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JESS REPORT ON

FORESTRY IN THE JUBBA VALLEY

JESS Report No. 27

Prepared by:

T. J. Synnott, Ph.D.
Associates in Rural Development, Inc.
110 Main Street, Fourth Floor
P.O. Box 1397
Burlington, VT 05402
U.S.A.

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ACRONYMS AND ABBREVIATIONS

AHT	Agrar- und HydroTechnik, GMbH
AID	Agency for International Development, Washington, D.C.
ARD	Associates in Rural Development, Inc.
CWS	Church World Services
FR	Forest Reserve
GSDR	Government of the Somali Democratic Republic
ha	hectare
JESS	Jubba Environmental and Socioeconomic Studies
JuDAS	Jubba Development Analytical Studies
LRDC	Land Resources Development Centre
LSU	Land System Units
m^3	cubic meters
MJVD	Ministry of Jubba Valley Development (now MNPJVD)
MNPJVD	Ministry of National Plan and Jubba Valley Development
NRA	National Range Agency
ODA	Overseas Development Administration
SG	specific gravity
spp.	species
SRS	Southern Rangelands Survey
t	ton

PREFACE

The Jubba Environmental and Socioeconomic Studies (JESS) are a three-year program of river-basin investigations being conducted in southern Somalia. JESS is part of a larger project, Jubba Development Analytical Studies (JuDAS), which is a cooperative effort between the U.S. Agency for International Development (AID) and Ministry of National Plan and Jubba Valley Development (MNPJVD, formally the Ministry of Jubba Valley Development) of the Government of the Somali Democratic Republic (GSDR). Associates in Rural Development, Inc. (ARD), was awarded a contract by AID (number AFR-0134-C-00-5047-00) to provide technical assistance and project management for JESS.

This report was prepared as part of the author's 33-day consultancy for ARD. The author was in Somalia from 16 September until 18 October 1987 and visited the Jubba Valley from 24 September to 6 October, travelling from Luuq to Kismaayo. In Mogadishu, he studied some of the available literature and had many talks and meetings with people involved in related subjects and projects.

The terms of reference, in summary, were to:

- evaluate existing forest resources and uses of tree and shrub products in the area, and predict effects of Jubba Valley development on these resources;
- review current forestry/agroforestry practices and future management needs; and
- propose measures for forest management, investment, monitoring, conservation and meeting projected needs for forest resources.

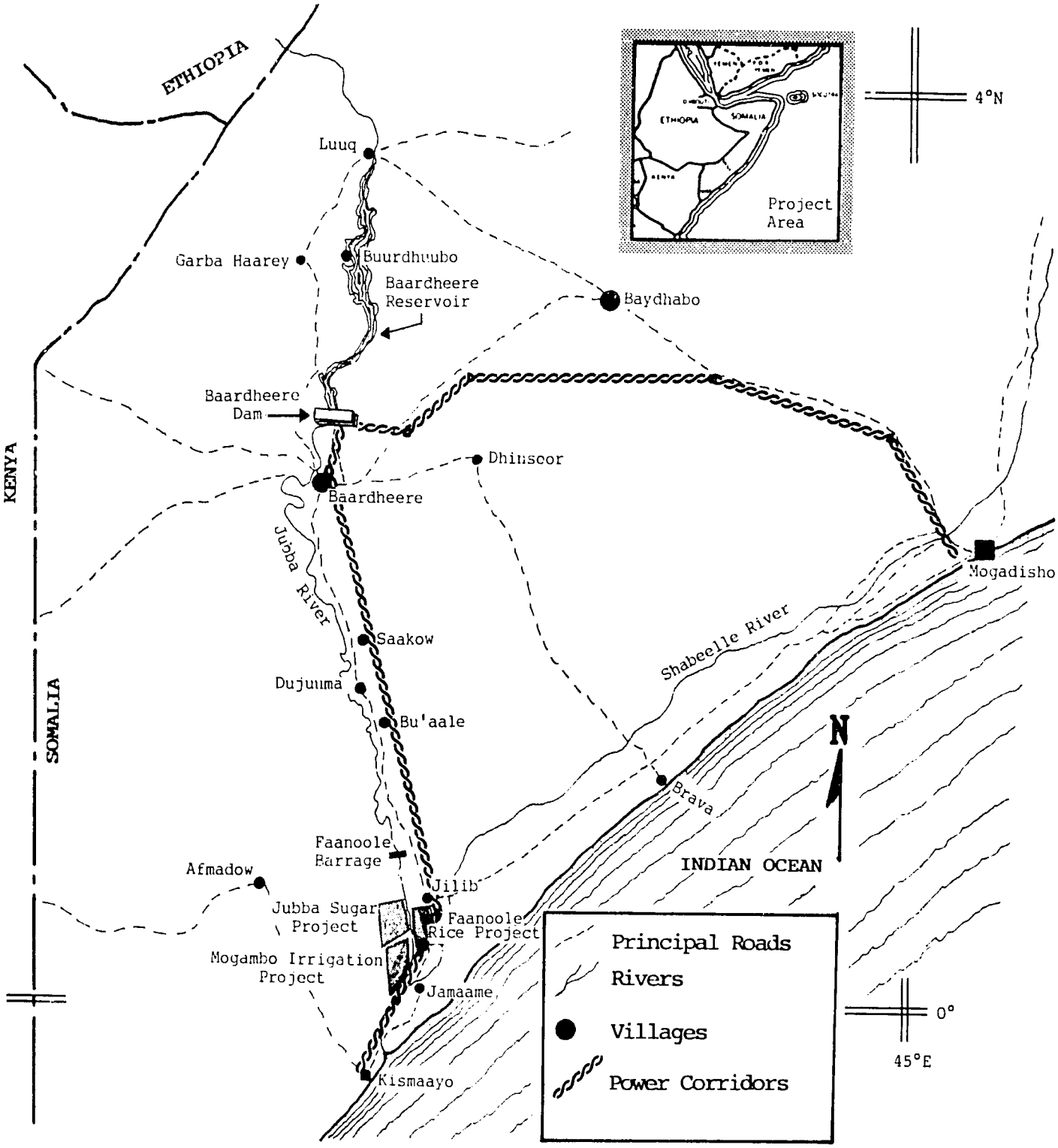
The study did not cover grazing, fodder resources or pastoral activities. The complete terms of reference are given in Appendix A.

The Agrar-und HydroTechnik GMBH (AHT) staff have not yet provided new information which could be used for quantifying resources, so the resources data presented here were obtained by consensus from available information. The main emphasis of this consultancy was on the practical issues of the present condition and degradation of the natural vegetation, the difficulties experienced by villagers in obtaining firewood within easy walking distance, and the likelihood of negative effects from proposed future developments. A large amount of attention has been paid to the status of the natural forests, despite their very small extent, since some of the ecological aspects are controversial. The agroforestry aspects have been treated

relatively briefly, not because they are unimportant but because their importance and the success already achieved locally are extremely clear and widely recognized.

This report is particularly directed at those planning development in the natural resource and land management sectors, to promote sustainable and managed use of existing woodland and bushland, the conservation of endangered habitats, and the creation of new wood resources, especially by farm planting.

Figure 1. Area of the Baardheere Dam Project and the Jubba Valley Development



I. EXECUTIVE SUMMARY

Most of the Jubba Valley is occupied by woodland and bushland of varying densities. All areas are subject to some degree of cutting and other uses by local residents and nomadic pastoralists, but in the great majority of the valley, the vegetation is in good condition. The stocking is not severely reduced and the productivity of the vegetation is probably close to its potential maximum. Around the small villages and even most of the towns, fuelwood and poles are gathered by hand without serious difficulties for the people or deterioration of the vegetation. Commercial gathering of firewood, mainly dead wood, is spread over wide areas without causing significant depletion. Charcoal is produced on a small scale in many places for town markets, often using dead wood or trees felled for land clearance, without serious consequences. However, if the demand for charcoal grows, or if the Jubba Valley is used to supply significant quantities to Mogadishu, the impact and deterioration will be much greater.

In Luuq District, the concentration of refugee camps has resulted in a very large local consumption of all types of wood and livestock browse. The degradation of vegetation and soils over a wide area is extreme and is getting steadily worse and more widespread. Many residents must now walk at least three hours to reach areas with suitable firewood, and the difficulties and local prices are increasing.

In the southern Jubba Valley, agricultural projects and local concentrations of workers have also greatly reduced the readily available supplies of firewood and other wood products, causing deterioration in the vegetation and difficulties for the residents.

Investment in management, in provision of fuelwood, and in tree planting will be essential to improve these situations and to avoid the same deterioration in future areas of settlement and development.

The remaining small areas of riverine forest and closed woodland are being cleared for agriculture at a rapid rate, eliminating important resources of large timber and a unique natural plant community. After evaluating their status and ecology, it is concluded that they are dependent on subsurface groundwater infiltrating from the river, and that regulating the floods will not necessarily endanger their future existence. The conservation of representative areas is justified by their uniqueness in Somalia, for the rare plants and animals which inhabit them and for future generations of Somalis who will learn and benefit from them.

Tree planting, especially with fruit and shade trees, is practiced throughout the Jubba Valley, although usually on a very small scale. The National Range Agency (NRA) runs a nursery in every district, and distributes several thousand free trees annually for planting in villages, refugee camps and compounds. Around Luuq, and on a smaller scale in Jilib, active extension programs with farmers have been successful, and many farmers are now planting fast-growing, multipurpose fuel/pole/fodder trees in rows and strips. These serve as a model for promoting tree planting in other districts to make an important contribution to local wood needs.

It is recommended that:

- improved nurseries and extension programs be developed in all districts, in combination with small pilot demonstration plantations and species trials, to promote tree planting on farms and in all settled areas, with the aim of contributing to local needs and reducing the demand for cutting in the natural vegetation;

- cutting and collection of fuelwood for sale continue to be regulated by NRA over sufficiently large areas, to ensure sustainable supplies without degradation;

- the existing Forest Reserves with the riverine forest, and any other areas found to be suitable for conservation, be demarcated, protected and managed; and

- forestry-related activities be implemented by NRA staff, and funding for the necessary extra equipment, transport, training and technical assistance be included in regional development plans.

II. FOREST RESOURCES

A. Introduction

Trees and shrubs of the Jubba Valley are of major importance both for their use values and for their protective function. Important components of this consultancy were, therefore, to evaluate the existing wood resource, both qualitatively and quantitatively; its use value at present and in the future; its function in reducing wind and water erosion; and the changes in all these which are expected to occur as a result of building a dam and other infrastructure; and of changes in the land use, population and river flow.

These objectives are hard to achieve in one month, especially since many of the components are known only very approximately from rather few sample data, and other variables, such as growth rates, have hardly ever been measured in these or neighboring regions.

While it is impossible to have much confidence in the present quantitative estimates (or to define their confidence limits), it is possible to present some figures based on the available data from the study area. These figures are compatible with estimates made in Kenya and with the observations, calculations and experiences of scientists working on these subjects, supplemented by the author's own reconnaissance survey. The JESS work in progress will provide more reliable resource data soon. More important now is a logical appraisal of the resource information in relation to the observed present and expected future impacts, in order to identify the key elements, changes and problems.

B. Existing Forest Resources

The stocking of wood resources in the Jubba Valley has a high variability, resulting from natural and man-induced factors. Even in areas which have been little affected by cutting, such as those far from water sources and used occasionally only by nomads, the vegetation varies from low bushed grassland to rather well stocked woodland. In areas close to the river, the variation is even more extreme, from cleared agricultural land to closed forest.

Table 1.40 of the Southern Rangelands Survey (SRS) (Watson and Nimmo, 1985) shows estimates of timber and wood fuel volumes in cubic meters per hectare, and of total annual production potential in tons per hectare, for nearly 200 land system units (LSU) in southern Somalia (Vol. 1, Part 1.2, pp. 122-8,). A partial description of how these quantities were calculated, and

the assumptions made, is given in the section "Estimates of Annual Production Potential for Charcoal and Woodfuel" (Vol. 1, Part 1.1, pp. 174-5).

The estimates do not take account of the species composition of the trees and shrubs studied, or of whether they are or can be readily used for timber, charcoal or firewood. Nevertheless, if the totals for timber and woodfuel are added together they give an estimate of total woody biomass, irrespective of potential uses.

Table 1, compiled from SRS Table 1.40, shows the estimated woody volumes (timber plus fuelwood) for the 46 ecological zones recognized. It is not easy to ascertain what minimum size was used to define "firewood," but it appears that it was probably a small size, perhaps two centimeters in diameter.

The lowest values, particularly those of zero to two cubic meters per hectare, refer almost exclusively to exceptionally open areas such as sand dunes, agricultural projects or wetlands. The highest values (reaching over 400 cubic meters per hectare in some individual LSU) refer to areas with closed forest or dense woodland. According to these data, the LSU most typical of the region have total woody resources ranging between three and 30 cubic meters per hectare. If an average specific gravity (SG) of 0.6* is used for all trees, shrubs, stems and branches, the equivalent typical woody biomasses are two to 18 tons per hectare. An SG of 0.6 is lower than that of the preferred fuelwood material, the stemwood and heartwood of *Acacia* spp. and other dense woods, but there are many abundant trees and shrubs with a much lower SG, including *Commiphora, Ficus* and notably *Adansonia*.

In the time available it has not been possible to attempt a correlation between these LSU (derived from satellite imagery and visual inspection) and the standard vegetation communities used for vegetation mapping. Thus, it is not possible to apply the Watson and Nimmo estimates directly to the appropriate mapping units used by AHT, JESS and the Land Resources Development Centre (LRDC) study of 1985. The difficulty is increased when very different vegetation communities are included within one LSU, uniform in geology, soil, slope or water relations, but not necessarily in existing vegetation (for example, LSU L.XLIII.147 includes forest, bushland and grassland, all in alluvial valleys and levees).

Although the assumptions made and the methods for calculating the biomasses leave much room for doubts about the correctness of the estimates in Table 1, they are the only data

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* If the specific gravity is 0.6, one cubic meter of solid wood weighs, on average, 600 kg.

TABLE 1

Geomorphological Group	Ecological Group	Woody Volumes in m^3/ha
A. Limestones	I	26.0
	II	13.1
	III	8.8
	IV	27.5
	V	18.2
	VI	3.3
	VII	8.2
B. Limestone Transitionals	VIII	5.2
	IX	19.7
	X	7.1
	XI	41.9
C. Volcanics	XII	5.9
D. Anhydrites	XIII	8.0
	XIV	3.6
E. Sandstones	XV	56.2
	XVI	53.7
F. Basements	XVII	22.4
	XVIII	14.0
G. Coastal Limestone	XIX	18.1
	XX	49.6
	XXI	48.6
H. Coastal Dunelands	XXII	0
	XXIII	9.3
	XXIV	25.5
	XXV	0
I. Inland Dunelands	XXVI	31.8
K. Undifferentiated Sediments	XXVII	24.1
	XXVIII	17.1
	XXIX	52.2
	XXX	24.2
	XXXI	9.4
	XXXII	81.2
	XXXIII	1.4
	XXXIV	7.3
L. River Alluviums	XXXV	9.3
	XXXVI	2.4
	XXXVII	15.1
	XXXVIII	10.4
	XXXIX	0
	XL	0
	XLI	0
	XLII	15.6
	XLIII	66.1
	XLIV	2.0
	XLV	164.9
M. Mangrove	XLVI	14.6

available. They can be used as indicators of the ranges and general levels of woody biomass in the area, pending a more detailed study (including biomass calculations in the JESS monitoring sites and a comparison of the SRS LSU with the latest photography).

The SRS estimates have been compared with the early and provisional calculations of woody biomass made by members of the joint Somalia-U.K. ODA Forestry Project in some overlapping areas of southern Somalia, which include data for total tree and shrub biomass as well as the biomass of woody material larger than five centimeters in diameter. Insofar as it is possible to compare similar vegetation communities, using brief description for each LSU in the SRS report, the Watson and Nimmo estimates appear to be somewhat higher than the British team's results.

A comparison has also been made with the results published by Western and Ssemakula (1981), referring to rangelands of Kenya. In this report, vegetation is classified into only five units, with canopy covers of less than one percent, one to two percent, two to 20 percent, 20-40 percent, and 40-80 percent. The estimated biomasses, referring to woody material usable for firewood and larger than two centimeters in diameter, appear substantially higher than the results obtained in Somalia for apparently similar canopy covers.

Table 2 presents provisional estimates of the total biomass of woody material for each of the AHT vegetation mapping units. These estimates refer to woody material of all species and sizes above two centimeters in diameter. They are intended to be compatible with the Watson and Nimmo data summarized in Table 1, assuming that their estimates of "firewood" include small sizes. The British team's data would indicate that the figures in Table 2 are too high, while the Western and Semakula results suggest that they are too low, but it has been agreed in discussions in-country during this consultancy that these are suitable provisional estimates.

The details for each ecological zone and LSU shown in the SRS report, and summarized in Table 1, demonstrate the great variations in stocking in the region as a whole, and within zones, ranging from dense tropical forest to completely treeless areas. The units used by AHT and JESS for classifying and mapping the vegetation are more uniform with respect to plant biomass, although they also inevitably include substantial variation due to the use of a few units of classification to divide a broad continuum of vegetation densities. At this stage, for planning purposes, it is neither possible nor necessary to make more than an approximation of the range of biomass typically present in each of the main vegetation units recognized in the JESS surveys.

TABLE 2

Vegetation Units	Woody Biomass m^3/ha	t/ha
Grassland: land dominated by grasses and forbs, with a canopy cover of trees or shrubs of <2%.	0-2	0-1
Bushed grassland: grassland with shrubs and some trees, scattered or in groups, with a canopy cover of up to 20%.	2-8	1-5
Bushland: land carrying shrubs up to about 6 meters high, with a canopy cover over 20%, interspersed with open grassy areas.	5-15	3-9
Bushland thicket: bushland in which the multistemmed shrubs form an almost full cover, difficult to penetrate, with few open grassy areas.	10-20	6-12
Woodland: land with over 20% canopy cover formed by trees or tall shrubs 10-15 meters high, easy to walk under, with a variable amount of smaller shrubs and a ground cover of grasses and forbs.	15-40	10-25
Woodland thicket: a closed woodland in which the trees and shrubs together form a complete cover, difficult to penetrate, with few grasses. (Acacia, Albizia, Commiphora, Dobera, Terminalia, Adenia, Adansonia)	30-60	18-40
Forest: land with a closed or almost closed canopy of trees 10-40 meters high, with a more open understory of smaller trees and shrubs, with little grass. (Newtonia, Ficus, Garcinia, Mimusops)	50-300	30-200

Table 2 gives details of the principal units of vegetation mapping and classification, and a range of woody resource biomass. It is suggested that most of the areas mapped in these units have a total biomass of more than two centimeters in diameter within the ranges shown in the table. Most sites probably carry a biomass in the lower part of the ranges shown; some sites within the mapping unit will also obviously have higher or lower values.

At the time of writing, estimates of the total areas mapped in each of these vegetation types were not available. When available, the figures should be multiplied to give an estimate of total resources existing in the study area, if such an estimate is required by the future planning authorities.

However, in this writer's opinion, the available resource data, including regressions for converting plant dimensions into solid volume or biomass, are not sufficient for making a more reliable estimate of woody resources or for calculating the precision of such estimates. Furthermore, the highly approximate estimates which can be made by multiplying area data by unit volumes or biomasses will probably be quite sufficient for planning purposes in the near future. Plans for forestry activities will be based on identified problems, shortages, yields and constraints, which operate at a local level.

The JESS sample sites are suitable for monitoring changes in cover, stocking and composition, such that a remeasurement in about five years or more should produce interesting results. However, none of the available regressions will enable accurate estimates of biomass per plot, because of the extreme variability between and within species. Equally, the plots will not necessarily enable accurate estimates to be calculated of biomass or biomass change over the JESS area as a whole.

The existing regressions of size on volume/biomass may be used for estimating resources only if a large number of sample trees or plots are measured in each vegetation type. The regressions calculated by N. Bird of the British forestry team, Mogadishu, have the strongest statistical base of any available for the region, but it is not known to what extent they can be applied to species other than the two *Acacia* species studied. In spite of doubts about the reliability of regressions used by Watson or by Western and Ssemakula, they are the best available means of estimating biomasses of some of the other species. In the author's opinion, they may be used for the same species, and also applied to species with similar forms and structures, to provide rough estimates (with no statistical precision) until better regressions are available. The JESS project does not have the resources for calculating more regressions, nor for carrying out large-scale sampling in order to estimate biomass from the available regressions.

Aerial photographs have already been used for vegetation mapping, and new large-scale photos have been taken of selected sites. Because of the difficulties of distinguishing the outlines of individual plants from those of their neighbors, and of determining their exact sizes, they appear to be of little use for quantitative biomass estimates. They will be very valuable for monitoring future vegetation changes, but only if a second set of photographs is taken of exactly the same sites from the same altitudes (a difficult task even for the original pilot).

The estimates in Tables 1 and 2 (even if they happen to be accurate) are only a part of the information needed for planning purposes or for identifying issues and problems, for two reasons.

First, data for total woody biomass (even when subdivided into size-classes appropriate for sawn timber, charcoal production and firewood) do not take into account the species composition or technical properties of the resource. Many of the trees and shrubs are not, in practice, valued as a fuelwood resource, although they may be valuable for some other purpose. Second, much of the woody resource occurs far from the places where it could be used; different products are collected over different distances, depending on their value and means of transport; and averages and ranges of stocking over the whole area reveal little about the supplies which are actually available within reach of the users.

C. Uses and Products of Forest Resources

It is now necessary to examine the actual uses made of different components of forest resources.

Vegetation in all parts of the Jubba Valley has been affected to some extent by cutting and browsing. Doubtless, even in more remote areas, biomass and species composition have been slightly affected by selective cutting of preferred species by nomads for housing and various implements. Near villages and cultivated land, and in areas more accessible by road or river, cutting and grazing have long been more intensive.

Certain effects of human and livestock use can be described with some confidence, in spite of a shortage of information. The total quantity and the average stocking of the forest resources in the Jubba Valley have been reduced, but to varying extents in different parts. Over very large areas, absolute and proportional reduction in biomass have been small, and most areas probably carry at least 50 percent of their potential (and past) maximum. Over significant areas within a few kilometers of towns, villages and agricultural areas near the river, the resource has been more severely reduced. In such areas, the resource has been reduced to 10 to 40 percent of the stocking the

area could carry--and probably did carry a few decades ago when settlements were fewer and smaller and the total settled population much lower than at present. In some areas, notably within a few kilometers of concentrations of refugee camps and major watering points, woody vegetation has been reduced to an even smaller proportion of its previous stocking. Even in these areas, however, there are usually some trees or shrubs, except in the most severely affected core of the area. These areas are known to bear the brunt of the shortage of resources for local uses and environmental protection.

The most severe reductions in the local biomass (although not necessarily the worst in terms of the size of the remaining resources or the environmental risks) are in the closed forests and *Acacia tortilis* and *A. zanzibarica* woodlands in the immediate vicinity of the Jubba River and other important drainage lines. It is clear from reports, photographs and continued observations that these communities have been greatly reduced in area and density by partial and complete clearances, often associated with permanent and temporary cultivation. This clearing is important even though these areas often carry a large stocking of shrubs and trees, as regrowth or as partly cut or lopped trees. It is probable that some areas of woodland now being cleared for cultivation are regrowth or natural regeneration which has developed after forest clearance for agriculture in past years.

Although there is clear evidence of reductions in forest resources, at least locally, more detailed consideration is needed before problems can be more accurately identified and possible solutions proposed. It is necessary to evaluate the availability of and demand for resources with different uses, values and local importance. The main categories to be considered are:

- large trees (>50 centimeters in diameter) for canoes and carpentry;
- medium trees for posts, beams and pillars;
- trees and shrubs for charcoal and firewood;
- poles and sticks for walls, fencing and roofing; and
- branches for fences and animal enclosures.

There is some overlap and flexibility in these categories. Small poles can be used for buildings and fuel even when larger ones would be better; and almost any woody material can be used for fuel if necessary, even when certain species and sizes are greatly preferred. Nevertheless, with current practices, only large trees can be used for traditional canoes; twigs cannot be

used for charcoal; and houses need long, fairly straight poles in large numbers.

Wood resources in each of these categories are exploited at different intensities, in different total quantities, often in different places, and have different values. Consequently, variations in resources in different areas, and problems caused by local supply and demand differences, are important for planning purposes.

Firewood is the most important category because of the quantities used and its daily impact. The overwhelming majority of Jubba Valley residents use only, or almost only, firewood for cooking. However, users are highly selective. Reports, confirmed by observations, show that in most towns and villages, most of the firewood used (and seen in markets, households and trucks) consists of dead wood, often long dead, as evidenced by patches of insect attack and partial decay. Some of the smaller pieces had bark partially or fully attached, but appeared to have been dead for at least a few months. Firewood cutters probably cut some live trees and branches to be left to dry for future collection and use, and several felled but unused trees were seen. This is not always the case, and in many areas there is plenty of dead wood available. The wood used is of high density, almost all from *Acacia, Terminalia* and a few other genera. Overall, and in most areas, firewood collection is not having a seriously damaging effect on the wood resource.

For most people, firewood resources are only a limited part of the total woody biomass, and much of the firewood is obtained without cutting trees. Surveys and interviews have indicated that most firewood users in villages and towns from Baardheere to near Jilib obtain firewood by collecting it from nearby bushlands and woodlands, and that this work typically takes from 1.5 to three hours on each occasion, two or three times a week. In these areas, firewood supplies are locally considered to be adequate. Some town residents buy firewood from dealers who arrange collections by lorry from greater distances. On the whole, good firewood is still abundant in relation to overall demand. The regional firewood consumption has been estimated at about 400 to 1500 kilograms (or 0.6 to two cubic meters) per person per year. These estimates may be compared to the typical biomass figures in Table 1 in relation to the total area and population of the region under study (data not available at the time of writing). There have been no measurements of local fuel consumption in the Jubba Valley. It looks likely that the lowest estimates refer to charcoal use in Mogadishu, quite inapplicable to the Jubba Valley. Since cooking methods are not particularly efficient in use of firewood in this region, and firewood is not in short supply over most of the area, average annual consumption is probably more than one cubic meter of high-quality firewood

per person per year; for provisional planning purposes, a consumption of 1,000 kilograms may be assumed.

However, in places where the local population has grown to a much larger size, the local demand is much larger and the impact on the resource correspondingly more severe. This is particularly true where refugee camps are so closely concentrated that areas used for collecting firewood overlap. In Luuq District, several refugee camps and the old town all lie within one to three kilometers of each other. The effect is the same as that of a town with a population of over 100,000 collecting firewood from surrounding woodland and bushland. The observed results are the same as those which occur in similar situations all over the drier parts of Africa. Woody biomass has rapidly declined, people have to walk increasingly long distances to collect firewood (often three hours from Luuq), and the preferred and more efficient fuels are increasingly unavailable. Smaller and less suitable (and time-consuming) materials are used for fuel and are not available for fencing, building or fodder material. Around these centers of population, the preferred resources of firewood and of all other woody resources have been severely depleted and locally eliminated within several kilometers, leaving only some stunted shrubs, a few trees or small woodland patches which have received special protection, or new communities of a shrub, *Calotropis procera*, which is virtually useless.

In these areas, a high proportion of individual family labor must now be spent on collecting fuel. In addition, the low plant cover greatly reduces the actual productivity of the local vegetation. Increased rates of erosion from the bare soil and decreased organic matter content reduce the long-term productive capacity of the local soils. These constraints are of major importance for planning purposes.

It must be stressed that the cause is not the refugee status of so many of the inhabitants. A similar effect occurs in other regions, and may occur elsewhere in the Jubba Valley when towns such as Baardheere and Jilib grow larger. It is similar, on a smaller scale, to the impact of Mogadishu on the regional resources preferred for charcoal. A particular feature of the fuel situation around Luuq is that a very high proportion of the population is unable to buy their firewood and must collect it within walking distance. A major part of the demand must be satisfied within a radius of perhaps 10 to 20 kilometers. This is a distinct contrast to the Mogadishu situation, and even to the situation in small towns, such as Bu'aale, where a significant proportion of the population, as wage earners, buys wood collected by dealers over much larger areas.

Another area of serious resource depletion is the other region of recent population concentration, near intensive

agricultural development areas in Jilib and Jamaame districts. In these areas, woody resources have been greatly reduced, even though there are substantial areas of well-stocked woodland and bushland. It appears that many of the lowest paid agricultural workers, as well as smallholders, depend on local firewood collection by family members. They may have entered the market economy for many aspects of their domestic budget, but they are still in the hunting-gathering economy for firewood. Where the population density is high, the local depletion of resources is also severe, and it is reportedly not uncommon for people to have to walk over two hours to find suitable firewood.

House construction requires large quantities of long, thin sticks and poles, and some thicker posts and poles. Typical houses require from several hundred to a few thousand poles, mainly of two to four meters in length and two to four centimeters in diameter, amounting to two to four cubic meters total. Reportedly, houses that are well constructed and maintained, preferably mudded inside and out, typically last for 15 to 30 years without major additions or replacements of poles (although unroofed and unmudded fences of woven poles may last only two years). Typical round houses are reported to contain five to 10 cubic meters of wood, and rectangular houses even more, when built with traditional techniques. During this consultancy, detailed measurements were made in only one house, a round house at the Government Rest House in Saakow. This house was eight meters across, and contained about 4,000 pieces, mostly smaller than two centimeters in diameter. It was calculated to contain 3.75 cubic meters of wood. Careful measurements of the wood content of more houses, and enquiries about how long they typically last, would provide some useful information. Clearly, the annual average consumption of building poles per person is much lower than for fuel, as is commonly the case elsewhere. No local estimates of this annual consumption are available, but studies elsewhere suggest that it may be about 0.1 cubic meters per person.

Building poles have a high use value and generally command higher prices than fuelwood. The cost of being transported over longer distances can more readily be covered. Many woodland trees and shrubs produce poles at various stages of their life, particularly when young or when coppicing after partial cutting. The pole resource is therefore widely available. Since ideal poles have clear specifications with regard to length and straightness, the actual cutting is also widely spread. Pole cutting affects forest resources over much wider areas than family collection of firewood, while annually removing quantities which are much smaller, both overall and per unit area affected.

Canoes are obtained from large riverine trees, particularly from *Ficus sycomorus* and *Mimusops fruticosus*. These species have historically grown mainly in closed forests, although *Ficus* is also found in more open communities. Riverine trees and forests now occur in much smaller quantities than in the recent past (see further discussion in Section II.) The remaining area of closed forest has been estimated at only about 10 percent of the total existing 40 years ago. Some large trees remain outside the forest, as relicts in land partly cleared for cultivation, but trees suitable for canoes have presumably declined by as much or more, as canoe trees have probably been removed from otherwise intact riverine forest areas. The pattern of cutting and use is different from that of other categories, since large trees are restricted to limited areas along the river. Canoes are used all along the river, so distances are not a serious obstacle to cutting.

Large trees are also used for carpentry, such as for making doors, chairs and stools for local use. In all the towns and villages visited, there were woodworkers and carpenters (sometimes only part-time, undertaking individual orders). They use a variety of timbers, often from trees already cut for agricultural clearing. The total resource available for carpentry is probably being steadily reduced by the extension of cultivation. The amount of carpentry practiced appears to be so small that it probably does not have a significant impact on forest resources. However, the demand for furniture and other timber products will certainly rise rapidly with economic improvements, and will eventually be constrained by a shortage of suitable resources. Large trees are also used locally for making beehives (*Dobera* and *Hyphaene*) and mortars (*Dobera*).

Charcoal making has a different pattern of distribution. In spite of contradictory official and unofficial information, this consultant was repeatedly told, and saw plenty of evidence, that charcoal available for sale in all district headquarter towns is produced locally, mainly within 10 to 20 kilometers of each town. Often it is associated with clearance of forest or tall *Acacia* stands for cultivation (dryland and irrigated), but also occurs elsewhere in forestland and woodland. Near Luuq, charcoal-making sites were seen in fine *Acacia tortilis* woodland. Near Baardheere, there is reportedly a charcoal cooperative at Busley. Near Bu'aale, a charcoal maker has been in operation for 11 years, selling in Saakow, Bu'aale and Jilib and claims a monthly production of 40 bags (usually about 60 kilograms each). At present, only a small proportion of town dwellers use charcoal. They still insist on a high-quality material. Only a few woods (*Acacia* and *Terminalia* spp.) are used for charcoal, and often only in the form of dead wood and trees cut for other reasons. The cutting is widespread and in general has a minor impact on the total forest reserve.

Thorn fences also consume large quantities of branches, shrub stems and regrowth. Almost all thorny or spiny plants are used, especially *Acacia*, *Balanites*, *Commiphora* and *Ziziphus*. Enclosures usually amount to little more than a linear pile of branches, 50 to 80 centimeters high, with more branches added from time to time to maintain the barrier. They are used to restrict movements of domestic animals, rather than for protecting them from predators. Enclosures are put around cultivated areas (rainfed and irrigated) and around private land valued for grazing. Many of these occur at some distance from the main concentrations of population and fuel consumption, and these thorny branches are not appreciated for fuel. The total wood resource in use for fences, and the amount cut annually, cannot be calculated, but it is probably on a scale similar to the consumption of building poles and charcoal wood.

More important, thorny branches are an extremely abundant resource, as the cut branches and stumps usually resprout and provide the material needed for repairs. The impact of cutting is restricted to the immediate vicinity of the fencing, and branches are not transported long distances (rarely as much as 500 meters). Therefore, in most agricultural and livestock areas, and in areas where nomads occasionally build stronger fences, the effect on local resources is minor and effects on regional resources is insignificant. However, in areas with a high proportion of fenced agricultural land, and especially around towns where construction of household fences is combined with constant browsing by livestock and a local shortage of firewood, fencing is an important factor in depleting the vegetation. The region around Luuq is an extreme example of this situation.

This discussion shows that cutting activities, and hence the process of biomass reduction, are a complex of separate and partly overlapping activities, occurring at different sites and different distances from the end-use. The end-uses themselves occur in different places--firewood and poles in towns, villages and rural areas; canoes along the river; fencing around fields. Impact on the vegetation may, at first sight, appear simple (e.g., either thinning or clearing), but it is also a complex process, interacting with regrowth. Only in a few special situations do the impacts combine to produce a continuing decline and eventual elimination of all woody vegetation.

Many other forest products are of local importance--edible fruits, fibers, medicines, tool handles, honey flowers and much else. Although important, they do not involve such large volumes or values as fuel and poles. Some forest products of socioeconomic importance are considered elsewhere in the JESS surveys. They are not considered further in this report. It is believed that, for planning purposes at this early stage of land management, the best way of maintaining supplies of these

products is to maintain the productivity of the habitats. The same principle applies to maintaining supplies of livestock fodder. The forestry activities proposed later in this report are designed to avoid or reduce habitat destruction by fuel and pole cutting, and thus to ensure the continued supply of these and many other products.

D. Dynamics Among Cutting, Growth and Resources

For planning purposes, it is not enough to know (or estimate) the standing biomass and the annual use or off-take unless these can be related to the growth rate or productivity of the various components and the net annual change in the resources. These are difficult to quantify, since annual productivity of the various woody components of different vegetation types has rarely been measured satisfactorily in woodland and bushland even on a research scale.

In mature, stable, undisturbed vegetation the net annual increment of wood is, on average, zero, with mortality balancing growth. Dead wood may decay, or be extracted as fuel, without affecting this "zero" growth rate. If some trees are cut, the biomass is reduced. Growth of the remaining trees and shrubs tends to restore the original biomass, resulting in a net gain in volume or weight. This net annual gain may itself be cut from time to time, and the remaining plants will continue to grow to replace it. Thus, a reduction in biomass is associated with an increase in net production. Achieving a maximum net annual increment, in theory and in practice, depends on the method and intensity of cutting. In most woody communities studied elsewhere, however, a high proportion of the maximum potential annual yield can be obtained with a standing biomass that is quite a low proportion of the undisturbed maximum.

In the Jubba Valley, a reduced standing resource of trees and shrubs does not necessarily mean a correspondingly reduced productivity. A significantly reduced production of useful wood will result from an excessive reduction in the standing resource, combined with such a high frequency of recutting or browsing that the remaining plants do not have time to grow to the required sizes.

In natural vegetation which is a mixture of species, sizes and ages, the total annual production of large sizes (logs for timber) is much less than that of small sizes (poles and branches). Therefore, if a community is subject to uncontrolled cutting and browsing of all sizes from thorn branches to large logs, annual production of large sizes will decline even when production of small sizes remains (at first) as high as ever. This has happened around many towns, where the standing resource

and annual supply of large trees has declined, while yields of branches and small wood remains high.

Many woodland and bushland communities inspected near settlements have a high intensity of utilization, thus a high annual production (within the limits of the local climate), and yet show no sign of a process of continuing deterioration. Most trees and bushes have had some stems and branches cut, but have continued growing or have resprouted vigorously, and the stocking appears high (50 percent canopy cover or more). This is consistent with a conclusion that continuous cutting and utilization, at an appropriate intensity, can maintain the productivity of the vegetation (and also its protective function) at levels close to the potential maximum, despite a substantial reduction in standing biomass.

In spite of a lack of any reliable information about biomass production or growth rates in this region, some estimates may be needed for planning purposes. The writer suggests that a "guesstimate" of 0.5 cubic meters or 300 kilograms per hectare per year may be used as the approximate annual increment of wood larger than two centimeters in diameter, in woodland and bushland communities that are already affected by cutting but not so degraded that there is a large proportion of bare ground. On this basis, the land within about 10 kilometers of a village may be capable of yielding about 15,000 cubic meters of wood per year on a sustainable basis--enough fuel and poles for more than 10,000 people. This estimate could be refined by adjusting it for different rainfall zones, but the apparent precision would be largely an illusion until more data are available. Actual useful yields are determined by the particular product required and the current state of the vegetation.

When the rate of removal by cutting or browsing is larger than the growth rate, the standing resource will steadily decline. At some point, its growth rate (net annual production) will also decline, and it will be impossible to maintain the same rate of removal. The cutting may then be distributed over a wider area, at greater cost or effort. If the rate of cutting also increases, the total area harvested must increase, together with the likelihood of serious depletion and total clearance in the nearest and most accessible areas. This process is now occurring around many of the towns, with their rapidly expanding populations, and it will accelerate. However, it is acute in only a few areas, such as around Luuq and the refugee camps, as described by Wieland and Werger (1985).

In essence, the problem around Luuq is not simply because too much wood is being cut. Rather, it is because it is being cut over too small an area. If the same rate of cutting could be distributed over a larger area, preferably uniformly, cutting could be sustained indefinitely without deterioration.

Unfortunately, the necessary area of bushland for such a large concentrated population would be too large for easy harvesting on foot.

Deterioration around the other smaller towns has been avoided because the cutting is distributed over a large area. Families insist on high-quality firewood, and are willing to work for an hour or two to find it, thus spreading the impact over a wide area. The total removed is in balance with the growth rate of the vegetation.

In this context, it is appropriate to mention the role of the NRA Forestry Department. In their attempts to control and tax the production of firewood and charcoal, the forest guards probably do little to reduce the total consumption but a great deal to distribute the cutting over a wider area. NRA performs an important role in ensuring that cutting does not exceed sustainable levels, except in areas of extreme demand, even though probably no areas are given total protection from cutting. Future increases and concentrations of population will make this role more difficult and more important. Any decline in yields around towns will have severe local consequences. These may be avoided if NRA and MJVD collaborate to plan and manage the cutting and supply of fuel according to local needs, by introducing incentives for cutting in specified areas and by promoting tree planting.

E. Conclusion

The total of all forest resources in the Jubba Valley, and the potential sustainable annual production, are very large in relation to the present internal demand and consumption. However, in areas of large concentrations of population, as around groups of refugee villages and agricultural projects, yields of wood from the natural vegetation within easy walking distance are inadequate to supply the local needs. The difficulties in obtaining firewood and the deterioration in the local environment are severe and getting worse.

Supplies of poles, charcoal and firewood can be sustained without environmental deterioration if they are transported over longer distances. In the case of large trees for carpentry, supplies are now so reduced that future demand cannot be satisfied from local resources.

III. RIVERINE FORESTS

A. Introduction

Riverine forests in the Jubba Valley have been reduced to a small fraction of their earlier size during the past half century (see JESS Report No. 17). By far, the main cause has been clearance for agriculture, a process which continues today.

The remaining areas of riverine forest are distributed in many small patches, principally in Bu'aale District, with some occuring downstream (and some significant areas of related forest along the "little Jubba"), and some small patches occurring as far north as the gorge above the Baardheere dam site. Many patches are very small, often less than one hectare in size. Some are little more than a small group of surviving trees. All can be considered here as riverine forests, easily recognized and distinguished from closed woodland on the basis of structure and composition even when partially opened.

Six separate areas of forest were visited during this consultancy. Interpretation of the ecological status of the forests is based on personal observations and on the written and verbal comments of other people who have seen them, guided by personal research into tropical forest regeneration and ecology, and previous knowledge of isolated and riverine forests in arid and semi-arid regions of northern Kenya and Uganda. However, this was a short visit to an area subject to many complex processes, made without the benefit of the company of the JESS ecologist. Many of the comments which follow are ideas and possibilities based on the author's experience elsewhere, rather than firm conclusions.

The following impacts are affecting these forests and may be expected to lead to continued decline:

- forest and woodland clearance for agriculture--JESS studies have shown a continuing decline in the area of closed riverine forests equivalent to 25 percent per year (compound) during the past four years (1983-87) (JESS Report No. 17);

- cutting trees for local consumption of firewood, charcoal, poles, fencing, timber and canoes;

- cutting trees for charcoal production for transport to Mogadishu and other centers;

- changes in flooding, sedimentation and groundwater regimes after dam construction;

- reduction of the area below a threshold for successful reproduction of some forest species, resulting in the disappearance of some species and communities; and

- browsing and grazing by livestock, likely to increase in intensity and duration if tsetse flies are reduced and if human and livestock numbers are increased, leading to reduced regeneration and densities and causing retreat of forest margins.

B. Protection

NRA has declared four Forest Reserves (FR) since about 1982. It was not possible to confirm the exact legal status and gazetted details of these reserves, but senior NRA officials have confirmed that their legal status is assured while their areas and boundaries and the mechanism for their continued protection are being reviewed. The areas shown below are the approximate areas of closed forest in each reserve as reported at the time of reservation, not the total FR area, which is and will be larger, to include some surrounding woodland.

Barako Madow FR	Bu'aale District	100 hectares
Shoonto FR	Bu'aale district	150 hectares
Kaytooy FR	Gelib District	50 hectares (?)
Nus-Duniya FR	Saakow District	50 hectares

The forest areas which previously existed around Kaytooy and Nus-Duniya (and in many other areas) have been largely eliminated or reduced to small fragments in recent years. In the case of Barako Madow and Shoonto, boundaries have been surveyed, mapped and marked with paint on large trees, partly following local roads. These boundaries include a few hundred hectares of closed woodland surrounding the forest. In both forests, access roads have been cut, circa 1984, and forests guards posted in nearby villages to improve protection.

Inspection showed that some poles are still being cut and removed from these two FRs, and a couple of small charcoal kiln sites were seen. However, it appeared that the intensity of current cutting is very low, although many signs of much older cutting were seen. It seems that the forest guards inhibit tree cutting, while not completely stopping it. Some large trees were found which had been felled and cut into convenient lengths several years ago, and were now decaying. The NRA representative said that they had been felled before the area had been declared

a Forest Reserve, and that their removal had been forbidden. In Shoonto, the access road reaches a large open area of bushed grassland with scattered trees and stumps, which had once been farmland, but no farming is permitted now. The area known to have been recently cleared in Barako Madow was not farmed and is now protected from further disturbance, according to NRA staff. Doubtless, the current low level of cutting and disturbance in these forests has some effect on their final composition, and may reduce the abundance of certain species, but it is not a threat to their conservation and integrity as forests.

The legal status of the unreserved patches of forest is not completely clear. It appears that the forestry authorities have substantial legal power to regulate or prevent tree cutting, especially for any commercial purposes, although in practice it is difficult for them to exert this authority. However, the Ministry of Agriculture apparently has power to authorize cultivation without reference to the forestry authorities, irrespective of the local vegetation, and there is little effective control over clearance and cultivation occurring without official approval. There is every reason to expect that the great majority of remaining unreserved forest patches will gradually be cleared during the next few years, and that unless more areas are protected as FRs immediately there will soon be no areas worthy of special protection. Experience elsewhere suggests that, even then, there will always be a few very small patches remaining, containing trees of no value, or on uncultivable soils.

C. Water Regime

The forest patches derive their water from all or several of the following five sources.

First, rainfall is about 500 to 600 millimeters per year, usually with two rainy seasons. The total is insufficient to maintain closed, multi-storied forest, but enough for dense woodland with an almost full cover of trees or shrubs, especially if some species are deciduous.

Second, early morning mist is common in this region, especially July through October. It does not contribute much water to the root system but certainly reduces evapotranspiration demand.

Third, surface flow and underground seepage come in from surrounding woodland. It is known that surface flow and sheet erosion occur in some of the woodlands and bushlands during heavy rains. Probably, some riverine forest areas receive some surface flow, at least in natural drainage lines and along seasonal water courses. It is more certain that soil humidity is maintained by

subsurface water flow from surrounding woodlands through many natural drainage lines at certain times of year. The importance of sub-soil drainage is shown in many broad valleys in the study area where there are dense groves of large *Acacia* trees and green grass long after the rains and far from the lowest water flow-line of the valley.

A fourth source is floodwater overflowing from the Jubba River. This is equivalent in some respects to a very heavy rainfall. Some sites may receive their full annual water requirements in one flood, although the water would not in practice remain available for a whole year. However, these floods are received at most once a year, usually less often. Some of the old, closed forest of Barako Madow FR, including the camp site of the 1986 U.K. scientific survey team, was not flooded by the high 1987 floods. No evidence of flooding was seen during a walk of about 1.5 kilometers from the campsite, through forest as dense and varied as any seen elsewhere. This shows that annual inundation is far from necessary to maintain the forest.

Fifth is subsurface water flows from the Jubba River. Some lateral seepage undoubtedly occurs from the main river channel, and much of the soil moisture in riverside forest is probably dependent on direct replenishment from the river for much of the year. It is not possible to quantify its importance without some soil auguring, but several factors suggest that it is a major source:

- the locally high regional saline water table, often with a layer of rainfed fresh water on top is shallow (0.5 to three meters in depth around Jilib and Jamaame)--this probably causes a broad perched water table of fresh water below and on both sides of the river (feeding many village wells and the surrounding trees);

- strata of thick limestone pavement, frequent just below the surface in many northern areas, would also tend to spread the river water laterally even if they occur at a depth of several meters;

- some desheegs, such as Banta, flood annually by infiltration without surface flow from the river--this is reportedly not common, but is convincing evidence of subsurface flow, and probably often occurs in a less conspicuous form; and

- substantial areas of riverine forest are not frequently flooded, yet are obviously thriving--such forests do not occur along the water courses that regularly dry out.

D. Regeneration

In the forests inspected, whether they had been inundated or not in 1987, the ground cover was typically sparse and included a typical mixture of herbs and young climbers, trees and shrubs. Without carrying out an enumeration, there was nothing unusual to be seen in the distribution of sizes, nor anything to suggest that the forest has an inadequate distribution of age classes, or that there are not enough young plants to replace the mature trees. As is usual in tropical forests, there is relatively little regeneration under the shade of the understory trees and bushes, but abundant young plants in natural gaps (e.g., in JESS site 39 under a recently dead ?*Newtonia*). Regeneration of some species is probably dependent on such gaps, giving opportunity to the light-demanding species. It is, therefore, quite normal that the young plants do no fully correspond to the species composition of the canopy. This is especially typical of forests affected by violent fluctuations (droughts, floods, waterlogging and windblow).

No evidence was observed of flood-induced seedling regeneration or a recent flush of seedlings in the forests. If such a flush occurred after the last rains or flood, it would probably be quickly reduced by browsing animals, as in other tropical forests, leaving only a few to survive and possibly mature.

However, a few examples of abundant seedlings were seen in sediments left by the flood in open areas. Near Luuq, an area of abundant young regeneration of *Tamarix* was found on a broad, low bank of sandy silt, left by the last flood. Near Jamaame nursery, patches of locally abundant seedlings of *Spyrostachys venenifera* were found on small steps of silt left on the river bank by the retreating flood. Both these species form thickets or low forest along the river bank and levee. This kind of seedling regeneration may be the start of a potential succession leading to forest if left undisturbed, or at least to the formation of conditions suitable for some larger river-edge species such as *Ficus*. Some areas of apparently even-aged *Acacia zanzibarica* occur, as near JESS site 76 above Baardheere, but these may have been formed by regeneration after forest clearance for agriculture rather than after flooding.

E. Nutrients

Flooding is also an important source of mineral nutrients, dissolved in the floodwater and deposited as mud and detritus (including stranded riverine animals, such as dead catfish, which are sometimes found in temporary ponds). Mud is not always deposited very widely or deeply on the forest floor--there was little sign of mud on the forest floors flooded five months previously. Much is probably filtered out and deposited in the ground vegetation close to the river margin.

Tropical forests are notorious for their ability to maintain themselves and cycle their nutrients, even in very poor soils. It is possible that the species mixtures of the riverine forests have evolved a nutrient cycle which is specially adapted to repeated flooding and silt deposition. However, there is no immediate reason to believe that a change in nutrient inputs, resulting from controlling the flood regime, will have significant short-term effects on the status of the forests.

F. Soil Saturation

Flooding saturates the forest soil for long periods, which is usually damaging for trees and other plants, except for specially adapted species of swamp forests. When the soil is waterlogged, trees are also often more vulnerable to windblow. No evidence was seen of mortality directly attributable to flooding, but there were more dead standing trees than in typical lowland tropical forests. Two trees have fallen, uprooted, beside JESS site 8 near Shoonto FR since the 1987 flood. It is probable that flooding has a negative effect on some species and contributes to tree instability. It is possible that the forest may become locally denser, with a slightly different composition, in the absence of flooding, other things being equal.

G. Wildlife

Wild animals, from hippos to bushbuck, and from beetles to bats, exert an important influence on the forest, by grazing and browsing, by pollination, and by eating and distributing fruits. All these have undoubtedly exerted a selective influence on different species and on the general composition of the forest. There is no indication that the current impact of wild animals, occasional entry of domestic animals or elimination of elephants are a threat to the conservation of the forests as such, although these and other more subtle changes will probably affect the species composition.

H. Forest-Woodland Dynamics

Most areas described here as forest consist of species seldom found in woodland or bushland. On the other hand, the typical woodland and bushland species exemplified by *Acacia* spp. are seldom found in closed forest. (Exceptions here and elsewhere are often caused by a retreat of the forest, leaving isolated forest trees in fields or fallow land, or more rarely by forest expansion.) Nevertheless, the density and biomass of some closed woodland are sometimes comparable to those of low or open forest.

In the Jubba Valley, notably between Bu'aale and Jilib, there are large areas of closed woodland where tree and bush cover is almost continuous and the vegetation has many elements of forest structure. Livestock densities are still low because of the presence of tsetse flies, and rainfall is adequate at 600 millimeters per acre. In some parts, the species composition and structure change repeatedly over short distances (50 to 100 meters) between closed and relatively open forest and closed and open woodland. This was seen most conspicuously in a large area of "forest" north of Shoonto, reached by the road from Bu'aale which continues through two villages to Shoonto, forming part of the Forest Reserve boundary.

These alternating vegetation communities are interpreted as being marginal, with the balance between forest and woodland determined by some limiting factor, probably soil moisture as determined by the riverine freshwater table. A change in moisture conditions, induced by a change in river levels (or historically by climatic fluctuations) may be expected to tip the balance for some marginal areas.

Some existing marginal forest areas may be dependent on extra abundant soil moisture associated with high river levels. If flooding is prevented, these may become more open or develop into partially deciduous woodland. Woodland species may gain entry and forest species fail to regenerate. On the other hand, some marginal woodland areas may be potentially able to support forest but are at present limited by the January to March dry season when river levels, and soil moisture, drop to a minimum. In such areas, after dam construction, when the river levels are maintained permanently above the present minimum, the forest species may be able to occupy these woodland sites, allowing some expansion of the forests.

It is not known how the soil moisture varies with distance from the river and with changes in flow levels. If the variations are small, only a small proportion of the area will be affected by the future changes in flooding. The whole area is adapted to violent seasonal and annual changes, and there is no

evidence that the expected change in river levels will have a drastic impact, one way or the other.

Hughes (1986), after studying the Tana River forests, suggested the possibility that forest and nabitat diversity may result from, and be dependent on, a regeneration succession initiated on newly deposited sediments, with very long cycles, and that changing the flood regime may greatly reduce the diversity of habitats. A very restricted version of this process may occur along the Jubba River, although the modest variation in forest communities appears to be related more to distance from the river, and thus the prevailing moisture regime, than to age or successional status. On a smaller scale, stabilizing the water regime will reduce variability by stabilizing the forest boundary, reducing the already small extent of periodic local expansion and contraction. It will also reduce mortality and gap formation caused by waterlogging, resulting probably in a slightly more homogeneous forest.

However, such subtle processes will probably be masked by effects of other impacts, including reduction in the size of the breeding population of the trees. The author has no information about the breeding systems of the trees which would allow him to predict the possible results.

I. Conclusion

The remaining small areas of riverine forest in the Jubba Valley are rapidly being degraded by wood cutting or cleared for agriculture. If present trends continue, most of these forest patches will be cleared within the next few years.

Shoonto and Barako Madow Forest Reserves are protected by NRA. As a result, current levels of human interference and of browsing by domestic and wild animals are not a threat to the continued existence of the forest. The control of flooding will probably affect some marginal communities along the forest-woodland transition boundaries. There is the possibility of a more serious effect, but it is most unlikely that control of flooding will seriously affect the forests. However, the survival of the forests will depend on continued adequate protection from fire, cutting and livestock.

If the demand for grazing, wood products and farmland continues to grow, and if NRA cannot protect them adequately, they will quickly be degraded and eliminated. These two remaining Forest Reserves are almost intact and are unique in Somalia. They provide sites of very great potential value for research, training, education and gene conservation. The expenditure needed to protect them is fully justified.

IV. FORESTRY ACTIVITIES IN THE JUBBA VALLEY

During this consultancy, visits were made to most NRA forestry offices and to all NRA nurseries along the Jubba Valley, in Luuq, Baardheere, Saakow, Bu'aale, Jilib and Jamaame district headquarters, and also to examples of all tree-planting activities. This section describes briefly the current forestry work being carried out.

A. Organizations Involved in Forestry Activities

National Range Agency, Forestry Department--A district forestry officer is stationed in each of the districts visited (although it appears that one person sometimes fulfills several positions within NRA). These staff have mostly had some technical training in the existing or previous forestry training schools in Somalia, and occasionally abroad.

Some but not all the forestry officers have a forestry vehicle, and the others have access to an NRA vehicle from time to time. They have basic office facilities, and a variable amount of tools and equipment. All have nurseries in or a few kilometers outside the district headquarters, of variable sizes (see below).

Forest guards and forestry workers are employed in all districts, in very different numbers (not obtained) according to the local resources and work program. The main activities are:

- seedling production in nurseries and free distribution of seedlings;
- planting and maintaining NRA plantations (especially Luuq, Bu'aale and Jamaame);
- control and supervision of dealers and producers of fuelwood and charcoal;
- timber production on a small scale (e.g., Bu'aale);
- protection of Forest Reserves (especially Bu'aale); and
- promotion of tree planting in towns and villages, especially with shade and fruit trees.

In most districts, distribution of trees to householders for planting takes place mainly for the annual tree-planting day in April. At present, extension programs to promote farm planting,

in shelter belts and agroforestry systems, are not a major activity, except in Luuq.

Church World Services (CWS), Refugee Forestry Programme--This group established the nursery in Luuq around 1983, in close collaboration with NRA, and carried out an extension program, especially in refugee villages, to promote tree planting. This program is still in operation, but is due to end in late 1988.

Gedo Community Forestry Project--This NRA project was begun in Luuq in late 1984 with USAID funds. It has carried out expansion and improvement of the Luuq nursery, and an intensive agroforestry extension program among local farmers, promoting a wide variety of trees and shrubs for many purposes. Some vehicles and much equipment have been bought, and extra staff and workers hired.

This project has had a very notable success, and a high proportion (although reportedly still fewer than half) of farms with irrigated land now have shelter belts and sometimes small plots of fast-growing species such as *Leucaena, Eucalyptus, Conocarpus, Casuarina, Albizia lebbeck, Azadirachta*, etc. (see Appendix B). The interest and enthusiasm of the local farmers, particularly for the good fodder and poles which they are already obtaining, are very high. Local interest is now so high that intensive promotion is perhaps no longer necessary to ensure the continued success of this program, but the organized production and distribution of seedlings will still be required. The USAID contribution to this project has ceased, so its future is uncertain.

World Concern--This group runs a leprosy center in Jilib, and a small nursery. A wide variety of trees and shrubs has been introduced for distribution, demonstration and trials. Seedlings of the most successful species are sold, and the demand is high. The work in progress here is quite exceptional in its attention to local species, local needs, and the introduction of new species of potential from a variety of international sources.

Japanese Volunteer Service--This group is working in Luuq on agricultural improvements among refugees. It maintains a small nursery (not seen by this consultant) and promotes tree planting along the same lines as the main NRA program in Luuq.

Swedish Primary Health Project--Members of this Bu'aale project also distribute seedlings, especially of palms and fruit trees, and encourage tree planting.

B. Nurseries

The following nurseries produce tree seedlings in the Jubba Valley:

NRA and CWS maintain a nursery in Luuq. It is well equipped with hand tools and water system, and a full complement of housing, residences, stores, etc. Several thousand plants of many species are in stock. The original spacious layout, equipment and pump were supplied by CWS in 1983. USAID provided funding for extra equipment, expansion and NRA involvement from October 1984 to December 1987. Seedlings are distributed free to households in the towns, villages and farms, using project vehicles to promote planting. The Japanese Volunteer Service also has a small nursery in Luuq.

NRA established a nursery in Baardheere around 1982, beside the Jubba River several kilometers outside the town. It has a small water pump feeding directly into irrigation channels but very few hand tools and no buildings or permanent fence. The nursery is roughly enclosed by a thorn branch fence. There are fewer than 500 plants now in stock, mainly neem and mango, most of which will be distributed on the annual tree-planting day.

In Saakow, NRA nursery first established its nursery in 1979. The site is now marked by a square plot of trees of neem, mahogany and Jerusalem thorn near the government rest house. It was later moved to a site near the river which was flooded out in 1987. The nursery now occupies a small plot near the town water pump, with a temporary thorn branch fence, a minimum of hand tools and no buildings. About 1,000 plants (mango, papaya, tamarind, neem) are in stock.

Bu'aale has had an NRA nursery for about 10 years. Its two hectares are well equipped with permanent buildings, stores, fencing, pump, hand tools, internal paths and irrigation channels. Some assistance has been received from the World Food Programme. The nursery has well-established plantation plots of teak, mahogany, neem, as well as many oleander, citrus, guava, mango, papaya, pomegranate and others. Tomatoes, lettuce and watermelon are grown for local consumption. About 5,000 seedlings of several species are in stock for free distribution.

The NRA nursery in Jilib is situated on about two hectares in Alessandria. It was established in the 1960s. Many large, old flamboyant, tamarind, mango, dhalab and a few others date from that time. There are young plantation plots and lines of eucalyptus, teak, Indian almond, neem, mahogany and others. Annual production is reported at a few thousand plants, for free distribution, but fewer than 500 plants were in stock, including neem, cassia, flamboyant, whistling pine, mango and teak.

Watering is done by hand, carrying water from the river, since the pump reportedly broke down some years ago.

The Agricultural Research Station Nursery in Jilib (not seen by this consultant) produces fruit trees, especially mango, for distribution to farmers and projects.

World Concern's small nursery in Jilib produces a very wide variety of local and introduced species, partly for distribution and sale to farmers and partly for research in collaboration with the Oxford Forestry Institute. This is an excellent demonstration of the potential of many species (notably several species of Leucaena, two Moringa species, Gliricidium sepium, and Sesbania grandiflora), and of combined tree and food production techniques.

NRA's Jamaame nursery, several kilometers outside the town, beside the river, is in a large area of land owned by NRA (legal status not known). There is a water pump, but no buildings. The nursery raises seedlings for farmers, households and for the NRA plantation. Several hundred teak, guava, eucalyptus, whistling pine and neem. NRA has a 16-hectare block plantation nearby, by far the largest and best in the Jubba Valley--mainly teak, with two species of eucalyptus and two of mahogany. The plantation is well tended, protected and irrigated, with annual planting from 1981 to the present. Different spacings and combinations of tobacco, lettuce and other crops are being tried.

C. Conclusion

Planting of shade trees and fruit trees is understood and practiced throughout the Jubba Valley, even in the smallest villages, although often on a very small scale. A very large number of tree species have proved themselves suitable and successful in many areas. Intensive extension activities have had conspicuous success around Luuq. All districts have staff experienced in raising trees, and a local tree-planting model is available as an example.

Local NRA nurseries range from apparently busy and resourceful (Luuq, Bu'aale, Jamaame) to relatively unproductive, with widely varying resources. Since almost all are fairly new, there is every reason to expect that steady improvements will continue in proportion to the funds available.

V. VEGETATION MONITORING

Techniques and proposals for monitoring vegetation change and growth rates have been discussed with the project ecologist, Dr. Ian Deshmukh. The recommendations are summarized here.

Repeated measurement of permanent plots allows greater precision in calculating changes and growth rates than other methods, including the repeated measurement of unmarked temporary plots. Although the initial costs are higher, the subsequent costs of obtaining a required level of precision will be much lower if at least some permanent plots are used.

In order to make sure that the exact site of the plot can be relocated, even after an interval of several years, a robust marking system is needed, in combination with accurate survey details and a careful description. A combination of earth caerns, trenches and buried steel pipes is recommended.

The access path to each plot should start at a permanent feature, such as a road, which can be precisely located on a map. The starting point may be marked by a caern of earth, about 50 centimeters high, a short distance from the roadway, using earth excavated from a direction trench, about 0.3 x 0.3 x 2.0 meters, pointing along a line towards the plot. For added certainty, a similar caern may be built on the opposite side of the road. The path to the plot should be precisely surveyed and measured and, if necessary, intermediate caerns and direction trenches built. The last caern should be centered at exactly, say, two meters north of the northeast corner of the square plot, the sides of which are oriented N-S-E-W. (Such details may be changed to suit the size and shape of the plot.) A center-caern need not be built unless the plot is much larger than 20 x 20 meters. At each corner, precisely measured, a steel rod or pipe of a convenient length, preferably one meter, may be hammered vertically into the ground, with the top concealed well below ground level.

If the survey and location details are well recorded, it will be possible to locate the plot corners to within a few centimeters with a tape measure, and precisely with a metal detector.

To characterize the plot, the species composition and the main elements of the biomass must be defined qualitatively and quantitatively. To measure biomass of the trees and shrubs, it will probably be necessary to measure more than one variable, e.g., crown diameter and height or stem diameters, on each occasion. This is because a biomass curve or regression based on one variable may give quite acceptable precision for the standing biomass on one occasion, but not for the change in the biomass

measured on successive occasions. The small amount of growth or decline may be large in relation to measurement errors and to the "precision" of the regression relationship.

If all trees and shrubs in each plot are individually measured on each occasion, net trends and changes may be estimated, for purposes of ecological monitoring (e.g., to detect a general deterioration or increase in the vegetation). However, this will not make it possible to calculate net annual or periodic production or growth rates. (Obviously, standing biomass may remain stable or even decline because of mortality or off-take, even though the plants may be growing vigorously.) Such calculations require marking, measuring and recording each individually numbered stem, in order to define losses and ingrowth. Setting up such intensively marked plots is not recommended until a system and an organization are established to ensure that such plots, and the data, will be used.

VI. RECOMMENDATIONS

At the time of writing this report, proposed development objectives and priorities for the Jubba Valley had not been fully defined. The need for some framework of objectives was suggested during discussions between the AHT and JESS teams. The following are tentatively proposed as a general development framework for the forestry sector of the Jubba Valley.

Objectives

- Satisfaction of the wood-product requirements of the region's inhabitants;
- maintenance of an adequate cover of vegetation sufficient to maintain the productive capacity of the soils and avoid unacceptable environmental deterioration; and
- long-term conservation of representative areas of rare and endangered communities of plants and animals.

Outputs

- Establishment of a management system for a stable and sustainable rate of cutting, extraction and browsing in the natural vegetation;
- increased production of wood, fodder and food from planted trees and shrubs; and
- effective management and protection of designated Forest Reserves and other conservation areas.

Activities

- Strengthening of the capabilities of the Forest Department staff to achieve these outputs, by providing the necessary materials and training;
- establishment of an extension service to promote tree planting by farms, households and villages;
- introduction of rational management and harvesting programs in the woodland and bush areas; and
- demarcation, patrolling and protection of Forest Reserves.

Inputs

- Materials needed for effectively mobilizing, supervising and communicating with the forest guards;
- materials and wages tc expand and improve all district nurseries and set up extension services;
- training courses, workshops and local study tours for extension and other forestry staff;
- design of a cutting plan for fuelwood and poles;
- species trials of more promising trees and shrubs; and
- data collection on growth rates and productivity of natural and planted trees.

The following recommendations are made for inclusion in the overall development plan for the Jubba Valley. It is envisaged that the early years of integrated development may be organized as a project with a component of foreign funding, monitoring and technical inputs. It is strongly recommended that the forestry component should remain the responsibility of NRA, with coordination by MNPJVD or a project director as appropriate, and that NRA should be strengthened to enable it to carry out this component. This will help to ensure that experiences gained in other parts of Somalia will be used in the Jubba Valley (and vice versa); and, more important, that NRA will be able to carry out these activities even when any overall development project or coordination comes to an end.

First, to partly redress the serious situation around Luuq, or at least to keep it from getting worse, major efforts should continue to encourage all landowners and householders to plant trees to contribute to their own and to local needs for wood and other products.

Second, to promote tree planting in all other districts, justified by the success and benefits already evident in Luuq, nurseries and extension activities should be improved throughout the valley.

Third, cutting of fuelwood and poles for sale in all towns should be regulated sufficiently to spread cutting over a wide enough area to avoid deterioration.

Fourth, when a population is expected to grow so large that sustained fuelwood supplies can no longer be obtained within easy walking distance without causing deterioration, measures must be taken in advance to ensure that fuel is transported over longer

distances. This will apply to towns which expand rapidly during or after dam construction or resettlement of refugees, such as Baardheere.

Fifth, the trees and shrubs in the inundation zone should be used before flooding starts. Charcoal burners and firewood dealers should be encouraged to exploit this resource before other areas. As an incentive, the wood may be issued free of charge, since it will otherwise be wasted. However, harvesting this wood in competition with dealers who collect high-quality fuel in the natural woodland will probably not be a profitable commercial undertaking. This study did not reveal any clear environmental reason for cutting or clearing trees in the inundation zone unless they can be used.

Sixth, special provisions should be made for fuel and pole supplies for construction camps, and for all workers involved in building the proposed dam. Fuel should be transported from clearly designated areas, not from the usual fuel collection areas of the towns and villages. Cutting should be strictly regulated to ensure an adequate supply of fuel without environmental deterioration. The wood in the inundation zone may be harvested for this purpose, as a provision of construction contracts.

Seventh, around refugee camps, where there is already a critical shortage of wood and severe environmental deterioration, and where the situation cannot be improved simply by regulating cutting, more action will be required. It is recommended that the responsible authorities take action to ensure provision of fuel just as they now provide for some other basic necessities such as food and water.

Eighth, the status of Shoonto and Barako Madow Forest Reserves (and any other areas worth the expense of conservation) should be clarified and strengthened immediately, before more is lost.

Finally, a monitoring system should be set up, with the main purpose of environmental-ecological monitoring, to detect and quantify habitat changes and trends, especially degradation, and with the secondary purpose of quantifying the annual productivity of the vegetation (which is more difficult and less urgently needed for planning purposes).

REFERENCES

The terms of reference for the forestry consultancy included checking the library resources of the Oxford Forestry Institute for forestry literature relating to Somalia. This was done in September. On arrival in Mogadishu, the references found in Oxford were checked against the comprehensive forestry bibliography prepared by Neil Bird and others of the British Forestry Project. Only a few extra references were found and these are now added to the main bibliography (in preparation).

Because this full bibliography exists, with forestry references for the whole of Somalia, a separate list for the Jubba Valley is not included here. A large number of reports and publications were consulted during this consultancy, and contributed to my interpretation of the forestry situation; the following have been referred to in this report:

Deshmukh, Ian. 1987. "JESS Interim Report: Riverine Forests of the Jubba Valley, Issues and Recommendations for Conservation." JESS Report No. 17. Associates in Rural Development, Inc., Burlington, Vermont.

Hughes, F. M. R. 1986. "The Tana River Floodplain Forest, Kenya." Unpublished Ph.D. thesis, Univ. of Cambridge.

Watson, R. M. and Nimmo, J. M. 1985. "Southern Rangelands Survey." Final Report to the National Range Agency. Mogadishu.

Western, D. and Ssemakula, J. 1981. "A Survey of Natural Wood Supplies in Kenya and an Assessment of the Ecological Impact of its Usage." KREMU, Nairobi, 48 p.

Wieland, R. G. and Werger, M. J. A. 1985. "Land Types and Vegetation in the Luuq District of South-Western Somalia." Journal of Tropical Ecology 1. pp. 65-87.

APPENDIX A

Scope of Work -- Phase II -- Forestry

Dr. Timothy Synnott - consultant

1. The contractor will conduct an eight week consultancy in Somalia on or about September 1987 for Associates in Rural Development, Inc. (ARD) as a part of the Jubba Valley Environmental and Socioeconomic Studies (JESS).

2. The general focus of this consultancy will be on social and biological implications of forest resource management in the Jubba Valley.

3. Prior to departure for Somalia, the consultant will receive a written or telephone briefing from the ARD project or technical manager.

4. Upon arrival in Somalia, the consultant will hold briefing meetings with the USAID project manager or designate, the JESS team leader or designate and the JESS ecologist to discuss the consultant's scope of work. At these meetings, a means for progress reporting during this consultancy will be defined.

5. The consultant will estimate the quantity of tree and shrub products used in the study area (fuel, poles, posts, fruits and foliage for food or forage). Factors to be taken into account are import, export, local use, socioeconomic importance and seasonal variations.

6. The consultant will estimate potential effects of dam construction and reservoir filling upon trees and shrubs. Factors to be taken into account are flooding of vegetation in the reservoir area, reduction of flooding downstream and use of wood for fuel, forage and construction during dam construction.

7. The consultant will make predictions of future demand for forest products taking into account various likely development scenarios as defined by the Ministry of Jubba Valley Development (MJVD).

8. The consultant will propose management measures necessary to satisfy future demand for forestry resources, including appropriate investment or development options.

9. Conduct a literature survey at the Oxford Forestry Institute and supply literature appropriate to JESS in Mogadishu.

10. The consultant shall review the aerial photo interpretation of changes in distribution of woody plants between 1960 and 1987 from materials provided by JESS.

11. The consultant will assess ongoing Somali forestry projects in or relevant to development of the Jubba Valley.

12. The consultant will also assist the JESS ecologist in the following activities:

a) Design of a vegetation monitoring system.
b) Assessment of wood mass in the study area.
c) Biological conservation measures in the study area.
d) Compilation of current and potential uses of plant species.

13. A word-processed report for this consultancy will be delivered to the JESS team leader at least one full day before departure from Somalia. This report will be written in a format which meets guidelines which the consultant will receive from the JESS team leader. This report will constitute a basis for a final briefing with the USAID project manager, the JESS team leader, the JESS ecologist and project personnel from MJVD. Revisions for the final report should be completed within two weeks after receiving comments from ARD and JESS.

14. At the discretion of the JESS team leader, the consultant may be required to present a one hour training seminar at the MJVD on a topic related to this consultancy.

APPENDIX B

Planted Trees and Shrubs of the Jubba Valley

There is a long history of tree planting in the Jubba Valley, beginning with coconut palms in coastal areas some centuries ago, and spreading with mangos and kapok trees in towns and private estates in the early years of this century. During the 1950s and 1960s, many more species were widely distributed and are now wellknown.

Only a minority of farmers and householders have planted trees on their own property, but almost every village, even the smallest, has at least a few planted trees of a few species. Some old towns such as Luuq have a wide selection of planted trees, including many large and old specimens.

During the past few years, still more species have been introduced. Some occur only in experimental plots, while others have been rapidly accepted and distributed, such as *Leucaena*. The following list shows species that are wellknown, widely planted and/or conspicuosly successful, and can be confidently recommended for extension programs.

Albizia lebbeck, boordi. Some old trees in Luuq, and younger trees elsewhere.

Annona spp., custard apple. Few, but successful, as in Saakow.

Azadirachta indica, neem, geeh-hindi. Abundant.

Carica papaya, papaya, paw-paw. Widespread.

Cassia spp., probably including *C. siamea* and *C. fistula* and some Australian fodder shrubs. Locally excellent.

Casuarina equisetifolia, whistling pine.

Citrus spp., oranges, lemons, limes, grapefruits, mandarines. Widespread.

Cocos nucifera, coconut, qumbo. Abundant in coastal areas, seldom inland.

Conocarpus lancifolius, damas, ghalab. Some old trees in Luuq, younger trees elsewhere.

Delonix reqia, flamboyant. Old trees in Jilib and elsewhere.

Entandrophraqma spp., mahoganies. At least two species seen, including reportedly *E. caudatum*, planted near old nurseries in Saakow, Bu'aale, Jilib, Jamaame.

Eucalyptus camaldulensis, the most common, successful eucalyptus.

Euphorbia tirucalli, often planted as hedging.

Leucaena leucocephala, especially near Luuq, very fast growth in irrigated plantations.

Manqifera indica, mango. Widely planted, especially near Jilib.

Moringa spp., one seen near Luuq, and two speciesat Jilib with exceptional growth rates.

Parkinsonia aculeata, Jerusalem thorn. Successful and locally naturalized.

Prosopis juliflora, mesquite. Luuq and elsewhere, good growth.

Psidium quayaba, zeitun, guava. Few, but productive.

Sesbania grandiflora, shawri. Excellent growth in irrigated windbreaks near Luuq and elsewhere.

Tamarindus indica, tamarind, ragay. Large old trees in Luuq, Jilib and elsewhere.

Tamarix aphylla, tamarisk, dhuur. In shelter belts.

Tectona grandis, teak. Successful with irrigation.

Terminalia catappa, Indian almond. In several towns.