A contribution to the economic geography of present-day forestry and forest products in the Sudan

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M.A. 58

ABSTRACT

The natural vegetation of the Sudan, ranging from desert scrub to tropical rain forests in the extreme southwest, is related to the occurrence of clayey and sandy soils and to rainfall which increases from almost zero southwards to over 1,200 mm. The southern third of the Sudan is the site of natural forests, while the main consuming centres lie in the populous north. To attain a self-sufficiency level in timber by 1985 plantations should be established at the rate of about 21,000 feddans annually. For gum Arabic, the country's second export, the operating marketing system should be reviewed to ensure more returns to the tappers.

Wholesale deforestation has rendered many formerly inhabited areas in the north a part of the desert; stray fires, grazing and agricultural practices undertaken in the forest have diminished the already limited forest wealth of the country and rendered erosion, sandstorms and desert encroachment serious problems. The adaptation of cultivation to forestry, the completion of fire-lining before early burnings take place and the provision of adequate water centres are urgently required by the situation.

Forestry has a more favourable impact on the terrain and climate than other types of land use. For forest plantations established on good quality land, the per unit area financial returns can compete very favourably with those for irrigated cotton, and are higher than those for "dura", wheat, ground nuts and grazing. If the over all forest influences could be evaluated in monetary terms, forestry would be shown to be a very profitable land use.

Some forest legislation needs to be reviewed; all the reserves should be under the control of a central authority with provincial agencies. For the protection of forestry, the official responsibility must be augmented by the creation of a sense of conservation among the public.

A Contribution to the Economic Geography of Present-Day Forestry and Forest Products in the Sudan

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Thesis for the Degree of M.A.

By

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Conversion Table

Kantar	=	100 lb.
Rottle	=	One lb.
Feddan	=	1.038 acres.
£S.	=	£1.0s.6d.
Piastre	=	2.4d.
m/m	=	0.24d.

Acknowledgements

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1. Dr. I.G. Simmons, Geography Department, University of Durham, for his supervision and valuable advice.

2. Forestry staff and Librarian, Forests Department, Khartoum.

3. Librarian, School of Forestry, University of Edinburgh.

4. The tenants of the Gezira, Nuba Mountains, Tokar and the pump schemes in the vicinity of Kosti- whose information constitutes the factual basis for Appendix IX.

5. The inhabitants of the starred towns and villages in Appendix V (ix).

CHAPTER I

Introduction

The Republic of the Sudan is one of the larger African, modern political units. Its longitudinal extension, from west of El Geneina to east of Tokar (from longitude $21\frac{1}{2}^{o}$E. to $38\frac{1}{2}^{o}$E.), is about 1,120 miles - Latitudinally it extends from Wadi Halfa on the border with the United Arab Republic to latitude $3\frac{1}{2}^{o}$N. on the border with the Congo Republic, i.e. about 1,250 miles. The area of the country is about 967,500 square miles, or 8.3% of the area of the African continent.

1. Land Forms:

Geologically the country has generally been stable though affected by the earth movements which produced the various features of the African Rift Valley. Although the main Rift Valley lies outside the boundaries of the country in Kenya and Ethiopia, features of its western arm reach the Sudan on both sides of the Bahr el Jebel, and have influenced the formation of minor relief features close to the southern frontier.(1) The northern parts of the country include the western area

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(1) J.H.G.Lebon, Land Use in Sudan, Geographical Publications Limited, Bude, Cornwall, 1965, p.5.

of the Red Sea Rift and the adjacent uplifted area of the Red Sea hills.

But no major crustal deformation has occurred since the beginning of the Cambrian period with the result that large tracts between 1,500 and 2,500 are almost featureless and contemporary major landscape features have been in existence since the Archaean age. But minor processes affecting the African plateau produced lesser Landform features. In the Mesozoic era the northern parts of the continent were tilted to the north and the northern third of the Sudan was, and still is, covered with Nubian sandstone; but this tilt was covered over by sedimentation which persisted until the late Tertiary era. The great plain of the Sudan, lying between the relatively upwarped areas of the Nuba Mountains, the Southeastern border of the country and the western extremity of the Ethiopian highlands, is the outcome of regional denudational and depositional processes. These relatively uplifted areas expose Basement complex outcrops. The crystalline rocks of the Basement complex, which underline the relatively thin sediments or superficial deposits, have been described by Andrew(1) as "folded metamorphic rocks, generally foliated, intruded by

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(1) G. Andrew, Geology of the Sudan in J.D. Tothill (ed.), Agriculture in the Sudan, O.U.Press, London, 1948, pp.94-5.

both foliated and non-foliated igneous rocks. This Basement complex is predominantly crystalline felspathic, but a few obvious sedimentary rocks occur locally, such as limestone (marble), slate and quartzite." In the middle reach of the Nile basin, in southern and southeastern Sudan, the main Archaean crystalline rocks are not exposed at the surface, but are overlain by Umm Ruwaba sediments of Tertiary age and other sediments of Quaternary age (Fig. 1).

Tertiary volcanic activity which was most intense in Ethiopia affected the Sudan. The westernmost tongues of the extensive lava flows reach the Sudan in the Boma plateau of the southeast and the Gedaref-Gallabat area. In the western parts of the country two phases of volcanic activity have been recognized in the Jebel Mara, and there may be more. Other upland areas of volcanic origin occur on both sides of the Nile between Berber and Merowe and in the Jebel Tagaba and the Jebel Meidob in the northern parts of Darfur Province.

The Tertiary and Quaternary sedimentary deposits include the Umm Ruwaba sediments and the clays of the middle reach of the Nile Basin. The Umm Ruwaba deposits, which consist of unconsolidated sands and clayey sands with some gravels, are covered by still more recent deposits, and are an important source of underground water. According

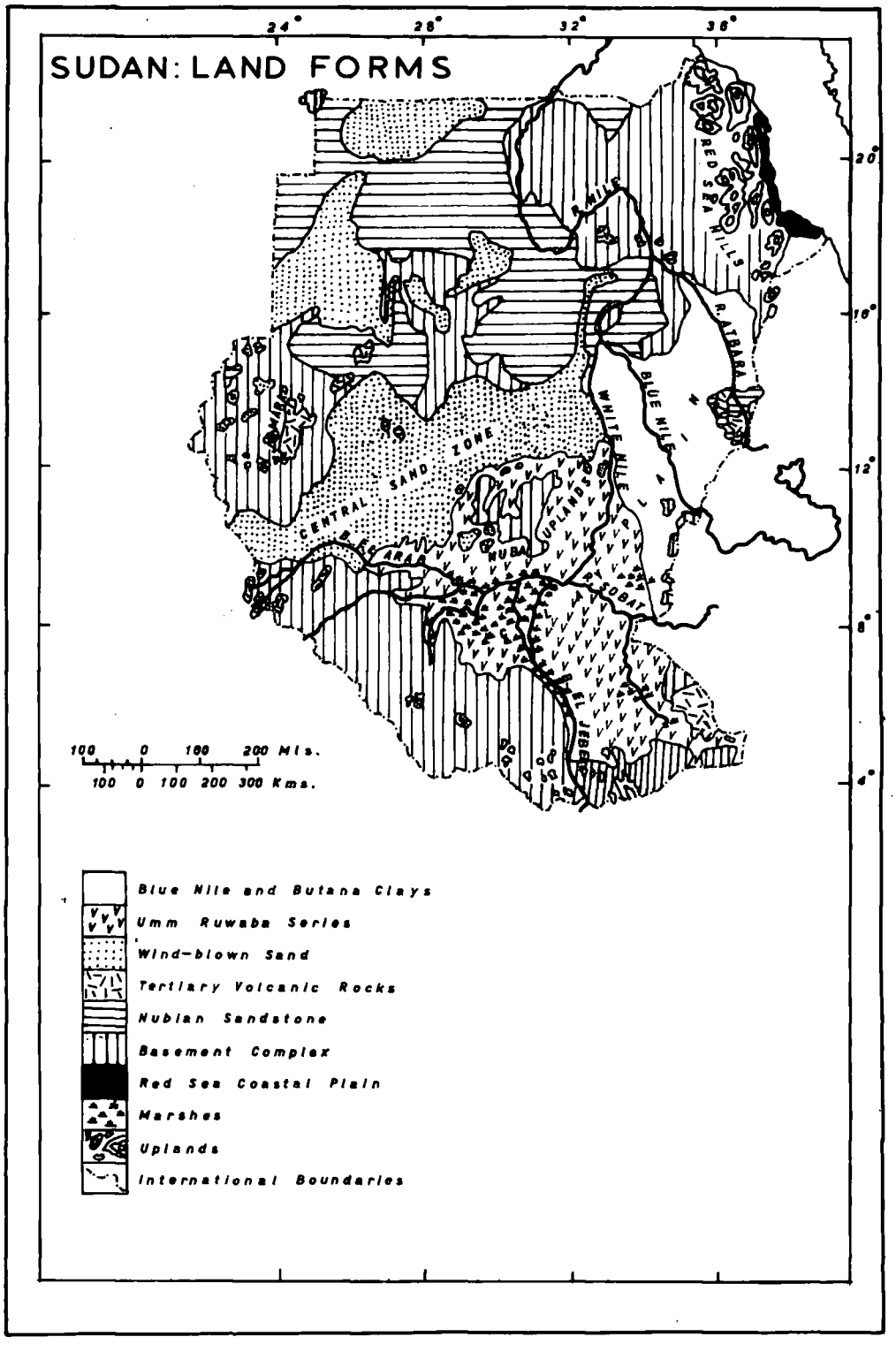

Fig. 1: Redrawn with amendments from Lebon, op. cit., 1965, p.4.

to Andrew[1], these water-deposited clays are of late Middle Pleistocene or early Upper Pleistocene age. Other deposits of Plio-Pleistocene age which are exposed along the Red Sea coastal plain include shales, clays, conglomerates, gypsum beds, and limestones. Near the foot of the escarpment of the recent raised coral reef in the Red Sea are extensive, thick river-terrace deposits.

The present landscape of the country is essentially flat. North of latitude $17\frac{1}{2}^{o}$N., the increasing coverage of sand eventually merges into the continuous dunes of the Libyan Desert. The greater part of this region does not show any feature attributable to rainfall or running water. The central and eastern Sudan is a country of generally flat plains except for the few hills which occasionally rise to a few hundred feet above the general level of the plain. Of more importance are those limited massifs which occur in the rainless parts of the Nubian sandstone desert, the Nuba Mountains in southeastern Kordufan, the Imatong-Acholi group in eastern Equatoria Province and the Jebel Mara in western Darfur Province. The Ingessana hills in the east are low outliers of the Abyssinian hills. Towards the Nile-Congo water-divide the country is undulating and the divide itself is not a prominent landscape feature. Parallel with the Red Sea, the Red Sea hills run along the Sudan coast

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(1) Andrew, op. cit., 1948, p.97.

from the Eritrean border to the frontiers with the United Arab Republic. Close to the frontiers with Uganda and the Congo Republic are hills and plateaux so affected by denudation and weathering processes that they are well-rounded and often display no cliffs or scarps. Other hills or hill groups must be regarded as mere inselbergs persisting on the surrounding plain because of the resistant materials composing their rocks, and exerting at the most limited influence on the vegetation cover of their localities.

2. Climate:

The great climatic variations of the country are reflected in a similarly wide range of vegetation growth. Climate ranges from the hot, rainless true desert in the extreme north, to semi-desert climate, through various grades of tropical continental climate, until it finally merges into the equatorial climate of southern Sudan. The dry season gradually shortens southwards and the total rainfall increases (Fig.2). The temperature range gradually changes following this gradual change in rainfall incidence. The seasonal temperature range is quite large in the north (18^{o}C. in Wadi Halfa) while in the south there is no cool season and the small seasonal temperature differences (4^{o}C. in Maridi) are mainly due to variations in cloudiness (Fig.3 and Appendix I).

The various characteristics of both the rainy season and the dry season are to be explained by the annual

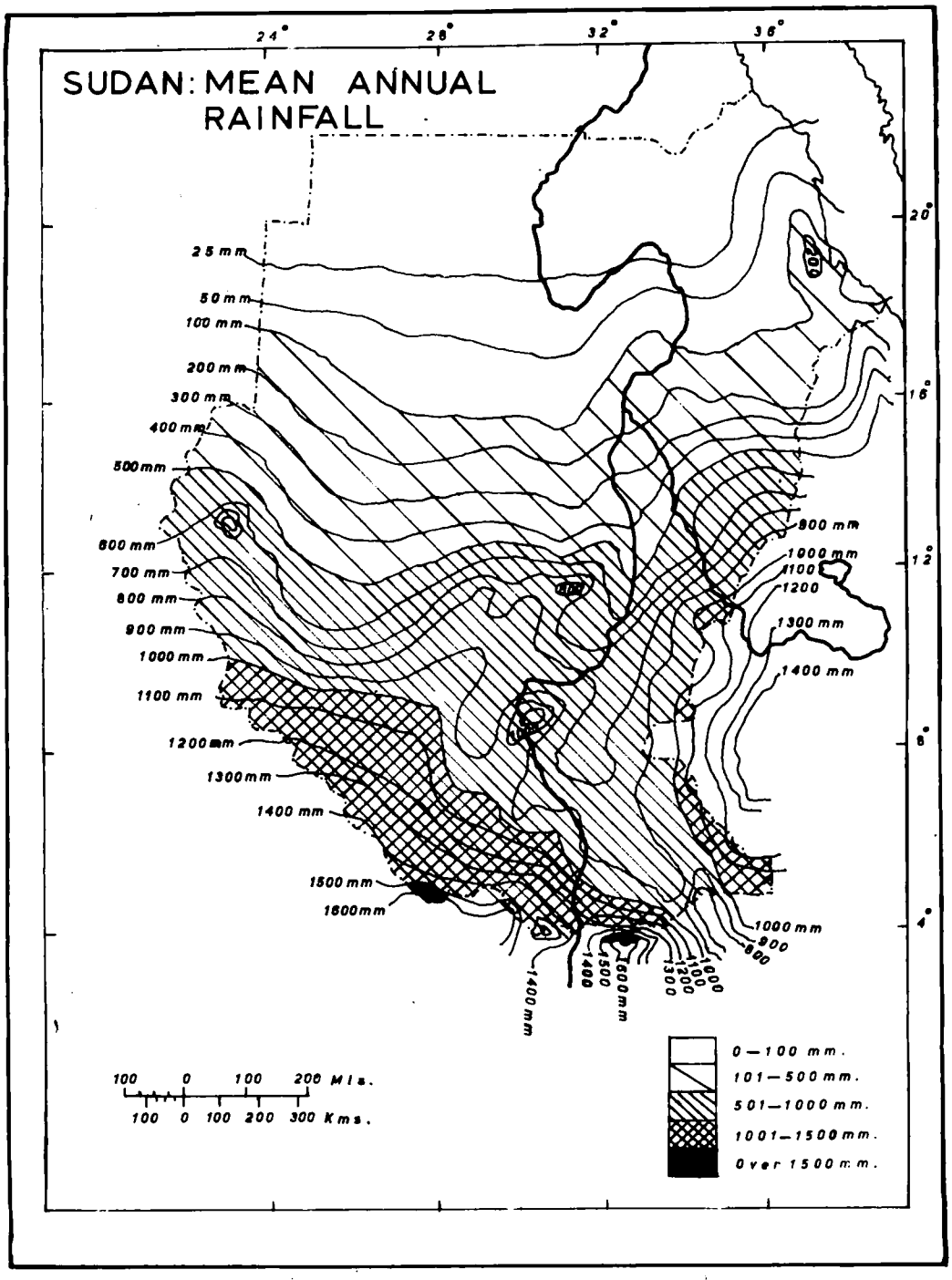

Fig. 2: Compiled from data of Appendix 1.

oscillations of pressure and air currents within the tropical zone. Rainfall, temperature and winds are generally related to the Intertropical Front which can be identified by April in southern Sudan, followed by strong southwesterly winds. As the Front moves northwards, the winds become humid and capable of producing frequent and heavy thunderstorms. The approaching climatic change is marked in Khartoum area by occasional violent dust storms, generally from the south. Walls of dense dust up to 7,000' high and 50 to 90 miles wide roll northwards. These dust storms are more significant in indicating the conditions of soil cover prevailing over their collecting ground (a clay plain) than as a factor influencing vegetation. By July when the Intertropical Front has reached its extreme northern position (the tropic of Cancer or Wadi Halfa - Aswan reach of the Nile), the rains have attained their most northerly extension in the Atbara-Abu Hamad zone, and the growth of vegetation has reached its maximum.

With the beginning of September the Intertropical Front starts to recede, and the rainfall diminishes especially in the northern parts of the country, and the skies start to clear allowing the temperature to rise. The Intertropical Front passes Khartoum in October, Malakal in November and by the end of the year it is beyond the boundaries of the country. Then the North East Trade winds

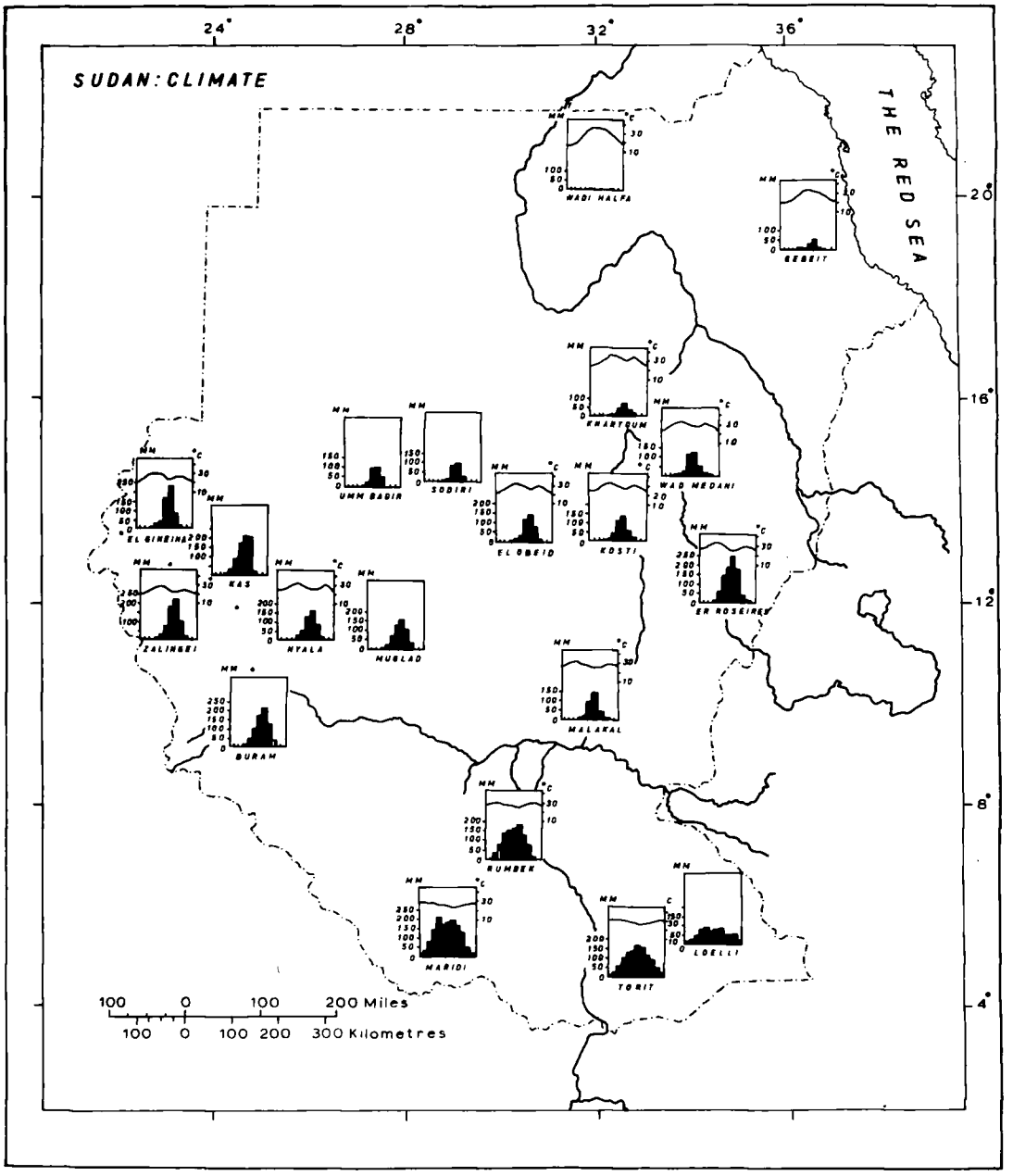

Fig. 3: Compiled from data of Appendix 1; the curves represent temperature and the solid blocks represent rainfall. For some stations temperature figures are not available.

prevail, and consequently humidity falls and the clouds disappear except for occasional cirus, marking the commencement of the dry season which lasts for 8 or 9 months in the north and for 2 or 3 months in the south. The steadily blowing northeast winds reduce the temperature, and the night temperature in northern Sudan may be as low as 45°F. when the source of airstream is eastern Europe.

The rainy season proper is confined to 1 to 3 months (July to September) in the north and 5 to 8 months (March to October) in the south. The occasional light showers which occur during the dry period are not significant to the vegetation growth, and are unaccompanied by any rise in humidity. August rainfall figures are the highest for almost the entire country (Fig. 3 and Appendix I). The annual total rainfall figures may fluctuate greatly; but generally they range from less than 25 mm. in the north (3 mm in Wadi Halfa) to over 1,000 mm. in the south (1418 mm. in Yambio).

There are two regional exceptions which do not fit this climatic pattern. The southeastern parts of the clay plain and the eastern extremity of the Ironstone Plateau receive an annual rainfall which is scanty for their latitude. While Yambio, in the centre of the plateau, receives 1,418 mm., Torit, further east in the same latitude, receives 994 mm., and Kapoeta, still further east and slightly more north, receives 776 mm; this shows that rainfall tends to decrease

eastwards. These relatively dry areas "are continuous with the Arid Zone of Uganda, north-east Kenya and southern Abyssinia. A dry corridor is traceable through the Somaliland coast and is commonly accepted as due to the break between the massifs of Abyssinia and East Africa, though the meteorologists have still to speak with an authoritative voice on this subject."(1)

The second regional climatic exception is found on the Red Sea coast and the northern parts of the Red Sea hills which receive both summer and winter rains. The southwesterlies bring summer showers to Port Sudan ($18\frac{1}{2}^{o}$N.) and to places even further north, such as Gebeit (21^{o}N.) which receives 33 mm. in July and 55 mm. in August. The winter showers, which are more important, fall generally between mid-October and the end of February. From the two rainfall regimes, the coastal plain and the Red Sea hills get an annual rainfall ranging from 60 mm. to 150 mm.

Rainfall, rather than temperature or soil, is the dominant phytogeographic influence. The natural vegetation ranges from desert scrubs in the rainless north, through various grades of savana, to true tropical rain forests in the south where rainfall attains its maximum. This effect is even more marked in the two local climatic regions. In

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(1) J.Smith, Distribution of Tree Species in the Sudan in Relation to Rainfall and soil Texture, Bulletin No.4, Agricultural Publications Committee, Khartoum, 1949,p.7.

the northern parts of the Red Sea coastal plain and the Red Sea hills, desert scrub predominates, though this area lies in the same latitudes as the rainless desert proper. On the other hand, the southeastern parts of the clay plain and the eastern extremity of the Ironstone plateau are, due to diminished rainfall, grassland areas, though the more humid areas in their same latitudes bear high woodland savana, modified tropical rain forests and even true tropical rain forests.

The effect of soil on natural vegetation is most profound in the predominantly sandy soils in the western parts and the heavy cracking clay soils of the central and eastern parts of the country (Fig.4). At the onset of the rainy season water penetrates the heavy clay soil through the cracks which, after the saturation of the top soil, close up so that the soil is practically impermeable. Thus the clay soil cannot absorb all the rain water in the wet season, and the water retention is confined to the upper layers. During the dry season, when cracks start to develop, the water available in the upper layers of the soil is readily exhausted and the soil is then physiologically dry. Consequently these soils cannot hold deep-rooted perennials. On the other hand, the predominantly sandy soils are highly permeable to water, and are capable of storing rain water in the lower horizons, with the result that during the dry period the water availability is relatively high. Hence with similar

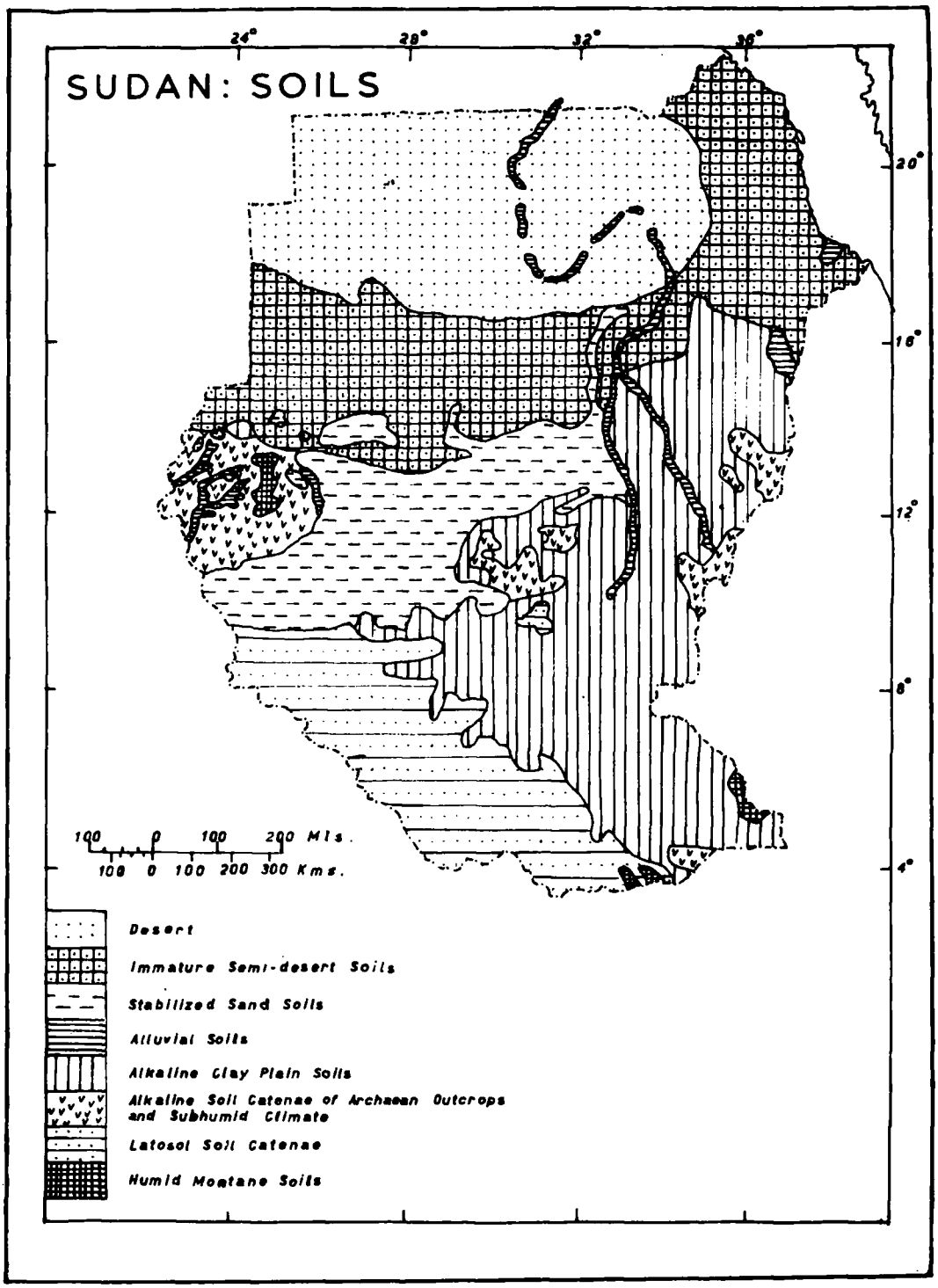

Fig. 4: Redrawn with amendments from Lebon, op. cit., 1965, p.44.

amounts of rainfall, sandy soils offer a greater opportunity for a better growth of vegetation than the heavy clay soils, especially for perennials. This soil effect is best exemplified by the grassland of the Butana clay plain and the woody areas west of the White Nile at similar latitudes.

3. Land Use:

The type and extent of land use is closely related to the availability of water supply. In terms of the soil moisture content the country can be divided into three zones. The northern zone is represented by Khartoum in Table I. Here, where the rainy season is short, rainfall never exceeds potential evapotranspiration and the soil is dry. The central zone covers the Upper Nile Province, the southeastern parts of the Bahrel Ghazal and Equatoria Provinces, and the southern parts of Darfur, Kordufan, Blue Nile and Kassala Provinces. Here the rainy season varies from 4 to 6 months, and rainfall exceeds evapotranspiration in the middle of the rain period (July - September). The soil is partially recharged in the latter half of the rainy season, and its moisture storage rises to a maximum of 65 mm. in September; but this is less than a quarter of the soil capacity (300 mm). This zone is represented by Kadugli. The third zone, and the smallest in extent, is confined to the southwestern part of the country, and is represented by Yambio. Because of the length of the rainy season (April - October), rainfall exceeds evapotranspiration for several months. The soil is fully recharged by the middle

of the rainy season, and run-off continues over a period ranging from 1 to 4 months.

Table I: Water Balance Computation for Representative Stations (in mm)

a. Khartoum:

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year
PE	70	82	151	177	199	194	192	176	180	176	141	90	1828
P	0	0	1	1	4	8	64	79	19	5	0	0	181
Δ	-70	-82	+150	+176	+195	+186	+128	-97	+161	+171	+141	-90	-1647
ST	0	0	0	0	0	0	0	0	0	0	0	0	0
AE	0	0	1	1	4	8	64	79	19	5	0	0	181
D	70	82	150	176	195	186	128	97	161	171	141	90	1647

b. Kadugli:

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D	Year
PE	134	131	103	174	199	158	142	129	130	143	133	127	1703
P	0	2	1	15	86	108	167	157	140	82	6	0	764
Δ	+134	+129	+102	+159	+113	-50	25	28	10	-61	+127	+127	-939
ST	15	9	7	4	3	2	27	55	65	53	35	23	298
AE	8	8	3	18	87	109	142	129	130	94	24	12	764
D	126	123	100	156	112	49	0	0	0	49	109	115	939

c. Yambio:

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year
PE	121	123	140	126	121	105	102	100	104	108	111	106	1367
P	15	29	90	147	177	166	177	192	177	158	70	19	1417
Δ	-106	-94	-50	21	56	61	75	92	73	50	-41	-87	50
ST	137	100	85	106	162	223	298	300	300	300	261	195	2467
AE	73	66	100	126	121	105	102	100	104	108	109	85	1199
D	48	57	40	0	0	0	0	0	0	0	2	21	168
S	0	0	0	21	56	61	75	92	73	50	0	0	428
RO	7	3	2	1	1	0	0	45	59	55	27	13	213

PE = Potential Evaporation; P = Precipitation; Δ = PE - P;
ST = Soil Moisture Storage; AE = Actual Evaporation;
D = Water Deficit; S = Water Surplus; RO = Run-off

Source: Lebon, op. cit., 1965, p.178.

The reliability of rainfall in the northern zone increases southwards, but even in these wettest parts of the region unirrigated crop production is usually accompanied by a high probability of failure. Hence grazing is the dominant type of land use in this zone, and agricultural practices are limited to the wetter parts and those localities where irrigation is possible. The most inaccessible region of the Sahara is found here, extending over almost one-fifth of the total area of the country. North and east of the delta of

the Wadi Hawar, there are hardly any oases, and none is comparable with the larger, permanently inhabited oases of the United Arab Republic. The only intermittent occupation is found at El Natrun where there are some salt deposits. This rainless, plantless desert is crossed by a single ancient caravan route (Darb el Arba'in or Way of Forty (days)) providing access to Darfur Province from Aswan, but it is gradually ceasing to be used.

The irrigated cultivation areas include the flush-irrigated desert deltas of the Khors Gash and Baraka in eastern Sudan. In the Gash delta a rotation of one crop (mostly cotton) followed by two years fallow is predominant; in Baraka delta, cropping, though not annual on every piece of land, is however permanent. In the valleys and deltas of both khors the fallow areas are grazed. The perennially irrigated cropland is confined almost wholly to the White and the Blue Niles near Khartoum, including Abdel Magid scheme and the northern part of the Gezira scheme, and along the main Nile between Khartoum and Wadi Halfa. Land on the alluvial terraces is readily irrigable by counter-weighted lever (shaduf) or Persian water-wheel (sagia) to grow fruits, vegetables, wheat and some fodder crops. The larger schemes sited on the slightly lower alluvial areas (basins), like the Zeidab scheme, have extensive distributing canals. Pump irrigation is widespread in the Shendi-Berber reach of the

Nile where agricultural schemes are situated on the alluvial terrace well above the level of the highest flood.

Cultivation by rain, which is confined to the southern parts of this northern zone, includes embanked field systems in the Semi-Desert Grasslands or Low Woodland Savana areas. The distribution of this type of cultivation is influenced by the availability of domestic water supplies, suitable soil and slope. The largest tract is in the Gezira, outside the area now irrigated, and extending southwards from the neighbourhood of Khartoum to the southern parts of the Gezira. This cultivation mode is also found east of the Blue Nile, in the hinterland of Rufaa and extending northwards to beyond Khartoum-Kassala road. From the White Nile to some distance west of El Obeid and from south of the Khor Abu Habl to about latitude 14^{o} N cultivation is almost continuous. Of a greater extent is the cultivated area extending from En Nahud southwestwards to the latitude of Muglad and Abu Matariq and westwards through Gubeish and Taweisha in the south and Wad Banda and Umm Kedada in the north. Smaller patches are found along the seasonal watercourses radiating from the few isolated hills, and these are used for the production of millets.

Grazing, extending from the desert to the southern extremity of this zone, is the predominant type of land use. The savana, with its short to medium grasses and scattered

small trees, provides most of the grazing land for both camel - and cattle- owning tribes living in the central and north-central parts of the country. The other grazing grounds are provided by northwestern Darfur Province where "gizu" (grasses with high moisture content and palatable to camels) grows in the rainy season, the semi-desert scrub and the semi-desert grasslands of the Butana and northern Kordufan. The most northern pastoral areas are occupied solely by the camel-owning tribes and sheep, cattle and goats are restricted to the wetter southern parts, though goats are found further north. Owing to the unreliability of rainfall and the scarcity of palatable plants in this zone, the surroundings of the larger settlements and the permanent water supply points and the valleys of the perennial and seasonal streams are heavily grazed.

In the second zone (central and south-central Sudan), where rainfall is plentiful, crop production is quite extensive. On the high areas of the Nuba Mountains and the Jebel Mara, terraced cultivation practices are common. These massifs, especially the Jebel Mara, retain water after the summer rainfall and liberate it slowly throughout the dry season in a number of springs. This relatively copious water supply has attracted more people who have terraced even the steep slopes. They grow food and some cash crops and own a few cattle, some pigs, goats and sheep. Commercial agriculture has been

introduced in the plains of the Nuba Mountains and, more recently, in the basin at Suni in the Jebel Mara. The only other irrigated agricultural schemes are the southern half of the Gezira scheme, the Managil Extension, the numerous pump schemes on the White and Blue Niles and the Kenana scheme to be established on the clay plain near El Roseires. To the north are extensive areas put under "harig"(1) cultivation and mechanized farming in the Gedaref area.

In the southern clay plain rainfall is frequent and heavy and the ground surface is so level that adequate drainage cannot take place. This is aggravated by the floods of not only the Nile and its tributary the Sobat but also streams coming into this plain from the Ironstone plateau, both east and west of the Bahr el Jebel, including the Lol, Ibba, Yei, Na'am and Sueh, as well as rivers descending from the Ethiopian highlands, like the Yabus. So most of the area is a marsh during the latter half of the rainy season. When they dry up during the dry season, their predominant grasses are initially palatable to cattle. The only permanent swamps are near the confluence of the Bahr el Ghazal and the Bahr el Jebel, and the Machar marshes north of the Sobat river. The relatively high areas in this marshy region provide the

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(1) "Harig" is the Arabic word for fire or conflagration, and is applied to a type of cultivation based on the firing of the old stand of grasses before cultivation is started.

settlement sites of the Nilotic tribes and their cattle during the rainy season.

There are some potential grazing areas which are not grazed for a variety of reasons. In the Low Woodland Savana of central Sudan, this occurs only in the far west and extreme east, i.e. hilly inaccessible parts of Darfur Province, forest reserves of the Blue Nile and Kassala Provinces and in game reserves near the Ethiopian border. Further tracts occur in the southeast in areas remote from the usual routes of migratory pastoral tribes. Another ungrazed zone lies in the transition from Low to High Woodland Savana, neglected because of its infestation by the tsetse fly. A part of the seasonally wet grasslands of the southern clay plain is not grazed; this is because this area is far from perennial streams near which the cattle-owning Nilotic tribes must establish their settlements during the rainy season. It is also remote from the southern uplands from which streams radiate, providing dry season water and pasturage for the Toposa. It corresponds with an uninhabited area lying on both sides of the straight part of the boundary between the Upper Nile and Equatoria Provinces.

The wooded areas include the Ironstone plateau which bears deciduous high woodland savana within the domain of the tsetse fly and is, therefore, neither grazed nor occupied for shifting cultivation, and the very limited high parts of the mountain areas, especially the Imatong

Mountains. Northwards inextensive woodlands are found in the savana areas of western and southwestern Darfur, southern Kordufan and Upper Nile Provinces. The ungrazed woodlands also include those which have been declared as forest or game reserves. The former comprises the remnants of the Acacia nilotica gallery forests of the Blue Nile valley, the evergreen tropical rain forests which are close to the frontiers with Uganda and the Congo Republic, and the other forest reserves scattered all over the country. Of the latter the largest are the Dinder Game Reserves flanking the Ethiopian frontier between Gallabat and the Blue Nile. Semi-deciduous high woodland savana, with some closed forests, is usually found where the annual rainfall figures approach 1,500 mm. This includes species which are only partly deciduous, and which flourish in the gallery forests of moist valley bottoms and other limited places to form thickets or small forests with closed canopies. This is found in western Equatoria and south western Bahr el Ghazal, in the absence of shifting cultivation.

The adaptation of the World Land Use Inventory classification to the Sudan was drafted and the first classification of land use was completed in 1957. A recent, more comprehensive and detailed classification, again based on the World Land Use Inventory, was completed in 1961. Table II shows that the total woodland area is less than 10% of the total area of the country; the total area of all forest

reserves is less than 0.5% of the Sudan's area. This means that less than 5% of the woodland of the country has been converted into forest reserves, and almost all of the rest is subject to misuse and depletion.

Table II: The 1961 Land Use Classification

	Types of Land Use	Area		
		Area in 000 feddans	(1)	% to total area
1	Settlements (Towns).	34.524		0.00006
4a	Perennially Irrigated Cropland.	1,432.647	0.24	
4a-6a	Intermittently Cultivated Flush-Irrigated Cropland, with Grazing.	854.064	0.14	0.38
4b-6a (7c)	Land Rotation (Undifferentiated Local Types), with Grazing, in Low Savana or Woodland Savana.	7,624.200	1.27	
$4b^{i}$-6a(7c)	Land Rotation (Embanked Field, $4b^{it}$), and Small Areas of Flush Irrigation ($4b^{if}$), with Grazing, in Semi-Desert or Low Savana.	4,335.068	0.72	
$4b^{ii}$-6a(7c)	Land Rotation(Northern Clay Plain,including Grass-Firing, with Grazing, in Low Savana.	8,897.320	1.48	
$4b^{iii}$-6a(7c)	Land Rotation (Sand Zone Types), with Grazing in Low Savana.	35,682.380	5.95	
$4b^{iv}$-6a(7b)	Land Rotation (Nuba Mountains Terraced Type), with Grazing in Woodland Savana.	811.206	0.14	

(1) One feddan = 1.038 acres or 4200 square metres.

Types of Land Use		Area		
		Area in 000 feddans	% to total area (1)	
$4b^{iv''}$ - 6a(7b)	Land Rotation (Nuba Pediments and clay Plains), with Grazing in Woodland Savana.	8,644.934	1.44	14.25
$4b^{v}$ - 6a(7b)	Land Rotation (Jebel Mara Terraced Type), with Grazing, in Montane Woodland Savana.	792.158	0.13	
$4(a)b^{vi}$ - 6a(7b)	Land Rotation (Wadi Azum Type), with Grazing, in Woodland Savana.	1,899.085	0.32	
$4b^{vii}$ - 6a(7b, 7c,7)	Land Rotation (Nilotic Type), with Grazing, in Woodland Savana or "High" Land of Southern Clay Plain.	16,144.846	2.70	
$4b^{viii}$ - 6a(7b)	Land Rotation (Terraced Upland and Piedmont Types of Equatoria), with Grazing, in Woodland Savana.	589.059	0.10	
6a(7b)	Used Unimproved Grazing, in Woodland Savana.	11,671.900	1.95	51.59
6a(7c)	Used Unimproved Grazing, in Low Savana.	133,810.771	22.32	
6a(g)	Used Unimproved Grazing, in Semi-Desert Grasslands.	29,473.684	4.92	
6a(8')	Used Unimproved Grazing of Seasonally Wet Grasslands.	36,074.292	6.02	
6a(8'')	Used Unimproved Grazing of Perennially Moist Riverain Grassland of Southern Clay Plain.	6,789.659	1.13	
6a(9)	Used Sparse Semi-Desert Grazing, alternating with Desert.	91.426.828	15.25	

Types of Land Use		Area		
		Area in 000 feddans (1)	% to total area	
6b(7b)	Unused Unimproved Grazing, in Woodland Savana.	1,213.357	0.20	
6b(7c)	Unused Unimproved Grazing, in Low Savana.	13,822.181	2.31	
6b(8)	Unused Unimproved Grazing, in Seasonally Wet Grassland of Southern Clay Plain.	8,478.026	1.41	3.92
7a-e	Evergreen Tropical Rain Forest.	918.827	0.15	
7a-e (m)	Montane Evergreen Tropical Rain Forest.	273.815	0.05	
7a-e/sd	Semi-Deciduous High Woodland Savana, with some Closed Forests.	14,283.380	2.38	9.61
7b-d	Deciduous High Woodland Savana.	11,443.562	1.91	
7f(i)	Tropical Rain Forest or High Woodland Savana, with Shifting Cultivation.	31,166.575	5.12	
8	Permanent Swamps.	6,348.460		1.06
9	Unproductive Desert.	113,945.136		19.01
W	Water Area or Principal Perennial Rivers.	615.488		0.10
	TOTAL	599,497.432		99.92006

Source: Lebon, op. cit., 1965,pp 74-5.

4. Population:

For the Sudan as a whole, the total population is 11,321,201 (1961); it is not evenly distributed over the country since the three provinces Blue Nile, Kordufan and Darfur contain about 50% of this figure (Table III). In the Blue Nile Province the southern parts (south of Sennar-Kosti railway line) and the northern parts (between Messeid and Khartoum) are very thinly populated. In Kordufan and Darfur Provinces, the areas with the highest density of population are those within easy reach of permanent underground or surface water supply.

There is a great range of population density (Fig.5). The emptiness of some localities is attributable to a number of causes, e.g. the higher parts of the Imatong Mountains, above 2,000 metres, are uninhabited, though their soils have shown themselves to be quite fertile near the gardens at Gilo and this may be due to the fact that most of these areas have been converted into forest reserves or else because the climate is too wet and cold for the inhabitants of the surroundings. Areas like southern Gezira and the plains between the White Nile and the Nuba Mountains owe their emptiness to the lack of permanent supplies of drinking water. The excavation of artificial tanks (hafayir) to hold water throughout the year is encouraging new settlements in the former uninhabited areas.

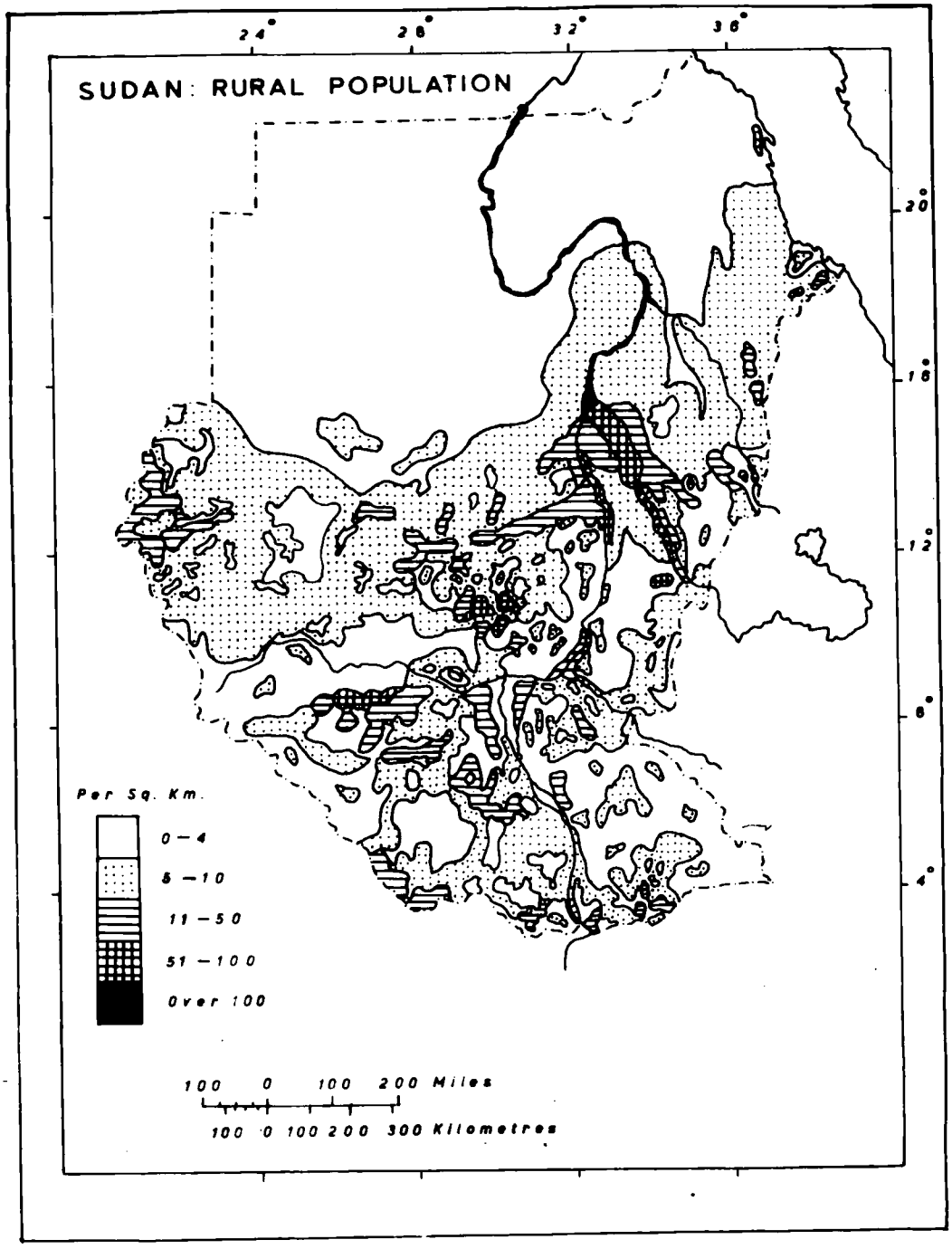

Fig. 5: Redrawn with amendments from Barbour, op. cit., 1961 , p. 98.

Lack of public security has always been responsible for the low population density along the upper reaches of the Blue Nile and the Atbara river, though water is available throughout the year in the former and for a number of months in the latter, and the soils are quite productive. Even today a large number of game poachers and robbers occasionally cross into the Sudan to kill some animals and steal grains and make their way back into Ethiopia. Sleeping sickness has greatly affected the distribution of population in the southern parts of the country; the inhabitants of most parts of eastern Equatoria Province avoid the breeding sites of Glossina palpalis along the streams. The northern parts of the Bahr el Ghazal Province are visited in winter by nomads and herdsmen from Kordufan and Darfur Provinces, but are soon deserted when Glossina marsitans appear at the beginning of the rainy season.(1)

The most extensive uninhabited region is the desert which is visited during the rainy season only by nomads from central Kordufan and Darfur Provinces to graze the "gizu" of northern Darfur and the other shrubs and herbs which grow along the valleys of the watercourses. The northwestern part of the country is permanently uninhabited.

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(1) J.D. Lewis, The Tsetse Fly Problem in the Anglo-Egyptian Sudan, S.N. and Records, 30 (1949).

In contrast with these areas there are patches of exceptionally high population densities related to a complex of geographical factors. The density of the Dinka population near Aweil - almost 100 persons per square kilometre[1] - is very high for the area because for much of the year the cattle of the Dinka are able to graze on the flood plains of the local rivers away from the villages; but during the rainy period they are driven to the limited relatively higher areas near the summer cultivations, and there their manure is used to fertilize the soil which is intensively cropped to support a large number of people. In the Northern Province in general, and the Merowe - Dongola reach of the Nile in particular, the people are essentially dependent on the crops that can be grown on the alluvial lands of the Nile. Owing to the high productivity of the soil, the land can support about 200 persons per square kilometre, and when the figure rises above this, the people usually emigrate toEgypt and the Three Khartoum Towns to earn a living for their families whom they leave behind. Thus the figures of the population of the province are swollen by a large number of inhabitants supported by remittances from outside the province and whose food supply is drawn from another part of the Sudan or even from beyond the boundaries of the country. In some parts of the Nuba Mountains, the high density of population is accounted for by the reluctance of the people to abolish their

(1) K.M. Barbour, The Republic of the Sudan, University of London Press Ltd., 1961, p.98.

traditional way of life and seek paid employment.

As for urbanization, the total urban population is slightly less than 9% of the total population of the country. It is only natural that Khartoum Province shows a far higher percentage of urban population than the rest of the country, and the southern provinces show the lowest figures (Table III). The density of population in urban areas is quite high (Fig. 6). The figure for the whole of Omdurman Municipality, for instance, is over 3,300 persons to the square kilometre (over 8,300 persons per square mile); this includes some peripheral areas which have not yet been built up and considerable open squares and public gardens within the town itself as well as some cultivated land along the main Nile and the White Nile; this indicates that in the most densely inhabited parts of the city the actual population must be greatly higher than the average figure.

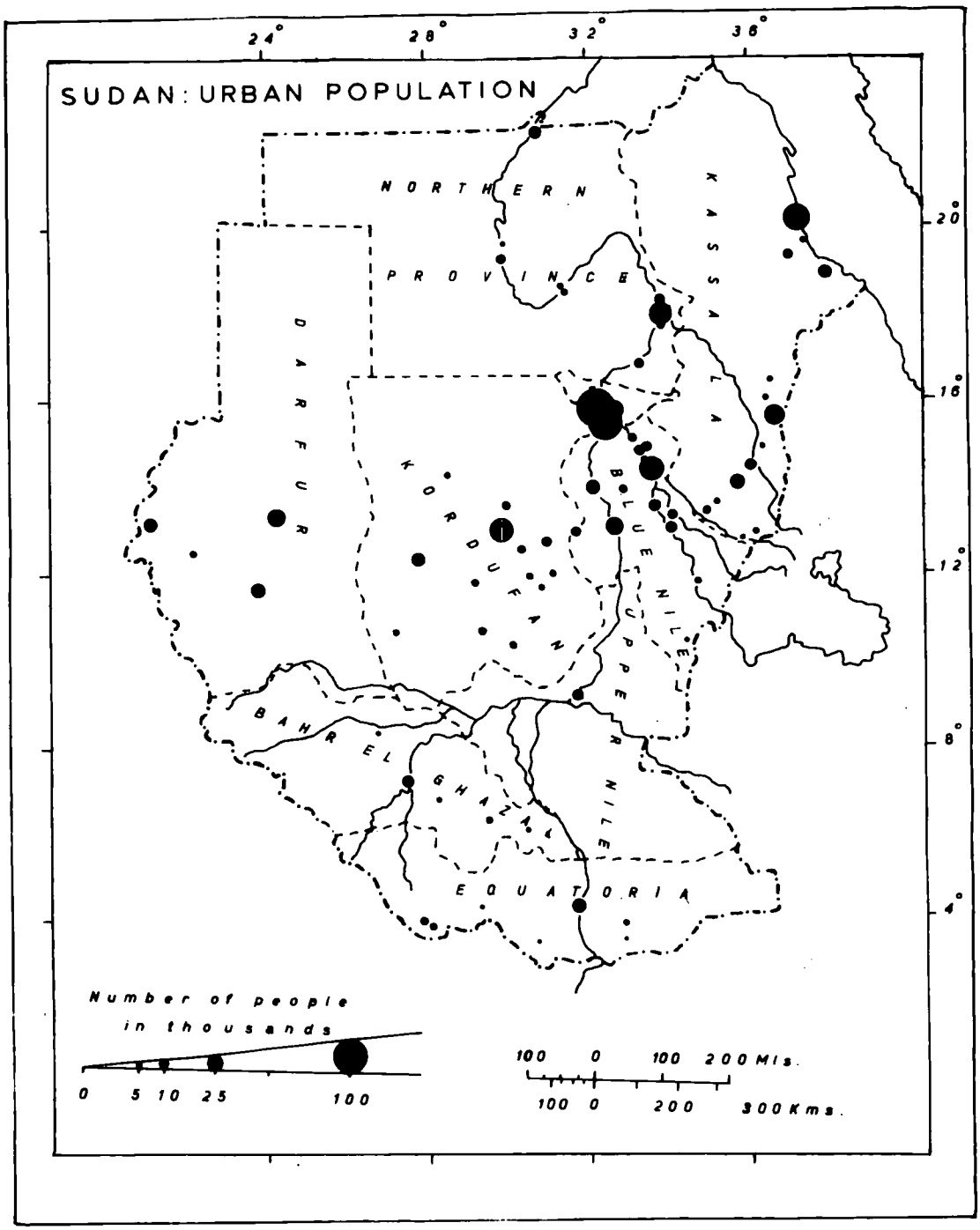

Fig. 6: Redrawn with amendments from Barbour, op. cit.1961 , p.104 .

Table III: Population by Province

Province	Population 000	% to Total Population	% of Urban Population
Bahr el Ghazal	1,093.9	9.7	0.14
Blue Nile	2,285.1	20.2	1.42
Darfur	1,467.0	12.9	0.33
Equatoria	997.9	8.8	0.14
Kassala	1,038.7	9.2	1.22
Khartoum	557.5	4.9	4.16
Kordufan	1,945.1	17.2	0.42
Northern	954.7	8.5	0.88
Upper Nile	981.3	8.7	0.11
SUDAN	11,321.2	100.1	8.82

The population of the Sudan is increasing at a very high rate. The country as a whole has a crude birth rate of 52 per thousand, which is exceptionally high by world standards. This is not evenly distributed because it is essentially the tribes of the southern provinces and the Nuba Mountains that have the highest figures, whereas the remaining parts of the country are less fertile, though still high by world standards. The crude death rate for the country is 23 per thousand; again it is not evenly distributed

and again the southern provinces show the highest figures (Table IV). The net rate of increase is 29 per thousand for the whole country, and it is highest for the southern two provinces, the Bahr el Ghazal and Upper Nile, which are the only provinces showing figures higher than the national rate of increase (Fig. 7).

Table IV: Population Trends by Province

Province	Crude Birth Rate %	Crude Death Rate %	Net Rate of Increase %
Bahr el Ghazal	8.4	3.0	5.4
Blue Nile	4.6	1.8	2.8
Darfur	4.1	1.7	2.4
Equatoria	5.4	3.1	2.3
Kassala	4.2	2.1	2.1
Khartoum	4.1	1.8	2.3
Kordufan	4.9	2.0	2.9
Northern	4.3	1.5	2.8
Upper Nile	6.8	3.6	3.2
SUDAN	5.2	2.3	2.9

The greater bulk of the country's natural forests is confined to the southern parts of the country, i.e. in the

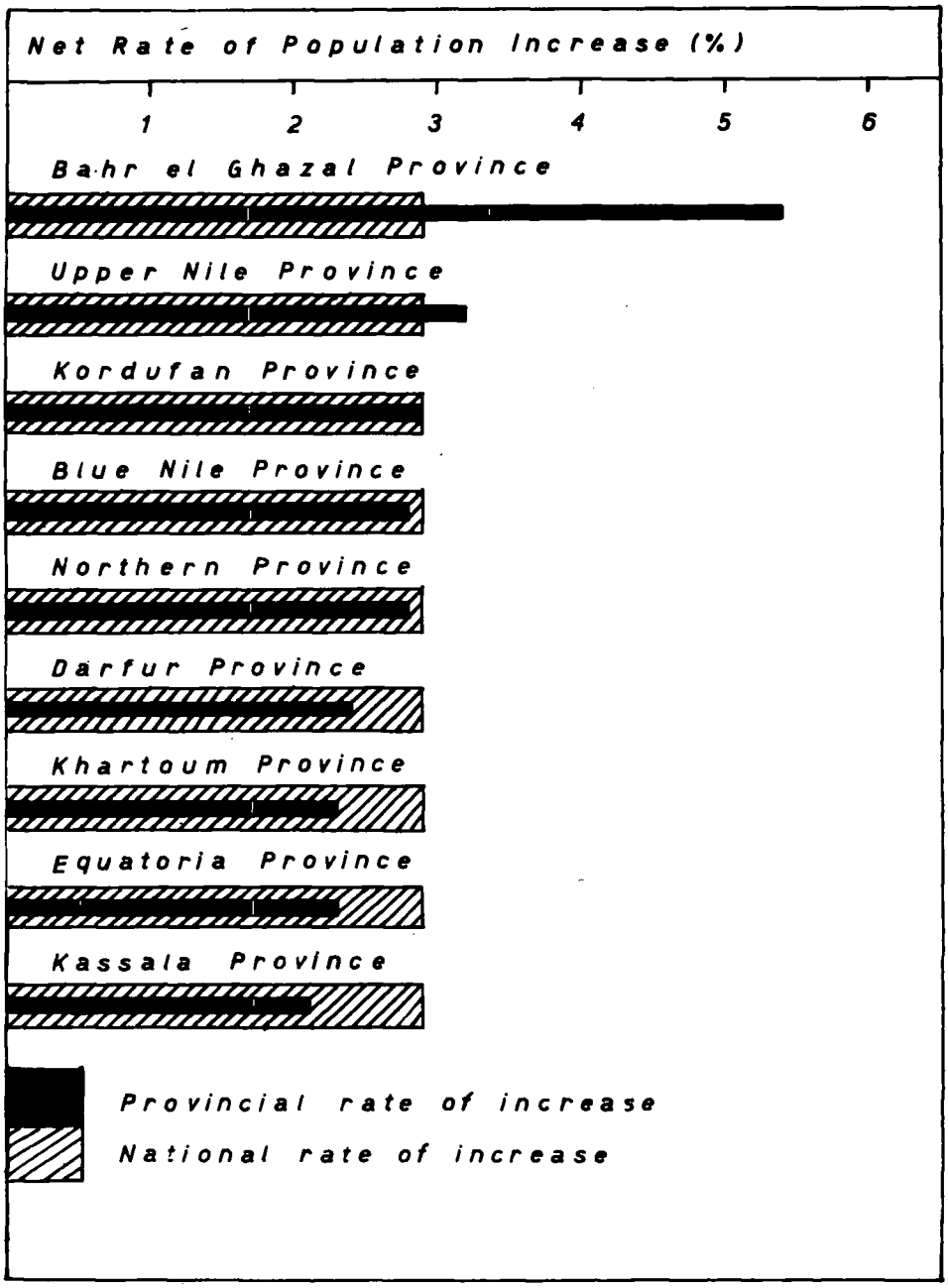

Fig. 7: Compiled from data of Table IV.

less densely populated areas and far from the greater consuming centres of the north. To meet the requirements of the populous north, wood should either be transported from the south, over about 800 miles or more, or else be grown locally in adequate plantations near the consumption centres. Out of the 2.5 million feddans of the forest reserve estate (natural and planted), over 50% is located within the southern three provinces (Table V), away from the major consumption centres. On one hand, Bahr el Ghazal province has about 28% of the total forest reserve estate and only about 10% of the total population, and on the other hand, the Northern Province has less than 0.2% of the total forest reserve estate though it has 8.5% of the total population of the country. Between these two extremes, the supply of forest produce (forest reserves) and the demand for it (population) varies from one province to another.

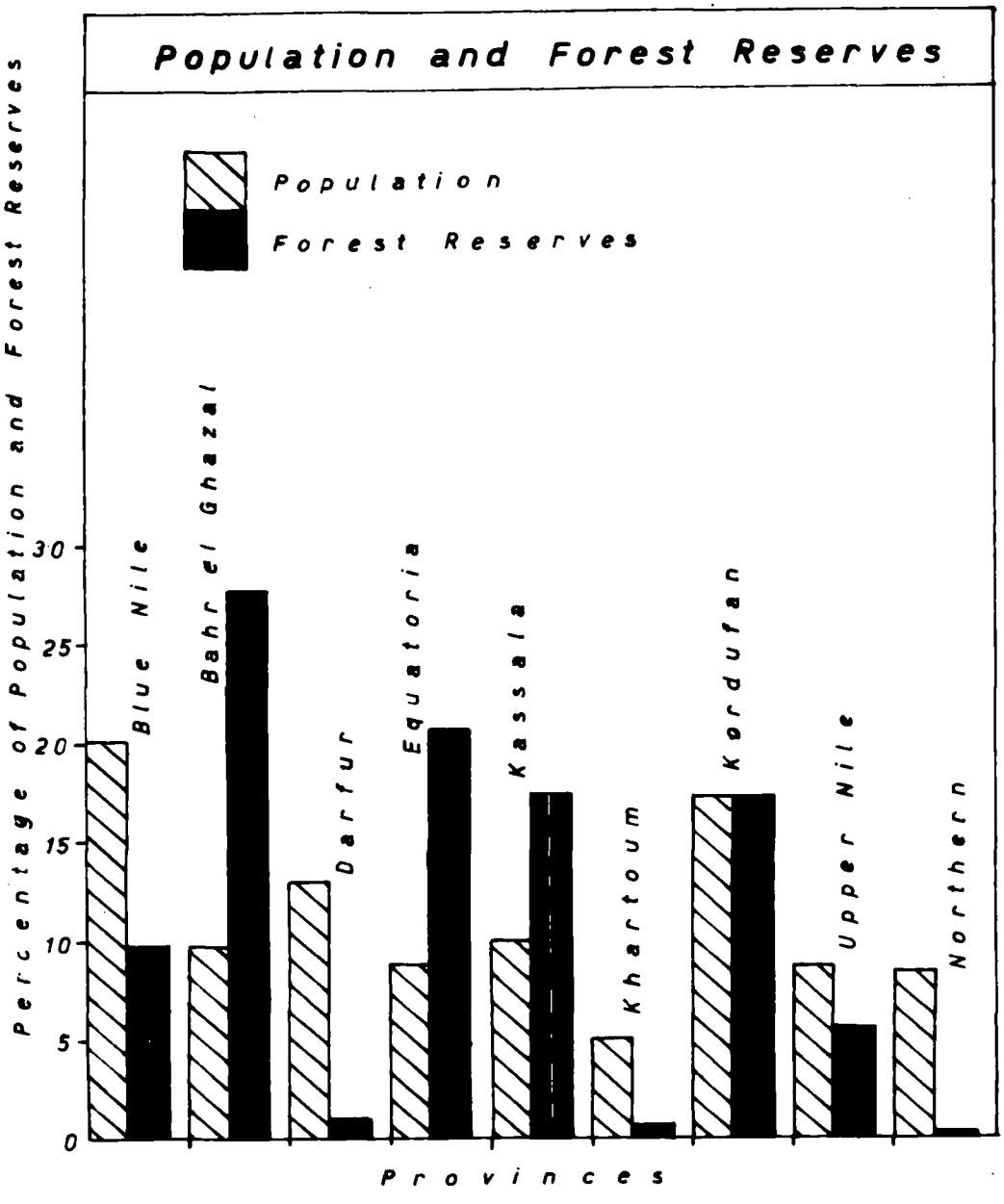

Fig. 8: Compiled from data of Tables III and V.

Table V: Total Forest Reserve by Province (on 30.6.63)

Province	Forest Reserve in Feddans	% of Forest Reserve
Bahr el Ghazal	716,933	27.80
Blue Nile	250,806	9.70
Darfur	23.883	0.93
Equatoria	533,395	20.70
Kassala	448,625	17.40
Khartoum	12,698	0.49
Kordufan	441,699	17.20
Northern	3,676	0.14
Upper Nile	142,696	5.60
SUDAN	2,574,411	99.96

Source: Forests Department, Report for the Period July 1962 to June 1963, Khartoum, p.46.

Chapter II

Classification of Vegetation and Forest Influences

A. Natural Vegetation

1. Classification of the Vegetation:

The classification used here is based on the work produced jointly by M.N. Harrison, former Pasture Research Officer, Ministry of Animal Production, Sudan, and J.K. Jackson, former Silviculturist, Forests Department, Sudan. Both authors had travelled over practically the entire country and had been familiar with plant associations. The relatively weak points of the one are the strong points of the other, one being more familiar with, and concentrating on, grazing areas, and the other dedicated to areas where forestry is important; this joint effort tends to be a more thorough account. The other published classifications of the vegetation of the Sudan (Appendix II) are either out-dated (Shantz and Marbut), general (Lewis), so detailed (Lebon), deal with only one part of the country (Southern Development Investigation Team) or produced primarily to show data other than vegetation (Ferguson), that they are not suited to the present study.

The major vegetation zones are determined by climatic factors (Appendix I) while the distribution of

forest plants and their varying types within a certain climatic zone is affected by edaphic factors. A modification has been made here to ignore the wide range of botanical details and to bring out the relationships of vegetation types, especially woodland, with climate, soils and other types of land use (Table VI).

Table VII: Summary of the Classification of Vegetation

Main Divisions	Sub-Divisions	App.Area in Feddans 000	
		Sub-Divisions	Main Divisions
I. Desert	-	-	170,660
II. Semi-Desert	(a) *Acacia tortilis-Maerua crassifolia* Desert Scrub.	43,884	
	(b) Butana Semi-Desert Grassland.	24,380	
	(c) Semi-Desert Grassland on Sand.	20,113.5	
	(d) *Acacia mellifera-Commiphora* Desert Scrub.	20,113.5	
	(e) Semi-Desert Scrub of Southern Red Sea Hills.	7,314	
	Total Semi-Desert		115,805
III. Woodland Savana	A. Low Woodland Savana		
	1. On Clay Soils		
	(a) *Acacia mellifera* Thornland		
	(i) On DarkCracking Clays alternating with Grass Areas.	22,551.5	

Main Divisions	Sub-Divisions	App.Area in Feddans 000 Sub-Divisions	App.Area in Feddans 000 Main Divisions
	(ii) On Hill Soils formed in Situ.	12,190	
	(b)Acacia seyal-Balanites Savana alternating with Grass Areas.	28,037	
	(c)Angeissus-Combretum Woodland Savana	11,580.5	
	2.On Stabilized Sand Dunes and Archaean Outcrops		
	(a)Gum Arabic Scrub Belt.	15,237.5	
	(b)Low Woodland Savana of Southwestern Kordufan and Southeastern Darfur.	20,113.5	
	(c)Terminalia-Sclerocarya Woodland Savana.	15,237.5	
	3.Special Areas		
	(a)Toposa Area Type.	8,533	
	(b)Hill Catena Type.	16,456.5	
	(c)Baqqara Catena Type.	4,266.5	
	(d)Raqaba Catena Type.	7,923.5	
	Total Low Woodland Savana	162,127	
	B. High Woodland Savana		
	(a)Deciduous High Woodland Savana	73,140	
	(b)Modified Tropical Rain Forest	8,533	
	Total High Woodland Savana	81,673	
	Total Woodland Savana		243,800
IV. Seasonal and Permanent Swamps Region			57,902.
V. Mountain Vegetation Zone			1,523.7

2. Description of the Vegetation Zones:

I. Desert: The most important of the herbs and grasses of the almost soilless and rainless desert is the valuable camel-pasture "gizu" which is confined to northern Darfur. It marks the target for the northward migration of some camel-owning tribes, which cover over 500 miles of distance to browse and thrive during the cool, dry season. Some eight principal species of "gizu", which were described by Newbold,(1) are Indigofera brachteolata, Indigofera arenaria, Crotalaria thebaica, Tribulus alatus, Fagonia cretica, Neurada procumbens, Triraphis pumilio and Aristida papposa.

II. Semi-Desert: This zone stretches from about the 75 mm. isohyet wetwards to a line south of which the growth of annual grasses is such as to render annual grass fires a probability; this line runs along the 250 mm. isohyet on sands and the 350 mm. isohyet on clays and heavy loams. The bulk of the rain, which comes in the form of local scattered light showers, very rarely falls outside the two months of July and August. The coastal area of the Red Sea has a winter rainfall regime with most of the rains between November and January and is a part of this vegetation zone. The vegetation is composed mainly of a mixture of grasses and herbs. Usually two-metres

(1) D. Newbold, A Desert Odyssey of a Thousand Miles, S.N. and Records 7(1924), pp.43-92.

high, scattered woody plants are interspersed with bare areas. The proportions of the annual and perennial grasses are almost equal on sands and loams, but on dark cracking clays the perennial grasses are virtually absent. Although this zone lies north of where the annual grass fires are frequent, some occasionally occur in the wetter parts but are not extensive and severe enough to play a significant role in the determination of the species composition of the vegetation. Grazing, particularly in the low-rainfall periods and around the settlement centres, has rendered vast tracts of land completely bare of plant growth.

The westward, gradual transition of the sub-division II (a) into II (d) awaits explanation. According to Harrison and Jackson, these two sub-divisions have a soil feature in common: they "occur on areas where there is a sharp division into hard-surfaced, off-flow soils more or less completely bare of vegetation, at one extreme, and on-flow soils that have scrub bushes and even some trees at the other extreme."(1) In the northern sands and the bare rocks of II (a), the vegetation, according to Worrall,(2) is essentially limited

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(1) M.N.Harrison and J.K.Jackson, Ecological Classification of the Vegetation of the Sudan, Forest Bulletin No.2 (New Series), Agricultural Publications Committee, Khartoum, 1958, p.5.

(2) G.A.Worrall, Patchiness in Vegetation in Northern Sudan, Journal of Ecology 48(1960), pp. 107 - 15.

to watercourses. Kassas[1] described many species of this zone, other than the dominant Acacia tortilis, including Leptadenia pyrotechnica, Capparis decidua and Ziziphus spinachristi.

In the Red Sea area, Lycium persicum, a tree not found anywhere else in the Sudan, is the characteristic species. In the sea itself, mangroves extend from the border with the U.A.R. southwards; while further inland on areas which are covered by the sea only at certain parts of the year, a saltmarsh type of vegetation exists. The sand at the upper edge of the salt-marsh bears Sporobolus spicatus as the dominant species. All these plant types offer valuable pasture for the camels of the Beja tribes; signs of overgrazing are spreading around Port Sudan and along seasonal streams.

The Butana Semi-Desert Grassland II (b) includes the central parts of the Gezira "as before the construction of the Gezira scheme it seems to have had similar vegetation",[2] but it has now been cleared, not only by the irrigation scheme, but also by pump schemes, rain cultivation and intensive grazing. Acacia nubica occurs as an indicator of overgrazing. Grasses do not form a continuous cover but exist in patterns which resemble ripples on a sandy beach; these patterns have

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(1) M.G. Kassas, Land Forms and Plant Cover in the Desert, Sudan, Bull. Soc. Géog-D'Egypte 29(1956), pp.43-58.

(2) Harrison and Jackson, op. cit., 1958, p.7.

been examined by Worrall[1] but no definite interpretation has resulted.

Bordering the Butana in the east and west are the Atbara river and the Blue Nile, which carry a different type of vegetation. Here Acacia nilotica and Acacia arabica occur in forests and thickets, yielding a low-quality type of gum and heavy wood. Although they attain their best development along the Blue Nile (on the small areas of the bends of the river which are flooded every summer), they also extend along the main Nile as far north as Wadi Halfa, along the White Nile as far south as Renk, and along the seasonal watercourses. Along the White Nile these Acacia nilotica forests are more widely distributed on the flats of the river, and they depend not on rainfall but on flooding for their moisture. In many places along these rivers, the forests and thickets have been denuded and overgrazed and semi-desert grasses have taken their place.

In the Semi-Desert Grassland on Sand Soils II (c), trees are often completely absent or occasionally exist as limited, scattered individuals. Towards the southern part of this zone where grazing has been more thorough, there are pure stands of Cyperus conglomeratus, a species unpalatable to grazing animals.

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(1) G.A. Worrall, The Butana Grass Patterns, Journal of Soil Science 10 (1959), pp. 34 - 53.

III. Woodland Savana:

This most extensive vegetation type comprises "any mixed type of vegetation composed of grass and bushes or trees or both in which the very variable proportion of grass to bushes or trees is determined by the frequency and intensity of fires. It is the type of vegetation characteristic of the dryish tropics with monsoon rainfall confined to a few months, followed by a long, hot, dry season."(1) It differs considerably from areas where trees are limited and scattered to areas where trees stand closely in thickets, restricting the growth of the grasses below. Woody plants must have a fair degree of resistance to fires which have a high frequency here. Towards the drier parts of this region, the light rainfall and its short duration render annual grasses more competitive than perennials and thus Acacia is the dominant genus. Rainfall ranges from 350 mm. in the north to about 1,450 mm. in the southern extremity of the zone. It has been divided on a rainfall basis into Low and High Woodland Savana, the dividing line being about the 850 mm. isohyet on sands and the 950 mm. on the clay plain.

III. A. Low Woodland Savana:

In the drier parts of the zone, Acacia species

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(1) Harrison and Jackson, op. cit., 1958, pp. 9 - 10.

predominate whereas in the wetter parts broad-leaved deciduous trees become more common. Trees are short and thorny, and the variety of species is not as great as in III.B. This region, which covers most of the central Sudan, has no soil formed in situ from the underlying rock except on limited localized hills on which rapid erosion processes are operating, but has two distinct types of soil: dark cracking clays in the east and stable sand dunes in the west. These soil differences are reflected in the two distinct types of vegetation, III.A.1. and III.A.2, each of which has been divided, on a rainfall basis, into three sub-divisions. The grasses are predominantly annuals and the limited perennials are shorter and less coarse than those of III.B.

In the Low Woodland Savana on Clay Soils (III.A.1.), the marked change in the overwhelming species clearly indicates the transition from one rainfall belt to another. The grasses here do not occur as a mixture, but "occur in patches, each patch being dominated by a single species almost to the exclusion of other species. The marked change from one species to another takes place suddenly and without obvious reason."(1) Further investigation in this grass patchiness is necessary. The sub-division III.A.1(a)(i) is characterized by an Acacia/grass cycle; here the dominant

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(1) Harrison and Jackson, op. cit., 1958, pp. 10 - 11.

tree is Acacia mellifera, existing in almost pure, impenetratable stands, thus greatly reducing the grass growth and rendering the thickets fireproof. Harrison and Jackson[1] explain this Acacia/grass by saying that the canopy of the impenetratable Acacia mellifera is broken by the deaths among the trees when they grow old; grass will start to grow more vigorously, and the fires, eventually sweeping these grasses, will kill the remaining trees; the site will ultimately be occupied by grassland which persists for a number of years before recolonization by Acacia mellifera takes place.

In zone III.A.1.(b), rainfall ranges from 600 mm. to 950 mm., but the heavy clays of this zone cannot absorb more than about 700 mm.; hence flooding conditions occur, leading to the disappearance of trees and dominance of grasses as far south as the swamps region, IV. The limited, relatively higher areas within these swamps, due to their slight degree of slope, have typical savana vegetation of this zone. These higher, slightly flooded or unflooded areas are too small to be mapped separately and hence included in region IV. In this zone (III.A.1.(b)), Acacia seyal and Balanites are mixed and distributed in varying proportions. During the native cultivation the Acacia seyal

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(1) Harrison and Jackson, op. cit., 1958, p.11.

are cut and burnt to give room for agriculture, and the Balanites are left pure. The sub-division III.A.1.(c) is essentially confined to sloping land; although Acacia seyal is sometimes found alternating with broad-leaved trees, Anogeissus schimperi and Combretum hartmannianum generally replace the Acacia species beyond the 800 mm. isohyet.

In the Gum Arabic Scrub Belt, III.A.2.(a), the characteristic tree which yields the Sudan's second export crop (gum Arabic), Acacia senegal, occurs widely in single-species thickets. In the cultivated areas Acacia senegal grows vigorously during fallow periods, and is tapped after 6 to 8 years until clearance is repeated between the 10th and 15th year.(1) This indicates that in at least part of its range Acacia senegal may be an essentially secondary species occurring after cultivation.(2) In the depressions, into which some clay has been washed, Acacia nubica and Adansonia digitata are found. The trunk of the latter tree, after being hollowed out, is used to preserve water of the rainy season to be used during the dry period when water shortage is acute in this area.

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(1) H.S.Blunt, Gum Arabic, with Special Reference to its Production in Sudan, Oxford University Press, 1926.

(2) Harrison and Jackson, op. cit., 1958, p.14.

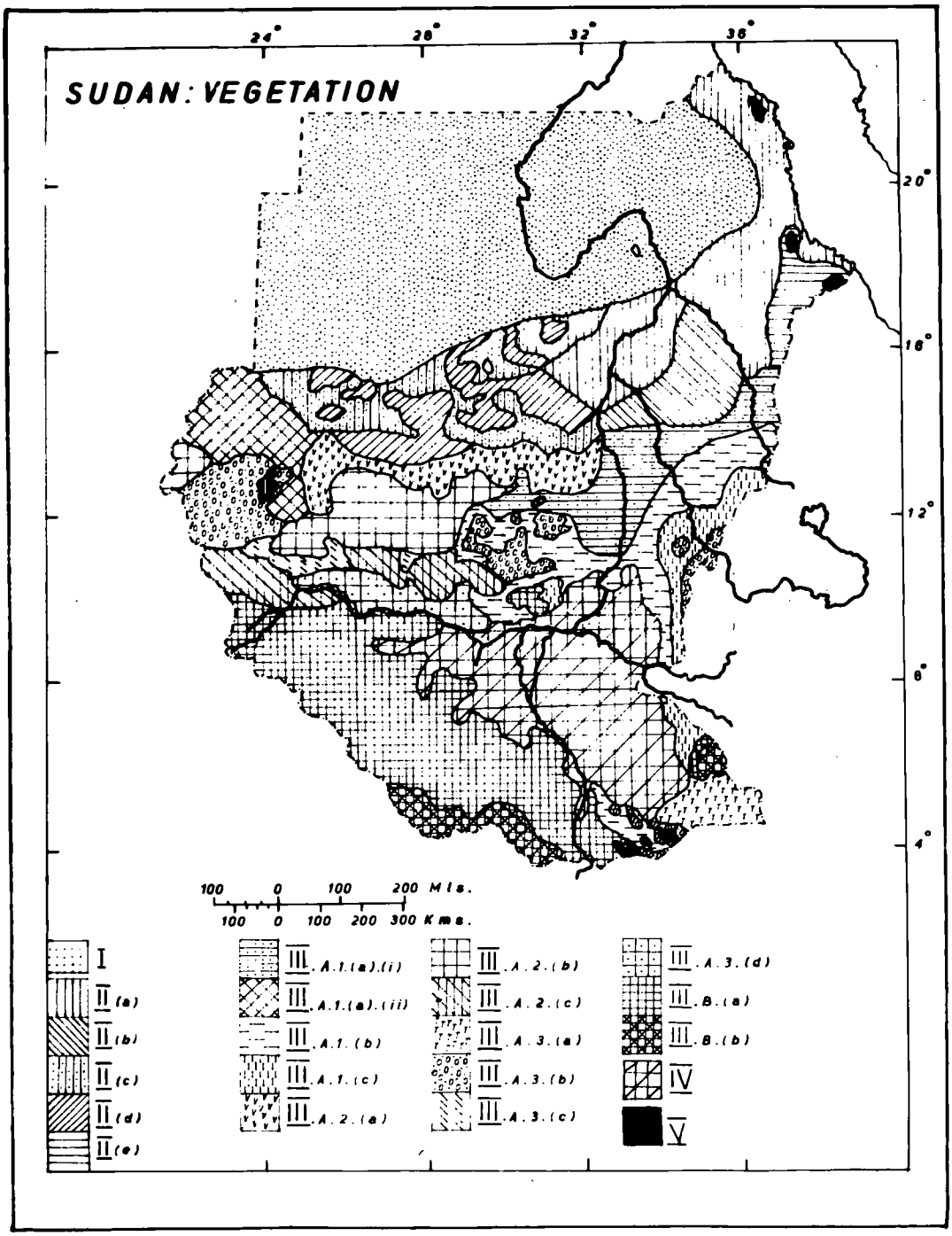

Fig. 9: Redrawn with amendments from Harrison and Jackson, op. cit., 1958. The symbols correspond with those in Table VII.

In zone III.A. 2.(b), the dominant tree species are related to the soil types; Combretum cordufanum is associated with softer sands, Dalbergia melonoxylon is found on harder sands and Albizzia amara is associated with sands having a hard red layer due to iron salts. This is characteristic of the El Obeid-En Nahud area where this hard layer is up to about a foot below the surface, but it is brought to the surface by erosion near towns and big villages. Acacia senegal is limited in distribution, either following shifting cultivation or on lower slopes leading into depressions.

The Low Woodland Savana reaches its maximum development in zone III.A.2.(c), where transition from the Acacia scrub is complete, and Acacia senegal is to be observed only where the soil is exceptionally dry.

The four Special Areas of the Low Woodland Savana are local types of mixed vegetation and cannot be fitted in the general pattern of the classification.

III.B. High Woodland Savana:

This type of vegetation is characteristic of the Ironstone plateau and occupies most of the Bahr el Ghazal and Equatoria Provinces. Here thorny species largely disappear, giving way to taller trees with generally more foliage. These are broad-leaved trees and include both deciduous and

evergreen species, though the former commonly reduce their foliage during the short dry season. Grasses are mostly perennials. The effects of cultivation and grazing vary considerably from areas which are ungrazed and uninhabited owing to infestation by tsetse fly to areas which are intensively cultivated and heavily grazed.

The Deciduous High Woodland Savana III.B.(a), is one of the most extensive vegetation types of the country, being continuous over the Ironstone plateau from Hufrat en Nahas to Torit. Rainfall, which falls in 9 months, varies from 900 mm. to 1,300 mm; during this lengthy period, the area is a jungle of deciduous and semi-deciduous trees; during the short dry season, grasses die out, growth of trees is restricted and fierce fires result from the combustion of the abundant dried plant matter. The vegetation is far from being uniform owing to catena development and the variable incidence of shifting cultivation. The trees do not usually mix together, but occur in separate patches on different soil types.

Throughout the sub-division, Khaya species are the most widespread; on the drier parts it is often found in the centre of dense evergreen thickets while on the wetter parts it is more scattered among the rest of the vegetation. Anogeissus occurs all over the zone west of the Bahr el Jebel

and below 800 metres of altitude; on the wetter ends of its range, it often forms closed woodland with little grass. Isoberlinia, which is restricted in distribution to areas west of the Bahr el Jebel, tends to exist in almost pure stands on the lighter soils, especially in the wetter parts of the region.

In zone III.B.(b), Modified Tropical Rain Forest, the heavy well-distributed rainfall is sufficient to produce true rain forest, but cultivation and fires deliberately started by man have reduced most of the forest to a high woodland savana in which trees grow together with tall grasses. Here the weeds, grasses and quick-growing bushes are competing with the young forest trees which will, apart from further human intervention, later become dominant. The number of species is large, but the major trees are Terminalia glaucescens, Albizzia zygea and Vitex doniana; the understorey is mainly Combretum binderianum and Grewia mollis. Along stream valleys and in areas where the forest has recently been destroyed, elephant grass predominates.

Gallery forests, which may be considered as reduced forms of rain forest, are confined to the neighbourhood of streams. They are best developed in this zone, but also extend into the northern zone, III.B.(a), and include Khaya grandifoliola, Cola cordifolia and Syzygium guineense as the dominant woody species.

Included in this zone are the small remnants of the true virgin tropical rain forest left in the Sudan. These are to be found at Lotti, Laboni and Talanga, east of the Bahr el Jebel, and at Azza and on the Aloma plateau west of this river. In these remnants the dominant species are Celtis zenkeri, Chrysophyllum albidum and Holoptelea grandis, and many others in the lower storey.

IV. Seasonal and Permanent Swamps Region:

The relatively high lands here, which are very limited in extent, are never more than 3 feet above the flood level, and are rarely flooded. Being the habitat of the tribesfolk and their animals during the rainy season, its natural vegetation has been altered by grazing and clearance of land for crop production. The palms, Hyphaene thebaica and Borassus aethiopium, are the most common surviving trees and, according to Lebon,(1) their existence is an indication of local sandy soil or of sandy water-holding beds below the surface clay. Where clay soils prevail from the surface until the end of root penetration area, Acacia species are common, especially Acacia sieberiana, A.seyal, A.fistula and A.senegal. The grasses here have been modified even more than the trees, to the extent that no one could yet tell their floral composition before the human occupation.

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(1) Lebon, op. cit., 1965, p.39.

Below the previous zone is a type which is usually flooded during the rainy period and is covered by swamp grasslands. During the dry season the low-lying areas are still moist and plant growth continuous but is usually kept short by grazing. The relatively shorter grass may be fired near the inhabited area to give room for cultivation, or else is grazed by cattle. Of more significance to the Nilotic tribes are the permanently moist grasslands because, though limited in extent, they grow throughout the dry season and hence provide grazing for cattle when the rest of the clay plain is barren. The dominant grass genus is Echinochloa, especially Echinochloa stagnina and E.pyramidalis.

The permanent swamp proper is located along the Bahr el Jebel, the Bahr el Zaraf and the Bahr el Ghazal; it does not extend far from the beds of these rivers because the characteristic vegetation requires ample moisture all the year round; the maximum width of the swamp is about 1.3 miles. The dominant plant is Cyperus papyrus. Almost similar conditions prevail in the permanent Machar marshes, north of the Sobat river.

V. Mountain Vegetation Zone;

In the Imatong and Dongotona Mountains of Equatoria Province, the wetter parts of the lower slopes up to 4,500', are covered with vegetation similar to that of the

zone III.B.(b), but with fewer species. On the rocky slopes and in the drier areas, Boswellia papyrifera and Terminalia brownii become common[1]. On the lower mountain zone, attaining a height of about 7,000', Syzygium spp. are dominant. Other trees include Olea hochstetteri, with a dense crown, Podocarpus milanjianus, forming the climax forest, Acacia xiphocarpa, occurring on shallow sandy soils, and Albizzia Gummifera, intervening between open areas and climax forest especially after cultivation. The upper mountain zone, extending between 7,000' and 9,000' of altitude, is covered by almost pure stands of Podocarpus milanjianus. This zone contains much larger areas of mountain meadow, with trees and grasses. Ericaceous species dominate the zone from 9,000' of altitude to the summits, above 10,000'. The dominant shrubs, Erica arborea and Myrica salicifolia, are accompanied by the grasses Exotheca abyssinia and Tripigon snowdenii.

At the southern end of the Didinga mountain range the summits of Mount Lotuka bear vegetation similar to that of the lower mountain zone of the Imatong Mountains, with Podocarpus milanjianus as the climax vegetation, and Albizzia spp. are commonly found. Northwards at a lower latitude, is a belt which originally appears to have been a forest of Juniperus procera and Olea chrysophylla which has been greatly

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(1) J.K.Jackson, The Vegetation of the Imatong Mountains, Sudan, Journal of Ecology 44 (1956), pp. 341 - 74.

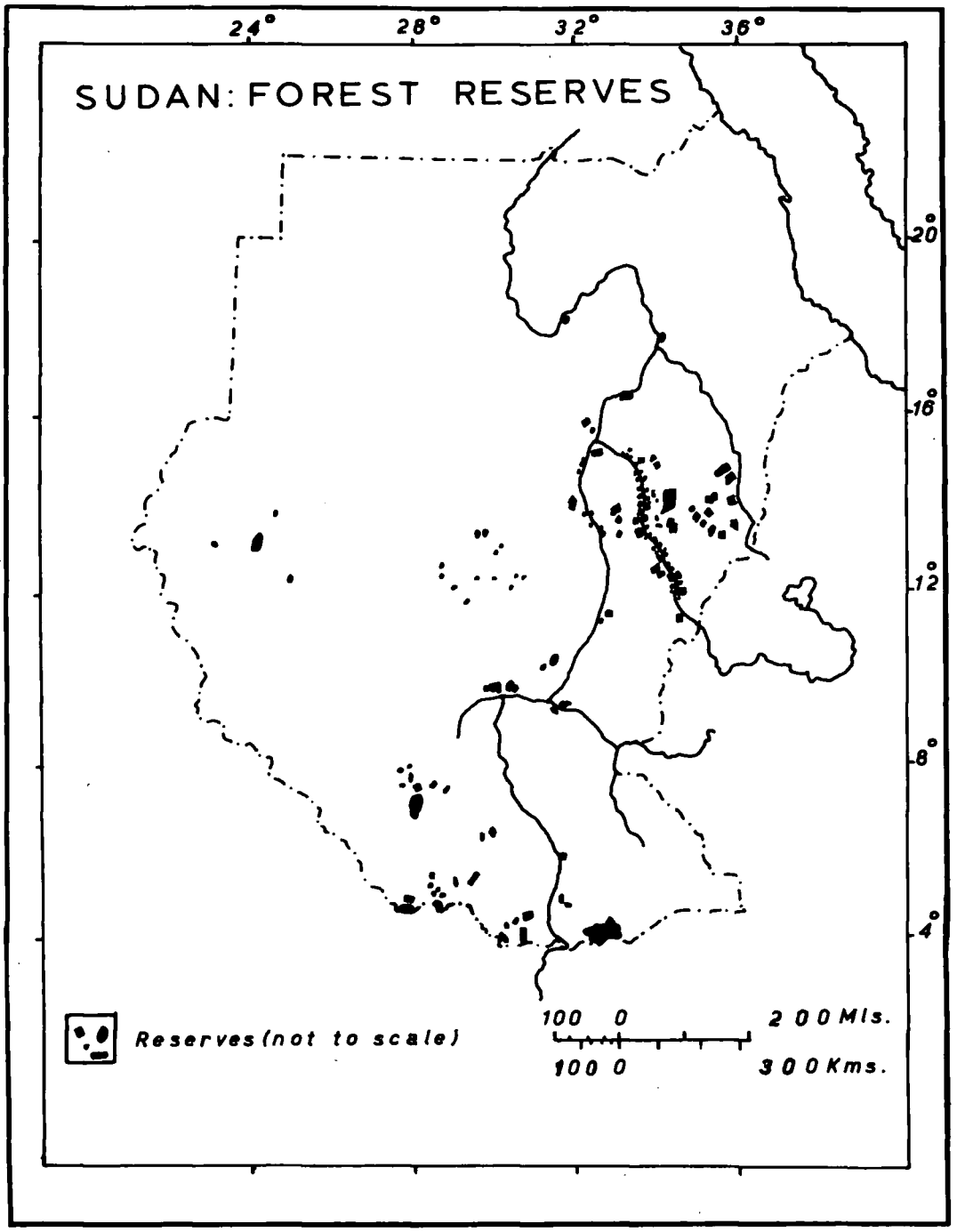

Fig. 10: Compiled from data of Forests Department, Report for the period July 1962 to June 1963, Appendix 1, Khartoum.

reduced by fire;[1,2] now there is only grassland with scattered trees and a few thickets of Podocarpus milanjianus. Further north and along the "wadis" and valleys, forests of Albizzia maranguensis become dominant.

The Jebel Mara is a volcanic crop, rising some 7,000' above the plateau of Darfur, and receiving about 900 mm of rainfall on its southern slopes. Below 5,500', the land is largely cultivated and here we find Cordia abyssinica, Thespesia grackeana and Ficus spp., interspersed with clearings for cultivation. The grasses of this zone include Cymbopogon spp., Andropogon gayanus and Heteropogon contortus. In the middle zone, between 5,500' and 6,500', Olea laperrini is the most common tree on older soils, with Acacia albida on immature volcanic tuffs. Ficus is dominant especially in valleys and sheltered places while Salix safsaf is concentrated near the streams. The trees are very sparse and most of the zone is open grassland. On the summits, the dwarf species Hyparrhenia multiplex and H. anthistirioides are widespread and the low ericaceous Blaeria spicata is common.

In the Red Sea hills, the wettest summits close to the Ethiopian frontier are covered by almost pure stands of Juniperus procera and some Olea chrysophylla. On the highest

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(1) Lebon, op. cit., 1965 p. 43.

(2) Harrison and Jackson, op. cit., 1958, p.25.

ground near Erkweit, above about 3,500', only Olea chrysophylla remains of these species. Much further north, on the summits of the Jebel Elba and the Jebel Asoteriba near the frontier with the U.A.R., trees are more scattered and Olea chrysophylla is the most common species.

B. Forest Influences:

Forests are often viewed as a source of timber, firewood and charcoal or else as occupying land which could otherwise be used for the production of agricultural crops or as grazing land. Of almost equal importance are those influences which the forest exerts on its environment and which are undervalued, if not completely ignored, only because they cannot be evaluated in monetary terms.

1. Influences on Climate:

Wind velocity may be reduced by the forest stand by 40 - 80%(1). The degree of reduction of the wind speed inside the forest is directly proportional to the height, length, width and density of the individual crowns and to the density of the forest stand. The thinning of the canopy increases evaporation, and so it has a drying effect, especially in the relatively arid, hot parts of the country.

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(1) J. Kittredge, Forest Influences, McGraw-Hill Book Company, New York, 1948, p.71.

The disappearance of forest stands has facilitated the free passage of wind and helped the prevalence of severe, damaging winds in Khartoum and Tokar areas.

Solar radiation is another factor of the forest microclimate. Sun rays do not bring only light, but also heat, and since the forest permits decreased light to penetrate, this must be accompanied by decreased temperatures. This admission of minimum heat and light, as in the remnants of the tropical rain forests which have not yet been interfered with, does not allow the dense growth of tall grasses which assist the spread of severe grass fires and hinder the free movement of man and game. Associated with this effect on solar radiation is the effect on air temperatures, the extremes of which are modified by the forest, rendering the climate more equable.

The relative humidity of the air inside the forest is higher than in the open, the increase being usually from 4% to 10%[1]. This is attributable to many factors: the mean temperature of the air is lower inside the forest than in the open and hence has a lower saturation point; the moisture content of the air inside the forest is increased by transpiration from the leaves; and the lower velocity of the wind inside the forest prevents the water vapour from being carried away rapidly. Closely connected with relative humidity and temperature is the effect of the forest on rainfall, which

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(1) R.S.Troup, Colonial Forest Administration, Oxford University Press, 1940, p.22.

is a debatable topic; the increase of rainfall is only slight. Of more importance is that the action of the heavy, torrential tropical rains is reduced to a significant extent by the canopy of the forest, thus protecting the soil inside the forest.

2. Influences on Soil:

Continuous cropping of land impoverishes the soil through the removal of nutrient substances, and fertility has to be restored by adding manures and fertilizers. The forest has an opposite effect; soils under forest cover are constantly enriched by the addition of organic constituents including nitrogen and inorganic material, all of which undergo progessive changes after leaf-fall through the agency of a large population of bacteria, worms, fungi, insects and other animals. Another important aspect is the effect of the forest on the structure of the soil, rendering it more porous and deeper than soil in the open; this is due to the penetration, expansion and subsequent decay of the roots, thus creating channels and changing the structure of the soil. This greater porosity and the ability of the forest floor to retain from 1 to 5 times its dry weight of water,[1] account for the higher soil moisture in the forest than outside There is a marked difference between the influence exerted

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(1) Kittredge, op. cit., 1948, p.213.

by the forest on soil and that exerted by other plant covers, especially grass which when dense and unbroken provides effective defence against surface erosion. But it affects the soil nutrient status only in a comparatively thin layer while the forest penetrates to a far greater depth. Also grass cover, because it is easily saturated with water, facilitates run-off while the natural forest tends to allow deeper infiltration and thus increased water supply.

If the vegetation cover is destroyed, the top-soil then exposed to the dessicating action of the sun and the erosive violence of torrential rains or strong winds, may be swept away in the space of a few years. Although the main agents of erosion are water in the rainy season and wind during the dry period, there are other agents which have acquired a major significance since they harden the top-soil and involve a loss of nutrients and permeability; such agents include grass and bush-fires, tree cutting, heavy grazing and shifting cultivation. The loss does not end by washing away the fertile top-soil, for the addition of large quantities of sediment to the drainage creates severe problems.

It is true that erosion cannot be completely eliminated or avoided but the protective cover provided by the forest reduces it. The forest is more than a defence against soil erosion; it also provides a protection for the soil on the most sterile and the most unproductive areas and enhances their quality. To destroy the forest or to replace

it by some unsuitable form of land use can have disastrous consequences on the productivity of the soil and the increase of the rate of erosion over considerable areas of the Sudan; this has resulted in the encroachment of desert and the sandstorms which sweep through the fertile lands of northern Sudan from the Sahara.

3. Planted Belts:

Since the various needs of the population for land make it impossible to re-establish the vegetation cover on the whole of its potential growing area, means to recover the changed or disturbed ecological balance should be found. One of the most efficient methods is the planting of shelter belts; by means of tree belts, the forest can be extended beyond the boundaries of its normal growth, for instance into the semi-desert areas. With the application of irrigation, ploughing and manuring, trees can be established in an environment normally inimical to their growth. Tree planting is thus essential in the northern parts of the Sudan which are often swept by sandstorms and threatened by desert encroachment, and where natural tree growth is hampered by climatic conditions. The main problem, constituted by the inadequacy of irrigation water, may be solved after the completion of the Aswan High Dam, and by the utilization of the seasonal streams radiating from the limited hills and isolated "jebels".

It is quite unfortunate that the vast majority, if not all, of the farmers and scheme-owners ignore the importance of shelter belts since they see only the drawbacks which tree growth imposes on the cultivation of a field; to them, it involves a loss of ground, hinders mechanization, and reduces the yield of a crop through its shading and the competition of its roots.

(a) Shelters for Crops:

Scheme-owners and farmers must be encouraged to plant shelter belts because the profits to be derived therefrom are twofold: the trees plantation can provide timber, firewood, roof poles and fence posts, and in the meantime they shelter the field crop. No experiments on yields have been undertaken in the Sudan, but Appendix IV gives a general idea of the effect of shelter belts on the yields of some crops in the steppe regions of the U.S.S.R. Shelters can also prevent direct wind damage to the rather delicate products like flowers and fruits.

(b) Shelters for Pastures:

This kind of shelter cannot be spoken of without stressing the necessity of improving the grazing lands of western and eastern Sudan by the provision of adequate water points and the growing of grasses palatable to animals on a scientific basis, and, above all, the careful control of these

pastures against over-concentration of animal population. A shelter "provides earlier growth and therefore greater production of grass. Better strains of grass can be grown, and therefore more stock, and also better strains of stock can be kept."(1) The shelter can also protect the animals against high winds. If the grazing land is limited, which is not the case in most parts of the country, the screen can be located in a place less suitable for the grass growth. The sudan, which has a large animal population grazing on an already overgrazed, exposed and erosion-threatened land, needs such belts to fix the soil, minimize erosion and help in providing adequate rich pastures.

Species of windscreen for both cropland and pastoral land should, wherever possible, be capable of the production of good timber because ultimately a time will come when it will be needed as forest produce. The following aspects should also be considered:

(i) Root competition should be curbed as much as possible.

(ii) Owing to the ever increasing need for mechanization, higher growing species must frequently be chosen for the protection of larger plots.

(iii) Where the cultivable land is limited, as is the case along the main Nile in the Northern Province, species which will develop broad crowns may be selected for plantation of belts.

(iv) Species poisonous to animals and species which spread easily into the adjacent fields must be avoided.

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(1) J.Van Der Linde, Trees Outside the Forest in F.A.O.(ed.), Forest Influences, Rome, 1962, p.157.

(4) Other Influences:

The presence of forests and trees is recognized as being beneficial to the health of the people living in their vicinity. Many component factors contribute to this influence: the more or less complete drainage of swamps increases the healthiness of marshy localities, probably by destroying the breeding-grounds of malarial mosquitoes; another component factor is the elimination of air pollution by the fixation of dust suspended in the air on the surface of the leaves. This is why an effort is always made to set aside parks inside towns and encircle the latter with green belts; woods or even groves of trees around habitations and settlements in otherwise bare country are of great value in relieving the monotony of the scenery; they provide recreational and leisure facilities. It is also for these reasons that attempts are made to plant trees in rows along both sides of the roads.

The forest has a regulatory effect on the stream flow by ensuring a higher degree of water infiltration during the rainy season to be liberated during the dry season; it also helps the prevention of silting behind dams and on the river floor by the fixation of the soil. When these forests are devastated, infiltration is reduced, and water runs off rapidly during the rainy season carrying large quantities of sediments into the rivers; quite often these fine particles, together with nutrient material in solution, are transported out into the sea and are thus lost while the coarses fragments are

deposited in the river beds. Thus deforestation involves a loss of nutrient materials and soils, or rise of the level of the river bed and an irregularity of streamflow. The rising of the level of the river bed may hamper or halt navigation on the river itself and cause the rivers to undercut their banks and change their courses or else to overflow their banks and cause excessive damage by flooding or by the deposition of coarse sediments over agricultural lands. The silting up of streams or depressions may also cause the formation of swamps or impervious pans. The irregularity of the streamflow may also cause floods, resulting in loss of crops, buildings, domestic animals and even human lives; floods may also seriously jeopardize the health of the population. The irregularity of streamflow is also accompanied by a high probability of crop failure in areas dependent on irrigation. This forest influence on streams is of great importance, which becomes greater not only with the steady rise in water requirements for industry, electricity, cultivation and grazing, but also because by the very reason of these requirements, the users of such waters settle near their source in ever increasing numbers, forming ever richer centres which are consequently liable to irregular water supplies.

Tourism is one of these influences which is relatively ignored. Forests, which are considered in less developed communities as being unsuitable for human habitation, now attract ever larger groups of people for more or less long

stays as people become crowded in urban centres and as communication facilities spread out and increase. The only counter-attractions to the forest are the sea, lakes and beaches, and resorts, where the forest is combined with these attractions, are often preferred. The Jebel Mara, the Red Sea and the El Dinder Game Reserves may provide popular tourist centres with more than one attraction. The preservation of wild game, which is another function provided by the forest, is important not only from a tourist point of view but also as a source of hard currency. Rhinoceros, for instance, is worth of the equivalence of L.S.7,000 in hard currency per head. Many wild animals now confined to the forests of the southern parts of the country were known to live further north, but started to migrate southwards with the increasing clearance of the forests of central and south-central Sudan. It is becoming more and more pressing to demarcate and protect forests necessary for the preservation of the dear game of the Sudan.

Dune stabilization is another forest influence the utilization of which is so common and world-wide that it needs no justification. Its significance is derived from the fact that sand creep over the agricultural lands of the northern parts of the Sudan has already started.

The aspirational influence of the forest has been realized throughout the ages, and poets, writers, painters

and philosophers have derived inspiration from it. From the earliest times the forest has left a very deep impression on the minds of people, and it is often associated with religious beliefs among some of the Nilotic tribes. This finds expression in the veneration of certain kinds of trees, while the folklore of many primitive tribes is bound up with the forest and the spirits which inhabit it.

Chapter III

Forest Products

Production is the most important aspect of forestry though it cannot be separated from protection. The main aim of all forest management is to maintain a sustained yield. In this chapter there is an emphasis on the main forest products of the country though reference to minor produce is made.

1. Sawn Timber:

Sawn timber may be divided into two categories - power sawn timber and hand sawn timber, and both combine to constitute the total production of sawn timber (including railway sleepers) in the Sudan. The production of railway sleepers from both power and hand sawn timber has been continually decreasing since the peak year, 1959/60. Although the number of railway sleepers produced from power sawn timber during 1962/63 is four times that produced in 1952/53, it is only about a half, two-thirds and three-quarters of the production during the years 1959/60, 1960/61 and 1961/62 respectively (Appendix V(1)). The production of railway sleepers from hand sawn timber in 1962/63, though seven-eighths of that of 1952/53, it is only about one-sixth, one-fifth and a quarter of the production during the years 1959/60, 1960/61 and 1961/62 respectively.

This downward trend of production of railway sleepers (Fig.11)cannot be taken as a criterion for the

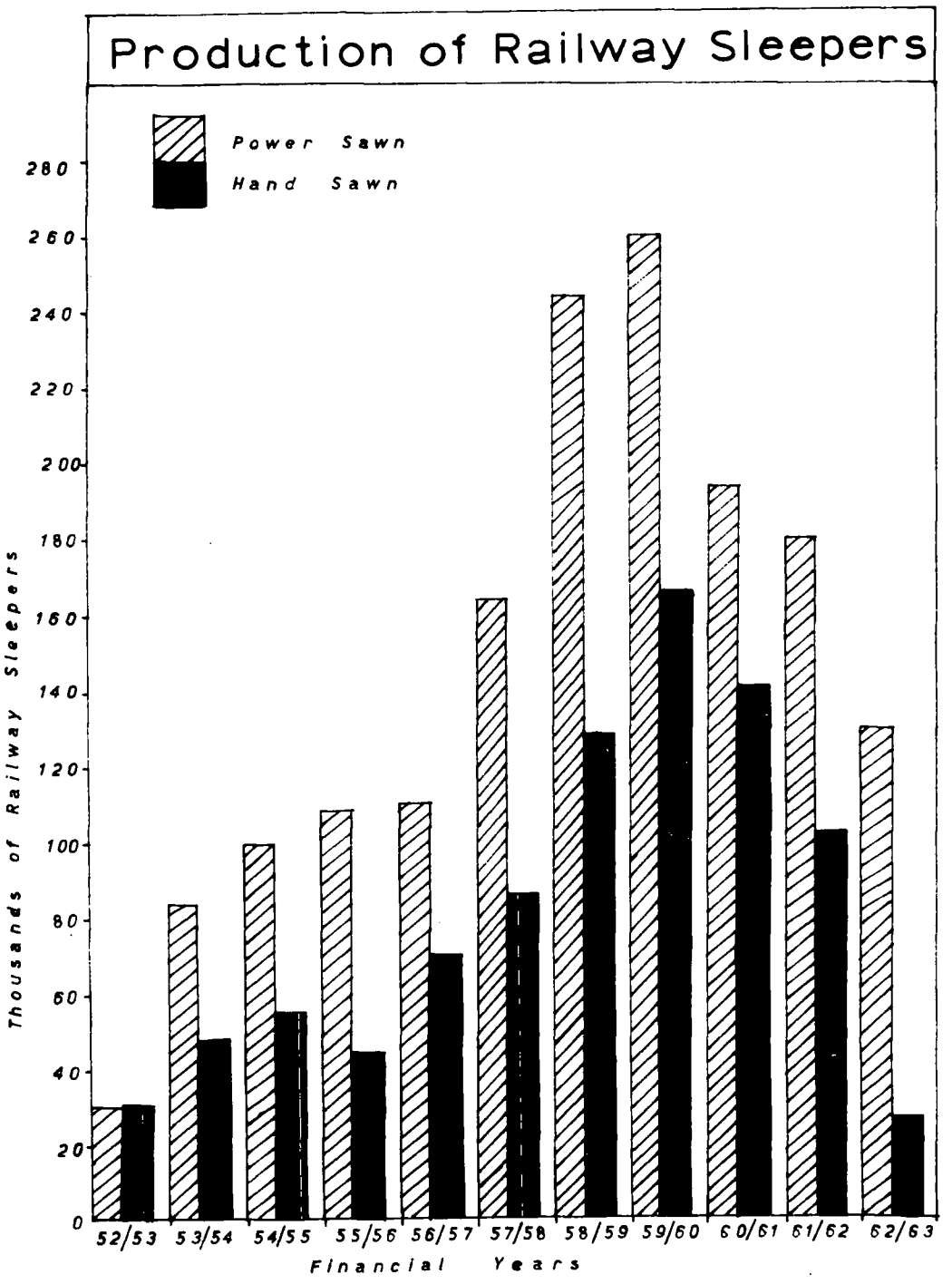

Fig. 11: Compiled from data of Appendix V(i) and (ii)

capability of the country to produce them, but it can only be regarded as an indication of the expansion of railway communication. The year 1959/60, showing the highest production of sleepers, coincided with the greatest railway extensions, southwards to Wau in the Bahr el Ghazal Province and westwards to Nyala in Darfur Province. The Sudan has now attained self-sufficiency in the production of railway sleepers for both the Sudan Railways Department and the Sudan Gezira Board. But it is necessary to remember that future economic development will essentially lean on an extensive network of railway communication and the Forests Department should be prepared to meet this future demand.

The quantitative contribution of the hand operated sawyer camps has always been significant. The proportion of the hand sawn to power sawn timber varied from 31% in 1952/53, to 29% in 1956/57, to 31.5% in 1958/59 and reached as high as 41% in 1960/61. These figures show that increasing dependence is laid on these hand sawing camps; in the short run this may be justified by the inability of the country to install expensive capital equipment, but in the long run it may be necessary to install such machinery with the aim of reducing the cost of production, increasing the productivity of the worker and meeting the requirements of the expanding population and economy.

With the exception of 1955/56 production, the total

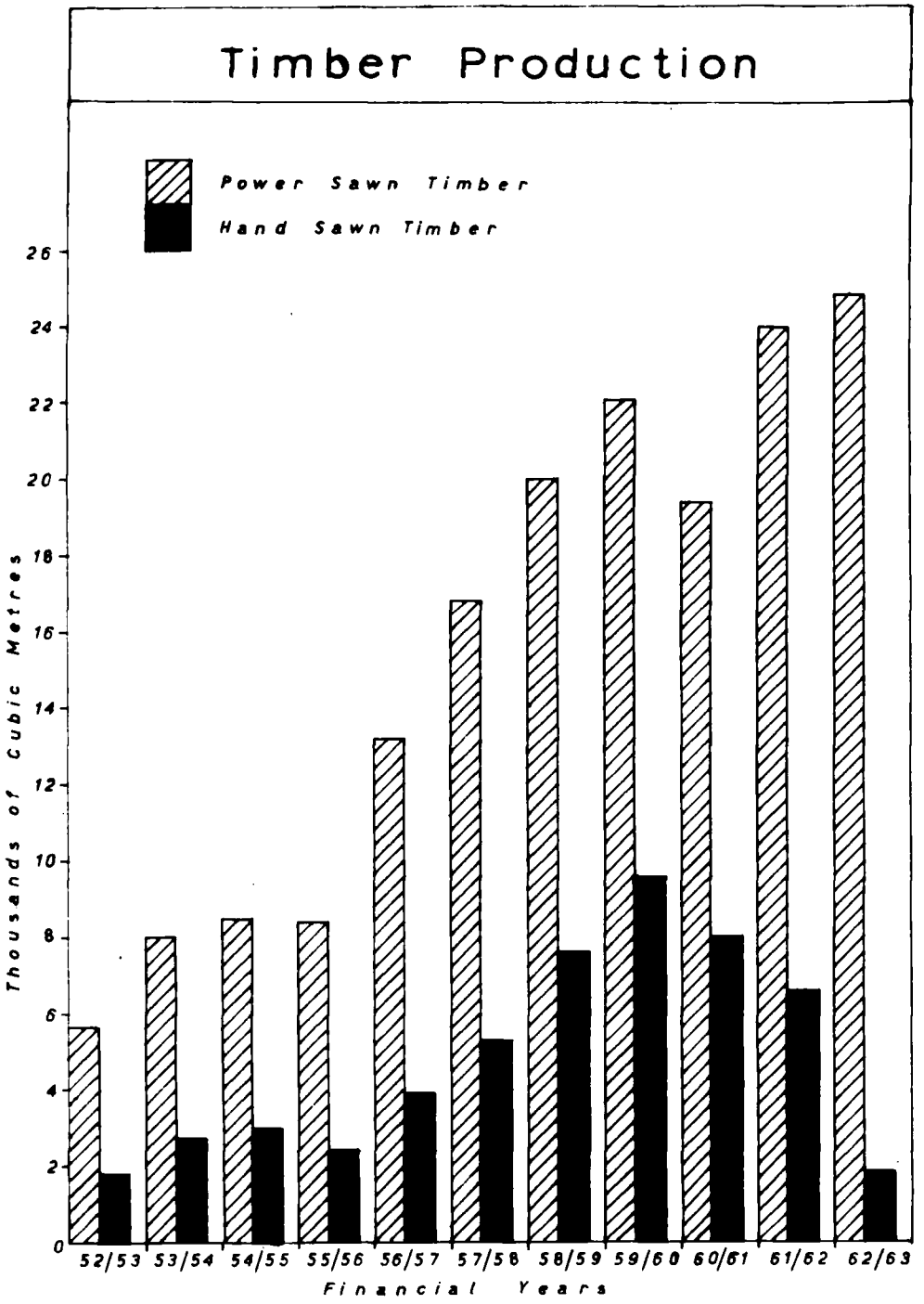

Fig. 12: Compiled from data of Appendix V(i) and (ii)

produce of sawn timber (Appendix V (iii)) annually increased by an amount varying from less than 700 to over 5,000 cubic metres; the production of 1955/56 was affected by the riots and political unstability which swept the southern parts of the country rather than by forest policy. The magnitude of production is essentially determined by the small area of forest reserves in the vicinity of sawmills, and the limited number of both sawing instalments and hand sawing camps.

Of the sawn timber, the hard wood continued to constitute over 95% of the total output (Appendix V(iii)and Fig. 13). This is only natural owing to the tropicality of the country's climate and the confinement of the altitudinal influence to very small localities. The percentage of soft timber shows a slight increase from 1.83 in 1952/53, to 2.67 in 1957/58, 1.98 in 1960/61, 3.01 in 1961/62, and 4.06 in 1962/63. Measured against the 1952/53 production figures, sawn soft wood continued to increase at a rate higher than that of the sawn hard wood; for soft timber, this percentage increase is 56 in 1956/57, 253 in 1958/59, 305 in 1960/61 and 691 in 1962/63 while the similar percentage increases for hard timber are 118, 244, 268 and 253 respectively for the same years.

The first survey to assess the present requirements of the country for the main forest products was conducted in 1962 by the Forests Department of the Sudan, assisted

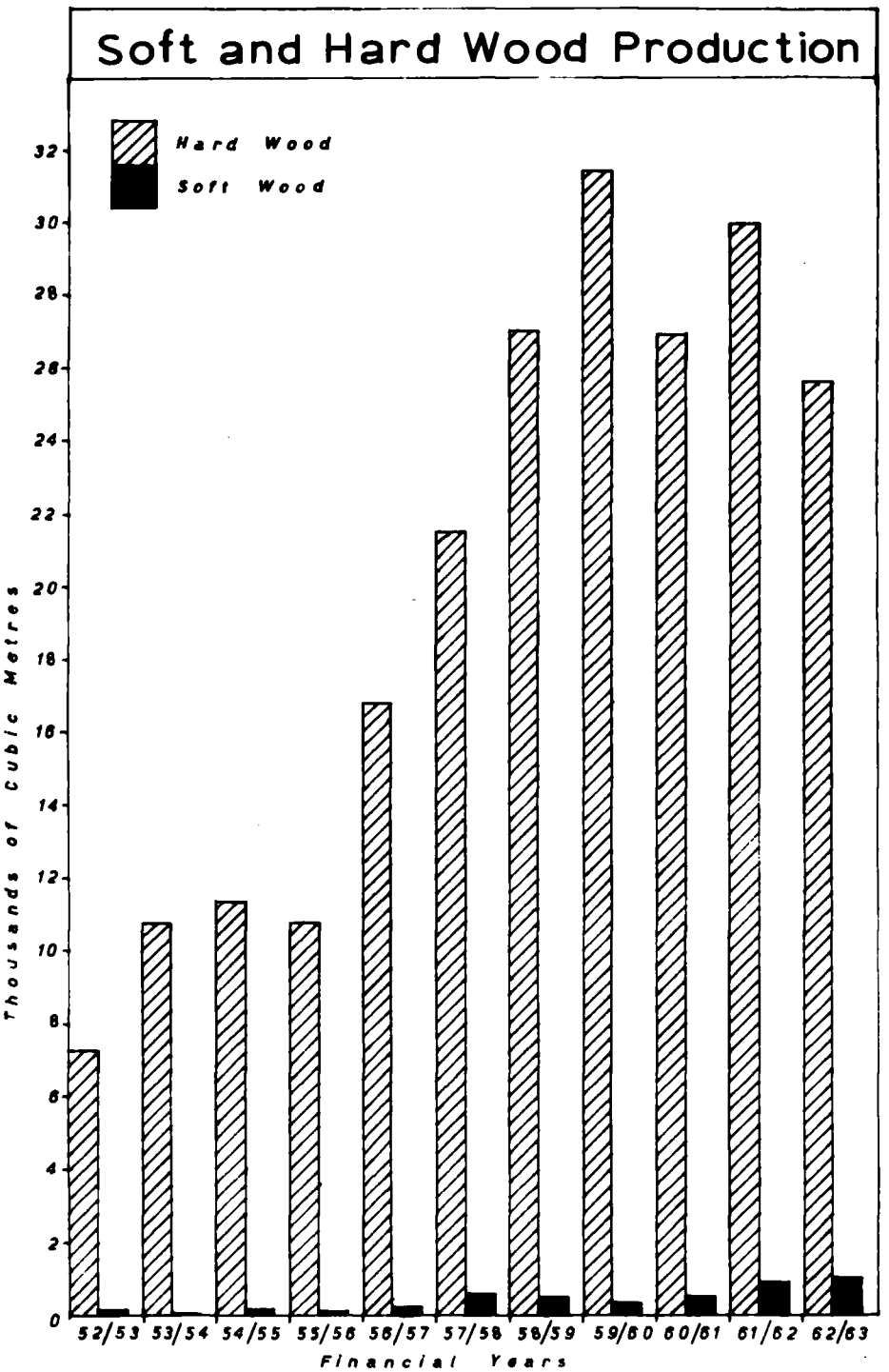

Fig. 13: Compiled from data of Appendix V(iii)

by the F.A.O. It was carried out in the form of a census called "The Forest Products Consumption Census", which is summarized in Appendix V(iv) and (v). This reveals that the rural sector, having about 92% of the total population, is the major consumer. The present annual production of sawn timber by the Forests Department is about 30,000 cubic metres; together with a private production of about 6,000 cubic metres the total annual production is about 36,000 cubic metres. Since the country's annual consumption of sawn timber is about 152,500 cubic metres, the Sudan now imports an average amount of about 60,000 cubic metres annually in the form of sawn timber and manufactures of sawn wood, and the remaining part enters in the form of packing materials or re-used timber.

By July 1970, the annual consumption of sawn timber is forecast to climb to about 185,000 cubic metres, and the production of the Forests Department is hoped to reach 76,000 cubic metres. If an allowance of 10,000 cubic metres is estimated to be privately produced, the total production will then be 86,000 cubic metres, with a difference of about 100,000 cubic metres. According to some officials of the F.A.O.,[1] the annual output of sawn timber from Sudan's forests, both reserved and unreserved, can amount to 154,760

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(1) F.A.O. Report No.1291 to the Government of the Sudan, Rome, 1960.

cubic metres of which about 80% will be in the form of poor quality timber; but these figures should be viewed with care as the report emphasized that adequate data was not available for a sound estimate and many of the figures were merely guess work. However inaccurate the report, it still remains valid that the planting of good quality timber forests near the consumption centres is the only way to meet the country's future requirements of sawn timber.

2. Firewood and Charcoal:

The demand for firewood and charcoal has increased since 1938 (Table VIII) to such an extent that the Forestry Division has had to take a greater part in the organization of its supply than had been anticipated at the time of enactment of the Forest Ordinances. This increase is generally due to the following:

(i) the increase in settlement and growth of towns,
(ii) a general improvement in the standards of living, and
(iii) an increased amount of money in circulation.

Table VIII: Despatches of Firewood and Charcoal from Railway Stations north of Sennar-Kosti Line

Year	Firewood in M^3	Charcoal in Tons
1937	2,000	4,722
1941	14,475	4,858
1945	40,630	10,134
1949	33,323	13,095
1958	137,817	109,021
1963	216,569	197,524

Sources: (1) T.H.Kipling, The Supply of Woodfuel and Roofing Poles to Khartoum, the Gezira and Government Departments, Bulletin No.5, Agricultural Publication Committee, Khartoum, 1950, p.3.

(2) Forests Department, Reports for the Period July 1958 to June 1959 and July 1962 to June 1963, Khartoum.

The Forest Products Consumption Census (Appendix V(v)) shows that over 80% of the total consumption of firewood and charcoal comes from the rural population, and that the per capita consumption in urban areas is less than one-third of that in rural areas.

(a) The Three Khartoum Towns:

The firewood and charcoal supply for the Three Khartoum Towns originates mainly in the following areas:

(i) the central forest reserves on the Blue Nile south of Sennar.

(ii) the central forest reserves on the Rahad and Dinder tributaries.

(iii) the unreserved forests between Hawata and Qala en Nahal.

(iv) the desert scrub forests around the Three Khartoum Towns.

Of these, firewood railed from the Blue Nile areas constitutes the larger part of the supply (Appendix V(vi) and Fig. 14). The demand for firewood has always been greater than that for charcoal, though the latter also shows a tendency to increase. Charcoal, which is used entirely for domestic purposes, gives a clearer indication than firewood of the rise in population and the standard of living. The increase in population, due to tne establishment of industries and the inflow of the rural population to find occupation, has pushed the demand for firewood and charcoal well above their supply.

Table IX: Consumption of Firewood, Charcoal and Paraffin in the Three Towns.

Year	Firewood in Tons			Charcoal in Tons	Paraffin in Gallons
	Railed	Not Railed	Total		
1960/61	16,808	9,377	26,185	10,650	1,688,995
1961/62	23,709	9,100	32,809	7,668	1,790,335
1962/63	11,799	7,375	19,174	12,823	1,104,000

Sources: Forests Department, Reports for the Periods July 1960 to June 1961, July 1961 to June 1962, and July 1962 to June 1963, Khartoum.

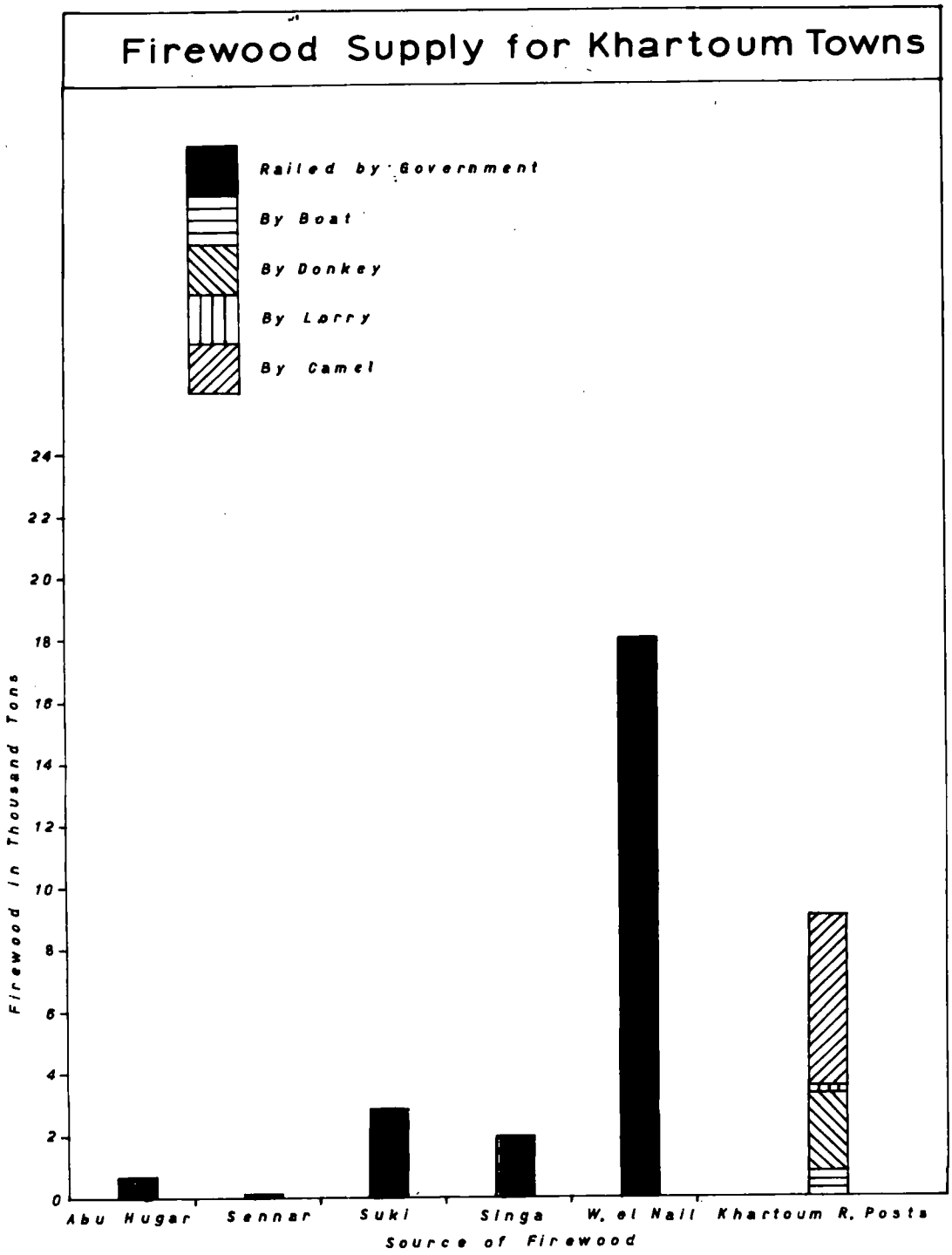

Fig. 14: Compiled from data of Appendix V(vi)

The Three Khartoum Towns consume annually a very large amount of unrailed firewood, ranging from 40 to 50% of the total annual consumption (Appendix V(viii)). Over 33% of the annual supply is brought by animals, lorries, boats and rafts from the desert scrub forests in the surroundings of the Three Towns; the remaining part of the supply comes from remote areas: the Fung in the Blue Nile Province and Kassala and Gedaref areas. As a result of the intensive local cutting, the desert scrub forest is diminishing quickly; in about 15 years the forest has retreated to about a 65-miles radius. Protective measures, like increasing the quantity of railed firewood and raising the royalty rates on desert scrub wood are essential.

The establishment of plantations within the area, or within easy reach of it, is the best solution. The Khartoum Green Belt, which covers an area of about 7,035 feddans, and the proposed Acacia nilotica (sunt) plantations in the annually inundated flats of the White Nile between Khartoum and Jebel Aulia, should supply the greater part of the future wood requirements of the Three Towns. These projects, through reduction in transport costs, are aimed at reducing the present market prices of firewood and charcoal.

(b) The Gezira:

The needs of the Gezira are mostly met from the central forest reserves on the Blue Nile north of Sennar. Additional quantities of wood are cut from the Rahad and Dinder

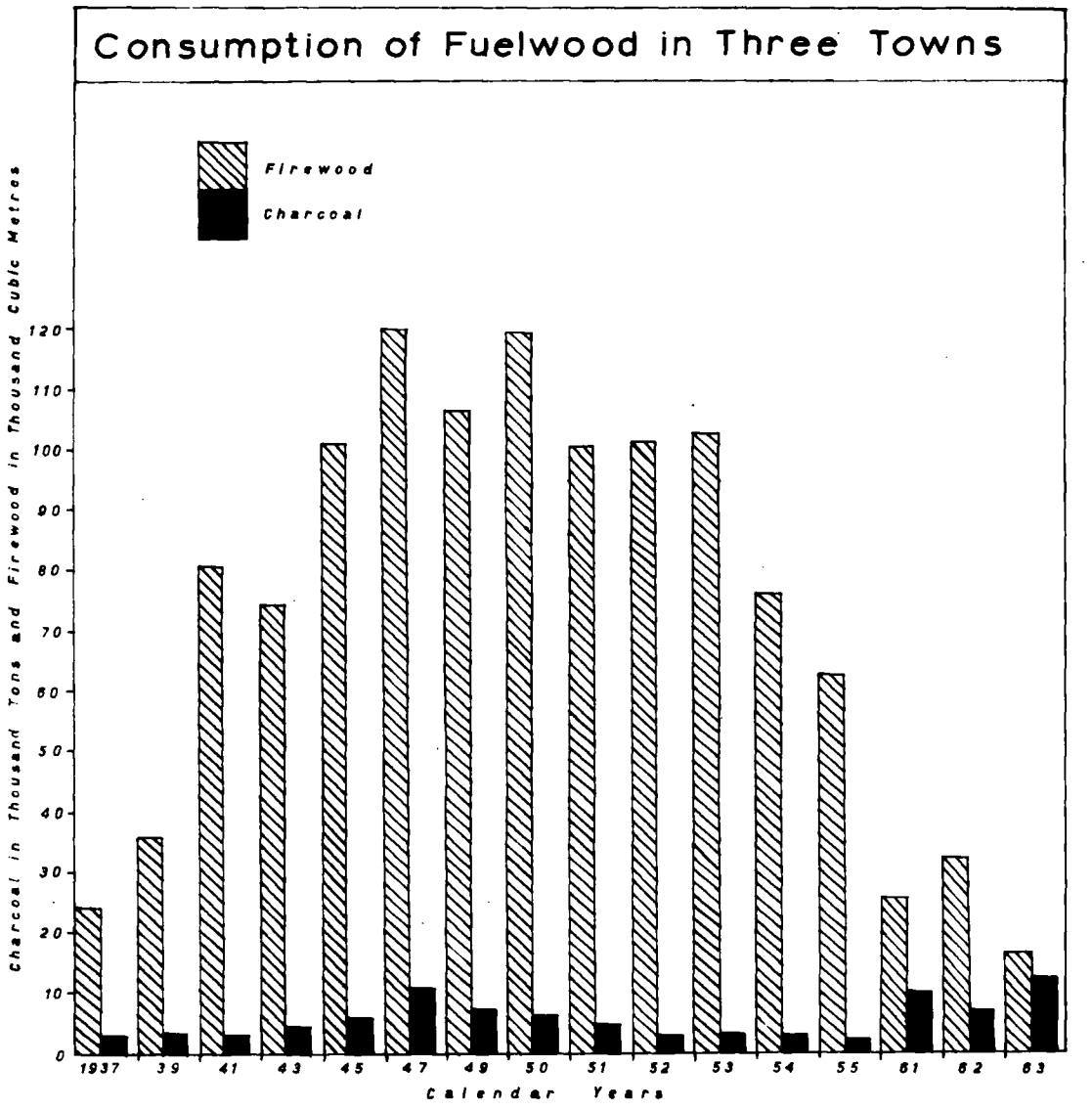

Fig. 15: Compiled from data of Appendix V(vii) and Table IX

tributaries and delivered by native boat and raft. The demand for firewood has always been high, and during the 1940's it overtook the demand for building poles (Appendix V(VIII)). The per capita consumption of fuel in the Gezira tends to be higher than in the remaining parts of the country other than the Three Khartoum Towns. It varies considerably from one part of the Gezira to another because of variation in the standard of living, availability of nearby forest reserves and proximity to the railway line. The areas lying within easy reach of the railway line combine firewood and charcoal for their fuel; on the other hand, the proportion of charcoal burnt rises the further the village is from the railway line, and in many places it practically replaces firewood, as in the case of Abu Udeina and Beweida (Appendix V (IX)). The total consumption figures for the entire area of the Gezira are not available, but table X is an approximate indication of the total consumption in selected places.

Table X: Consumption of Firewood and Charcoal in Selected Places (1962/63)

Place	Firewood in M^3	Charcoal in Tons
Wad Medani	33,100	2,775
Singa	20,240	308
Suki	9,080	122
Northern Fung Rural District	99,870	847
Roseires and Damazin	1,830	221
Kurmuk	1,110	74

Source: Forests Department, Report for the Period July 1962 to June, 1963, Khartoum, 1963.

The Gezira, owing to the relatively higher standard of living and the better medical services, has a higher net rate of population increase than the other parts of the Blue Nile Province; this is reflected in the higher demand for fuel wood. During the period from July to the end of the year, the average total demand for fuel wood is about 850,000 cubic metres; but during the period from the beginning of the year to the end of June, when the seasonal labourers pour into the Gezira, the average total demand for these forest commodities rises to about 1,200,000 cubic metres.

(c) Other Parts of the Country:

The annual consumption (average for the years 1961,62 and 63) of firewood and charcoal in other selected

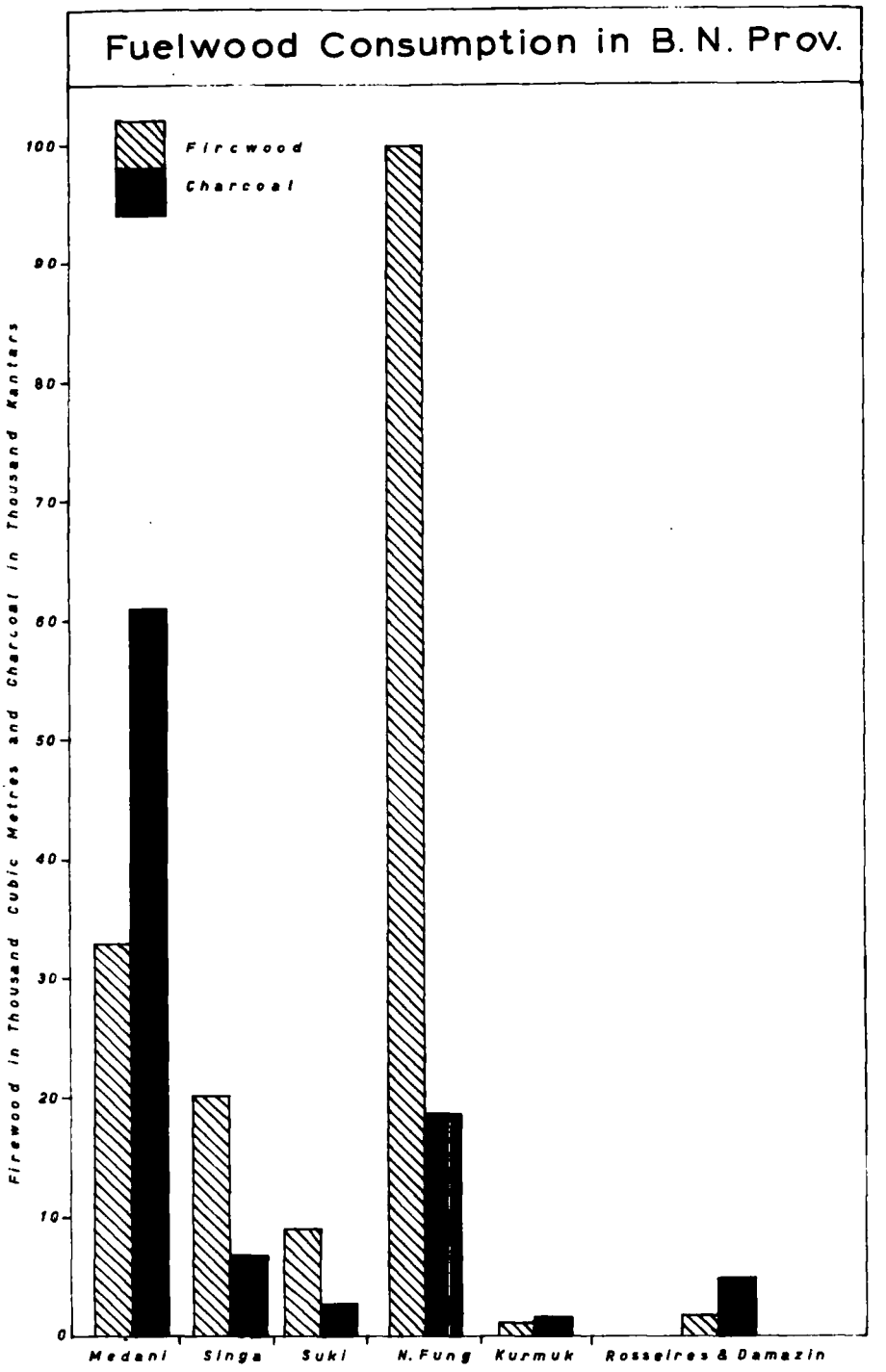

Fig. 16. Compiled from data of Table X.

places is given in Appendix V (X). The consumption of fuel wood is almost confined to towns in the Western Division and the three southern provinces owing to the low standard of living and the nomadic nature of the rural population of the west and the subsistance economy of the Southern Sudan. However, the demand has shown a tendency to increase, especially in Kordufan and Darfur Provinces, during the last decade.

In the Northern Province, fuel wood is still brought by lorries from Kassala Province to Atbara and Ed Damar; firewood is also railed into the Shendi area from the Eastern Division. But still the fuel wood supply for the province as a whole is far below the demand. The estimated annual consumption for the entire province is about 107,000 tons of charcoal and 2,000,000 cubic metres of firewood. The rural population of the area collects wood from the desert scrub forest for their domestic purposes, and those along the Nile, especially in Wadi Halfa-Abri reach, use the leaves of the date palm trees to augment their scrub fuel wood.

Fuel Prices:

It has been calculated that the use of fuel wood at present sale prices (ranging from L.S.1.1 to L.SO.2 per cubic metre over the whole country) is four times as cheap as the use of paraffin, and charcoal is twice as cheap as paraffin;

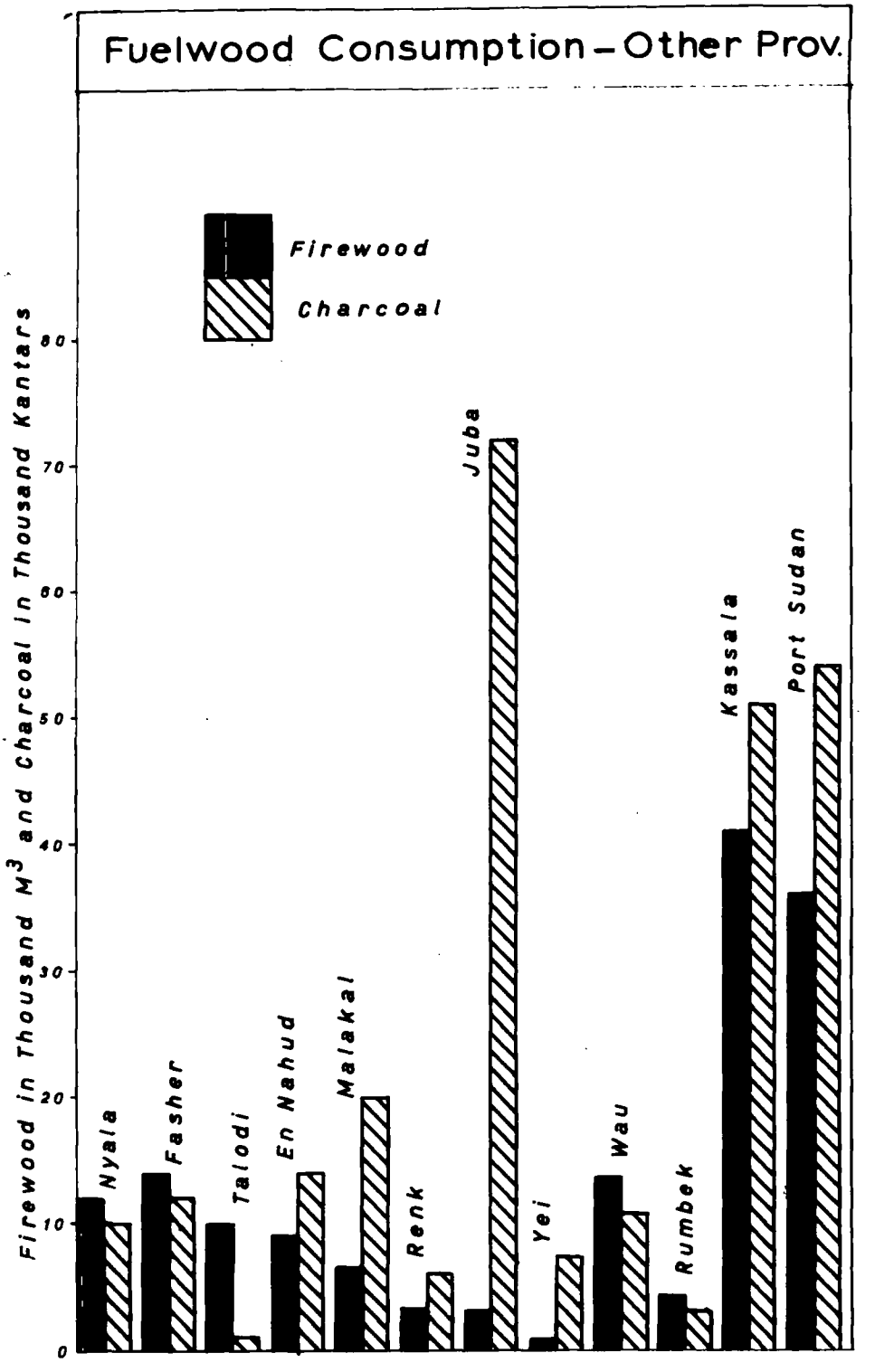

Fig. 17: Compiled from data of Appendix V(x).

it has also been found that the proportion of fuel points to the total points of cost of living in the Sudan is far less than in other countries.(1) The present heavy subsidy of formation and production costs of firewood may be justified by the advantage of the use of fuel wood on imported fuel, like kerosene, to the national economy, by the fact that fuel wood growing, production and trade provide employment opportunities for thousands of poorer Sudanese citizens and by the indirect values or influences of such firewood forests.

The prices of firewood are highest in the Three Khartoum Towns. It has been suggested that these prices can be reduced by handing the whole operation from cutting to retailing of food to private enterprise. This may be true in the short run, but it is inevitable that the prices will soon start to rise as the demand increases and the supply of the present accessible wood diminishes, if it is not supplemented by new plantations. When the whole operation becomes a monopoly of the private sector, the enterprisers will cut down, if not completely eliminate, competition between themselves and the quantity supplied will be kept just below the demand, thus pushing the prices up. Another equally important aspect is that the heavy subsidies now paid by the

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(1) M.K.Shawki, A Note on Firewood and Charcoal Supply and Costs, Sudan Silva 7 (1), 1957, p.10.

government would not be paid by the private sector, a factor which will also entail a rise in the prices of firewood.

Furthermore, the handing over of the whole business to private enterprise, which is wholly governed by the desire to maximize its profits, will eventually endanger the protection aspect of forests. So it is highly advantageous that the whole business should remain in the hands of the public sector, not only in the Three Khartoum Towns but over the whole country.

3. Round Timber and Bamboo:

The requirements of the Sudan for telegraph poles are ever-increasing. The production in recent years is not high and is confined mainly to the Eastern and the Western Divisions; in 1961/62, the Eastern Division produced 19,323 telegraph poles while the Western Division produced 7,732, 10,274 and 6,233 in the years 1959/60, 1961/62 and 1962/63 respectively. The production of such poles does not constitute a large part of the total production of round timber.

The total production of round timber, other than firewood, (Appendix V(XI)) is less than 50% of the total annual consumption which is about 1,000,000 cubic metres; but large amounts, usually used by the local inhabitants for their various domestic purposes, are not included in the production

figures. The biggest market for round timber is constituted by the heavier populated areas of the north; about 50 - 68% of the large amounts of the bamboo poles produced in the southern Sudan and southern Fung are transported to the more populous areas of the Gezira and the Three Khartoum Towns.

Future Need for Timber:

The requirements of the country for timber are not likely to fall, but to increase, in the foreseeable future for the following reasons:

(a) the upward demographic trend is high (2.9%).

(b) the main forest products which were imported into the country in 1963 show a tremendous increase over the figures of 1962 for instance; this increase is about 22.7% for pulp and pulp products, about 23.7% for round wood and about 24.9% for processed wood. (1)

(c) following the economic advancement of the country, the permanent settlement of the over 3 million nomads and semi-nomads will need an immense production of timber and bamboo poles.

(d) the rise in the standard of living will be accompanied by a general conversion of the rural traditional dwellings in which large quantities of various types of grass are used to a better housing standard depending on veneer sheets, round wood and bamboo poles.

(e) wood will continue to be used as fuel for the various domestic purposes because its price is four times as cheap as kerosene and charcoal twice as cheap as kerosene. This situation is likely to continue till the unreserved woodlands are declared as

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(1) F.A.O., Yearbook of Forest Products Statistics, Rome, 1964, pp.50,58,60 and 68.

forest reserves or else their devastation becomes so thorough that an acute shortage of fuel wood pushes its price above that of kerosene.

(f) no coal or oil deposits have yet been discovered in the Sudan, and consequently the generated hydro-electric power will continue to be completely utilized in the operation of the existing and planned industries. A conversion from fuel wood to electricity for domestic uses is not likely because the marginal productivity of electricity will continue to be higher in industrial fields than as a domestic fuel.

(g) the expansion of the economy will essentially lean upon a tremendous increase of railway and telegraph communication to link all parts of the country, and hence a great need for sawn and round timber. Concrete, as a substitute for sawn railway sleepers, cannot be used because its cost of production is far higher than that of sleepers.

(h) the industrialization of forest products, for the production of various types of pulp manufactures, oil, fodder crops, tanning material, sacks, ropes and threads, to meet the requirements of the expanding local market requires the establishment of forest plantation of selected species.

(i) the necessary protection against the increasing dangers of wind and sand erosion, desert creep, severe destructive winds, silting, floods and fluctuation of riverflow necessitates the reservation of natural or the creation of new forests on the threatened sites.

(j) from the world point of view the higher standard of living does not necessarily mean an automatic reduction in the per capita consumption of fuel wood; in Finland, where the standard of living (gross domestic production) is over 10 times higher than that in Tanganyika, the per capita consumption of fuel is more than that in Tanzania (Appendix V(XII)).

For all these reasons by the time the population doubles (about 1985) the Sudan will need 4 times as much timber as it is consuming at present; by then the country

will annually need about 150 million cubic metres of firewood, 4.25 million cubic metres to produce about 7.1 million tons of charcoal, 4 million cubic metres of other forms of round timber and about 700,000 cubic metres of sawn timber.

The possibilities for an immediate increase of the country's timber production are not great, they can barely meet its present needs, but certainly they cannot cover its future requirements. It is essential to remember the wasteful manner in which timber is cut and charcoal burnt; also a lot of wood cut in the clearance of land for agricultural practices is never utilized; there are also large amounts of wood annually burnt by hunting and stray grass-fires. This harvest from the forests of the country is no light rate of depletion if not controlled or immediately replanted. The complete utilization of this harvest may improve the situation; other improvements may be expected in the natural forests as a result of protection against uncontrolled fires and shifting cultivation. It is vital that as large a proportion as possible of the land bearing millable timber should receive the protection that can only be afforded by making it into forest reserve. But even this will not be enough, and the only solution to the problem is to grow forest plantations at a higher rate than the present one. The natural forests of the country cannot assure the future supply of sawn timber because most of their timber

is of low quality, but they can continue to supply a large part of the country's requirements for firewood and other forms of round wood. The country's needs for firewood and charcoal could be satisfied by the creation of 11,000 feddans of forest plantation annually; the demand for other forms of round timber could be met by planting 3,000 feddans annually; for sawn timber needs to be met it will be necessary to create 5,500 feddans of hardwood plantations and 1,400 feddans of softwood plantations every year. By the time the population doubles, the country will have new plantations of 275,000 feddans for firewood and charcoal, 75,000 feddans for other forms of round timber and 137,500 feddans of hard wood and 35,000 feddans of soft wood for sawn timber.

The emphasis is laid on plantations because production of timber from them is advantageous in many respects One feddan of teak plantation, for instance, would produce as much timber as 200 feddans of natural forest, thus greatly reducing logging and extraction costs. Timber grown in plantations will also enable sawmills to be established in permanent sites, thus making the installation of better machinery possible and economical. It will also enable permanent villages for forestry workers to be constructed.

So if the future needs are to be satisfied, forest plantation should be done at the rate of 20,900 feddans annually; reservation of the natural forests should

progressively increase at a rate of about 20% of the figures in the year just previous to the enforcement of the Ten Year Plan for Economic and Social Development.

Table XI: Plantation and Reservation of Forests

(in Feddans)	Standard Year 1959/60	1960/61		1961/62		1962/3	
		Desired	Actual	Desired	Actual	Desired	Actual
Areas Planted	7,620	20,900	10,299	20,900	13,971	20,900	15,639
Areas Reserved	266,280	319,536	121,622	372,792	90,782	426,048	7,801
Areas Planted and Reserved	273,900	340,436	131,921	393,692	104,753	446,948	23,440
Areas Mapped	124,252	149,102	211,839	173,952	76,637	198,802	72,794
Total Forest Reserve as on 30.6.	2,354,206	2,694,642	2,486,127	3,088,338	2,590,880	3,535,282	2,614,320

Sources: Forests Department, Reports for the Periods July 1959 to June 1960, July 1960 to June 1961, July 1962 to June 1963, Khartoum.

According to these estimates the desired plantation will reach a figure of 522,500 feddans by the time the population doubles, and the desired reservation will reach about 23,965,00 feddans; the total forest reserve will then be about 27 million feddans (about 45,000 square miles), or about 4.5% of the total area of the country. But in reality though the rate of plantation is increasing, it is still

only about 75% of the desired figure in the third year of the Plan, and the actual reservation is only 2% of the desired reservation of natural forests (Table XI); this has given a total forest reserve of only about two-thirds of the desired total forest reserve. The present rates of afforestation and reservation of natural forests, low as they are, may be further lowered in future as indicated by the increasing gap between the desired and the actual figures of the surveyed and mapped areas. Unless the actual plantation and reservation figures reach, or at least approach, the desired figures, shortage of forest produce for the coming generation will be the ultimate result. This gap between demand and supply indicates the extent of the general lack of appreciation of forestry, the reluctance to devote more money and land to it, and the undervaluation of the grievous consequences.

During those three first years of the Development Plan, the distribution of the new forest plantations among the various divisions, and within each single division, varies considerably (Table XII). Most of these plantations have rightly been located in the areas with higher population densities, thus giving the Blue Nile Province the greater proportion of these plantations. Within the Blue Nile itself, the greater majority of them has been allocated in the Gezira to satisfy the needs of the relatively higher concentrations of population. The low ratio of the new planted forests which have been sited in Khartoum and the Northern Provinces can be related to the

small area lying within the administrative boundaries of the former, and the climatic aridity and the negligible population density away from the main Nile in the case of the latter. Between these two extremes are situated the three southern provinces where the eradication and clearance of forests have not yet been as thorough as in the northern parts of the country.

Table XII: Distribution of New Forest Plantations (in Feddans)

Division	1959/60	1960/61	1961/62	1962/63
Eastern	2,764.0	4,568,50	7,215.25	9,344.65
Western	1,400.6	1,943.15	1,826.00	2,049.00
Equatoria	1,654.7	2,278.35	3,084.00	2,775.80
Bahr el Ghazal	562.0	854.71	677.00	210.00
Upper Nile	620.0	644.00	1,030.00	944.00
Khartoum and Northern	578.5	9.50	139.00	316.00
Total	7,619.8	10,298.21	13,971.25	15,639.45

Sources: Forests Department, Reports for the Periods July 1959 to June 1960, July 1960 to June 1961, July 1961 to June 1962 and July 1962 to June 1963, Khartoum.

4. Gum Arabic:

Gum acacia, or gum arabic as it is more usually called in commerce, is obtained from Acacia senegal, a tree

that appears to be confined to the area between latitudes 11°N and 14°N., and extends in a belt from the southern parts of the Red Sea coast to Senegal in the West African coast(1). Although gum arabic is produced in East Africa, Nigeria and Senegal, the Sudan has an almost complete monopoly of the world's markets, its production sometimes rises to 90% of the world's total production.

(a) Gum Tree Cycle and Wounding:

Two distinct types of verek forests can be distinguished: the "geneina" type which is the result of regeneration on previously cultivated land, and the "wadi" type the regeneration of which seems to have taken place without the soil being cultivated, i.e. natural regeneration as opposed to aided regeneration. According to Blunt(2), it appears that Acacia verek yields gum only when it is in an unhealthy condition which may be due to the following:

(1) Lack of moisture in the soil; Acacia verek pushes out long lateral roots in its search for water.

(2) The extreme poverty of the soil in soluble salts; it has been found that the best gardens of Acacia verek, from a gum yielding point of view, are usually those on land which has been cultivated for many years, and has consequently been worn out and made unsuitable for further crop production.

(3) Stunted growth of the tree; it has been noticed that anything done to make them healthier lessens the quantity of the yield.

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(1) A.H.W.Weir, Observations made while studying Gum Arabic Production in Anglo-Egyptian Sudan, Unpulished Report to the Forestry Division, Khartoum, 1928, p.8.

(2) Blunt, op. cit., 1926, p.41.

With some minor variations, the cycle or rotation in the acacia gum area starts with the cultivation period which begins with the clearance of the acacia scrub by the cultivators, leaving a characteristic vegetation of sparse grass and Balanites aegyptaica (heglig). The sand dunes are put under the cultivation of Pennisetum typhoideum (dukhn) and Sarghum vulgare (dura) for 4 to 10 years after which the soil becomes exhausted and infested with Striga hermonthica (buda), a root-parasite of these cereals. At this stage the land is abandoned, and it then passes into the second phase. During this colonization stage, the land starts to be colonized by Cenchrus biflorus (haskanit), Acacia senegal and Acacia seyal, all of which regenerate on the freshly worked and cleared soil. In three years time the acacias reach a height of about $1\frac{1}{2}$ metres and in about 5 years they are ready to be wounded. This marks the start of the next stage of the cycle, the "geneina" (garden) phase, during which the dominant acacias are wounded for gum; this lasts for 6 to 10 years. The last stage, the deterioration phase, starts when the trees begin to die out almost simultaneously as a result of heavy wounding. Eventually the land is burnt over, and recultivated.

For wounding the tree, the native has a small, especially shaped axe which he drives under the bark of the tree, making an incision as far as possible without injuring the cambial layer or cutting into the wood, with a leverlike motion. He then pulls the axe back and thus breaks the bark,

leaving two ends; he pulls one end upwards and the other downwards. The length and breadth of the strips vary with the size and age of the tree; the piece of the bark removed may be as small as one foot or may extend from the point of the cut to the ground and up to the main stem along a branch. When too much wood is removed, the wood will be exposed to insect and fungoid attack, and when too little is removed the wound rapidly occludes, and in both cases there is little or no exudation. This skilled operation, in which every year a different part of the trunk is wounded till the tree ceases to yield gum, is acquired over a number of years. If the tree is wounded too early in life, it is liable to die before giving the maximum yield; the best quality gum is obtained from trees about 6 - 7 years old.

The weather plays a significant role in the exudation of gum; if the temperature is over 100 ^{o}F. after wounding the gum starts to flow almost at once, and the collector can reap the harvest after 20 - 30 days; if it is lower than 90^{o}F, this period extends to 40 - 60 days. The early wounding experiment conducted at Umm Ruwaba Experimental Plantation in 1928, under the supervision of Massey, Government Botonist and Show, Assistant Conservator of Forests, confirmed "that tapping (wounding) is best done between 1st November and 15th December".(1) This result is still valid

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(1) Weir, op. cit., 1928. p.20.

and it enables the inhabitants to collect the gum throughout the entire hot, dry season.

Research to improve the method of collecting and the quality of gum is of vital importance if the Sudan is to secure this significant industry. So far research undertaken to improve the gum gardens has shown that direct sowing of seeds with agricultural crops, as demonstrated on a large scale in the Gedaref area, is the cheapest and most effective method of establishing "hashab" plantations. Experiments showed that much better growth in the early stages takes place on clay or sandy clay soils than on sandy soils. The greatest "hashab" forests are found on the sandy soils of Kordufan and Darfur Provines, hence the importance of establishing plantations on the clay soils of the Blue Nile and Kassala Provinces. Large scale mechanized sowing of "hashab" on clay or sandy clay soils should be continued, especially after the success of the first experiment when 800 feddans were mechanically established in Rawashda at Gedaref area during the 1962 rainy season.

Shifting farmers can increase their income by sowing "hashab" seeds together with their agricultural crops, but the "hashab" trees should be about 4 metres apart (Fig.18) to secure a maximum number of trees, to give them enough space to grow and to ensure free movement when harvesting the gum. The "hashab" seeds can be grown a year

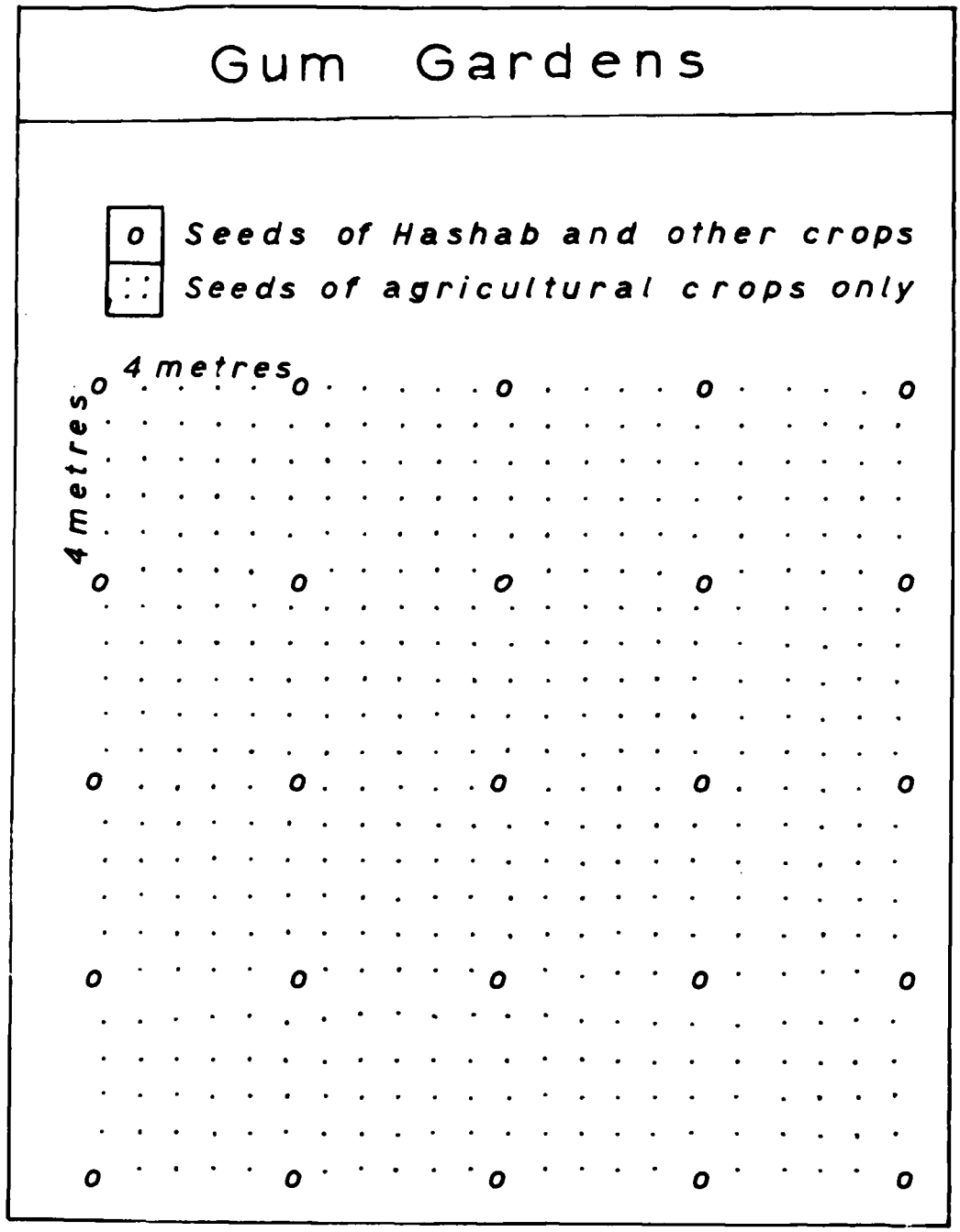

Fig. 18: Redrawn from Forests Department, op. cit., leaflet No.4 (in Arabic), 1961.

before the farmer abandons the plot and moves to another. This method is very advantageous since its costs are low (6 oz. of seeds, costing only L.S. 0.025, are enough for a complete feddan); it saves time since the farmer can sow his "hashab" and other crops at the same time; it accelerates the regeneration of the vegetation when the plot is deserted and consequently helps the exhausted soil to be fixed and retain its fertility. This simple, cheap method of "hashab" plantation is capable of the establishment of 300 trees in each feddan which, after 5 - 6 years, will produce about 1.55 kantars of gum annually, valued at L.S. 3.750; after 10 years of production, during which the farmer has earned about L.S. 37.500 without involving any appreciable cost of production, the trees may be cut to be used as firewood, and the plot of land, which has returned its fertility, can be cultivate with agricultural crops.

(b) Gum Production and Trade:

Over 90% of the total gum production of the country enters international trade; the main commercial grades of Sudan's gum are the following five:

(1) Natural gum, it consists of gum in its original condition as picked from the trees. Pickers are expected to exercise great care in removing the gum from the trees, and a premium may be paid for clean "natural" gum. This type of gum is not normally exported since in the greater majority of cases hand-sorting will be required, and the cheap skilled labour necessary for this operation is not available in importing countries.

(2) Cleaned gum; Sudan's gum is mostly traded as "clean"; impurities such as bark, twigs and pieces of other types of gum are removed by hand-sorting together with the smallest fragments and gum dust.

(3) Clean and sifted gum[1]; gum is collected, stored and cleaned in sandy desert country, so an admixture of sand is commonly present. Some of this sand and gum dust are removed by sieving, after which gum is packed in sacks to avoid further contamination.

(4) Hand-Picked Selected gum; small quantities of gum are specially selected by hand-picking to consist only of larger pieces of specified size and colour.

(5) Bleached gum; there is a small demand for gum which is almost colourless. This is satisfied by bleaching especially selected gum by exposure to the sun during the hottest season for a period of at least two months. This process reduces the moisture content, imparting a uniform light colour and frosted appearance.

Before the establishment of the Gezira cotton scheme, gum arabic was the most important item in external trade. The proportion of the export value of gum to the total value of exports has declined from 36% in 1906, 34% in 1907, 31% in 1911, 43% in 1912 and 39% in 1923 to about 11% in recent years, but the production and exports of gum "hashab" (Appendix V(XIII)) and gum "talh"(Appendix V(XIV)) continued to increase, though there were some adverse fluctuations. The output of gum "talh" is only a small part of that gum "hashab" (Fig. 19), both because the gum "talh" is inferior in quality and the "talh" tree is more restricted in distribution than the "hashab" tree. The decline of

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(1) M.G.A. Chadwick, The Market for Gum Arabic, unpublished report to the Forests Department, Khartoum, p.38.

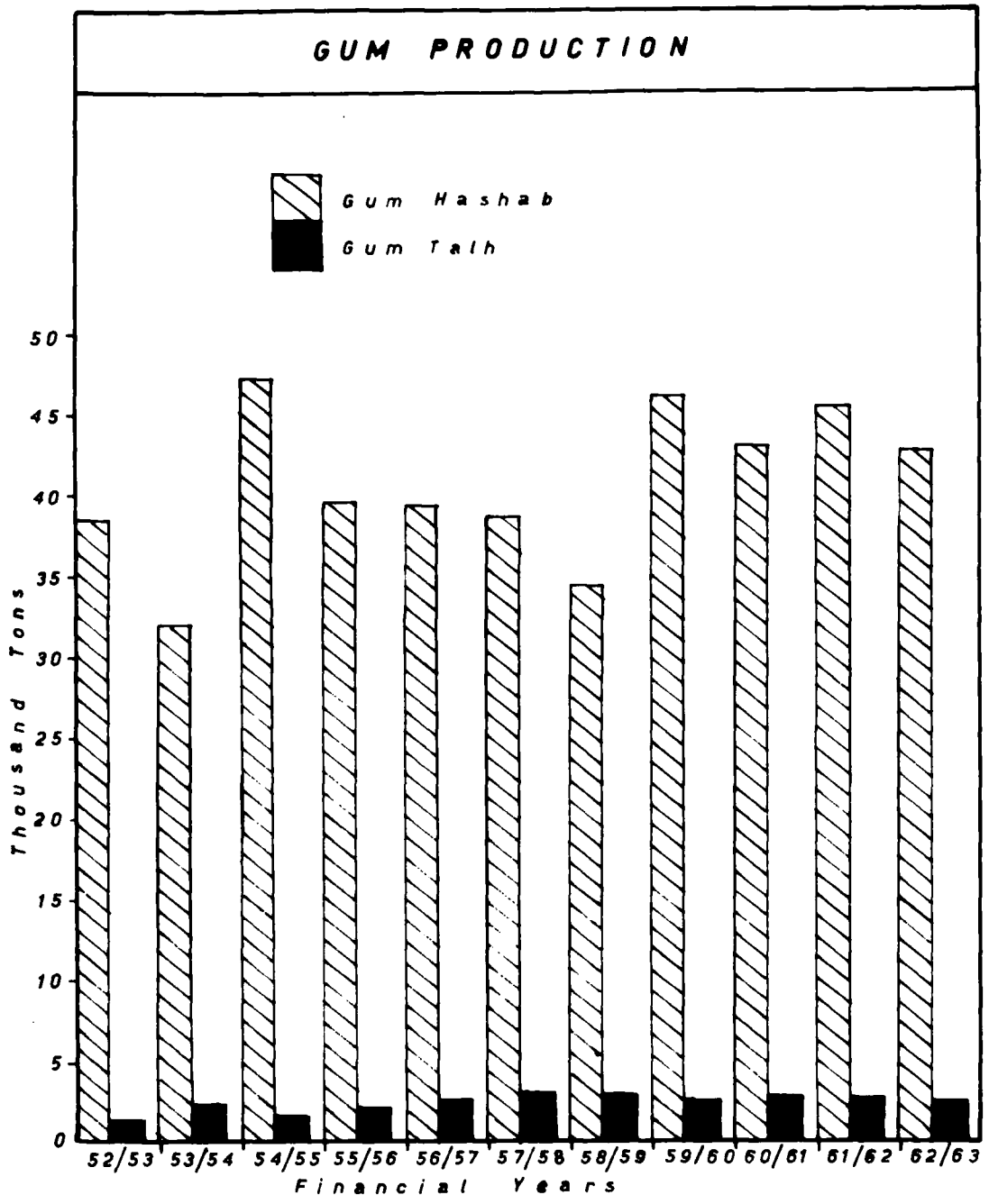

Fig. 19: Compiled from data of Appendix V(xiii) and (xiv)

gum "talh" exports in recent years may be partly attributed to the fact that India, which formerly took a large part of the Sudan's gum "talh", has reduced its imports of this commodity as a part of a general campaign to reduce imports. Users in India are, therefore, encouraged to use locally produced gum from other Acacia species.

The Sudan's dominant position in international gum trade is not yet seriously threatened (Table XIII) despite the competition from Senegal and Nigeria, which has adversely affected the prices and exports of gum "talh".

Table XIII: World Exports of Gum (in Tons)

Country	1952	1953	1954	1955	1956	1957	1958
Sudan	32,015	39,707	37,913	40,308	48,881	41,242	48,28
(French) West Africa	5,583	4,477	5,488	5,385	5,551	5,617	5,54
Nigeria	2,515	1,830	728	1,709	1,132	785	1,85
Tangan-yika	564	1,346	1,534	2,125	1,542	683	50
Total	40,677	47,350	45,663	49,527	57,106	48,327	56,18

Source: Chadwick, op. cit., p.32.

Of the total gum export values (Appendix V(XVI)), the value of gum "talh" is only about 3.8%. Gum is shipped from the Sudan to many countries. The statistics of exports for 1961 show 52 countries mentioned individually, by name,

and at the end of all this the mention "other countries" still appears, showing the vast areas which import Sudanese gum. Of these the U.K. and U.S.A. are by far the most significant importers (Appendix V (XVII)).

At the moment the World's total demand for gum seems to be satisfied to the extent that it does not justify any appreciable increase in gum production. Any tremendous increase in output may over-flood the world's markets unless other uses of gum have been discovered, or a big part of the product would be used in some of the various manufacturing fields, such as confectionary, sizing and finishing textiles, adhesives, in the manufacture of ink, drugs, matches, polishes and insecticides.

(c) Marketing System:

Before reaching the final selling practice, auction, gum is traded in by five main groups:

(1) Natives who own gardens but do not have transport and sell their gum to others who have.

(2) Natives who own gardens and have transport animals or have gardens and pool the village transport.

(3) Camel-owning tribes who go, in good seasons, for miles into the remote and waterless areas to wound gardens which are not regularly put under production, and take the product to the market.

(4) Camel-owning tribes who simply go round buying gum and taking it to the market.

(5) Camel-owning speculators who, on the chance of a

few piastres, buy gum in one market and take it to another market nearer to the railway line.

The present system of auctioning the gum was first introduced at En Nahud in 1922, and then at the main gum market, El Obeid, in 1923. Towards the end of 1948, the government suggested to the merchants that the country was not getting adequate return for its near-monopoly of gum, that the collector was not receiving a fair price and that speculation and unhealthy competitions among operators in the export market were contributory causes of the instability that was apparent in the trade. The Sudan Government appointed an investigator (J.C. Gardiner) to examine and make recommendations on the marketing of gum. He found that the marketing system in force at El Obeid was on the whole satisfactory, in that it stimulated competition and was not conducive to the formation of rings. The dealers' activities were known to be beneficial, and to have some effect in minimizing price fluctuations. In considering the role of exporters, Gardiner concluded that such competition as existed between them was normal and had not materially affected the export price. Nor did he find evidence that an insufficiency of capital had had more than a trifling effect on the price obtained by the Sudan for its gum. So the government accepted a recommendation to leave the gum trade free from official interference.

The marketing system is advantageous over the former

barter system in which the tapper possibly got part cash and part in cancellation of some debt, either of his own or a relative. It saves time since the whole buying and selling operations last for only a few hours; it prevents low quality gum from getting into the market since all gum is open to inspection. The main drawback is that under such a system the merchants may combine to keep the market price low.

There is a series of beneficiaries related to the system of hiring out the gum gardens, all contributing to the lower income of the tapper. This system has been in operation since the beginning of this century, and it was discussed by the Central Economic Board(1), which noted that it was possibly not feasible at that moment to prohibit this leasing, but that the practice would probably die a natural death. Instead of doing so, the system has grown and the number of beneficiaries has increased. At present the tapper has to pay in one way or another to one, or more or all of the following:

(1) Last year's tapper, possibly a sub-tenant of No.2.

(2) A man who taps trees or hires trees to a tapper and pays a rent in cash or kind to No.3.

(3) The owner of the garden; he is owner by virtue of one or more of the following:

    (a) The garden grew up on land which he or an ancestor cultivated.

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(1) The Central Economic Board at its 89th meeting in May 1915 minuted (Minute of 89th Meeting of C.E.B. on 18 - 5- 15/31/15 Vol.4.); Unpublished.

(b) He pays an annual "awaid" (form of tax) to the nearest potent tribal leader as insurance of title.

(c) He may be on a partnership basis with the original owner.

Below is an analysis of cash returns per kantar, under this system, to the government and to persons holding interest in gum gardens. The first case (Table XIV and Fig. 20) occurs where no dues are payable except to the government (royalty), paid by the tapper and not by the garden owner; this case is fairly limited in occurrance. Under such a system, the actual gum tapper gets less than one-third of the

Table XIV: Analysis of Cash Returns from Gum; First Case

Total yield of garden	4 kantars		
Distance from market	2 days		
Camel hire	P.T.40 per day per 4 kantars		
Market Prices	P.T. 280, 260 and 240		
Prices in P.T.	280	260	240
Camel hire	20	20	20
Owner's share $\frac{\text{Price} - 20}{2}$	130	120	110
Government Share			
(1) Royalty	50	50	50
(2) Freight	30	30	30
Total Government share	80	80	80
Tapper's share $\frac{\text{price} - 20}{2}$ - Royalty	80	70	60

price of his gum at the first price level, less than one-third

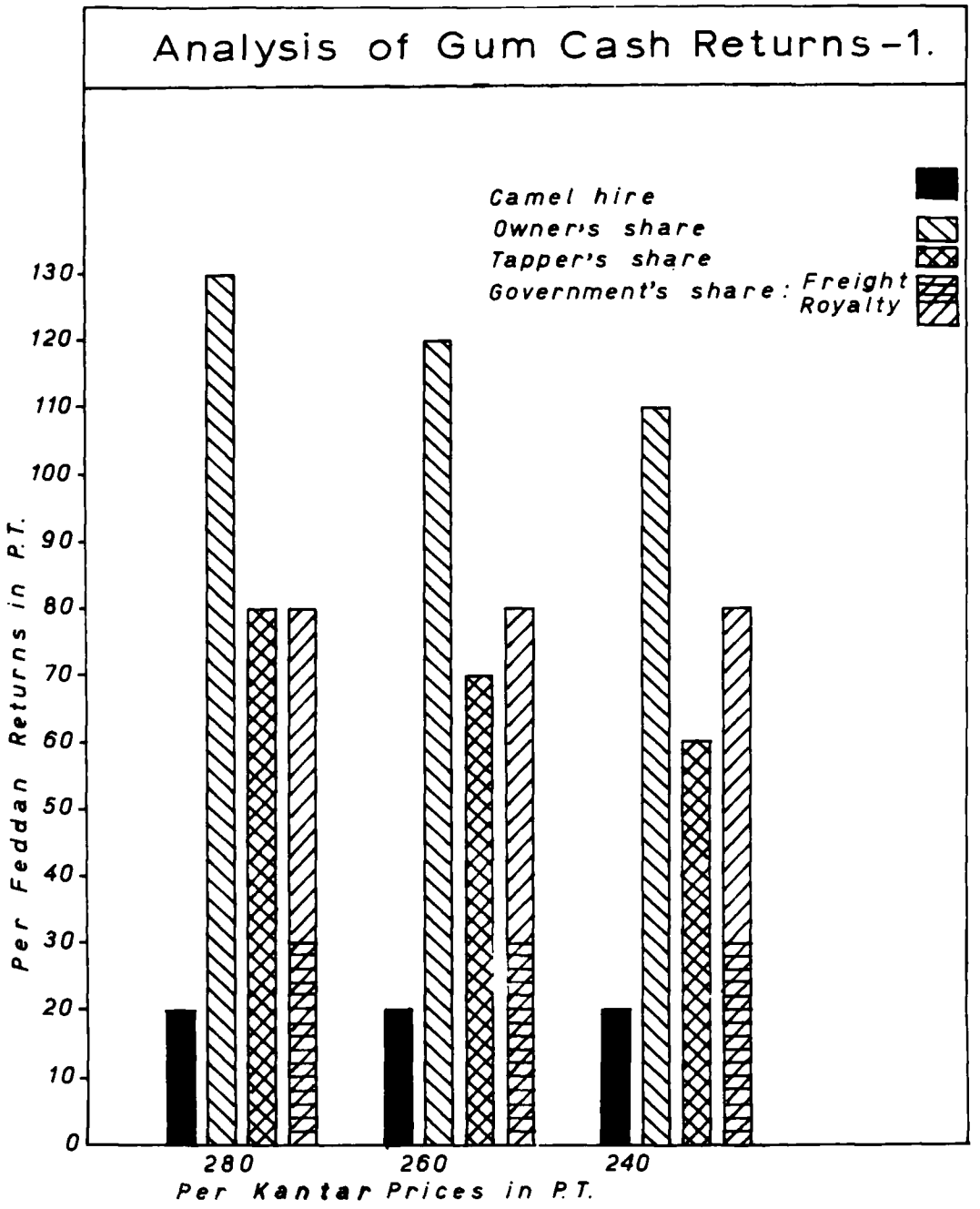

Fig. 20: Compiled from data of Table XIV.

at the second and one-quarter at the third price level.

Table XV: Analysis of Cash Returns from Gum: Second Case

Total yield of garden	4 kantars
Distance from market	2 days
Camel hire	P.T. 40 per day per 4 kantar
Market prices	P.T. 280, 260 and 240

Market prices in P.T.	280	260	240
Camel hire	20	20	20
Awaid	15	15	15
Pay to Amin	15	15	15
Total paid	50	50	50
Owner's share $\frac{\text{Price} - 50}{2}$	115	105	95
Government Share (1) Royalty	50	50	50
(2) Freight	30	30	30
Total Government Share	80	80	80
Tapper's share $\frac{\text{price} - 50}{2}$ - royalty	65	55	45

The second case (Table XV and Fig. 21), which is more commonly found, occurs where the owner of the garden pays local "awaid" to a "shartai" (tribal head) or "omda" (local governor). The owner gives his garden to an "amin" (agent) on a half share basis, and the "amin" in turn sells his interests to a tapper for about P.T.60. In all three price levels, the actual gum tapper gets less than one-fifth

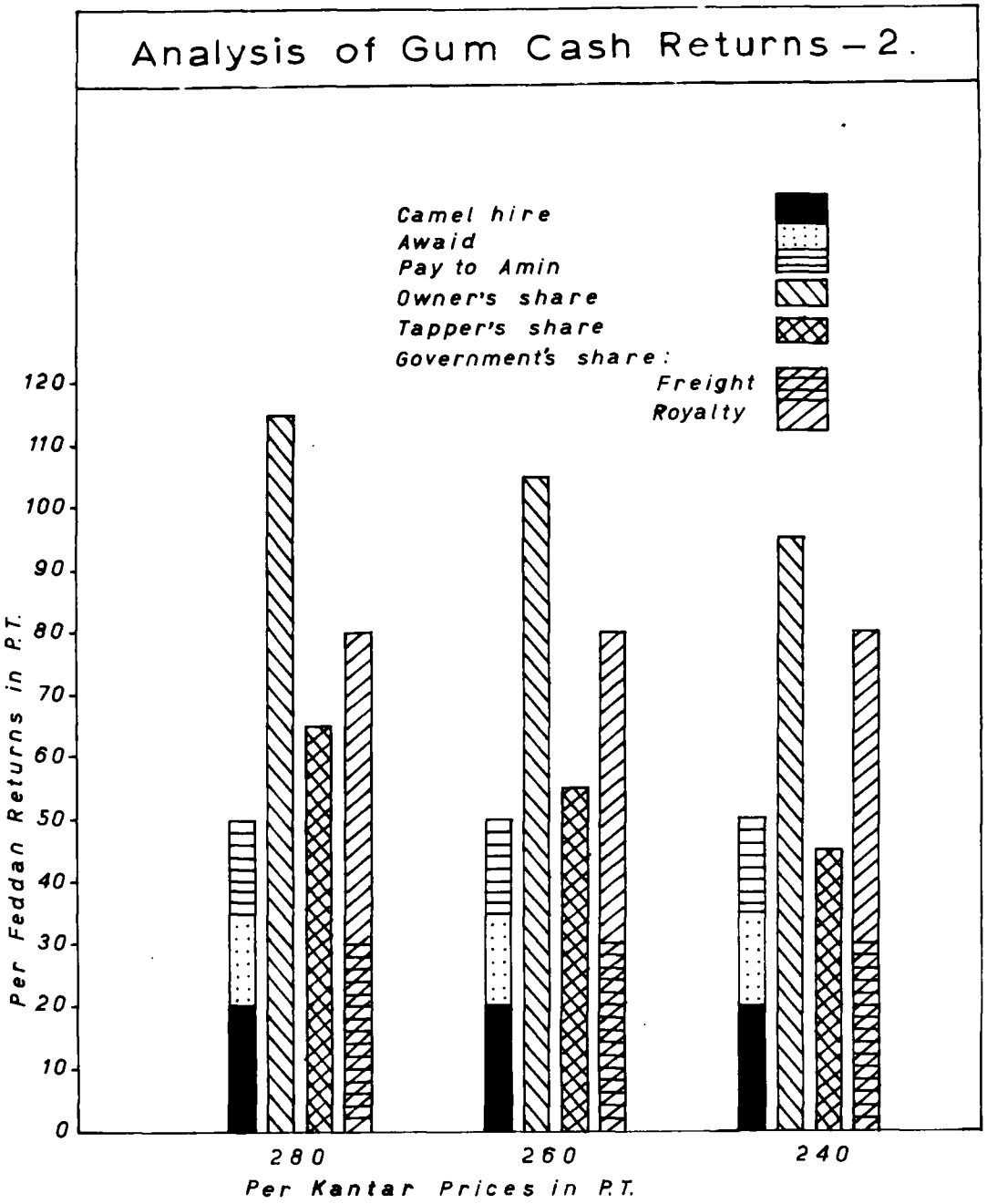

Fig. 21: Compiled from data of Table XV.

of the price of his gum, far less than what the owner of the garden of the government gets.

These low returns of the actual tappers which may have adverse effects in discouraging them from tapping all the accessible trees are the outcome of the following:

(1) The hiring system through which the tapper loses about half the price of his gum.

(2) The large number of middlemen who, to sell the product for an acceptable price in the main markets, should get it for a fairly low price at the source.

(3) The high royalty rate imposed by the government, and the various local forms of tax.

(4) The crying need of the tappers for cash and their ignorance of the real value of their commodity.

To stimulate the tappers to tap all the gum trees and extend their coverage of tapping, it is necessary to ensure that they receive an appreciable share of the price of their gum. The establishment of a central co-operative society with branches covering the entire gum producing areas may perform this function, despite the widespread illiteracy and lack of co-operative education at the moment. This society should see to it that land at the disposal of any person is just large enough for him to tap; this might be difficult in the short run where tribal chieves and local governors possess large estates of land, but in the long run this may be solved by some sort of compensation; this will put an end to the hiring system now in operation. To eliminate the large number of middlemen and to cut down the transportation cost, branches of the society can be established in various producing areas so

that the tappers can deliver their gum after one day's journey at the maximum. This system would increase the cash returns of the tapper even if the royalty rate continued to be the same and the society charged as high as 10 per cent of the gum value for its various activities including the selling of gum in the main market. Under such a system the per kantar cash returns to those having interest in gum is given in Table XVI and Fig. 22.

Table XVI: Analysis of Cash Returns from Gum; Third Case

Total yield of garden	4 kantars		
Distance from society site	1 day		
Camel hire	P.T. 40 per day per 4 kantars		
Market prices	P.T. 280, 260 and 240		
Market prices in P.T.	280	260	240
Camel hire	10	10	10
Government Share			
(1) Royalty	50	50	50
(2) Freight	30	30	30
Total	80	80	80
Society's share	28	26	24
Tapper's share	192	174	156

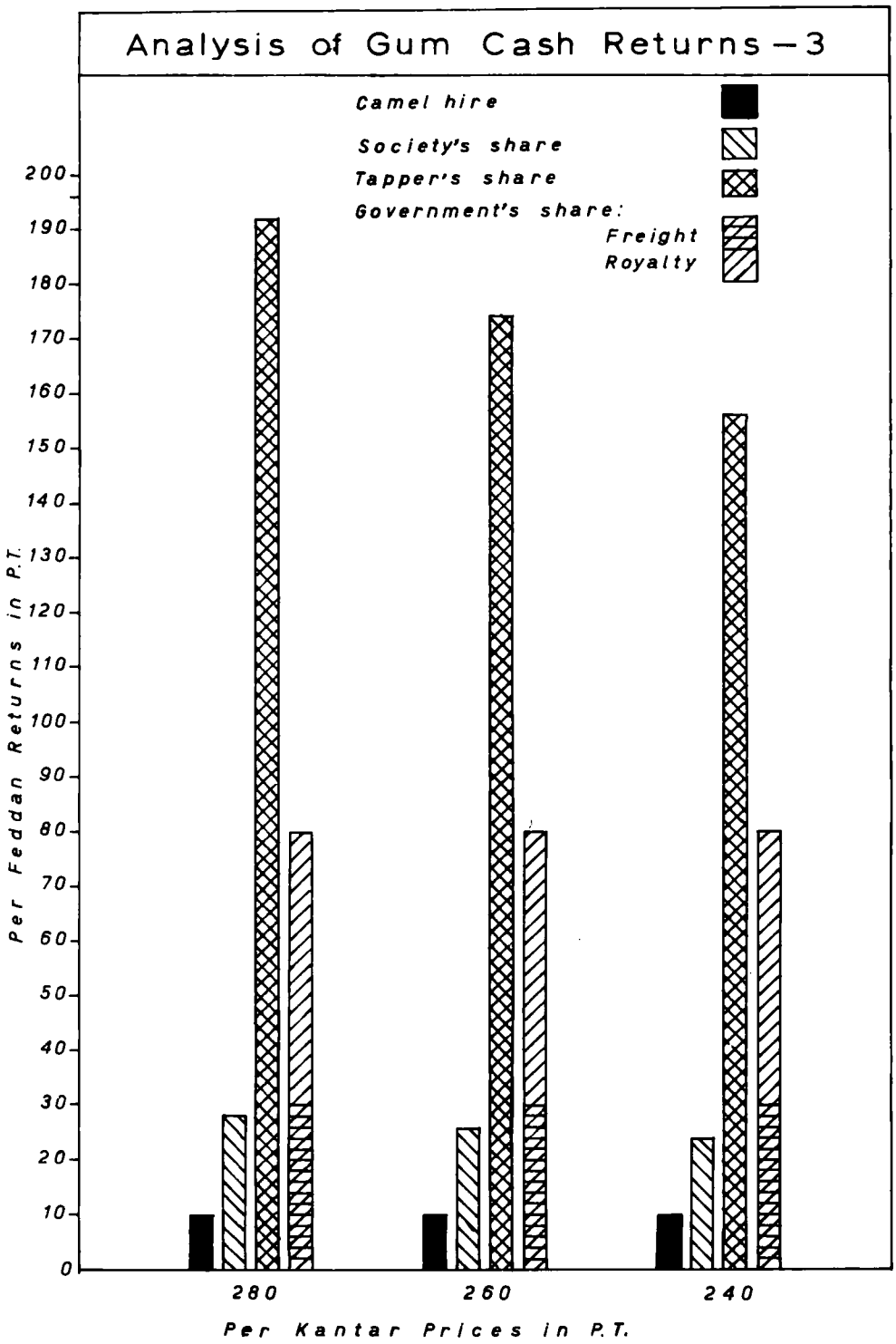

Fig. 22: Compiled from data of Table XVI.

5. Other Forest Products:

These include a wide range of products, mostly for local needs though some enter the international trade of the country. For tanning, pods of Acacia nilotica (sunt) have been extensively produced and locally used all over the Sudan for quite a long time. No records have been kept for its production because no royalty or any other control measure is imposed on it. Table XVII may give an indication of its wide production.

Table XVII: Despatches of "Sunt" pods in 1955/56 (in Tons)

Market	Quantity from Kordufan	Quantity from Darfur
Er Rahad	45	30
Umm Ruwaba	501	425
Sherkeila	700	520
Total	1,246	975

Source: Forests Departments, Report for the Period July 1955 to June 1956, Khartoum, 1956.

Apart from Kordufan and Darfur Provinces, the important producing areas of "sunt" pods (garad) are Kassala and the Blue Nile Provinces. In 1962, 58 tons of "garad" were collected by the Forests Department from the "sunt"

forests of the Eastern Division for the Government Tanning Unit in Khartoum. Recently, arrangements were made for the supply of 20 tons of "garad" from the Singa and Hawata tracts to the United Nations Special Fund Project for analysis. The results of this analysis may be of great interest to the country for it might create a wider scope for the utilization of the potential resources of "garad" for leather tanning. Another forest produce associated with Acacia nilitica is saw-dust, but it is now exploited only on a small scale. In 1963 small quantities of this produce were sent to the Plant Protection and Pest Control authorities for making baits.

Whole fruits of dom (dom nuts) are collected every year from most parts of the country. In the eastern parts these are collected mainly from the Gash forests to supply the factory at Kassala which processes them for the production of cattle fodder. In the west, the Northern and Blue Nile Provinces, "dom" nuts are collected for local consumption and local markets. A small scale trade in this commodity began in 1955 when 2,400 tons were exported to Hong Kong, India, Greece and Pakistan.

"Zaaf", the leaf fibres of the "dom" palm is one of the most important minor forest products in Upper Nile Province for the manufacture of a wide range of articles including ropes, strings, baskets, mats and various types of containers; but as production is done by private individuals,

no reliable statistics are available. During 1960, 500 tons of "zaaf" in the Fung area and 600 tons in Kassala Province were collected for the manufacture of ropes and baskets. In the western parts of the Sudan, "zaaf" is also produced in big quantities, especially from the palm forests at Liri in Kordufan and Nyala in Darfur.

Small quantities of honey and bees-wax are continually collected by local inhabitants in Kassala and the Blue Nile Provinces for both domestic use and sale; in the southern parts, Bahr el Ghazal Province is the most important producer of these two forest commodities, its average annual production being estimated at 70 tons of bees-wax and 24,000 tons of honey. The people of the Nuba Mountains, who collect large amounts of bees-wax and honey, produce "Luban" gum, an exudation of Boswellia papyrifera (gafal), to be used for burning inside houses as an insect repellent; it is produced for domestic use as well as for sale.

All the three southern provinces produce varying amounts of "sisal" ropes, palm oil, bees-wax, honey, "luhl" (Butyrosperumum niloticum) nuts and "lulu" oil. Between 16,000 and 20,000 "rottles" (lbs) of "lulu" oil were produced in 1960, the bulk being from Raga and the Lakes District of the Bahr el Ghazal Province. During 1962, 10 tons of rubber were collected by the Equatoria Project Board in Yambio area. In the same year 226 "rottles" of "sisal" oil, 199 "rottles" of palm oil and 1,466 baskets were produced and sold locally

by the Forests Department in the central parts of the Bahr el Ghazal Province. Small quantities of "senna" (Cassia auctifolia) are also produced in the southern provinces. On a wider scale is the utilization of fruits and roots by the people, especially those who are almost permanently dwelling in the forest and producing few or no crops.

The utilization of wood in the manufacture of furniture and ornamental works is of great importance. The population of the Sudan now manufacture all their needs of furniture and ornaments locally and from locally produced timber. Mahogany, which attains a magnificant smooth finish, is widely used in furniture making. The southern parts of the country are famous for their heavy, good-quality furniture, the production of which is far above their local demand, the surplus being exported to the northern bigger markets.

These minor forest products are essentially for local consumption and the part that enters international trade is quite small (Appendix V (XVIII)).

6. Forest Industries:

As a branch of the national economy, forest industries have a role to play in the promotion of economic growth by performing those functions which any other branch faces; to satisfy local needs, to create employment opportunities and, in the long run, to contribute to the international trade of the country.

Apart from sawmilling, which is found mainly in Fung, Katire, Loka and Nyimakak, none of the main forest industries is in existence at the moment. The board manufacturing seems to have better opportunities. The consumption rate of the country is not generally low because in 1963 the country imported 3,800 tons of fibre-board and 1,400 tons of particle-board[1] and this is high enough to justify the establishment of a fibre-board factory with a daily production of about 10 tons, and a particle-board factory with a daily production of 4-5 tons. The raw material locally available for board manufacture is varied and abundant. Eucalyptus species and Cassia siamea have proved to be suitable for particle-board manufacture, and if an irrigated plantation is established near Khartoum, like the Khartoum Green belt, it can feed a small factory at Khartoum to produce 2 - 2.5 tons per day[2]. In the southern parts of the Sudan, many species are suitable for board manufacture; also thinnings and residue from the conifer plantations in the Imatong Mountains can serve as a raw material. But these areas are so remote that any board produced there will have a high transport cost since the main markets are located far in the north.

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(1) F.A.O., op. cit., 1964, p.50.

(2) K.O.Khalifa, Potential Forest Industries, Sudan Silva 14(11 1963, p.13.

Other forest industries which can be established include the processing of "dom" nuts into fodder. Such cattle fodder is essential for supporting the big cattle population, especially in southern Darfur, eastern Bahr el Ghazal and the western Upper Nile Provinces where their over-stocking on the poor limited grazing land is apparent. The establishment of a factory for the production of sacks, ropes and strings from the "dom" palm leaves can be investigated with special reference to the Gash forests and forests at Liri and Nyala. If the experiments carried out by the United Nations Special Fund Project and the Plant Protection and Pest Control authorities proved successful, the production of baits from the saw-dust of "sunt" will be of great value to the agricultural schemes upon which almost the entire economy depends. Of equal importance is the possibility of producing a high-quality tanning material from "sunt" pods (garad); this is important for the Sudan's increasing external trade in hides and skins. The promotion of oil extraction seems to have a wide opportunity of success especially in the Zande scheme where at least four oil-bearing trees have successfully been grown; these are Butyrospermum niloticum (lulu), Lophira alata (meni oil tree), Elaeis guineensis (oil palm) and Canarium schweinfurthii. This industry will have a large market in the southern parts of the country which are quite remote from the existing oil industries of the northern regions.

Before deciding to establish any of the forest industries, a careful scientific analysis and the testing of the species and the forest products need to be carried out. An equally careful survey should include the location factors which influence the costs and prices of the processed products. These location factors include such elements as the geographical pattern of markets and production areas, the distribution of timber stand, the cost of transporting raw materials and finished commodities, climatic and social conditions, the availability of power and labour and the established network of communication.

Chapter IV

Forestry and Land Use - 1

At the stage when man is dependent on nature, as in the primitive areas of southern Sudan, his activities are determined to a very large extent by the forest. The attitudes of different people to the forest vary considerably; to the forest man, it provides food and shelter, to the pastoral man it is repellent and the home of predators, and to the cultivator it is a loss of ground which could otherwise be put under agricultural production.

Man, in his need for food and clothing, makes ever increasing demand on land. In the past agriculture advanced at the expense of the original vegetation and many forest types were transformed. The human intervention with natural vegetation has resulted in varying modifications of the climax forests and the complete eradication of the forest over extensive areas. In the Sudan this human intervention has been connected with different activities practised in the forest; these, which include various types of cultivation, grazing, settlement, fire and wood cutting, will change the natural vegetation cover in the north to steppe and finally to desert conditions if they are not controlled in one way or another.

1. Shifting Cultivation:

Shifting cultivation has a long history in almost all parts of the Sudan except the Desert and Semi-Desert where rainfall is rarely sufficient to permit unirrigated cultivation, in the areas infested by the tsetse fly, and in the permanently inundated swamps of the southern clay plain. It is essentially the main type of cultivation practised apart from the irrigation schemes. It is not safe to generalize about shifting cultivation because the various practices and the nature of the terrain in each case have different effects on forests and soils. Jackson and Shawki[1] have distinguished 8 types of which the one practised in the gum belt is perhaps the most beneficial to the forest and the soil, but unless there is control the increasing pressure on the land may shorten the fallow period and consequently lead to the final disappearance of the forest and the exposure of soil to erosion.

In Equatoria Province the practice should ideally be eradicated from all mountain areas by their declaration as forest reserves to protect the remaining forests and soils. In the woodland savana the local shift of agricultural land, as a result of exhaustion, may be accompanied by movement of the whole village, but more often the houses remain in their place because of domestic water supply. The fallow period is not

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(1) J.K. Jackson and M.K. Shawki, Shifting Cultivation in the Sudan, S.N. and Records Vol. 31, pt. 2, 1950, pp 211 - 6

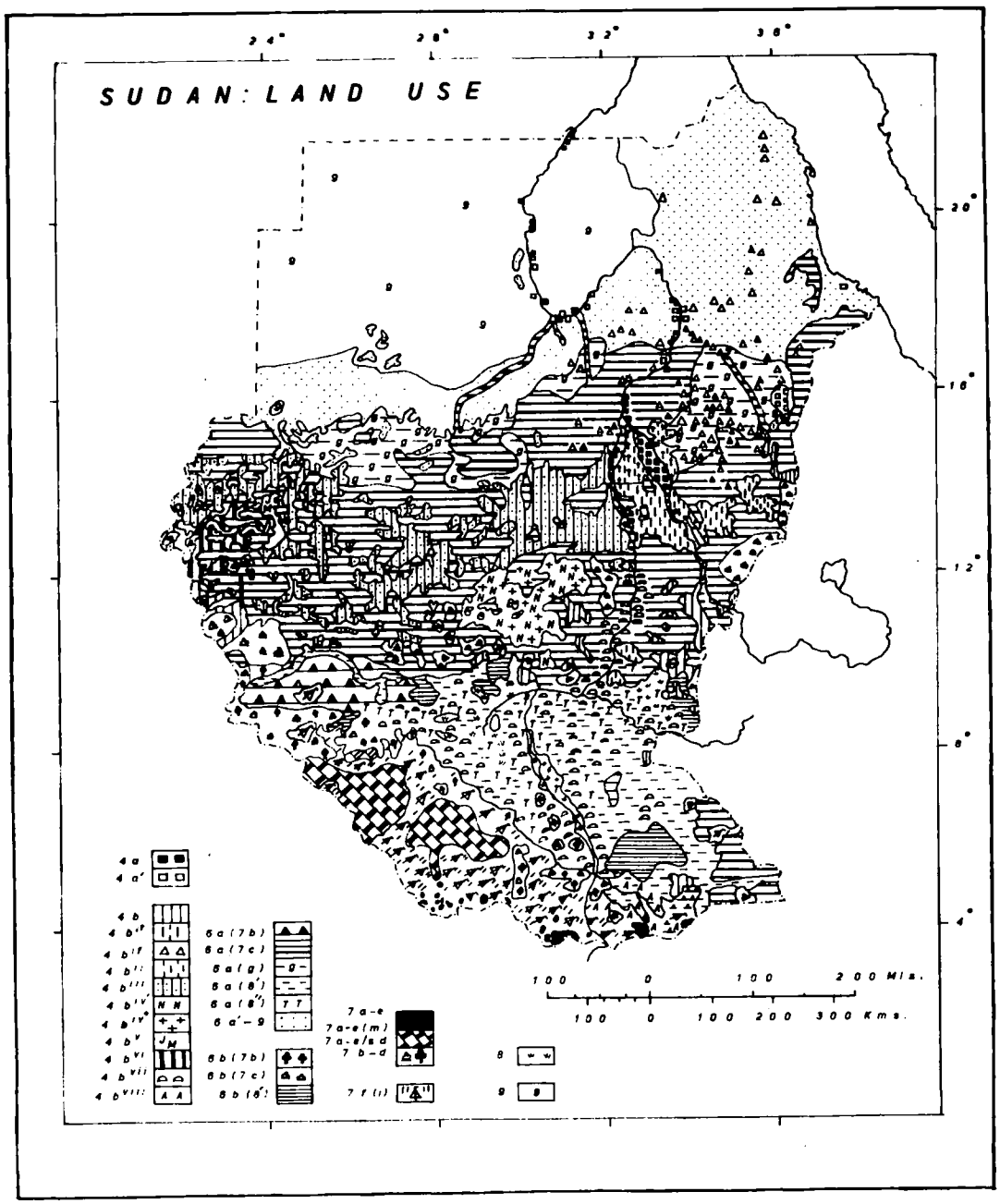

Fig. 23: Redrawn from Lebon, op. cit., 1965; the symbols correspond with those in Table 11.

determined by the availability of agricultural land but by the desire of the people to remain as near as possible to their villages and to avoid the heavy task of the clearance of new land. The effect of this practice on the fertility of the soil is determined by the length of the fallow period and the intensity of cultivation between successive fallow periods; no permanent or serious damage may be done to the soil if the fallow period is long enough (8 - 11 years) to allow the regeneration of the trees. The proper fallow system is disturbed in many places, especially where settlements have been stabilized in the interest of tsetse fly control and health, educational and other social services.

Within the domain of the Nilotic people, which has originally been covered by a local type of savana (palm woodland)[1], the agricultural practice may vary slightly from one place to another. The Shilluk cultivation is mostly confined to river sides, and it is continuous (with no form of rotation) for 3 - 4 years before the land is abandoned. The practice of the northern Dinka and Mabaan is different in that the cultivators do not clear the trees but simply lop and top them. Thus the effect of the practice on forests is not generally significant although there are some areas suffering from over-cultivation and severe soil deterioration; but large scale deforestation for the provision of agricultural land has not yet taken place.

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(1) Lebon, op. cit., 1965, p.96.

The protection of the forests and the slopes of the Nuba Mountains and the Jebel Mara necessitates the transfer of settlements from the slopes down to the plain or, in the case of the Jebel Mara, to the southern third where perennial streams are numerous enough to minimize the pressure on forests and soils.

Table XVIII: Effects of Shifting Cultivation

Locality	Natural Vegetation	Cultivation	Crops	Effects on Soil	Remarks
1. Central Kordufan, Central Darfur, southern Kassala and Southern Blue Nile Provinces.	The gum-yielding Acacia senegal.	Shifting cultivation with a well-defined rotation.	Sesame, dura and dukhn.	Helps the soil to retain its fertility during fallow period.	Working of soil for cultivation facilitates regeneration of Acacia senegal.
2. Equatoria Province.	Woodland savana.	Cultivation for 2-3 years on the steep slopes of the Dongotona hills.	Sweet potatoes, cassava and millets.	Soil washed down slopes and most of hills below 6,000' converted to bare rocks.	The small remnants of tropical rain forest are not yet seriously affected.

Locality	Natural Vegetation	Cultiv-ation	Crops	Effects on Soil	Remarks
3. Equat-oria Province.	Woodland savana.	With a short fallow period (2 - 5 years).	Ground nuts, cassava, millets, sesame, maize, and tobacco.	Severe soil deter-ioration in many places; sheet and gulley erosion in Raga and Deim Zubeir.	Forest reduced to fire-climax, and broad-leaved forests to thorny forests in many places.
4. On the clay plain and to less extent on the sandy loams west of the White Nile.	Grassland	"Harig" cultiv-ation for about 3 years; rest period 2-5 yrs.	Mainly millets.	Soil fertility may be maintained if during colon-ization period grasses escaped fire.	It does not affect forests because the area is predomin-antly a grassland.
5. Along main Nile between Khartoum and Atbara, Blue Nile between Khartoum and Roseires and on Dinder and Rahad tribut-aries.	Dominants are Ziziphus spinachristi on "gerf" land and Acacia arabica on basins.	Except for a very short fallow period cultiv-ation is cont-inuous.	Mostly fruits and veget-ables.	Not harmful to soils because fertility is ann-ually renewed by flood.	Forests on "gerf" land are not affected, but on basins they are drast-ically affected especially north of Khartoum.

Locality	Natural Vegetation	Cultivation	Crops	Effects on soil	Remarks
6.Areas in the vicinity of villages "bildat".	Various grades of semi-desert scrub and low savana.	It is perennial or with a very short fallow period.	Dura, dukhn and other cereals.	Severe erosion even on sandy soils, and its effects may be permanent.	When soil is worn out the whole village may move to a new site; severity of erosion is proportional to length of fallow period and density of village population.
7.Margins of clay plain in Upper Nile Province.	Acacia Spp. and broad-leaved deciduous species.	Varies from light to intensive with no rotation at all.	Mostly dura.	In local areas the soil has seriously deteriorated.	Its effects on forests are not significant because rainfall is high and the Nilotic people are interested more in their cattle than in agriculture.
8.The Jebel Mara and the Nuba Mountains.	Savana.	Terraced cultivation on steep slopes.	Cereals and some fruits and vegetables.	Over-cultivation has led to severe soil erosion.	Woodlands have been restricted to fairly limited areas.

Sources: Jackson and Shawki, loc. cit., 1950.

Lebon, op. cit., 1965, pp. 79 - 100.

Though very little information on the ecological rate of change of forests has been collected in the Sudan, in the South there is considerable evidence that during the last 100 years large areas of closed forest have been reduced to fire-swept woodlands by the combined effect of shifting cultivation and fires.(1) There is, therefore, an urgent need to modify shifting cultivation and adapt it to forestry since little immediate change is foreseeable. There is as yet no land hunger in the Sudan, but local over-concentrations have already appeared; these have been unavoidable in Kordufan and Darfur where there is a marked restriction of water supplies; but in areas infested by the tsetse fly, these have deliberately been created to facilitate the control of sleeping sickness. Such over-concentrations of agricultural people cause the fallow period to be short and the dangers of erosion to be prominent. The creation of new water points can alleviate these over-concentrations, but it can equally mean merely new areas of denudation owing to lack of control and failure to grasp the capacity of each newly created water centre.

Some of the modifications to improve this system of cultivation have been introduced in different parts of the country. In Equatoria Province the greatest modification is found in the Zande scheme. The modified system of cultivation adopted here consists of sub-division into plots; the farmer is allowed to cultivate any part of his plot for only three

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(1) Jackson and Shawki, op. cit., 1950 p.220

successive years after which he must allow it to revert to bush fallow, and another piece of land within his area is to be prepared for cultivation. It is strictly prohibited to cultivate bare slopes, steep slopes or any area along or in the immediate vicinity of stream valleys, rivers and springs. This system ensures that forests outside the allotted areas will not be devastated and that forests along streams, rivers and springs will be secured for protective measures.

The replacement of fires in the "harig" system of cultivation by disc harrowing after the germination of the new season's grass has occurred in few places; the application of this modification to as large areas as possible will greatly reduce the risk of fires spreading from the cultivation areas into forests. In the case of "bildat", the introduction of a fallow period where it does not exist and its lengthening where it is short is necessary; but where the pressure on land is so great that the cultivation cannot afford a long fallow period, the application of fertilizers and manures becomes necessary to keep the land in good condition. In the gum belt, suggested modifications include the adoption of extensive fire protection systems and the cultivation of agricultural crops with "hashab" seeds (Fig. 18). In the South, attempts to prohibit burning have proved ineffective, but an early burning policy could take their place since early fires are less fierce and consequently cause comparatively little damage to the trees.

The adaptation of cultivation to forestry reached its greatest development in the "gerf" land and on the basins of the Blue Nile where the riverain Acacia arabica forests were worked by cutting immediately followed by resowing. Its cultivation as a "taungya"(1) crop was greatly helped by the rise in the price of maize in the early forties; the system is simple and beneficial especially where land hunger is marked: it is to employ labour to sow maize together with Acacia arabica seeds and at the end of the production period the maize crop is shared between the labourers and the Forests Department. Under this system the Department controls the whole operation and is able to obtain relatively cheap labour at a time when there is a general tendency for wages to inflate. In the basins along the Nile between Khartoum and Wadi Halfa, contractors were allowed to sow and harvest a maize crop free, in return for sowing the Acacia seeds with the crop; this practice could be adapted extensively in the Northern Province owing to the limited cultivable land. But to extend this system over the other parts of the country, it is not necessary to determine the agricultural crops to be grown, but rather to leave the contractor or labourer to grow whatever crop he wishes provided that this will not adversely affect the normal growth of the trees; this has now become quite possible because experiments have shown that good results can be obtained from the

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(1) "Taungya" is a Burmese word denoting reafforestation by sowing tree seeds with agricultural crops.

sowing of agricultural crops with tree seeds. In the other parts of the country where cultivable land is abundant, cultivators are reluctant to take part in the "taungya" system because they have enough land which they can cultivate at will and without the restrictions necessary when trees are raised among their own crops.

This "taungya" system does not only ensure a rational utilization of land and conservation of soil, but also contributes to the country's production of consumption and cash crops. It will help to produce food crops for the Nilotic and Beja people who are frequently swept by famines, and those who live along the main Nile (north of Khartoum) and who often suffer from low floods and crop failures. Of equal importance is the effect of this system on the promotion of tree growth, as indicated by the initial results of experiments conducted during 1953.(1)

Besides these modification, there is the legal aspect. The Central Forest Ordinance of 1932 declares that all rights are extinguished where central forest reserves are established, and no type of shifting cultivation should be practised except in the form of "taungya" for regeneration of the forest . Under the Provincial Forest Ordinance the authorities of the

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(1) J.K.Jackson and F.G.G. Peake, Forestry Research in the Sudan 1950 to 1954, Forest Memoir No.7, Agricultural Publications Committee, Khartoum, 1955, pp.11 - 3.

local government may declare certain species of trees to be "protected trees" and these should not be cut down or injured in any way without permission, even in the course of cultivation. In practice this provision is very difficult to enforce because of the scattered nature of the cultivation, lack of adequate forest staff and general unawareness among the people of the indirect values of the forest.

2. Other Agricultural Practices:

In agriculture, the nature of the shallow tropical soils and their relative poverty in nitrogen, as in most of southern Sudan, must be guarded with the highest possible care; the undulating terrace, like that of Equatoria Province, essentially requires special handling. The long dry season of the central parts of the country, which is accompanied by wide-spread fires and followed by torrential rains, is especially favourable to soil erosion.

In Equatoria Province many of the local inhabitants have been given plots for coffee plantations, but lack of control resulted in many people taking more land than they were allotted; many of these areas are on steep slopes and often on the very edge of the streams and "khors", and the trees and bushes have been completely cleared from the sloping land which is cultivated without ridging. Some of these cleared plots contain some of the few remaining parts of the gallery forests. The situation is further aggravated by the fact that these areas are on marginal land and rainfall for

coffee plantations. Also the establishment of tobacco farms in the same province has involved a great deal of deforestation of sloping terrain and along streams, and erosion has started in these areas. These tobacco farms are small and so scattered that it is very difficult to control deforestation, and impracticable to arrange fuel plots on a sustained yield basis. Under such conditions it is vital to include in the local Standing Orders provisions for the control of forest clearance for commercial agriculture on unfavourable sites.

3. Grazing:

Grazing has had far reaching effects on the natural vegetation and the soils of many areas. Under natural conditions, before the intervention of man and his domestic animals, there would have been a whole spectrum of wild grazing and browsing animals each of which is a selective feeder, maintaining an ecological balance with the natural vegetation. When these wild animals are replaced by domesticates this balance is upset because there is now much more pressure on certain vegetation species which are actively selected by the limited range of the domestic animals. This pressure will be kept to a minimum when grazing is light and controlled, but with heavier grazing resulting from more animal stock or use for longer periods, there will be a decrease in the more favoured species and consequently the value of the grazing land will deteriorate. Over-grazing will produce a serious

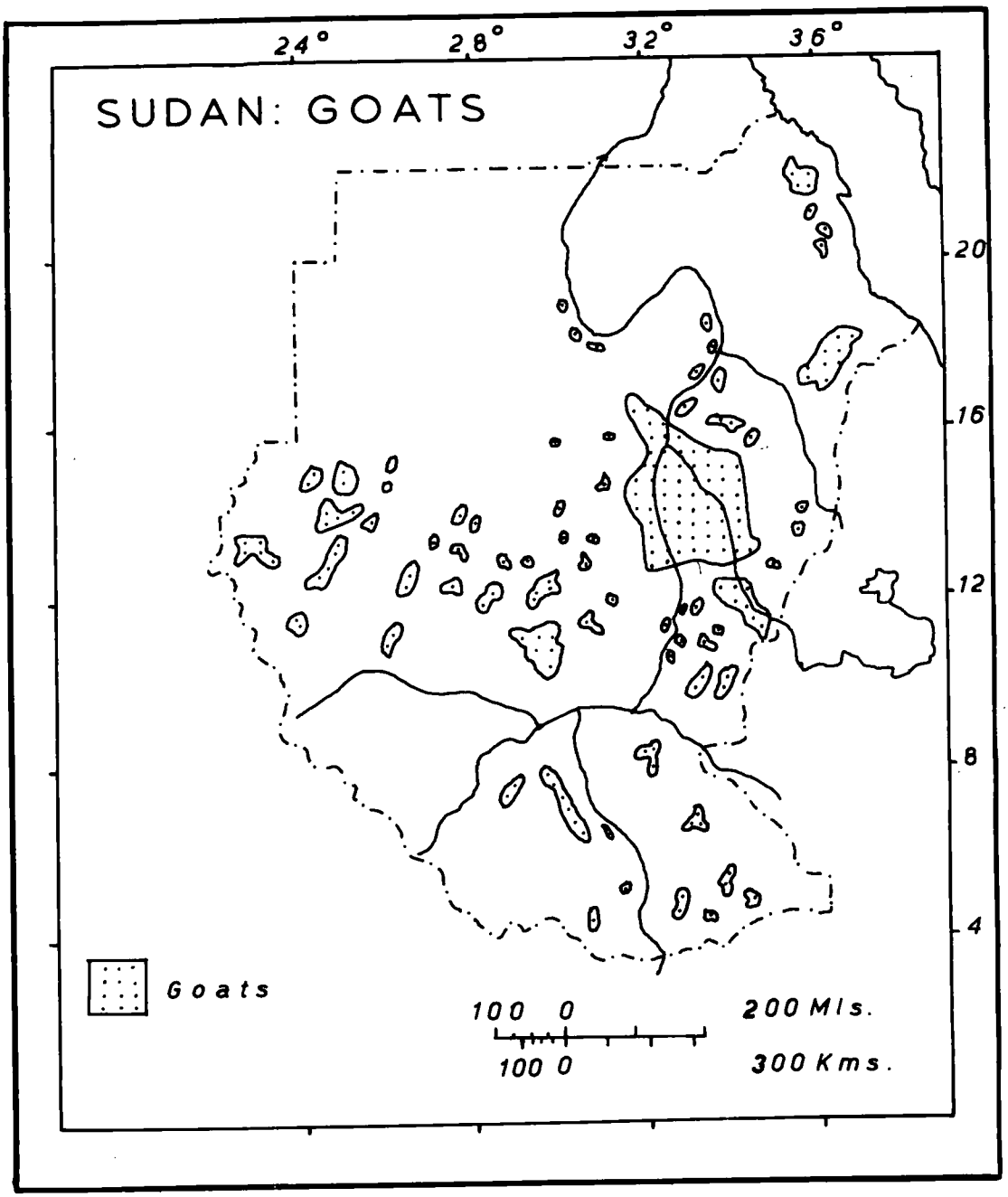

Fig. 24: Redrawn with amendments from Barbour, op. cit., 1961, p.90.

reduction, if not a complete disappearance, of the vegetative cover, which will in turn give rise to severe soil erosion.

During the forty years, 1918 - 57, the total number of the four main domestic animals: sheep, cattle goats and camels (Fig.s 24 - 7), has increased from 3.7 millions to 21.8 millions. Sheep, goats and cattle have all increased from sixfold to ninefold while camels increased by about eightfold. The government's aim till 1947, because of fear of consequences of an undue increase of the flocks and herds, was to stabilize the number of animals, but after 1947 owing to better prospects of increasing water supplies by digging reservoirs, it decided to maximize the application of proved methods of disease prevention on the assumption that animals could be safely increased to support a growing human population and to create a surplus for export. In 1961 the accepted animals' numbers were: camels 2 millions, cattle 9 millions, sheep 8.5 millions and goats 6.5 millions.(1)

The tribes of southern Sudan keep a large number of cattle as a sign of prestige. The number of the cattle is increasing at a high rate because very few are slaughtered or sold for cash while neither the area of the grazing land is increased nor the quality of the pasture improved. The grazing land is

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(1) A.R. Bayoumi, Some Problems of Land Use and Rural Water Development in the Republic of the Sudan, Unpublished Report to the Ministry of Agriculture, Khartoum, p.7.

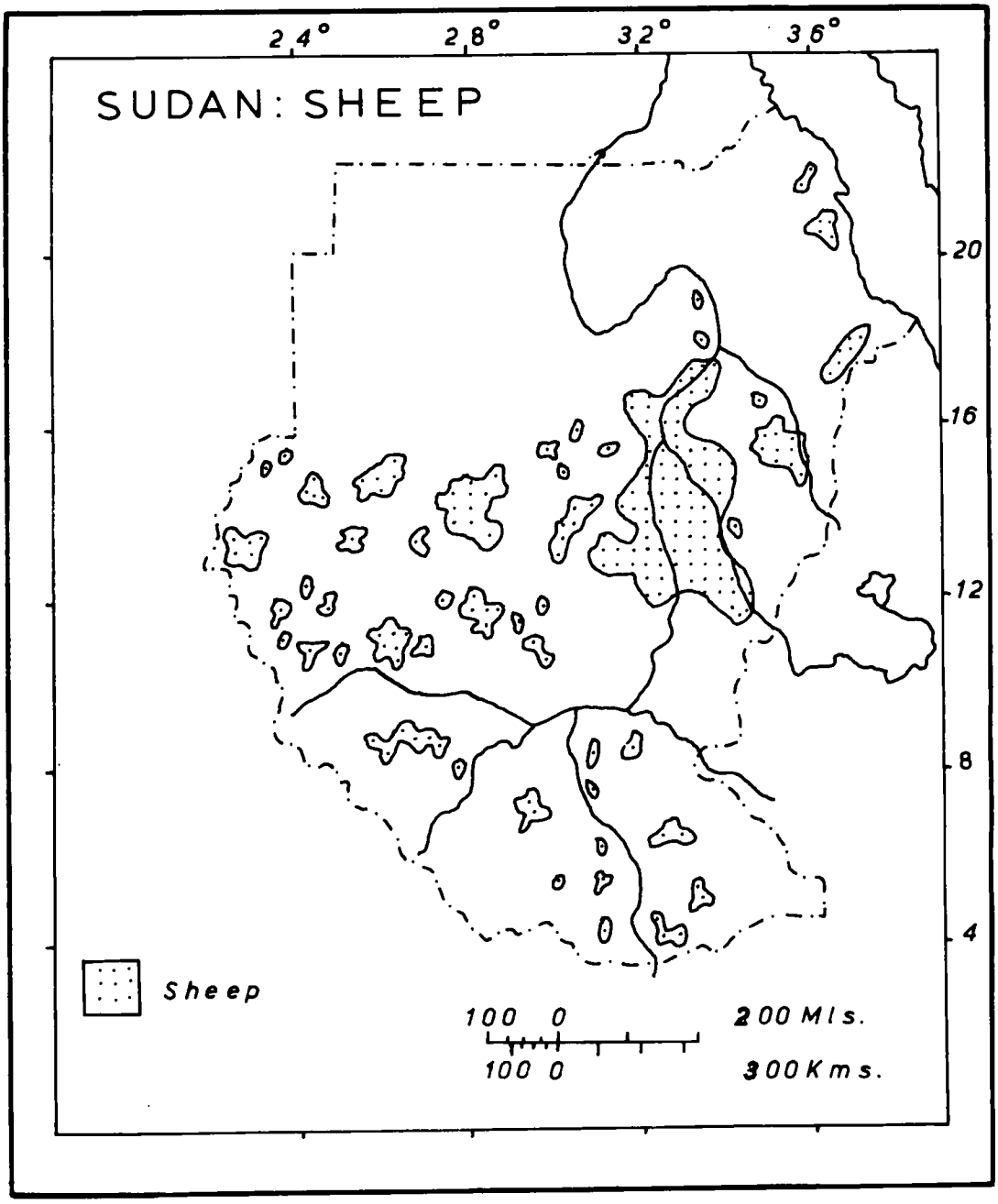

Fig. 25: Redrawn with amendments from Barbour, op. cit., 1961, p.90.

confined to areas above the flood level and areas outside the domain of the tsetse fly. The reduction of the number, or at least lowering the rate of increase of cattle, the extension of the grazing land and the raising of the quality of the pasture are urgent needs for the protection of the forest and the soil, especially after it has become evident that erosion has already started in the over-grazed northern parts of the Bahr el Ghazal and most of Equatoria Province. To reduce the number of cattle, by attributing an economic significance to them, will be at least at the present time, a fruitless attempt because "the cattle as a sign of prestige" has long been rooted in their folklore and traditions to the extent that the various aspects of their life are determined accordingly. It will be a long time before the spread of education and the economic development of their area alter their social structure and weaken these strong traditions. The extension of the grazing land involves the eradication of the tsetse fly in woodland savana belt and the provision of water points in those ungrazed lands on the southeastern extremity of the clay plain.

In Kordufan and Darfur Provinces, where the lack of water constitutes the main problem, the situation is no less drastic. The large number of animals here (cattle and camels) has a wide area to move over but between the Bahr el Arab and the northern and the western frontiers there is a lack of rich pastures. Early in the rainy season the nomads start their

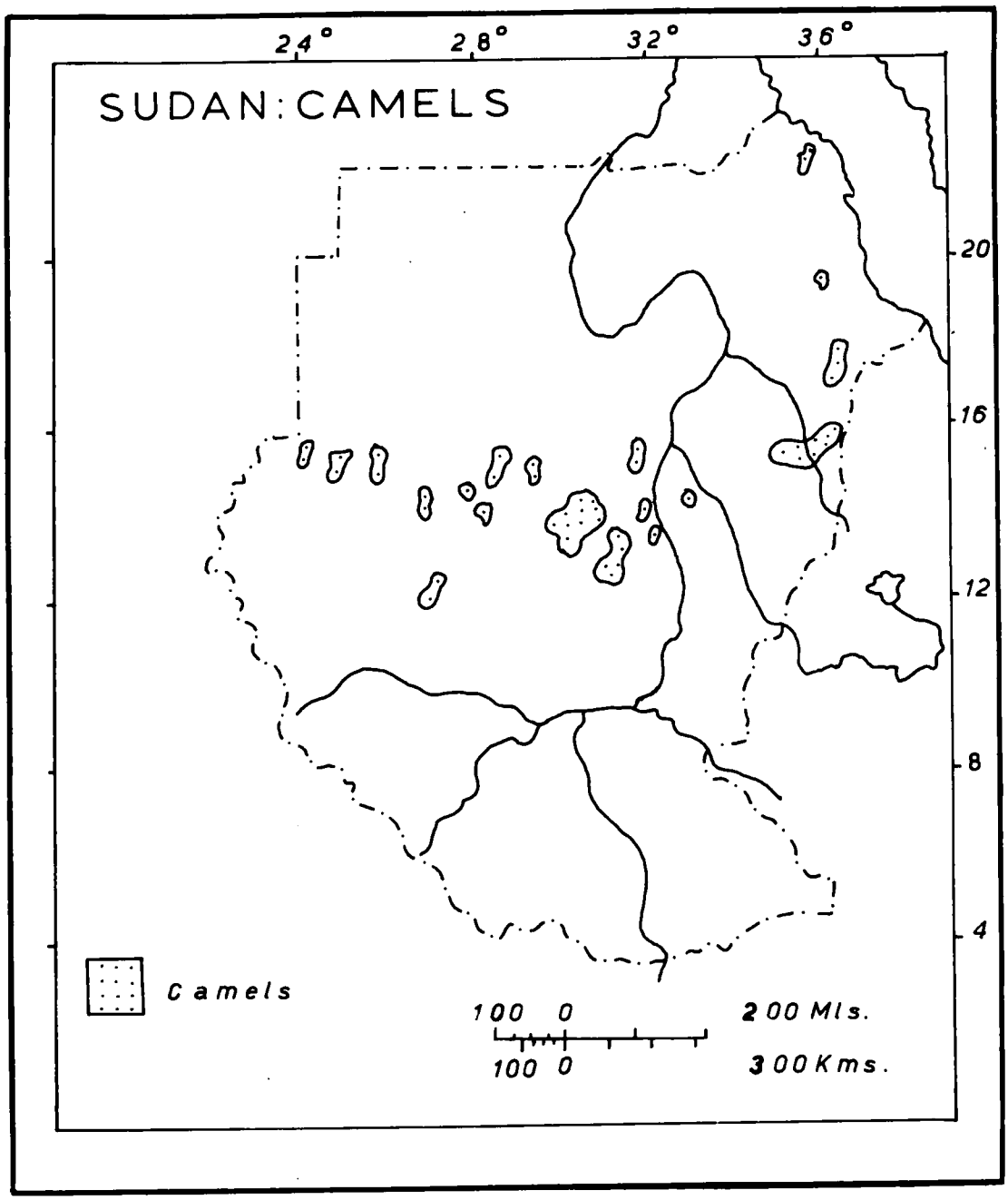

Fig. 26: Redrawn with amendments from Barbour, op. cit., 1961, p.90.

northward journey the target for which is provided by the "gizu" species on the southern fringes of the desert. They stay there till the "gizu" grasses are completely grazed, with the result that the soil becomes exposed for almost the whole year, paving the way for desert creep. During the dry season some of the pastoralists stay with their animals near the comparatively limited water supply centres, the concentration around whicn is usually far above their capacities in view of grasses and water supply. So formany miles around these centres the land is over-grazed and exposed to wind erosion for most of the dry season. Some of the camel-owning tribes come in contact with the Hawasma and the Messeriga Zuruq during the dry season in the vicinity of Delling and Abu Zabad, an areas which is already over-grazed according to Harrison(1) to the extent of 20%.

The semi-desert grassland of the Butana, apart from the occupation of man and his animals, would have been covered withalmost pure stands of Blepharis spp., which are palatable to camels and sheep during almost the whole year, and to cattle during the rainy season only(2). Blepharis, if heavily grazed, cannot regenerate and completely disappears, as in almost all the over-grazed areas of the plain. Blepharis has disappeared from the banks of the river Atbara for a width of about

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(1) M.N. Harrison, Report on Grazing Survey of the Sudan (to the Ministry of Animal Production) 1955, part III,p.26

(2) Lebon, op. cit., 1965, p.160.

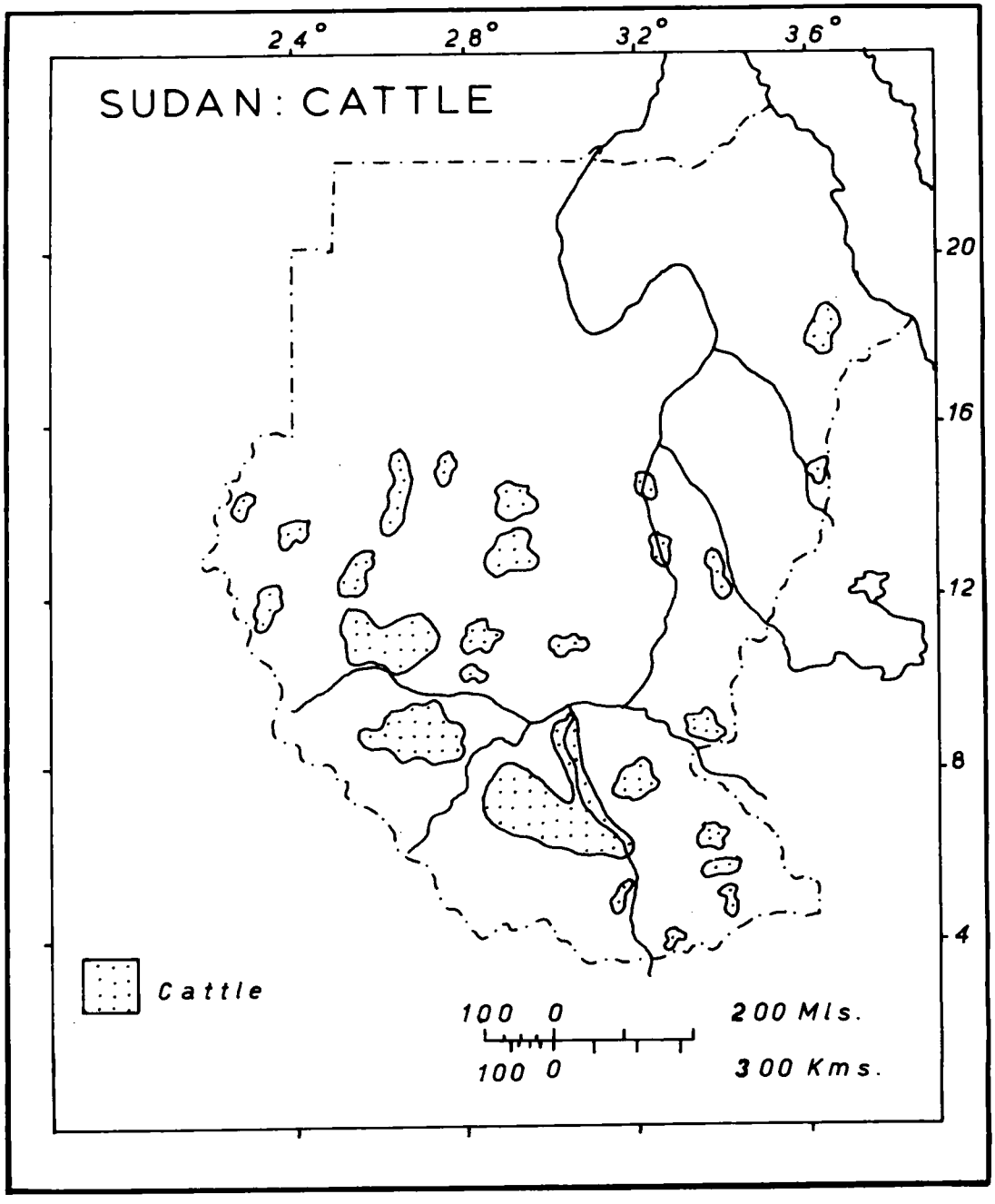

Fig. 27: Redrawn with amendments from Barbour, op. cit., 1961, p.90.

20 miles. The provision of water points would release the pressure from the over-grazed centres and would give the Blepharis a better chance for regeneration; the new water centres should be confined to the western, central and southeastern parts of the Butana, and should be reserved for the use of cattle and sheep only, leaving the camels to feed on the drier areas.

Grazing by cattle and sheep can have serious consequences, but the effect of the goat on the semi-desert vegetation is much more drastic. The main domain of the goat is the semi-arid region extending roughly between latitudes 13° and 17°N., and covering an area of about 200,000 square miles; this region is one of the most populous parts of the country; the natural vegetation comprises small trees and bushes which are within easy reach of man and his animals. The ecological balance has been tipped in favour of aridity and desert conditions in this region which is over-used by man and over-grazed by animals.

The goat was considered a problem after it had been realized that desert conditions had started to extend southwards. In this region about 5 million goats are kept for the provision of milk. The goat is a ubiquitous feeder and can thrive on anything other than absolute desert, and eat all the plants within its reach, leading to the loss of practically all the vegetation and the consequent prevention of regeneration. The situation is aggravated by the steady

increase in the number of goats because none enters international trade and few are slaughtered. The various measures of control have been hampered by the social side of the problem: the goat is considered as the source of milk for the poor sector of the population. One of the measures tackled was the enclosure of towns and big village perimeters to preserve the natural vegetation within them, but this enclosure system could not be carried out widely enough. In fact this system increases the concentration of the goat on the unenclosed areas which constitute about 80% of the total thus subjecting them to more severe erosive actions. Another measure was the allocation of certain areas for the grazing of the goat, but this proved to be impractical because the goats were very rarely confined to them. Taxation, as a measure to discourage people from keeping large number of goats, was attempted but did not give encouraging results. Another attempt in the Gezira scheme was the treatment of foliage with repellents, but it proved fruitless because the goats remained unaffected.

The problem is acute because through the activities of the goat the threat of the desert creep is becoming a reality. The most effective solution seems to be, as Ballal has advocated(1), the complete extermination of the goat from

(1) A. Ballal, The Goat as a Problem in the Semi-Arid Region of the Northern Sudan, Sudan Silva 12 (11),1962,pp.22 - 4.

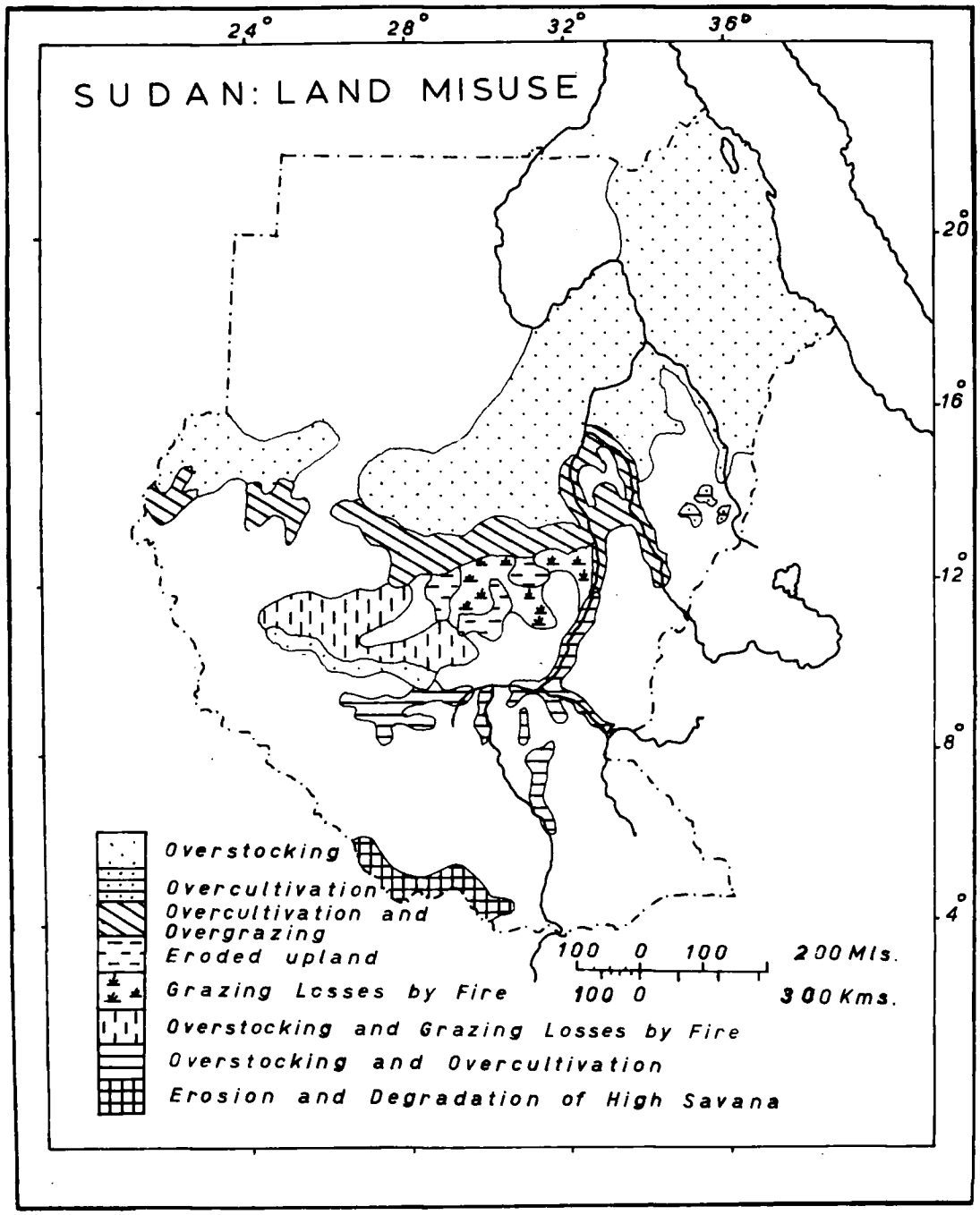

Fig. 28: Redrawn with amendments from Lebon, op. cit., 1965, p.169.

this region despite the fact that it is the source of animal protein for the poor. Lately some individuals, encouraged by the state, started some dairy farming schemes in big towns to encourage the use of cow's milk instead of the goat's milk, but the response was almost negligible because the price of cow's milk was so high that the poor could not afford it. If such dairy farms are owned and efficiently run by the state, or alternatively by co-operative societies formed by the people themselves and aided by the state, cow's milk can be made available in abundance and at a reasonable price since the motive of the state or the co-operative society will then be to serve the poor man and not to rob him. This will ensure adequate animal protein, and thus pave the way for the extermination of the goat from this region.

4. Settlement:

Settlement will continue to be an important type of land use in the coming few years because a large proportion of the population is either semi-sedentary or without any definite form of settlement. The creation of permanent settlements for those people needs to be undertaken with due regard to the climatic conditions, the nature of the terrain and the water supply.

To a large extent the inhabitants of Equatoria Province have certain agricultural and social customs and

practices modified by their environment, and these favourably accorded with these conditions; these practices included the spreading of the population thinly over the poor shallow tropical soils and this rendered shifting cultivation a relatively suitable form of land use. The serious new feature is the deliberate change of this mode of settlement by administrative arrangement to create dense concentrations of settlement along the main roads. Another face of the change in modes of settlement in Equatoria is the official encouragement of the downward movement of tribesmen from the hills and hillsides to dense concentrations in the valleys, as has been done by the Latuka in the Katire area of the Imatong Mountains. The positive side of the settlement of the Latuka is that it terminates deforestation, over-cultivation and over-grazing on the mountains, and consequently aids the regeneration and conservation of trees. But in the case of the Zande settlement the tropical soil is too poor to carry dense concentrations of agricultural and pastoral people; deforestation, over-cultivation and over-grazing will be the logical results.

Creation of similar heavy concentrations of settlement has also occurred in the western parts of the country where new water supplies were provided to release the pressure on the alread over-populated areas. Most of these new water points have only meant new areas of denudation owing to the human and animal over-concentrations resulting from the provision of water in such an arid region. Here, as well as in the recently introduced

types of settlement in Equatoria, a healthy balance between the degree of concentration and the capacity of the area must be maintained if the general standard of living of the local people is to be raised without seriously endangering the vegetation and the soils of these localities.

In the Bahr el Ghazal Province, the area within the domain of the tsetse fly is about 90,000 square miles, extending around a line running northeast to southwest through Wau. To exterminate the tsetse fly and render the area favourable for human and animal habitation, the Gogrial Tsetse Campaign, arranged by the Ministry of Animal Resources, has cleared off all trees and completely burnt an area of about 800 square miles north of Wau. The eradication of the tsetse fly is undoubtedly desirable, but it is unfortunate that this campaign was not referred to any land use or conservation committee to weigh and balance the costs and benefits and to see if there were any other reasonable solution. Not only will such wholesale clearance of forestland cause accelerated soil erosion and water dissipation, but it will also threaten to create sites for heavy concentration of cattle herds with consequent over-grazing and a further enhancement of erosion unless the situation is carefully guarded with the provision of a proper balance between the requirements of the human and animal population and the capacities of the area. This complete tree clearance also means that the newly created settlements will depend on other areas for the provision of wood fuel and all other forms of round wood.

Near Er Roseires, the Kenana agricultural scheme is about to be established. A primary aim should be that the agricultural village communities should get their wood requirements from within the scheme itself. If each village consists of 200 families, and each family of 7 persons on the average, then such a community will need about 600 feddans of forestland for firewood and charcoal; an allowance of about another 100 feddans should be made for the provision of other forms of round wood. If the rotation system is similar to that of the Gezira (4-year rotation), then about 8 - 10% of the total area of the scheme should be put under forests. The existing natural forests may be preserved, wherever possible, to meet the people's requirements before the forest plantations are ready for felling. The inhabitants will undoubtedly keep some domestic animals, particularly cattle, the pasture for which must also be carefully considered.

5. Fire:

Some vegetation fires are essentially due to natural causes, especially lightning, but the vast majority of these fires are started by man. For at least 350,000 years it is known that man has had control of fire, but it is not known exactly for how long he has been systematically burning the natural vegetation of his environment. This firing is done for a number of reasons: to provide grazing at a time of the year when it is scarce, to clear the land for the various types

of cultivation and for easy movement, to drive game from the wood to facilitate their capture, to kill certain parasites, to give room for settlement, and even to enjoy the sight of a good blaze, especially at night. So fire is not in itself a type of land use, but it has always been associated with some land management practices.

Fire severely damages many of the woody plants though it stimulates the growth of some savana species. The degree of damage increases with the frequency of the burning and the intensity of the individual fires which depends on the intensity of the vegetation cover and the time of the year when burnings are undertaken. Early burning, in the beginning of the dry season when grasses are green and have a high moisture content, is estimated to consume 20-30% of the herb cover, while late burning, at the end of the dry season when grasses are fully dry, may consume over 90% of the grass mat. Wind and the time of the day when burnings take place also affect the severity of the fire.

The immediate effects of the fire are to kill tree seedlings, to kill some perennial plants and permanently destroy annuals, to burn up vegetation debris, to destroy the humus and to expose and dry the soil surface. The secondary effects, according to Ferguson,(1) are as follows: (1) by exposing the soil the rain will beat it into a hard

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(1) H. Ferguson, Deterioration of Soil and Vegetation in Equatoria in Soil Conservation Committee's Report, Khartoum, 1944, p.139.

surface layer (especially in clay soils) or wash it away (especially in sandy soils). (2) by burning the ground vegetation and the debris there will be no effective barrier to running water. (3) by burning humus and humus-forming materials the absorptive capacity of the soil will be reduced and the physical structure upset, and a loss in plant nutrients will be caused. (4) by destroying tree seedlings vegetation will deteriorate and the grass/tree ratio will be increased. This increase in grass/tree ratio will in turn increase the severity of fires and consequently their damaging effect. Another long term effect is that the reduced absorption of rain water and the greater run off will cause a loss in the water supply which, couplied with a general reduction in trees, may cause permanent damage. This process is progressive and, if allowed to follow its irreversible course, the creation of desert conditions will be its ultimate end. The economic effects of fire include the destruction of the present and the potential forest resources, reduction of the productive capacity of the soil, and consequently a permanent reduction in the natural wealth of the country.

The line running roughly along the 850 mm. isohyet on sands and the 950 mm. isohyet on clays divides the country into parts with regard to fire-danger. South of this line the density of the grass mat renders annual grass-fires highly probable. The frequency of fires in southern Sudan is high despite the fact that the early rains help to prevent the

spread of fires originating from shifting cultivation areas. One factor contributing to this high fire-frequency is the considerable disarray of early burning times which may start as late as February because of the prolonged rainy season. Over the central parts of the Sudan, the frequent spread of fires is mainly due to the inability of the authorities to complete the firelining before the early burnings are started by the local people. Fires are also known to be started by herdsmen to enable new grasses to grow for their domestic animals. One such fire destroyed 27 feddans of teak and "neem" in Equatoria in 1955. Cultivators and honey-collectors also start dangerous fires; in 1963 honey-collectors completely burnt 174 cubic metres of firewood in Upper Nile Province. A considerable amount of the forest of southern Sudan, especially in Equatoria Province, has been completely and deliberately burnt by the military force in its fight against the rebels and bush-fighters in 1955 and subsequent years.

With frequent fires the woodland savana will degenerate to a tree savana and eventually, if fires are continued for many years, to scrub or grass savana. Vidal-Hall[1] has studied the existing state of the High Woodland Savana and the remnants of the Tropical Rain Forest in Equatoria and Bahr el Ghazal Provinces. He points out that the Tropical Rain Forest has been retreating as a consequence

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(1) M.P.Vidal-Hall, The Silviculture and Regeneration of the Forest Types of Equatoria and Bahr el Ghazal Provinces, Forest Memoir No.4, Agricultural Publications Committee, Khartoum, 1952.

of frequent fires, and that more open types of savana have increased at the expense of the closed types containing some forest trees. He also points out that the gallery forests which exist along the river courses extending from the forest zone into the savana zone, exist only because the dampness of the valley bottoms limits the influence of the fires; but where fires can spread annually in a thick mat of dried grass, only fire-resistant tree species can live and even their growth is retarded. The effects of these burnings on the soil may well be disastrous, though no detailed studies have been undertaken in the Sudan. But the facts so far established indicate that the soil is adversely affected by repeated severe burning because the soil fauna and flora, the organic matter, the nitrogen content and the general fertility will be diminished. These detrimental changes do not occur with the light burning which may, to varying extents, actually increase the soil fertility.

The country should aim at minimizing the frequency and severity of fires. One reason for fire spread has been associated with firelines which have proved to be too narrow (about 4 - 5 metres) around some forest reserves in the western provinces. Such firelines should be as broad as the unwanted land of the country can permit, and mechanization needs to be used in firelining to ensure their completion before the big fires of the early burning period threaten the forest reserves. It is not true that the working period of such machines will be

so short that it does not justify the costs involved because these can be simple and cheap machines attached to tractors which can go back to their normal agricultural processes after the completion of the firelining, and so no problem of excess capacity will be involved. Secondly, these machines can work for 6 - 7 months starting in the north immediately after the rainy season in September or early October and moving southwards following the end of the rainy period until they finish the southern areas where the rainy season extends to February or even March. Such mechanized method reduces costs and manpower, hastens the work and removes grass lumps more thoroughly. Other protective measures include an increase in the number of officials to promote control and supervision of forest reserves and natural unreserved forests. Heavy fines on, and long imprisonment of, individuals starting fires have some effect, but they can never be satisfactory protective measures. A nationwide campaign to create a sense of conservation seems to remain the single most effective remedy. Until the fire-causer is convinced that he is trying to get his immediate returns at the expense of the agricultural potentialities and the grazing qualities of the land to be used by the coming generations, and until there is fuller co-operation between officials and the public, fires will continue to be a serious threat to the vegetation cover and the soils of the country.

Effects of Land Use:

The various types of land use which have involved, and are still involving, forest clearance have had adverse effects on the country's water supply and soil.

1. Effects on Water Supply:

There is accumulating evidence that the water supply of the northern parts of the country has diminished in the last 400 - 500 years. Describing the Neolithic habitation in the Lebyan desert of the Sudan, Arkell(1) states that sherds and Neolithic axes have been found in a number of localities now without permanent habitation, in numbers and distribution which suggest permanent villages. It is thought that these desert people retreated to the south and southeast; the evidence consists of the similar implements and pottery which have been found in the Nile valley between Kerma and Shellal, and of the fact that the pottery now in use in the Nuba Mountains bears a great ressemblance to that of the Tama and Masalit who lived around Bir Natrun in the Neolithic age. Arkell also notices that there is a southward trend in the former sites of northern towns, and gives a number of examples - Uri near the Jebel Mutarrag (1500 A.D.) is now almost waterless, and Kobe, northwest of Fasher, (1800 A.D) is now without water supply; Turra, at the northern end of the

(1) A.J. Arkell, A Note to the Soil Conservation Committee, Khartoum, 1944.

Jebel Mara range, was densely inhabited about 1500 - 1600 A.D., but now the diminished water supply supports only a fairly thin population; in 1500 A.D. the main east-west route across Kordufan and Darfur Provinces ran through the sites of Kawa, Faragab, Bara, Uri Wara and north of Lake Chad, but now it runs through Kosti, El Obeid, El Fasher, Abbeshe and south of Lake Chad.

Andrew[1] stresses that there is evidence of considerable Moslem pilgrim traffic across the Red Sea to Jeddah in the thirteenth century from a port afterwards abandoned for lack of drinking water. The pilgrimage in 1497 of the Emperor El Haji Mahmoud to Mecca from Goa via In Gades and Agades and Bilma (lat. 16° - 17°N.) with 800 people and numerous horses and donkeys shows that this region must have been fertile and comparatively well watered at the time; now this region is a part of the desert. Large communities were living in permanent villages on the line Goa-In Gades-Agades as late as the eighteenth century, and the remains of these villages can still be seen in the sand. Andrew also states that Lake Undar was a permanent lake till 1913, but at the present time it is practically dry during the period from March till the rains commence in July or August.

This indicates that the water supply of these areas has diminished and that since about the fifteenth century

(1) G.Andrew, The Climate of the Sudan in Soil Conservation Committee's Report, Khartoum, 1944, p.154.

the southern boundary of the Sahara appears to have advanced southwards and to be still advancing. Can this phenomenon be attributed to any major climatic changes which the Sudan has undergone in recent geological times? The answer to this question may be sought in the soil succession, the fossil record, meteorological records, annual measurements of the river volumes and the recorded history of the region. From the soil succession point of view, Andrew(1) argues that the uniformity, thickness and type of the silts of the Nile valley now being deposited show that the Nile regime has remained constant probably throughout the Neolithic to the present day, and from this a regional constancy of climate may be safely assumed. The soils of the Hashaba, Fatisa and Dueim pump scheme area were deposited under water because fossil remains of the water snail are of general occurrance throughout the upper ten feet of the soil; the rarity of the fossil remains of the land snail indicates that since the drying out of this region the climate has never been wet enough to enable this water snail to flourish, indicating that no wide climatic fluctuations have taken place in recent geological times.

The record of the colume of water flowing in the main tributaries of the Nile, kept by the Egyptian Irrigation Department since the beginning of this century, and the records of the more recent meteorological stations show that no major

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(1) Andrew, op. cit., 1944, p.5

climatic change has occurred during this relatively short period. The history of the northern part of the Sudan as known from archaeological research covers a period of 5,000 years and reveals nothing in the distribution or condition of buildings erected throughout the whole of this period, or of graves to show that the climate was essentially different from that of today; the perfect state of preservation of the elaborate mural decorations in the Temple of Abu Simbel just north of Wadi Halfa shows that the climate of this area has been as dry as it is today since the close of the reign of Ramses II in 1225 B.C. The fact that the flesh on bodies buried about 4,000 years ago near Kerma was so were preserved as to enable sex determination to be made from it also indicates that the climate has undergone no major change.(1)

The fact that the climate of the area has not greatly changed for better or worse since the close of the final major wet phase in Pleistocene times confirms that the diminution of the water supply and the southward creep of the desert over previously cultivable land has essentially been brought about by irrational land use practices which had involved the whole clearance of vegetation.

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(1) Andrew, op. cit., 1944, p.6.

2. Effects on Forests and Soils:

The deforestation and the destruction of the ecological balance associated with the different types of land use have adversely affected the soil over the different parts of the country. In Khartoum and the Northern Provinces it has already been stated that the harvest of wood from, and over-grazing in, the desert scrub forest have led to an increase in the frequency and intensity of sand storms and the formation of mobile sand dunes. Over the southern provinces increasing soil erosion and water dissipation have become the natural answer to the various types of misuse. In Upper Nile Province, though characterized by its general flatness, tree clearance for irrigation agriculture is progressively expanding, wind and water erosion increasing and shortage in fuel wood and building poles impending. In Equatoria, where gully erosion is not extensive, sheet erosion is common, and the ironstone plateau shows many areas of bare ironstone from which the surface soil has been completely washed away. The main factors contributing to the general erosion are over-grazing and grass-fires.

The human activities in those areas have not given rise to as serious results as in some parts of the Blue Nile and Kassala Provinces where the previous conditions, namely sparse population largely dependent on domesticated animals and very extensive tracts of woodland savana, have not been

conducive to the formation of public conscience about the conservation of natural resources. Because of the combined effects of annual grass-fires, uncontrolled grazing, excessive tree cutting for firewood and charcoal, shifting cultivation and pump schemes, this woodland savana has completely disappeared from around Sennar and Suki and from a large portion of Luani and Singa areas. Erosion has become a serious problem in the Gezira, northern Fung and Kassala, in such areas as Wad Medani, Hag Abdalla and Reseires on the Blue Nile, at El Gueisi on the Dinder tributary, and near Showak-Butana Bridge and Khashm el Girba on the Atbara river.

In Kordufan and Darfur Provinces deforestation, explosive rate of erosion and soil deterioration are attributed to grazing practices, creation of new water points without sufficient consideration to the carrying capacity of the surrounding land, and the rapid agricultural expansion allowed under indefinite crop rotation systems. Over-grazing has led to the disappearance of the three most favourable grazing plants (Aristida plumosa, Blepharis spp. and Monsonia spp.) from the vicinity of the water centres in the western parts of the region; these plants are also absent over much larger areas to the east, where almost pure stands of the little-grazed plant Cyperus conglomeratus have taken their place. So severe and thorough has been the grazing near Bara that sand has become unstable, and is again forming moving dunes which

have begun to invade the cultivated zone.[1] Deterioration of vegetation and soil is apparent in Khuwei and En Nahud areas, and to a greater extent along the Kosti-El Obeid railway line to which more and more people have been attracted by the bore-wells sunk at the railway stations and the administrative centres. Here the savana has been reduced to sparse stunted scrub.

The inhabitants of the Nuba Mountains, occupying the more accessible parts of the uplands, have reduced the woodland savana to mere scrub in most places, and to eroded bare rocks or scree in some places especially on the abandoned areas of terraced cultivation. The areas now under cultivation, namely the pediment and the clay plain, have been deforested. This large scale clearance of woodland, aided by fire action, has eliminated trees and accelerated erosion in the clay. The provision of sunk wells on the gravels at the foot of the mountains and the creation of reservoirs on the clay plain have not helped the dispersion and increase of cultivated land to the same extent as the opening up of new areas to extend the attack on woodland and soil.

In Darfur Province the most outstanding examples of misuse are to be found east and north of the Jebel Mara, in the basins of the Wadi El Ku and the Wadi Kaja. The silt terraces

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(1) Lebon, op. cit., 1965, p.161.

and the availability of the water supply throughout the dry season within a few feet in these basins have created many settled villages and an ever increasing number of cultivators. These favourable sites have also attracted many tribesmen and their herds from remote areas in the north and northeast, where the water supplies are not available for the whole year. All these have contributed to the present state of society where the human and animal populations are too dense and the amount of cultivation exceeds the available water supplies in these two "wadis". The over-population and over-grazing have seriously upset the ecological balance in the area, especially around the water centres; the creation of naked perimeters in these areas has accelerated wind erosion and the stabilized sand dunes are being converted to a mobile state. El Fasher is the most notable example of wind erosion, especially the tract known as El Fasher Plain. An almost similar extent of erosion can be noticed at Tawila, at Mellit and at El Geneina.

In the Red Sea hills and the Beja area, the eradication of some trees has been taking place for quite a long time. Andrew(1) quotes from Turner's report that the tops of the hills above 6,500' were covered with forests, mostly juniper; the old charred stumps in places where juniper has long ago died out show that it was once spreading over a much larger area than at present. He suggests that sometimes between 20 and 50 years ago extensive fires occurred over a

(1) G.Andrew, The Red Sea Hills in Soil Conservation Committee's Report, Khartoum, 1944, p.56.

period of years, probably deliberately started by the local people to kill weeds and juniper which were not palatable to goats, and thus to make a larger grazing area for their animals. He estimates that in some places more than 50% of trees of over 40 years of age show fire damage. The resulting forests are so exploited and often completely destroyed that severe soil erosion and rapid run-off have become a prominant feature of the area; there is not now sufficient moisture for the juniper except on the most favourable localities such as the ravines. On the steeper slopes, where the run-off is quick, old trees are slowly dying out and very few young trees are coming to take their place. The situation is aggravated by the enormous need of the local inhabitants for firewood, charcoal and timber; the monthly demand of Port Sudan only has been estimated by Gleisberg(1) at about 23,000 kantars of firewood and about 570 tons of charcoal. To supply these requirements the people must monthly cut an area of about 10,000 feddans. Another alarming fact is that the population of Port Sudan and the Beja area are expanding at a high rate.

In the Toka area the results of the irrational land use practices are more drastic. The present channel of the

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(1) C.F. Gleisberg, Some Problems of Forestry at Port Sudan and Neighbourhood, Sudan Silva 8 (1), 1958, p.25.

Khor Baraka is at least partly due, according to Kennedy-Cooke[1], to deforestation and consequent erosion and sand storms so that the two previous channels of the Khor Baraka have become overwhelmed with dust. Forest clearance has been going on for a long time reaching a climax in about 1860 when Mumtaz Pasha, Governor-General of the Sudan, cleared the trees away to make room for the production of cotton; since then the rate of erosion and the intensity of sand storms have been magnified. Arkell[2] estimates that since the start of the erosion, the scouring effect of the torrential rains on soil dried by the summer heat and denuded of forests has carried away more than 90% of the alluvial silt that supported forests on the banks of the khor.

The relatively recent creation of the Tokar agricultural scheme has not involved only further devastation o: woodland and destruction of other vegetation types, but has also attracted humans and animals in numbers far exceeding the carrying capacity of the land. The increasing over-grazing especially by the goat, and uncontrolled cutting have rendered the remaining forests scattered and old, unable to regenerate naturally. Increasing soil erosion has changed the nature of

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(1) B. Kennedy-Cooke, Tokar and the Baraka Delta in Soil Conservation Committee's Report, Khartoum, 1944, p.61.

(2) A.J. Arkell, Khor Baraka in Soil Conservation Committee's Report, Kharoutm, 1944, p.59.

the Khor Baraka from a narrow khor to a wide plain one. Formerly the forests were responsible for the fixation of the soil and had an important regulatory effect on the flow of the khor.

High winds roar almost continuously over the area, raising extremely dense clouds of dust except for the period when the khor is actually flowing, from July to September. Only on the tops of the higher hills does any form of plant successfully grow; otherwise all the vegetation is either dead or permanently covered with dust. Apart from the actual river bed practically the whole area is wind-eroded. During the rainy season in September or October, the northeast winds (hababai) starts to blow over the dry bare surface, causing the sand dunes to move over the often unharvested fields; this violent, sand-laden wind tends to dry by mid December but may continue well into January. In April or May, a more violent and more heavily sand-laden southerly wind (habub) blows; it is so dense at its worst that it is practically impossible to see even a few yards ahead. The action of the wind has changed, and is still changing the face of the delta by erosion and the piling up of dunes, though the two winds work counter to each other; but the action of the "habub" is more dominant in shaping the landscape because, according to Kennedy-Cooke,[1] if it has added 10% to the height of a dune the "hababai" will

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(1) Kennedy-Cooke, op. cit., 1944, p.62.

not remove more than 2% of it. Numerous irregularly-shaped sand dunes have become a feature of the delta and they are in constant motion when a wind is blowing. Their advance over the delta and into Tokar town has been estimated by Kennedy-Cooks as ranging from 2 to 5 metres per annum.

What has happened to the Khor Baraka and Tokar town might soon happen to the other areas of the Red Sea coast, and in future the country may face the same dangers at Suakin and Port Sudan towns and the Khor Arba'at.

Chapter V

Forestry and Land Use - II

The Land Use and Rural Water Supplies Development Board has defined its task as promoting "the proper use of the land for the purpose of cultivation of crops, utilization and development of pasture lands or forests, according to the capability and suitability of such land, in priorities demanded by national needs and economy and in such a manner as to maintain such utilized land in good heart and perpetual productivity."(1) This definition was drawn after the country realized that the most important problem confronting agriculture, which contributes over 60% of the national income, is the wise use of land, water, plant and animal resources.

The land capability classification used by the United States Department of Agriculture may be taken as typical. It recognizes 8 classes of land ranging from I which is "very good land from all points of view" to class VIII which cannot be used for any purpose other than recreation, wildlife and similar functions.(2)

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(1) M.K. Shawki, Integration of the Conservation and Development of Wild Resources with Programmes of Economic Development in Modern States, Sudan Silva 14 (11), 1963, pp. 5 - 6.

(2) J.K. Jackson, Some Thoughts on the Place of Forestry in Land Use Planning, Sudan Silva 12 (11), 1962, p.17.

The land classes I, II and III are suitable for cultivation though increasing necessary care is required with the lowered quality of land up the column, whereas the class IV can be used for occasional cultivation or a form of shifting cultivation. The remaining classes, V, VI and VII, can only be used for forestry and pastoral land.

Before the introduction of the development programmes in 1948, forests covered more and better quality land. Almost all the development between 1949 and 1963 was agricultural in nature and in the former forestland ranging from class II to IV. By the end of 1963 the area under irrigated agriculture has a total of about 4 million feddans, or more than double what it was in 1950; the area under mechanized rain crop production has now reached a figure of more than a million feddan, and is about 30 times greater than in 1950; the railway network has increased by about 3 times during this period. New settlements have sprung up following these developments, making more and more forests accessible to irrational utilization. Out of the 157 million pounds of Sudan's own funds which were spent on these developments only one million was devoted to forest, land and water conservation. Between 1953 and 1963 the forest estate has slightly more than doubled, increasing from 1,040,276 to 2,574,411 feddans. The estimate of the forests as occupying 9.61% of the total area of the Sudan (Table II) cannot be accepted because over 90% of

this area is unreserved and thus open for various agricultural and pastoral practices. Only the forest reserve estate, which amounts to less than 0.5% of the area of the Sudan, can be considered as proper forests because only this area is subject to rational use.

The overwhelming agricultural expansion and neglect of forestry may be due partly to the erroneous assumption that a particular class of land should wholly be devoted to that particular use; for instance land classes I, II,and III should be used for agriculture and nothing else. This is due to the negative attitude of such classifications in saying what should not be grown on a particular class of land, because it is beyond their scope to say what is the best type of land use to be practised on land which is suitable for multiple use, such as class I.

Forestry, the relatively undervalued type of land use, and agriculture, the most dominant and emphasized land use type, are comparable in many ways, and in some respects forestry has a more favourable impact on the economy.

(a) Forestry and agriculture are alike in the sense that they both encourage the rational development of the products of the soil; but they differ because the rotation of agriculture is usually a matter of years while forestry is a matter of decades or even centuries. So while the cultivator is satisfied with a security of land tenure

over a few years, a forester requires it in perpetuity.[1] Thus forestry has a greater magnitude of conservation of soil than agriculture.

(b) In contrast to agriculture, in which the land must be broken up and prepared before being brought under cultivation and in which seed sowing must precede harvesting time, forestry has started almost everywhere with harvesting or exploitation; here the cost of production, reduced to felling cost only, is negligible if compared to that of agricultural crops. To Petrini[2], this forestry by exploitation has a "dumping" effect compared with productive forestry, and it is always much cheaper to devastate existing forest areas than to create new ones, for which interest must be charged on the various costs of establishments and it has always been true that this destructive undertaking sells its timber with profit at lower prices.

(c) The forestry production is much less dependent upon unfavourable economic and environmental conditions than agriculture. In the case of forestry, weather cannot cause crop failure except in young plantations, and cannot jeopardize the quality of the harvest by bad harvesting conditions. If at one time of the year the wood market prices

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(1) J.R. Ainslie, Forestry the Father of Agriculture, The West African Review, September 1935, p.13.

(2) Sven Petrini, Elements of Forest Economics, translated by Mark L. Anderson, T. and A. Constable Ltd, Edinburgh, 1951, p.5.

are low, if the harvesting labour is scarce or if labour is too costly, trees can be left to continue growing till more favourable conditions prevail. So forestry, as an industry, is more adaptable to unfavourable conditions.

(d) In regions where the natural conditions are not favourable and the soil is shallow, poor in mineral elements or the terrain is broken, agriculture cannot be practised while forests of one type or another can grow or be planted on almost all classes of land except for the true desert. Where agricultural crops cannot be grown, forestry gives the highest financial returns.

(e) There are many industries, based on forestry, which can be established in the rural areas to aid in minimizing the great disparities between urban and rural societies; also forest industries, such as hunting and sport, can be established. Forest grazing is playing an immensely significant role in the life of the nomadic and semi-sedentary people. Other useful functions which can be attributed to forestry include the provision of various recreational facilities for both natives and visitors.

A. Forestry as a Branch of the Economy:

Under favourable conditions forestry can yield very high financial returns as in the Po valley of norther Italy and the valleys of northern Iraq, where the most profitable form of land use is the cultivation of poplars. In the Sudan the reluctance to devote more money and land for forestry is

an indication of the assumption that forestry gives low financial returns. This under-appreciation of the importance of, and the role to be played by, forestry in the national economy has resulted in unbalanced and short-term planning systems in which forestry comes almost last in the long queue. But even under the present conditions - low expenditure and confinement to low-quality land - the contribution of forestry to the national economy is significant.

The production of forest produce, especially firewood and the minor forest products, can only estimated on a very rough basis because the local inhabitants all over the country collect considerable amounts to meet their requirements; so the figures given by the Forests Department do not give the real picture of the total forest production; this is true for th forest products consumed within the boundaries of the country as well as for those entering international trade. Appendix XII shows that the internally consumed forest products amount to over 21 million pounds in value according to official figures; but this is apart from the large quantities used by the people in their daily life, and apart from other products like "lulu" oil, palm oil, sawn timber used by the local people for furniture, doors, windows and ornamental works, and the round timber for various purposes and apart from the large range of manufactures like ropes, fodder crops, threads, mats, baskets and various containers. The value of the annual total

internally consumed forest produce may exceed 40 million pounds. Forestry has already been able to satisfy the entire country's requirements for railway sleepers, most of its needs of sawn hard timber and other internally consumed commodities valued at over 20 million pounds.

The export values of forest products (Appendix VIII) account for about 10% of the total exports of the country for the average of the 10 years, 1952 - 61. They amount to about 20% of those of cotton, the main cash crop, for 1961 and to about 18% of its average export value for the period 1952 - 61. The contribution of forestry to the country's stock of hard currency is more significant than that of grazing; the export values of animals and their hides and skins amount to about 70% of those of the forest produce.

Forest influences are another equally significant aspect to be considered in the evaluation of the place of forestry as a type of land use in the national economic structu and land use planning. These forest influences, though cannot be evaluated in monetary terms as the forest products, possess economic bearings which can be convincing to those concerned with planning. An attempt to evaluate some of these influences is included later in this chapter.

Forestry, as a branch of the economy, absorbs a large part of the otherwise unemployed labour force, and thus helps to increase the domestic production and enable those labourers

to earn their livings. Forestry can still offer further employment to more and more people since it is noted that some of its activities suffer from shortage of permanent or daily-paid labour. In the 1962/63 rainy season, for instance, it was reported that the number of permanent labourers in the Fung area was increased by 50%, and the number of the man-days of daily-paid labourers by 14% compared with the 1961/62 figures. In almost all the other parts of the country labour was scarce for one period or another of the year 1962/63; in Khartoum, Upper Nile and Northern Provinces labour was short throughout the year, wile this labour shortage was severely felt in the Jebel Mara area during the cultivation and the harvest periods. In the Bahr el Ghazal Province labour shortage was acute during the first and the last quarters of the year, while in the Zande area daily-paid labour was extremely scarce during the dry season when the inhabitants usually leave their daily employments to practise their traditional hunting. This indicates that forestry can absorb more permanent and daily-paid labourers and thus help to modify the grievances of unemployment. The number of permanent labourers employed during the period July 1962 to June 1963 was over 4,100 and the man-days of the daily-paid labourers reached a figure over 7,500,000, giving a total man-days of over 8,600,000.

To those labourers employed in forest activities should be added those who depend on gum arabic in one way or

another. Most of the semi-sedentary and some of the nomadic people occupying the gum belt of Kordufan, Darfur, Blue Nile and Kassala Provinces should be considered as getting their living from forestry since they are either gum tappers, collectors, dealers or merchants; they are dependent, to varying extents, on "hashab" and "talh" forests. Where supplemented by crop production, gum usually maintains a comparatively good standard of living in these areas.

B. Returns Per Unit Area:

Is it wholly true that forestry is a type of land use which gives low financial returns or can it compete with other forms of land use? For the discussion of the economics of these commodities which have an exchange value (marketable) the cost/benefit ratio is important. The application of this indicator to the agricultural production in the Sudan is made difficult by the fact that a great many agricultural processes are done by the farmers themselves who usually do not include th price of their own work in the cost of production; it is also hampered by the fact that land (as a factor of production) has no recognized value in most parts of the country. Though the returns of production can be calculated with a fair degree of accuracy, the cost of production can only be estimated on a rather rough basis. The determination of net financial returns per unit area, to determine the type of land use which gives the highest financial returns, can only be done on rough estimates (Table XIX and Appendix IX).

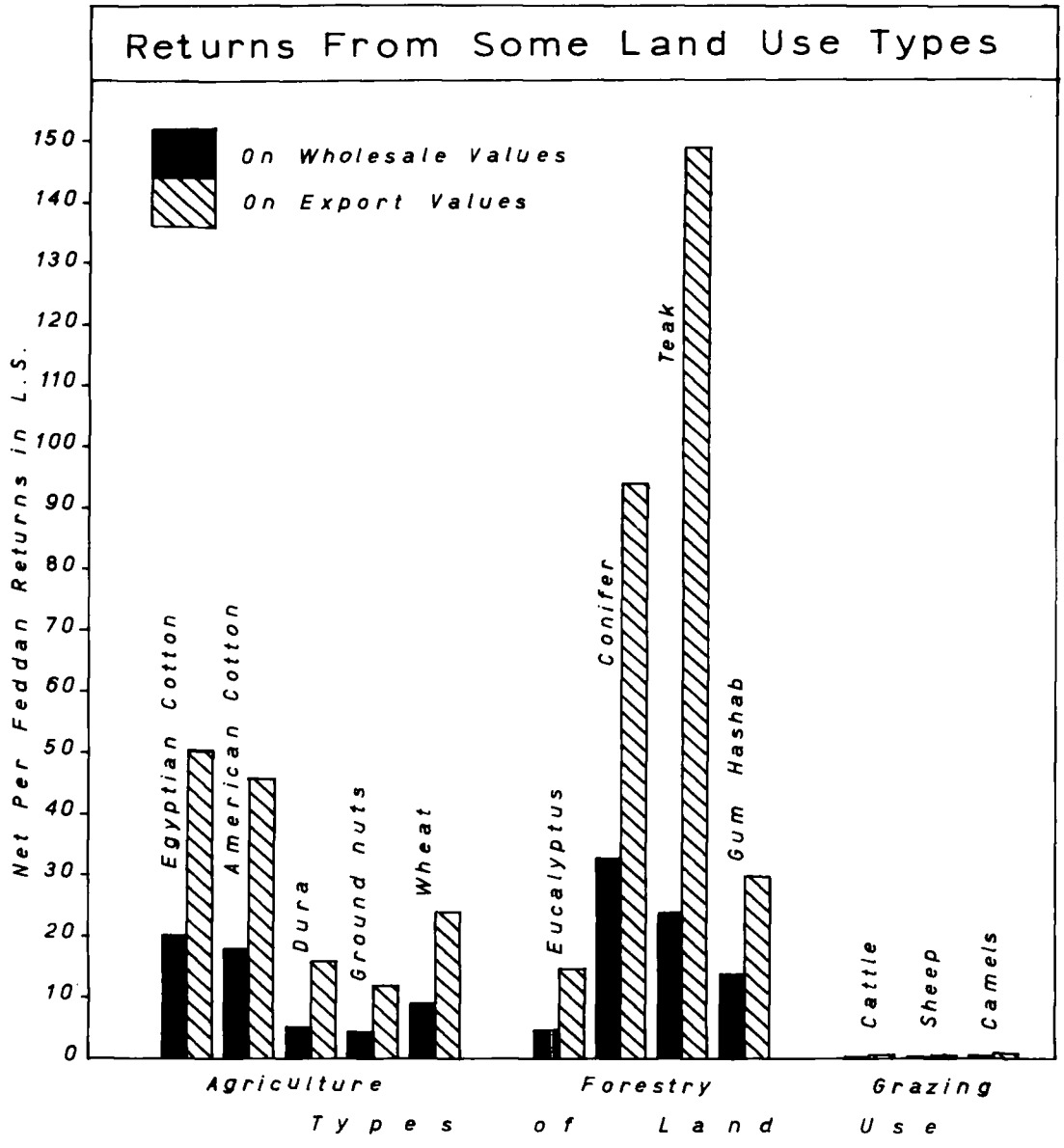

Fig. 29: Compiled from data of Table XIX and Appendix IX.

Table XIX: Net Per Feddan Returns from some Types of Land Use (£S)

Crop		Wholesale Value	Export Value
A. Agriculture:			
1. Irrigated Egyptian Cotton:	(a) Gezira	22.210	55.330
	(b) White Nile Schemes	16.232	42.296
	(c) Private estates and "Sagias"	19.526	49.478
	(d) Gash Delta	0.494	7.982
	(e) Sudan	20.175	50.675
2. American Cotton:	(i) By Irrigation:		
	(a) Gezira	24.768	61.623
	(b) Northern Province	6.030	20.330
	(c) Sudan	17.787	45.826
	(ii) By Rain:		
	(a) Gedaref area	1.417	3.064
	(b) Nuba Mountains	1.718	3.625
	(c) Equatoria	1.186	2.635
	(d) Upper Nile	1.505	3.229
	(e) Sudan	1.457	3.138
3. Dura:	(a) By irrigation	5.352	15.720
	(b) By rain	1.768	4.760
	(c) By flood	3.692	10.540
4. Ground Nuts:			
	(a) By irrigation	4.414	11.595
	(b) By rain	2.363	6.317
	(c) By flood	0.650	2.045

Crop	Wholesale Value	Export Value
5. Wheat: (a) By irrigation	9.135	23.780
(b) By flood	11.600	29.020
B. Grazing		
1. Cattle	0.037	0.074
2. Sheep	0.043	0.074
3. Camels	0.089	0.172
C. Forestry		
1. Firewood plantations (Eucalyptus)	5.154(Retail value)	15.154
2. Conifer plantations	39.154	94.154
3. Teak plantations	24.154	149.154
4. Gum "Hashab"	14.306	30.063

Sources: 1. Appendix IX

2. J.K. Jackson, Some Thoughts on the Place of Forestry in Land Use Planning, Sudan Silva 12 (11), 1962, pp. 17 - 21.

1. Firewood:

Firewood is the cheapest and most needed forest product. Its production was over 30% of the total wood production in 1961/62. The revenue paid to the government for standing trees to produce firewood from outside forest reserves, i.e. the royalty value of firewood, is about

£S.0.250 per cubic metre in most parts of the country, and this figure can be taken as the average. Its average retail value is about £S.0.750; if a cubic metre of firewood is burnt into charcoal, the equivalent value of charcoal produced will be about LS.0.900. Firewood has no export value in itself, but its value in terms of foreign exchange can be determined by the calculation of the value of imported kerosene which will be needed to replace it, i.e. the cost of substitution which is an important utility indicator. In calorific value one cubic metre of firewood is equivalent to 49 gallons of kerosene, and at a value of LS.12.000 per ton, this will be worth of £S.2.000.(1) The annual yield of firewood varies from one cubic metre in the drier savana regions to about 6 cubic metres per feddan in the southern parts of the country, and an average of 3 cubic metres will not be more than expected. So firewood gives £S.0.750 per feddan on royalty value, £S.2.250 on retail value, £S.2.700 if burnt into charcoal and £S.6.000 in equivalent value of kerosene. For firewood collected from unreserved natural forests the cost of production is negligible.

Plantation of quick-growing trees like Eucalyptus, established for the production of firewood, can yield as high an average as 8 cubic metres per feddan. Thus the gross per

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(1) J.K.Jackson, op. cit., 1962, p.20.

feddan returns will be £S.2.000 on royalty value, £S.6.000 on retail value, £S.7.200 if burnt into charcoal and £S.16.000 in equivalent value of kerosene.

2. Timber Plantations:

Jackson(1) estimates the yield of the conifer plantations in the Imatong Mountains as 10,000 cubic feet (about 300 cubic metres) in thirty years per feddan. This is equivalent to 333 cubic feet (about 10 cubic metres) per feddan per annum. If it is assumed that the standing value of this timber is £S.0.120 per cubic feet, this will give an annual financial return of £S.40.000 per feddan. This volume of wood (10 cubic metres) will produce about 5 cubic metres of sawn timber which, at a price of £S.19.000 per cubic metre, are worth of £S.95.000; thus one feddan of conifer can economize the equivalence of £S.95.000 in foreign exchange. The other forest commodity, teak, is expected, according to Jackson's estimates, to yield about 3,000 cubic feet (about 84 cubic metres) of wood per feddan after 60 years, or 50 cubic feet (about 1.4 cubic metres) per year. Assuming a price of £S.0.500 per cubic feet, the standing value of this will be equivalent to £S.25.000 per feddan per annum; at a price of £S.3.000 per cubic foot, its import value will be £S.150.000 per feddan per annum.

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(1) Jackson, loc cit.

3. "Hashab" Plantations:

"Hashab" plantations will have rather lower yields. If the trees are sown or planted about 4 metres apart, the feddan can hold about 400 trees; at an average annual production of 1.35 lbs of gum per tree, the feddan will produce about 5.4 kantars. At an average price of £S.2.900 per kantar at El Obeid market, the feddan will give a gross financial return of £S.15.660. An average export price of £S.5.818 per kantar (£S.128.000 per ton) will give a return of £S.31.417 in foreign exchange per feddan per year.

Net Financial Returns:

The costs of the various production processes differ greatly from one part of the country to another according to the local cost of living and the availability of labour, but Table XX may be accepted to represent the average.

Table XX: Average Cost of Silvicultural Operations Per Feddan, 1961/62.

Silvicultural Operation	Average Cost in £S.
Initial Ground Clearance.	1.246
Preparation of Ground.	1.952
Canalization and Ridging.	8.900
Planting or Sowing.	2.067
Broadcasting.	0.993
Weeding.	2.363
Watering.	3.600
Closing of Cracks.	0.325
Cost of 1,000 Plants.	7.100
Thinning.	1.565
Fireliningper Km.	3.088
Timber Cutting.	0.648
Total	33.847

Source: Forests Department, Report for the Period July 1961 to June 1962, Khartoum, pp. 88 - 91.

If we assume that the life of a forest plantation is 40 years, then the annual cost of production will be £S.0.846 per feddan, which is very low if compared with that of agricultural crops. Teak plantations will give a net financial return of £S.24.154 on wholesale prices, and can economize the equivalence of £S.149.154 in foreign exchange per year per feddan; conifer plantations will give a net

financial return of £S.39.154 on wholesale prices, and can economize the equivalence of £S.94.154 in foreign exchange per feddan per annum. Plantations for the production of firewood can give net annual per feddan values of £S.2.000 on royalty rates, £S.5.154 on retail values, £S.6354 if converted into charcoal and £S.15.154 in equivalent value of kerosene. For the "hashab" plantations, if we assume a similar cost of production and an average life of 25 years, the annual cost of production will be about £S.1.354; the annual per feddan net returns will be £S.14.306 on wholesale prices and £S.30.063in foreign exchange.

4. Forest Influences:

Here it is the forest influence, and not the forest itself, which is emphasized though the two are inseparable. The magnitude of the forest influences is not confined to forest soils, fields or crops, but extends beyond that to affect the combination of soil and water, factors on which the entire economy of the country depends. To think that there is no relation between the economic value of a forest and the utilitarian value of its influences is false. It is of great importance to use these species which have the highest economic value and the most rapid growth for protective measures; this remains valid even if the required outlay must be higher than that required by a low economic value forest which can exert the same influences.

The application of utility indicators may better illustrate the economic significance of forest influences; if their utilitarian values could be expressed by sufficiently convincing indicators or index numbers, good progress could be made towards the creation and development of a consciousness of their socio-economic character. The comparative economic evaluation of forest influences is extremely vital since the lack of such utility indicators has hampered the steady development of forestry in the Sudan.

(a) Cost factor:

Cost, which is a price or an exchange value, is only important when the produced commodity is marketable. Forest influences, though linked to the soil and cannot be transported, have definitely a market since any construction (e.g. field) benefiting from one influence or more has naturally a higher exchange value than comparable assets not enjoying these advantages created by the forest.(1) This difference in exchange values must naturally be attributed to the forest influences involved. The benefits derived would increase with a decrease in the cost of production of these forest influences; where a forest stand is already in existence, this cost of production may be considered as zero or very low, being confined to the cost of guarding the forest against devastation. For forests to be established, we can consider the cost of production as

(1) T. Francois, Evaluation of the Utility of Forest Influences in F.A.O, Forest Influences, Rome,1962, p.250.

that in Table XX. The cost of production seems to increase with time since if a piece of land has passed the equilibrium point and is not left to revert to forest cover, it will continue to deteriorate which will in turn involve an increasing cost of afforestation. The problem is that the cost of establishing a forest is the cost of production of the over-all forest influences and it is not possible to determine the part of this cost which is attributable to the individual forest influences.

(b) Benefit Factor:

It is difficult to assess the benefits derived from forest influences because they frequently refer to values which cannot be expressed in monetary terms. The annual appropriations required to repair the damages resulting from the devastation of a forest, i.e. the cost of substitution, can be regarded as benefits which were formerly being derived from a forest influence. Here again since it is difficult to determine the over-all benefits derived from a forest stand, it is more difficult to determine the benefits which can be attributed to the individual forest influences. It is intended here to give rough estimates of the possible values attributed to the over-all forest influences in selected parts of the country.

In the vicinity of Merga, Abu Tabari, Bir Natrun, the Jebel Rahib and the Jebel Tageru used to be permanently inhabited. If we assume that the type of land use practised was one which gives the lowest financial returns, i.e. grazing, then the land must have yielded at least £S.0.070 per feddan per annum; if we assume that the area extends for 7 miles in width and 400 miles in length from west to east, then the annual financial returns will be about £S.160,000. If we accept that the present state of aridity has been brought about, even partly, by the devastation of the natural vegetation, then at least a part of this amount can be considered as the annual financial return of the forest influences. When we take into consideration the cost of the houses and the various social services and institutions, the commercial transactions which were in operation and the social cost paid by the inhabitants when they were forced by increasing aridity to migrate, these returns will greatly increase. Now if it is ever possible to re-establish permanent settlements in those sites, the cost of establishment will be tremendously high; this cost of substitution can also be regarded as the financial returns which were being derived from the forest influences before the devastation of the natural vegetation.

The deforestation of the banks of the Khor Baraka and the wholesale clearance of trees over the entire scheme have changed the nature of the river bed itself, and accelerated erosion at a frightening rate. This has resulted in severe

winds which have in turn led to the formation of sand dunes within the delta and over the former productive land; the rate of sand creep is about 2 - 5 metres per annum in the delta and into Tokar town; about 25% of the delta area has been covered with sand dunes and a great part of the canalization system has been abandoned owing to changes of the khor flow. If we accept that the cotton area would have been increased by 25% had it not been for the formation of sand dunes, then the annual financial losses will be over £S.600,000 at an average yield of 2.2 kantars per feddan and a net per feddan export value of £S.20.330. The greater part of these losses can be considered as the annual financial returns of the forest influences. If we took into consideration the cost of the abandoned system of canals and the inconveniences caused by the severe winds, the annual financial returns of the over-all forest influences would increase considerably.

In 10 years time and at an annual creep of 4 metres of sand dunes along 100 miles of land, more than 1,500 feddans of productive land will be covered with sand dunes. This will then involve an annual financial loss of about £S.30,000. The establishment of a forest belt along this area can reduce this annual creep by about 75%, if it could not totally prevent it; then the gross annual benefits derived from this belt will be about £S.22,000. The establishment of this belt will be

equivalent to about 50 feddans in cost, about £S.40, and the difference may be considered as the net annual financial returns of the created forest influences. The afforestation of the khor banks will regulate its flow, fix the soil on the banks and will eventually stabilize the position of the cultivated land. This will lessen erosion too and economize the cost of the canalization system which is usually abandoned whenever the khor starts to change its course or even to fluctuate considerably in its annual flow.

The influence of the forest on regulating the flow of streams is of vital importance in a country where the major problem is constituted by the lack of water supply especially during the dry season. The Khor Arba'at radiates from the Red Sea hills and is responsible for the entire fresh-water supply of Port Sudan town, the only sea port of the country. If the devastation of the forests on the catchment area and the slopes continues, the khor may change its course further away from the town or its flow may be greatly diminished. By then the town may find itself compelled to depend for its water supply on the purification of sea water, a process which involves at present a higher cost of production than fresh-water. The cost of substitution may now be considered as the financial returns derived from the regulatory effect of the forest on the Khor Arba'at. The fact that the human and the industrial requirements for fresh-water

supply in the area are continuously increasing necessitates not only the preservation of the remaining forest land but also the immediate re-afforestation of the denuded areas.

The effect of shelter belts on the quantity and the quality of agricultural crops has been established in many countries. Appendix IV shows that sheltered agricultural fields give a yield about 50% higher than those of similar unsheltered fields per unit area on the average. If the water requirements are available, such a system of shelter belts can be introduced, after the necessary experiments, into the Gezira, Managil and other agricultural schemes. If the 50% increase proves to be true, then the per feddan net export value of Egyptian cotton will be increased by £S.27.650, that of "dura" £S.7.860 and that of ground nuts by £S.12.835 in the Blue Nile Province. Out of the total area (2 million feddans) of the Gezira and Mangil schemes, 500,000 feddans are annually put under cotton, 250,000 under "dura" and 125,000 und ground nuts. This will give an annual increase of £S.13,825,00 in the export values of cotton, £S.1,955,000 in the value of "dura" and £S.1,604,000 in the value of ground nuts, and a total annual increase of about £S.17,394,000. This means that every 1% production increase due to shelter belts will bring an annual increase of about £S.340,000. Any such increase should be regarded as the annual financial returns of the influences exerted by the created shelter belts.

Wildlife is enjoyed by some people, both from within and outside the country, who visit the Dinder Game Reserve and the natural forests of the soutern parts of the country. The creation of many other game reserves, especially in Equatoria Province, will ensure the preservation of a large number of the tropical wild animals which are now retreating fast in the face of deforestation, will widen the scope of the industry and put it under better management.

There are two main types of value that arise from wildlife in a forest: commercial and aesthetic and moral values. The commercial values, or the income derivable from wildlife in a forest, includes the income from the sales of hunting and fishing privileges and the income from the sale of all other privileges (e.g. camping, photography, foods, drinks and the like) to the forest visitors so long as they are attracted by wildlife in the forest. In measuring the economic value of wildlife, which can be determined by the ratio of output in satisfaction to input in terms of money and time spent the output of the commercial values can be calculated in monetary terms; but it is difficult to measure the output of the aesthetic and moral values, but it is reasonable to assume that output is at least equal to input because the people will not go on spending their money and time in a particular form of recreation unless they are getting as satisfactory returns as they would get in some other use of their money and time.

Chapter VI

Forest Policy, Legislation and Ten Year Plan

A. Forest Policy and Legislation:

The first Forest Ordinance was enacted in 1908, and was superseded by a more progressive set of Forest Conservation Rules in 1917. The Central Forest Ordinance and the Provincial Forest Ordinance, now in enforcement, were passed in 1932, and the Royalties Ordinance in 1939. The Provincial Forest Ordinance was amended in 1948 to enable the then Governor to delegate all, or a part of, his powers to Local Government authorities within whose area any provincial forest reserve is located.

The main features of forest policy as laid down in 1932 are as[1] follows:

(i) All fellings, other than such as is required for village needs (and wherever possible for those also) will be concentrated in definite felling areas chosen where regeneration, either by natural or artificial means, can be assured. Such areas will be declared forest reserves.

(ii) Cutting in these reserves will be allowed in accordance with a definite felling programme and will be controlled by a system of licensing. Collection of royalty on timber cut from forest reserves will be discontinued and the revenue to the government will more simply and effectively be secured by the machinery of wood licenses

(1) Forests Department, Report for the Period July 1956 to June 1957, Khartoum, pp.11 - 2

which will provide for the disposal of felled or standing timber by sale or by auction. In future a royalty will be collected only on forest produce cut from areas other than forest reserves; the object of retaining the royalty system in this instance is to encourage the concentration of cutting inside reserves.

(iii) The construction and preservation of forest reserves involves, to a greater or lesser degree, the regulation of rights and restrictions of privileges among the people of the tract within which the forest is situated. So such areas must be selected with due regard to the fuel and timber as well as agricultural requirements of the inhabitants in the immediate neighbourhood, who will either have a certain area of forest set aside for their use or will be granted permission to obtain their normal requirements of fuel and timber within the reserve itself. In such cases free licenses will be issued granting permission to cut or remove specified amounts of wood.

(iv) In future land owners should be encouraged to regard timber as marketable produce to be grown on a rational basis in the same way as food crops and with a similar absence of restriction. Although the government will retain the right to levy royalty on such produce if used for commercial purposes, governors will be granted discretion to exempt, subject to financial approval, such produce from payment of

royalty in cases where it is desirable to encourage planting by private landowners.

(v) It should be the object of provincial officials to educate local inhabitants in the duty of protecting forests against damage by fire or by grazing, using whenever possible the agency of native administration.

(vi) In gum areas it should be the object of provincial officials to maintain the existing stock in a healthy condition and, by control of markets, improvement of communication and sowing, to encourage the exploitation of new areas.

(vii) It should be the object of the Forests Department to investigate and develop more fully the country's natural resources of timber and other forest produce which may commercially replace imported materials.

To implement this policy, it has been decided to divide the responsibilities between the Forests Department and the provincial local authorities. The Department will be responsible for the supply of timber and fuel wood to the Three Khartoum Towns, Port Sudan, Wad Medani, the Gezira and the government departments. The remaining parts of the country will come under the responsibility of the local authorities whose duty is to ensure that permanent supplies of forest produce are sufficient to meet the internal requirements of their respective areas.

The 1932 Ordinance gives the Minister of Agriculture powers to declare as a forest reserve any land at government disposal or privately owned land, the owners of which request him to reserve it, or any other land at all after he acquires and registers it to the government in full ownership and free from all liabilities.

To protect the forest reserves, it is prohibited and punishable by up to 2 years imprisonment or up to £S.50 fine or both for cutting, collecting, injuring or otherwise interfering with any forest produce of a reserve, kindling, keeping, carrying or causing a fire in a forest reserve, or removing, defacing, damaging or interfering with a boundary mark or blazed tree or fence of a forest reserve. It is also prohibited and offenders are punishable by up to 6 months imprisonment or £S.10 fine or both for entering upon, remaining in, pasturing cattle or causing to enter upon or remain in a forest reserve. The 1932 Ordinance empowers the then Governors of provinces to protect trees for special purposes, and these are not to be cut or consumed for trade except by a license. Also it gives the courts power to order offenders, in addition to other punishment, to pay compensation of £S.1 in respect of each tree interfered with. The Central and Provincial Forest Ordinances make the public responsible to give information of fire or other forest offences and to assist in extinguishing fire.

By the Royalties Ordinance of 1939, royalty was laid on all timber, firewood and charcoal except:

(a) that obtained on permit from central or provincial forest reserve.

(b) timber, firewood and charcoal exempted from or allotted a lower rate of royalty; this is to be done by the then Governor on the consent of the Minister of Finance on material intended for personal and private use in construction of water wheels, houses in rural areas, agricultural implements, public purposes such as bush schools, or domestic fuel or timber grown on private plantations.

The Ordinance also orders that all timber, firewood and charcoal subject to royalty should be brought to revenue stations before being disposed. The punishment for infringement and for evading or attempting to evade payments or royalty is £S.10 or 6 times the amount of royalty, whichever is greater. The Ordinance also states that the material concerned in an offence together with any means of conveyance shall be forfeited to the government.

During 1959 the royalty rates of 1939 as amended in 1952 were again amended. They were lowered for firewood transported by animals and raised for firewood transported by mechanical means as follows:

Camel load reduced from 150 m/m to 75 m/m in Khartoum Province.

Camel load reduced from 90 m/m to 45 m/m in the other Provinces.

Donkey load reduced from 60 m/m to 30 m/m in Khartoum Province.

Donkey load reduced from 35 m/m to 15 m/m in the other provinces

For firewood moved by trains and motor cars the royalty rates were raised as follows:

from 400 m/m to 450 m/m per cubic metre in Khartoum Province.

from 250 m/m to 300 m/m per cubic metre in the other provinces.

Firewood transported by boats and rafts remained at the same royalty rate of 200 m/m per cubic metre in Khartoum Province and 120 m/m per cubic metre in the other provinces.

The Local Government Ordinance empowers the local councils to issue local orders to protect trees and control grazing, fire and tree cutting within areas under their jurisdiction.

Review of Some Policy Aspects:

1. Division of Responsibility:

There are two categories of forest reserves as stated in the forest ordinances and rules; these are the Central Reserves, under the control of the Forests Department,

and Provincial Reserves, under the control of Local Government authorities. This division of responsibility cannot be regarded as working efficiently and successfully for the implementation of the policy declared. The major draw backs of this system can be summarized as follows:

(a) The local councils are not willing to cater for the establishment, development or protection of provincial reserves. Instead they are eager to spend on what they consider "necessary and popular" development aspects such as buildings. Very few local councils in the heavily populated areas spend as much as 4% of their annual budget on forest activities. Not only that but whenever there is a deficit in their budgets, they fall back heavily on their forest reserves because they consider the forest as a source of immediate revenue rather than an investment for the future.

(b) There is an increasing tendency among local councils to exploit their forest reserves wastefully. Taking the advantage of the fact that no royalty is imposed on wood coming from forest reserves, they make forest reserves areas of forest destruction instead of forest development; they are, therefore, opposing the aims of forest policy.

(c) The figures for forest reservations reveal signs of failure of this system. Until the beginning of 1959 only 32,890 feddans have been designated Provincial Forest Reserves over the entire country, i.e. at a rate of only 1,265 feddans per annum while Central Reserves amount to 1,862,218 feddans; areas

surveyed but not yet declared Provincial Reserves are only 16,882 feddans whereas similar central areas total 809,184 feddans. A reversed picture of the above figures is expected, i.e. by far bigger areas should be made into Provincial Forest Reserves; this is because the population of the rural areas who depend on the Provincial Forest Reserves total 11,321,203 (1960) and annually consume about 36,846,800 solid metres of round wood and 86,275 cubic metres of sawn timber, while the urban population of the country is only 1,035,153 (less than 9%) and consume annually 5,825,275 solid metres of round wood and 20,123 cubic metres of sawn wood.

(d) The local councils have very little knowledge of forestry, and are liable to interfere with good forestry prescriptions, e.g. by ordering premature or overcutting. The councils are not sufficiently capable of drawing rules and regulations or maintaining efficient control on their forest reserves. Moreover a forester cannot easily put his technical advice in practice without the authority of the local government, which tends to be weak on this matter.

(e) This division of reserves is artificial financially since the expenditure in both is met from the government funds. Under this system there is no significant expenditure on forests outside the Central Reserves, and the budget of the Forests Department is kept low because it is supposed to look after the Central Reserves only. Under a centralized system more

monetary provisions would be available for forest activities, and they could be spent more evenly over the whole country according to the relative requirements of each area.

The centralization of all the woods of the country, which was advocated by Shawki[1], may correct these drawbacks; it would mean greater responsibilities for the Forests Department which must be efficiently equipped in every sense, especially in respect of adequate well-trained technical staff to cope with such a change in policy. This new system should include the establishment of provincial forest agencies in the various parts of the country and under the direct control of the central forest authorities. These provincial agencies should establish constant, close relations with the local authorities whose local knowledge and co-operation would be of immense value in the fields of surveying and future planning.

The various policies of the different parts of the country should differ in accordance with the different physical and human characteristics of each area. Within the general frame-work of forest policy, each provincial forest agency should have some autonomy to allow for local conditions and requirements. One future aim should be to reserve all natural forests and to guide each province to depend as entirely as possible on its own wood supplies, at least as far as firewood and charcoal are concerned.

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(1) M.K. Shawki, Review of Certain Aspects of the 1932 Forest Policy, Sudan Silva 8(1), 1958, pp. 9 - 12.

2. Royalty Rates:

For Khartoum Province the royalty rate was reduced in 1959 for firewood brought by camels and donkeys by 50%. Firewood brought into the Three Khartoum Towns by animals is essentially cut from the desert scrub forests around Khartoum, and these forests have been clearned for a distance of 10 - 50 miles. If the policy objective is to protect these scrub forests, lessen the frequency and intensity of sand storms and to stop the southward creep of the desert, the reverse should be done. This reduction in royalty will act as a stimulus for the rural population around Khartoum to exploit more thoroughly the desert scrub forests, and sell their firewood at a lower price because of the lower rate of royalty and the negligible transportation costs. If the royalty is increased, tne price of such firewood will rise and the imported firewood can compete with it. By restricting the market for desert scrub firewood, the rate of exploitation of these forests can be lowered till it comes to cease at length, thus ensuring the fixation of sand and avoiding sand storms and desert creep.

Although the Three Khartoum Towns are the greatest consumers of paraffin (1,688,995 gallons in 1959/60), they also consume large quantities of firewood and charcoal the demand for which still exceeds their supply. During 1959/60 the amount of firewood railed into the Khartoum Towns reached

16,808 tons : 5,300 from Dinder, 4,800 from Sennar, 3,600 from El Hawata and 3,108 from Singa; this indicates that over 60% of the area's supply of firewood is railed from the Blue Nile and Kassala Provinces. The authorities have raised the royalty rate for firewood railed into the area from 400 m/m to 450 m/m per cubic metre, evoking reactions from both supplier and consumer. On the supply side, it may discourage the contractors to rail more firewood into the area, thus reducing the already limited supply. On the consumer side, the interaction of the greater demand and the limited supply keeps the prices of firewood up, and the increase in royalty will push the price even higher. The royalty rate for firewood railed into the Khartoum area should be reduced, rather than increased,

(a) to relieve the mounting cost of living for the low-income people.

(b) to encourage contractors to rail more firewood into the Khartoum area to bridge the gap between demand and supply.

(c) to lower the retail price of the railed firewood to compete with the desert scrub firewood, and replace it wholly in the long run.

3. Official and Public Responsibility:

The forest acts and rules are theoretically capable of the preservation and the promotion of forest reserves since they combine an official responsibility and a public one. But in practice their implementation is hampered by many serious

factors; the Sudan is too extensive a country for the limited forest staff to supervise thoroughly all its forest reserves and unreserved woodlands; the public is not aware of its responsibility towards forest protection though it uses forest produce in everyday life. While a sense of responsibility is most needed in the south and the west (areas where the concentration of forest reserves is high and the forest problems are serious), the Nilotic tribes of the south and the nomadic pasturalists of the west are among those who suffer most from illiteracy and lack of forestry education.

The forestry staff has to be increased in number and efficiency; a nation-wide educational campaign is essential to teach people the direct and the indirect values of the forest, and how to protect the forests against fires and other dangers. Only through the knowledge of the official staff and the public can the forest policy be successfully implemented and the forest reserves and unreserved woodlands be protected and promoted.

4. A State-Private Sector:

The limited forest industries now in existence are the monopoly of the state. This public sector needs to be augmented by the private which is not now taking any part in the forest industries. Individuals governed wholly by the profit motive are not willing to invest in forestry because the prolonged production period involves the growth of the interest

on the invested capital during the long period of the stand's development. Another reason is the general lack of experience, but there are still some people who acknowledge that the various forest products and even forest influences can be commercialized.

It is worth trying to encourage the reluctant private sector to enter into the sphere of forestry. The initiation for the establishment of forest plantations jointly by the public and the private sectors could come from the state. In such a venture the state would furnish the business with technical advice and experience, and the mere existence of the state in this business may narrow the margin of losses expected by the inexperienced private sector. This may eventually stimulate the diversion of capital now invested in other channels of the national economy into the forestry sector, thus increasing the total capital investment in forestry activities. The main functions of the state would then be to ensure that such establishments are distributed over the country as evenly as the environmental suitability and location factors can permit, that the forest industries established are the most needed by the country, and that the profit motive accompanying any private investment is diluted with other national considerations.

B. Forests Department Ten Year Plan:(1)

The objectives of this plan are:

(a) to maintain as forest, under the assured protection that only forest reservation can give, a sufficient area of the country to preserve and ameliorate climate, and to conserve soil and water supplies; according to the forestry authorities this means that at least 15% of the land area of the Sudan should eventually be forest reserves

(b) to provide for the present and future needs of the population in firewood, charcoal, building poles, sawn timber and other forest products, and to replace these items now imported by locally grown forest products.

(c) To ensure that the production of gum arabic keeps pace with the world demand for the product, and to increase this demand where possible.

(d) to utilize forest products as completely and as economically as possible.

(e) to provide the greatest possible revenue to the government, as far as consistent with these aims.

To further these aims the Forests Department will also:-

(f) provide employment and a source of cash income in many of the less developed parts of the country.

(g) utilize natural resources at present unutilized or wastefully exploited.

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(1) Forests Department, Summary of the Forests Department Ten Year Development Plan 1961/62 - 1970/71, Sudan Silva 13(11 1962, pp. 17 - 22.

(h) maintain and improve the fertility of the soil under the protection of forests.

When the National Technical Development Committee decided to extend the plan period from 7 to 10 years, 3 more schemes for:

(1) Forest Reservation

(2) Afforestation, and

(3) Utilization of trees to be cut from the areas that would be put under new agricultural schemes, and the Development of Rubber Plantations in the Sudan,

were submitted. Their total estimated cost was £S.1,736,000 of which only £S.120,000 were approved for rubber research and plantation. The other profjects were cut down from £S.3,098,637 to £S.2,410,000 (Table XXI); the schemes for the "Rational Utilization of Desert Scrub", and the two experimental factories of fibre-board and plywood were omitted.

Table XXI: Forest Projects of the Ten Year Development Plan

Scheme	Sum of Money in £S.	
	Required	Approved
1. Forest Reservation	358,550	350,000
2. Forest Plantation	380,200	380,000
3. Khartoum Green Belt	299,000	210,000
4. Wattle Plantation	26,150	26,000
5. Experimental Shelter Belts	25,150	25,000
6. Irrigated Plantation, Blue Nile	357,500	250,000
7. Firewood Plantation on White Nile Flats	109,800	50,000
8. Pilot Scheme for Regenerating Acacia Woodland	13,200	13,000
9. Management and Development of Dom Forests	49,800	49,000
10. Encouragement of Tree Planting in Private Agricultural Schemes	74,100	30,000
11. Rational Utilization of Desert Scrub	43,030	Omitted
12. Forest Industries:		Omitted except for
(a) General Testing	83,830	120,000 for
(b) Experimental Fibre-Board Factory	277,000	Rubber
(c) Experimental Plywood Factory	30,558	Research
13. Timber Production:		
(a) New Equipment	459,250	410,000
(b) New Sawmills	92,640	90,000
(c) Suki Workshop	10,000	10,000
(d) Preservative Plant	7,000	7,000
14. Gum Arabic	55,000	55,000
15. Soil Conservation	120,955	120,000
16. Research and Education	77,084	75,000
17. Administrative Requirements	199,010	140,000
TOTAL	3,098,637	2,410,000

Source: Forests Department, Summary of the Forests Department's Ten Year Development Plan 1961/62 - 1970/71, Sudan Silva 13(11), 1962, pp 18 - 9.

General Remarks:

1. The estimated cost for the Forests Department's Schemes for 7 years was £S.3,098,637; when the plan period was extended to 10 years, the budget of the Forests Department should have been increased by over 40% but instead its budget was reduced by more than 20% due partly to the critical financial position of the country and partly to the relative lack of appreciation of forestry as a form of land use. Capital is, therefore, one of the greatest limitations to the forest development schemes despite the favourable fact that production costs in forestry are lower than in other sectors of the economy. This shows that an urgent action is needed to attract private investments.

2. The irrigated plantations in the Blue Nile Province (10,000 feddans), the firewood plantation on the White Nile flats between the Jebel Aulia and Khartoum, and the other plantation and reservation schemes, all aim to meet all the requirements of the population for round wood and sawn timber by the end of the plan period, June 1971. All these schemes look to an increase of 1,400,000 cubic metres of firewood and 40,000 cubic metres of sawn timber. If these quantitative objectives of the plan were achieved, then the annual

production by the end of June 1971 will be less than 35 million cubic metres of round wood and about 53,330 cubic metres of sawn wood. By the end of the plan period, with an upward demographic trend of 2.9% the population of the country will reach about 15,000,000, and the annual consumption will be about 51,870,000 cubic metres of round wood and about 180,000 cubic metres of sawn timber. The difference in sawn timber (about 126,670 cubic metres or over 65% of the demand) is to be imported from abroad, and that in round wood (about 17 million cubic metres or over 30% of the demand) will eventually come from forests outside reserves. So the plan falls short of tne attainment of self-sufficiency level, confinment of wood cutting to forest reserves and replacement of these items now imported by forest products grown within the country.

The plantations established after the enforcement of the plan will not be mature by the close of the plan period, and this means that more dependence should eventually be laid on mature natural forests, which should come under reservation. Such reservation should be concentrated on higher areas capable of the production of soft woods because, according to the United Nations statistics,(1) the Sudan imported 93,000 cubic metres of soft sawn timber valued at £S.1,666,191 in 1963 and only 500 cubic metres of sawn hard wood valued

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(1) F.A.O., Yearbook of Forest Products Statistics, Rome, 1964, pp.46 and 60.

at £S.44,568. The preservation of 29% of the forest land, i.e. 2.8% of the total area of the country, can fulfil the twofold goal of ensuring the self-sufficiency level on the 1970/71 basis and the protection of the unreserved natural forests against irrational exploitation.

3. If it is the object of the plan to provide "a source of cash income in many of the less developed parts of the country",(1) and increase "employment opportunities in the modern part of the economy, and thereby cause a shift of workers from the traditional or subsistance sector",(2) then it is expected that industrial schemes be given special preference. It is only through the expansion of forest inventory work and the study and testing of the different kinds of forest produce that a modern forestry sector can be established in the rural areas.

It is fortunate that the approved sum of money for the establishment of wattle plantations and other trees producing tanning materials is enough to grow from 4,000 to 5,000 feddans. On rough estimates this is assumed to be sufficient for the Sudan's need for these materials. The Dom Forests scheme, which aims at the protection of these forest and their development to ensure a sustained production level, will

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(1) Forests Department, Summary of the Forests Department's Ten Year Plan 1961/62 - 1970/71, Sudan Silva 13(11), 1962, p.17.

(2) Sudan Government, Ten Year Plan for Economic and Social Development, Khartoum, p.6.

prove to be essential because the fibre of these trees has high industrial potentialities especially for fodder and sack making. The monetary provisions approved for the rubber plantations are far below the limit necessary for successful management and development of this product which has proved to grow quite satisfactorily in the southern parts of the country.

During 1963 the Sudan imported 1,200 cubic metres of plywood valued at £S.58,844, and 3,800 metric tons of fibre board valued at £S.13,929, according to United Nations statistics(1). The omission of the plywood and fibre board experimental factories was quite unfortunate, not only for the supply of these needs and the provision of employment opportunities but also for the great social transformation which would accompany their establishment.

4. It is regrettable that the Ten Year Development Plan had been drawn out before the Forests Department started the first census of the forest products consumption in the Sudan with the aid of the F.A.O. It is, therefore, not related to the present or future needs of the country.

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(1) F.A.O., Yearbook of Forest Products Statistics, Rome, 1964, pp. 46,50,60,68.

Conclusion

The lines along which forestry can be promoted differ from one part of the country to another according to environmental disparities. In the Northern Province these lines include the complete preservation of the remaining desert scrub forests for protective measures, the encouragement of people to grow date palm trees partly as a cash crop and partly for soil fixation, the creation of forest reserves in every basin to meet the requirements of the local people, close supervision of royalty collection and the encouragement, and if necessary compulsion, of pump scheme owners to keep 10 - 15% of their scheme areas under permanent forest cover. The protection of the perimeters of big towns against devastation, the introduction of green belts and the increase of public parks and recreational woodlands in towns like Atbara ought to be a part of a forest policy. In Khartoum Province it should include the imposition of high royalty rates on all wood originating from the desert scrub forests and from outside reserves, reservation of all areas capable of easy regeneration and introduction of quick-growing exotics like Prosopis julifora, and the extension of the Khartoum Green Belt to include all the Three Towns for production, protection and recreational purposes. In the meantime, an adequate supply of firewood and charcoal must be ensured from Kassala and the southern parts of the Blue Nile Province.

In the Blue Nile Province forestry could be promoted

through the intensification of irrigated plantation in the cotton growing area, the protection of gum-yielding Acacia senegal forests against clearance, the protection of the severely eroded banks of the Blue Nile north of Sennar and the overgrazed and eroded perimeters of the northern towns like Wad Medani, Hassaheissa and Abu Quta. The introduction of the 10 - 15% forest plots of all areas of the private schemes along the Blue and White Niles and the experimentation of shelter belts in the cotton growing area with due attention to water requirements should be important parts of the forest policy.

In Kassala Province the objectives of forestry should include the protection of the Gash and Baraka schemes, the Hyphaene thebaica forests of the river Atbara, the poor scrub of the north against cutting and overgrazing, and the severely eroded perimeters of Port Sudan, Kassala, Gedaref and Tokar. The control of extensive annual stray fires in the southern parts of the province is also important. The preservation, or else the planting, of forests on the catchment area of the Khor Arb'at and on the steep slopes of the Red Sea hills is essential. The burning of firewood into charcoal should be prohibited in the northern parts to which adequate supplies of this commodity should be arranged from the southern region; exportation of charcoal to Egypt and across the Red Sea should be strictly prohibited.

Kordufan and Darfur Provinces are the home of the gum

industry which is only second to cotton in the external trade of the country. So the functions of policy here are closely linked to the Acacia senegal tree - its protection, its regeneration and wounding, the improvement of the quality and quantity of gum Arabic and its marketing, and researches into the chemistry of gum to extend its market through the discovery of new uses. Other functions are related to the increasing population concentrations resulting from the western extension of the railway to Nyala, and the problems of erosion and sand creep. The creation of more forest reserves for the provision of timber and firewood has become more than ever an urgent necessity. Sand movement has become a constant problem in the northern parts and around the limited permanent water centres, and is becoming so along the railway lines from Tendelti to Nyala and from Babanousa to the Bahr el Arab. The provision of new water centres and the construction of many reservoirs can serve more than one function - they can spread the human and animal population and thus release the severe pressure on the existing few water points; they can also help greatly in the establishment of quick-growing protective forests on the threatened sites. The intensification of softwood plantations in the Jebel Mara should be an essential part of the forest policy.

In the Upper Nile Province which is one of the few areas where good tree growth can be attained, the concentration

of plantations where useful tree species have proved to grow successfully, and the experimentation with indigenous and exotic tree species to find better timber trees for the southern clay plain are the main functions of the forest policy. The protection of the overgrazed areas and the control of the severe, frequent fires which roar over the Sudd region when it dries constitute the main other tasks.

Equatoria and the Bahr el Ghazal Provinces are the home of the broad-leaved forests and mountain forests. Valuable species, such as mahogany and teak, have been sown in the river Jur in the Bahr el Ghazal Province, the deciduous forest land of the undulating ironstone country of Yei district and the mountains of the Imatong of Torit district in Equatoria. These areas are more distant than the Upper Nile Province from the populous consuming centres of the north, and hence bulky timber cannot be transported without entailing high costs. Fires are the greatest danger to these forests. The mountain areas should immediately be reserved and softwood plantations introduced wherever altitude permits their growth. Many sawmills must be established to meet the future demand of the local people, with the intention of dedicating the Suki sawmills to supply the northern parts of the country.

Forestry should not be confined to poor quality land on the erroneous assumption that it is a type of land use which gives low financial returns, and despite the fact that

the country's supply of forest products is far short of its demand for these commodities. Forestry annually contributes not less than £S.50,000,000 to the gross domestic production, and if we could evaluate in monetary terms the over-all influences of the forests of the country, this figure might reach well above £S.100,000,000. For forest plantations established on good quality land, the per unit area returns (in export values) can compete very favourably with those for irrigated cotton. These forestry per annum returns are twice greater than those for wheat, three times greater than those for ground nuts, five times greater than those for "dura" and over 100 times greater than those for grazing (Appendix IX and Fig.29).

Forests established for production purposes would not only satisfy the requirements of the rising population but might also contribute to the country's external trade through the creation of a surplus of forest produce. To bridge the existing and the future gap (up to the time the population doubles) between the supply of and demand for forest commodities, plantations should be established at an annual rate of 11,000 feddans for the production of firewood and charcoal, 3,000 feddans for the production of other forms of round timber, 5,500 feddans for the production of sawn hard timber and 1,400 feddans to satisfy the country's needs for sawn soft timber. These should be established on good quality land if they are expected to be profitable. Firewood,

being a bulky commodity, must be produced near the consumption centres; some of the land now under the production of "dura" can be devoted to the production of firewood not only because the per unit area financial returns of the latter are higher than those derived from the former but also because the production of "dura" is greater than the local market while the supply of firewood is far behind the demand for it. The 19,500 feddans annually needed for the production of round wood and sawn hard timber must be on the good quality lands of the basins in the Northern Province, the clay plain of the Blue Nile and Kassala Provinces and the alluvial tracts, the loams of Kordufan and Darfur Provinces. The opportunities for the production of softwood, small as they are, must be fully utilized to eliminate the dependency of the country on overseas sources for this product. The two major high areas, the Jebel Mara and the Imatong Mountains, must be dedicated to the production of the country's requirements for softwood.

In a country like the Sudan, where great power sources are lacking and hopes of great mineral deposits have proved illusory, the renewable natural resources - water, soil and plant cover - will continue to be the keys to the future economic structure. Forestry, through increasing and controllin the water supply and promoting the quality of the soil, naturally enriches the natural wealth of the country; conversely the devastation or the irrational utilization of the forest will indubitably dissipate this wealth.

BIBLIOGRAPHY

A. BOOKS:

1. Andrew, G. Geology of the Sudan in J.D.Tothill (ed), Agriculture in the Sudan, O.U. Press, London, 1948.
2. Andrews, F.W. The Vegetation of the Sudan in J.D.Tothill (ed), Agriculture in the Sudan, O.U. Press, London, 1948.
3. Barbour, K.M. The Republic of the Sudan, University of London Press Ltd., 1961.
4. Blunt, H.S. Gum Arabic, with Special Reference to its Production in Sudan, Oxford University Press, 1926.
5. Booth, G.A. Working Plan for the Acacia Nilotica Forest Reserves, Gezira Circle, Agricultural Publications Committee, Khartoum, 1954.
6. Booth, G.A. Working Plan for the Forest Reserves of the Southern Blue Nile Circle, Miscellaneous Publication No.2, Agricultural Publications Committee, Khartoum, 1950.
7. Duerr, W.A. and Vaux, H.S. Research in the Economics of Forestry, Charles Lathrop Pack Forestry Foundation, Washington, 1953.
8. F.A.O., Grazing and Forest Economy, Rome, 1953.
9. F.A.O., Yearbook of Forest Products Statistics, Rome, 1964.
10. Forests Department, Improvement of Gum Gardens and Establishment of New Ones (in Arabic), Leaflet No.4, Khartoum, 1961.
11. Francois, T. Evaluation of the Utility of Forest Influences in F.A.O., Forest Influences, Rome, 1962.
12. Harrison, M.N. and Jackson, J.K. Ecological Classification of the Vegetation of the Sudan, Forest Bulletin No.2 (New Series), Agricultural Publications Committee, Khartoum, 1958.
13. Jackson, J.K. and Peake, F.G.G. Forestry Research in the Sudan, 1950 to 1954, Forest Memoir No.7, Agricultural Publications Committee, Khartoum, 1955.
14. Jackson, J.K. The Dongotona Hills, Forest Memoir No.1, Forests Department, Khartoum, 1950.

15. Jackson, J.K. Mount Lotuka, Didinga Hills, Forest Memoir No.3, Agricultural Publications Committee, Khartoum, 1951.

16. Kipling, T.H. The Supply of Woodfuel and Roofing Poles to Khartoum, the Gezira and Government Departments, Bulletin No.5, Agricultural Publications Committee, Khartoum, 1950.

17. Kittredge, J. Forest Influences, McGraw-Hill Book Company, New York, 1948.

18. Lebon, J.H.G. Land Use in Sudan, Geographical Publications Limited, Bude, Cornwall, 1965.

19. Pavari, A. Forest Influences in F.A.O., Forest Influences, Rome, 1962.

20. Petrini, S. Elements of Forest Economics, Translated by Mark L. Anderson, T. and A. Constable Ltd., Edinburgh, 1951

21. Shawki, M.K. Forests in the Sudan (in Arabic), Forest Memoir No.4, Forests Department, Khartoum, 1961.

22. Shawki, M.K. Summary of the History of Forests in the Sudan (in Arabic), Forest Memoir No.4 (New Series), Forests Department, Khartoum, 1962.

23. Smith, J. Distribution of Tree Species in the Sudan in Relation to Rainfall and Soil Texture, Bulletin No.4, Agricultural Publications Committee, Khartoum, 1949.

24. Smith, J. and Petrie, A.M. Native Housing in Relation to Forestry in Anglo-Egyptian Sudan, Imperial Forestry Institute, University of Oxford, 1939.

25. Sudan Meteorological Service, Climatological Normals 1930-1960, Khartoum, 1961.

26. The Information Production Center, Agricultural Statistics, Ministry of Agriculture, Khartoum, 1964.

27. Troup, R.S. Colonial Forest Administration, Oxford University Press, 1940.

28. Van Der Linde, J. Trees Outside the Forest in F.A.O., Forest Influences, Rome, 1962.

29. Vidal-Hall, M.P. The Silviculture and Regeneration of the Forest Types of Equatoria and Bahr el Ghazal Provinces, Forest Memoir No.4, Agricultural Publications Committee, Khartoum, 1952.

30. Vidal-Hall, M.P. and Williams, G.H.D. Teak as a Plantation Tree in the Sudan, Forest Memoir No.8, Agricultural Publications Committee, Khartoum, 1956.

B. PAPERS :

1. Ainslie, J.R. Forestry the Father of Agriculture, The West African Review, September 1935.

2. Ballal, A. The Goat as a Problem in the Semi-Arid Region of the Northern Sudan, Sudan Silva 12 (11), 1962.

3. Champion, H. The Significance for the Sudan of Current Trends in Forestry, Sudan Silva 10 (1), 1960.

4. Childs, F.W. Recreational Values versus Forest Products in Land Use Planning, Soc. Amer. Foresters Proc., 1957.

5. Dunn, P.M. Multiple Forest Use in Practice, Pulp & Paper 30 (7), 1956.

6. Forests Department, Summary of the Forests Department's Ten Year Development Plan 1961/62 - 1970/71, Sudan Silva 13 (11), 1962.

7. Gleisberg, C.F. Forestry in Kassala Province, Sudan Silva 12 (11), 1962.

8. Gleisberg, C.F. Some Problems of Forestry at Port Sudan and Neighbourhood, Sudan Silva 8 (1), 1958.

9. Jackson, J.K. The Vegetation of the Imatong Mountains, Sudan, Journal of Ecology 44 (1956).

10. Jackson, J.K. Some Thoughts on the Place of Forestry in Land Use Planning, Sudan Silva 12 (11), 1962.

11. Jackson, J.K. The Introduction of Exotic Trees in the Sudan, Sudan Silva 10 (1), 1960.

12. Jackson, J.K. and Shawki, M.K. Shifting Cultivation in the Sudan, S.N. and Records Vol.31, pt.2, 1950.

13. Kassas, M.G. Land Forms and Plant Cover in the Desert, Sudan, Bull.Soc. Géog-D'Égypte 29 (1956).

14. Khalifa, K.O. Potential Forest Industries, Sudan Silva 14 (11),1963.

15. Khalifa, K.O. Khartoum Green Belt, Sudan Silva 10 (1), 1960.

16. Lebon, J.H.G. On the human Geography of the Nile Basin, Geography, 45 (1960).

17. Lewis, J.D. The Tsetse Fly Problem in the Anglo-Egyptian Sudan, S.N. and Records, 30 (1949).

18. Muir, W.D. Forestry as an Economic Form of Land Use, Aust.Timb.J. 30 (2), 1964.

19. Newbold, D.A. Dessert Odyssey of a Thousand Miles, S.N. and Records, 7 (1924).

20. Obeid, M.H. Wood for Today and Tomorrow, Sudan Silva 14 (11), 1963.

21. Shawki, M.K. A Note on Firewood and Charcoal Supply and Costs, Sudan Silva 7 (1), 1957.

22. Shawki, M.K. Integration of the Conservation and Development of Wild Resources with Programmes of Economic Development in Modern States, Sudan Silva 14 (11), 1963.

23. Shawki, M.K. Review of Certain Aspects of the 1932 Forest Policy, Sudan Silva 8 (1), 1958.

24. Shawki, M.K. Functions and Services Rendered by the Forests Department, Sudan Silva 10 (1), 1960.

25. The Empire Forestry Association, The Forest, Forestry and Man, London, June 1947.

26. Williams, M.E. Land Use Aspects in Silviculture, Sudan Silva 7 (1), 195

27. Willimot, S.G. Soils and Vegetation of the Buma Plateau, S.N. and Records, 38 (1957).

28. Worrall, G.A. The Butana Grass Patterns, Journal of Soil Science 10 (1959).

29. Worrall, G.A. Patchiness in Vegetation in Northern Sudan, Journal of Ecology 48 (1960).

30. Worrell, A.C. Four Ways to evaluate Forests but none is satisfactory alone, Pulp & Paper 32 (7), 1958.

31. _____ Gum Acacia in the Sudan, The Chemist and Druggist, June 26, 1954.

C. PUBLISHED REPORTS :

1. Allegri, E. Report on Forest Resources, Sudan Silva 8 (1), 1958.
2. Andrew, G. The Climate of the Sudan in Soil Conservation Committee's Report, Khartoum, 1944.
3. Andrew, G. The Red Sea Hills in Soil Conservation Committee's Report, Khartoum, 1944.
4. Arkell, A.J. Khor Baraka in Soil Conservation Committee's Report, Khartoum, 1944.
5. Ferguson, H. Deterioration of Soil and Vegetation in Equatoria in Soil Conservation Committee's Report, Khartoum, 1944.
6. F.A.O. Report No. 1291 to the Government of the Sudan, Rome, 1960.
7. Forests Department, Report for the Period July 1952 to June 1953, Khartoum, 1953.
8. Forests Department, Report for the Period July 1953 to June 1954, Khartoum, 1954.
9. Forests Department, Report for the Period July 1954 to June 1955, Khartoum, 1955.
10. Forests Department, Report for the Period July 1955 to June 1956, Khartoum, 1956.
11. Forests Department, Report for the Period July 1956 to June 1957, Khartoum, 1957.
12. Forests Department, Report for the Period July 1957 to June 1958, Khartoum, 1958.
13. Forests Department, Report for the Period July 1958 to June 1959, Khartoum, 1959.
14. Forests Department, Report for the Period July 1959 to June 1960, Khartoum, 1960.
15. Forests Department, Report for the Period July 1960 to June 1961, Khartoum, 1961.
16. Forests Department, Report for the Period July 1961 to June 1962, Khartoum, 1962.
17. Forests Department, Report for the Period July 1962 to June 1963, Khartoum, 1963.

18. Francis, D.A. Interim Report to the Government of the Sudan on Forest Inventory, Rome, 1960.

19. Hancock, G.M. The Grass-Acacia Cycle in the Blue Nile Province south of Sennar in Soil Conservation Committee's Report, Khartoum, 1944.

20. Kennedy-Cooke, B. Tokar and the Baraka Delta in Soil Conservation Committee's Report, Khartoum, 1944.

21. Lebon, J.H.G. Current Development in the Economy of Central Sudan, Report of a Symposium, held at Makerere College, Sept.1955

22. Smith, J. and Macintosh, E.H. Perimeter Protection, with special Reference to Khartoum in Soil Conservation Committee's Report, Khartoum, 1944.

23. Sudan Government, Ten Year Plan for Economic and Social Development, Khartoum.

D. UNPUBLISHED MATERIAL :

1. Arkell, A.J. A Note to the Soil Conservation Committee, Khartoum, 1944.

2. Bayoumi, A.R. Special Fund Project of Land and Water Use Survey of Kordufan Province, a Lecture Delivered at the Philosophical Society of the Sudan on 23rd Jan. 1963.

3. Bayoumi, A.R. Some Problems of Land Use and Rural Water Development in the Republic of the Sudan, Report to the Ministry of Agriculture, Khartoum.

4. Chadwick, M.G.A. The Market for Gum Arabic, A Report to the Forests Department, Khartoum.

5. Harrison, M.N. Report on a Grazing Survey of the Sudan, to the Ministry of Animal Production, Khartoum, 1955.

6. Jackson, J.K. The supply of the Sudan's Needs in Sawn Timber, A Report to the Forests Department, Khartoum.

7. McCall, A.G. Report on a Visit to Nigeria (on Gum Arabic).

8. Moir, T.R.G. A Note on the Distribution of Grasses on the clay Plains of the East Central Sudan.

9. Roper, E.M. and Smith, J. Two Reports jointly written on "Gum Arabic" and "Royalty on Gum" and submitted to the 9th Meeting of B.E.T. held on 14.3.1936.

10. Smith, J. Report on the Marketing of Gum, Khartoum.

11. Smith, J. Report on the Improvement of Grazing for herds, Khartoum, 1933.

12. Smith, J. Report on Gum in Kordufan, to B.E.T., Khartoum, 1937.

13. Smith, J. Dairy in Gum Areas in Kordufan, Khartoum, 1937.

14. Sudan Government, Precis Annual Report for 1937; Part I: Agriculture and Forestry, Khartoum.

15. The Board of Economics and Trade, Minute of the 9th Meeting on 14.3.36.

16. The Board of Economics and Trade, Minute No.66 of the 10th Meeting on 2.2.37.

17. The Board of Economics and Trade, Minute No.77 of the 13th Meeting on Feb.1938.

18. The Central Economic Board at its 89th Meeting in May 1915 minuted (Minute of the 89th Meeting of C.E.B. on 18-5-15/31/15 Vol.4).

19. Weir, A.H.W. Observations made while studying Gum Arabic Production in Anglo-Egyptian Sudan, a Report to the Forestry Division, Khartoum, 1928.

Appendices

Appendices (Continued)

The following stations are representatives of the vegetational zones, and the letters correspond with those in Table VII and Fig.9. For some stations, temperature, pressure and humidity figures are not available :

Wadi Halfa - I :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	17.4	19.3	23.8	28.8	33.6	34.8	35.1	35.0	32.8	30.2	24.2	19.2	27.8
Rainfall	(mm)	TR	TR	TR	TR	1	0	1	TR	0	1	TR	TR	3
Pressure	(mb)	999.5	998.4	996.1	993.7	991.8	994.4	989.7	989.9	991.6	994.2	996.7	998.9	994.3
Relative Humidity	(%)	34.7	28.3	21.0	17.3	16.7	16.7	18.7	23.3	24.3	26.0	32.7	35.3	24.7

Khartoum - II (a) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	24.8	26.2	29.8	33.4	35.5	35.4	32.6	30.9	32.7	33.5	29.7	25.9	30.9
Rainfall	(mm)	0	TR	TR	1	5	7	48	72	27	4	TR	TR	164
Pressure	(mb)	967.6	966.7	964.9	963.6	963.1	963.7	964.4	963.9	964.6	964.5	966.1	967.5	965.1
Relative Humidity	(%)	27.7	22.7	18.0	16.7	21.3	27.0	43.3	54.0	42.3	29.0	27.3	29.7	29.7

Wad Medani - II (b) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature (°C)	25.4	26.8	30.3	33.6	34.5	33.0	29.8	28.0	29.4	31.0	29.2	26.1	29.8
Rainfall (mm)	0	0	TR	3	16	31	122	129	55	6	1	0	373
Pressure (mb)	964.1	963.2	961.5	960.4	960.6	961.7	963.0	963.7	962.9	962.0	962.8	964.1	962.5
Relative Humidity (%)	27.3	20.3	14.3	13.3	22.3	34.0	53.3	65.7	58.3	39.7	27.7	29.3	33.7

Sodiri - II (c) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall (mm)	0	0	0	1	3	9	77	89	26	1	0	0	206

Umm Badir - II (d) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall (mm)	0	0	0	0	2	15	94	98	35	TR	0	0	244

Gebeit - II (e) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	19.9	20.2	22.5	26.0	30.3	33.1	32.1	31.7	31.4	27.1	23.8	21.1	26.6
Rainfall	(mm)	1	TR	1	2	9	5	33	55	13	6	3	1	129
Pressure	(mb)	924.9	922.8	922.4	922.2	921.5	920.6	920.3	920.5	921.5	923.7	924.1	925.1	922.6
Relative Humidity	(%)	74.3	69.7	61.7	49.7	39.0	32.0	42.3	45.0	40.7	57.3	70.3	73.3	54.7

Kosti - III.A.1.(a).(i)

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	25.5	26.8	30.2	33.3	33.8	32.1	29.0	27.6	28.8	31.1	29.7	26.4	29.3
Rainfall	(mm)	0	0	1	4	18	47	110	143	60	22	1	0	406
Pressure	(mb)	966.8	965.9	964.3	963.2	963.0	965.3	966.1	966.4	965.8	964.9	965.5	966.8	965.2
Relative Humidity	(%)	20.0	25.7	21.3	20.3	31.0	44.0	60.0	70.7	63.7	46.3	32.3	32.3	40.0

Nyala - III.A.1.(a).(ii) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	25.0	26.3	29.5	32.1	32.2	30.6	27.3	26.2	27.2	30.1	28.9	25.7	28.5
Rainfall	(mm)	0	TR	TR	3	25	54	122	162	81	18	0	0	465
Pressure	(mb)	937.2	936.7	935.4	935.0	935.2	936.2	936.4	936.5	936.3	936.1	936.4	937.3	936.3
Relative Humidity	(%)	17.0	13.5	13	15.	28.5	46.0	63.0	70.0	58.0	34.5	22.5	20.0	33.5

Torit - III.A.1.(b) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	30.5	30.9	30.7	28.9	28.1	26.9	25.6	25.6	27.0	28.1	29.5	29.5	28.5
Rainfall	(mm)	4	21	49	96	122	122	164	147	118	91	40	20	994
Pressure	(mb)	941.2	940.7	940.4	941.5	942.5	943.8	944.1	943.9	943.3	942.1	941.3	941.4	942.2
Relative Humidity	(%)	35.0	36.0	43.5	56.5	61.5	67.0	73.0	73.5	69.0	61.0	51.5	44.5	56.0

Er Roseires - III.A.1.(c) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	28.0	29.2	32.2	34.0	33.0	28.7	26.6	25.8	26.9	29.2	29.7	28.3	29.2
Rainfall	(mm)	0	TR	1	11	58	126	166	221	152	36	5	0	776
Pressure	(mb)	956.4	955.8	954.5	954.3	955.4	957.2	957.9	958.0	957.7	956.3	955.8	956.7	956.3
Relative Humidity	(%)	33.3	29.0	24.3	29.3	40.6	57.3	71.3	76.0	72.3	59.3	39.3	35.6	47.6

El Obeid - III.A.2.(a) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	23.3	24.9	28.7	31.8	32.6	31.4	28.1	26.8	28.1	30.1	27.6	24.1	28.1
Rainfall	(mm)	0	0	0	3	20	33	121	145	77	19	0	0	418
Pressure	(mb)	946.6	945.9	944.4	943.3	943.4	944.4	945.0	945.2	945.0	944.4	945.5	946.6	944.9
Relative Humidity	(%)	26.0	21.3	17.3	15.7	30.3	42.0	61.3	70.3	61.3	39.0	25.3	25.7	36.7

El Geneina - III.A.2.(b) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature (^{o}C)	22.7	24.6	28.2	30.5	30.9	29.7	26.1	24.3	25.7	27.1	25.4	23.1	26.5
Rainfall (mm)	0	TR	1	4	27	36	162	230	79	10	0	0	549
Pressure (mb)	922.9	922.3	921.1	920.8	921.1	922.3	922.5	922.8	922.8	922.5	922.8	923.1	922.3
Relative Humidity (%)	18.7	15.7	14.3	16.3	27.7	40.0	64.3	78.0	65.0	35.7	22.0	22.0	34.3

Muglad - III.A.2.(c) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall (mm)	0	0	0	5	23	64	126	149	104	25	0	0	496

Loelli - III.A.3.(a) :-

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall (mm)	9	7	43	73	93	65	71	79	46	48	48	19	601

Zalingei - III.A.3.(b) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	22.6	23.9	27.3	29.3	30.0	27.4	24.9	23.1	24.4	25.5	24.1	22.8	25.4
Rainfall	(mm)	0	TR	1	7	33	73	177	223	104	20	TR	TR	538
Pressure	(mb)	912.2	911.7	910.6	910.6	910.9	912.2	912.3	912.4	912.5	911.9	911.9	912.3	911.8
Relative Humidity	(%)	32.0	28.3	24.7	26.7	34.3	51.7	70.0	82.0	71.0	52.0	36.7	33.7	54.3

Buram - III.A.3.(c) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall	(mm)	0	0	0	8	45	97	171	218	122	38	0	0	699

Rumbek - III.B.(a) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	29.7	29.8	31.1	29.9	28.9	27.4	26.1	26.2	27.1	28.4	29.3	28.7	28.5
Rainfall	(mm)	1	3	28	75	139	152	153	185	125	73	9	1	944
Pressure	(mb)	962.4	961.9	961.2	961.6	962.7	964.3	964.9	964.6	963.9	962.9	962.3	962.7	962.9
Relative Humidity	(%)	39.0	35.5	41.5	54.5	64.5	71.0	76.5	76.0	72.5	67.0	54.5	44.0	58.4

Maridi - III.B.(b) :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	27.9	27.9	28.2	26.6	26.3	25.0	23.9	24.2	25.5	26.1	27.0	28.0	26.4
Rainfall	(mm)	9	25	74	144	207	170	177	189	168	127	47	14	1351
Pressure	(mb)	930.5	930.6	929.4	929.8	930.6	932.1	932.2	931.9	931.4	930.8	930.1	930.0	930.8
Relative Humidity	(%)	50.5	49.5	60.0	73.0	74.5	79.0	81.5	80.0	77.0	74.0	66.0	57.5	68.5

Malakal - IV :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Temperature	(°C)	28.1	29.7	32.0	32.3	29.8	27.5	26.0	25.8	26.7	27.8	28.9	28.0	28.6
Rainfall	(mm)	0	0	0	16	66	83	119	163	68	15	7	0	537
Pressure	(mb)	964.5	965.7	962.9	962.6	964.6	966.3	966.9	966.8	965.9	965.1	964.4	964.8	964.9

Kas - V :-

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	YEAR
Rainfall	(mm)	0	0	0	5	26	78	161	200	99	16	1	0	586

Source : Sudan Meteorological Service, Climatological Normals 1930 - 1960.

APPENDIX II

Correlation of Classification Used with Other Classifications.

It is intended here to correlate the classification used in Chapter 11 with some classifications of the vegetation of the Sudan to give a wider view of the work undertaken in this respect. The numbers given under the title "Classification Used" (in Chapter 11) correspond with those in Table VII and Fig.9.

I Schweinfurth's description of the vegetation of the Nile Valley (1868) contains the earliest classification of the vegetation of the Sudan. He divides it into the following :

Schweinfurth	Classification Used
1. Cultivation Zone	Not included
2. Desert Zone	
(a) The Upper Egyptian - Nubian Desert	I
(b) The Sinaitic Mountain Region (in Elba and Asoteriba in Red Sea Hills).	V
3. Transitional Zone	II
4. Steppe Zone	III
5. Woodland Zone	III.A.1.(c);III.A.3.(b);III.B.

II Engler (1910) produced a general classification of the vegetation of Africa; he mapped the following zones in respect of the Sudan:

Engler	Classification Used
A. North African-Indian Desert Region	
(a) Thebáic-Nubian Province	
1. West Nubian Subprovince	I
2. East Nubian Subprovince	I
3. Subprovince of the Nubian Valley as far as Khartoum.	I; II (a).

(b) Transitional Province with much Grass-Steppe and deciduous woodland.

1. Western subprovince

(i) District of Jebel Mara. V

(ii) District of Northern Province II (b); II (c).

B. African Woodland and Steppe Region

(a) Sudanese Park-Steppe Province

1. Subprovince of Upper Nile Country from the northern boundary of the Baobab tree to the lower boundary of the Abyssinian Kwolla at the foot of the mountains.

(i) District of Southern Kordufan III.A.2.(a),(b),(c).

(ii) District of Bahr el Ghazal Country. III.B.(a).

(iii) District of the Upper Nile Basin with the White and Blue Niles. III.A.1.(b); IV.

(b) North-East African Highland and Steppe Province.

1. Subprovince of the Eastern Etbai Country

(i) Etbai coastal district. II (a).

(ii) Etbai hill country and highland II (a), (e); V

2. Subprovince of the Abyssinian and Galla Highlands.

(i) Northwestern Abyssinian district. III.A.1.(c).

(c) West African or Guinea Woodland Province

1. Central African Subprovince

(i) Southern Ghazal sources and Upper Uele District, Nile-Congo Watershed. III.B.(b).

III Shantz and Marbut (1923) produced a classification of the vegetation of Africa. Below is what applies to the Sudan :

Shantz and Marbut	Classification Used
1. Desert	I
2. Semi-desert Shrub	
(a) Desert Shrub	I
(b) Desert Shrub-Desert Grass.	II
3. Grassland	
(a) Acacia-Desert Grass Savana.	II;III.A.1.(a); III.A.2.(a).
(b) Acacia Tall Grass Savana.	III.A.
(c) High grass-Low tree Savana.	III.B.
(d) Mountain grass.	V
(e) Marsh grass.	IV
4. Forest	
(a) Oases.	Not found separately.
(b) Thorn forest.	II;III.A.; IV.
(c) Dry forest.	III.B.
(d) Tropical Rain forest.	III.B.(b).
(e) Temperate rain forest.	V

IV Broun (1928) classified the vegetation of the Sudan into :

Broun	Classification Used
1. Riverside flora, with Acacia nilotica and A. seyal.	II (b).
2. Desert flora	I
3. Semi-desert	drier parts of II
4. Arid	wetter parts of II;III.A.1.(a); III.A.2.(a).
5. Dry	Rest of III.A.
6. Special flora of the Red Sea Hills.	V
7. Littoral flora of the Red Sea Hills	II (a).

V. In 1947 Whyte divided the northern Sudan into the following vegetational zones :-

Whyte	Classification Used
1. Desert	I
2. Acacia/Desert Scrub Zone	II
3. Acacia/Grass Savana	III.A.1.(a),(b); III.A.2.(a).
4. Dry Broad-Leaved Savana	Rest of III.A.
5. Red Sea Hills and Coast	II; V.
6. The Nile Swamps	IV.

VI,VII.

Andrews (1948) divided the vegetation of the Sudan into 7 types; Smith's classification (1949) is almost the same one as Andrews' with slight modifications. It is, therefore, easy to correlate them with each other and with the classification used :

Andrews	Smith	Classification Used.
1. Desert	(i) Desert.	I; II (a).
2. Acacia Desert Scrub	(ii) Acacia Desert Scrub	II
3. Acacia Short Grass Scrub	(iii) Acacia Short Grass Country	III.A.1.(a);III.A.2.(a).
4. Acacia Tall Grass Forest	(iv) Acacia Tall Grass Country	III.A.1.(b) & (c); III.A.2.(b) & (c); III.A.3.(c) & (d); IV.
5. Broad-leaved woodland and forest	(v) Mixed Deciduous Fire-Swept Forests	III.B.
	(a) Laterite or red Ironstone type.	
	(b) Sand type.	
	(c) Foothill type.	
6. Forests	(vi) Mixed Deciduous Grassless Transitional Forest	III.B.(b).
(a) Gallery forests.		III.B.(b).
(b) Bowl forests.		V.
(c) Cloud forests.		

7. Sawmps and Grasslands	(vii) Closed Lowland Forest including Fringing or Gallery Forest.	IV.
(a) Permanent Swamps.		
(b) Seasonal Swamps.		IV.
(c) Grassland.		in many zones.
(d) Mountain meadow	(viii) Mountain or Cloud Forest	V.

VIII. The Southern Development Investigation Team (1954) has produced an ecological map of the southern Sudan; the main zones are :-

Team	Classification Used
1. Central Rainlands Region	
(a) Northern part.	III.A.1.(a).
(b) Southern part.	III.A.1.(b).
2. Flood Region.	IV
3. Ironstone plateau.	
(a) Central hills.	III.B.
(b) Lower Mountain Slopes and Hills.	III.B.
4. Green Belt.	III.B.(b).
5. South-Eastern Plain.	III.A.3.(a).
6. High altitude areas.	V

IX Bowen (1926) produced a map, though primarily concerned with the distribution of birds, the divisions are based on the various types of the vegetation. This map was produced by Mackenzie in 1954 :

Bowen	Classification Used
A. East and South African Sub-Region	
1. Desert	I
2. Sudanese Arid	
(a) Arid (Scrub)	Dry parts of II; Nile Valley in I.
(b) Arid (Acacia grass).	II.(a),(b),(e).
(c) Arid (Acacia forest).	III.A.1.(a) & (b);III.A.2.(a) & (b

3. Sudanese Savana	
(a) Savana I.	III.A.2.(c); III.B.
(b) Savana II.	III.A.1.(c).
(c) Savana III.	III.A.3.(a); III.B.
4. East African Highland	
Highland I.	V.
5. Abyssinian Highland	
Highland II.	III.B.(b).
B. West African Sub-Region	
1. Ubangi Savana	
(a) Savana IV.	III.B.(b).
C. Special Areas	
1. Jebels	III.A.3.(b); V.
2. Sudd	IV.

X In 1953 Lewis produced his classification of the vegetation of the Sudan. His 14 divisions are :-

Lewis	Classification Used
1. Palearctic.	I
2. Baiyuda	I
3. Beja	II.(a); II.(e).
4. Fasher-Butana.	II (b),(c) & (d); III.A.1.(a); III.A.2.(a) & (b);
5. Central rainlands.	III.A.1.(b) & (c); III.A.2.(c);
6. Flood Plain	IV. III.A.3.(c) and (d
7. Sudd.	IV.
8. Raga-Loka	III.B.(a).
9. Watershed.	III.B.(b).
10. Torit-Loelli	III.A.3.(a); III.B.(b).
11. Mara	III.A.3.(b); V.
12. Nuba	III.A.3.(b).
13. Boma-Gemi	III.B.(b).
14. Imatong	V.

XI A reference may also be made to the map of the Main Agricultural Regions of the Sudan published by Ferguson (1954), and also included in Mackenzie (1954). It includes the following agricultural regions, excluding irrigated areas.

Ferguson	Classification Used
1. Desert	I
2. Semi-Desert Pastoral Regions.	II.(b); III.A.3.(a).
3. Qoz sands	III.A.2.
4. Central Clay Plain	
(a) Northern part	II.(b); III.A.1.(a).
(b) Southern part	III.A.1.(b); III.A.3.(a).
5. Flood Plain Region	IV.
6. Ironstone Region	III.B.(a).
7. The Green Belt	III.B.(b).
8. Miscellaneous Hilly Regions	III.A.3.(b).
9. Mountain Regions	V.

XII The most recent classification of the vegetation of the Sudan has been produced by Lebon in 1965 :-

Lebon	Classification Used
I. Desert	I
(a) Gizu	I
II. Semi-Desert Acacia Scrub and short Grasslands of North Central Sudan	II
A. Semi-Desert Acacia scrub of Red Sea Hills and Khartoum Area.	II.(a).
B. Semi-Desert short Grassland (with Acacia scrub) of Northern Kordufan and Northeastern Darfur.	II.(c) & (d).
1. Semi-Desert short Grassland of Northern Kordufan and Northeastern Darfur.	II.(c).

	2. Acacia Thorn Scrub with short Grass of Northern Kordufan and Northeastern Darfur.	II.(d).
(a)	Red Sea Coastal Plain	II.(a).
(b)	Butana short Grassland	II.(b).
(c)	Semi-Desert Scrub of Southern Red Sea Hills.	II.(e).
(d)	Montane Forests and Grasslands of Southern Red Sea Hills.	V.
III.	Low Woodland Savana of Central Sudan.	III.A.
	A. Low Woodland Savana of the Clay Plain.	III.A.1.
	1. Thorn Scrub of Blue Nile Province.	III.A.1.(a).(i).
	2. Low Woodland Savana with Grass of Blue Nile Province and south-central Kordufan.	III.A.1.(b).
	3. Woodland Savana of Southeastern Blue Nile Province.	III.A.1.(c).
(a)	Toposa Area.	III.A.3.(a).
(b)	Blue Nile and Atbara Valleys.	II.(b).
(c)	"Raqaba" Type.	III.A.3.(b).
(d)	"Baqqara" Type.	III.A.3.(c).
	B. Low Woodland Savana of the Stabilized Dunes on Archaean Outcrops in Kordufan and Darfur.	III.A.2.
	1. Gum Arabic Scrub with Grassland of Central Kordufan and East-Central Darfur.	III.A.2.(a).
	2. Low Woodland Savana of Southwestern Kordufan and Southeastern Darfur.	III.A.2.(b).
	3. Woodland Savana of Southwestern Kordufan, Southeastern Darfur and the Ethiopian Piedmont.	III.A.2.(c).

(a) Acacia Scrub and Short Grassland of North-Central Darfur.	III.A.1.(a).(ii).
(b) Woodland Savana of West-Central Darfur.	III.A.3.(b).
(c) Montane Forests and Grasslands of Jebel Mara.	V.
(d) Nuba Mountains Catena.	III.A.3.(b).
IV. Deciduous High Woodland Savana and Swamp Grasslands of Southern Sudan.	III.B.(a); IV.
A. Deciduous High Woodland Savana.	III.B.(a).
B. Seasonally Wet Grasslands of the Southern Clay Plain.	IV.
(a) Woodland Transitional to Wet Clay Grasslands.	III.B.(a).
(b) Unflooded Palm Woodlands.	IV.
(c) Perennially Moist Riverain Grasslands.	IV.
(d) Permanent Swamps.	IV.
V. Modified Tropical Rain Forests of the Southern Borderlands.	III.B.(b).
A. Degraded Tropical Forests.	III.B.(b).
(a) Virgin Remnants of Tropical Rain Forests.	III.B.(b).
(b) Gallery Forests.	III.B.(b).
(c) Forests of Imatong and Dongotona Mountains.	V.
(d) Forests of Didinga Mountains.	V.

Sources: (1) M.N.Harrison and J.K.Jackson, Ecological Classification of the Vegetation of the Sudan, Forest Bulletin No.2 (New Series), Agricultural Publications Committee, Khartoum, 1958.

(2) J.H.G.Lebon, Land Use in Sudan, Geographical Publications Limited, Bude, Cornwall, 1965.

(3) J.Smith, Distribution of Tree Species in the Sudan in Relation to Rainfall and Soil Texture, Bulletin No.4, Agricultural Publications Committee, Khartoum, 1949.

(4) F.W.Andrews, The Vegetation of the Sudan in J.D.Tothill (ed.), Agriculture in the Sudan, O.U.Press, London, 1948.

Appendix III

Vernacular and Botanical Plant Names

Abu dhanabi	Ctenium elegans
Abu rikhis	Andropogon gayanus
Abu shutur	Kigelia aethiopica
Abu surug	Prosopis africana
Agul	Fagonia cretica
Ansora	Hyparrhenia pseudocymbaria
Aradeib	Tamarindus indica
Araka	Salvadora persica
Arrada	Albizzia amara
Babanus	Dalbergia melanoxylon
Banu	Eragrostis tremula
Bayad	Acacia plumosa
Bogheil	Blepharis spp.
Burnus	Hyparrhenia rufa
Danab el naga	Schoenefeldia gracilis
Derma	Indigofera brachteolata
Doleib	Borassus aethiopium
Dom	Hyphaene thebaica
Dunbelab	Sehima iscaemoides
Gafal	Commiphora africana
Gambil	Cordia abyssinica
Gau	Aristida spp.
Gummeiz	Ficus spp.
Guru	Monsonia senegalensis
Guttab	Tribulus alatus
Haraz	Acacia albida
Hashab	Acacia senegal
Haskanit	Cenchrus biflorus
Heglig	Balanites aegyptiaca
Homra	Khaya senegalensis
Humeid	Sclerocaryea birrea

Kadada	Dichrostachys glomerata
Kitr	Acacia mellifera
Kuk	Acacia sieberiana
Kurmut	Cadaba glandulosa
Kushein	Indigofera arenaria
La'ot	Acacia nubica
Leiyun	Lannea humilis
Mahogany	Khaya grandifoliola
Mamluka	Schmidtia pappoghoroides
Marakh	Leptadenia pyrotechnica
Naggara	Sorghum spp.
Nal	Cymbopogon nervatus
Natash	Crotalaria thebaica
Neem	Azadirachta indica
Nissa	Aristida papposa
Saadan	Neurada procumbens
Sahaba	Anogeissus schimperi
Saleiyan	Triraphis pumilio
Sallam	Acacia ehrenbergiana
Samr	Acacia tortilis
Sarha	Maerua crassifolia
Seyal	Acacia raddiana
Sidr	Ziziphus spinachristi
Siha	Acacia arabica
Subakh	Combretum hartmannianum
Sunt	Acacia nilotica
Talh	Acacia seyal
Teak	Tectona grandis
Tebeldi	Adansonia digitata
Tumam	Panicum Tergidum
Tundub	Capparis decidua
Umm bukheisa	Crateva adansonii

Umm dajog	Combretum cordufanum
Umm khirr	Brachiaria obtusiflora
Umm tuleih	Sterculia setigera
Ushar	Calatropic procera
Vuba	Isoberlinia

Appendix IV

Average Effect of Shelter on Yields of Crops, in the Dry Regions of the U.S.S.R.

Station	Crop	Yield in Kg.per Hectar		Increase in Yield in Sheltered Steppe	
		in Sheltered Steppe	in Open Steppe	Kg.	%
Kamennaya Steppe	Winter rye	1630	1390	240	17
	Oats	1420	1380	40	3
	Alfalfa	3000	990	2,010	203
	Grass (Bromus)	1910	960	950	99
Saratow	Summer wheat	1540	930	610	66
	Winter rye	2380	1730	650	38
	Potatoes	10150	5970	4180	70
	Alfalfa	5170	2450	2720	111
Mariupol	Winter wheat	1710	970	740	76
	Barley	1520	1020	500	49
	Grass	2170	1560	610	39
Krasnokutsk	Winter wheat	1310	1180	130	11
	Summer wheat	1170	620	550	88
	Barley	2370	1850	520	28
Rostashi	Winter wheat	1430	1240	190	15
	Summer wheat	1280	1210	70	6
	Rye	1420	1180	240	21
	Potatoes	10250	6010	4240	71
	Hay(Bromus)	1320	1160	160	14

Appendix IV (Cont.)

Station	Crop	Yield in Kg. per Hectar		Increase in Yield in Sheltered Steppe	
		in Sheltered Steppe	in Open Steppe	Kg.	%
Guselskii	Winter wheat	1120	910	210	23
	Summer wheat	1270	1230	40	3
	Oats	1480	1670	-190	-11
	Barley	1900	1630	270	17
	Hay	2130	970	1160	119
	Lentil	1690	1070	620	58

Source: J. Van Der Linde, Trees Outside the Forest in F.A.O., Forest Influences, Rome, 1962, p.145.

Appendix V

Production and Consumption of forest products.

V(i) Production of Power Sawn Timber 1952 - 1963.

Year	Railway Sleepers		Other Sizes in M^3	Total Hard wood in M^3	Total Soft wood in M^3	Total in M^3
	Number	M^3				
1952/53	30,727	1,903	3,746	5,517	132	5,649
1953/54	83,912	4,530	3,548	8,066	12	8,078
Difference	+53,185	+2,627	- 198	+2,549	-120	+2,429
1954/55	99,428	5,369	3,131	8,408	92	8,500
Difference	+15,516	+ 839	- 417	+ 342	+ 80	+ 422
1955/56	108,790	5,874	2,539	8,338	75	8,413
Difference	+9,362	+ 505	- 592	- 70	- 17	- 87
1956/57	153,234	8,275	4,896	12,965	206	13,171
Difference	+44,444	+2,401	+2,357	+4,627	+131	+4,758
1957/58	164,659	9,326	7,490	16,240	576	16,816
Difference	+11,425	+1,051	+2,594	+3,275	+370	+3,645
1958/59	244,815	12,730	7,314	19,578	466	20,044
Difference	+80,156	+3,404	- 176	+3,338	-110	+3,228
1959/60	260,648	14,763	7,353	21,740	376	22,116
Difference	+15,833	+2,033	+ 39	+2,162	- 90	+2,072
1960/61	194,932	11,041	8,392	18,899	534	19,433
Difference	-65,716	-3,722	+1,039	-2,841	+158	-2,683
1961/62	180,785	10,262	13,776	23,142	896	24,038
Difference	-14,147	- 779	+5,384	+4,243	+362	+4,605
1962/63	131,587	8,506	16,365	23,828	1,043	24,871
Difference	-49,198	-1,756	+2,589	+ 686	+147	+ 833

Source: The eleven annual reports published by the Forests Department for the period July 1952 to June 1963, Khartoum.

V(ii): Production of Hand Sawn Timber, 1952 - 1963

Year	Railway Sleepers		Other Sizes in M^3	Total in M^3
	Number	M^3		
1952/53	31,182	1,695	64	1,759
1953/54	47,584	2,568	144	2,712
Difference	+16,204	+873	+80	+953
1954/55	54,854	2,962	-	2,962
Difference	+7,270	+394	-144	+250
1955/56	44,539	2,405	53	2,458
Difference	-10,315	-557	+53	-504
1956/57	70,062	3,783	91	3,874
Difference	+25,523	+1,378	+38	+1,416
1957/58	86,021	4,872	433	5,305
Difference	+15,959	+1,089	+342	+1,431
1958/59	128,184	7,247	353	7,600
Difference	+42,163	+2,375	-80	+2,295
1959/60	165,808	9,391	186	9,577
Difference	+37,624	+2,144	-167	+1,977
1960/61	137,057	7,763	227	7,990
Difference	-28,751	-1,628	+41	-1,587
1961/62	111,969	6,330	288	6,618
Difference	-25,088	-1,433	+61	-1,372
1962/63	27,530	1,744	85	1,829
Difference	-84,439	-4,586	-203	-4,789

Source: The same as Appendix V(i).

V(iii) Total Production of Sawn Timbers, 1952 - 1963

Year	Railway Sleepers		Other Sizes M^3	Total Hard Wood M^3	Total Soft Wood M^3	Total M^3
	Number	M^3				
1952/53	61,909	3,598	3,810	7,276	132	7,408
1953/54	131,496	7,098	3,692	10,778	12	10,790
Difference	+69,587	+3,500	-118	+3,502	-120	+3,382
1954/55	154,282	8,331	3,131	11,370	92	11,462
Difference	+22,786	+1,233	-561	+592	+80	+672
1955/56	153,329	8,279	2,592	10,796	75	10,871
Difference	-953	-52	-539	-574	-17	-591
1956/57	223,296	12,058	4,987	16,839	206	17,045
Difference	+69,967	+3,779	+2,395	+6,043	+131	+6,174
1957/58	250,680	14,198	7,923	21,545	576	22,121
Difference	+27,384	+2,140	+2,936	+4,706	+370	+5,076
1958/59	372,999	19,977	7,667	27,178	466	27,644
Difference	+122,319	+5,779	-256	+5,633	-110	+5,523
1959/60	426,456	24,154	7,539	31,317	376	31,693
Difference	+53,457	+4,177	-128	+4,139	-90	+4,049
1960/61	331,989	18,804	8,619	26,889	534	27,423
Difference	-94,467	-5,350	+1,080	-4,428	+158	-4,270
1961/62	292,754	16,592	14,064	29,760	896	30,656
Difference	-39,235	-2,212	+5,445	+2,871	+362	+3,233
1962/63	159,117	10,250	16,450	25,657	1,043	26,700
Difference	-133,637	-6,342	+2,386	-4,103	+147	-3,956

Source: The same as Appendix V(i)

V(iv) Consumption of Sawn Timber

Consumer	Structural M^3		Joinery M^3		Furniture M^3		Total M^3	
	Per capita	Total	Per capita	Total	Per capita	Total	Per capita	Total
Rural Household	0.00170	16,605	0.00210	21,407	0.004100	44,339	0.007274	82,351
Rural Non-Household	0.00010	1,104	0.00004	449	0.000209	2,371	0.000788	3,924
Urban Household	0.00520	5,377	0.00440	4,571	0.005300	5,435	0.014865	15,383
Urban Non-Household	0.00004	457	0.00021	221	0.003920	4,057	0.004574	4,735
Government	0.00346	42,703	Included	Included	0.000089	1,095	0.003544	43,798
Private Institution	0.00009	1,139	Under	Under	0.000001	27	0.000094	1,166
Industrial	0.00009	1,180	Structural	Structural	-	-	0.000095	1,180
The Sudan	0.00555	68,565	0.00216	26,648	0.004639	57,324	0.012345	152,537

Source: Sudan Silva 14(11), 1963, p.21.

V(v): Consumption of Firewood and Charcoal

Consumers	Consumption of Firewood and Charcoal in M^3	
	Per Capita	Total
Rural Household	3.1576	35,745,470
Rural Non-household	0.0933	29,094
Urban Household	0.0441	4,983,214
Urban Non-household	0.8027	830,932
Government	0.0023	28,866
Private Institution	0.0003	3,578
Industrial	0.0014	17,333
The Sudan	3.3698	41,638,487

Source: Sudan Silva, 14 (11),1963, p.22

V(vi): Sources of Firewood supply for the Three Khartoum Towns (1961/62)

Source	Quantity in Tons					
	Railed by Government	By Boat	By Donkey	By Lorry	By Camel	Total
Abu Hugar	644	-	-	-	-	644
Sennar	65	-	-	-	-	65
El Suki	2,891	-	-	-	-	2,891
Singa	2,065	-	-	-	-	2,065
Wad el Nail	18,044	-	-	-	-	18,044
Royalty Stations	-	842	2,486	200	5,572	9,100
Total	23,709	842	2,486	200	5,572	32,809

Source: Forests Dept., Report for the period July 1961 to June 1962, p.79.

V(vii) Consumption of Firewood and Charcoal in the Three Khartoum Towns

Year	Charcoal in Tons	Firewood in M^3		
		Railed	Scrub	Total
1937	3,170	7,000	17,500	24,500
1938	3,210	11,760	22,421	34,181
1939	3,270	12,624	23,331	35,955
1940	3,197	31,052	29,071	60,123
1941	3,169	50,662	29,862	80,524
1942	3,060	41,226	29,351	70,577
1943	4,610	43,977	28,591	72,568
1944	4,550	75,089	23,751	98,840
1945	6,070	82,950	18,109	101,059
1946	7,270	106,050	11,812	117,862
1947	10,920	94,052	26,159	120,211
1948	6,840	60,137	35,038	95,175
1949	7,464	68,932	37,681	116,613
1950	6,475	88,824	30,145	118,969
1951	4,819	69,650	29,750	99,400
1952	3,259	52,990	47,729	100,719
1953	3,600	64,165	38,000	102,165
1954	3,435	37,471	38,444	75,915
1955	2,847	19,540	23,440	42,980

Source: M.K. Shawki, A Note on Firewood and Charcoal Supply and Costs, Sudan Silva 7 (1), 1957, p.12.

V(viii): Wood Sold from Typical Forest Reserves, Gezira

Year	Forest	Firewood in Tons	Building Poles in Tons	Percentage of Building Poles
1940	Hillaliya	288	123	42.7
1941	"	1,022	359	35.1
1942	"	529	190	35.9
1943	"	471	57	12.1
1944	Hebeika	256	10	3.9
1945	"	540	34	6.3
1946	"	440	20	4.5
1947	Kab	2,900	600	20.7
1948	"	1,700	385	22.7
1949	"	1,733	450	26

Source: T.H. Kipling, The Supply of Woodfuel and Roofing Poles to Khartoum, the Gezira and Government Departments, Bulletin No.5, Agricultural Publications Committee, Khartoum, 1950, pp. 6 - 7.

V(ix): Fuelwood Consumption per Person per Month, Gezira

Place	Situation	Firewood in M^3	Charcoal in lb.
Abu Quta*	Abdel Magid Scheme	0.04	19
Abu Udeina*	" " "	Negligible	9
Abu Usher*	East Gezira	0.15	11
Beweida	East Bank, Blue Nile	Negligible	20
Fadasi*	East Gezira	0.04	19
Hag Abdalla	" "	0.07	13
Hasaheissa*	" "	0.24	23
Hash	West "	0.05	11
Kamlin	East "	0.20	18
Madeina Arab	West "	0.33	12
Managil	" "	0.19	18
Messalamiya*	East "	0.10	11
Mureibia	" "	0.04	9
Rufaa	East Bank,Blue Nile	0.09	22
Tayiba*	East Gezira	0.09	13
Wad Medani*	" "	0.29	23

Source: T.H. Kipling, op. cit, 1950, p.14.

N.B. The original figures have been changed according to the results of investigation done by the author during March, April and May, 1963 in the places marked with a star. These figures were collected during the cotton picking season when cash was plentiful and when some hundred thousand seasonal workers were brought from outside the Gezira; so the annual offtake is less than 12 times these figures.

V(x) Consumption of Firewood and Charcoal in other parts of the Sudan

Place	Division or Circle	Firewood in M^3	Charcoal in Kantars
Nyala	Darfur Circle	12,000	16,000
Fasher	" "	14,000	12,000
Gineina	" "	7,000	9,000
El Obeid	Kordufan Circle	44,000	160,000
Talodi	" "	10,000	1,000
En Nahud	" "	9,000	14,000
Malakal	Upper Nile Division	6,870	19,994
Renk	" " "	4,200	6,110
Melut	" " "	2,150	3,240
Juba	Equatoria Division	3,050	72,100
Yei	" "	856	7,560
Yambio	" "	2,010	29,980
Wau	Bahr el Ghazal Division	13,740	10,800
Rumbek	" " "	4,280	3,080
Yirol	" " "	4,793	2,105
Gedaref	Kassala Circle	37,110	37,910
Kassala	" "	40,879	51,070
Port Sudan	" "	36,140	54,040

Source: Forests Department, Reports for the Period July 1960 to June 1963.

V(xi) Production of other forms of Round Timber and Bamboo

Division / Year	Heavy Poles	Medium Poles	Light Poles	Forked	Rafters	Fencing Posts	Off-cut	Others	Bamboo
1960/61									
Eastern	4,437	41,760	39,325	12,617	-	172	-	537	1,250,00
Khartoum and Northern	7,967	-	30	-	-	166	-	-	-
Western	Figures are not available								
Equatoria	1,315	-	50	-	-	-	-	-	-
Upper Nile	Figures are not available								
Bahr el Ghazal									
1961/62									
Eastern	2,640	17,282	2,026	14	-	-	-	-	149,841
Khartoum and Northern	177	938	3,037	-	-	528	-	-	-
Western	1,159	-	-	-	-	-	-	2,015	153,240
Equatoria	2,533	-	21,612	-	-	-	-	-	99,067
Upper Nile	427	644	7,746	291	-	-	-	-	1,354
Bahr el Ghazal	-	1,705	-	-	70	-	100	-	32,589
1962/63									
Eastern	7,048	12,900	18,811	1,772	-	-	-	-	14,479
Khartoum and Northern	1,140	2,638	1,327	1,811	-	-	-	-	-
Western	6,253	15,839	-	-	-	-	-	-	10,241
Equatoria	6,815	6,290	12,740	-	-	-	-	-	213,860
Upper Nile	198	75	12,116	617	-	-	-	-	-
Bahr el Ghazal	138	440	2,307	-	3,847	-	-	-	3,270

Source: Forest Department, Reports for the period July 1960 to June 1963.

V(xii) Standard of Living and Per Capita Consumption of Major Forest Products in some countries.

Country	Per Capita G.D.P. in L.S.	The Per Capita Consumption of Major Forest Products				
		Fuelwood in M^3	Industrial Round Wood in M^3	Total Round Wood in M^3	Sawn Wood in M^3	Plywood in M^3
U.S.A.	770.2	0.260	1.670	1.930	0.500	0.046
Canada	581.8	0.410	2.115	2.525	0.450	0.051
U.K.	377.8	0.010	0.635	0.645	0.170	0.011
Finland	274.0	3.045	1.390	4.435	0.590	0.120
Portugal	78.6	0.350	0.210	0.560	0.040	0.001
U.A.R.	34.4	0.002	0.038	0.040	0.006	Negligible
Sudan	28.5	3.370	0.088	3.458	0.012	"
Tanganyika	19.5	2.265	0.065	2.330	0.006	"

Source: Sudan Silva 14 (11), December 1963, p.23.

V(xiii) Production and Exports of Gum "Hashab"

Production		Exports	
Season	Quantity in Tons	Quantity in Tons	Year
1952/53	38,617	37,517	1953
1953/54	32,017	35,125	1954
1954/55	47,395	37,702	1955
1955/56	39,665	44,099	1956
1956/57	39,584	38,093	1957
1957/58	38,750	44,000	1958
1958/59	34,600	37,759	1959
1959/60	46,200	45,817	1960
1960/61	42,955	47,571	1961
1961/62	45,647	34,734	1962
1962/63	42,713	12,712	1963 till end of April

Source: Forests Department, Reports for the period July 1952 to June 1963.

V (xiv) Production and Exports of Gum "Talh"

Production		Exports	
Season	Quantity in Tons	Quantity in Tons	Year
1952/53	1,454	2,190	1953
1953/54	2,483	2,788	1954
1954/55	1,700	2,606	1955
1955/56	2,096	4,782	1956
1956/57	2,711	3,149	1957
1957/58	2,989	4,289	1958
1958/59	2,927	4,571	1959
1959/60	2,552	5,788	1960
1960/61	2,869	3,719	1961
1961/62	2,750	3,613	1962
1962/63	2,600	1,279	1963 till end of April

Source: The same as Appendix V (xiii).

V(xv) Production of Gum "Hashab" by Province

Province	1960/61	1961/62	1962/3
Kordufan	24,260	25,725	24,685
Darfur	7,085	8,328	8,545
Kassala	6,808	8,184	6,305
Blue Nile	4,802	3,410	3,178
Total	42,955	45,647	42,713

Source: Forests Department, Reports for the period July 1960 to June 1963.

V(xvi) Export Values of Gum

Year	Value in L.S
1952	2,471,731
1953	2,990,348
1954	3,633,103
1955	4,679,817
1956	5,363,889
1957	4,491,178
1958	5,207,271
1959	5,069,506
1960	6,969,487
1961	6,142,518
1962	4,585,696
1963	1,608,398 up to end of April

Source: Forests Department, Reports for the Period July 1952 to June 1963 p. 84.

V(xvii) Main Markets for Gum "Hashab" - average for period 1957 - 59

Export Destination	Average Quantity taken in Tons	Percentage
United Kingdom	9,111.0	22.9
U.S.A.	8,886.3	22.3
Italy	3,841.3	9.5
Netherlands	2,593.3	6.5
France	1,925.7	4.8
Belgium	1,667.7	4.2
Japan	1,643.3	4.0
West Germany	1,593.3	4.0
China	1,218.7	3.0
Australia	1,036.0	2.6
Denmark	810.3	2.0
Sweden	708.7	1.8
India	641.3	1.6
Other Countries	4,265.0	10.6
Total	39,941.9	99.8

Source: M.G.A. Chadwick, The Market for Gum Arabic (Unpublished Report), p.35.

V(xviii): Exports of Some Minor Forest Products.

Year	Commodity	Quantity Exported in Tons	Value in L.S.
1954/55	Senna - all kinds	433	55,444
	Sunt pods (garad)	1,317	21,050
	Bees-Wax	132	47,377
1955/56	Dom nuts - whole	2,625	23,774
	Senna - all kinds	249	34,876
	Sunt pods	695	9,766
	Bees-wax	152	65,832
1956/57	Dom nuts - whole	2,195	17,867
	Bees-wax	129	55,232
	Senna - all kinds	325	25,564
	Sunt pods	881	12,486
1957/58	Bees-wax	145	50,628
	Senna - all kinds	425	46,750
	Dom nuts - whole	2,114	24,334
	Sunt pods	1,225	19,640
1959/60	Bees-wax	66	26,665
	Senna - all kinds	404	45,600
	Dom nuts - whole	2,582	26,628
	Sunt pods	2,503	34,735
1961/62	Bees-wax	60	19,626
	Senna - all kinds	230	14,996
	Dom nuts - whole	1,334	13,237
	Sunt pods	893	12,655
1962/63	Bees-wax	68	23,566
	Senna - all kinds	650	95,580
	Dom nuts - whole	1,273	12,106
	Sunt pods	880	17,435

Source: Forests Department, Reports for the Period July 1954 to June 1963.

Appendix VI

Reported Fire Damage in Selected Years

Year	Location	Number of fires	Area affected	Comments
1953/54	Wad Nimir, Abu Tigan, Wad Beheiga Kebe, Murtagello, Ngohalima, Akanda and Hyin Akok.	16+	Over 64 feddans	The most serious damage was in the teak plantation of Equatoria. Khartoum and Northern Provinces were reported free from damage.
1955/56	Ronga, Bardana, Umm Girra., Howata-Gedaref area, Saref el Falata, Liri, Layuna, El Yoi, Mek Mahmoud, Murtagello, Kebe, Korare, Luluba, Loka, Kuruk, Nagdiar and Abu Khreis.	19+	Over 780 feddans and 77 M^3 of fire-wood.	Khartoum, Northern and the Bahr el Ghazal Provinces were reported free from fire damage.
1961/62	Umm Dahab, Umm Shoka, Wad Dafta, Rawashda, Umm Gir, Tiban, El Rumila, Umm Abdalla and Khor Along.	12+	Over 43 feddans	No fires were reported from Darfur, Khartoum and Northern Provinces. The most serious damage was in the Bahr el Ghazal Province where 25 feddans of teak were burnt.

Appendix VI (cont.)

Year	Location	Number of fires	Area affected	Comments
1962/63	Gezira, Fung and Kassala circles, Galgani, Bunzuga, Tibbun, Umm Sheheita, the Jebel Mara, Kajiko, the central and East Bank Circles of Equatoria, Ngohalima, Tonj, Nagdiar and Zarzur.	33+	Over 5152 feddans and 593 M^3 of fire-wood.	No fires were reported from the Northern and Khartoum Provinces; the most serious damage was the complete burning of the firewood deposits

Source: Forest Department, The reports for those years, Khartoum.

Appendix VII

Values of Some Internally Consumed Forest Products (1961)

Commodity	Approx. Value in L.S.
Railway Sleepers	510,000
Sawn Timber	298,200
Firewood and Charcoal	20,150,000
Round Wood	206,000
Bamboo (big towns only)	8,500
Dom nuts	38,100
Tanning material	73,400
Bees wax	25,700
Senna	29,300
Total	21,339,200

Sources: (1) Forests Department, Reports for the Periods July 1960 to June 1961 and July 1961 to June 1962.

(2) M.K. Shawki, Forests in the Sudan (Arabic), Forest Memoir No.4, 1961, pp. 6 - 7

Appendix VIII

Exports from Forest and Grazing Lands

	Export Value for 1961 in L.S.	Average Value for 1952-1961 in L.S.
1. Forest Lands		
Gum Arabic	6,142,518	4,718,229
Senna	27,889	42,102
Garad	13,939	23,077
Bees wax	21,987	44,615
Dom nuts	13,160	28,345
Total	6,219,493	4,856,368
2. Grazing Lands		
Camel	1,879,000	1,113,751
Cattle	806,856	769,800
Sheep	665,220	479,026
Hides and skins	1,039,336	958,066
Total	4,390,412	3,320,643
3. Cotton	31,155,143	27,042,535
4. SUDAN	60,959,878	40,993,694

Source: The Information Production Center, Agricultural Statistics, Ministry of Agriculture, Khartoum, 1964, p.50.

Appendix IX

Returns from Some Land Use Types

1. Cotton:

For the cost of production, the table below has been drawn by the author to give an average picture; it represents the average of nine 10 feddan cotton fields in the Gezira, White Nile and Tokar delta for the seasons 1960/61, 1961/62 and 1962/63. The work of the cultivator has been priced at the prevailing prices and included on rough estimates:

	£S	
Initial preparation of Land	4.000	
Sowing	3.000	
Resowing	1.500	
Weedings	20.000	
Waterings	6.000	
Picking	1.000	per kantar
Transport to nearest station	0.100	per kantar
Clearance of field	19.000	
Incidental expenses	5.000	
Total Expenses per 10 feddans	58.500	+ Picking and transport costs
Total expenses per feddan	5.850	+ Picking and transport costs

During the season 1961/62 the per feddan production

of the irrigated Egyptian cotton was 4 . 6 kantars in the Gezira, 3.62 in the White Nile schemes and 4.16 in the private estates and "sagias" of the Blue Nile Province. For Egyptian cotton grown by flood in the Gash delta the figure was only 1.04 kantars; the per feddan production of this type of cotton for the whole Sudan was 4.25 kantars. The average share of the Egyptian cotton grower was £S.7.200 per kantar; this gives gross per feddan returns to the grower of £S.33.120 in the Gezira, £S.26.064 in the White Nile schemes, £S.29.952 in the private estates and "sagias", £S.7.488 in the Gash delta and £S.30.700 for the Sudas as a whole. The net per feddan financial returns will be £S.22.210 for the Gezira, £S.16.232 for the White Nile schemes, £S.19.526 for the private estates and "sagias", £S.0.494 for the Gash delta and £S.20.175 for the Sudan. The net per feddan export value of irrigated Egyptian cotton is £S.55.330 for the Gezira, £S.42.296 for the White Nile schemes, £S.49.478 for the private estates and "sagias", £S.7.982 for the Gash delta and £S.50.675 for the Sudan.

The American cotton is grown by irrigation in the Blue Nile Province, in the Zeidab Pump Scheme, in Berber-Shendi reach and Dongola-Merowe reach of the Nile in the Northern Province, by flood in Tokar delta in Kassala Province and the Khor Abu Habl in Kordufan Province, and by rain in the Gedaref area, the Nuba Mountains and in Equatoria and Upper Nile Provinces. The average export price was about £.S.13.000

per kantar of which about 50% goes to the grower. Under irrigation the per feddan production was 5.67 kantars in the Gezira and 2.2 in the Northern Province; this gives a gross per feddan financial return to the producer of £S.36.855 in the Gezira and £S.14.300 in the Northern Province; this will give a net per feddan return of £S.24.768 in the Gezira and £S.6.030 in the Northern Province. For the per feddan export values, the gross figures will be £S.73.910 and £S.28.600 and the net figures £S.61.623 and £S.20.330 for the Gezira and the Northern Province respectively.

The average per feddan production of American cotton grown by flood was 2.2 kantars in Tokar and 3.1 in the Khor Abu Habl. This gives the grower a gross financial return of £S.14.300 and £S.20.150, and a net return of £S.6.030 and £S.10.890 in the two areas respectively. The gross per feddan export values for the two areas are £S.28.600 and £S.40.300, and the net figures are £S.20.330 and £S.31.040 respectively.

For rain grown American cotton the average per feddan production for 1961/62 was 2.376 kantars of unginned cotton for the Gedaref area, 2.75 for the Nuba Mountains, 2.09 for Equatoria Province and 2.486 for Upper Nile Province. A rain cotton grower in the Gedaref area said that he was given £S.50.000 for his 31 kantars of unginned cotton. If we accept this as the average, then a wholesale price of £S.1.613 per unginned kantar gives a gross per feddan return of

£S.3.833 for the Gedaref area, £S.4.436 for the Nuba Mountains, £S.3.371 for Equatoria Province and £S.4.009 for Upper Nile Province. It is difficult to determine the cost of production in this case because the rain cotton growers do not usually employ paid-labour; a rain cotton grower in the Gedaref area estimated the cost of production on his 10 feddan field at £S.10.000; if we accept this as the average, though it is too low to be true, then the net per feddan returns will be £S.2.833 for the Gedaref area, £S.3.436 for the Nuba Mountains, £S.2.371 for Equatoria Province and £S.3.009 for Upper Nile Province. At an export price of £S.180.000 per ton of ginned cotton, the export price of the unginned kantar will be about £S.3.000; this will give a gross per feddan return of £S.7.128 for the Gedaref area, £S.8.250 for the Nuba Mountains, £S.6.270 for Equatoria Province and £S.7.458 for Upper Nile Province. The net figures will be £S.6.128, £S.7.250, £S.5.270 and £S.6.458 for the four areas respectively. Here it must be remembered that these figures are for the crop of one year, but cotton grown under rain conditions cannot be grown year after year on the same piece of land without a fallow period; if we assume that for half the time the land will be left to retain fertility under bush fallow, then the actual figures will be half of those calculated above. The net per feddan returns will then be £S.1.417 for the Gedaref area, £S.1.718 for the Nuba Mountains, £S.1.186 for Equatoria

Province and £S.1.505 for Upper Nile Province at the wholesale price; at the export price the net figures will be £S.3.064, 3.625, 2.635 and 3.229 respectively.

For the Sudan as a whole the net per feddan wholesale value will thus be £S.17.787 for irrigated cotton, £S.8.860 for cotton grown by flood and £S.1.457 for cotton grown by rain. The net per feddan export values for cotton grown under these different conditions will be £S.45.826, £S.25.685 and £S.3.138 respectively.

2. "Dura":

It is grown on extensive areas all over the country and under quite different environmental conditions for both domestic consumption and export. In 1961/62 its average per feddan yield was 12.96 kantars under irrigation, 7.48 under rain conditions and 8.56 under flood conditions. Again the wholesale prices vary considerably from place to place and from one time of the year to another, but £S.0.700 can be taken as the average price per kantar. After the transportation of "dura" to the nearest market or consumption centre and after grinding it into flour, its average retail value will be £S.1.400 per kantar. The export price for the year was about £S.30.000 per ton.

Under irrigation the per feddan gross returns will be £S.9.072 on wholesale prices, £S.18.144 on retail prices and

£S.19.440 on export prices. The average per feddan cost of production is about £S.3.720 (the average for 30 tenants in three different parts of the Gezira was £S.18.600 per 5 feddan field in 1961/62). Thus the net per feddan returns will be £S.5.352 on wholesale prices, £S.14.424 on retail prices and £S.15.720 on export prices.

For "dura" grown under rain conditions the per feddan returns to the grower were £S.5.236, and the retail and export values were £S.10.472 and £S.11.220 respectively. The average per feddan cost of production for 1961/62 can be taken as £S.1.700 (the average cost of production for 10 growers in the Nuba Mountains and 10 growers in the Gedaref area was £S.8.500 per 5 feddan field). So the net per feddan returns will be £S.3.536, £S.8.772 and £S.9.520 on wholesale, retail and export values respectively. But "dura" is not grown by rain on the same plot of land every year; so if we assume that for half the time the land will be left fallow to retain fertility, then the net per feddan wholesale value will be £S.1.768, the retail value will be £S.4.386 and the export value will be £S.4.760.

For "dura" grown by flood, the gross per feddan wholesale value is £S.5.992, the retail value £S.11.984 and the export value is £S.12.840. If we accept the average per feddan cost of production as £S.2.300 (for 8 growers in Tokar

delta the average cost of production was £S.11.500 per 5 feddan field), then the net per feddan wholesale value will be £S.3.692, the retail value £S.9.684 and the export value £S.10.540.

3. Ground Nuts:

The yields of ground nuts differ greatly due to the great variety of conditions under which it is grown. The average per feddan yield for ground nuts grown by irrigation in 1961/62 was 11.308 kantars, 6.226 kantars for ground nuts grown under rain conditions and 2.2 for ground nuts grown by flood. The average wholesale price was £S.1.000 and the retail price was £S.1.400 per kantar; at an export price of about £S.50.000 per ton, the export value of the kantar will be £S.2.270. Ground nuts are not grown every year on the same field.

For ground nuts grown by irrigation the per feddan gross returns to the grower will be £S.11.308, the retail value will be £S.15.831 and tne export value will be £S.25.669. For ground nuts grown under rain conditions the gross per feddan wholesale, retail and export values will be £S.6.226, 8,7116 and 14.133 respectively; for ground nuts grown by flood these per feddan gross values will be £S.2.200, 3.080 and 4.994 respectively. The per feddan cost of production varies considerably from place to place, but the following figures

can be taken as the average: £S.2.480 for irrigated ground nuts (in the Gezira the average cost is about £S.12.400 per a 5 feddan field), £S.1.500 for ground nuts grown under rain conditions (in the Gedaref area the average cost is about £S.7.500 per 5 feddans), and £S.0.900 for ground nuts grown by flood (the average cost in Tokar delta is about £S.4.500 per a 5 feddan field). This will give net per feddan returns of £S.8.828 on the wholesale value, 13.351 on the retail value and 23.189 on the export value for irrigated ground nuts. The net values for ground nuts grown under rain conditions will be £S.4.726, 6.216 and 12.633 respectively, and those for ground nuts grown by flood will be £S.1.300, 2.180 and 4.090 respectively. When we allow for the fallow period, then the annual per feddan wholesale, retail and export values will be £S.4.414, 6.676 and 11.595 for irrigated ground nuts, £S.2.363, 3.158 and 6.317 for ground nuts grown under rain conditions, and £S.0.650, 1.090 and 2.045 for ground nuts grown by flood.

4. Wheat:

Wheat is grown by irrigation mainly in the Northern and Blue Nile Provinces, and by flood in Kassala Province; it is not grown under rain conditions and it does not enter international trade. The average per feddan yield is 15.1 kantars for irrigated wheat and 18 kantars for wheat grown by flood. The wholesale price in 1961/62 was £S.0.850 per kantar and the retail value, after transportation to nearest

market or consumption centre and after conversion to flour, was almost double this figure. Wheat in itself has no export value, but in terms of foreign exchange equivalence and at an average world price of about £S.40.000 per ton, the export value of wheat will be £S.1.820 per kantar. The irrigated wheat will thus have a gross per feddan wholesale value of £S.12.835, a retail value of £S.25.670 and an export value of £S.27.480. Wheat grown by flood will have a gross per feddan wholesale value of £S.15.300, a retail value of £S.30.600 and an export value of £S.32.720.

The average cost of production for 10 farmers in the Northern Division and Messelamiya Division of the Gezira was £S.18.500 per a 5 feddan field; this will give a cost of £S 3.700 per feddan. If we accept this as the average, then the net per feddan value of irrigated wheat will be £S.9.135 at the wholesale price, £S.21.970 at the retail price and £S.23.780 at the export price. For wheat grown by flood the same values will be £S.11.600, 26.900 and 29.020 respectively. This will be the case if we assume that wheat is grown on the same piece of land year after year though in many places there is a short fallow period.

5. Grazing:

Grazing is a type of land use which gives very low financial returns per unit area. The carrying capacity of a

typical grazing land in Kordufan may be estimated as 30 cattle per square mile, with an average annual off-take of $7\frac{1}{2}\%$. This can be taken as the average figure for the average grazing land in the Sudan. With this same annual off-take the carrying capacity of the grazing land may be estimated at about 100 sheep or about 40 camels per square mile. The average wholesale prices of sheep, cattle and camels may be taken as £S.3.500, 10.000 and 18.000 per head respectively. This will give wholesale financial returns of £S.26.250 per square mile in case of sheep, £S.22.500 per square mile in case of cattle and £S.54.000 per square mile in case of camels. The per feddan returns will be £S.0.043 for sheep, £S.0.037 for cattle and £S.0.089 for camels. At per head export prices of £S.6.000 for sheep, £S.20.000 for cattle and £S.35.000 for camels, then the annual yield in foreign exchange will be £S.45.000 per square mile for sheep, £S.45.000 for cattle and £S.105.000 for camels. The per feddan annual yield will thus be £S.0.074 for sheep, £S.0.074 for cattle and £S.0.172 for camels.

6. For the per feddan returns for some forest products see Chapter V.

Table VI: The Vegetation Zones and the associated Physical, Climatic and Human Influences.

Vegetation Zone		Distribution		Physiog-nomy	Dominant Species		Firewood and Building Poles Estimate in M^3	Timber Estimate in M^3	Forest Reserve in Feddans (up to 30.6.63)	Soil Type	Relief	Rainfall in mm.	Gr
Symbol	Name	Location	Area in Feddans 000		Trees	Grasses							
I	Desert	From lat.16°N in the west and 19° N. in the east to the northern frontier. excluding the Red Sea Hills area.	170,660	Desert	Acacia nilotica and Acacia aribica along the Nile.	"gizu"	Negligible	Negligible	Negligible	Sands derived mainly from Nubian sand-stone rocks, and alluvium along the Nile.	Low plateau with scattered low hills.	0-75	Confi cours north Kordu Provi
II(a)	Acacia tortilis - Maerua crassifolia Desert Scrub	Along the Red Sea and around Khartoum.	43,884	Desert scrub	Acacia tortilis, Maerua crassifolia, Schoenefeldia gracilis, Acacia nubica and Balanites aegyptiaco.	Panicum turgidum and many Aristida species.	18,500,000	85,000	143,800	Grey saline clay, calcareous or alkaline; hills show bare rocks	Ranges from clay plain to a plateau of Basement complex rocks to the Red Sea Hills.	75-300	Heavy camel:
II (b)	Butana Semi-Desert Grssland	Between the Atbara river and the Blue Nile as far south as lat. 14°N.	24,380	Grassland	Acacia mellifera along watercourses and around "jebels"; Acacia nubica on overgrazed areas.	Blepharis spp., Cymbopogon nervatus and Sorghum spp.	4,000,000	Negligible	202,100	Dark cracking clay; cracks medium to small.	Gently undulating plain.	150-350	Most a overgr
II(c)	Semi-Desert Grassland on Sand.	Northern Kordufan and Northeastern Darfur.	20,113.5	Grassland	Cyperus conglomeratus	Blepharis spp. and Monsonia senegalensis	3,000,000	Negligible	60,900	Sands and gravels, brown to red in colour.	Rugged plateau and rocky hills.	100-300	Overgr especi easter
II(d)	Acacia mellifera - Commiphora Desert Scrub.	Northern Kordufan and Northeastern Darfur.	20,113.5	Desert scrub	Acacia mellifera, Commiphora spp., Maerua crassifolia. Acacia raddiana Boscia senegalensis.	Aristida spp., Tetrapogon spathaceus, Chrysopogon aucheri, and Panicum turgidum.	16,500,000	105,000	90,400	Light-brown to red sand alternating with grey clay.	Rugged plateau and "qozes"	75-350	Medium by cam
II(e)	Semi-Desert Scrub of Southern Red Sea Hills.	In the extreme east between latitudes 15° and 19°N.	7,314	Desert scrub	Acacia etbaica, Acacia glaucophylla, and Acacia tortilis.	Sporobolus spicatus	10,000,000	55,000	18,500	Grey clay soils	Low rugged hills.	100-400	Light t
III.A.1. (a) (i).	Acacia mellifera Thornlands, on Dark Cracking Clay, alternating with Grass Areas.	From northern fringes of the Nuba Mountains, through the centre of Blue Nile Province into Kassala Province.	22,551.5	Savana	Acacia mellifera	Brachiaria obtusiflora	101,000,000	175,000	273,700	Dark cracking clay.	Gently undulating plain.	400-570	Light t
III.A.1. (a)(ii)	Acacia mellifera Thornland on Hill Soils formed in situ.	Central and western Darfur.	12,190	Savana	Acacia mellifera, Commiphora africana, Boscia senegalensis, Acacia senegal and Acacia seyal.	Aristida spp. Loudetia togoensis and Brachiaria lata.	89,000,000	110,000	Negligible	Light, grey clay formed in situ.	Rocky hills, pediments and Plateaux of Nubian sandstone, volcanic rocks and Archaean rocks.	200-500	Light
III.A.1 (b)	Acacia seyal - Balanites Savana, alternating with Grass Areas.	Southern parts of Kassala, Blue Nile and Kordufan Provinces and in the south.	28,037	Savana	Acacia seyal and Balanites aegyptiaca.	Hyparrhenia pseudocymbaria and Cymbopogon nervatus.	103,000,000	200,000	198,100	Heavy dark cracking clay.	Gently undulating plain and low-lying areas.	600-950	Light
III.A.1. (c)	Anogeissus - Combretum Woodland Savana.	The western foothills of the Ethiopian uplands.	11,580.5	Savana	Anogeissus schimperi, Combretum hartmannianum and Acacia seyal.	Hyparrhenia pseudocymbaria and Hyparrhenia rufa.	114,000,000	430,000	44,200	Alkaline clay soils.	Transitional between hills and plain.	700-1050	Light
III.A.2. (a)	Gum Arabic Scrub Belt.	Central Kordufan and east central Darfur.	15,237.5	Savana	Acacia senegal, Acacia nubica and Adansonia digitata.	Aristida pallida, Eragrostis tremula and Blepharis spp.	84,000,000	115,000	72,300	Sand soil, and clay soil in depressions.	Stable sand dunes and depressions.	280-450	Medium
III.A.2. (b)	Low Woodland Savana of Southwestern Kordufan and Southeastern Darfur.	Southwestern Kordufan and Southeastern Darfur.	20,113.5	Savana	Combretum cordufanum, Dalbergia melonoxylon, Albizzia amara and Acacia senegal.	Eragrostis tremula, Aristida pallida and Ctenium elegans.	69,000,000	170,000	48,100	Sand soil, sometimes hardened by iron salts.	Stable sand dunes and some depressions.	450-625	Medium
III.A.2. (c)	Terminalia-Sclerocarya Woodland Savana.	Southwestern and Southeastern Darfur and Southwestern Kordufan.	15,237.5	Savana	Terminalia laxiflora, sclerocarya birrea, Anogeissus schimperi and Prosopis africana.	Hyparrhenia confinis, Ctenium elegans and Blepharis spp.	85,000,000	12,000	35,500	Sandy soils.	Stable sand dunes and Archaean outcrops.	500-800	Heavy
III.A.3. (a)	Toposa Area Type.	Eastern Equatoria Province.	8,533	Grassland	Acacia mellifera	Chrysopogon aucheri, Schima nervosum and themeda triandra.	36,000,000	Negligible	60,100	Alkaline clay soils and red loams.	Rugged plateau and scattered hills	550-850	Medium
III.A.3. (b)	Hill Catena Type.	Scattered in east. west, Nuba Mountains and the south east.	16,456.5	Woodland	Acacia nubica, dom-palm, Acacia albida, Anogeissus spp. and Combretum spp.	Blepharis spp., Chloris gayana, Chloris pilosa and Chloris prieurii.	76,000,000	620,000	49,500	Ranges from stable sand to dark cracking clay to bare rocks.	Hills, isolated or grouped	560-1300	Light t
III.A.3. (c)	Baqqara Catena Type.	Southern parts of Darfur Province.	4,266.5	Savana	Tamarindus indica, Crateva adansonii, Acacia seyal, Lannea humilis and Acacia mellifera.	Aristida spp., Schoenefeldia gracilis, Tripogon minimus, Chloris spp. and Brachiaria spp.	34,000,000	65,000	98,700	Sandy soils alternating with non-cracking clays.	Gently undulating, with some pools.	700-950	Light
III.A.3. (d)	Raqaba Catena Type.	Extends 30 to 70 miles north of the Bahr el Arab.	7,923.5	Savana	Acacia seyal, Acacia mellifera and Lannea humilis.	Aristida spp. Chloris spp and Cymbopogon nervatus.	48,000,000	90,000	Negligible	Dark cracking clays and non-cracking clays.	Plain with low-lying, annually flooded areas.	900-1050	Heavy
III.B. (a)	Deciduous High Woodland Savana.	Over the iron-stone plateau for a distance of 600 miles and average width of 200 miles.	73,140	Savana	Anogeissus schimperi, Khaya senegalensis and Isoberlinia doka.	Hyparrhenia rufa, Hyparrhenia dissolute and Hyparrhenia filipendula.	270,000,000	21,000,000	851,000	Varies from laterite to red loams to heavier grey soils.	Gently undulating plateau, dis ected by streams.	900-1350	Medium t
III.B. (b)	Modified Tropical Rain Forest.	The extreme southern parts of the country.	8,533	Woodland	Terminalia glaucescens Albizzia zygea, Vitex doniana, Combretum binderianum and Grewia mollis.	Imperata cylindrica, Panicum maximum, Setaria sphacelata and Hyparrhenia cymbaria.	90,000,000	12,700,000	78,500	Mostly red loams.	Undulating plateau.	1350-1600	Light to
IV	Seasonal and Permanent Swamps Region.	The southeastern part of the country.	57,902.5	Savana	Hyphaene thebaica, Borassus aethiopium, Acacia sieberiana, Acacia fistula, Acacia seyal and Acacia senegal.	Echinochloa stagnina, Echinochloa pyramidalis and Cyperus papyrus.	29,000,000	Negligible	89,000	Alkaline clay soils.	Almost level clay plain, with limited upland areas.	600-950	Heavy
V	Mountain Vegetation Zone.	The Imatong, Red Sea hills, Dongotona Mnts. Didinga Mnts. and the Jebel Mara.	1,523.75	Woodland	Boswellia papyrifera, Terminalia brownii, Syzygium spp., Podocarpus milanj-ianus, Erica arborea. Albizzia spp., Cordia abyssinica, Olea laperrini, Juniperus Procera and Olea chrysophylla.	Exotheca abyssinica, Tripigon snowdenii and Cymbopogon spp.	2,100,000	16,000,000	158,800	Slightly alkaline brown loams and slightly acid, red loams.	Mountain ranges and isolated "jebels".	700-1500	Light to

SOURCES:

1. M.N. Harrison and J.K. Jackson, Ecological Classification of the Vegetation of the Sudan, Forest Bulletin No.2 (New Series). Agricultural Publications Committee, Khartoum, 1958.
2. J. Smith, Distribution of Tree Species in the Sudan in Relation to Rainfall and Soil Texture, Bulletin No.4, Agricultural Publications Committee, Khartoum, 1949.
3. J.H.G. Lebon, Land Use in Sudan, Geographical Publications Limited, Bude, Cornwall, 1965.
4. G.A. Worrall, The Butana Grass Patterns, Journal of Soil Science 10 (1959). pp. 34 - 53.
5. J.H.G. Lebon, Current Developments in the Economy of Central Sudan, Report of a Symposium, held at Makerere College, Sept. 1955, pp. 57 - 66.
6. M.K.Shawki, Forests in the Sudan (in Arabic), Forest Memoirs No.4, Forests Department, Khartoum, 1961.
7. Forests Department, Report for the period July 1962 to June 1963, Khartoum, 1963.