flood irrigation and hand watering by hose or watering can, and also of combinations of the two methods, will also be studied. Flood irrigation of pots from the bottom upwards seems to be extravagent in the use of water, but it may be that it is more beneficial than application of water from the surface.

7.2.1.6 Weeding

The frequency of weeding required during a season, and the desirability or otherwise of watering for some time to stimulate weed growth and its removal before sowing tree seeds will be investigated.

7.2.1.7 Root pruning

With many species, and especially indigenous ones, root growth is so rapid in comparison with shoot growth during the seedling stage that the trees cannot survive planting out if their roots have to be severed when they are lifted from the nursery. For this reason pruning as soon as roots begin to emerge from the pot, and subsequently at regular intervals until the seedling above ground attains the required size, is necessary. Berry (1978) maintained that pruning eight times in a season is optimum, but this needs to be verified for each species.

7.2.1.8 Shading

The shade requirements of each species, from time of sowing to that of planting out, will be studied. Most, if not all, species will require some exposure to the sun to harden them off before being lifted from the nursery.

7.2.2 The irrigation of trees

Water is essential, both for seedlings in the nursery and for the trees when planted out, and it is proposed to experiment with alternative sources of water, to utilise different sources of energy to pump it, and to carry out trials using different methods of conveying it from its source to the trees. Work being done in Sudan by the Institute of Terrestial Ecology on soil polymers to increase water retention in the soil is very pertinent.

7.2.2.1 Water sources

Although water supplies for this forestry project will come mainly from the Kelli Irrigation Scheme, soon to be rehabilitated under the NRIRP, it is intended to draw water also from the groundwater table using locally constructed shallow and sub-artesian wells to find out the extent to which afforestation programmes on the boundaries of agricultural schemes can become independent of the river water used in such schemes. One shallow well will be dug in the nursery and two on the west side of both Strips No.7 and No.8 (see Table 17 and Figure 2.) One sub-artesian ('Matara') well will be constructed in the nursery and one each at the cente point but on the west side of Strips Nos. 6,7, and 8.

PLATE 19 The Forestry Division nursery at Ed Damen. April 1985

PLATE 16 Eucalypts in sunken beds. Ed Damer nursery, April 1985

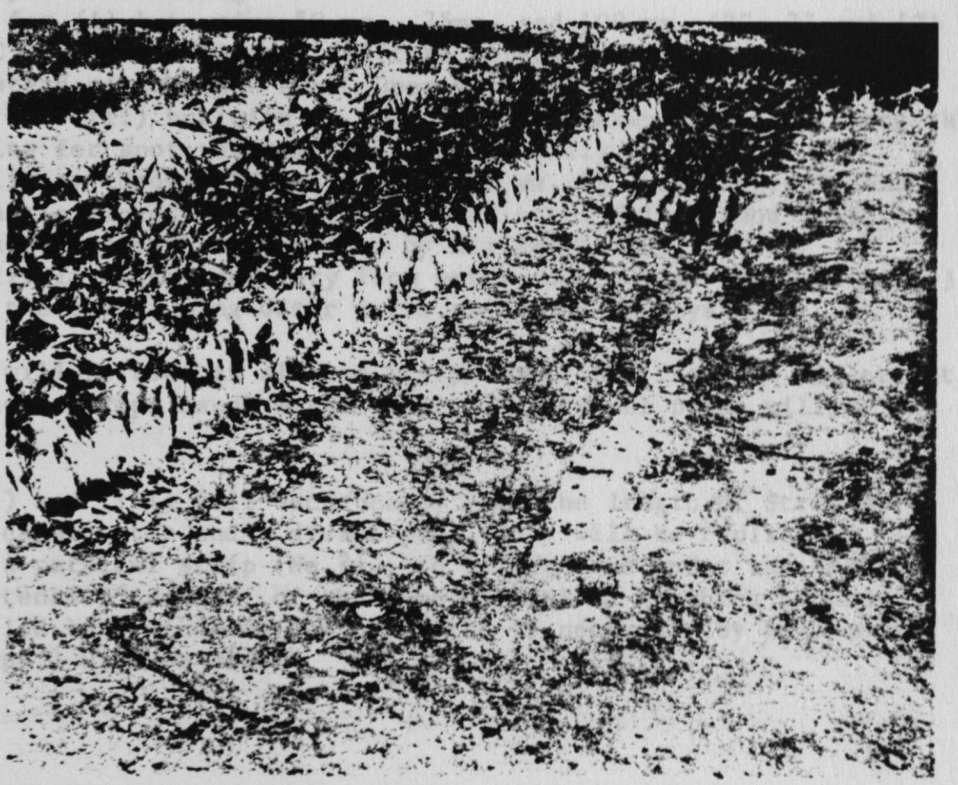


PLATE 17 The clear polythene pots in use by the Forestry Division are not very durable

7.2.2.2 Energy sources for pumping

8 h.p. water cooled diesel-engined pumps with 4" intakes and outlets, of a type and make similar to those currently being used for forestry in Nile Province, will be used; one in the nursery and one in each of the eight plantation strips inherited from the JAP. In addition, and in order to investigate the potential of energy sources other than diesel fuel, it is intended to install 3 windmill pumps over subartesian wells and 5 hand/animal powered pumps over the shallow wells. Provision is also made to enable trials to be made on the use of solar pumps.

In matters concerning the use of wind and solar energy the expertise available from IT Power Ltd., an offshoot of the Intermediate Technology Development Group (ITDG) should be consulted.

The Renewable Energy Adviser at ODA has welcomed the possibility of having solar and wind pumps installed in a project such as this where proper performance monitoring can be arranged. He also considers that monitoring of the little-known yet essential true operating costs of the 8 h.p. diesel pumpsets is needed since these are widely used in the private sector (see Appendix 2).

7.2.2.3 Methods of water conveyance

Methods to be compared include -

i. Standard Open Abuishrin (A/xx) channels with lateral offtakes leading to open furrows, as practiced already.
ii. As above but with the A/xx and laterals lined with black polythene sheeting.
iii. As for (i) but using 50 mm., 75mm. and 100 mm. (2", 3" and 4") PVC piping with lateral offtake points at 50 m. intervals instead of the open A/xx. Open water in the furrows.
iv. As for (iii) but with 20 mm. (¾") hose take-off points along the mains for spot watering of trees manually.
v. Delivery through PVC mains with 13 mm. (½") PVC laterals and plastic microtube drippers to each tree. This method is to be adapted from that described by Hillman (1984)
vi. Entirely manual delivery from water source (ie. canal or well,) to the trees using water carts pulled by donkeys.

Method (i) will be used in all the Strips inherited from the JAP except No.7. In these Strips canal water supplied by diesel pumps will be used.

Methods (ii) and (iii) will each occupy half the length of Strip No.7 also using canal water and a diesel pump. They will be replicated however in a parallel strip (No.7A), to be acquired under the NAPC 'reserve extension' powers, of the same dimensions in which ground-water supplied by a windpump (supplemented if necessary by hand/animal powered pumps,) will be used.

Method (iv) will be carried out in Strip No.6A, another reserve extension area parallel and equal in size to Strip No.6, and will use groundwater supplied by a wind pump.

Method (v) is to be used in Strip No.8A, a third reserve extension, parallel and equal in size to Strip No.8. Solar and hand/animal pumps will be used to draw upon groundwater.

Method (vi) will be used mainly for trees planted along roadsides, but will also be used in part of at least one of the Strips so that comparative cost and efficiency data may be obtained.

With each method used the quantity of water supplied and frequency of application will be recorded. Baselines upon which variations are recorded will be 200 m^3 (about 44,000 gals.) per feddan twice monthly for flood irrigation, and 2 gals./tree twice weekly for spot irrigation.

7.2.3 Species Trials

Trials with all the species listed in Table 16, except Acacia albida, will be carried out in the form of line planting in each of Strips Nos. 1, 6, 6A, 7, 7A, 8 and 8A. As these Strips are each 50 m. wide this will allow 16 rows at 3 m. spacing, (one row for each species). Within the rows trees will be planted 2 m. apart. To allow for possible differentials between water supply to rows the sequence of planting species in relation to row will be varied in each Strip.

As well as testing the survival and growth of each species, studies will be made to establish optimum sizes and times of planting for each.

7.2.4 Windbreaks

The objective is to find out, within lands (presently unused,) allocated to the ODA project and therefore free from the prejudices of already established farmers, what species could best be used within agricultural schemes to minimise the adverse effects of wind and wind-blown sand on farm crops. For this purpose it is intended to carry out trials using six species -

Albizia lebbek
Cassia siamea
Casuarina equisetifolia
Conocarpus lancifolius
Eucalyptus camaldulensis
Leucaena leucocephala

In view of space limitations within agricultural schemes trials will be restricted to single and double rows of trees. These trees will be planted in an East-West direction (at right angles to generally prevailing winds,) and, because available Strips are very narrow, will extend in length to three times the width of each Strip. This will involve further invocation of NAPC 'reserve extension' powers.

It is intended to carry out the investigations in Strips Nos. 2, 3 and 4; all to be irrigated with canal water in the established way, using diesel pumps, A/xx and open furrows. It is also expected that later, when windbreaks have been established, the land between may be farmed so that the actual efficacy of such windbreaks in terms of improved farming conditions may be measured and demonstrated.

In each Strip the first windbreak will be laid out 200 m. south of its northern extremity in order that when future farming trials commence there will still remain an unprotected, control, area. Subsequent windbreaks will be 300 m. apart (ie. approximately the distance between A/xx in the Kelli Scheme); which should be sufficient for each to be judged on its own merits.

The lengths of Strips available are such that six 2-row windbreaks (ie. one for each species) can be established in Strip No.2 and three 1-row windbreaks in each Strips Nos. 3 and 4.

7.2.5 Roadside and canal planting (Plates 18 and 19)

Here again investigations are to be carried out outside of the Kelli Scheme itself on operations which are intended for future application within the Scheme. As the object of roadside and canal planting in the Scheme will be primarily to assist in wind protection, the same species as for windbreaks will be used.

Trials will be carried out -

i. Along Scheme canals which supply water to the Strips, and which should always contain water (except during the April - June 'irrigation gap.')
ii. Along A/xx in the Strips, which contain water intermittently.
iii. Along road adjacent to project Strips, where there is no immediate water supply.

Apart from the selection of most appropriate species for such planting investigations will inevitably have to be directed towards the most suitable methods of watering and protecting such trees.

7.2.6 Farm trees and inter-cropping

By virtue of its powers of nitrogen fixation, the fodder value of its leaves and pods, and the fact that it is leafless during the rainy season, Acacia albida (an indigenous species) is widely recognised as one of the most valuable trees to be found in farms. When mature it has a broad crown, and therefore requires a wide spacing. Under this project it is intended to devote the whole of Strip No.5 to trials planting A. albida at spacing of 10 x 10 m., 15 x 15 m. and 20 x 20 m. Furthermore, as this is the situation which would occur within the Kelli Scheme, it is proposed to plant these trees simultaneously with farming in Strip No.5. As the Strip is only 8.3 feddans in area and will include only 240 trees it should be possible for one diesel pump, using canal water, to irrigate the area.

7.2.7 Fencing

Trials to compare the efficiency, durability and costs of various types of fencing will be carried out. These will include -

i. Barbed wire and squared wood fence posts, as used previously under the JAP. Because of its high cost, and previous history of inefficiency, this type will only be used over a part of Strip No.1 close to Kelli village and a part of one other Strip which is remote from human habitation.

ii. Mesquite fencing panels, as produced under the Green Deserts project (see Appendix 6). Material for such panels can be obtained at Makniya, and will serve to demonstrate that even Mesquite which has invaded dry canals and farmlands can be utilised to advantage.

iii. Live hedges, both sown and planted, using species such as Prosopis chilensis, Acacia nilotica and Zizyphus spina-christi at very close spacing.

iv. Individual tree guards. These will be particularly necessary for the Acacia albida planted at wide spacing in Strip No.5 and for trees in windbreaks, canal and roadside planting. Investigations will include various types of guards which can be made from locally available materials (eg. thorns, matting, etc.,) and plastic tree guards such as those referred to at 6.3.1 (iv).

Additionally trials will be carried out using plastic tree guards, buried at least 20 cm. (the length of plant pot,) as funnels through which water is applied to the plants; this should retain water closer to plant roots and reduce surface evaporation.

Dr. Julian Evans, a senior silvicultural research officer with the U.K. Forestry Commission at Alice Holt who supplied the tree guards for testing by Green Deserts, has indicated that he would by very willing to become associated with any trials involving the use of plastic tree guards, of which there are several types available in the UK ranging in size up to 6" diameter.

7.2.8 Management and Utilistion

Although the main objective at this stage of the project will be the establishment of trees by planting, the design and implementation of sound management practices and subsequent utilisation of produce grown will also be undertaken. In these respects a start will be made with the existing production block at Makniya and any other already established tree plantations accessible within the area.

7.2.9 Records

None of the works to be carried out under this project will be of lasting benefit unless they are fully documented. Records, including costs, will therefore be maintained at all times concerning every

PLATE 18 Part of Seyal Scheme showing a dry A/xx channel. One bank could be planted with trees

PLATE 19 Trees planted along a minor canal in Egypt. Apart from protection they provide valuable timber, charcoal and firewood

aspect of operations carried out by the project. They will be kept on a daily, weekly and monthly basis, and quarterly progress reports will be submitted through the British Embassy in Khartoum to the BDDEA in Nairobi, with a copy to the desk officer at ODA, London. The General Manager, NAPC, and the Forestry Division in Nile Province will be kept fully informed concerning project activities and, at all times, every possible effort will be made to ensure that the local population is involved as much as possible, and encouraged to understand and appreciate the reasons for which these investigational activities are being carried out. It is essential that the local people understand that this project is designed to investigate improved methods of establishing the most useful trees to themselves, and that it is not just for the benefit of 'government' alone.

7.3 STAFF AND TRAINING

Because of the specialised nature of many of the activities involved in this project provision is made to allow inclusion of consultancy services, presently envisaged as including IT Power Ltd., (wind and solar energy), the Centre for Overseas Research and Development, Durham University (trickle irrigation and information concerning the silviculture of Prosopis cineraria), and the UK Forestry Commission Research Station, Alice Holt (tree guards). The field Project Manager will be a TCO university graduate in Forestry or a closely related subject, with previous experience in arid zone afforestation; if necessary he will receive prior familiarisation on the usage of wind and solar pumps at the IT Power/Halcrow Global Renewable Energy Testing Station in Wiltshire.

It is expected that the Government of Sudan (GOS) will supply one university graduate and one experienced technician forester as counterparts to work with the TCO, and that they may be provided with further training outside Sudan appropriate to their qualifications and the needs of the project.

The GOS will also be expected to make available skilled overseers for work in the nursery and at the planting sites.

Permanent staff required by and seconded to the project will be given a project allowance to compensate for hardships involved living and working in a difficult area. Temporary workers will be paid out of project funds.

7.4 FINANCIAL ANALYSIS

Details of the financial analysis are presented in Appendix 7, while the results of the analysis are shown below. Only Net Present Values (NPV's) have been calculated and as expected with this type of project, the values are negative at both 10% and 15% rates of discount:

NPV	Discount rate %
- 1,363,620	10
- 1,367,448	15

NPV's improve but remain negative if the expatriate forester's salary is excluded from the deficit in PY 1, 2 and 3.

NPV	Discount rate %
- 932,773	10
- 953,899	15

PART 8 REFERENCES

BAYOUMI A A (1976 and 1977). The role of shelterbelts in Sudanese irrigated agriculture with particular reference to the Gezira. Sudan Silva No. 21, Vol. III 1976 and No. 22 Vol III 1977.

BAYOUMI A A, KHALIFA K O and SALEEM A A (1984) Study for the establishment of forestry planatations, shelterbelts and canal planting in the Northern Region. Sudan Renewable Energy Project, Energy Research Council, The National Council for Research. Khartoum, 1984.

BERRY M J (1978) Forest operations in the Nile Province, Northern Sudan: Irrigated Shelterbelt Project. Reports of an LRDC Mission, 2 October - 4 November 1978. Land Resources Development Centre, Overseas Development Administration, London 1978.

BHALOTRA Y P R (1964) Wind Energy for Windmills in Sudan. Sudan Meteorological Service Memoir No.7.

BOSSHARD W C (1966) Drought Resistance of Tree Species. Republic of the Sudan. Forests Department & UNDP. Forestry Research and Education Project. Pamphlet No.32.

CALLAGHAN P J, BACON P J, LINDLEY D K and El MOGHRABY A I (1985) The energy crisis in the Sudan : Alternative supplies of biomass. Institute of Terrestial Ecology.

EARL D E (1984) Charcoal production. Sudan Renewable Energy Project, Energy Research Council. Report No. 002. Khartoum, 1984.

FOGGIE A (1967) Forestry and forest policy in the Gezira area FAO Report No.Ta 2411, Rome.

Goda S El D (1977) Plantation forestry on Sudan. Sudan Silva No. 22, Vol III Sudan Forestry Society, Khartoum.

HILLMAN F (1984) Trickle irrigation: a low-cost, low pressure, low technology system. Editor Dr. R.W. Dutton. Centre for Overseas Research and Development, University of Durham, Preliminary reports Vol. 8 B No.1.

ICRAF/BAT (1982) Agroforestry Systems of small-scale farmers. Proceedings of workshop held in Nairobi. Sept. 1982. Edited by Hoekstra DA and Kugum FM.

JACKSON J K (1960) Forest Management, FAO Report No. 1291, Rome

SIR M MACDONALD & PARTNERS & HUNTING TECHNICAL SERVICES (1964) Roseires Soil Survey. The Nile from Khartoum to Kareima. Soils and engineering reconnaissance. Report No.5. London

SIR M MACDONALD & PARTNERS LTD (in association with Hunting Technical Services Ltd and Sir Alexander Gibb and Partners), 1979, Reappraisal of the Northern and Nile Provinces Pump Schemes.

SIR M MACDONALD & PARTNERS LTD (1984) NRIRP Phase 1 Study. Interim Report.

MUKHTAR (1978) Woodfuel as a source of energy in Sudan. Forests Administration. Khartoum.

MUKHTAR (1982) Decreasing energy availability in Sudan with particular consideration on rural energy supply. Ministry of Energy and Mining, Khartoum.

MUSNAD H A (undated) Establishment of Shelterbelts under harsh Desert Conditions of N. Sudan (unpublished).

MUSNAD H A & ELMAK O A (1983) Pod production of Misquite (Prosopis chilensis) in the Nile Province. Sudan Silva No. 25 Vol. V.

SAINI T S (1964) Present wood consumption and future requirements FAO Report No. 1821, Rome.

SALEEM A A (1975) The Significance and Importance of Shelterbelts in the Sudan. Sudan Silva No.20, Vol. III Sudan Forestry Society.

SALEEM A A (1977) General principle of shelterbelts design with reference to application in the Sudan. Sudan Silva No.22, Vol. III 1977.

SNEA (1982) Sudan national energy assessment. Executive summary. Khartoum.

SNEA (1983) National Energy Administration. Base year energy supply/ demand balances and demand projection methodology Annex 1. Khartoum.

TAPP C W N (1984) Review of Forestry Projects in Sudan. Agricultural Research Council, Khartoum, USAID.

TAPP C W N (1984) Government Forestry Activity in Sudan 1979-1984 Data Sheets (performed for IBRD Forestry Review Mission.)

World Bank (1983) Sudan issues and options in the energy sector. Report No.4511-SU.

APPENDIXES

APPENDIX 1 POPULATION OF SELECTED VILLAGES IN SOUTHERN DISTRICT OF NILE PROVINCE, 1983

Village Council	No. of Households	Population		
		Males	Females	Total
WAD HAMID RURAL COUNCIL				
Nagazo	142	406	457	863
Alhawawit	257	738	696	1,434
El Galaa	283	906	766	1,672
Sheikh El Abas	261	764	760	1,524
Wad Hamid	299	859	928	1,787
Al Gabrab & El Galaat	272	571	720	1,291
Hagar El Tir	515	1,699	1,748	3,447
Al Kumur	307	770	958	1,728
Al Thawra	284	862	897	1,759
Wadi Bushara		719	735	1,454
Al Hugna	713	2,101	2,172	4,273
Hagar wad Salim	215	610	614	1,224
Wad El Habashi	495	1,342	1,493	2,835
Al Arif Nomads & Abu Rigaiwa	702	1,771	1,809	3,580
EL MATAMA RURAL COUNCIL				
El Saial el Sageer	298	960	1,038	1,998
El Saial El Kabir	179	550	591	1,141
El Ugda & Al Gilie	150	421	444	865
Al Karada	248	557	773	1,330
Al Hamrab	224	691	801	1,492
Al Arifi	124	317	347	664
Al Iz Hussein	206	492	570	1,062
Kali	314	817	961	1,778
Matama (Nomads)	619	1,675	1,534	3,209
Bagarousi	263	618	526	1,144
El Maknia	184	347	465	812
El Hadahid	101	225	314	539
Al Hilaila	166	270	335	605
Al Ibeidab	182	364	464	828
Al Kimir & Al Maia	442	1,235	1,449	2,684
Al Gubba	220	491	609	1,100
Al Giweir	549	1,385	1,706	3,091
Al Nurab	546	1,211	1,700	2,911
Al Sufur	423	1,008	1,263	2,271
Al Gubush	172	463	554	990
Goz Bara	276	548	794	1,342
Goz Badr	250	551	777	1,328
Al Gabalab	282	757	1,067	1,824
Al Magaweer	583	1,337	1,750	3,087
Taiba Al Khawad	410	938	1,177	2,115
Er kweit	236	538	667	1,205
Al Gireif	220	538	649	1,187

Village Council	No. of Households	Population		
		Males	Females	Total
EL MATAMA RURAL COUNCIL (contd)				
Al Hikaika	91	256	313	579
Salwa	146	480	437	917
Um Sanad	119	330	409	739
Al Bawalid	138	334	394	728
Al Sulaab	128	396	479	875
Wadi El Dabi	214	601	636	1,237
Wadi Khalil	216	627	691	1,318
Tabaga	295	735	901	1,636
Al Gubba & El Kardamab	230	605	714	1,319
Al Hobagi	323	804	1,028	1,832
SHENDI RURAL COUNCIL				
Al Atarab	265	720	856	1,576
Al Sidra Al Ghaba	238	684	826	1,510
Al doshein	200	423	563	986
El Taragma	278	757	887	1,644
Al Maslaha & Hagar Beshir	108	283	313	596
Abu Gidad & Al Higina	188	586	451	1,037
Alladiat & Albatrorab	255	716	636	1,352
Kigina & Al daknog	231	594	531	1,125
Al Misiktab South	206	536	530	1,066
Al Saggai	264	750	691	1,441
Al Shigalo	738	2,204	2,313	4,517
Al Ahamda Al Dileig	206	599	951	1,550
Al Misiktab Hillat El Sheikh	218	526	566	1,092
Arkeweit	280	679	700	1,379
Al Misiktab Al Goz	263	524	799	1,323
Al Misiktab Al Ushara	271	838	908	1,746
Timeid Hag Taha	216	518	537	1,055
El Dalaga & Al Manaseer	157	389	404	793
Um Usheira & Um Hatab	237	545	565	1,110
Al Garna & Al binieber	106	190	249	439
Al Siteir	44	126	115	241
Al Misiktab bir Al Sherif	109	356	346	702
Al Tundub	133	420	419	839
Al Dueimat	142	292	373	665
Abu Eltai & Wad-Kulban	105	340	319	659
El Zakiab	154	429	451	880
Abu Al Hassan & Al Madamab	220	541	619	1,160
Goz El Hag	328	897	1,097	1,994
Al Atalab	217	490	687	1,177
Deim Al garrai east & west	228	611	805	1,416
Deim Al garrai North & South	577	643	759	1,402

Village Council	No. of Households	Population		
		Males	Females	Total
SHENDI RURAL COUNCIL				
Al Bagrawia	416	1,018	1,213	2,231
Al Shibilia	152	306	391	697
Gadaw	349	897	1,032	1,929
Um Ali	276	624	781	1,405
Al Khalwat	122	281	295	576
Abu Gaidoam	201	666	749	1,415
Al Zaraghna	174	450	541	991
Al Kandarria	153	498	441	939
Al daiwmab	264	740	953	1,693
Abu Tileih	266	755	803	1,558
Deim Um Tireifi	209	568	610	1,178
Wad Banaga	290	954	824	1,778
Wad Banaga Al Gubba	140	354	403	757
Al Taiseeb & Al Magarba	95	270	220	490
Al Salama Bahri	116	227	296	523
Wad Banaga Banat & Al Kurkugam	150	340	415	755
Al Damboia & Wad Al Kaani	156	425	482	907
Al Basabeir Al Deim	140	273	367	640
Al Basabeir Al Saq	298	761	670	1,431
Al Mallaha	133	363	434	797
Wadi Al doama & Awlad hamid	137	489	451	940
Al Zurug	226	682	686	1,368
Wad Al Hag	132	360	426	786
Banat Wad Noura	157	608	577	1,185
Hosh Bannaga	324	900	1,007	1,907
Al Salama Gibli	115	239	357	596
Goz Al Mutraq	105	192	249	441
Al Mereikhat	192	498	488	986
Gendato South	220	493	815	1,308
Al Igaiga	258	641	818	1,459
Gendato North	98	248	252	500
Al Sheikhat	161	531	597	1,128
Wad Al Obeid	158	447	477	924
Al Idrisab	106	341	315	656
Al Hassanab	125	476	390	866
Al Himaidab	158	467	461	928
Tendelti & Al Omda	107	291	322	613
Al Gilaia Central	248	688	704	1,392
Al Gilaia Al Gami	302	1,030	878	1,908
Al Hafian	235	580	609	1,182
Moais	398	1,253	1,283	2,536
Timaid Al Nafaab	368	833	1,072	1,905
Silimania (Nomads)	636	1,588	1,774	3,362

Village Council	No. of Households	Population		
		Males	Females	Total
SHENDI RURAL COUNCIL (contd)				
Al Kafanga (Nomads)	112	315	306	621
Al Naqua (Nomads)	205	567	603	1,170
Nomads (sector I)	545	1,744	1,628	3,372
Nomads (sector 2)	607	2,014	1,824	3,838

APPENDIX 2 : LETTER FROM RENEWABLE ENERGY ADVISER

OVERSEAS DEVELOPMENT ADMINISTRATION
Eland House Stag Place London SW1E 5DH

Telephone 01-213: 4889
or Switchboard 01-213:3000

Mr M Errington
Land Resources Development Centre
Tolworth Tower
Surbiton
Surrey
KT6 7DY

Your reference

Our reference

Date 17 June 1985

Dear Mr Errington

SUDAN - NRIRP - SOLAR AND WIND PUMPING

Following the discussion with Mr Wedderburn and you, I have made some very rough estimates of the costs of equipment that would be needed for small-scale demonstration installations to provide irrigation water for a few feddans. A much more thorough exercise will be needed if it is decided to go ahead and design for field trials.

The sources of information on the wind climate are not at all consistent, but for present purposes, I have assumed an annual mean windspeed of 3.7 m/s (8.5 mph) with a minimum in June of 2.9 m/s and a maximum in December of 4.6 m/s. On this basis, a 24 foot diameter 'Kijito' machine would deliver 120-160 m^3/day on average against 10 m total dynamic head and about 60m^3/day ih June and up to 300 m^3/day in December. Such a machine costs £8,500 ex Works in Kenya and about £12,500 installed with 50 m^3 tank in Kenya. I would guess that the extra transport to N. Sudan would bring the cost to £14-15,000.

The solar climate is the best in the world, with about 4,000 hr/yr of sunshine and daily mean global radiation (horizontal surface) of about 6.5 kwh/m^2 . The December radiation is about ⅔ that for June. On this basis, and taking manufacturer's figures for a 500 watt "Solapak" solar pump, costing £5,500 f.o.b. UK (perhaps £8,000 installed in Sudan) might be expected to deliver about 30m^3/day annual average against the same head as the wind pump, with 15-20 m^3/day in December and 30-35 m^3/day in summer. The very high ambient temperaturesin Sudan in summer reduce the output compared to equally sunny, cooler, situations.

Within the limits of this crude estimate, I do not regard the difference in costs between wind and solar as very significant - largely due to the great sensitivity of windpump output to windspeed coupled with dubious windspeed data. Also, windspeed is more site-specific than solar radiation.

/ I welcome

Mr M Errington
Land Resources Development Centre

17 June 1985

I welcome very much the possibility of having one or two solar and wind pumps installed in a project such as this where proper performance monitoring could be arranged as part of the scheme of things. It is possible that we could find some Red ~~Bed~~ money to help with monitoring costs. I suggest also that, whether or not the wind/solar installations go ahead, the project should include some monitoring of the true operating costs (fuel, attendance, maintenance, repairs, loss of water when fuel unavailable) of the 8 hp diesel pumpsets used by the private water supplies. Such costs are little-known and yet are essential to the taking of rational decisions for or against wind or solar power.

I look forward to hearing the outcome of the discussions with BDDEA.

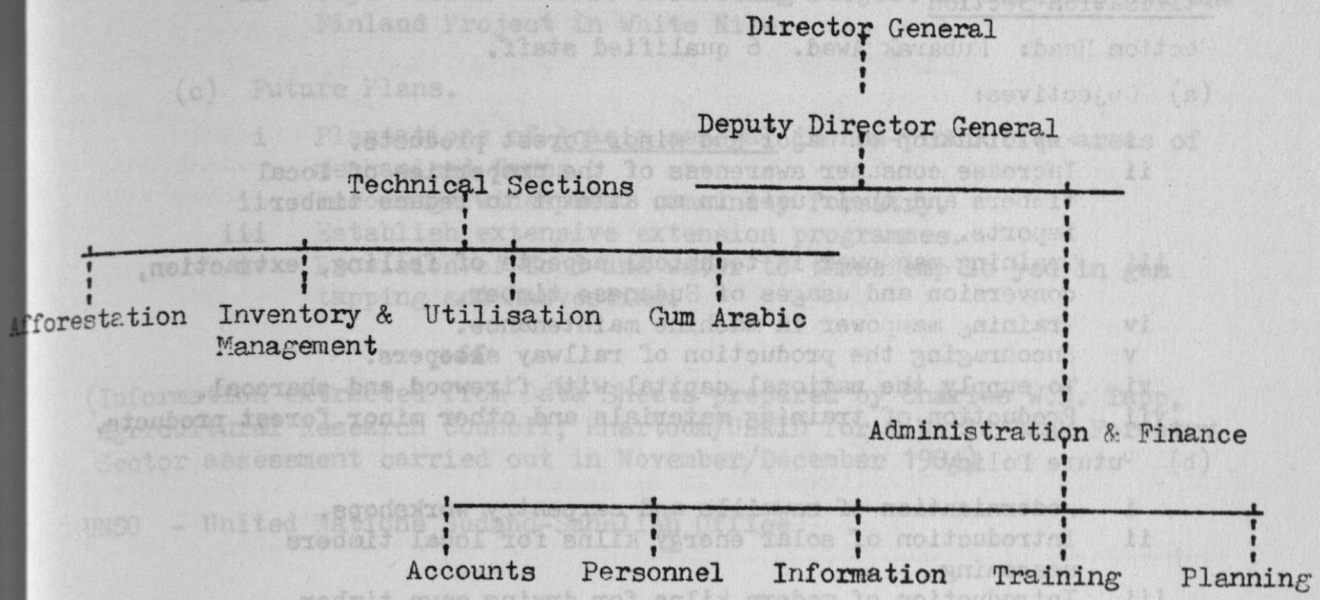
Yours sincerely

J D L Harrison
Renewable Energy Adviser

APPENDIX 3.1 Central Forest Administration

Report reflects the views, policies and ideas of the CFA. No editorial licence is employed.

Organisational Chart:



Responsibilities of Director General

(a) Overall supervision of CFA

(b) Public relations, both with GOS and donor agencies

(c) Policy orientation and implementation

(d) All legal matters pertaining to forestry in Sudan

Responsibilities of Deputy Director General

(a) Budgetary preparation and expenditure management

(b) Control of personnel - recruiting, transfer, promotion, discipline

(c) Coordinating the activities of all sections in the CFA

(d) Supervision of technical activities, including donor projects.

Management, Inventory and Reservation Section

Section Head: Mohamed Hanafi. 12 qualified staff.

Section is divided into 3 divisions.

(a) Management Division

Division prepares and writes management plans for different forest areas in Sudan (e.g. Blue Nile Working Plans). Field visits entail surveying, inventory work and map preparation. Socio-economic factors are also considered.

(b) Inventory Division

Concerned with evaluating standing volumes by species in different parts of the co untry. Aerial photography and satellite imagery has been used by the division.

(c) Reservation Division

Basic aim is to reserve 15% of the country (80 million fe.). To

date 3 million fe. are gazetted with a further 3 million identified for reservation.

Utilisation Section

Section Head: Mubarak Awad. 6 qualified staff.

(a) Objectives:

i Exploitation of major and minor forest products.
ii Increase consumer awareness of the properties of local timbers and their uses in an attempt to reduce timber imports.
iii Training manpower in technical aspects of felling, extraction, conversion and usages of Sudanese timber.
iv Training manpower in machine maintenance.
v Encouraging the production of railway sleepers.
vi To supply the national capital with firewood and charcoal.
vii Production of training materials and other minor forest products.

(b) Future Policy

i Modernisation of sawmills and carpentry workshops.
ii Introduction of solar energy kilns for local timbers seasoning.
iii Introduction of modern kilns for drying sawn timber.
iv Planning and establishing paper, particle board, plywood and veneer factories at suitable sites.

Afforestation Section

Section Head: Ali Saleem. 4 qualified staff.

(a) Objectives.

i Preparation, execution and monitoring of plans and projects concerned with afforestation.
ii Afforestation in rainfed and irrigated areas and the establishment of shelterbelts in agricultural areas and around towns and villages.
iii Conservation and protection of natural and plantation forest from illegal felling.
iv Increase the afforested area, especially in mechanised farming.
v Establishment of forest nurseries.
vi Preparation and supervision of the CFA Development Budget.
vii Project identification and planning
viii Preparation of annual reports.

(b) Responsibilities of the section have been severely curtailed since decentralisation, though the section hopes to see such responsibilities re-centralised in the near future. The section does support the regions through the development budget, help organise staff training and encourage extension activities.

Gum Arabic Development Section

Section Head: Mohamed Khalil. 4 qualified staff.

(a) Objectives.

i Increase gum arabic production up to 50,000 tonnes/year.
ii Guarantee continuation of gum arabic production to satisfy world demand.
iii Participation in desertification control through restocking of Acacia senegal trees.
iv Improve Sudan Bofp.
v Encourage employment in rural areas.
vi Help prevent rural-urban migration.
vii Increase rural living standards.

Present Duties.

(b) XXXXXXXXXXXX

i Supervision of all Acacia senegal plantations that fall within the provinces serviced by CFA development budgets.

ii Supervision of UNSO Restocking Project in Kordofan and the Finland Project in White Nile.

(c) Future Plans.

i Plantations of Acacia senegal in non-productive areas of mechanised farms.

ii Encourage widespread community forestry.

iii Establish extensive extension programmes.

iv Provision of food and water to those emp lo yed in gum tapping and harvesting.

(Information extracted from Data Sheets prepared by Charles W.N. Tapp, Agricultural Research Council, Khartoum/USAID for a World Bank Forestry Sector assessment carried out in November/December 1984)

UNSO - United Nations Sudano-Sahelian Office

APPENDIX 3.2 Organisation and Staff of the Forestry Division in Nile Province

Director General
Ministry of Agriculture & Natural Resources
(Dr. Badawi Babiker Osman)

Director
Department of Natural Reso urces
(Sd. Abdullah Ibrahim El Fadl)

Head of Forestry Division
(Sd. Mohamed El Habib Hamad)
Conservator of Forests

Shendi District Office:	Conservator of Forests	(Sd. Mahgoub Salih)
	Asst. Cons. Forests	(Sd. Kamal Ahmed Mohamed)
Ed Damer District Office:	Asst. Cons. Forests	(Sd. Ibrahim Abdel Bagie)
	Asst. Cons. Forests	(Sd. Hyder El Safie)
Berber District Office:	Asst. Cons. Forests	(Sd. Omar Ibrahim)

Staff of the Joint Afforestation Project (JAP)

Shendi:	Conservator of Forests	(Sd. Ahmed Ali Dirdiri)
	Asst. Cons. Forests	(Sd. El Sheikh Ahmed Babiker)
Ed Damer:	Conservator of Forests	(Sd. Osman Ahmed El Mak)
	Asst. Cons. Forests	(Sd. Jaafar Awadalla)

APPENDIX 4 CONVERSION FACTORS FOR FUELWOOD AND CHARCOAL

1. Fuelwood

1 camel load = 4.0 kantars = 0.44 m^3
1 donkey load = 1.5 kantars = 0.17 m^3
1 head load = 0.5 kantars = 0.03 m^3
Saini (1964)

1 ton fuelwood equivalent to 3.3 stacked m^3
Jackson (1960)

1 m^3 stacked fuelwood equivalent to 0.71 m^3 solid in round (overbark measurement)
Foggie (1967)

1 metric tonne dry fuelwood equivalent to 3 m^3 growing stock
SNEA (1982-83)

2. Charcoal

1 ton charcoal = 17 m^3 of stacked wood
Jackson (1960)

1 sack charcoal equivalent to 110 rotles

20 sacks charcoal to 1 metric tonne

1 metric tonne charcoal = 17 m^3 stacked wood = 12.07 m^3 solid
Foggie (1960)

1 metric tonne charcoal requires 6 metric tonnes wood

1 metric tonne charcoal equivalent to 18 m^3 growing stock
SNEA (1982-83)

APPENDIX 5.1 Nile Province Budgets in recent years

Year		Expenditure £s.		Revenue £s.
1979/1980	Chapter I	109,465	Royalties	13,932
	Chapter II	90,644	Revenues	305
	Total	200,109		14,237
1980/1981		N/A	Royalties	15,904
			Revenues	2,384
	Total			18,288
1981/1982	Chapter I	90,971	Royalties	26,541
	Chapter II	12,380	Revenues	4,090
	Total	103,351		30,631
1982/1983	Chapter I	88,936	Royalties	30,827
	Chapter II	15,310	Revenues	5,593
	Total	104,246		36,420
1983/1984		N/A		
	Total			34,964

(Information extracted from Data Sheets prepared by Charles W.N. Tapp, Agricultural Research Council, Khartoum/U.S.A.I.D. for a World Bank Forestry Sector Review Mission carried out in Nov./Dec. 1984)

APPENDIX 5.2 Afforestation and Production in Nile Province in recent years

Year	Afforestation		Production
	Planted area (Feddans)	Species	
1979/1980	-	-	No production except a few telephone poles. Fuelwood and charcoal imported from Blue Nile and Kassala
1980/1981	6	Eucalyptus	35m^3 fuelwood
1981/1982	23	Eucalyptus	24m^3 fuelwood
1982/1983	7	Prosopis chilensis	4010m^3 fuelwood 532 roofing poles
	14Km. (Along edges of canals & ditches)	Prosopis chilensis	
1983/1984	119	Prosopis chilensis & Eucalyptus	No production

(Information extracted from Data Sheets prepared by Charles W.N. Tapp in the Agricultural Research Council, Khartoum for the IBRD/USAID coordinated Forestry Sector Assessment carried out in November/December 1984)

Note: Areas planted as listed above cannot include planting carried out under the SCC/GOS Joint Afforestation Project.

1 Feddan = 1.038 acres = 0.42 hectare

APPENDIX 5.3. Forestry Nurseries in Nile Province

Year	No. of Nurseries	Total No. Seedlings	Species
1979/80	5	83,377	Mainly Eucalyptus and Prosopis
1980/81	N/A	N/A	N/A
1981/82	6	145,189	Eucalyptus, Prosopis and different shade trees
1982/83	6	213,073	Mainly Eucalyptus; Prosopis and Conocarpus lancifolia
1983/84	8	307,907	Mainly Eucalyptus and Prosopis; different shade trees

(Source: Data collected by C.W.N. Tapp in 1984 for IBRD Forestry Sector Review mission)

The following information was provided by Forestry Division headquarters, Ed Damer, in April 1985

Location	Annual production capacity	Year established	No. of labourers	Area (feddans)
Shendi	100,000	1965	6	3
Ed Damer	100,000	1967	7	2
Berber	50,000	1969	4	2
Zeidab	100,000	1973	5	1.5
Gersi	25,000	1982	4	1.5
Abu Hamad[1]	10,000	1984	2	4
Aliab[1]	10,000	1984	1	2
El Bauga[1]	50,000	1985	1	3
Atbara		Proposed		
Total	545,000			

APPENDIX 6..

GREEN DESERTS LTD

FORESTRY AND NOMADIC PASTORALISM PROJECT - INFORMATION SHEET

Mesquite Fencing Units:

Shelterbelts of mesquite (Prosopis chilensis) have been extensively planted in Nile Province in the Northern Region of the Sudan over the last 10 years, and constitute a valuable resource. The trees can be selectively thinned to provide a sustained yield of small diameter poles and brushwood without prejudicing their function as shelterbelts. This project has used such thinnings to construct fencing units that are cheap and easily transportable, are made entirely from locally grown materials and are produced by local unskilled labour. So far, after 6 months use, they have proved to be durable and effective at excluding livestock providing the fences are inspected regularly. The units are also more acceptable than barbed wire to the local population, and are generally more acceptable in the landscape.

They are constructed as follows: 12 - 16 stems are cut 200cm long and 2 - 3½cm in diameter. They need not be particularly straight, and seldom are, and should retain plenty of side shoots. These stems are then laid out in a 2m square lattice, with half of the stems vertical and half horizontal. The stems are interwoven and tied together with rope made from leaves of the Dom Palm (Hyphaene thebaica). When the framework is complete any large holes are filled by weaving small thorny branches into the lattice. The more thorns the better although this can cause problems for the fence makers. The finished units can be stacked ready for transport. Each unit has little structural strength of its own, but when tied to a supporting stake in the ground it becomes a formidable barrier to animals and people alike. If animals are seen to browse on the fencing, used sump oil can be painted on as a deterrent.

Cost: Fence makers were paid £s 2 for each unit plus stake they produced ($1 - £s2.25). The mesquite cost £s1.5 for 1 unit plus stake, and the rope £s0.14 per unit.

Total cost per unit plus stake: £s3.64

Cost to fence 1 feddan (1 acre): £s473 excluding transport and erection costs.

This is less than a quarter of the cost of a barbed wire fence for materials alone. The concept of "Grow your own fences" is both ecologically sound and cost effective.

Stephen Bristow
Project Manager
Ed Damer - Nile Province - Sudan

November 1984

APPENDIX 7 FINANCIAL ANALYSIS

A7.1 DEVELOPMENT SCHEDULE

The proposed schedule of tree planting is set out in Table A7.1, which also indicates minimum yield expectations of fuelwood. Yields of 3 m^3/feddan/year have been assumed and all species have been assumed to give similar amounts.

TABLE A7.1 Schedule of tree planting and assumed yields of fuelwood, m^3

Project year (April - March)	No. of tree seedlings planted	Coppiced yield m^3
1 (1986-87)	49,500	
2	49,500	
3		
4		
5		
6		
7		
8		210
9		210
10		
11		
12		
13		
14		210
15		210
16		
17		
18		
19		
20		210
21		210
22		
23		
24		
25		
26		210
27		210

The number of trees to be planted will be:

	Per year	Total
Species trials (2 x 3 m spacing)	40,480	80,960
Windbreaks (in single & double rows)	855	1,710
Roadside and canals (single row)	7,800	15,600
Farm trees (different spacing)	120	240
Total	49,255	98,510

Assuming 700 trees/feddan (this is not totally accurate because of different spacing in some cases) then a total area of about 70 feddan will be planted each year.

No yield occurs until Tree Year 8; thereafter yields occur every six years from regrowth after coppicing.

Price used to value the fuelwood has been taken as LS1.50/bundle, equivalent to LS50/m^3.

A7.2 COSTS

A7.2.1 Development Costs

A7.2.1.1 Tree nursery and field establishment

Nursery costs are shown in Table A7.2 and are based on costs determined by FAO (FAO, 1985) for producing seedlings of Eucalyptus microtheca: though the planting of a variety of tree species is recommended in the present proposals, the FAO data is considered to be sufficiently representative of planting costs to be applied to all species.

Field establishment and maintenance costs/feddan and per tree are presented in Table A7.3, while total establishment and maintenance costs over the life of the project are set out in Table A7.4.

A7.2.2 Capital Expenditure

Details of capital expenditure over the life of the project are presented in Table A7.5 under five main headings, and are expressed in constant 1985 terms.

Capital cost estimates used in the financial analysis are based on three sources:- ex-factory UK prices, ex-Khartoum and Port Sudan prices and ex-Kenya prices. For the former, and where appropriate, an additional 25% addition has been made to cover spares and 30% to cover freight, insurance etc between UK and the Kelli site. In the case of the in-Sudan prices an additional 5% has been included to cover costs to site, while a 20% mark-up has been made on items originating in Kenya for similar reasons. The final cost has been converted to Sudanese Pounds using exchange rates of UK £1 = LS 3.5 and KS1 = LS 0.17. All items are assumed to be imported free of duty. Full capital replacement costs throughout the life of the rotation, have not been included, only those initial costs directly relating to the ODA 3 year period of assistance.

A7.2.2.1 Housing

It is not anticipated that any new housing would be constructed. The expatriate forester would be housed in rented accommodation, (Table A7.10).

A7.2.2.2 Plant and machinery

This category includes engines, pumps and windmills; cost estimates are detailed below in Table A7.6.

TABLE A7.2 Nursery:Seedling Production Costs Per 1000 Seedlings in LS(Constant 1985 Terms)

OPERATIONS	LS	Mandays	Cost per 1000 seedlings Labour	Transport materials	Total
1.Polythene bags (LS20 per 1000)				20.00	20.00
2.Transport of soil(1 load/4000 bags;4 loads/day)					
Labour(loading and unloading): 5mdxLS3.00/md	15.00				
Tractor_fuel/oil:0.09gallons/kmx120kmxLS4.5/gall	48.60				
_driver's wage(including overtime):	6.00				
Cost for 16000 bags	69.60				
Cost for 1000 bags	4.35			4.35	4.35
3.Filling polythene bags(1md/500 bags)3		2.00	6.00		6.00
4.Seed supply(cost of seed collection LS10/kg)					
30kg seed produce 500000 seedlings					
30x10/500000x1000				.60	.60
5.Sowing seed by hand(1md/1500 bags)		.67	2.00		2.00
6.Singling(1md/750 bags)		1.33	4.00		4.00
7.General maintenance(weeding and irrigation)					
0.053md/1000eedlings daily average_240 days					
(8 months) maximun in nursery		12.72	38.16		38.16
Total cost per 1000 seedlings		16.72	50.16	24.95	75.11
Total cost per feddan(700 seedlings)		11.70	35.11	17.47	52.58

Source: Based on costs determined by FAO Project GCP/SUD/033/NET (1985)

TABLE A7.3 Field Establishment and Maintenance Costs Per Feddan in LS (Constant 1985 Terms)

OPERATIONS	LS	Tree year 0 (TY0)			
		Mandays	Cost LS per feddan Labour	Transport materials	Total
1.Land preparation					
Driver's wage including overtime	6.00				
Fuel:1.8 gallons/hour x 6hours x LS4.5/gallon	48.60				
Daily cost for 15 feddan	54.60				
Cost per feddan	3.64			3.64	3.64
2.Seedling production		11.70	35.11	17.47	52.58
3.Transportation of seedlings(1 trip/2000 sedlings: 4 trips/day)					
Labour(loading and unloading):6md x LS3.00/md	18.00				
Tractor_fuel/oil:0.09gallons/km x 120km x LS4.5/gallon	48.60				
_driver's wage(including overtime)	6.00				
Cost for 8000 seedlings	72.60				
Cost per feddan	6.35			6.35	6.35
4.Planting of seedlings (1md/100seedlings)		7.00	21.00		21.00
		18.70	56.11	27.46	83.57

Source: Based on costs determined by FAO Project GCP/SUD/033/NET (1985)

TABLE A7.3 (continued)

OPERATIONS	Tree Year 1(TY1)				Tree Year 2(TY2)			
	Md	Labour (LS3/md)	Transport materials	Total	Md	Labour (LS3/md)	Transport materials	Total
1.Irrigation	4.40	13.20		13.20	4.40	13.20		13.20
2.Weeding	12.00	36.00		36.00	6.00	18.00		18.00
3.Protection	3.00	9.00		9.00	3.00	9.00		9.00
4.Beating_up	.60	1.80		1.80	.60	1.80		1.80
5.Seedlings for beating_up(10%)			5.26	5.26			2.63	2.63
6.Transport			4.96	4.96			2.48	2.48
Total	20.00	60.00	10.22	70.22	14.00	42.00	5.11	47.11

Source: Based on costs determined by FAO Project GCP/SUD/033/NET (1985)

Tree Year 3(TY3)				Tree Year 4-9(TY4-9)				Tree Year 10-27(TY10-27)			
Md	Labour (LS3/md)	Transport materials	Total	Md	Labour (LS3/md)	Transport materials	Total	Md	Labour (LS3/md)	Transport materials	Total
4.40	13.20		13.20	4.40	13.20		13.20				
3.00	9.00		9.00	3.00	9.00		9.00	3.00	9.00		9.00
		1.65									
7.40	22.20	1.65	22.20	7.40	22.20		22.20	3.00	9.00		9.00

TABLE A7.4 Schedule of Tree Planting Costs in LS (Constant 1985 Terms)

Planting Year	Field Planting Costs	Reference Table	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10
PY1	70 feddan	A7.3	5849.9	4915.4	3297.7	1554	1554	1554	1554	1554	1554	630
PY2	70 feddan	A7.3		5849.9	4915.4	3297.7	1554	1554	1554	1554	1554	1554
	TOTAL PLANTING COST		5849.9	10765.3	8213.1	4851.7	3108	3108	3108	3108	3108	2184

PY11	PY12	PY13	PY14	PY15	PY16	PY17	PY18	PY19	PY20	PY21	PY22	PY23	PY24
630	630	630	630	630	630	630	630	630	630	630	630	630	630
630	630	630	630	630	630	630	630	630	630	630	630	630	630
1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260

PY25	PY26	PY27
630	630	630
630	630	630
1260	1260	1260

TABLE A7.5 CAPITAL ASSETS IN LS (CONSTANT 1985 TERMS)

	Est on-site unit costs	PY1	PY2	PY3	PY4	PY5	PY6	PY7
1.PLANT AND MACHINERY								
Diesel engine 8hp(UK Lister)	7875	70875						
4" Pump	630	5670						
Solar Pump (small)	4550	9100						
Solar Pump (large)	25000	25000						
Windmill	63000	189000						
		299645						
2.VEHICLES.TRACTORS AND TRAILERS								
MF 265 Tractor	31900 *	31900						
5-tonne Trailer	26390	26390						
Landrover	45500	91000						
Water Tank-Trailer	5915	5915						
Boat and Outboard Motor	15925	15925						
Water Cart (Donkey)	700	5600						
		176730						
3.EQUIPMENT AND MATERIALS								
Tractor-mounted Hole Borer	5530	5530						
Ridging Plough	2090	2090						
Handtools	9100	9100						
Water Tank	1500	13500						
Water Tower	2275	9100						
Plastic Piping: cost/meter								
1/2"	2.47	19760	19760					
3/4"	3.47	26025	26025					
2"	7.84	6272	6272					
3"	16.5	11550	11550					
4"	19.8	13860	13860					
Plastic Sheeting(1500guage-cost/m2)	2.36	3540	3540					
Barbed Wire Fencing (cost/km)	1750	3500						
		123827	81007					
4.WELL CONSTRUCTION								
Shallow Well	300	1500						
Sub-artesian Matara Well	2500	10000						
		11500						
5.CONSULTANCY WORK								
Design for Solar/Wind Pumps	7000	7000						

TABLE A7.6 Cost estimates of plant and machinery, £, KS and LS

	Ex-factory £	On-site cost £	Ex-Kenya KS	On-site cost KS	Ex-Khartoum LS	On-site cost LS
Diesel engine 8 hp (UK Lister)	-	-	-	-	7,500	7,875
4" Pump	-	-	-	-	600	630
Solar Pump (small)	1,000	1,300	-	-	-	4,550
Solar Pump (large)	5,500	7,150	-	-	-	25,000
Windmill	15,000	18,000	-	-	-	63,000

A7.2.2.3 Vehicles, tractors and trailers

The current c and f cost delivered at Port Sudan of a MF 265 tractor is in the order of £8,700, including assembly charges and dealer's commission: this is equivalent to LS 30,450, (Table A7.7).

Cost estimates of all other stems are based on UK sources and are illustrated in Table A7.7.

TABLE A7.7 Cost estimates of vehicles, tractors and trailers.

	Ex-factory £	On-site cost £	Ex-Port Sudan LS	On-site cost LS
MF 265 Tractor	-	-	30,450	31,900
5-tonne Trailer	5,800	7,540	-	26,390
Landrover	8,000	13,000	-	45,500
Water Tank Trailer (500 gallons)	13,000	1,690	-	5,915
Boat and outboard motor	3,500	4,550	-	15,925
Water cart (donkey)				700

A7.2.2.4 Equipment and materials

Items costed in this section are shown in Table A7.8.

TABLE A7.8 Cost estimates of equipment and materials

	Ex-factory £	On-site cost £	Ex-Khartoum LS	On-site cost LS
Tractor-mounted hole-borer	1,215	1,580	-	5,530
Ridging plough	460	598		2,090
Handtools*	2,000	2,600	-	9,100
Water tank	330	429	-	1,500
Water Tower	500	650	-	2,275
Plastic piping - cost/m				
½"	-	-	2.35	2.47
¾"	-	-	3.30	3.47
2"	-	-	7.13	7.84
3"	-	-	15.00	16.50
4"	-	-	18.00	19.80
Plastic sheeting (7.5mx20m 1500 gauge)	77.80	101.00	-	354
Barbed wire (1km)	-	-	-	1,750

* Handtools would include axes, saws, pangas, soil augers, etc.

A7.2.2.5 Well construction

Cost estimates make allowances for the local construction of two types of well commonly found in the study area. The shallow wells, some 6-8 m in depth, cost an average of LS 300, while the deeper sub-artesian wells (Matara) with a maximum of 15 m static head lift cost an average of LS 2,500.

A7.2.2.6 Consultancy Work

If solar and windpump field trials are to go ahead, then a more thorough design exercise will be required before any items are purchased. This is estimated to cost £2,000, (LS 7,000).

A7.2.3 Operating Costs

Operating costs include those direct recurrent costs associated with the operation of the project, and include salaries and wages of senior and supervisory staff, house rental and running costs of vehicles and equipment. These are set out below in Table A7.9.

An accounting figure of £45,000 (LS 157,500) is used against the expatriate forester; this sum covers salary, air transport between Europe and Sudan and all allowances for both the expatriate and all family members.

Basic salary for the Sudanese Forest Officer has been taken at LS 350 per month; the addition of provision for allowances, pensions, sick-pay etc raises this amount to about LS 700 per month (FAO 1985).

A Forest Ranger earns LS 150 per month basic which with an additional 80% for overheads gives LS 270 per month. An Overseer earns LS 90 a month plus say 70% for overheads giving LS 153 per month (FAO, 1985).

A7.3 INDIRECT AND OTHER BENEFITS

Bayoumi (1977) reports that following the establishment of windbreaks, a saving of at least 10% in irrigation requirements for agricultural land can be achieved. If presently 1 feddan requires twelve irrigations of 400 m^3 per month (4,800 m^3 per annum), then a 10% reduction in irrigation requirements will allow an additional 480 m^3, sufficient to irrigate a further 0.1 feddan.

The windbreaks established on Strips 2, 3 and 4 will protect the following area:

		feddan
Strip 2 - 210 m x 1600 m = 336,000 m^2	=	80
Strip 3 - 840 m x 150 m = 126,000 m^2	=	30
Strip 4 - 840 m x 150 m = 126,000 m^2	=	30
		140

TABLE A7.9 General and administrative costs in LS (constant 1985 terms)

	Annual salary/wage or annual cost	PY1	PY2	PY3	PY4	PY8	PY9
Salaries and wages							
Expatriate Forester	157,500	157,500	157,500	157,500	-		
Sudanese Forester	8,400	8,400	8,400	8,400			
Forest Range	3,240	3,240	3,240	3,240			
Overseerer	1,836	16,524	16,524	16,524			
Total Sudanese Salaries		28,164	28,164	28,164	(see Table A7.10)		
House rent Expatriate Forester	2,400	2,400	2,400	2,400			
Running costs - vehicles and equipment							
Landrover	6,190	12,380	12,380	12,380			
Diesel engine	3,200	12,800	28,800	28,000		28,800	12,800
		25,180	41,180	41,180		28,800	12,800

and in addition, provide the equivalent of an additional 10% of land or 14 feddans.

If a value could be placed on the crops grown on this land then an approximate indirect benefit of the establishment of the windbreaks is obtained. Sir M. MacDonald and Partners (1984) provided a range of returns, net of production costs and water charges, for a range of crops;

	LS/feddan	Cropping intensity/season
Faba beans	1152	0.03
Grain sorghum	454	0.075
Foder sorghum	469	0.075
Wheat	488	0.15
Onions	1709	0.03
		0.63

giving an average return/feddan of LS 539.30. Using this figure to value the output of the 14 feddans gives a total of LS 7550.2 per season or LS 22,651 per annum, onwards from PY6.

As well as the indirect benefits afforded by windbreaks, several of the tree species planted will yield fruit which has a commercial value. Accurate yields of these fruit are presently uncertain, hence nominal yields of 1 kg/tree/year have been used. Table A7.10 shows tree species and numbers as well as assumed annual yields and values; the latter over the assumed relation have been included within the benefits shown in Table A7.11.

TABLE A7.10 Yield of fruit/annum by kg, sacks and value

	No. of trees	Unit	PY4-8	PY9-27
Acacia nilotica	5,000	kg	5,000	5,000
		sacks	125	125
		value	2,500	2,500
Zizyphyus spina-christi	5,000	kg		5,000
		sacks		125
		value LS		6,250
Total value of fruit			2,500	8,750

A4 OPERATING ACCOUNT AND CASH FLOW

The operating account presented in Table A7.11 gives details of benefits and costs directly associated with the implementation of the proposals. As shown, the operating surplus does not become positive until PY10.

TABLE A7.11 OPERATING ACCOUNT IN LS (CONSTANT 1985 TERMS)

	Reference Table	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8
AREA HARVESTED (FEDDAN)	A7.1								70
PRODUCTION									
Volume of Fuelwood m3	A7.1								210
Revenue @ LS50/m3 Fuelwood									10500
Indirect Benefits from Windbreaks							22651	22651	22651
Value of Fruit	A7.10				2500	2500	2500	2500	2500
TOTAL BENEFITS					2500	2500	25151	25151	35651
COSTS OF PRODUCTION									
Tree Establishment and Maintenance	A7.4	5849.9	10765.3	8213.1	4851.7	3108	3108	3108	3108
TOTAL PRODUCTION COSTS		5849.9	10765.3	8213.1	4851.7	3108	3108	3108	3108
GENERAL AND ADMINISTRATIVE COSTS									
Salary-Expatriate Forester	A7.9	157500	157500	157500					
Salaries and Wages-Sudanese Staff	A7.9	28164	28164	28164					28164
House Rental	A7.9	2400	2400	2400					
Running Costs	A7.9	25180	41180	41180	28800	28800	28800	28800	28800
TOTAL GENERAL AND ADMINISTRATIVE COSTS		213244	229244	229244	28800	28800	28800	28800	56964
OVERALL TOTAL COSTS		219093.9	240009.3	237457.1	33651.7	31908	31908	31908	60072
OPERATING SURPLUS (DEFICIT)		-219094.	-240009.	-237457.	-31151.7	-29408	-6757	-6757	-24421

Table A7.11 (continued)

PY9	PY10	PY11	PY12	PY13	PY14	PY15	PY16	PY17	PY18	PY19	PY20	PY21	PY22
70					70	70					70	70	
210					210	210					210	210	
10500					10500	10500					10500	10500	
22651	22651	22651	22651	22651	22651	22651	22651	22651	22651	22651	22651	22651	22651
8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750	8750
41901	31401	31401	31401	31401	41901	41901	31401	31401	31401	31401	41901	41901	31401
3108	2184	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
3108	2184	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
28164					28164	28164					28164	28164	
12800													
40964					28164	28164					28164	28164	
44072	2184	1260	1260	1260	29424	29424	1260	1260	1260	1260	29424	29424	1260
-2171	29217	30141	30141	30141	12477	12477	30141	30141	30141	30141	12477	12477	30141

Table A7.11 (continued)

PY23	PY24	PY25	PY26	PY27
			70	70
			210	210
			10500	10500
22651	22651	22651	22651	22651
8750	8750	8750	8750	8750
31401	31401	31401	41901	41901
1260	1260	1260	1260	1260
1260	1260	1260	1260	1260
			28164	28164
			28164	28164
1260	1260	1260	29424	29424
30141	30141	30141	12477	12477

In Table A7.12 capital expenditure in years 1 and 2 is included and again the overall surplus does not become positive until PY10. It will be noticed that full capital replacement costs throughout the life of the rotation have not been included, only those incurred in PY1 and 2 within the 3 year period of proposed assistance. Even then, NPVs are negative at both 10% and 15% rates of discount:

NPV	Discount Rate %
- 1,363,620	10
- 1,367,448	15

NPV's improve but remain negative if the expatriate forester's salary is excluded from the deficit in PY1 2 and 3:

NPV	Discount Rate %
- 932,773	10
- 953,899	15

TABLE A7.12 CASH FLOW IN LS (CONSTANT 1985 TERMS)

	Reference Table	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8
SURPLUS(DEFICIT) ON OPERATING ACCOUNT	A7.11	-219094	-240009	-237457	-31151.7	-29408	-6757	-6757	-24421
EXPENDITURE									
Capital Expenditure									
Plant and Machinery	A7.5	299645							
Vehicles,Tractors and Trailers	A7.5	176730							
Equipment and Materials	A7.5	123827	81007						
Well Construction	A7.5	11500							
[illegible]	A7.5	7000							
Contingencies 10%		61870.2	8100.7						
TOTAL EXPENDITURE		680572.2	89107.7						
SURPLUS (DEFICIT)		-899666.	-329117.	-237457	-31151.7	-29408	-6757	-6757	-24421

TOTAL COST PY1-3 (LS) -1466240

TARGET 1400000 (£400000 @ £1=LS3.5)

NET PRESENT VALUE	%
-1363620	10
-1367448	15

PY9	PY10	PY11	PY12	PY13	PY14	PY15	PY16	PY17	PY18	PY19	PY20	PY21	PY22
-2171	29217	30141	30141	30141	12477	12477	30141	30141	30141	30141	12477	12477	30141
-2171	29217	30141	30141	30141	12477	12477	30141	30141	30141	30141	12477	12477	30141

Table A7.12 (continued)

PY23	PY24	PY25	PY26	PY27
30141	30141	30141	12477	12477
30141	30141	30141	12477	12477

APPENDIX 8 ITINERARIES: 15 MARCH - 16 MAY 1985, SUDAN AND EGYPT

Where differences in itineraries occurred, these are indicated.

Friday 15 March	Depart London Heathrow 1515 hrs, arrive Khartoum 0130 hrs, booked into Hilton Hotel
Saturday 16 March	British Embassy closed, at hotel
Sunday 17 March	To British Embassy to see Aid Secretary Mr John Hawkes - discuss programme and arrange to travel to Atbara on Thursday.
	From Embassy arranged meetings by phone for next three days.
	Sight-seeing tour of the Three Towns.
Monday 18 March	To Forest Department, Faculty of Agriculture University of Khartoum (situated at Shambat, Khartoum North) to see Dr M A EL Rasheed - general discussion on forest sector and policy.
	To National Desertification Unit (formerly the Desert Encroachment Control and Rehabilitation Project-DECARP) to see Dr. Hassan Musnad, Director.
Tuesday 19 March	To Oxfam Office to see Mr N. Winer (formerly of Green Deserts Project in Nile Province).
	To NAPC Office for brief meeting with Sayed Beshir Mahgoub, General Manager NAPC prior to his departure for UK.
	To Department of Statistics to see Sayed Omar El Tay, Director and then to Census Office, to see Sayed Abdel Wahab Ali Modawi, Director concerning population data in Nile Province.
Wednesday 20 March	To Central Forest Administration to see Sayed Ali Amin Saleem, Head of Shelterbelt Division and Mr J. Ball, FAO Forest Adviser.
	To Sudan Council of Churches to see Sayed Kalim Osman Khalifa, Project Manager Joint Afforestation Project.
	To World Bank for discussion with Miss Ingrid Foik concerning Bank involvement in forest sector.

Thursday 21 March	Travel to Atbara by air arriving at 1630 hrs to be met by Mr F. Lord, ODA Supplies Adviser; booked into Nile Hotel.
Friday 22 March (offices closed)	Tour of Atbara and Ed Damer with Mr Lord. Remainder of day in hotel reading reports.
Saturday 23 March	To NAPC Office, Ed Damer to meet Acting Head Sayed Makmoud (both General Manager, Sayed Beshir Mahgoub and Deputy General Manager Sayed Ali Abdul Raman away).
	To Regional Ministry of Agriculture, Ed Damer where able to meet Dr Badawi Babiker Osman, Director General; Sayed Mahammed El Habib, Head of Forestry Section; Sayed Osman Ahmed El Mak, Research Officer/Extension Officer, Joint Afforestation Project.
	Met Mr S. Bristow, Green Deserts Project (lives in Ed Damer).
Sunday 24 March	Work at hotel - discuss report format and future work programme.
Monday 25 March	To Regional Ministry of Agriculture, Ed Damer - see Sayed Abdalla Ibraheim El Fadl, Director Natural Resources discuss programme for following day.
	Met Miss D. Hamada, FAO Project concerned with income levels of rural women, Nile Province.
Tuesday 26 March	Visit to Zeidab accompanied by Sayed Jaffar Awadalla, Asst. Conservator of Forests, to see JAP shelterbelts and production blocks.
Wednesday 27 March	Visit to Aliab accompanied by Sayed Osman Ahmed El Mak to see shelterbelts, production blocks and canal planting.
Thursday 28 March	To NAPC Office, Ed Damer to obtain maps of schemes.
	To Regional Ministry of Agriculture, Ed Damer to see Sayed Musa Mohammed Gibril, agricultural economist.
	Discussions with Mr S. Bristow re proposed SOS Sahel Project which he will join in October 1985.
Friday 29 March (offices closed)	Work at hotel - report writing.

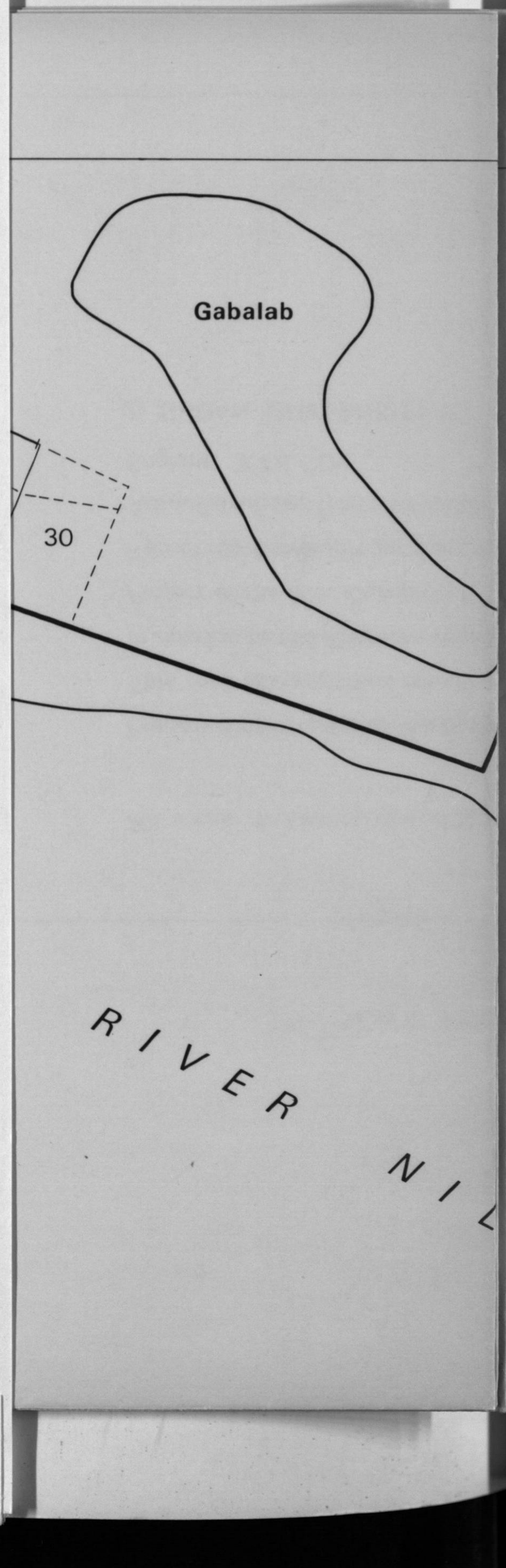
Saturday 30 March	Visit to El Bauga accompanied by Sayed Osman Ahmed El Mak - also visit forestry nursery at Berber.
Sunday 31 march	Work at hotel - report writing: plan work programme for following week.
Monday 1 April	To Regional Ministry of Agriculture, Ed Damer - accompanied by economics staff, Sayed Khalafalla Ali, carried out interviews with traders in Damer market.
Tuesday 2 April	1) Wedderburn - to Shendi accompanied by Sayed Ali Mohamed. Met Director of Agriculture, Shendi (Sayed Khalil Bashir). Visited Gandato Scheme together with Sayed Mahgoub Salih, Conservator of Forests. Overnight at NAPC Resthouse, Shendi.
	2) Errington - further interviews with traders in Ed Damer market.
Wednesday 3 April	1) Wedderburn - visited Seyal and Keli Schemes with Sayed Ali Dirdiri, Conservator of Forests. Overnight at NAPC Resthouse, Shendi.
	2) Errington - interviews with traders in Atbara, accompanied by Sayed Khalafalla Ali.
Thursday 4 April	1) Wedderburn - met Sayed Abdul Maxud, Director NAPC, Shendi. Returned to Atbara.
	2) Errington - interviews with traders in Atbara.
	General strike in Khartoum; anti-government demonstrations in Atbara.
Friday 5 April (offices closed)	Remain at hotel; anti-government demonstrations and general strike continues.
Saturday 6 April	Advised to stay at hotel - report writing; general strike continues. Announcement that President Nimeiri has been deposed.
Sunday 7 April	Stayed at hotel; general strike in Atbara ends at 10.00 hrs. Remainder of day report writing and reading.
Monday 8 April	Errington to visit doctor - diarrhoea attack. Wedderburn collecting fuel and preparing Landrovers for desert trip. Discussions on Report layout.
Tuesday 9 April	Visit to Green Deserts Project, Hasaniya area accompanied by Mr S. Bristow; overnight at Umm Merwa.

Wednesday 10 April	Further visits to project sites in Hasaniya; return to Atbara.
Thursday 11 April	Work at hotel - report writing and reading.
Friday 12 April (offices closed)	Work at hotel - report writing and reading.
Saturday 13 April	Visit Forest Department, Ed Damer for further discussions;
Sunday 14 April	Visit Forest Department, Ed Damer and Water Corporation re-queries on groundwater. Visits to local 'Matara' wells.
Monday 15 April (offices closed)	Public Holiday. Work at hotel - report writing and reading.
Tuesday 16 April	Discussions with Mr S. Bristow.
Wednesday 17 April	Visit Forest Department and Water Corporation, Ed Damer. Visit Forest Department solar pump and private wells south of Ed Damer.
Thursday 18 April (offices closed)	Public Holiday. Work at hotel - report writing and reading.
Friday 19 April (offices closed)	Work at hotel - report writing and reading.
Saturday 20 April	Travel to Shendi - accompanied by Mr F. Lord, ODA Supplies Adviser who also wished to visit NAPC schemes. Overnight at NAPC Resthouse, Shendi.
Sunday 21 April	Visit Forest Department, Shendi where met Sayed Mahgoub Salih and Sd. Ali Dirdiri, then to NAPC office and Director Sd. Abdul Maxud. Visited forest nurery in Shendi. Overnight at NAPC Resthouse, Shendi.
Monday 22 April	1) Wedderburn - visited Kelli and Seyal schemes. 2) Errington - interviews with traders in Shendi market. Overnight at NAPC Resthouse, Shendi.
Tuesday 23 April	Visited Gandato and Kaboushia schemes. Overnight at NAPC Resthouse, Shendi.

Wednesday 24 April	Returned to Atbara via west bank of Nile passing through Seyal, Kelli, Kitiab and Zeidab schemes.
Thursday 25 April	To Forest Department, Ed Damer for further discussions. Report writing and reading.
Friday 26 April (offices closed)	Rest Day.
Saturday 27 April	To Forest Department, Ed Damer to collect information.
Sunday 28 April	To NAPC Office, Ed Damer for meeting with General Manager Sayed Beshir Mahgoub. To forest nursery to experiment with irrigation sleeves using plastic tree guards.
Monday 29 April	Work at hotel - report writing.
Tuesday 30 April	Work at hotel - report writing.
Wednesday 1 May	Final visits to Regional Ministry of Agriculture and NAPC.
Thursday 2 May	Travel to Khartoum by air arriving at 1830 hrs; booked into Araak Hotel.
Friday 3 May (offices closed)	Work at hotel - report writing.
Saturday 4 May	Work at hotel - report writing.
Sunday 5 May	To British Embassy to see Aid Secretary Mr John Hawkes - report on time in Atbara; discuss administrative arrangements for visit to Egypt (departure date planned for 11 May). To Central Forestry Administration - further discussion with Mr J. Ball FAO Forest Adviser; also met Director Sayed Abu Baka Abdu Rahman Kamil. Arrange meeting with Mr Charles Tapp Natural Resources Co-ordinator CARE.
Monday 6 May	To British Embassy to see Aid Secretary. From Embassy phone several commercial companies in Khartoum for prices of equipment and materials. To Sudan Meteorological Department for climatological data of Nile Province stations and reports.

Tuesday 7 May	To CARE for discussion with Mr Charles Tapp.
	To British Embassy to see Aid Secretary: programme for Egypt visit agreed but scheduled to start on 9 May. Tickets and reservations hastily changed - departure date now 9 May.
Wednesday 8 May	To British Embassy to see Aid Secretary - collect passports and tickets, finalise all outstanding administrative issues.
	To CARE office to make use of forestry literature and reports.
Thursday 9 May	Travel to Cairo by air arriving 10.00; booked into Marriot Hotel.
	To Horticultural Research Institute of Agricultural Research Centre, Ministry of Agriculture where met the Director Dr Salah Baha El Deen and Head of Timber Trees and Forestry Research Department Dr Ibrahim A. Heikal. Also met Dr Robin Sowden, Science Officer, British Council who had liaised with Dr Salah to arrange programme.
	Visit to Institute forestry nursery with Dr Ibrahim and his staff.
	British Council arranged for a hire car to be available during our stay.
Friday 10 May (offices closed)	Rest day - sightseeing in Cairo.
Saturday 11 may (offices closed)	To Kantar Field Research Station, Nile Barrages: see nursery and canal planting of trees.
Sunday 12 May	To Sadat City (a new industrial city being built north-west of Cairo) to see examples of trees established alongside roads by use of drip irrigation.
	Travel through extensive area of private and public reclaimed land to see established trees lining roads and canals and wide use of windbreaks to protect citrus trees.
Monday 13 May	To Zoria Botanical Gardens in Cairo then north along 'old agricultural road' to Benha observing roadside and canal planting and production blocks.

Tuesday 14 May	To 10th Ramadan new industrial city on Ismailia road to see further examples of drip irrigation. Also visited Salhia Agricultural Project to see pivot irrigation system for lucerne and vegetable crops.
Wednesday 15 May	Discussions with Dr Ibrahim and his staff at Horticultural Research Institute. To British Council to see Dr Robin Sowden regarding administrative matters.
Thursday 16 May	Depart Cairo for London arriving Heathrow at 12.00 hrs.


Gabalab
30
RIVER NIL