OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

07383

Distr.
RESTRICTED

UNIDO/IOD.74
2 March 1977

ORIGINAL: ENGLISH

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

INVESTMENT PROGRAMME FOR THE DEVELOPMENT OF THE WOOD INDUSTRY IN THE SUDAN[1/]

VC/SUD/74/129/Rev.1

Techno-economic feasibility study: Establishment of a plywood mill in the Sudan

Prepared for the Government of the Sudan
on behalf of the
United Nations Industrial Development Organization
by the
Forest Research Institute in Zvolen
and
Polytechna, Foreign Trade Corporation, Prague

1/ This document has been reproduced without formal editing.

TABLE OF CONTENTS

ABSTRACT

The report prepared by a team of consultants from Czechoslovakia on hand of UNIDO's Contract 75-22 describes the work undertaken in Sudan in July, August and September 1975 aiming at assessing the techno-economic conditions for establishing a plywood plant in the South of the Country.

The findings confirm the actual need of plywood on the home market and the outlines expected increase in consumption for the nearest future. Export possibilities are analyzed as well. A plant capacity of 5000 m^3 plywood per annum is recommended.

The raw material availability in southern provinces has been checked and four sites for the establishment of the plywood mill were evaluated. Preference is given to Wau, where the necessary peeler log supply of about 11.100 m^3 per annum can be secured and where the existing sawmilling capacities allow for a complex utilization of logs.

The Feasibility Study shows that the project would bring to the Sudan important gains both in commercial profits and in macro-economic benefits. At the same time, important savings of foreign currency would be achieved.

The locally produced plywood could be sold with an adequate profit in Khartoum to wholesalers for £S 180 per m^3 instead of the present price of £S 390 per m^3, and its retail price would be £S 198 per m^3 instead of £S 500 per m^3 as at present.

Disclaimer:

The conclusions and recommendations given in the report are those considered appropiate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages.

Acknowledgement:

This study has been prepared by the team of experts in close cooperation with Sudanese authorities, institutions, counterparts and staff. In carrying out the necessary inquiries and field trips a great number of organizations, both public and private, have been contacted and a very large body of informers approached. It is a pleasure to recall these numerous visits and meetings with people who were all extremely kind andhelpful and did their best to assist the experts in their task.

Special mention should be made of the Industrial Research and Consultancy Institute in Khartoum and its Director, Mr. Abdel Rahman Abdel Halim Obeid who provided in Mr.Ahmed Ali Ahmed an excellent counterpart for Khartoum. In the South the responsibilities of the counterpart were taken over very successfully by Mr.Cuor Deng Mareng, Inspector of the Regional Ministry of Commerce, Industry and Supplies in Juba. Also the Forestry Department made its staff available and several Conservators and their subordinates assisted the team-leader during his field trips in Equatoria and Bahr-el-Ghazal provinces.

Only thanks to the understanding, cooperation, and help of all these people and the sympathetic attitude of all the Sudanese authorities, officials, managers and indeed the public at large could the present work be carried out. This is here gladly acknowledged.

LIST OF PEOPLE CONTACTED

In the Sudan

Idris Ali Ahmed, Ministry of Industry, Khartoum
Sanhuri, Ministry of Industry, Khartoum
Amin Abu Sineina, Deputy Minister of Industry, khartoum
Abdel Rahman Abdel Halim Obeid, Director of Industrial Research and Consultancy Institute, Khartoum
Kamal Osman Kalifa, Director of Forestry Department, Khartoum
Kamal Hasan Badi, Deputy Director of Forestry Department, Juba
Hamza Hanudi, Utilization Officer, Forestry Department Khartoum
Peter Mazia Rusum, Conservator of Forests, Equatoria
Baipath Majvec Rilpou, Conservator of Forests, Bahr-el-Ghazal
Ali Kandidu, Acting Assistant Conservator, Yambio
Philip Adam, Forestry Department, Juba
Valentino Mein Bulimka, Forestry Department, Juba
David Bassiouni, Director, Regional Ministry of Agriculture, Juba
Daniel Matthews, Director, Regional Ministry of Commerce, Industry and Supplies, Juba
Cuor Deng Mareng, Inspector, Regional Ministry of Commerce, Industry and Supplies, Juba
Michel Hyland, Deputy Resident Representative, UNDP, Khartoum
Miguel Bermeo, UNDP, Khartoum
P.Astolfi, in charge of the UNDP sub-office in Juba
Peter Dood, Adviser, Regional Ministry of Agriculture, Juba
Gerard van Herhoeven, Adviser, Agricultural Training Centre, Yambio

Kishor P. Sheth, Interfreight /Kenya/ Ltd., Juba
J. Mueller, German Aid, Juba
Alexander Dahia, Chief Civil Engineer, Regional Ministry of Communications, Transport and Roads
Chappel, Road Expert, UNDP, Juba
R.L.Mills, UNDP, Juba
Manolis Andriotis, merchant, Maridi
Zoran, Yougoslav Energoproject, Juba
Derrick Maze, Maritime Forwardes, Juba
Michel Miama, Afforestation Officer, Wau
Anthony Tikmo, Assistant Deputy Commissioner, Wau

In Egypt

Adel A.Bahgat, General Manager, General Trading and Chemicals Co., 1/A Ramsis Str., Cairo
Stephen J. Szivos, Senior Industrial Development Field Adviser, UNDP, Cairo
Zdeněk Formánek, Commercial Section of the Czechoslovak Embassy

CONVERSION FACTORS AND ABREVIATIONS

Measures

1′(one foot) = 30.48 cm
1"((one inch) = 2.54 cm
1 ha = 2.38 feddans
1 feddan = 0.42 ha
1 m3 (cubic metre) = 35.31 cubic feet

Weights

1 m3 of logs (green) = 1,000 kg
(air dry) = 800 kg
1 m3 of plywood = 720 kg

Conversion

1 m3 of plywood = 150 panels of 4′x 6′x 3 mm
= 112 panels of 4′x 8′x 3 mm
= 84 panels of 4′x 8′x 4 mm
= 56 panels of 4′x 8′x 6 mm
= 22 panels of 4′x 8′x 15mm

Currency and exchange rates

One Sudanese Pound (£S) = 100 Piasters (Pt)
= 1,000 milliemes (mms)

£S 1 = £ 1.33 = US $ 3
£ 1 = £S 0.75 = US $ 2.25
US $ 1 = £S 0.333 = £ 0.44

One Egyptian Pound (£Eg) = 100 Piastres (Pt)
= 1000 milliemes (mms)

£Eg 1 = £ 0.8 = US $ 1.8 = £S 0.6
£ 1 = £Eg 1.25
US $ 1 = £Eg 0.555
£S 1 = £Eg 1.666

Abbreviations:

b.h. diameter = breast height diameter, i.e. diameter 1.3m height

1. INTRODUCTION

In response to a request of the Governement of the Sudan for a Feasibility Study for plywood production a contract has been signed by UNIDO in Vienna and POLYTECHNA in Prague on 9 September 1975. According to this contract, the study should cover the following topics:

i) present market for plywood in the Sudan and neighbouring countries and its future development;

ii) evaluation of the raw material situation;

iii) elaboration of a specific proposal for the erection of a plywood factory.

This work has been entrusted to a team consisting of the team leader, F.PAPÁNEK, Forest Economics Expert; A.POLÁČIK, Wood Technologist; and J.BÍM, Industrial Engineer. The duration of stay of the members of the team in the field was as follows:

F.PAPÁNEK:	10 July to 6 October 1975	89 days
A.POLÁČIK:	10 July to 22 August 1975	44 days
J.BÍM:	14 August to 3 September 1975	21 days
	Total	154 days

The team spent a total of 22 weeks in the field, collecting necessary data and information and visiting potential sites for a plywood mill in the South of the country.

In the scope of work a detailed market survey for plywood and other wood-based panels was elaborated with estimates of future trends in increase of consumption. There is no doubt that the proposed first plywood plant in the Sudan at a capacity of 5000m3 panels a year is fully substantiated.

The information on potential raw material resources were checked, compiled and evaluated for four main regions in the South.The felling and transport costs were calculated for variants under consideration. Wau was selected and recommended as the most convenient site for establishing the plywood plant.

For the plywood factory the technological procedure was outlined with identification of main machinery and equipment. On hand of own experience investment costs were estimated for both machinery and construction work including expected installation, wiring costs etc.

Calculations prove the economic viability of the project. Short term and long term measures were recommended for assessment of forest resources and for the establishment of the plywood plant-

2. MARKET

2.1 Present Situation

Present annual plywood imports are in the range of 2,500 m3. In the last five years a slight tendency to increase has appeared. The main suppliers of plywood are China and Romania. Details are given in Annex (A1).

Plywood is used mainly in furniture manufacture (about 80%), to a much smaller extent in construction for partitions and ceilings (20 %). The use of plywood as a packaging material and for containers is only at its initial stages.

Governement agencies account for some 20 % of plywood consumption, the main bulk of plywood (80 %) being used by the private sector.

The territorial distribution of plywood consumption in the country is essentially identical with the distribution of urban population and with the overall level of urbanization. Most urban centres have small scale workshops making furniture. Housing and construction in which plywood could be used is, like carpentry workshops, also limited only to urban communities.

By far the largest consumption of plywood is concentrated in the capital Khartoum, i.e. in the so called "Three cities" (Khartoum, North Khartoum and Omdurman). Here occur the most important construction activities requiring plywood as a building material. Here also the furniture industry is concen - trated as is shown by the following data:

Furniture industry in the Sudan
Number of workers in a plant

	25 and more		less than 25
	all in Khartoum	in Khartoum	outside Khartoum
Number of establishment	7	64	63
Number of workers	455	423	334
Output in £S	17,000	316,000	157,000

The rural population is using virtually no plywood. The per capita consumption of plywood in the capital is estimated to be four times the consumption of the remaining urban and semiurban population. Consequently, the territorial distribution of plywood consumption is assessed as follows:

Area	Population total	Population urban	Relative level of consumpt.	Weighting	Estimated plywood consumpt.
	million				
Three Cities	0.8	0.8	4x	3.2x	1,600 m3
Remaining North	11.2	1.3	x	1.3x	700 m3
Southern Region	4.0	0.3	x	0.3x	200 m3
Total Sudan	16.0 mil.	2.4 mil.		4.8x	2,500 m3
Percentage	100 %	15 %			

The usual size of imported plywood is 4'x 6'x 3 mm. The wholesale price for this plywood is £S 390/m3, the retail price varies from about £S 500/m3 in Khartoum to more than £S 800/m3 in the South. Details concerning the price of plywood are given in Annex A/2.

The present excessive price of plywood in the Sudan is a consequence of inadequate supply of this commodity which does not meet actual demand.

The use of plywood and its future development should be viewed in close interrelation with the use of other wood-based panels and of sawn timber.

There is a small particle board plant producing in Khartoum which is protected from competition from abroad. Its products are used mainly in construction. The wholesale price of particle boards is £S 122/m3, the retail price is £S 144/m3.

Small quantities of hardboards - not mentioned in the Foreign Trade Statistics - are imported from time to time and sold on the retail market for £S 340/m3. Information concerning particle boards and hardboards is contained in Annex A/3.

A considerable drain on the country's foreign currency resources is caused by imported coniferous sawnwood which, according to the Foreign Trade Statistics, amounted in 1974 to over 32,000 tons with a corresponding value of over £S 3.6 million. Domestic sawnwood production, consisting almost entirely from hardwoods, is insignificant. For details see Annex A/4.

Besides the sawmills, there is in Khartoum a match factory operating since the early 1960's (the splints are mostly imported); a packaging and carton factory which started production in 1960 uses also imported raw material.

With regard to this situation in the market of forest products there is no doubt that the establishment of a plywood industry based on domestic raw material would greatly alleviate the existing shortage of wood-based building materials

and of furniture and ease the strain timber imports make on the country's balance of payment.

2.2 Future Trends in Consumption

Present consumption of plywood in the Sudan is 0.16 m3 perl,000 inhabitants which is only one fifth of that in Africa (1970 - 0.8 m3 per 1,000 inhabitants).

Consumption of plywood in the Sudan is expected to increase due to:
- elimination of exaggerated wholesale and retail price margins by matching supply with demand
- growth of population, especially urban
- higher living standards related to GDP or GNP
- further technical development and progress.

The rate of growth of population is 3.1 % (4) and, with the enormous land surface of the Sudan, and the improving living standards this rate will be probably maintained for some time in the future.

But much more important for the increase of plywood consumption is the growth of urban population. The percentage of urban population increased annually in the 9 years from 1955/56 to 1964/65 by 4.9 %(5). This rate of increase may safely be projected also for the next 10-15 years in view of the influx of rural population into urban centres and the fast growth of towns and cities.

The population of the Sudan is expected to increase at the following rate:

Year	Total population 3 % growth	Urban population 5 % growth
1975	16.0 million inhabitants	2.4 million inhabitants
1980	18.6 -"- -"-	3.1 -"- -"-
1985	21.5 -"- -"-	3.9 -"- -"-
1990	25.0 -"- -"-	5.0 -"- -"-

According to official papers the 1971/72 Gross Domestic Product per inhabitant in the Sudan is US $ 141 which is about two thirds of the average GDP for Africa (6,7). The GDP is expected to grow in the Sudan at a rate of 3 % reaching

in the year	GDP in US $
1975	154
1980	179
1985	207
1990	240

According to an FAO study (7) the recent and projected per caput consumption of plywood and veneer by regions is for Africa as follows:

Year	1961	1971	1981	1991
m3/1000 inhabitants	0.5	1	3	5

Based on an assumed 10 % growth of plywood consumotion.The following figures result:

Year	Population in mill.	GDP in US $ per capita	Plywood consumption m3/1000 per capita	total in m3	at a growth rate of 10%
1975	16.0	154	0.16	2,560	2,500
1980	18.6	179	0.22	4,092	4,000
1985	21.5	207	0.30	6,450	6,500
1990	25.0	240	0.42	10,500	10,400

The assumed 10 % growth rate of plywood consumption for the Sudan is consistent with the average annual growth rate for plywood consumption for Africa which is (7):

8.4 % for the period 1950-1960
9.7 % for the period 1960-1970, and estimated to be
8.7 % for the period 1971-1981
11.1 % for the period 1981-1991

The average annual growth of apparent plywood consumption in Africa from 1970 to 1973 even reached 13.3 %, and FAO (8) anticipates a 15 % growth of plywood production in developing countries for the period 1975 - 1985.

Projecting the present annual plywood consumption of 2,500 m3 at a 10 % growth rate into the future, the following target figures for plywood consumption are obtained:

five years' time in 1980	4,000 m3
ten years' time in 1985	6,500 m3
fifteen years' time in 1990	10,000 m3

In attempting a break-down of this annual consumption of plywood according to end-uses the following assumptions are made:

i) Plywood consumption for furniture making will retain its dominant position but will grow at a somewhat slower rate than other consumption so that its weighting will be reduced in 15 years' time from the present 80% to about 63%. Thus the volume of plywood consumption will increase 3.3 times in 15 years.

ii) On the contrary, plywood consumption for construction, including waggon construction, will increase at an ever faster rate with a 6 times increased volume consumption in 15 years' time. The corresponding increase

in its weighting would be from 20 % to 29 %.

iii) In the Southern Sudan, an extensive tea and tobacco plantation programme is under way. Especially the tea development will result in an ever growing demand for tea chests. The Army complains of the poor quality of particle board manufactured in the Sudan and would warmly welcome locally produced plywood for such end-uses as packing ammuniton etc. Plywood could replace metal in containers for air transport. The consumption of plywood for these and related uses is estimated to reach 200 m3 in 5 years, 500 m3 in 10 years and 800 m3 in 15 years.

iv) Consequently, the following plywood consumption according to end-uses can be expected:

Year	Furniture	Construction	Containers	Total	Forecasted consumption
1975	2,000 m3	500 m3	-		2,500 m3
1980	3,000 m3	800 m3	200 m3		4,000 m3
1985	4,500 m3	1,500 m3	500 m3		6,500 m3
1990	6,600 m3	3,000 m3	800 m3		10,400 m3

2,3 Potential Exports

A striking development in world plywood trade is the changing international pattern stemming from the growth of exports from developing market economies, as has been pointed out at the New Delhi World Consultation of Wood-based Panels in 1975. Due to a number of factors such as its high value per unit of volume, plywood appears to have the gratest potential for international trade of all wood-based-panel products.

Veneer exports have grown over the past years nearly as fast as plywood exports.

The timber resources of the Sudan are not so large as to enable considerable plywood exports, but nevertheless are sufficiently important to allow a minor part of the plywood production to be diverted to foreign markets, improving thereby the economic effect of the plywood industry. It is suggested that between one fifth and one third of the envisaged Sudanese plywood production could be set aside for exports. Such exports would off-set the adverse effect of imports of adhesives on the balance of payments, indeed they could result in net earnings of foreign currency by the plywood industry.

During field work a short market survey was made in Egypt the results of which are given in Annex A/5.

Egypt is consuming annually some 50,000 - 60,000 m3 of plywood, both imported and locally produced, and thus represents an important potential market outlet. Annual imports of plywood may amount to anything between 30,000 and 50,000m3. Mahogany plywood of good quality, produced in the Sudan, would have a value exceeding by at least 20-30% the usual sort of imported plywood, consequently it could be sold in the present market situation in Alexandria for a C&F price of about US $ 350-360/m3. The freight rate for plywood from Port Sudan to Alexandria being US $ 48.26/m3, the FOB price in Port Sudan for Sudanese plywood would be around US $ 300/m3 which could be interesting and incite plywood exports from the Sudan to Egypt.

Still more than Egypt, Saudi Arabia would seem to be a possible outlet for Sudanese-made plywood, since the freight rate for plywood from Port Sudan to Jedda would be only US $ 23.33/m3.

In considering potential plywood exports, it should be borne in mind that mahogany-faced plywood sheets would represent on the international market a commodity that could compete as to quality and decorative value with any available brand of plywood and would easily compete with the kind of plywood supplied at present to countries in the Middle East. Sudanese plywood would have the advantage of the raw material not being expensive, and if in spite of the small capacity of the plant a reasonable production cost could be achieved by efficient management, if costs of internal transport would be lowered, and if a premium on foreign exchange earned is granted, then exports of plywood from the Sudan are a possibility which should be earnestly attempted.

2.4 Conclusions

i) Growing requirements for plywood in the domestic market and also potential opportunities for plywood exports to neighbouring countries warrant the establishment of a plywood industry in the Sudan.

ii) In determining the capacity of a plywood plant for the Sudan both the extent of present and future market requirements and the availibility of timber should be considered. Estimated demand for plywood in 1980 - when full production of the proposed plywood mill would have been reached - is 4,000 m3 per annum. The minimum economic capacity of a plywood plant is considered to be 5,000 m3 of plywood per annum. This capacity represents, at the same time, the viable concentration of peeler logs which is economically feasible with regard to existing forest resources in the Sudan. Consequently, the recommended solution is the establishment of a 5,000 m3 plywood mill. This would meet the country's demand for plywood in 1980 and, at the same time, allow for plywood exports of the order of 1,000 m3 per annum, should Sudanese plywood be available at a competitive price.

iii) According to the expected end-uses the following specification of plywood is recommended for the 5,000 m3 plant which is to be established:

Thickness	End-uses: Furniture	Con-struction	Containers	Exports	Total
3 mm	1,800 m3	-	100 m3	600 m3	2,500m3
4 mm	800 m3	-	-	200 m3	1,000m3
5-10mm,Ø6mm	200 m3	-	100 m3	200 m3	500m3
15mm	-	1,000 m3	-	-	1,000m3
Total	2.800 m3	1,000 m3	200 m3	1,000 m3	5,000m3

iv) Looking further ahead, beyond the scope of this Feasibility Study, the following development of the plywood industry in the Sudan could be contemplated:

Period	Number of plants	Annual plywood production	Domestic consumption	Exports
1976-1980	1	5,000 m3	4,000 m3	1,000 m3
1981-1985	2	10,000 m3	6,500 m3	3,500 m3
1986-1990	3	15,000 m3	10,400 m3	4,600 m3

The successive increase of the number of plants instead of shifts is recommended because of the low stocking of forests which makes an economic concentration of larger quantities of logs at the factory site more difficult .

v) In the calculation made in this Feasibility Study it is assumed that the present exorbitant consumer price for plywood sheets will be reduced by more than half, i.e. from£S 390,00/m3 to £S 180,00/m3,

if plywood imports are substituted by domestic production. It is needless to say that such an important price reduction would automatically increase demand for plywood to a multiple of its present level.

vi) In order to improve the profitability of plywood production direct commercial relations with the end users are recommended through the establishment of a warehouse in Khartoum. The plywood mill in Wau would ship the plywood to Khartoum and sell it ex warehouse to consumers in Khartoum at the retail price and to wholesalers in the other urban centres in the North at the wholesale price. The plant in Wau would sell plywood ex factory to wholesale dealers in the South, as well as to plywood exporters. By establishing a retail outlet in Khartoum and Wau the selling price of plywood will be minimized and unnecessary intermediaries avoided.

3. RAW MATERIAL

3.1 Forest Resources

There are important timber resources in the South of Sudan, though in the absence of any forest inventory, in lack of forest maps and working plans it is extremely difficult to estimate potential yields of the forest.

Libor Putna (13) gives the following estimate:

	savanna woodland with high rainfall (900 to 1800 mm)	montane vegetation with rainfall from (500 to 2000 mm)
Area of production forests (square km)	164,000	6,000
Timber volume cubic meter	34 million	16 million
Average cubic meter per ha	2	27

Bulletin 16 of the Forest Department classifies 445,000 square km as productive forest land in the Sudan with an average standing volume of just over 1 cubic meter per ha. According to this source montane forests extend to about 3,000 square km and contain about 30 % of the total standing volume, i.e. 16 million m3, or 53 per ha.

Johannes Weck (14) estimates that the average annual yield of plantations could be 8 to 12 m3 per ha in the humid savanna and 8 to 20 m3 per ha in the montane rain forest.

According to J.K.Jackson whose excellent Report (1), though written in 1960, is still considered to be the most reliable source of information on forestry in the South, the estimated potential annual yield of sawn timber in southern Sudan is as follows:

Isoberlinia doka (Vuba)	128,000 m3
Daniella oliveri (Bu)	1,250 m3
Khaya senegalensis (Dark Mahogany)	2,500 m3
Khaya grandifolia (Light Mahogany)	800 m3
Olea hochstetteri, Podocarpus milanjianus and other species of montane foresta	1,000 m3
Other species approx	4,000 m3
T o t a l	137,550 m3

These figures have been quoted by Mr.Kamal Osman Kalifa, Director of the Forestry Department in Khartoum, at the time of the team's visit as the actual possibility of utilization of the forests.

3.2 Sawmilling

The use of Sudan's forest resources is only beginning. Sawmilling capacity is only a fraction of the potential yield of the forests, and actual sawnwood output is still much lower than the installed capacity.

Capacity of timber production reached its all-time peak in 1963 with an output of 13,600 m3 sawn timber. The present installed sawmilling capacity in Equatoria and Bahr-el-Ghazal Provinces would allow an annual production of almost 20,000 m3 sawn timber on a one-shift basis, corresponding to an intake capacity of about 50,000 m3 saw logs. Actual output of sawn

timber is said to be at present only about a quarter of the rated capacity owing mainly to transport difficulties, lack of fuel and spare parts, and inefficient management.

The territorial distribution of the sawmilling capacity is as follows:

Capacity of saw-mill - m3 sawn timber

Bahr-el-Ghazal		Equatoria	
Wau	4,000	Katire	2,000
Bisselia	1,000	Gilo	1,000
Pongo Nuer	2,000	Nzara	2,000
Pongo Aweil	2,000	Nuni	2,000
Matiang	2,000	Loka (to be installed in 1976)	2,000
Subtotal	11,000	Subtotal	9,000
	Bahr-el-Ghazal		11,000
	Equatoria		9,000
	Total		20,000

The sawmills are owned and operated by the Forestry Department, consequently no stumpage fee is paid for saw logs. Royalties are collected only on fellings made outside the forest reserves, their aim being the protection of timber resources by concentrating timber fellings in the forest reserves where plantations can be established after felling.

The prevailing tree species used for sawmilling and representing about 85 % of the total sawn timber output is Mahogany (both Khaya senegalensis and Kh.grandifolia). Only the Nuni sawmill which lies in the Vuba belt processes almost exclusively Vuba (Isoberlinia doka). A more or less important admixture of some other tree species occur in the sawmill

yards which may be, according to the nature of the surrounding forest, Isoberlinia doka, Clorophora excelsa, Terminalia superba or T. glaucescens, Afzelia africana, Daniella oliveri, Maesopsis eminii, Tectona grandis, Cedrella toona, Cupressus lusitanica etc.

3.3 Peeler Logs

Most tree species converted into sawn timber are suitable also for plywood and/or veneer production. Judging from the saw logs which have been inspected during the team's visit to the South about 30 % of peeler logs are at present used for sawn timber. Sometimes peeler and veneer logs are processed even into railway sleepers. The absence of plywood production prevents the rational utilization of forest resources.

The present girth limit of 45" i.e. 36 cm b.h. diameter is from the viewpoint of plywood production fully satisfactory and would yield peeler logs with an average diameter of at least 40 cm.

In order to accumulate funds for the establishment of plantations after the utilization of the natural forest a recommendation is made in Annex B/1 to introduce a stumpage fee for peeler logs amounting to 60 Pt/m3.

Both peeler logs and saw logs occur usually in the same tree and their separation by crosscutting is of primary importance for the outturn of peeler logs. The relatively high percentage of 30 % peeler logs form the total volume of felled timber which is calculated in this report can be reached only with careful and responsible crosscutting.

Peeler logs should be as long as possible, the basic lengths of 130,190 and 250 cm being combined into the following aggregate lengths: 260,320,380,390,440,500 cm or more if conditions of transport permit it. To these lengths at least 7% should be added when cutting logs in the forest.

Normally logs should not be stored in the yard for more than three months. This would prevent the deterioration of logs. The main concern should be the prevention of cracks, therefore protection of the log supply from direct sunrays is recommended. Should adverse climatic conditions and transportation difficulties during the rainy season require the stocking of a log supply for more than three months, sprinkling or other forms of log protection may become necessary, e.g. protective coating of log ends against checks and splits using lime or paraffin, treatment with 4 % solution of $CuSO_4$ or $ZnCl_2$, protection by Wollmanit from the FRG, by UL salts from the GDR etc.

3.4 Potential Sites for Plywood Production

At the time of the team's visit to the Forestry Department in Khartoum the Director, Mr.Kamal Osman Kalifa, pointed out that in his opinion there were four potential sites for the establishment of a plywood mill in the South, i.e.

1. The Imatong mountains
2. The Loka-Nuni area
3. The Yambio-Nzara area, and
4. The Wau-Raga area.

All these four sites were visited by the team and as far as possible short trips to the forest were made. At the Survey Department in Khartoum aerial photographs of some strips of forest surveyed ten to twenty years ago in the Imatong

mountains, the Nzara region and halfway between Wau and Raga were inspected. Based on information provided by the local forest staff, on data contained in various reports, on the inspection of aerial photographs, and on personal impressions a preliminary evaluation of timber resources for the purpose of plywood production is made in Annex B/2.

Among the forest regions inspected one - the Loka-Nuni area - was eliminated as unsuitable for plywood production. In the remaining three forest regions an annual supply of between 12 and 13 thousandt m3 of peeler logs seems to be guaranteed. In the Imatong Forest Reserve Katire was chosen as a possible location of the plywood mill, the other two contemplated sites are Nzara in western Equatoria and Wau in Bahr-el-Ghazal province. The logging cost is different in each case and the total cost of the peeler logs at the factory yard has been assessed as follows:

	Cost in £S per m3		
	Katire	Nzara	Wau
Cost at factory yard	12.33	14.84	10.75
Supplement 10 % 20 %	2.47	2.96	2.15
Contingency 10 %			
Total cost of raw material	14.80	17.80	12.90

Because there is no experience with large-scale logging operations in the Sudan, a supplement is added as a safeguard against possible increase of logging cost in case large-scale operations should raise the present cost of contracting or require the stepping in of the Forestry Department.

From among the three forest regions where sufficient timber resources for plywood production can be found preference is given to Wau for several reasons.

Wau has the cheapest and best raw material, and the easiest terrain for large-scale logging operations. It has a railway connection with the North of the country and thus can provide the cheapest, quickest and most reliable transportation of plywood to the consumer centres. Development in and around Wau benefits of a high priority both socially and economically because of the need to create employment. The authorities of the Southern Region, and especially the Forestry Department, put high priorities for the industrial development of the Bahr-el-Ghazal province, as they consider it the most backward part of the South. At the same time, Bahr-el-Ghazal Province has the largest number of sawmills on a restricted area which enables an advantageous integration of the proposed plywood plant with the sawmilling industry.

3.5 Forest Inventory

The assessment of the raw material supply may convey a true general picture of each site, but needs further clarification and verification as to the surface of the forest, its composition by species and its standing volume.

The need for a forest inventory as a basis for industrial utilization of timber resources has been stressed many times in a number of reports. Indeed, the idea of a plywood mill in the Sudan which emerges in various reports during the 60's and 70's has been up to now always either evaded or deferred until the completion of a forest inventory, or rejected outright because of an alleged lack of timber (10).

Yet there can by no doubt - and all the evidence points to the fact - that there exist in the southern Sudan, at least at the three mentioned sites, important resources of natural forests with large-sized trees of valuable species which occur in sufficient quantity to be used for plywood production. Insufficient information concerning these timber resource cannot serve as a justification for denying the possibility of plywood production. On the contrary, a positive decision on the establishment of a plywood mill would serve as an impetus and will be an economic justification for a closer survey of the forest, as well as hasten the collection of information and data on the existing timber resources in the areas concerned.

Under these conditions, a forest inventory linked with an aerial survey and the testing of tree species should be carried out with all possible speed in the vicinity of the site selected for the plywood plant, as a follow-up to this Feasibility Study. Recommendations with terms or reference and a cost estimate are given in Annex B/3.

3.6 Recommendations

In conclusion to the evaluation of the raw material situation the following recommendations are made:

i) Timber resources in the Wau-Raga region seem to be the most promising source of raw material for a plywood mill, its optimum location being Wau.

ii) Information on timber resources in the region proposed confirm the viability of plywood production. Nevertheless a forest inventory based on an aerial survey and supplemented by testing prospective species is urgently recommended in the influx area of the mill site.

iii) Forest land which could yield a supply of timber for plywood production should be declared a Central Forest Reserve. This would be in line with the pursued policy of extending the present area of forest reserves - 735,000 ha in southern Sudan or 1.1 % of the total surface of the Southern Region - to the target figure of 15 %.

iv) New impetus should be given to the establishment of plantations replacing the natural forests as a raw material basis for both sawn-wood and plywood production. In addition to the 8,600 ha of teak plantations which will mature in 15 to 20 years experiments should be started with the introduction of fast-gowing soft-wood species.

4. TRANSPORT

4.1 General Condition

In any industrial development in the Sudan transportation is the major constraint. This is especially true of plywood production in which both the raw material and the commodity produced are heavy, bulky and costly to transport and distances involved between the timber resources in the South and consumer centres in the North are enormous.

The weakest link in all the chain of transportation in the Sudan is always the connection between the North and the South of the Country. There are practically two lines of communication: the Nile from Juba to Kosti, and the railway line from Wau through Babanousa to Khartoum. Both transportation lines are in very poor state.

Theoretically, transport from Juba to Kosti down the Nile takes 6 days, to Khartoum 10 days; upstream the duration of transport should be 10 days from Kosti, 15 days from Khartoum. But practically it takes weeks and months to get much needed supplies through this route. Maximum lifting capacity of crane is 30 t in Khartoum North, 10 t at Kosti and 5 t in Juba. But the army and the Mechanical Transport Department in Juba have cranes of over 20 t lifting capacity. There are no storing capacities at Juba and the handling of goods, both loading and unloading, should be done by the owner of commodities.

Railway transport from the South to Khartoum would seem to be faster than on the Nile, since it takes a train 3 to 5 days to travel from Khartoum to Wau.

There are no loading or storage facilities in Wau. Loading and unloading should be done by the owner of goods. There is no waggon scale, consequently freight rates are charged for a 16 t load whatever the real load is. The railway extension from Babanousa to Wau was built in the 1960's with haste and is probably the weakest and least efficient link in all the network of Sudan Railways.

Both communications, the railway and the Nile, are fully loaded on the way from the North to the South. In the opposite direction, from the South to the North, most railway cars and barges go empty.This one-way traffic favors the location of any industrial plant in the South since it helps to utilize better the return movement of vehicles by sending its output to the consumer centres in the North.

For the time being no radical improvement in either Nile shipping or railway transport can be expected. Wherever the plywood plant will be situated, serious trouble must be anticipated arising out of the long and unreliable transport connection between North and South Sudan.

4.2 Road traffic in the South

A major concern in establishing a plywood mill is the inadequate and unsatisfactory infrastructure of the Southern Region especially with respect to road communication. There are in Equatoria and Bahr-el-Ghazal provinces five main road links (called in Michelin's map "partially improved roads") which are said to be all-weather roads:

Juba - Nimule - Uganda
Juba - Yei - Zaire
Juba - Maridi - Tumbura - Wau (leading also into the Central African Republic)
Jumba - Rumbek - Wau,
Juba - Torit - Kapuete - Kenya (last section on construction)

All these roads could be also of importance for a plywood plant. But economic transportation on these roads would require the following precautions:

i) Transport should be concentrated as far as possible into the dry season, and restricted during the rainy season.

ii) High priority should be given to road improvement and maintenance.

iii) Replacement of the ferry operating on the Buseri river by a bridge should be taken into consideration

iv) A speed limit should be set up and the time of departure and arrival of lorries checked by control posts.

v) The training of drivers and maintenance mechanics should be intensified and improved and, when necessary, expatriate instructors should be hired.

vi) More attention is to be paid to the supervision and control of drivers.

vii) Maintenance of vehicles should be better organized.

4.3 Evaluation of Sites

In plywood production transportation cost depends on a number of factors among which the distance from the forest to the plywood mill and further from the plywood mill to consumer centres is of decisive importance. Therefore the selection of the site for the plywood mill, i.e. its location between

the forest and the costumer, is of greatest importance for the feasibility and profitability of the enterprise.

Five possible sites for a plywood mill in the Sudan are being considered and their economic implications discussed in this report. These locations are Katire, Nzara, Wau, Juba and Khartoum. Furthermore, export possibilities of plywood to neighbouring countries through the ports of Port Sudan and Mombasa are examined.

The distances involved and the freight rates are given in Annex C/1.

On the basis of the freight rates and handling charges quoted in Annex total transportation costs of logs and plywood for various locations of the plywood mill are computed, assuming the following concentration of sales:

Wau	10 % or	500 m3	of plywood
Khartoum	70 % or	3,500 m3	of plywood
Port Sudan	20 % or	1,000 m3	of plywood
T o t a l	100 % or	5,000 m3	of plywood

The calculation of cost of logs at the factory yard and of final cost at each site considered is given in Annex C/2.

The selection of the most suitable site must take into account that transportation of any sort is the bottleneck of every industrial development and has to be kept at a minimum in order to make a project viable. If the transportation task is evaluated in t/km, the following picture is obtained for the five potential sites:

000 t/km

Location	Katire	Nzara	Wau	Juba	Khartoum
Hauling	375	500	375	375	375
Log transport by road	-	-	813	2,075	813
by rail (Wau-Khartoum)					18,725
Plywood transport					
by road	648	1,879	-	-	-
by rail	-	-	3,883	-	-
on Nile	5,378	5,378	-	5,378	598
exports	567	567	567	567	567
	6,968	8,324	5,638	8,395	21,078

This shows that Wau and Katire are the sites with the smallest and cheapest overall transport. A larger cost and a larger volume of transport is involved by selecting the Nzara and Juba site. As to the site in Khartoum, though economically it still seems to be a possibility, it is not feasible technically. The railway line from Wau to Khartoum could not handle this volume of transportation.

4.4 Conclusion

From the viewpoint of transport Wau is recommended as the best site for a plywood mill for the following reasons:

i) Location of the plywood mill in Wau results in the smallest volume of overall transport of logs and plywood

ii) Logging in the Wau area is the cheapest and the cost of logs at the factory yard is the lowest of all alternatives

iii) The site in Wau has the advantage of reducing road transport to a minimum

iv) Communication with the North of the country is cheapest by the railway.

5. PLYWOOD PLANT

In accordance with the conclusions and recommendations of Chapter 3 and 4 a Plywood Plant is to be established in the South of Sudan with following main characteristics:

5.1 Manufacturing programme

Capacity: 5000 m3 of plywood per year
Number of shifts: 2
The expected quantity of 5000 m3 plywood panels is proposed to be manuf-actured in following qualities and dimensions:

Type:	Thickness: in mm	Dimensions in mm	Quantity m3/year	Percentage in %
Interior	3	1220x1830 (i.e.4x6')	1500	30
Interior	3	1220x2440 (i.e. 4x8')	1000	20
Interior	4	1220x2440 (i.e. 4x8')	1000	20
Interior	6 (5-10)	1220x2440 (i.e. 4x8')	500	10
Exterior (WBP)	15	1220x2440 (i.e. 4x8')	1000	20
			5000 m3	100 %

The quality of plywood panels has to correspond to requirements of BS 1203:1954, BS 1204:1956 as well as to ISO-Recommendations R 1098 and R 1954.

The size 122x183 cm i.e. 4'x 6'for 3 mm thickness is recommended in view to the established market requirements for plywood panels in the Sudan. For the larger part of production dimensions of 122x244 cm i.e. 4'x 8'are proposed in order to utilize more efficiently the machinery envisaged not to mention the better recovery of both the raw material and the plywood panels manufactured.

5.2 Technology

The technological procedure of manufacturing plywood is generally known and desribed in detail in a number of published technical handbooks. The following Chapter is, therefore, confined to emphasize the main principles.

For planning the first plywood plant in the Sudan preference is given to equipment and procedures which are easy to handle and do not require high and expensive mechanization neither very high skill, nevertheless enable to manufacture plywood panels of highest quality competitive on international markets.

The plywood plant in Wau should be situated near the railway station adjoining the Wau Trainings Sawmill with which it shall have the log yard in common.This close neighbourhood will facilitate cooperation between the two plants and integration of production with respect to

- the selection of peeler logs from among the saw logs delivered
- the utilization of sawmill waste in the boiler of the plywood plant
- the conversion of peeler log cores into sawnwood at the sawmill
- the use of existing equipment for maintenance and repair eventually the use of a stand-by generator.

It should be noted that the amount and quality of timber supply available in Wau would permit, besides plywood production, also an additional production of sliced veneer.

In this way logs of highest quality and large dimension, especially over 120 cm diameter, could be utilized to best advantage, for exports especially.Approximate cost of produc-

tion for sliced veneer are given in Annex E. Data on raw material and market for this product will need further study.

Peeler logs for plywood production will be handled by means of a mobil crane on the log yard as well as for filling and emptying the steaming pits (for capacity of steaming pits see Annex D/2). Steamed logs will be crosscut by a chain saw and moved on a carriage to the peeling machine (see Annex D/2) and elevated by means of an electrical hoist without centering device.

Veneers in thicknesses of 1,2 mm, 2,0 mm, 3,0 mm and 4,0 mm will be peeled in width and quantities specified by the actual production programme. Waste veneer occuring at starting the peeling operation will be transported to a hogger and used as fuel for the boiler.

Peeled veneers will be reeled and stored. Reels with green veneers will be moved from the store to a clipping machine and cut to foreseen length . Clipped veneer sheets will be moved to an S-type belt dryer (for capacity calculation see Annex D/2) and dried veneer will be sorted according to quality and end-use. Undersized pieces of veneer will be jointed and spliced and occuring defects patched.

Prepared veneers are transported by lift truck to the assembly station, where the inner plies for interior quality of plywood will be spread with Urea-formaldehyde glue mixture (for details see Annex D/1). For exterior plywood Phenol-formaldehyde foils will be used.

Loading to the press (for details see Annex D/2) and unloading of pressed plywood panels will be done by hand.

Plywood panels will get final dimensions on a double sizing saw and afterwards surface sanded. Defects are repaired and finished panels stored for despatch.

Details concerning consumption, capacities, investment and production costs are to be found in respective Annexes (see detailed Table of Contents).

5.3 Summary of consumption figures

Detailed calculations are to be found in the attached Annex D/1 and show the following resulting figures for:

- raw material
- glue
- heat
- electricity
- water
- manpower

i) Raw material

The log supply is expected to include the following tree species:

Khaya senegalensis	67 %
Afzelia africana	10 %
Daniella oliveri	10 %
Isoberlinia doka	10 %
Miscellaneous	3 %

Logs from forests are to be delivered in combinations of basic peeling length of 1300 mm, 1900 mm and 2500 mm.

Diameter of logs: minimum 360 mm, maximum 1200 mm.

For manufacturing plywood a recovery figure of 45 % is assumed which results in a consumption figure of 2,222m3 of logs per 1 m3 of plywood or
an annual consumption of logs 11,110 m3

In view to the fact that the actual diameter of logs will exceed the calculated minimum diameter the amount to be delivered to the plant is ineconomic calculation estimated to 11,100 m3/year

ii) Glue

For interior plywood:
- Urea formaldehyde glue delivered in powder form
  - for splicing undersized veneers 2,3 t/year
  - for assembling and pressing plywood 147,7 t/year
  150,0 t/year
- technical flour (non edible, used as extender) 65 t/year
- ammonium chloride (NH_4Cl) 2,1 t/year

For exterior plywood (WBP)
- Phenolic foil (TEGO-Type) 400.000 m2/year

Summary of raw materials

Type	Amount per year	per day	
Peeler logs	11.100m3	40,36 m3	
UF-glue (powder)	150 t	545 kg	
Water	187 m3	0,68 m3	
Technical flour	65 t	235 kg	
Hardener	2,1 t	7,6 kg	(calculated in price of glue)
Fenolic foil	400.000m2	1,455 m2	

iii) Heat

Operation	Heat requirements		Steam requirements	
	Gcal/year	Gcal/hour	t/year	t/hour
Steaming	1.588	0,25	2.941	0,45
Drying veneers	5.951	1,33	11.022	2,50
Pressing plywood	1.694	0,39	3.137	0,71
Boiler house	923	0,14	1.710	0,26
	10.156	2,11	18.810	3,92

Note: steam is calculated as saturated steam at 12kg/cm2 in the boiler, corresponding 180°C in the dryer

Wood waste as fuel for the boiler:

Required amount	23,5t/day
At disposal in the plant	12,7t/day
From other sources	10,8t/day

iv) Electricity

Installed load	774 kW
Consumption per year	596 MWh
Consumption per 1m3 of plywood	120 kWh

v) Water

Industrial water	8900 m3/year i.e.	32,4m3/day
Water for the boiler	17000 m3/year i.e.	61,8m3/day
Drinking water	4100 m3/year i.e.	14,9m3/day
	30.000 m3/year	109,1 m3/day

vi) Man power

Plywood plant at Wau:

Management	6	persons
Administration	23	-"-
Foremen and skilled workers	40	-"-
Semi-skilled and unskilled workers	80	-"-
	149	persons

Warehouse at Khartoum: 16 persons

Note: Technicians and workers engaged in road building, felling, logging, transport etc. are not included above.

5.4 Total Summary of Investment Costs

The investment costs are specified in more details in Annex D/3, D/4 and D/5, The total summary is given below:

	Foreign currency	Local currency	Total
Production machinery and equipment	516,310	142,170	658,480
Construction works	-	277,000	277,000
Transport and office equipment	-	61,600	61,600
Preliminary expenses	22,000	92,600	114,600
Total	538,310	573,370	1,111,680

6. ECONOMY

6.1 Sales

The structure of the potential market is specified in details in the chapter dealing with the marketing aspects of the project. In this summary, the calculation of sales value is made under these assumption:

Sales (in m3)

	Ex factory Wau	Khartoum wholesale	Khartoum retail	Total
3 mm	800	500	1,200	2,500
4 mm	300	200	500	1,000
5-10 mm Ø6mm	200	100	200	500
15 mm	200	200	600	1,000
Total	1,500	1,000	2,500	5,000

Selling prices (in LS per m3)

	Ex factory Wau	Khartoum wholesale	Khartoum retail
3 mm	168.0	180.0	198.0
4 mm	141.0	153.0	171.0
5-10 mm (Ø6mm)	135.0	147.0	162.0
15 mm	137.0	149.0	164.0

The expected structure of quality grades and the details as to the calculation of average selling prices are given in Annex F/1

Sales revenue (in 1,000 LS)

	Ex factory Wau	Khartoum wholesale	Khartoum retail	Total
3 mm	134.4	90.0	237.6	462.0
4 mm	42.3	30.6	85.5	158.4
5-10mm	27.0	14.7	32.4	74.1
15 mm	27.4	29.8	98.4	155.6
Total	231.1	165.1	453.9	850.1
Average selling price (in LS per m3	154.1	165.1	181.6	170.0

The level of sales revenue indicated above is assumed to be reached in the 4th operating year. The amounts of sales receipts in the first three operating years of the start-up period are quoted in Annex F/2.

6.2 Capital requirements

i) Investment costs

The investment cost of the production machinery and equipment are calculated as having to be paid entirely in foreign currency, whereas the construction works and the deliveries of transport equipment and furniture are planned to be fully sub-contracted to Sudanese suppliers.

Detailed specifications with the necessary technical data and price estimates are given in chapter 5 and annex D/3 and D/4.

Summary of investment costs (in KS)

	Foreign currency	Local currency	Total
Production machinery and equipment	516,310	142,170	658,480
Transport and office equipment	-	61,600	61,600
Construction works	-	277,000	277,000
Preliminary expenses	22,000	92,600	114,600
T o t a l	538,310	537,370	1,111,680

ii) Permanent working capital

a) Current assets

	KS
Rawmaterial (stock for approx. 6 weeks production)	18,000
Adhesives (approx. 3 months)	12,000
Spare parts and technical materials (80% of the amount of resp. annual costs)	30,200
Stock of plywood (1 month in ex-factory prices)	63,800
Credit to customers	141,700
Provision for cash	15,000
Total	280,700

b) Current liabilities

Supplier's credit for raw material, adhesives, technical material and spare parts	36,900
Bank credit (70% of the credit to customers)	99,200
Credit for other supplies and provisions	10,000
Total	146,100
Net permanent working capital (a-b)	134,600

Note: to furnish data for the macro-economic evaluation of the project, the foreign currency element in the net working capital is calculated to be ŁS 23,400.

iii) Total capital requirements (in ŁS)

	Foreign currency	Local currency	Total
Investment costs	538,310	573,370	1,111,680
Permanent working capital	23,400	111,200	134,600
T o t a l	561,710	684,570	1,246,280

6.3 Plan for financing

During the stay of the consultant's team in the Sudan, the governement authorities were not prepared to specify the expected sources of financing the project. To enable a rough preliminary assessment of the impact of financial charges

on the profitability of the project, a potential solution discussed with the Industrial Bank of Sudan and the Sudan Development Corporation has been adopted. It is assumed that the project should take full advantage of credit possibilities offered by the Industrial Bank of Sudan under the following conditions:

- the applicant is required to contribute at least a minimum of 1/3 of the total cost of the project
- the maximum loan can not exceed £S 700,000
- loans are granted for periods not less than 2 years and not exceeding 15 years; the Bank normally grants a reasonable period of grace before commencement of re-payment to permit completion of the project
- the current rates charged by the Bank are 9.5 % on mediumterm loans (2-6 years) and 8.5 % on long-term loans (6-15 years) for local currency and 9.5 % on foreign exchange loans.

Besides the credit from Industrial Bank of Sudan, it is assumed the supplier of the production machinery and equipment may grant a medium-term loan covering approx.30 % of the C&F value of production machinery and equipment.

Summary of sources of financing

	£S	Interest rate	Payable in
Equity capital	425,000	-	-
Supplier's credit	150,000	9.5 %	5 years
Long term loan (I.B.S.)	400,000	8.5 %	12 years
Medium-term loan (I.B.S.)	300,000	9.5 %	6 years

It is assumed that the commencement of repayment of the loans from the Industrial Bank of Sudan may be postponed as it is to be seen in the repayment scheme (see Annex F/3).

The simulation of the financial position of the plant during two years of construction and 15 years of operation is shown in the cash-flow forecast (see Annex F/4). The replacements of the equipment will be paid from the firm's cash reserves.

6.4 Estimates of costs and profits

6.4.1 Operating costs

The running-in period is assumed to cover the first three years of operation. In the fourth operating year, the full capacity of 5,000 m3 plywood has to be reached with the corresponding full level of operational costs resumed in the following table:

		£S
a)	Raw material (peeler logs) 11,100 m3 x £S 12.90	143,190
b)	Urea formaldehyde adhesive (in powder form) 150 tons x £S 190.0	28,500
c)	Flour - extender 65 tons x £S 100.0	6,500
d)	Phenolic foil (Tegofilm) 400,000 m2 x £S 0.033	13,200
e)	Electrical energy 596 MWh x £S 35.0	20,860
f)	Water 30,000 m3 x £S 0.04	1,200
g)	Repairs and spare parts 4% on production machinery, 5% on vehicles and handling equipment, 2% on furniture and office equipmentm 1% on construction works	31,634

h)	Consumption of technical materials (tools, et.) 1% on production machinery	6,150
i)	Insurance 0.2 % on buildings and machinery,0,5 % on stock of plywood, 5% on vehicles	7,810
j)	Wages and salaries (details given in Annex D/1)	66,760
k)	Social security - obligatory (a simplified calculation of 10% on the wage bill is assumed) - facultative (covering risks not insured by the state social security scheme in the range of 5% on the wage bill)	10,014
l)	Transport costs (3,500 m3 of plywood sold through Khartoum section will be transported by railway) 3,500 x £S 10.519	36,817
m)	Sales expenses 5% on the value of sales in ex-factory prices	38,275
n)	Plant overheads, administrative expenses, etc. 10% on operating costs (excl.transport costs and sales expenses)	33,582
T o t a l		444,492
Contingency approx. 5% on total		22,218
Grand total		466,710

Taking in consideration the lower output in the first three years of the running-in period, the calculation of the consistent levels in the operational costs was made in Annex **7/2**

Note: Costs of steam are calculated in depreciation of investments for the boiler and in wages-. Wood waste will be used as fuel.

6.4.2 Schedule of depreciation

	Investment costs in £S	Depreciation rate in %	Annual depreciation in £S
Production machinery and equipment	615,040	10	61,504
Handling equipment	43,440	20	8,688
Construction works	277,000	5	13,850
Vehicles	28,600	25	7,150
Furniture	33,000	10	3,300
Preliminary expenses	114,600	20	22,920
T o t a l	1,111,680		117,412

Note: Beginning from the 6th operating year, the sum of annual depreciation will decrease to £S 94,492. The replacements of machinery and equipment will not affect the amount of depreciation.

6.4.3 Profits and taxation

Table of the annual operating accounts for the whole period of 15 years of operation analyses the development of sales revenues, operating and other working costs, gross profit and net profit (see next page).

The calculation of the net profit is made under assumption that an exemption from payment of profit tax will be granted, according to the industrial investment regulations, for the period of the first 5 years. Beginning from the 6th year of operation, the normal rate of 60% of the profit tax is planned to be delivered to the Sudanese financial authorities.

Annual operating accounts / in £S /

Operating years	Sales receipts	Operating costs	Depreciation	Interest paid	Total expenses	Profit /loss/ before tax	Cumulative profit /loss/ before tax	Tax on profit	Net ptofit	Cumulative net profit
1	420,100	335,220	117,412	76,749	529,381	- 109,281	- 109,281	-	- 109,281	- 109,281
2	679,900	432,500	117,412	74,391	624,303	55,597	- 53,684	-	55,597	- 53,684
3	772,500	462,310	117,412	68,067	647,789	124,711	71,027	-	124,711	71,027
4	850,100	466,710	117,412	59,404	643,526	206,574	277,601	-	206,574	277,601
5	850,100	466,710	117,412	49,933	634,055	216,045	493,646	-	216,045	493,646
6	850,100	466,710	94,492	39,589	600,791	249,309	742,955	149,585	99,724	593,370
7	850,100	466,710	94,492	31,997	593,199	256,901	999,856	154,141	102,760	696,130
8	850,100	466,710	94,492	23,693	584,895	265,205	1,265,061	159,123	106,082	802,212
9	850,100	466,710	94,492	21,077	582,279	267,821	1,532,882	160,693	107,128	909,340
10	850,100	466,710	94,492	18,239	579,441	270,659	1,803,541	162,395	108,264	1,017,604
11	850,100	466,710	94,492	15,160	576,362	273,738	2,077,279	164,243	109,495	1,127,099
12	850,100	466,710	94,492	11,819	573,021	277,079	2,354,358	166,247	110,832	1,237,931
13	850,100	466,710	94,492	8,194	569,396	280,704	2,635,062	168,422	112,282	1,350,213
14	850,100	466,710	94,492	4,261	565,463	284,637	2,919,699	170,782	113,855	1,464,068
15	850,100	466,710	94,492	-	561,202	288,898	3,208,597	173,339	115,559	1,579,627

The loss of the first operating year covered by the profits of the two successive years indicate that liquidity problems may be faced at the beginning of operations (the financial solution can be seen in Annex F/4). However, starting with the fourth year of operation very massive inflows of annual net profit will contribute to the fast increase of cash reserves.

6.5 Commercial profitability of the project

The commercial profitability of the plant is naturally highly depending on the pricing policy. Though the estimates of prices have been made with the objective to enable the maximum promotion of the local market, reducing present price levels by more than 50%, the level of profit shows very reasonable margins as can be seen from the following profitability rations based on data of costs and profits of an average year (arithmetical mean based on 15 operating years) and of the 8th (mediane of this time series):

		average year	8th year
Rate of return as ratio of	$\frac{\text{profit before tax + depreciation}}{\text{investment}}$	25.4%	28.9%
	$\frac{\text{profit after tax and before depreciation}}{\text{investment}}$	16.6%	16.1%
Pay-back period as ratio of	$\frac{\text{investment}}{\text{profit before tax + depreciation}}$	3.9 years	3.5 years
	$\frac{\text{investment}}{\text{profit after tax and before depreciation}}$	6.0 years	6.2 years

More data concerning the profitability of the project can be found in Annex F/5 comprising, besides several more profitability ratios, the calculation of the internal rate of return and the break-even analysis. The results of these calculations (the internal rate of return equalling 23.2% and the break-even point at the level of 44,2%) emphasize still more the above stated conclusions regarding the high commercial profitability of the project, though at the same time plywood prices are being reducedmuch below their present level.

The sensitivity analysis based on potential fluctuations of sales revenues, operating costs and investment requirements confirms once more the very strong position of the home production of plywood when compared with sales of imported plywood. It indicates that changes in prices might have the most important impact on the level of profitability and demonstrates the really wide and safe limits for the future pricing policy of the plant (for more details see AnnexF/6).

6.6 Macro-economic evaluation of the project

The establishment of a plywood factory in Wau with an annual output of 5,000 m3 of plywood would bring the following social benefits to the Sudan (see Annex F/7).

i) The imports of plywood could be stopped immediately and replaced by much less important imports of adhesives, spares and technical materials; the yearly net savings of foreign currency (both from substitution of import and potential exports) would reach up to the amount of approx. U$ 750,000 annually (for more details see annex F/7).

ii) The major aspect, however, to be considered is that of employment. The direct effect of the implementation of the project will be to provide employment for the people both in the plant itself (165 new jobs) and in logging and forestry operations. Besides, the spending power generated from wages and salaries will tend to increase employment in other sectors of economy as well. At the same time, the skill of the labour force would increase by training, social benefits customary in industrial plants would improve the social standard and a higher social standing would be achieved for all the staff and workers of the factory.

iii) An attempt to give an aggregate view of the balance between social benefits and social costs is shown in the social costs benefits analysis (Annex F/7). The social rate of discount in the range of 8.4% indicates a very high level of national economic profitability of the project.

iv) Another persuasive indicator of the significance of the project for the national economy of the Sudan is the high level of the value added (approx.£ 500,000 in the 8th operating year).

v) Domestic consumption of plywood could be almost doubled, thus helping to alleviate the existing shortage of building materials and expanding the manufacture of furniture. In concrete constructions, imported coniferous sawnwood used for shutterings could be replaced by plywood and thus sawnwood imports could be reduced and additional foreign currency saved.

vi) The current waste caused by using timber of peeler log quality of Mahogany and other valuable tree species for inferior purpose would be largely stopped and a rational utilization of the country's timber resources encouraged.

vii) Forestry in the influx area of the plywood mill would be encouraged to convert natural forests to plantations, to intensify forest management and to develop training and research activities in forestry.

viii) By establishing a plywood plant in the Sudan, technical progress in the industrial development of the wood processing sector would be assured. This would be especially felt in furniture production and in the building industry.

ix) The establishment and operation of a plywood plant would provide justification for infrastructure improvements and stimulate public investments (roads, electricity etc.).

x) Substantial financial returns could be expected from a well managed plywood plant, creating revenues in the form of stumpage, taxes, interest and profits. (e.g. £S 265,205 of profit before tax in the 8 year - see chapter 6.4).

But the establishment of a plywood plant in the Sudan is also a challenge. No false hopes should be raised by implying that this venture is going to be an easy task. Only able planning, efficient management, harmonious cooperation, and an earnest endeavour can bring the desired results.

7. FINDINGS AND RECOMMENDATIONS

7.1 Findings

The findings of this Feasibility Study can be summed up as follows:

i) There is in the Sudan a sufficient immediate market outlet for the output of a 5,000 m3 plywood plant, and once local production is started it can be safely assumed that demand will double in about five years.

ii) There are sufficient timber resources in the Southern Region for the establishment of several plywood plants of this capacity, using annually 11.100 m3 of peeler logs. These could be located in Wau, in the Imatong, and in Nzara.

iii) The recommended site for establishing the first plywood plant is Wau.

iv) The establishment of a 5.000 m3 plywood plant in Wau is technically and economically feasible.

v) Domestic plywood production would result in cutting the present plywood price in the Sudan by more than half and yet still be highly profitable and bring important social benefits and gains to the national economy.

7.2 Recommendations

In order to carry out successfully the proposed project, the following recommendations should be observed:

i) On hand of the Study the respective Authorities of the Sudan should:
   - consider, evaluate and confirm the viability of the proposed investment
   - make available the financial resources needed
   - entrust an Organization with further work aiming at establishing the plywood plant.

ii) For selecting and purchasing machinery and equipment the procedure should be followed as specified in the UNIDO paper issued under ID/WG 151/6 on 19 March 1973 "General selection guidelines for woodworking machinery". (A copy of the paper may be obtained on request from UNIDO, Vienna)

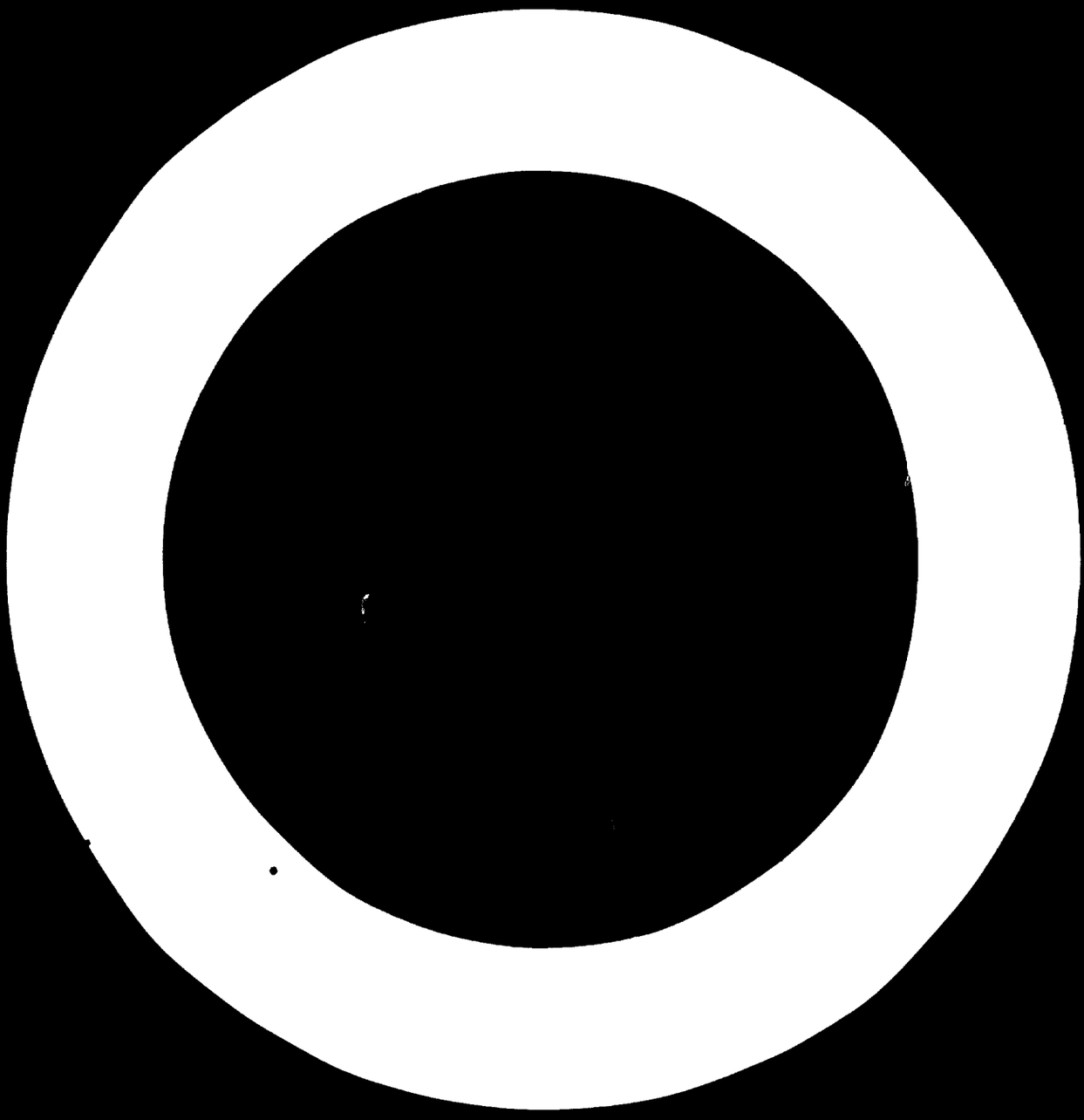
iii) In the frame of the Contract with the selected deliverer of machinery provisions should be included for sending two designated technicians to a running plywood mill of a similar capacity for a period of 3-6 months in order to get acquainted with the production flow as a whole, especially with running and maintaining the peeler, the dryer and the press.

iv) The development of infrastructure in the Wau region should receive high priority

v) A forest inventory and logging plan for the influx area of the plywood plant should be prepared without delay.

vi) In order to increase consumption of plywood at reasonable cost direct retailing should be organized by setting up marketing channels both in Wau and in Khartoum.

vii) In view to the promising prospects for sliced veneers consideration should be given to possibilities of extending the production facilities and programme in this respect.



ANNEX A

A/1. PLYWOOD IMPORTS

Imports of plywood into the Sudan are not negligible neither in quantity nor in value. For the last five years the official Foreign Trade Statistics give the following figures for plywood imports:

Year	Quantity in kg	Value in £S	Unit value in £S/t
1970	273,185	25,530	93,453
1971	1,688,852	171,485	101,539
1972	1,632,077	191,169	117,132
1973	2,791,189	253,974	90,991
1974	1,118,057	302,078	270,181
Average per annum	1,500,672	188,847	125,842

However, it should be noted that imports of plywood in 1974 cannot be regarded as normal in the second half of that year. In the first six months of 1974 plywood imports reached 827,058 kg and a corresponding value of £S 219,933. The considerable drop of imports in the second half of the year was caused not by lack of demand but by a temporary shortage of foreign exchange and the need to import items having higher priority like fuel.

Also the 1970 imports seem to be entirely abnormal and should therefore be excluded from the calculation of the average. Based on the more or less normal years 1971-1974 an annual import of plywood in the range of 1,800 t would seem to be a fair average.

The bulk of plywood imports comes from China and Romania, only small quantities are supplied by India, Japan, UK, France, Federal Republic of Germany, Italy, Bulgaria, Czechoslovakia and Ethiopia.

The average weight of these plywood imports is estimated to be 720 kg per m3 (i.e. 4.8 kg per sheet 4′x 6′x 3 mm). An average annual import of 1,800 t of plywood would therefore amount to 2,500 m3 per annum. This would be the present annual apparent consumption of plywood in the Sudan also in the opinion of plywood importers.

The standard size of imported plywood sheets is 4′x 6′x 3mm. Exceptionally also plywood sheets of other size and thickness are seen in the market (e.g. sheets 4′x 7′or 4′x 8′or sheets of 4 mm thickness).

As to quality, most of the imported plywood is of class BB and CC. Plywood imported from China is usually of poor quality; Romanian beech plywood sheets are much better and sold at up to a 30 percent higher price.

Annex A/2

A/2. PRICE OF PLYWOOD

All plywood is imported to the Sudan via Port Sudan.
The present wholesale price for a sheet of plywood in Khartoum is £S 2.60 per sheet of 4'x 6'x 3 mm ex warehouse or £S 390/m3.
The Carpenters Union - a cooperative society with 1,200 members in Khartoum also sells plywood sheets to its members at this price.

The consumer price charged by the retail dealer is at least £S 3.00 to 3.20 per sheet of plywood, but may go up as high as £S 3.75 per sheet or £S 480/m3 up to £S 550/m3.

In the South the consumer price is still much higher. In Juba where plywood is transported as air cargo from Khartoum at a cost of £S 57,60/m3 the consumer prices reach up to £S 850/m3.

When adding different taxes making a total of 55%, the transport cost to Khartoum of £S 30 per ton, the importers margin of 15% and the margins of the wholesaler and retail dealer each of 10 %, the calculated price should be about £S 250/m3 of plywood.

The actual exorbitant prices for plywood are possible because the present plywood imports are inadequate and do not meet the country's demand. All dealers of plywood agree that the market could absorb easily double the present consumption without any sales promotion effort.

A/3. PARTICLE BOARD AND HARDBOARD

There is a particle board factory in North Khartoum with an annual production capacity of 6,000 m3 on a three-shift basis, but the actual output is much lower. In 1974 the output was 2,200 m3 on a two-shift basis. The raw material used is Eucalyptus (50 %), and bagasse (50 %). The size of boards for 96 % of the output is 4'x 8'x 6 mm. The boards are of poor quality. The price of a board (4'x 8'x 6 mm) ex factory is £S 2.18, excise duty is £S 0.02 per sheet, the consumer price in Khartoum is £S 2.56 per board. Most (75 %) of these particle boards are used in construction for ceilings etc.; only about 25 percent goes into furniture production. In order to protect this home-based particle board production no imports of particle boards are allowed into the Sudan.

The import of hardboards (fibreboards) is restricted , but licences for import of hardboard are granted from time to time to the Carpenters'Union and to the May Corporation. The price of a hardboard sheet (4'x 6'x 3.2mm) in the market of Khartoum is £S 2.40.

A/4. IMPORTS AND PRODUCTION OF SAWNWOOD

About 50,000 m3 of coniferous sawn timber is imported annually into the Sudan, consisting of redwood (Pinus silvestris) from Sweden and the USSR and of white wood (Picea excelsa) from Austria and Romania in equal proportions. Sudan Building Material Company and Sudan Railways are the only importers. In 1974 the C&F price in Port Sudan was US $ 167 per m3 for white wood and US $ 250 per m3 for redwood. Customs duty and related items totalled 40% transport by truck to Khartoum costed £S 10-11 per m3. The importer adds a margin of 15 %, the wholesale and retail dealer each 10 %. According to this calculation the retail price should be £ 124 for white wood and £S 162 for redwood.

The actual consumer price in Khartoum is £S 162/m3 white wood and £S 252/m3 for redwood. This retail price seems to be also an inflated one.

About two thirds of the sawn timber are used in furniture manufacture and one third in construction, of which about 10,000 m3 of sawn timber are for shutterings.

Little is done to meet the country's sawn timber demand from its own forest resources. There are 14 sawmills operating in the Sudan, 9 of which are located in the southern Region. All sawmills are government owned and operated by the Forest Department. Their combined output representing some 7,000 m3 of sawn timber per annum consists almost exclusively of hardwoods. The bulk of this production are railway sleepers.

A/5. MARKET SURVEY IN EGYPT

Egypt has a plywood production capacity of 10,000 to 15,000 m3 per annum, but its output is very irregular because of fluctuations in the import of peeler logs. There are four plywood plants in Egypt (all of which are state owned), three belonging to the Egyptian Woodworking Co. and one to the Nile Match Co. About half of the raw material is imported from Europe (mainly poplar and beech), the other half of the raw material originates in African countries. There are also 2 veneer plants, the output in 1973 was 3,000 m3.

Information gathered from plywood importers seem to indicate annual plywood imports in the range of 30,000 to 40,000 m3.

Plywood is imported mostly from the USSR (birch), from Romania (beech) and from the Far East, mainly Taiwan and Korea (lauan).

The retail price of plywood sheets in Cairo is:

Country of origin	Dimension	Pt/sheet	Leg/m3
Italy	153x153cmx3mm	180	256
	x4mm	200	214
Finland	122x183cmx4mm	260	291
Lebanon	122x183cmx3mm	190	284

ANNEX B

RAW MATERIAL

B/1 Stumpage recommendations
B/2 Evaluation of timber resources
B/3 Forest inventory
B/4 Suitability of timber species

Annex B/1

B/1. STUMPAGE RECOMMENDATIONS

If the proposed plywood mill will operate - like the sawmills - in the organizational framework of the Forestry Department, the question of stumpage will not arise. But if it will represent a joint venture of the Ministry of Agriculture and the Ministry of Industry, even with a share of profit going to the Forestry Department, it is necessary to introduce stumpage as an element of cost into the calculation of cost for plywood. Besides that, a stumpage item would be needed, if the plywood industry were entirely separated from the Forestry Department as a private enterprise. Since up to now no stumpage fee has been fixed and levied for the forests of the Sudan, an attempt had to be made to determine a practical value for stumpage in this Feasibility Study.

As a basis for the computation of stumpage the actual cost of silvicultural operations in establishing and maintaining a plantation during the rotation period was taken.

The rotation period was put at 80 years.

According to records from Equatoria and Bahr-el-Ghazal provinces the present cost of silvicultural operations is estimated as follow:

Ground preparation initial	LS	3.50 per feddan
-"- -"- final	LS	2.50 per feddan
Nursery stock	LS	3.50 per feddan
Planting	LS	3.30 per feddan
Weeding	LS	4.00 per feddan
Firelining	LS	3.20 per feddan
T o t a l	LS	20.00 per feddan

Overheads are not likely to exceed 60 % of the direct cost, consequently the total cost of silvicultural operations amounts to £S 32 per feddan, or £S 80 per ha.

The mean annual increment of plantations (mostly teak) cannot be less than 1 m3 of logs per feddan, or 2.5 m3 per ha. Based on this safe asumption, the average stumpage for logs would be

$$\frac{80}{2.5 \text{ m3} \times 80 \text{ years}} = \text{£S } 0{,}40 \text{ per m3}$$

It is now assumed:

- that the stumpage for peeler logs should be twice that of saw logs

- that the occurrence of peeler logs is on the average half of that of saw logs.

Under these two assumptions the stumpage for saw logs is £S 0.30 per m3 and for peeler logs £S 0.60 m3, since 1/3 m3 x 0.60 £S + 2/3 m3 x 0.30 £S = 0.40 £S/m3.

The stumpage paid for the production of 1 m3 plywood will be accordingly £S 1.33 per m3 plywood(i.e. 2.22 m3 logs x £S 0.60/m3).

ANNEX B/2

B/2. EVALUATION OF TIMBER RESOURCES

After elimination Loka-Nuni area (see Chapter 3,4) three possible sites with timber resources warranting the establishment of a plywood mill have been further identified and evaluated, namely

1. Katire in the Imatong Mountains
2. Nzara near the Zaire border
3. Wau, capital of Bahr-el-Ghazal Province

1. Imatong Mountains

The volume of peeler logs is estimated as follows:

Imatong Forest Reserve, total area	115,000 ha
" " " forest land	100,000 ha
Montane production forest	60,000 ha
Foothill production forest	15,000 ha
Annual felling area for 30 years	2,500 ha

	montane forest	foothill forest	Total
Volume of saw logs, m3/ha	25	18	
Species suitable for plywood	80 %	75 %	
Cutturn of peeler logs	20 %	67 %	
Annual felling, saw logs	42,000	4,500	46,500
peeler logs	8,000	4,500	12,500

Logging cost for peeler logs at the sawmill yard in Katire is calculated as follows:

	KS/m3
stumpage for peeler logs	0.60
felling and crosscutting, output 0.4 m3 per man-day, daily wages 30 Pt	0.75

skidding, 300 m, KS 5 per hour, output 2 m3 per hour	2.50
hauling, 30 km, Pt 18 per m3 and km	5.40
road construction, 8 m of hauling roads per ha, KS 1200 per km incl.maintenance	1.92
increased cost of saw log hauling, 30 instead of 15 km, 30 % saw logs, (2.70 : 2.33=)	1.16
Total cost of peeler log at factory yard	12.33

This cost may be regarded as a favourable one from the financial viewpoint, but from the silvicultural viewpoint the situation is less satisfactory. The main drawback is that the saw log volume remains for the greatest part unutilized in the forest, consequently the exploitation of the forest cannot be followed by subsequent conversion of the natural forest into plantations. It should be noted that there are coniferous plantations (Cupressus lusitanica and some pine species) in the Imatongs which do extremely well, and large-scale planting of fast-growing coniferous species at short rotations should be the aim of forestry operations in the Imatongs.

This would, of course, require a very large increase of the existing sawmilling capacity. Since the Katire sawmill could process even in its present state without any reconstruction all incoming saw logs from the foothill forest, it would be necessary to install at Itibol and preferably at two or three other sites in the montane forest a number of sawmills with a total intake capacity of 42 000 m3 of roundwood. Such an increase of the sawmilling capacity would allow, together with large-scale

charcoal production, and perhaps even with a chipboard plant, the complete utilization of the natural forest and its subsequent conversion to softwood plantations.

2. Nzara area

The influx area of the plywood mill would comprise a rectangle of (30 + 10) x (50 + 50) km, representing a surface of 4,000 square km/see map/

Assuming a 50 % forest cover the forest land is	200,000 ha
of this being gallery forests (mainly Khaya grandiofolia)	10,000 hs
savanna forests (mainly Chlorophora and Terminalia)	190,000 ha
Distributed over 30 years, the annual felling area is	6,666 ha

The volume of peeler logs is estimated as follows:

	gallery forest	savanna forest	Total
peeler log volume, m3/ha	15	1.2	
" " " per annum,m3	5,000	7,600	12,600)
30 % saw log volume in trees felled for peeler logs	2,143	3,257	5,400
Total fellings	7,143	10,857	18,000

Thus, fellings for the plywood mill would supply, at the same time, also saw logs for the sawmill in Nzara.

Cost involved in supplying peeler logs in the Nzara area is estimated as follows:

	£S/m3
stumpage for peeler logs	0.60
felling and crosscutting,output 0.5 m3 per man-day, daily wages Pt 30	0.60

skidding, 500 m, ℒS 6 per hour, output 3 m3 per hour	2.00
hauling 40 km, Pt 18 per m3 and hour	7.20
road construction, road density 5 m/ha, ℒS 800 per km incl. maintenance	2.12
increased cost of saw log hauling 40 instead of 10 km, 30 % sawlogs (5.40 : 2.33 =)	2.32
Total cost of peeler logs at factory yard	14.84

This would be, from the financial viewpoint, an acceptable result, but it should be borne in mind that the exploitation of the natural forest is unsatisfactory, since only the cream of timber resources is utilized and no silvicultural improvement is achieved. This situation could be remedied by a substantial increase of the sawmilling capacity at Nzara which would allow, at least partially, the full utilization of existing timber resources, both for plywood and sawnwood production, and the subsequent conversion of the natural forest to teak plantations, or, even better, to plantations of fast growing softwood species.

3. Wau-Raga area

The forest area between Wau and Raga was photographed and evaluated by the Inventory Section of the Forestry Department in 1963. As a result a map is ℒ available showing the Vuba belt and savanna rich in large-crowned trees.

In the Vuba belt there were 20.5 trees per ha with a volume of 8.66 m3 per ha, corresponding to an average tree volume of 0.43 m3 which would seem to be of sufficient size for

containing peeler logs of a diameter of around 35 cm.

In the savanna there were on a surface of 320 square km 240,000 mahogany trees with a volume of 40,000 m3, or 1.67 m3/tree

14,000 Afzelia trees with a volume of 30,000 m3 or 2.01 m3/tree

3,000 Daniella trees with a volume of 6,000 m3, or 2.00 m3/tree.

This amounts to an average stocking of 2.4 m3 per ha.

An aerial reconnaiasance which had been untertaken with a survey plane revealed that there were more than tree timea as much Vuba and mahogany.Afzelia africana and Daniella oliveri in the areas south of Deim Zubeir and east of the area investigated. Theae areaa have been photographed at the end of January 1963. The atatement was made then by M.S.S.Gassouma, Foreat Inventory Officer.

However Gassouma's report was questioned by a committee which visited the area in December 1963, reporting: "It cannot be aasumed (indeed the visit showed the contrary) that sufficiant merchantable timber can be found where the photos reveal "dense" forest.

Not much more is known about this forest since that time. But it is a fact there are 5 sawmills established in the area to the north and weat of Wau with an important sawmilling capacity, as has been already indicated. In the opinion of the Conservator of Forests in Wau, Mr, Baipath, the supply of logs for all these sawmills is wellsestablished for the future, and could be even increased, though it may be ne-

cessary to transfer one or two sawmills to other sites nearer to the timber resources in the near future. Furthermore, it is urgently required to build a bridge across the Bousseri river, replacing the ferry operating there now, in order to start timber exploitation also to the south of the river.

With regard to this situation, the best solution for starting plywood production in Bahr-el-Ghazal Province seems to be to increase sawmilling to the full capacity of the existing sawmills in Wau, Besselia, Pongo Nuer, Pongo Aweil and Matiang and to add an extra 43 % to the felling volume for supplying peeler logs to the plywood plant, assuming a 30 % outturn of peeler logs from the volume of felled timber. The plywood mill would be situated in this case in the centre of the area for the delivery of peeler logs which lies practically in Wau itself.

Consequently, the timber supply for the plywood mill could be best provided in this manner:

	Thousend of cubic meters			
Sawmill	Peeler logs 30 %	Saw logs 70 %	Total fellings 100 %	Distance in from Wau
Wau	4,3	10,0	14,3	-
Besseliea	1,1	2,5	3,6	35
Pongo Nuer	2,4	5,5	7,9	85
Pongo Aweil	2,3	5,5	7,8	90
Matiang	2,3	5,5	7,8	150
T o t a l	12,4	29,0	41,4	

Accordingly, fellings in the range of 41,400 m3 per annum could provide 29,000 m3 of saw logs for the existing five sawmills and, at the same time, around 12,400 m3 of peeler logs for the plywood mill.

The transportation of peeler logs to the site of the plywood mill in Wau would be done from the sawmills in Besselia and Pongo Nuer by lorries on the Raga road, and by train from the sawmills Pongo Aweil, which is only 8 km from Mundit railway station, and Mattiang, which is next to the railway station in Aweil. The cost of transportation would be:

To Wau from	Volume	Distance	Unit cost	LS per annum
Besselia	1,100 m3	35 km	Pt 7.5/m3/km	2,888
Pongo Nuer	2,400 m3	85 km	Pt 7.5/m3/km	15,300
Pongo Aweil	2,300 m3	8 km	Pt 7.5/m3/km	
		90 km	LS 1.57/m3	4,991
Mat-iang	2,300 m3	150 km	LS 1.87/m3	4,301
Wau	4,300 m3			
Loading and unloading	12,400 m3		Pt 25/m3	3,100
				30,580

or LS 2.47 per m3 of peeler log.

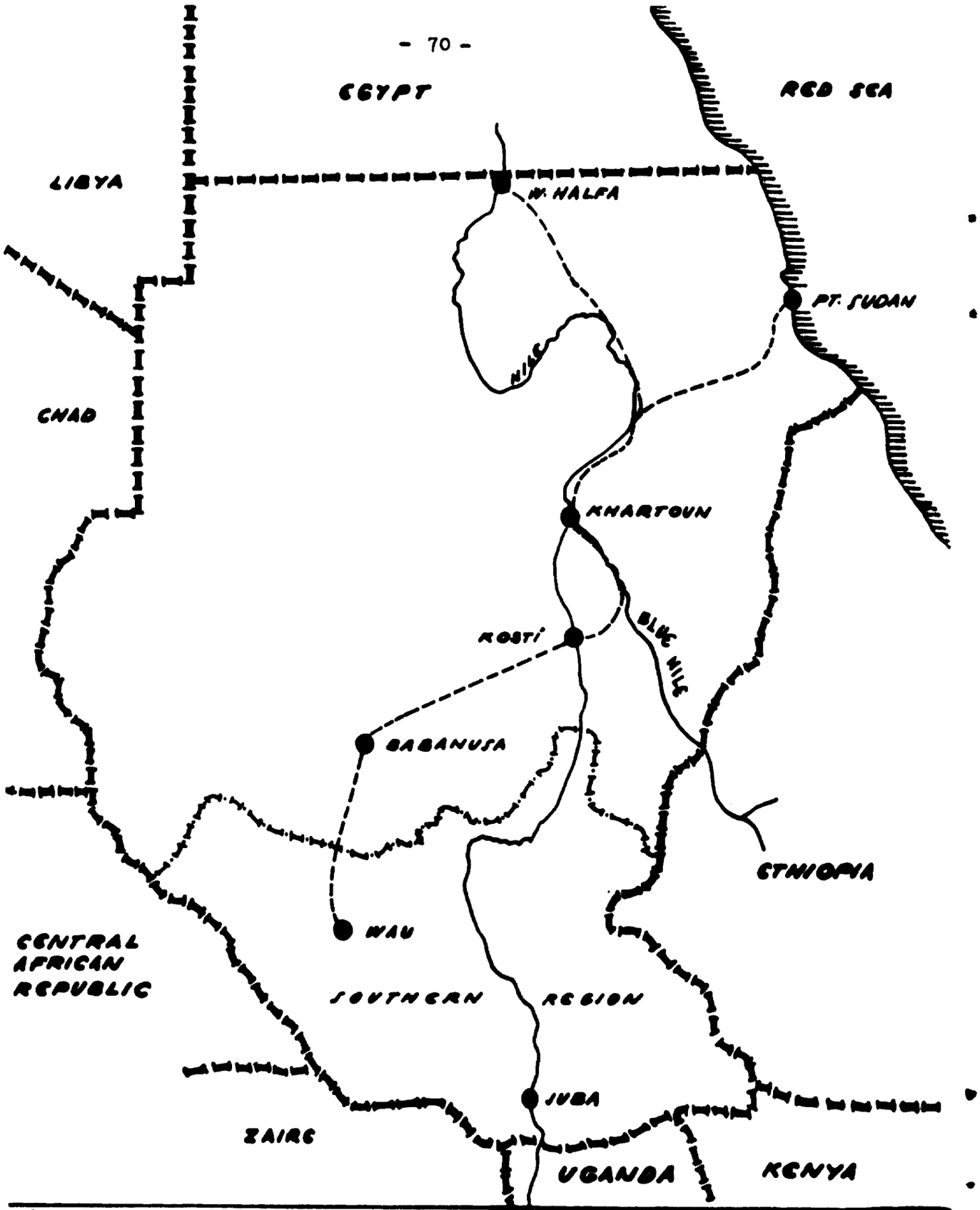
It is estimated that fellings in the order of 41,400 m3 of logs per annum could be made for at least 30 years along a 60 km wide strip stretching 180 km to the north of Wau along the road and railway to Aweil, and 115 km to the west of Wau along the road to Raga, i.e. 30 km behind Matiang and Pongo Nuer.

The maximum distance of log transport from the two mentioned strips to the five sawmill sites would practically not exceed 50 km and the average distance would be around 30 km (see map).

Estimated forest land:	600,000 ha
Annual felling area over 30 years	20,000 ha
Average log volume	2 m3/ha
Annual fellings - saw logs	28,000 m3
- peeler logs	12,000 m3
Total fellings	40,000 m3

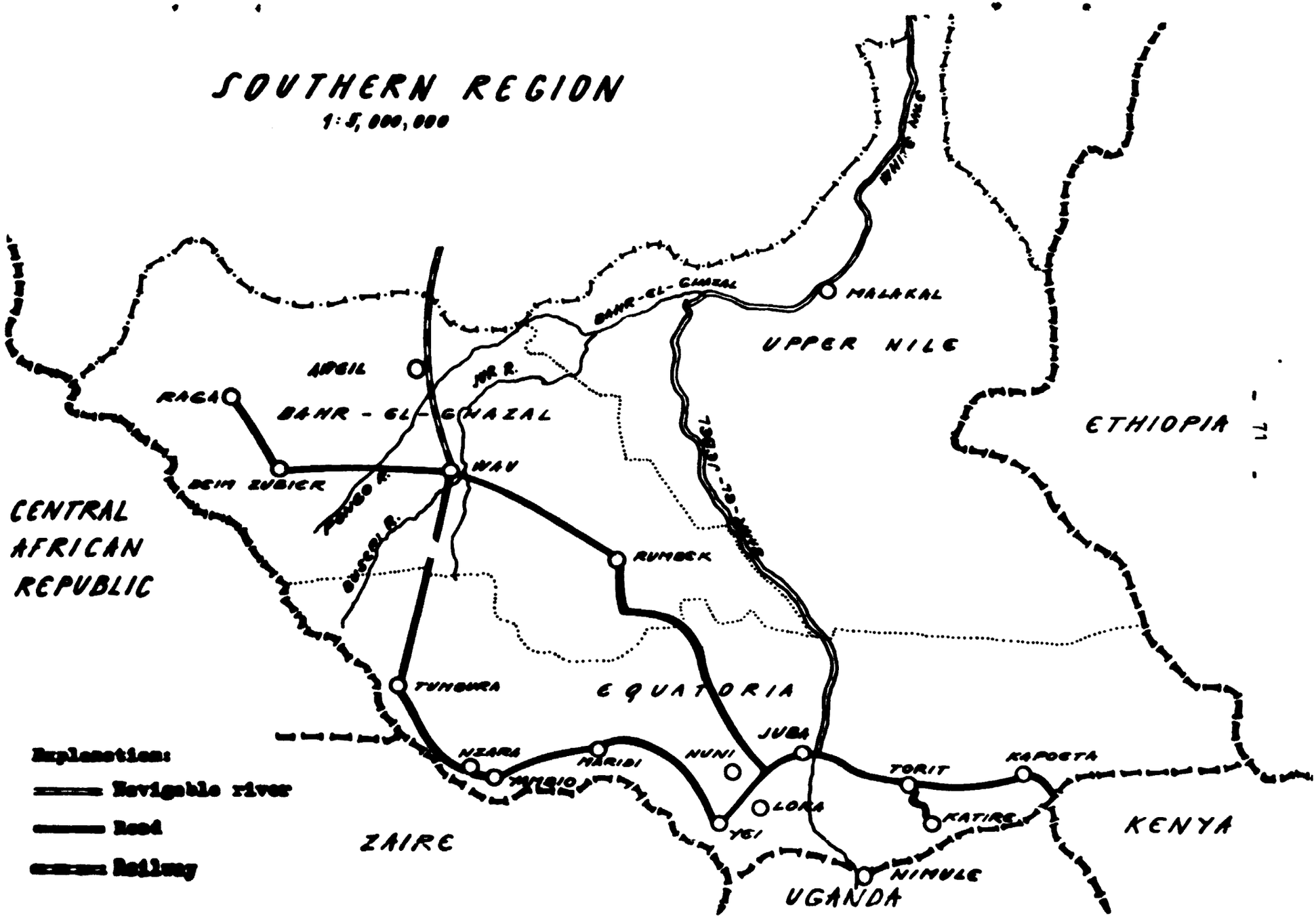
Estimated cost of peeler logs at factory yard:	LS/m3
stumpage for peeler logs	0.60
felling and crosscutting (piece work)	0.53
skidding, 500 m, LS 1.50 per hour, output 2 m3 per hour	0.75
hauling, 30 km, Pt 18 per m3 and km	5.40
road construction, road density 5 m per ha, LS 400 per km, including maintenance	1.00
delivery from sawmills to plywood mill in Wau	2.47
Total cost of peeler log at factory yard	10.75

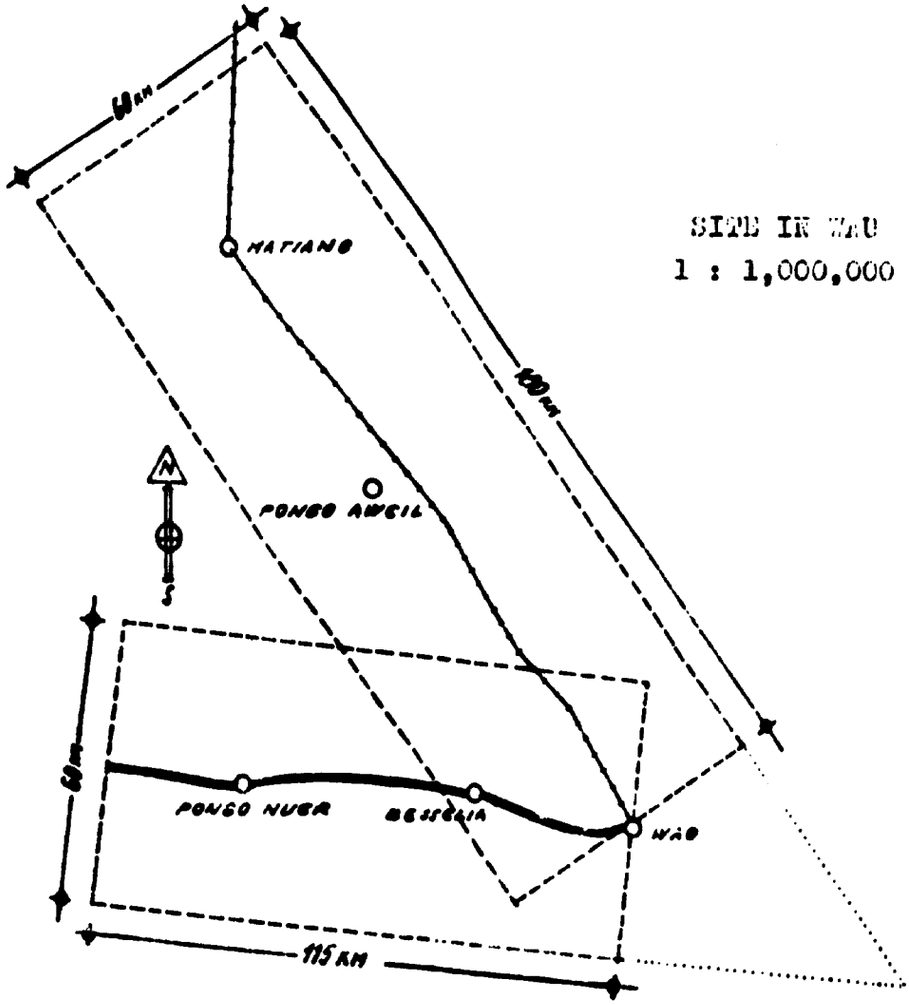
This may be regarded as a very satisfactory result from the economic viewpoint, caused by the integration of the plywood plant with existing sawmilling capacities. But what is still more important from the viewpoint of feasibility is the bright outlook for longstanding utilization of the vast timber resources which lie to the west of the two mentioned strips and especially in the Kuru - Deim Zubeir - Raga area and behind it to the south up to the border of the Central African Republic.



THE SUDAN

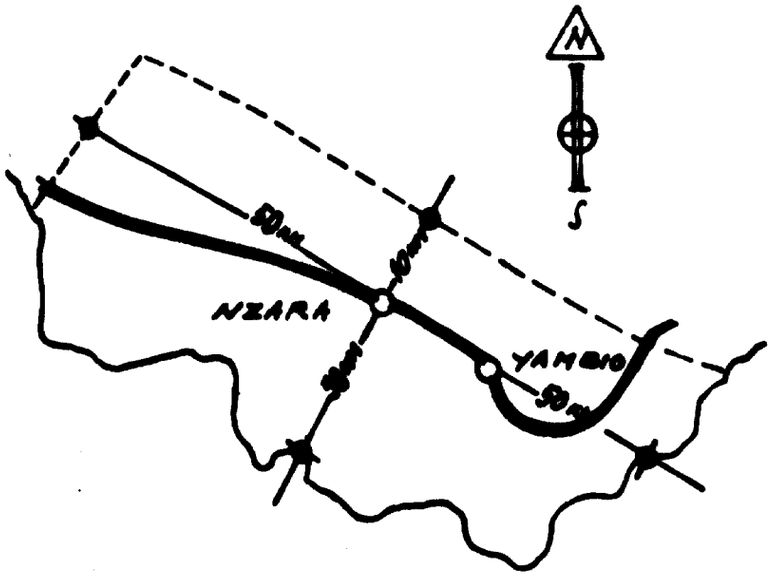
1: 10,000,000


SOUTHERN REGION
1:5,000,000
MALAKAL
UPPER NILE
BAHR-EL-GHAZAL
ABOIL
RAGA
WAU
BEMI ZUBIER
CENTRAL AFRICAN REPUBLIC
RUMBEK
ETHIOPIA
TUNGURA
EQUATORIA
JUBA
NZARA
NARIDI
NUNI
TORIT
KAPOETA
YEI
LOKA
KATIRE
KENYA
ZAIRE
NIMULE
UGANDA
Explanation:
Navigable river
Road
Railway



SITE IN WAU
1 : 1,000,000

SITE IN NZARA
1 : 1,000,000



ANNEX B/3

B/3. FOREST INVENTORY

In preparation of the forest inventory a serial survey should be carried out without delay.

The aerial survey should comprise about 17,000 square km of land on both sides along the road from Wau to Aweil and 30 km behind Aweil, and along the road from Wau to Pongo Nuer and 30 km behind Pongo Nuer. The width of the strip photographed should be 60 km.

The scale of the photographs taken should be 1 : 30,000, this would enable the drawing of maps in the scale of 1 : 25,000. Longitudinal overlapping should be 60 %, transversal overlapping 30 %.

The size of the photographs taken should be 18 x 18 cm, or 23 x 23 cm. For the 18 x 18 cm size a camera with a 200 mm focal length, for the 23 x 23 cm size a camera with a 150 mm focal distance should be used.

In order to facilitate identification of tree species from aerial photographs spectro-zonal photographic material should be used, if available. Otherwise black and white photographs would do.

The Forest Inventory Project could be carried out either as part of the multinational aid programme for the Sudan, or on a bilateral basis. This forest inventory should prepare forest maps of the respective areas, determine stocking, tree species representation, volume and annual yield, and plan the outlay of a network of forest roads.

The project should cover an estimated surface of 400,000 hs of forest land in Bahr-el-Ghazal province around Wau, Besselia, Pongo Nuer, Pongo Aweil and Matiang, and prepare a logging plan for 10 years. Besides that, assistance should be given in the testing of interesting tree species as to their suitability for the production of plywood and sliced veneer. The staff of the project should consist of

	Assighment	
	Project Area	Khartoum
1 Project Manager and Forest Management Expert	12 months	5 months
1 Inventory Officer	12 months	3 months
3 Field Inventory Assistant Officers	each 12 months 36 months	3 months
1 Consultant for Photogrammetry	6 months	1 month
1 Consultant for road network and logging	4 months	2 months
T o t a l	70 months	14 months

Sudanese staff provided by Sudanese Government should include at least 7 counterparts, 4 forest rangers, 4 forest guards, 12 drivers and assistant drivers, 32 unskilled labourers.

Sampling on 0.5 % of the forest land should be carried out.

Equipment required: 1 survey plane for 30 days, 4 landrovers and 2 light lorries, radio transmission and receiving equipment, camping equipment, calculators and typewriters.
Estimated total cost: US $ 450,000.
Financing could be from bilateral or multilateral sources.

ANNEX B/4

B/4. SUITABILITY OF TIMBER SPECIES

The more important tree species occourring around the possible sites of the plywood mill have been already tested as to their suitability for plywood production by M.Tag Eldin Hussein Nasroun from the Soba Research and Education Institute in 1974 with the following results:

Botanical name	Local trade name	African Timbers(16) suitable	not tested
Suitable:			
Acacia aleberana		x	
Albizzia aylmeri	Sereira	x	
Albizzia lebbeck		x	
Albizzia zygia	Albizzia sohaul	x	
Boswellia papyrifera	Gafal	x	
Ceiba pentandra		x	
Chlorophore excelsa		x	
Cordia africana	Inderab	x	
Cupressus lusitanica		x	
Daniella oliveri	Bu	x	
Eucalyptus camaldulensis		x	
Eucalyptus tereticornis		x	
Isoberlinia doka	Vuba		x
Khaya grandifolia	Mahogany tari	x	
Khaya senegalensis	Mahogany adi	x	
Mitragyna stipulosa	Mitragyna	x	
Olea hochstetteri	Zaytun	x	
Podocarpus milanjianus	Podo	x	
Pseudocedela kotschyi	Duruba	x	
Sclerocarya birrea	Homoid	x	
Syzgium guineense	Kuji	x	

Tectona grandis	Teak	x	
Terminalia ssp.	Derut	x	
Terminalia superba		x	
Could be used:			
Acacia albida	Haraz		x
Afzelia africana	Pai	x	

Further testing of prospective tree species could be carried out at the Soba Research and Education Institute and at the match factory in Khartoum.

Besides that, the following 10 tree species have been tested at the Federal Forest Research Institute in Reinbeck (Federal Republic of Germany):Cordia africana, Afzelia africana, Burkea africana, Prosopis africana, all excellent in technological qualities, and Terminalia glaucescens, Acacia polyacantha, Acacia sieberiana, Albizzia ayloneri, Albizzia zygia, Vitex doniana (11).

Five species have been tested also in Czechoslovakia in 1973 as a preparatory stage for this Polytechna-UNIDO contract (Pseudocedrela Kotschi, Cordia africana, Vuba isoberlinia, Boswellia papyrifera, and Khaya senegalensis), giving likewise positive results.

ANNEX C

TRANSPORT

C/1 Distances and freight rates
C/2 Transport costs

Annex C/1

C/1. DISTANCES AND FREIGHT RATES

Distances involved are

a/ by road

Katire - Juba	180 km
Nzara - Juba	522 km
Nzara - Wau	477 km
Juba - Wau	846 km
Juba - Mombass	1.638 km

These distances are quoted from Michelin's map of North-East - Africa, N° 154, it being borne in mind that according to Michelin in Africa distances rarely can be given with absolute accuracy,

b/ by rail

Wau - Khartoum	1.498 km
Wau - Port Sudan	2.285 km
Wau - Wadi Halfa	2.407 km
Khartoum - Port Sudan	787 km
Khartoum - Wadi Halfa	909 km
Khartoum - Kosti	383 km

The distances are taken from the Transport Statistical Bulletin 1974, p.20.

c/ on the Nile

Juba - Kosti	1.436 km
Juba - Khartoum	1.660 km

These distances are quoted from the Transport Statistical Bulletin 1974, for the Kost-Khartoum section road distance according to the Michelin map being added.

The freight rates (in LS/m3) are at present as follows:

a/ by road	for logs	for plywood
from Katire to Juba	11.48	8.27
from Nzara to Juba	23.49	16.91
from Nzara to Wau	21.47	15.46
from Juba to Wau	-	27.41
from Juba to Mombase	-	28.80

These rates are calculated according to the official tariff established by the Commissioner in Equatoria province (Pt 7 per ton/mile) and in Bahr-el-Ghazal province (Pt 12 per ton/mile), for transportation of goods on main roads. For the transportation from Katire to Juba this rate applies only as far as Torit (135 km from Juba); for the road from Katire to Torit (45 km) the maintenance of which is the responsibility of the Forestry Department, the rate of Pt 12 per ton/km was applied. The road connection from Nzara to Wau cannot be used economically at the present conditions because the existing ferry on the Bousseri river offers slow service and a low weight limitation. Freight rate to Mombasa is given according to charges for transport made by Interfreight (Kenya) Ltd.

b/ by rail	for logs	for plywood
from Wau to Khartoum	14.168	10.519
from Wau to Port Sudan	-	15.127
from Wau to Wadi Halfa	-	16.855
from Khartoum to Port Sudan	-	5.551
from Khartoum to Wadi Halfa	-	7.279
from Kosti to Khartoum	4.728	-

The freight rates quoted above are valid since 1 July 1975. They are based on the assumption that 30 m3 of plywood (21.6 ton) or 20 m3 of logs (16 ton) could be loaded on a 30 ton waggon.

c/ on the Nile (For a full barge 100 ton or 500 ton both for logs and plywood)

	in £S/ton
from Juba to Kosti	17.100
from Juba to Khartoum	21.700

The River transport Corporation is authorized to transport goods only to and from Kosti. Direct transport on the Nile to or from Khartoum requires special authorization by Sudan Railways.

The loading space of a 500 tons barge is 500 m3. It is estimated that on such a barge 333 m3 of logs or 500 m3 of plywood could be loaded. Transportation cost in £S/m3 would therefore be:

	for logs £S/m3	for plywood £S/m3
from Juba to Kosti	25.676	17.100
from Juba to Khartoum	32.583	21.700

in US $/m3

d/ by sea

For plywood	from Port Sudan		from Mombasa	
to Jedda	26.33	/19.50/	31.73	/23.50/
to Alexandria	48.26	/35.75/	53.33	/39.50/
to Hamburg	82.62	/61.20/	88.16	/65.30/

These freight rates apply for 1 t or 1 m3 whichever is more (weight for volume basis) and include the Suez surcharge (2.5 %), bunker surcharge (8.5 %), the currency adjustment factor (10 %) levied on the basic rates and surcharges, and finally, the congestion surcharge which varies from port

to port. The basic rate is given in parenthesis.

	in US $/ton or m3	
<u>for machinery</u>	to Port Sudan	to Mombasa
from Hamburg	144.94	170.94

The basic freight rate is US $ 118.70 to Port Sudan and US $ 140 to Mombasa. To it are added 2.5% Suez surchage , 8.5 % bunker surchage, and finally on the total the 10 % currency adjustment factor. The freight rate includes loading and unloading costs. A heavy lift charge of US $ 25.90 is made for every piece exceeding 6 tons, for pieces over 15 tons weight the charge is US $ 73.20 + US $ 3.50 per each additional ton or a part thereof. The freight rate applies to 1 t or 1 m3 whichever is more.

Installed crane lifting capacity in Port Sudan is 15 tons, heavier pieces can only be unloaded by ship's crane.

For the export of plywood to Egypt there is theoretically an alternative way of transportation from Wadi Halfa on the Nile to Assuan and from there eventually by train to Cairo. The freight rate on the Nile from Wadi Hlafa to Assuan charged by the Nile Navigation Company is £S 5/ton. But there are not facilities at Wadi Halfa, no port, no arrangement for the handling of goods, consequently no commodities pass on this transportation line in either direction. For the time being, this transport system would require a vividly uneconomic amount of unloading and reloading from train to steamer and from steamer to train and must consequently be ruled out until facilities in Wadi Halfa improve.

Handling charges for plywood in Port Sudan would be £S 1/ton (Pt60/ton for unloading from railway and stacking, Pt 25/ton

for loading on boat, Pt 15/ton miscellanous). Handling charges in Mombasa should be about the same. For machinery handling charges would amount to £S 2/ton, for heavy items up to £S 3/ton.

The handling charges on the Nile and railway for logs or plywood, including loading and unloading, would be about Pt 40/m3.

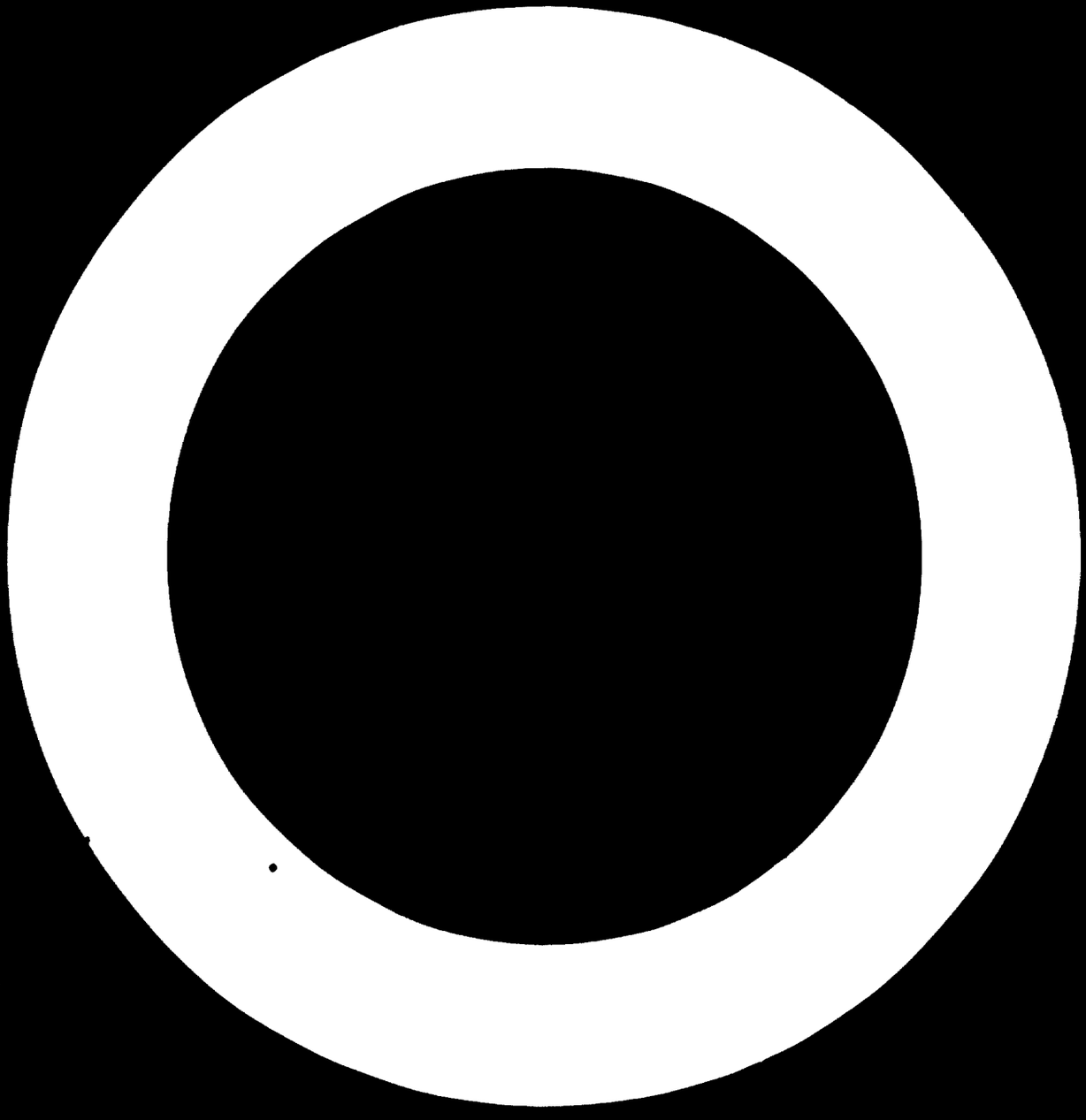
Annex C/2

C/2. TRANSPORT COSTS

The cost of logs at factory yard and final transport costs for each site are given in the following calculation:

	Cost in £S per m3				
	Katire	Nzara	Wau	Juba	Khartoum
Logging cost	14.80	17.80	12.90	14.80	12.90
Transport of logs	-	-	-	11.48	14.17
Cost of logs at factory yard	14.80	17.80	12.90	26.28	27.07
Cost of logs per m3 of plywood	32.86	39.52	28.64	58.34	60.10
Transport of plywood					
To South	8.67 1/	17.31 4/	- 7/	- 9/	1.09 11/
To Khartoum	19.89 2/	19.89 5/	7.64 8/	19.89 10/	-
To Port Sudan	1.19 3/	1.19 6/	3.11	1.19	1.19 12/
Final cost of site	62.61	77.91	39.39	79.42	62.38

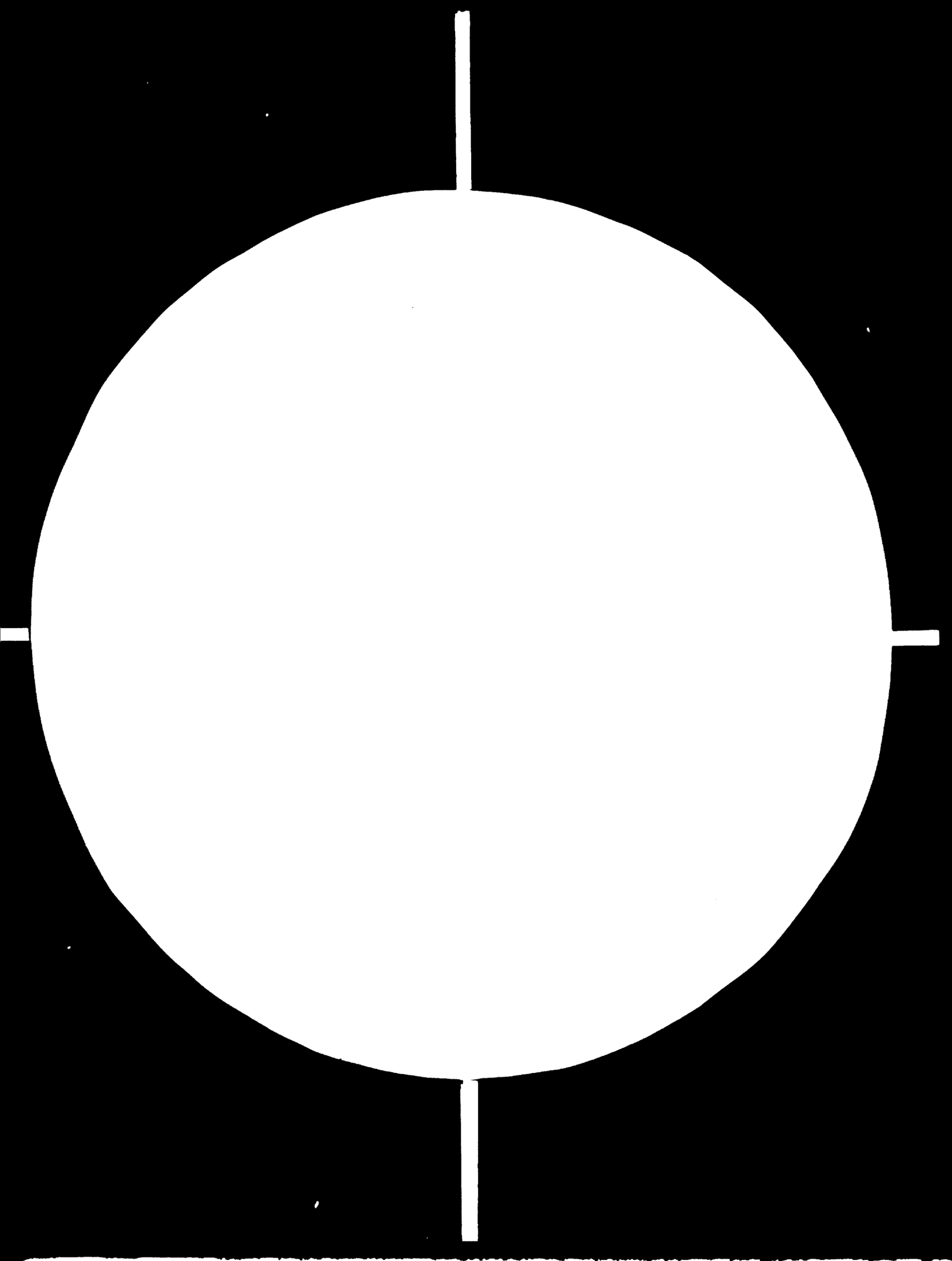
	£S/m3		£S/m3
1/ Katire-Juba	8.27	7/ Wau-Khartoum	10.52
Handling	0.40	Handling	0.40
Total	8.67	Total	10.92
Cost share 100%	8.67	Cost share 70%	7.64
2/ Juba-Khartoum	21.70	8/ Wau-Port Sudan	15.13
Handling	0.40	Handling	0.40
Total	22.10	Total	15.53
Cost share 90%	19,89	Cost share 20%	3.11
3/ Khartoum-Port S.	5.55	9/ Juba-Khartoum	21.70
Handling	0.40	Handling	0.40
Total	5.95	Total	22.10
Cost share 20%	1.19	Cost share 90%	19.89
4/ Nzara-Juba	16.91	10/ Khartoum-Port S.	5.55
Handling	0.40	Handling	0.40
Total	17.31	Total	5.95
Cost share 100%	17.31	Cost share 20%	1.19
5/ Juba-Khartoum	21.70	11/ Khartoum-Wau	10.52
Handling	0.40	Handling	0.40
Total	22.10	Total	10.92
Cost share 90%	19.89	Cost share 10%	1.09
6/ Khartoum-Port S.	5.55	12/ Khartoum-Port S.	5.55
Handling	0.40	Handling	0.40
Total	5.95	Total	5.95
Cost share 20%	1.19	Cost share 20%	1.19

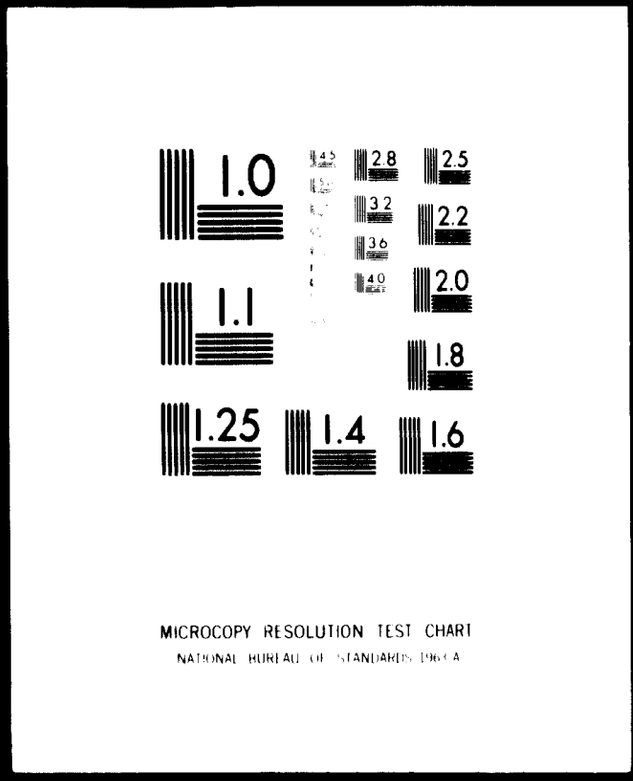


We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

G-332

77.09.26





D/1. CONSUMPTION FIGURES

Consumption figures are listed for:

- raw material
- glue
- heat
- electricity
- water
- man power

i) Raw material

Tree species and dimensions of logs to be processed are specified in Chapter 5.3. The following table shows the recovery and waste figures for individual manufacturing operations. The table represents the basic information for calculating the capacities of machinery and equipment, as well as the consumption figures.

Raw material consumption

Operation	Recovery		Losses and waste		
	%	m3	specification	%	m3
Delivered logs	100	11.100	-	-	-
Crosscutting	94,0	10.443	offcutts	6,0	666,0
	93,0	10.332	sawdust	1,0	111,0
Peeler logs	93,0	10.332	-	7,0	777,0
Peeling	79,0	8.777	wet veneer waste	14,0	1554,0
Clipping	65,0	7.221	wet veneer waste	14,0	1554,0
Wet veneers	65,0	7.221	-	35,0	3889,0
Drying veneers	59,0	6.555	losses in volume	6,0	667,0
Dried veneers	59,0	6.555	-	41,0	4555,0
Splicing	57,0	6.333	veneer waste	2,0	222,0
Veneers for pressing	57,0	6.333	-	43,0	4777,0
Pressing	52,0	5.777	losses in volume	5,0	556,0
Unsized plywood	52,0	5.777	-	48,0	5333,0
Sizing plywood panels	58,5	5.388	offcutts	3,5	389,0
Sized plywood	48,5	5.388	-	51,5	5722,0
Sanding	45,0	5.000	dust	3,5	388,0
Finished plywood	45,0	5.000	-	55,0	6110,0

ii) Glue

Spreading veneers

The amount of glue mixture to be spread 0,15 kg/m2

The surface of veneers for interior plywood to be spread:

Plywood (interior) final size	Veneer sheets mm	Surface to be spread m2/panel	Amount of glue mixture kg/panel
4′x 6′x 3 mm	1,2+1,2+1,2	4,94	0,741
4′x 8′x 3 mm	1,2+1,2+1,2	6,50	0,975
4′x 8 x 4 mm	1,2+2+1,2	6,50	0,975
4′x 8′x 6 mm	1,2+4+1,2	6,50	0,975

Plywood (interior)	Number of panels/year	Amount of glue kg/year
4′x 6′x 3 mm	223,955	165,9
4′x 8′ x 3 mm	111,977	109,1
4′x 8′x 4 mm	83,983	81,8
4′x 8′x 6 mm	27,994	27,2
		384,0 kg

Assuming 5 % losses in preparation and spreading of glue the total amount will be 384,0 t+19,0t= 403,0 t/year

The glue mixture will consist of:

Urea Formaldehyde glue (65% dry content)	56,4%	227,0	t/year
Technical flour	16,0%	6466	-"-
Water	23,6%	95,0	-"-
Hardener in 13% solution	4,0%	16,4	-"-
Total	100%0%	403,0	t/year

For technical and commercial reasons it is recommended to deliver Urea-Formaldehyde glue in powder form i.e.
227,0 t x 0,65 = 147,7 t

The calculated mean consumption
of glue mixture 80,6 kg/m3 of plywood
of glue powder 27,4 kg/m3 of plywood

Splicing veneers

From the yearly amount of 6.555 m3 dried veneers about 20% are supposed to be spliced i.e. 1.310m3/year. At a mean thickness of 1,5 mm the veneers to be spliced would amount to 873.300 m2/year. At a calculated consumption of 0,004 kg UF glue per m2 the required quantity of glue would be:
3,5 t/year (at 65 % dry content) or
2,3 t/year in powder form

Exterior plywood

For manufacturing water and boil proof plywood (WBP) phenolic glueing foils of the type TEGOFILM are proposed.

According to envisaged manufacturing program /chapter 5,1) 1000 m3 of this quality of plywood at a thickness of 15 mm are to be produced. Supposing seven veneers for a plywood panel (1,2 -2,0 -3,0 -3,0 -3,0 -2,0 -1,2 mm) six sheets of phenolic foil will be needed.

The yearly requirement:
1000 m3 x 2 x 2,9 m2 x 6 = 382.800 m2

For economic calculations an amount of 400.000 m2 of phenolic foil per year is taken into account.

iii) Heat

Steaming of logs

A specific heat requirement is assumed of 0,13 Gcal/m3 of logs
The annual consumption: 11.100m3 x 0,13...1,443 Gcal
Assuming losses of 15 % the total heat consumption will be:
1,588 Gcal/year

Drying veneers

For the type of proposed dryer a heat consumption of 1500 kcal for 1 kg of evaporated water is assumed.

The yearly amount of wet veneers being	7.221 m3
the water to be evaporated amounts to	3.607 tons
which requires a heat amount of	5.410 Gcal/year
resp. with calculated losses	5.951 Gcal/year

Pressing plywood

Heat requirements for two 8-daylight presses are estimated to	0,35 Gcal/h
The presses are operating two shifts i.e. 4.400 h x 0,35 Gcal	1.540 Gcal/year
including losses	1.694 Gcal/year

The consumption of heat for the boiler being calculated to 10 %, the total heat requirements are as follows:

Operation	Heat requirements		Steam requirements	
	Gcal/year	Gcal/h	t/year	t/h
Steaming of logs	1.588	0,25	2.941	0,45
Drying veneers	5.951	1,33	11.022	2,50
Pressing plywood	1.694	0,39	3.137	0,71
Boiler house	923	0,14	1.710	0,26
T o t a l	10.156	2,11	18.810	3,92

Specific heat consumption for 1 m3 of plywood 2,03 Gcal.
For production of steam an automatic boiler is to be provided for an output of 5,0 t steam at 12 kg/cm2 per hour (2,6 Gcal/h).

Requirement for chemically treated water	6.000 m3/year
for cooling water	11.000 m3/year
for fuel (wood waste)	23,5 t/shift

iv) Electricity

The total installed load in the plywood plant	774 kW
Number of working days (2 shifts)	275
Number of working hours per year	4.400
Load factor	0,55
Maximum for calculation	426 kW
Yearly utilization rate of maximum	1.400 hours
Yearly consumption 426,0 kW x 1400 h =	596 MWh
Mean consumption of electric energy for 1 m3 of plywood mill amount to:	120 kWh

v) Water

On hand of industrial experience the water requirements are estimated for:

- replacement of evaporation losses in steaming pits	2.300 m3/year
- cleaning of pits (once a week)	4.200 m3/year
- preparation of glue mixture	200m3/year
- daily cleaning of mixing and spreading devices	2.200 m3/year
Industrial water	8.900 m3/year
Requirement for the boiler is calculated to	17.000 m3/year
Drinking water	4.100 m3/year
Total water consumption	30.000 m3/year
Mean consumption of water per 1m3 of plywood	6 m3

vi) Manpower (for 2 shifts)

	Number	Per person	Annual salaries or wages in YS
A - WAU			
General manager	1		3.600
Technical manager	1		3.000
Plant engineer	1		1.800
Assistant plant engineer	2	900	1.800
Administration manager	1		1.800
Senior accountant	1		1.200
Accountants	2	600	1.200
Senior clerks	2	600	1.200
Junior clerks	3	400	1.200
Secretaries	2	360	720
Typists	2	300	600
Office boys, watchmen	5	180	900
Chief mechanic	1		700
Production Supervisors	3	560	1.680
Storekeepers	2	560	1.120
Foremen	8	480	3.840
Skilled workers	30	400	12.000
Semi-skilled workers	35	300	10.500
Unskilled workers	45	200	9.000
Drivers	2	240	480
T o t a l	149		58.340

	Number	Per Person	Annual slaries or wages in L.S
B- KHARTOUM			
Sales Manager	1		2.400
Senior clerk	1		960
Accountant	1		960
Junior clerks	2	400	800
Secretary	1		400
Typist	1		360
Driver	1		300
Storekeeper	1		600
Unskilled workers	3	280	840
Watchmen, messenger	4	200	800
T o t a l	16		8,420
G r a n d t o t a l	165		66.760

Annex D/2

D/2. CAPACITIES OF KEY MACHINES

Capacities are calculated for equipment and machines which usually are bottlenecks in the production line for plywood i.e.:

- steaming pits
- peeling lathe
- veneer drier
- hydraulic press

i) Steaming pits

Steaming cycle	72 hours
Time at disposal for steaming (235 x 24h)	5640 hours
Volume of steaming pit (12 x 3 x 3 m)	108 m3
Utilizable volume (108 m2 x 0,4)	43,2 m3
Number of cycles per year (11.110m3 : 43,2)	253 cycles
Time required for steaming (253 x 72h)	18,216 h/year
Number of pits required (10216 h : 5640h)	3,23 pits

The proposed number of steaming pits 4
(12 x 3 x 3 m)

ii) Peeling lathe

Assuming a diameter of peeler logs of at least 40 cm the following number of logs for peeling was calculated:

length of peeler log of 1300 mm (for veneer sheets with perpendicular grain)	47,2 pieces per shift
length of peeler log of 1900 mm (for veneer sheets with longitudinal grain)	15,6 -"-
length of peeler log of 2520 mm (for veneer sheets with longitudinal grain)	23,0 -"-
	85,8 pieces per shift

Total working time shift (60'x 8)	480 min.
Reduced actual working time per shift estimated to (replacement of knives etc)	360 min.
Peeling time required according to specification of deliverer of the lathe	3 min.10 sec.
Peeling time calculated $\frac{360}{85,8}$ =	4 min.20 sec.
Reserve in capacity	27 %

For the calculated output of peeled veneers a peeling lathe of following parameters is recommended:

maximum diameter of log	1300 mm
minimum length of log	1300 mm
maximum length of log	2700 mm
diameter of telescopie spindles	110/170 mm
diameter of telescopic dogs	130/280 mm
installed load	86 kW
revolution rate of spindles	150 per minute
peeled thicknesses of veneer	0,6-5,0 mm

with extension cheeks and backup bearings

iii) Veneer drier

Taking into account the manufacturing programme and different sizes and thicknesses of veneers needed for each type of plywood panels the following amounts of veneers have to be dried:

Thickness: mm	Length: mm	Amount per shift m3	Amount per hour m3
1,2	1900	2,35	0,29
1,2	2520	3,70	0,46
1,2	1300	2,01	0,25
2,0	1300	1,74	0,23
3,0	1300	0,45	0,11
3,0	2520	0,92	0,05
4,0	1300	0,73	0,09
Total		11,90 m3	1,48 m3

For drying the listed amount of veneers a 3-deck jet drier with a belt conveyor with impact air circulation is proposed.

Capacity of drier	2,1 m3/h
Working width	4100 mm
Heated length	14,0 m
Starting moisture content of veneer	80 %
Final moisture content of veneer	80 %
Expected thicknesses of veneer	0,6 - 5,0 mm
Installed load	120 kW
Heat consumption	1,33 Gcal/h

iv) Hydraulic press

At an expected utilization rate of 0,83 the net working time for the press will be:

per shift	664 hours
per year (2shifts)	3652 hours

In order to get the required number of day-lights in the press the following calculation has been elaborated.

From the proposed amounts of plywood to be manufactured, the number of plywood panels for each dimension and thickness was deduced. In dividing the yearly amount by the net working time the number of panels to be pressed per hour result. Taking into consideration the pressing cycle for each thickness the required number of day-light is obtained.

Thickness mm	Number of panels per hour pieces	Pressing cycle min.	Required number of day-lights in the press
3	91,9	6	9,2
4	30,0	6,5	3,3
6	7,7	7,5	1,0
15	6,1	12,0	1,3
Calculated number of day-light			14,8

In view to the fact that a press of a high number of day-lights need an expensive mechanization for loading and unloading, preference is given to two hydraulic hot presses, each of them with 8 day-lights.

Dimensions of the pressing plates 1350 x 2600 mm

D/3. EQUIPMENT LIST

Equipment	Number of pieces	Load in kW	Heat Gcal/h	Estimated price KS
A. Log yard				
Mobile crane	1	-	-	25.500
Chain saw	2	8,0	-	2.000
Sub-total		8,0		27.500
B. Production line				
Equipment for steaming	1	6,0	0,25	8.000
Equipment for crosscutting	1	-	-	500
Railtrucks for logs and waste	2	-	-	500
Monorail with electric hoist 5 tons	1	10,0	-	1.500
Veneer lathe	1	86,0	-	55.000
Hand operated reels with magazin	1	-	-	6.000
Truck for undersized veneer at clipper	1	-	-	200
Veneer clipper	2	10,0	-	7.000
Veneer drier 3-deck	1	120,0	1,33	90.000
Veneer jointer	1	13,0	-	10.000
Veneer splicer	1	3,0	-	5.000
Veneer patching machine	1	3,0	-	3.000

Glue spreader	1	4,0	-	8.000
Glue mixer	1	2,0	-	1.000
Hydraulic press 8-daylight	2	72,0	0,39	45.000
Sizing saw	1	12,0	-	10.000
Belt sander	1	50,0	-	16.000
Sub- total		391,0	1,97	266.700

C. General services and installations

Grinding dept.	6	6,0	-	11.000
Automatic boiler, chem.prep.of water pumps and distribution		100,0	0,14	90.000
Exhausting equipment		36,0	-	7.000
Waste hogger and blower		50,0		3.900
Installation of motors and light		50,0	-	9.000
Laboratory equipment		3,0	-	1.500
Maintenance equipment		30,0	-	10.000
Fork lift truck		-	-	6.000
Sub - total		275,0	0,14	138.400

Annex D/4

D/4. CONSTRUCTION WORKS

Owing to the climatic conditions in Wau, the economic life of constructions is assumed to be 20 years. No replacements are planned during the 15 years period included in the cash-flow forecast.

A. Factory at Wau	£S
Levelling and preparation of the site, incl.log yard 20,000 m2; 0,5 £S/m2	10,000
Roads on the site 1,000 m2; 2.5 £S/m2	2,500
Operations building, incl.foundations 2,400 m2; 50 £S/m2	120.000
Warehouses for plywood, spare parts, materials 1,200 m2; 30 £S/m2	36.000
Administration building 200 m2; 35 £S/2	7,000
Garage, workshops for vehicles 100 m2; 20 £S/m2	2,000
Concrete drainage /apron/around operational building and warehouses 350 m; 8 £S/m	2.800
Canteen, first-aid center, social services 300 m2; 25 £S/m2	7.500
Perimeter fence, incl.entrance area 600 m; 5 £S/m	3.000
Boiler house 150 m2; 20 £S/m2	3.000

	£S
Steaming pits and steam supply	8.900
Water and sewage installation	2.000
Fire protection	5,000
Total	209.700

B. Housing at Wau

2 residential houses for managers	20.000
Guesthouse	8.000
Total	28.000

C. Warehouse and sales section at Khartoum

Land, incl. levelling 500 m2; 1.5 £S/m2	750.
Warehouse 200m2; 40£S/m2	8.000
Administration building 50 M2; 30 £S/m2	1.500
Garage 40 M2; 15 £S/m2	600
Perimeter fence 70 m; 5 £S/m	350
Total	11.200

Summary of construction costs	£S
A. Factory at Wau	209.700
B. Housing at Wau	28.000
C. Warehouse and sales section at Khartoum	11.200
D. Design work (6 % on A - C)	14.930
E. Contingency (approx.5 % on A-D)	13.170
Total	277.000

Annex D/5

D/5. SUMMARY OF INVESTMENT COSTS

1. Production machinery and equipment.

It is not excluded that minor items of equipment might be sub-contracted to local suppliers (the value of potential local deliveries is estimated not to exceed approx. 3 % of the total value of production machinery and equipment). As the details of such a sub-contract could not be satisfactorily specified in this initial phase of the project, the investment costs of the machinery and equipment are calculated under the assumption that the total sum has to be paid for entirely in foreign currency.

According to the Sudanese industrial investment regulations, it can be reasonably assumed that all machinery and equipment may be granted the full exemption of custom duties.

The straight line of depreciation will be used. The writeoff period will be 10 years for the production machinery and equipment and 5 years for the handling equipment.

Two replacements or repairs of investment character are planned to be carried out in the 7th and 11th operating years (the amount of investment requirement being 20 %, resp. 50 % of the initial cost of the machinery and equipment). The prices are assumed to be constant. The handling equipment is planned to be replaced every 6th year.

Calculation of the value of erected machinery in £S

	Foreign currency	Local currency	Total
Price C&F Port Sudan:			
A) log yard equipment	27,500	-	27,500
B) production line	266,700	-	266,700
C) general services and installations	138,400	-	138,400
Total C&F Port Sudan	432,600		432,600
Insurance (1.0 %)	-	4,330	4,330
Price C&F Port Sudan	432,600	4,330	436,930
Exchange tax (14,875 %)	-	64,350	64,350
Development tax (ĕ %)	-	8,650	8,650
Additional tax (5 %)	-	21,630	21,630
Clearing, insurance, transport to site (2,5%)	-	10,820	10,820
Value of machinery at site	432,600	109,780	542,380
Engineering, supervision (3 %)	4,330	8,650	12,980
Assembly and installation (10 %)	32,440	10,820	43,260
Value of erected machinery	469,370	129,250	598,620
Contingency and inflation allowance (10 %)	46,940	12,920	59,860
Total	516,310	142,170	658,480

2. Summary of construction works

	£S
A. Factory at Wau	209,700
B. Housing at Wau	28,000
C. Warehouse and sales section at Khart.	11,200
D. Design work (6 % on A-C)	14,930
E. Contingency (approx.5% on A-D)	13,170
Total	277,000

3. Transport, office and housing equipment

Price estimates for transport, housing and office equipment are considered as paid for in local currency. Even if partially imported, all these items are available on the local market and no exemption from custom duties are expected to be granted.

The service life of the vehicles is assumed to be 4 years, the write-off period for the office and housing furniture will be 10 years. It is planned to replace the vehicles every 5 th year and the furniture in the 11 th operating year (the replacement being made under the condition of constant prices).

Equipment to be purchased includes:	£S
1 lorry 10 T(Wau)	10,000
1 lorry 6 T (Khartoum)	6,000
Landrover (Wau)	5,000
Medium-price car (Khartoum)	5,000
Office furniture and equipment	10,000
Furniture and equipment for residential houses	12,000
Furniture and equipment for the canteen and first-aid center	8,000
Total	56,000
Contingency (10 %)	5,600
Total	61,600

4. Preliminary (development) expenses

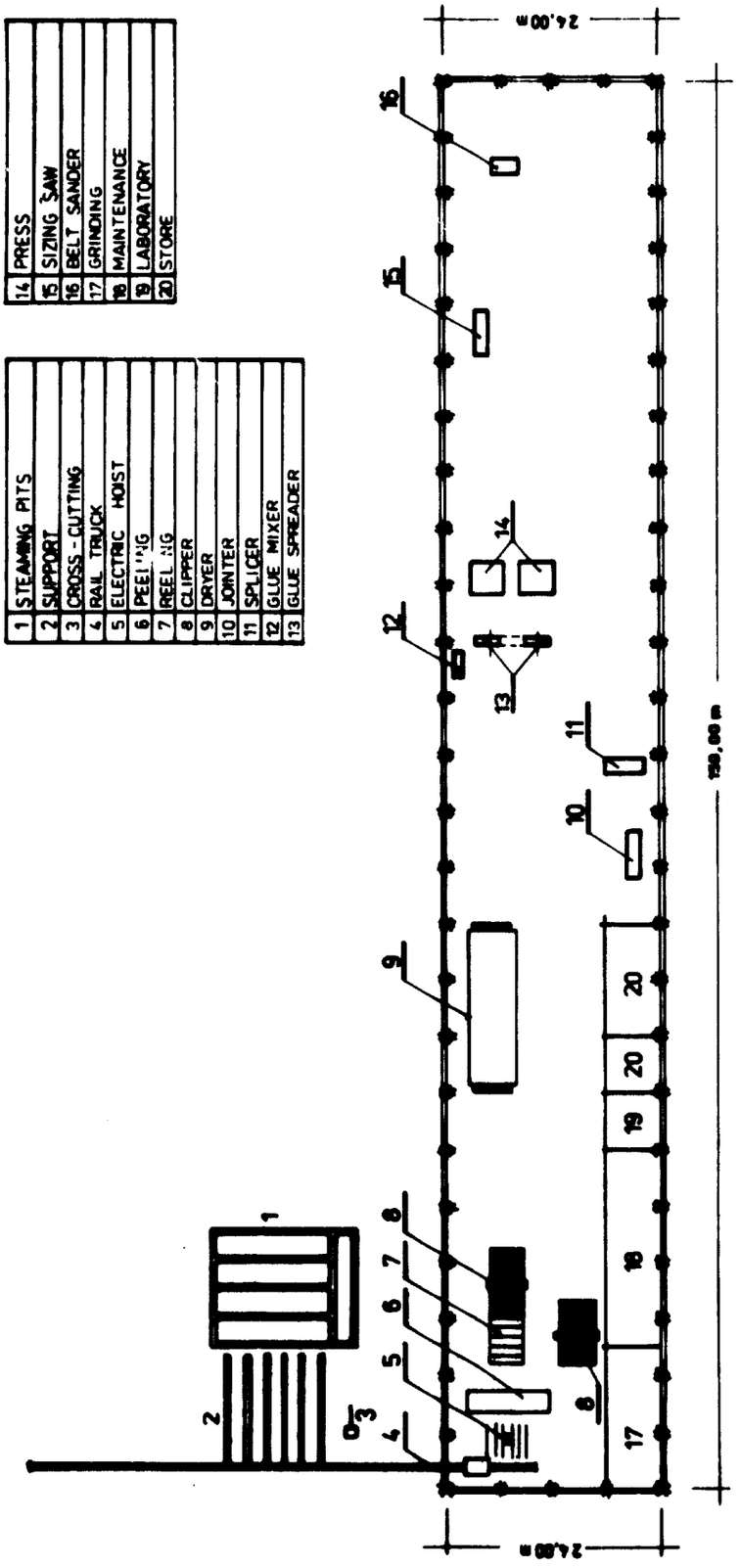
The assessment is based on experiences with similar industrial projects and discussions in the Sudanese consultancy institutes and firms. The write-off period will be 5 years.

	Foreign currency (LS)	Local currency (LS)	Total (LS)
Cost of establishing the company	-	2,000	2,000
Tendering and commissioning services, technical assistance	9,000	9,000	18,000
Wages and salaries during construction	1,000	32,600	33,600
Training of technical and managerial personnel	12,000	4,000	16,000
Interest on capital during construction x/	-	45,000	45,000
Total	22,000	92,600	114,600

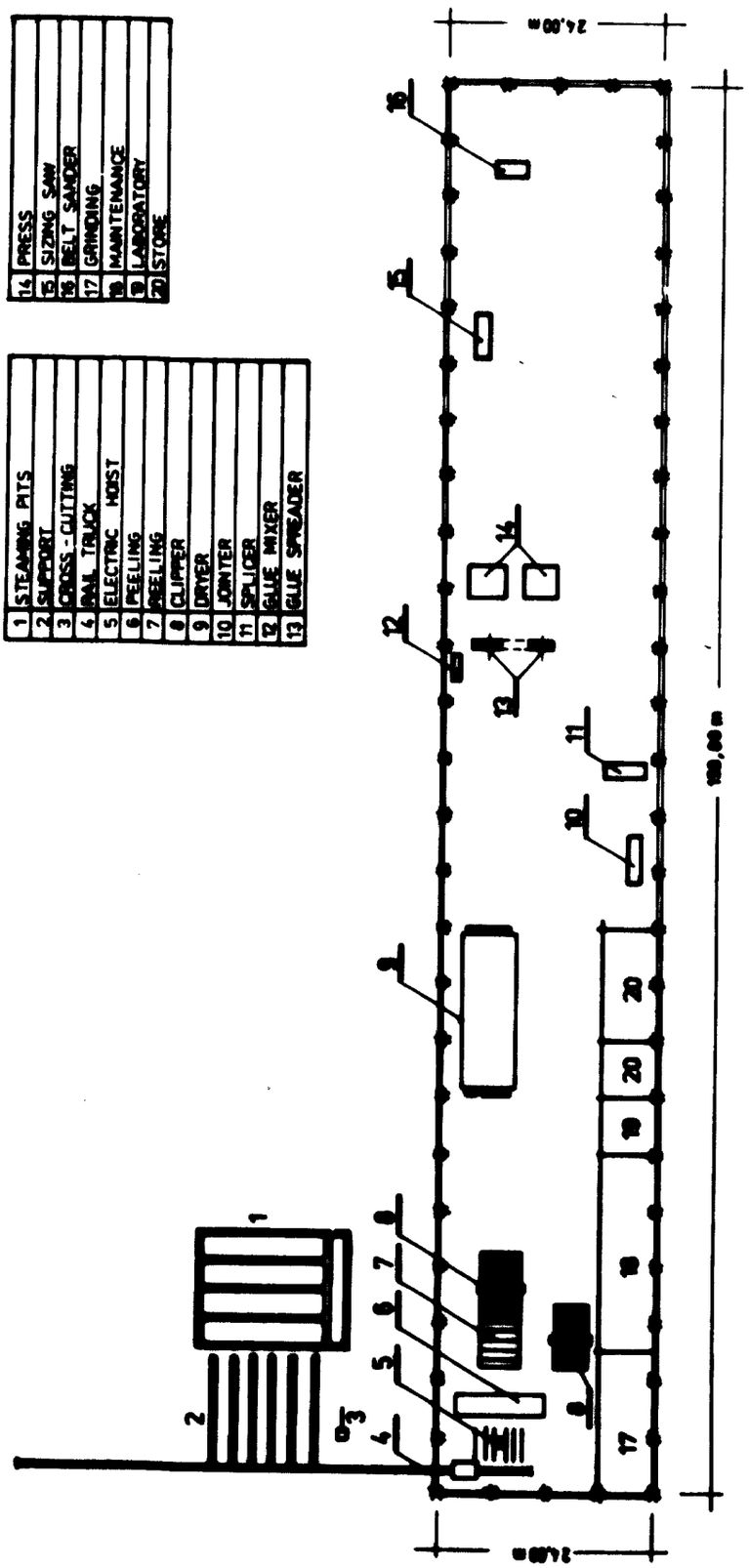
x/

Note: according to the timing of construction and installation works, interest on capital during construction is assumed to be 60 % of the sum of interest paid in the first operating year

PLYWOOD PLANT



PLYWOOD PLANT



Annex E

SLICED VENEER

Annex F

SLICED VENEER

In spite of different modern surface finishing techniques remain sliced veneer a very interesting product on the world market. In view to many excellent wood species occuring in Sudan's forests it is recommended to consider the possibility of producing sliced veneer in addition to the proposed plywood manufacture.

The task being outside the scope of the contract at least a concise information is outlined in order to get a guidline for further considerations.(For the proposal a technological process using forced drying is assumed, which means a more sophisticated solution. Air drying of sliced veneer would be possible, thus reducing investments and capacity)

As far as siting in concerned plant for slized veneer should be attached either to the proposed plywood plant at Wau or to one of the operating sawmills.

Proposed output: 2,000.000 square m per annum
Mean thickness of sliced veneer: 0,7 mm
Log consumption: 1,3 m3 of logs per 1,000m2 of veneer
Annual log consumption: 2,600 m3
Daily log consumption: 9,5 m3
Electric power requirement estimated to 180 MWh/year
Heat requirement estimated to: 3.200 Gcal/year
Water requirement: 2.800 m3/year
Labour (skilled and unskilled): 40 (partly in twoshifts)

Investment costs

Should the plant be attached to the plywood mill a lot of equipment (such as crane, grinders, crosscutting saw etc.) as well as of construction work (log yard, roads, offices etc.) could be used in common, thus lowering the investment costs and depreciation costs.

Nevertheless certain new investments will be required such as:

	Estimated price in LS
Horizontal Veneer Slicer (length of knife 3000 mm)	40.000.-
Chain Rip Saw for flitches (gardine motor)	6.000.-
S-Belt Veneer Drier, width 3.100 mm	40.000.-
Veneer Clipper, length 3700 mm	12.000.-
Hoist and trucks	3.000.-
Machinery	101.000.-
Insurance, transport, assembly, installation and contingencies	51,000.-
Total Machinery	152.000.-
Extension of production building 900 m2	45.000.-
Steaming vat (12x3x3m)	2.500.-
Construction work	47.000.-
Design work, contingencies etc.	5.500.-
Total construction work	53.000.-

	Investment costs ₤S	Depreciation ₤S
machinery and equipment	152.000.-	15.200.-
construction work	53.000.-	2.650.-
permanentworking capital	32.500	
	237.500	17.850.-

Operating costs:	₤S
Raw material 2,600m3x 22,0 ₤S	57,200.-
Energies, wages, overheads etc, estimated to	67.800.-
Total operating costs	125.000.-

Sales:

Average price C&F North European Port 0,30-0,40 US $ per m2
Assuming a selling price of 0,40 US $ or 0,133 ₤S per m2
the sales revenue will amount to 0,133 ₤Sx2,000.000m2 =
= 266,000 ₤S

Profitability:

Investment costs	₤S	237.500.-
Sales revenue		266.000.-
Annual expenses:		
- operational costs	125.000.-	
- depreciation	17.850.-	
- transport costs	40.000.-	
		182.850.-
Profit before tax		83.150.-
Net profit		33.260.-
Net profit + depreciation		51.110.-
Pay-back period		
Investment /net profit + depreciation		4,6 years

Annex F

E C O N O M Y

F/1 Pricing of the output
F/2 Receipts and costs during the start-up period
F/3 Calculation of annual repayments of loans
F/4 Cash-flow forecast
F/5 Calculation of the commercial profitability of the project
F/6 Sensitivy analysis
F/7 Macro-economic evaluation of the project

Annex F/1

F/1. PRICING OF THE OUTPUT

Selling prices

The calculation of the average selling prices is based on the following assumptions:

a) it is expected that under normal conditions (beginning from the third operating year) the structure of quality grades should be (according to British Standards):
   - for interior plywood (thicknesses from 3 to 10 mm):

quality BB (and better)	20 %
quality BB/C	50 %
quality C	30 %

   - for exterior plywood only two quality grades will be produced:

quality BB	50 %
quality BB/C	50 %

b) the transport and sales expenses will be positively influenced by the fact that the bulk of the output will be distributed through the firm s own selling bureau in Khartoum; this will allow to bring the wholesale and retail margins to relatively low levels when compared with the present situation of imported plywood.

The summary of the planned ex factory prices is given in the following table:

Prices ex factory Wau in £S per m3

	Quality			Average
	BB	BB/C	C	price
3 mm	192.0	172.0	146.0	168.0
4 mm	161.0	144.0	122.0	141.0
5 mm	157.0	140.0	119.0	137.0
6 mm	155.0	138.0	117.0	135.0
8 mm	152.0	136.0	116.0	133.0
10mm	151.0	135.0	115.0	132.0
15mm (ext.grade)	145.0	130.0	-	137.0

Based on the average ex-factory prices indicated in the preceeding table, the wholesale and retail prices are calculated in the following way (in £S per m3):

	Ex factory WAU	Khartoum wholesale	Khartoum retail
3 mm	168.0	180.0	198.0
4 mm	141.0	153.0	171.0
5 mm	137.0	149.0	164.0
6 mm	135.0	147.0	162.0
8 mm	133.0	145.0	160.0
10mm	132.0	144.0	159.0
15mm	137.0	149.0	164.0

Note: in the calculation of the sales receipts, the 6 mm plywood is taken as representing the whole group from 5 to 10 mm (considering the relatively small volume of this group, such a simplification cannot affect the exactness of the calculation).

Annex F/2

F/2. RECEIPTS AND COSTS DURING THE START-UP PERIOD

Sales (in m3)

	Operating year		
	1	2	3
Ex factory Wau	200	650	1,050
Khartoum wholesale	400	900	950
Khartoum retail	1,900	2,450	2,500
T o t a l	2,500	4,000	4,500

Selling prices (in £S per m3)

	Operating year		
	1	2	3
Ex factory Wau	143.3	149.5	154.1
Khartoum wholesale	155.3	161.5	165.1
Khartoum retail	173.3	178.5	181.6

Note: it is assumed that during the first two years the output may be of lower quality:
- 1st year:BB/C - 50 %, C - 50 %
- 2nd year:BB - 10 %, BB/C - 50 %, C - 40 %

Sales revenue (in 1,000 £S)

	Operating year		
	1	2	3
Ex factory Wau	28.7	97.2	161.8
Khartoum wholesale	62.1	145.4	156.8
Khartoum retail	329.3	437.3	433.9
T o t a l	420.1	679.9	772.5

Operating costs during the running-in period
(as a percentage of the final amount)

	operating years		
	1	2	3
Level of output	50	80	95
Sales through Khartoum (as percentage of total Kh.sales)	66	96	99
Raw materials	58	85	98
Power materials	65	87	100
Spare parts, technical materials	60	85	100
Wages and salaries[x/]	90	95	100
Sales expenses	70	90	100
Transport costs	66	96	99
Overheads, administrative, expenses, insurance	80	90	100

x/Note: During the first two operating years, the wage bill is to be increased to pay the salaries of two expatriate experts; their salaries, incl.allowances are assumed to be £ 700 and £S 600 per month, the annual expense being £S 15,600 (40 % of this amount to be paid in foreign currency).

Summary of operating costs during the running-in period (in ₤S)

	operating year		
	1	2	3
Raw materials	83,050	121,712	140,326
Urea formaledehyde adhes.	16,530	24,225	27,930
Flour (extender)	3,770	5,525	6,370
Phenolic foil	7,656	11,220	12,936
Electrical energy	13,559	18,148	20,860
Water	780	1,044	1,200
Repairs and spare parts	18,981	26,889	31,634
Consumption of technical materials	3,690	5,227	6,150
Insurance	6,248	7,029	7,810
Wages and salaries	75,684	79,022	66,760
Social security	11,353	11,853	10,014
Transport costs	24,299	35,344	36,449
Sales expenses	26,793	34,448	38,275
Plant overheads	26,866	30,224	33,582
Total	319,259	411,910	440,296
Contingency (approx.5%)	15,961	20,590	22,014
Grand Total	335,220	432,500	462,310

F/3. CALCULATION OF ANNUAL REPAYMENTS OF LOANS

As can be seen in the cash-flow forecast, see Annex F/4, the operational loss in the first operating year may have a very negative impact on the financial situation of the plant. To improve the liquidity in the first two years, the following measures in the financing schedule are proposed:

a) to postpone the repayment of principal of the medium-term and long-term loans from the Industrial Bank of Sudan for the first, resp. the first two years,

b) to use the system of repayment in equal annual instalments.

All data concerning the debt service are given in the table on the following page.

Annex F/3

Annex F/3

Calculation of interest and annual repayment instalments

Loan	Amount M$	Rate	Period		Operating year 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Supplier's credit	1150,000	9.5%	5 years	Principal	24,814	27,172	29,754	32,581	35,679									
				interest	14,249	11,891	9,309	6,482	3,384									
				Instalment	39,063	39,063	39,063	39,063	39,063									
Medium-term loan /I.B.S./	300.000	9.5%	6 years	Principal	-	39,375	43,117	47,214	51,700	56,612	61,982							
				interest	28,500	28,500	24,758	20,661	16,175	11,263	5,893							
				Instalment	28,500	67,875	67,875	67,875	67,875	67,875	67,875							
				Principal	-	-	20,459	22,198	24,085	26,133	28,355	30,766	33,382	36,220	39,299	42,640	46,265	50,198
Long-term loan /I.B.S./	400.000	8.5%	12 years	interest	34,000	34,000	34,000	32,261	30,374	28,326	26,104	23,693	21,077	18,239	15,160	11,819	8,194	4,261
				Instalment	34,000	34,000	54,459	54,459	54,459	54,459	54,459	54,459	54,459	54,459	54,459	54,459	54,459	54,459
Aggregate repayment of principal					24,814	66,547	93,330	101,993	111,464	82,745	90,337	30,766	33,382	36,220	39,299	42,640	46,265	50,198
Aggregate interest					76,749	74,391	68,067	59,404	49,933	39,589	31,997	23,693	21,077	18,239	15,160	11,819	8,194	4,261
Aggregate annual instalment					101,563	140,938	161,397	161,397	161,397	122,334	122,334	54,459	54,459	54,459	54,459	54,459	54,459	54,459

Annex V/4

Annex V/4

Cash-flow forecast /in $/

	Construction		Operating years														Terminal value
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
A. Sources of cash	280,000	985,000	420,100	679,900	772,500	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	
1. Financial resources, total /1.1 + 1.2/	280,000	985,000																
1.1. Loans		850,000																
1.2. Equity	280,000	145,000																
2. Sales revenue			420,100	679,900	772,500	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	
B. Uses of cash	267,260	952,100	463,703	573,438	683,707	628,107	656,707	782,069	866,195	680,292	710,462	683,564	1007,872	687,416	718,191	691,951	640,049	
1. Fixed capital expenditure /1.1+1.2+1.3/	253,800	857,880					28,600	43,440	123,010		28,600		322,460		28,600			154,410
1.1 Construction works	110,800	166,200																69,250
1.2 Machinery and equipment	108,000	612,080					28,600	43,440	123,010		28,600		322,480					85,160
1.3 Preliminary expenses	35,000	79,600																
2. Permanent working capital	13,460	94,220	26,920															134,660
3. Operating costs			335,220	432,500	462,310	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	
4. Debt service /4.1+4.2/			101,563	140,938	161,397	161,397	161,397	122,334	122,334	54,459	54,459	54,459	54,459	54,459	54,459	54,459		
4.1 Interest on loans			76,749	74,391	68,067	59,404	49,933	39,589	31,589	23,693	21,077	18,239	15,160	11,819	8,194	4,261		
4.2 Repayment of loans			24,814	66,547	93,330	101,993	111,464	82,745	90,337	30,766	33,382	36,220	39,299	42,640	46,265	50,198		
5. Tax on profit								149,585	154,141	159,123	160,693	168,395	164,243	166,247	168,422	170,782	173,339	
C. Surplus /deficit/ of cash /A - B/	12,740	42,900	-43,603	106,462	148,793	221,993	193,393	68,031	-16,095	169,808	139,638	166,536	-157,772	162,684	131,909	158,149	210,051	
Surplus /deficit/ accumulated		55,640	12,037	118,499	267,292	489,285	682,678	750,709	734,614	904,422	1044,060	1210,596	1052,824	1215,508	1347,417	1505,566	1715,617	

Annex F/5

F/5. CALCULATIONS OF THE COMMERCIAL PROFITABILITY OF THE PROJECT

The commercial profitability of the project is naturally highly depending from the pricing policy of the future plant. As the estimates of prices have been made with the objective to enable the maximum promotion of the local market of plywood (and therefore determined to allow only a satisfactorily high level of the rate of return), there remains a very broad margin to raise the commercial profitability of the project- if it proves to be desirable - as will be shown in the sensitivity analysis exemples.

The calculations of the commercial profitability are based on two basic data:

- costs and profits of an "average" year (arithmetical mean)
- costs and profits of the 8th operating year (mediane)

as can be seen from the following table (in KS):

Total capital investment 1,246,280

Forecast operational accounts:

	average year	8th year
Sales	804,913	850,100
Expenses:		
- operating costs	455,370	466,710
- depreciation	102,132	94,492
- interest paid	33,505	23,693
- total	591,007	584,895

	average year	8th year
Tax on profit	108,598	159,123
Profit:		
- before tax + depreciation	316,038	359,697
- before tax	213,906	265,205
- after tax (net profit)	105,308	106,082
- after tax and before depreciation	207,440	200,574

Return on investment as ratio:	average year	8th year
$ROI_1 = \frac{\text{profit before tax + deprec.}}{\text{investment}}$	25.4%	28.9%
$ROI_2 = \frac{\text{profit before tax}}{\text{investment}}$	17.2%	21.3%
$ROI_3 = \frac{\text{profit after tax and before deprec.}}{\text{investment}}$	16.6%	16.1%
$ROI_4 = \frac{\text{net profit}}{\text{investment}}$	8.5%	8.5%

Pay-back period as ratio:

$PBP_1 = \frac{\text{investment}}{\text{profit before tax + depreciation}}$	3.9 years	3.5 years

Commercial profitability as ratio of sales and profit:

$RSP_1 = \frac{\text{profit before tax}}{\text{sales revenues}}$	26.6%	31.2%
$RSP_2 = \frac{\text{net profit}}{\text{sales revenues}}$	13.1%	12.5%

Break - even analysis

The break-even point (BEP) where revenues and costs, incl. depreciation are equal (that means the lowest production at which the plant could operate without endangering its financial viability) will be calculated on the presumed data for the 8th operational year (in ℒS):

sales			850,100
variable costs:			
	raw material	143,100	
	adhesives	48,200	
	water, energy	22,060	
	transport costs	36,817	
	contingency	12,513	
			262,780
fixed costs:	depreciation	94,492	
	interest paid	23,693	
	insurance	7,810	
	overheads	33,582	
	contingency	2,070	161,647
semi-variable costs:	remaining costs, incl.contingency		160,468

$$BEP\ (\%) = \frac{FC + 0.3 \times SVC}{SR - VC - 0.7 \times SVC} \times 100$$

where: FC - fixed costs
SVC - semi-variable costs
VC - variable costs

$$BEP = \frac{161,647 + 0.3 \times 160,468}{850,100 - 262,780 - 0.7 \times 160,468} \times 100 = 44.2\ \%$$

Costs / Benefits analysis / in [illegible] /

	Construction		Operating years															Terminal value
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
B. Benefits																		
Loans		850,000																
Sales revenues			420,100	679,900	772,500	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	
Total		850,000	420,100	679,900	772,500	850,100	850, 100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	850,100	
C. Costs																		
Fixed capital expenditure	253,800	857,880					28,600	43,440	123,100		28,600		322,460		28,600			154,410
Permanent working capital	13,460	94,220	26,920															134,600
Operating costs			335,220	432,500	462,310	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	466,710	
Debt service			101,563	140,938	161,397	161,397	161,397	122,324	122,324	84,459	54,459	54,459	54,459	54,459	54,459	54,459		
Tax on profit								149,585	154,141	159,123	160,693	162,395	164,243	166,243	168,422	170,782	173,339	
Total	267,260	952,100	463,703	573,438	623,707	628,107	656,707	782,069	866,195	680,292	710,462	683,564	1007,872	667,416	718,191	691,951	640,049	289,010
B - C	-267,260	-102,100	- 43,603	106,462	148,793	221,993	193,393	68,031	-16,095	169,808	139,638	166,536	-157,772	182,684	131,909	158,149	210,051	289,010
B-C accumulated		-369,360	-412,963	-306,501	-157,708	64,285	257,678	325,709	309,614	479,422	619,060	785,596	627,824	790,508	922,417	1080,566	1290,617	1579,627
Net present value /12 %/	-267,260	- 91,175	-34,752	75,801	98,632	125,870	98,050	30,750	- 6,502	61,301	44,963	47,796	-40,547	37,255	27,040	28,941	34,238	47,109
NPV 12 % accumulated		-358,435	-393,187	-317,386	-222,754	-96,884	- 1,186	31,916	25,414	86,715	131,678	179,474	138,927	176,182	203,223	232,164	266,402	313,511
Net present value /25 %/	-267,260	- 81,680	- 27,906	54,509	61,005	72,814	50,669	14,287	- 2,704	22,754	14,941	14,322	-10,886	8,948	5,888	5,535	5,881	8,092
NPV 25 % accumulated		-348,940	-376,848	-322,337	-261,332	-188,518	-137,849	-123,562	-126,266	-103,512	-88,571	-74,249	-85,135	-78,187	-70,383	-64,848	-58,967	-50,875

Interal rate of return /%/ = $P_1 + \frac{a}{a-b} / P_2 - P_1 /$

where: P_1, P_2 - rates of discount

a, b - accumulated net present values of discounted cash flows

IRR = $12 + \frac{313,511}{313,511 + 50,875} / 25 - 12 / = 23,2\ \%$

Annex F/6

F/6. SENSITIVITY ANALYSIS

Several simple examples showing the impact of the potential future market and costing development indicate the very strong position - in terms of profitability - of the domestic production of plywood (considering the wide price margin when compared with the imports of plywood to the Sudan).

The sensitivity analysis is based on the data of the 8th year of operation (the mediane member of the time series of 15 years taken into account in the study). The results can be summarized in the following conclusions:

- the selling price exercises the greatest influence on the return on investment of the project as can be seen mainly in the last column of the table: the increase of sales revenues by 9.7 % is sufficient enough to compensate the aggregate impact of increases both of investment and operating costs by 10 %;
- the increase of investment costs has the relatively lowest impact on the return on investment (if no additional effect on interest on loans is assumed);
- if the sales revenues were increased by 20 %, the return on investment (as ratio of gross profit to investment) would climb up to 34.9 % with prices remaining only about 50 % of the present price level on the Sudanese market!

Sensitivity analysis examples / in $/

	Basic data	Sales revenues increased by 20 %	Sales revenues cut by 10 %	Operating costs increased by 10 %	Investment costs increased by 10 %	Sales revenues increased to compensate the increase in investment and operating costs by 10 % /to retain basic ROI/
Total capital investment	1,246,280	1,246,280	1,246,280	1,246,280	1,370,908	1,370,908
Sales revenues	850,100	1,020,120	765,090	850,100	850,100	932,741
Expenses, total	584,895	584,895	584,895	631,566	594,344	641,015
of which: operating costs	466,710	466,710	466,710	513,381	466,710	513,381
depreciation	94,492	94,492	94,492	94,492	103,941	103,941
interest paid	23,693	23,693	23,693	23,693	23,693	23,693
Profit before tax	265,205	435,225	180,195	218,534	255,756	291,726
Tax on profit	159,123	261,135	108,117	131,120	153,454	175,036
Profit after tax and before depreciation	200,574	268,582	166,570	181,906	206,243	220,631
Net profit	106,082	174,090	72,078	87,414	102,302	116,690
Return on investment as ratio:						
- profit before tax/investment	21.3 %	34.9 %	14.4 %	17.5 %	18.7 %	21.3 %
- profit after tax and before depreciation / investment	16.1 %	21.6 %	13.4 %	14.6 %	15.0 %	16.1 %
- net profit / investment	8.5 %	14.0 %	5.8 %	7.0 %	7.5 %	8.5 %
Pay-back period as ratio of:						
- investment /profit after tax and before depreciation	6.2 years	4.6 years	7.5 years	6.9 years	6.6 years	6.2 years
Ratio of profitability as percentage of: - net profit /sales revenues	12.5 %	17.1 %	9.4 %	10.3 %	12.0 %	12.5 %

Annex F/7

F./7 Macro-economic evaluation of the project

1. Value added.

For the calculation of the value added (from the macro-economic point of view), the following items are taken into consideration (in LS):

	operating years	
	4th	8th
Raw material (90%), incl.contingency	135,315	135,315
Wages and salaries, incl.social security and contingency	76,774	76,774
Interest paid	59,404	23,693
Profit before tax	206,574	265,205
Total value added	478,067	500,987

$$\text{Ratio of value added} = \frac{\text{value added}}{\text{sales revenues}} \times 100$$

$$RVA_4 = \frac{478,067}{850,100} \times 100 = \underline{56,2\ \%}$$

$$RVA_8 = \frac{500,987}{850,100} \times 100 = \underline{58,9\ \%}$$

2.Social costs (benefits analysis)

For the assessment of the macro-economic profitability of the project, a soewhat simplified method of the social costs /benefits analysis (as compared to the UNIDO's Guidelines) was used.

As the conclusions are commented in the chapter 6.6, in this annex only short remarks to the methodology are added:

- the output was evaluated in the world prices: 250 US$ per 1 m3 of plywood,

- for the calculation of social opportunity costs the following premiums were used: foreign exchange + 0.5
  unskilled labour - 1.0

- in the component "uns-killed labour", the semi-skilled labour trained in the project is included

Components of investment costs (in KS)

	Foreign exchange	Domestic[1/] materials	Unskilled labour
Production machinery and equipment	516,310	136,760	5,410
Transport and office equipment	26,400	35,200	
Construction works	13,850	180,050	83,100
Preliminary expenses[2/]	22,000	38,000	9,600
Total	578,560	390,010	98,110

Note[1/] - The component "skilled labour" is included
Note[2/] - Interest on capital during construction is excluded

Components of working capital (in K'S)

Foreign exchange	23,400
Domestic materials	100,400
Unskilled labour	10,800

Annual operating costs / broken-down into components / in $

	Foreign exchange				Domestic materials /incl. skilled labour/				Unskilled labour			
	1	2	3	4-15	1	2	3	4-15	1	2	3	4-15
Raw material	8,305	12,171	14,032	14,319	24,915	36,514	42,098	42,957	49,830	73,027	84,196	85,914
Urea formaldehyde adhesive	12,397	18,169	20,948	31,375	4,133	6,056	6,982	7,125				
Flour-extender					3,770	5,525	6,370	6,500				
Phenolic foil	5,742	8,415	9,702	9,900	1,914	2,805	3,234	3,300				
Electrical energy					13,559	18,148	20,860	20,860				
Water					780	1,044	1,200	1,200				
Repairs and spare parts	11,389	16,133	18,980	18,980	7,592	10,756	12,654	12,654				
Technical materials	2,767	3,920	4,612	4,612	1,923	1,307	1,538	1,538				
Insurance					6,248	7,029	7,810	7,810				
Wages and salaries	6,240	6,240			51,980	53,300	43,940	43,940	17,464	19,482	22,820	22,820
Social security					11,353	11,353	11,014	11,014				
Transport costs					21,869	31,810	32,804	33,135	2,430	3,534	3,645	3,682
Sales expenses	1,340	1,722	1,914	1,914	24,113	31,004	34,447	34,447	1,340	1,722	1,914	1,914
Plant overheads	1,343	1,511	1,679	1,679	22,836	25,691	28,545	28,545	2,689	3,022	3,358	3,358
Total	49,523	68,281	7,867	72,779	195,985	242,842	252,496	254,025	73,751	100,787	115,933	117,688
Contingency	2,476	3,414	3,593	3,639	9,798	12,139	12,625	12,696	3,687	5,037	5,796	5,883
Grand total	51,999	71,695	75,460	76,418	205,783	254,981	265,121	266,721	77,438	105,824	121,729	123,571

Resources flows / in M$ /

	Construction		Operating years															Terminal value
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Supplier's credit		190,000																
2. Output /foreign exchange/			197,917	326,667	375,000	416,667	416,667	416,667	416,667	416,667	416,667	416,667	416,667	416,667	416,667	416,667	416,667	
3. Construction and replacement costs																		
3.1 Foreign exchange:																		
- construction works	5,540	8,310																
- production machinery and equipment	81,430	461,280					12,300	34,650	98,408		12,300		235,306		12,300			
- preliminary expenses	14,000	8,000																
- total	100,970	477,590					12,300	34,650	98,408		12,300		235,306		12,300			
3.2 Domestic materials /incl. skilled labour/:																		
- construction works	72,080	108,030																
- production machinery and equipment	25,920	146,040					16,300	8,790	24,602		16,300		87,154		16,300			
- preliminary expenses	21,000	17,000																
- total	118,940	271,070					16,300	8,790	24,602		16,300		87,154		16,300			
3.3 Unskilled labour:																		
- construction works	33,240	49,860																
- production machinery and equipment	650	4,760																
- preliminary expenses		9,600																
- total	33,890	64,220																
4. Permanent working capital:																		
- foreign exchange	2,340	18,720	2,340															
- domestic materials	11,120	67,940	21,340															
- unskilled labour		7,560	3,240															
5. Operating costs:																		
- foreign exchange			51,999	71,695	75,460	76,418	76,418	76,418	76,418	76,418	76,418	76,418	76,418	76,418	76,418	76,418	76,418	
- domestic materials			205,783	254,981	265,121	266,721	266,721	266,721	266,721	266,721	266,721	266,721	266,721	266,721	266,721	266,721	266,721	
- unskilled labour			77,438	105,824	121,729	123,571	123,571	123,571	123,571	123,571	123,571	123,571	123,571	123,571	123,571	123,571	123,571	
6. Debt service / foreign exchange /			39,063	39,063	39,063	39,063	39,063											
7. Working capital and scrap value																		
- scrap value /domestic materials/																		154,410
- working capital:																		
- foreign exchange																		23,400
- domestic materials																		100,400
- unskilled labour																		10,800

Social costs /benefits analysis / in $ /

	Construction		Operating years															Terminal value
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
B. Social benefits, total		225,000	296,876	498,000	562,500	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	288,910
Supplier's credit		225,000																
(Output			296,876	498,000	562,500	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	625,000	
Working capital and scrap value																		288,910
C. Social costs, total	285,025	1,083,475	367,227	421,119	436,906	439,943	474,693	442,113	553,562	381,348	416,098	381,348	821,461	381,348	416,098	381,348	381,348	
Construction and replacement costs	270,395	987,455					34,750	60,765	172,214		34,750		440,113		34,750			
Permanent working capital	14,630	96,020	24,850															
Operating costs			283,782	388,984	378,311	381,348	381,348	381,348	381,348	381,348	381,348	381,348	381,348	381,348	381,348	381,348	381,348	
Debt service / supplier's credit /			58,595	58,595	58,595	58,595	58,595	58,595										
B - C Social net benefits	- 285,025	- 858,475	- 70,351	68,881	125,594	185,057	150,307	182,887	71,438	243,652	208,902	243,652	-196,461	243,652	208,902	243,652	243,652	288,910
SNB accumulated		-1,143,500	-1,213,851	-1144,970	-1019,375	- 834,319	- 684,012	- 501,125	-429,687	-186,035	22,867	266,519	70,058	313,710	522,612	766,264	1009,916	1299,886
Present value of SNB / 6%/	- 285,025	- 889,542	- 62,612	57,880	99,470	138,298	105,986	121,680	44,792	144,242	116,567	128,405	- 97,641	114,273	92,335	101,603	95,999	114,225
Present value of SNB / 6%/ accumulated		-1094,567	-1157,179	-1099,319	-999,849	- 861,611	- 755,645	-634,025	-589,233	-444,991	-328,424	-200,019	-297,660	-183,387	- 91,052	10,551	106,550	220,775
Present value of SNB / 12% /	- 285,025	- 766,618	- 56,070	49,043	79,878	104,927	76,206	82,685	28,861	87,958	67,286	69,988	- 50,490	55,796	42,825	44,588	29,715	47,256
Present valueof SNB / 12% / accumulated		-1051,643	-1107,713	-1058,670	-978,792	- 873,865	-797,659	-714,994	-686,131	-598,175	-530,909	-460,981	-511,471	-455,675	-412,850	-368,262	-320,547	-881,292

Flows of foreign currency / in US $ /

	Construction		Operating years															Terminal value
	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
A. Outflow of foreign currency, total	309,930	1,488,930	280,206	332,274	348,569	346,443	383,343	333,204	524,478	229,254	266,154	229,254	935,872	229,254	266,154	229,254	229,254	
1. Outflow of capital, total	309,930	1,488,930	124,209	117,189	117,189	117,189	154,089	103,950	295,224		36,900		705,918		36,900			
Construction works	16,620	24,930																
Machinery and equipment	244,290	1,383,840					36,900	103,950	295,224		36,900		705,918		36,880			
Preliminary expenses	42,000	24,000																
Permanent working capital	7,020	56,150	7,020															
Debt service /supplier's credit/			117,189	117,189	117,189	117,189	117,189											
2. Current outflow, total			155,997	215,085	231,380	229,254	229,254	229,254	229,254	229,254	229,254	229,254	229,254	229,254	229,254	229,254	229,254	
Advances			54,417	79,752	91,980	93,825	93,825	93,825	93,825	93,825	93,825	93,825	93,825	93,825	93,825	93,825	93,825	
Spares, technical materials			42,468	60,159	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	70,776	
Expatriate staff			18,720	18,720														
Raw material			24,915	36,513	42,096	42,957	42,957	42,957	42,957	42,957	42,957	42,957	42,957	42,957	42,957	42,957	42,957	
Other expenses, incl. contingency			15,477	19,941	21,888	21,696	21,696	21,696	21,696	21,696	21,696	21,696	21,696	21,696	21,696	21,696	21,696	
B. Inflow or savings of foreign currency, total		450,000	593,750	980,000	1,125,000	1,250,000	1250,000	1250,000	1250,000	1250,000	1,250,000	1250,000	1,250,000	1, 250,000	1,250,000	1,250,000	1,250,000	
Supplier's credit		450,000																
Substitution of imports /or exports/			593,750	980,000	1,125,000	1,250,000	1250,000	1250,000	1250,000	1250,000	1250,000	1250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	
Working capital /terminal value/																		70,200
C. Net savings of foreign currency /B-A/	-309,930	-1,038,930	313,544	647,726	781,431	903,557	866,657	916,796	725,522	1020,746	983,846	1020,746	314,828	1,020,746	983,846	1,020,746	1,020,746	
Net savings of foreign currency accumulated		-1,348,860	-1,035,316	-387,590	393,841	1,297,398	2164,055	3080,851	3806,373	4827,119	5810,965	6831,711	7,846,539	8,167,285	9,151,135	10,171,877	11,192,623	11,262,823

References

J.K.Jackson, Report to the Government of the Sudan on ... orest Management, FAC 1960,

2/ ...ueller-Eckhardt, Final Report to the Government ... the Su... on wood-based board materials, FAO-UNDP, No... 2402, 196...

3/ L.H.Ma...rstam and partners /UK/ Ltd, Consult... Engineers, Chipboa... anufacture in Sudan, Feasibility ...dy, 1974

4/ Le visage ... la pauvreté, CERES, 45, 1975

5/ Statistical ...rbook 1973, Democratic R... lic of the Sudan, Depart... of Statistics

6/ National Income ...ounts and Support... Tables 1971/72, Khartoum, April 1...

7/ World Consultation ... Wood-based ...els, New Delhi, February 1975, Doc.N...

8/ Ernst Grosshenning, Die ...der ...urniererzeugung, Holz als Roh-und Werkstoff 29, Hei... 1971

9/ Heinrich Segebrock, Reise ...r Sudan, 1963, Bonn, 143 pp. published by Kurt Schr...f...

10/ Avetafului - Munteanu ...nsche... nal Report concerning possibilities of woo... ilizatio... Sudan, Bucuresti, 1972

11/ H.Gottwald, D.Noac... natomische u... hysikalisch-technische Untersuchungen a... olzarten der Repu... Sudan, Mitteilungen der Bundesfors...gsanstalt für Forst-... d Holzwirtschaft. No.64, Reinb... 1966

12/ Sudan Indus... al Research Institute, Pre-I...stment Study of a Plan... or the Manufacture of Plywood, ...h 1970

13/ Libor B..., Sudan Forests and Forest Industr... 1971

14/ Johan... Weck, Aussichten einer Forst- und Holzw...schaft in S...n, 1960

15/ S... raper, Imatong Forestry Project, July 1973

16/ ...olza, W.G.Keating: African Timbers - The Properties, ...ses ...nd Characteristics of 700 Species, Melbourne, 1972

References

1/ J.K.Jackson, Report to the Government of the Sudan on Forest Management, FAC 1960,

2/ H.Mueller-Eckhardt, Final Report to the Government of the Sudan on wood-based board materials, FAO-UNDP, No.TA 2402, 1967

3/ L.H.Manderstam and partners /UK/ Ltd, Consulting Engineers, Chipboard Manufacture in Sudan, Feasibility Study, 1974

4/ Le visage de la pauvreté, CERES, 45, 1975

5/ Statistical Yearbook 1973, Democratic Republic of the Sudan, Department of Statistics

6/ National Income Accounts and Supporting Tables 1971/72, Khartoum, April 1974

7/ World Consultation of Wood-based Panels, New Delhi, February 1975, Doc.No.I

8/ Ernst Grosshenning, Die moderne Furniererzeugung, Holz als Roh-und Werkstoff 29, Heft 4/5, 1971

9/ Heinrich Segebrock, Reiseführer Sudan, 1963, Bonn, 143 pp. published by Kurt Schroeder

10/ Avatafului - Munteanu - Enache, Final Report concerning possibilities of wood utilization in Sudan, Bucuresti, 1972

11/ H.Gottwald, D.Noack, Anatomische und Physikalisch-technische Untersuchungen an Holzarten der Republik Sudan, Mitteilungen der Bundesforschungsanstalt für Forst- und Holzwirtschaft. No.64, Reinbeck, 1966

12/ Sudan Industrial Research Institute, Pre-Investment Study of a Plant for the Manufacture of Plywood, March 1970

13/ Libor Putna, Sudan Forests and Forest Industries, 1971

14/ Johannes Weck, Aussichten einer Forst- und Holzwirtschaft in Sudan, 1960

15/ S.A.Draper, Imatong Forestry Project, July 1973

16/ E.Bolza, W.G.Keating: African Timbers - The Properties, Uses and Characteristics of 700 Species, Melbourne, 1972

List of background papers

Sudan Foreign Trade Analysis 1969-1973, Khartoum, April 1975

Transport Statistical Bulletin 1974, National Planning Commission, Khartoum

Internal Trade Statistics 1972, National Planning Commission, Khartoum

Five Year Plan of Economic and Social Development /amended/, 1970/71 - 1974/75, National Planning Commission, Khartoum

Abdel Wahis Yousif, Southern Sudan in Perspective, Khartoum

J.M.Bryer, S.Haugaard, J.B.Smart, Reactivation of Forestry Production in Southern Sudan, FAO, 1973

Länderkurzberichte Sudan, 1972

C.L.James, Report to the Government of Sudan on a forest resource survey program, FAO, 1968, No.TA 2515

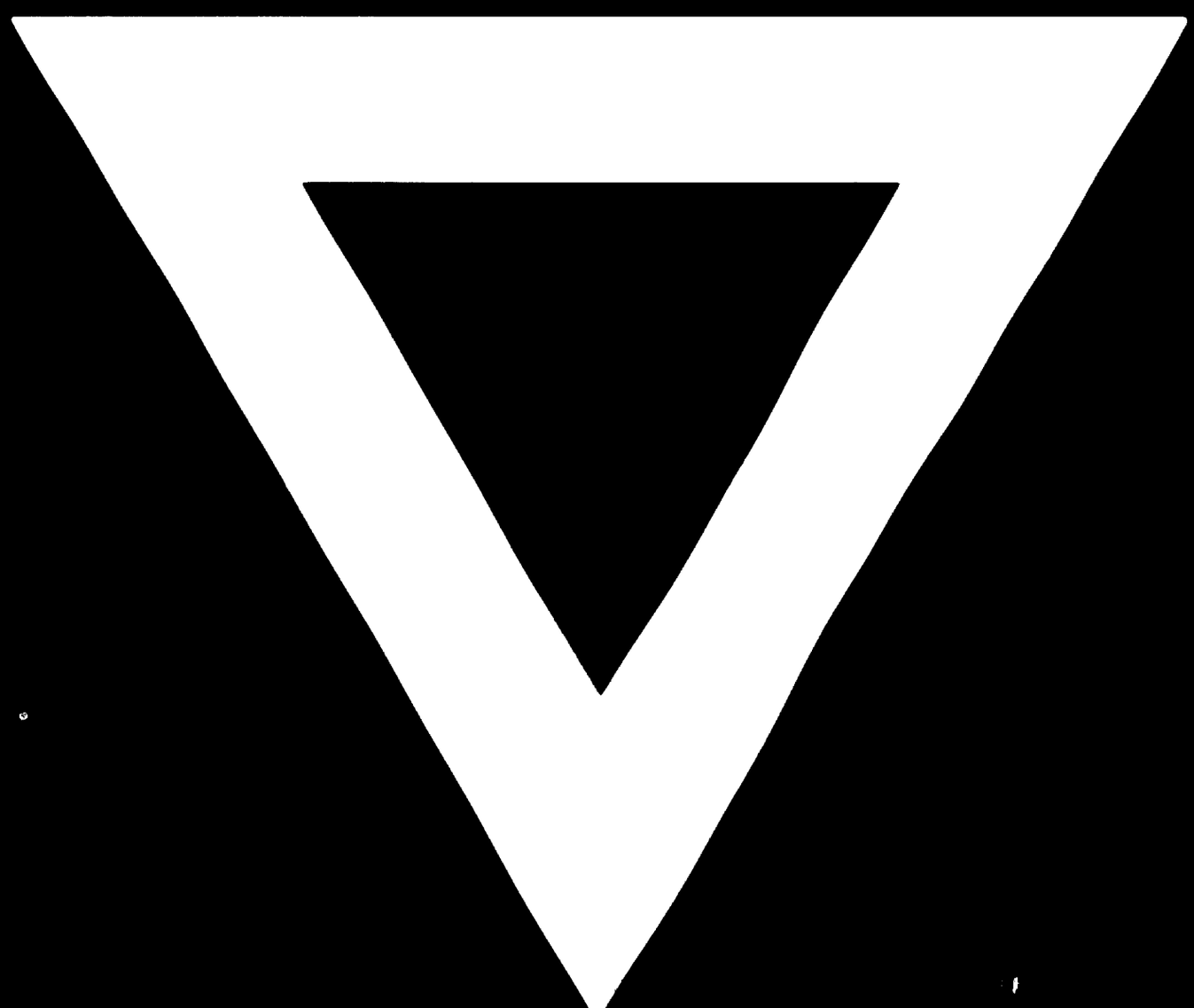
D.A.Stellingwerf, Report to the Government of the Sudan, Forest Inventory and Aerial Photographs, FAO 2009, 1965

Saini, Report to the Government of Sudan on present wood consumption and future requirements, FAO 1964

P.A.Durguet, Summary Report to the Government of the Sudan on the utilization of Sudanese woods, FAO, 1963

K.O.Khalifa, Estimate of the Forest Resources of the Sudan and its yield through the interpretation of air photographs, 1962.

G-332



77.09.26