DROUGHT TOLERANT MULTI-PURPOSE PLANT SYSTEMS IN KENYA

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DROUGHT TOLERANT MULTI-PURPOSE PLANT SYSTEMS IN KENYA

A RESEARCH PROJECT DOCUMENT

Prepared by

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in collaboration with

THE FACULTY OF AGRICULTURE
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PLANT SYSTEMS IN KENYA

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DROUGHT TOLERANT MULTI-PURPOSE
PLANT SYSTEMS IN KENYA

SUMMARY

Kenya which bestrides the equator in East Africa has a total area of 582,646 square kilometres. The country has five contrasting topographic regions: the Lake Victoria Basin, the Central Rift Valley and its associated highlands, the eastern plateau, the semi-arid and arid areas in the north and the south, and the coastal region. Consequently, considerable variation exists in the climatic pattern within the country. In general, the total amount of rainfall varies between 50 and 175 cm. The rainy season extends from late March to May, and the mean annual temperature varies between 13°C and 27°C.

The present population of Kenya is 14 million, which increases at an annual rate of over 3 per cent. More than 90 per cent of the population lives in dispersed rural settlements. The northern half of the country is only sparsely inhabited but high population concentration are to be observed in the Lake Victoria Basin, the Rift Highlands, and coastal belt, leaving extensive stretches of relatively empty country between them.

Agriculture is the mainstay of Kenya's economy, contributing over a third of the gross domestic product, about 60 per cent of the nation's exports, and one-third of all wage employment.

The most extensively occurring soils are the sandy loams of the semi-arid regions between the coast and the Rift Highlands. To the north are vast areas covered by the red desert soils, mainly sandy loams. The arid north and northwest have areas of shallow stony soils with frequent rock outcrops.

Since most parts of Kenya have poor soils and receive rainfall much below 1000 mm per annum, the productivity in these areas is extremely low. Rapid population growth and meagre opportunities for employment

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in the industrial sector have led to a substantial growth in the number of small holders who farm and ranch in Kenya's marginal lands. Consequently, there is over-exploitation of the land resources leading to considerable degradation.

Land use systems need to be developed for the improvement of these areas to meet the growing demand for food, fuel, wood, and other plant products, on a sustained basis. Agroforestry systems which combine adaptable species of multi-purpose trees with compatible agricultural crops seem to be of great scope and potential in these areas. Accordingly, this project has been prepared by the University of Nairobi and ICRAF with the following specific objectives.

(i) to evolve farming systems involving multi-purpose trees and food crops, and to select the most suitable species;

(ii) to study the production potential of the proposed systems;

(iii) to assess the input requirements, management techniques and economic advantages of the systems;

(iv) to evaluate the effect of farming systems on soil fertility and conservation; and

(v) to demonstrate the feasibility and desirability of the system in the context of current farming practices.

The basic experiments will include:

1. Intercropping of three multi-purpose tree species with two food crop species and two fodder crop species;

2. selection and screening of species;

3. nursery and propagation studies.

The project will be administratively located in the Department of Soil Science, Faculty of Agriculture, University of Nairobi, and it will be initially for a duration of three years.

The anticipated donor assistance to the project is US$674,[illegible] US$ 224,733 annually for three years. This includes a small capital budget of US$43,000, and a trianing component of $67,000. The University of Nairobi's contribution to the project is US$70,300 or US$23,433

annually for three years all of which is accounted for by salaries and allowances to scientists and support staff.

DROUGHT TOLERANT MULTI-PURPOSE
PLANT SYSTEMS
IN KENYA

BACKGROUND

Area

Kenya bestrides the equator in East Africa. It has a total area of 582,646 square kilometers, and is bounded on the north by Ethiopia and the Sudan, on the west by Uganda, on the south by Tanzania, and on the east by the Indian Ocean and the Somali Democratic Republic.

Topography

The country has five contrasting regions: the Lake Victoria Basin, the central Rift Valley and its associated highlands, the eastern plateau, the semi-arid and arid areas in the north and south, and the coastal region.

(i) The Lake Victoria Basin extends eastward from the lake to the Mau escarpment and is composed of a level plateau between 900 and 1300 metres approximately, above sea level. The rolling grassland is dissected by an eastern extension of the lake, known as the Kavirondo Gulf. The region is very fertile and is intensively cultivated with cotton, sugarcane, and subsistence crops.

(ii) The central Rift and the highlands may be divided into two sections: the main escarpment to the west and the Aberdare to the east. The valley is from 50 to 130 km wide, and its floor rises from 450 metres in the north around Lake Turkana to over 2,000 metres at Lake Naivasha, slopping to 600 metres at the Tanzania border in the south. The Mau escarpment rises over 2,600 m and stretches over 320 km northward from Tanzania border. The Aberdare Range, which forms the eastern border of the Rift Valley, rises to nearly 3,300 metres The relief of the highlands is complicated and contains plains, deep valleys and mountains. The soils are fertile.

(iii) The eastern plateau. Sandwished between the eastern highlands

and the coastal strip, the plateau slopes gently towards the sea. The entire region suffers from periodic drought, and is considered the country's traditional famine area.

(iv) The semi-arid and arid regions. To the north and northeast the eastern plateau merges with an area of increasing aridity that covers most of northern Kenya. A similar area is to be found in the southern part of the Rift Valley. There are scattered trees and grasses, but the meagre and unreliable rainfall usually supports only dwarf shrubs and bush. Areas of real desert are found, however, only in the region east of Lake Turkana.

(v) The coastal belt runs for about 250 miles along the Indian Ocean. the coastal plain is bordered on the west by a series of low hills. In the south the plain consists of a narrow strip two to ten miles wide; to the north the plain broadens, forming the 160 km-wide Tana lowlands that extend along the Somali border.

Soils

The most fertile soils, consisting of dark brown loams, occur in the highlands. Loams, sandy loams, and clays are found in the plateau lands of west Kenya, the Rift Highlands and part of the coast. However, the most extensively occurring soils are the sandy loams of the semi-arid regions between the coast and the Rift Highlands. To the north are vast areas covered by the red desert soils, mainly sandy loams. The arid north and northwest are characterized by areas of shallow stony soils with frequent rock outcrops and desert soils.

Climate

Seasonal climate rhythms are controlled by the large-scale pressure systems of the western Indian Ocean and adjacent landmasses. The rainy season extends from late March to May, with air flow from the east in both hemispheres. From June to August the southeast winds gradually prevail in the south; north of the Equator, however, they blow from the southwest. During this season of very low rainfall, the weather is stable. October marks the beginning of the transition period, which ends in December, with the return of the northeast winds.

In the Lake Victoria Basin, annual maximum mean temperatures range from 22° to 34°C, and the mean minimum from 10° to 18°C; precipitation varies between 100 and 175 cm. annually. The higher areas of the Rift Valley experience mean temperatures of 16° to 27°C and rainfall of from 50 to 150 cm. . In the highlands mean temperatures vary from 13° to 16°C, and about 130 cm of rain fall yearly from March to September in the west and from 85 to 150 cm in the east. occurring from March to May and from October to December. Annual maximum mean temperature over the eastern plateau range from 22°C to less than 18°C, and the minimum mean temperatures from 10° to less than 6°C. In the arid regions, maximum mean temperatures are above 26°C and the minimum mean over 14°C. The eastern plateau receives only 50 to 75 cm of precipitation annually, while the arid regions receive less than 50 cm. The coast has a mean annual temperature of more than 27°C, and rainfall of between 100 and 150 cm.

Some Socio-economic features

The population of Kenya is 14 million, and the rate of growth is of the order of 3 per cent per annum. More than 90 per cent of the population lives in dispersed rural settlements. In the greater part of the country, land is held by traditional command ownership, and virtually no community settlements have developed, except along the coast.

The regional distribution of population exhibits marked inequalities. The northern half of the country is only sparsely inhabited, most of the population being concentrated in the Lake Victoria Basin, the Rift Highlands, and the coastal belt. On the eastern plateau isolated settlements occupy the more elevated areas, leaving extensive stretches of relatively empty country between them.

Agriculture is the mainstay of Kenya's economy contributing over one-third of the gross domestic product , about 60 per cent of the nation's exports, and one-third of all wage employment. About four-fifths of the country is unsuitable for cultivation, however, and farming is restricted to the highlands, the western plateaux, and parts of the coast.

The main cash crops are coffee, tea, sisal, wattle, sugar and grains.

Staple crops include maize,pulses, millet and potatoes. Stock raising is also important, including cattle for dairying and for meat. Most of the country's livestock is kept by the dry regions of subsistence pastoralists who seldom market their animals. Commercial stock raising is practised on small farms as well as on large ranches.

JUSTIFICATION

The problems of agriculture, forestry and animal production in the semi-arid zones of the world are well-known. As we have seen, most of Kenya receives rainfall much below 1000 mm per annum and consequently the productivity in these areas is seriously hampered by drought. Indeed large proportions of Kenya's land surface are conventionally considered to be waste lands because of low rainfall and/or infertile soils.

However, rapid population growth, limited arable land, and a shortage of employment opportunities in to industrial and service sectors have led to a substantial growth in the number of small holders who farm and ranch in Kenya's marginal lands. This trend is expected to continue into the twenty-first century. While increased settlement and exploitation provide a basis for the livelihood of small-scale farmers, the results are not unmixed blessing. Soils are subject to serious erosion; much of the natural cover of the range lands has been overgrazed, and in some areas the ground cover has been completely removed.

It is therefore not surprising that standards of living are low. Indeed, during times of rainfall deficiency the Government of Kenya has had to divert scarce developmental funds to provide famine relief. Moreover, the degradation and depletion of the areas' soil and forest resources do not augur well for the future generations who might be found to live on such marginal lands.

Land use systems need to be developed for the improvement of these lands, to meet the growing demand for food, fuel, wood, and other plant products, on a sustained manner without causing soil deterioration and ecological degradation. Farming systems suitable

for these areas with limited resources and poor plant growing conditions seem to be those which combine adaptable pecies of multipurpose trees with compatible agricultural crops. Some information is available on certain forest tree species suitable for the purpose, e.g.: Leucaena leucocephala, some attributes of which are given in Appendix IV. However, the potential of Leucaena and similar other species, and the extent to which they are amenable to combination systems with agricultural annual crops, have not been studied, especially under Kenyan semi-arid conditions. The proposed project is intended to undertake such studies.

THE PROJECT

The broad objective of the project is to develop and evaluate agroforestry systems involving trees and shrubs for increasing food production and facilitating the rehabilitation of the marginal rainfall areas of Kenya.

The specific objectives are as follows:

(i) to evolve farming systems involving multipurpose trees and food crops, and to select the most suitable species;

(ii) to study the production potential of the proposed systems;

(iii) to assess the input requirements, management techniques and economic advantages of the systems;

(iv) to evaluate the effect of farming systems on soil fertility and conservation; and

(v) to demonstrate the feasibility and desirability of the system in the context of current farming practices.

Materials and Methods

The Species

Varieties/species of trees, fodder plants, and agricultural crops suitable for semi-arid areas will be selected. Some information is already available on the suitability of certain species, and these will be used for immediate initiation of the trials. Simultaneously, other promising species will be introduced for the purpose of conducting screening trials. Species of known value that will be included in the trials are:

Forest species

Leucaena leucocephala
Prosopis cineraria
Acacia albida

(The attributes of these species are given in Appendix IV).

Agricultural species

Maize, Zea mays - Katumani Composite-B, or
Sorghum, Sorghum bicolor
Cowpea, Vigna unguiculata

Forage species

Rhodes grass, Chloris gayana
Buffel grass, Cenchrus ciliaris

Basic Experiments

A. Intercropping

The three species will be intercropped with the two food crops and two fodder crops. The trees will be planted out at 3 espacements, and the crops at a single density each.

The espacements of the tree crops will be as follows:

Acacia albida

5.5 x 8.0 m
8.0 x 8.0 m
6.0 x 10.5 m

Others

6.0 x 8.5 m
8.5 x 8.5 m
6.5 x 11.0 m

It is proposed that the agricultural crop be tried at the following

espacements:

maize - 60 x 30 cm
sorghum - 60 x 15 cm
cowpea - 60 x 15 cm

The forage species will be planted out at espacements of 8 x 8 cm, at 3 to 5 seeds per hole. There will be replicated check plots of pure stands of all the species included in the experiment.

B. Selection and screening of species

In addition to the tree species listed aobe, a number of woody species which have shown value as multi-purpose trees/shrubs in location of a similar nature to Kenyan semi-arid conditions will be selected and screened.

The programme will begin with the following species, but others will be included with the passage to time.

Prosopis juliflora
Azadirachta indica
Acacia cynophylla
Zizyphus mauritania
Atriplex spp

As the screening process proceeds, the successful forest tree species will be planted out and intercropped in a manner similar to that outlined in the intercropping trials. The same agricultural species will be used, and the range of espacements and agricultural crop and forage species densities adopted in these trials will be repeated. In addition, the forest tree species will be grown in mixture with other forage species such as *Atriplex*, the forest tree species being planted out at the spacings stated earlier, and the *Atriplex* being grown at uniform densities between the rows of the trees.

C. Observations and studies

1. Measurements of the growth of the intercrops from sample areas selected at random at periodic intervals.

2. Observations of the growth characters of the tree crops.

3. Measurements of the growth of the tree crops: Height measurements of six monthly intervals for the first eighteen months; thereafter measurements of diameter at breast height and height measurements in the same intervals.

4. Yields of the individual crops.

5. Inventory of the inputs used for each treatment.

6. Economic calculation on income accrued, to be recorded based on the current market price of the produce at the time of harvest.

D. Soil studies

The studies will concentrate on the effect of different management systems on soil fertility changes, and also the effect of soil factors on the establishment, growth and yield of the selected species.

Soil from the experimental plots will be sampled at the beginning, middle and end of each season (wet and dry) and analysed for soil moisture, pH, available nutrients and organic matter content.

Soil microbiological studies will be concerned with the isolation and identification of the Rhizobia that will be found to inhabit the root nodules of the crops under investigation. The capacity of the crops to nodulate and fix atmospheric nitrogen in the various cropping systems will be studied. Plant samples will be obtained from forest, forage and food crop stands (pure or mixed) at the beginning, middle and end of both wet and dry seasons of each year in order to examine the effect of the treatments and season on nodulation. The quantities of atmospheric nitrogen fixed by each cropping system will thus be estimated. Subsequently, correlations will be drawn between nitrogen fixation, and crop growth and yield.

E. Nursery and Propagation Studies

Because the project will start with small quantities of propagating materials it will be necessary to establish techniques for maximum seed production and germination, particularly for fodder species. Moreover, since Leucaena crosses readily and some varieties (e.g. Salvador and Pery types) do not set seed prolifically, it is planned to investigate alternative methods of propagation especially for these types. These will include vegetative propagation by use of

cuttings and/or transplants.

F. Duration of the Project

The experiment is proposed for an initial period of 3 years.

G. Site Preparation

The University of Nairobi has recently acquired about 2,000 hectares of undeveloped land at Kibwezi, and plans are under way for the Faculty of Agriculture to establish a Dryland Field Station there for teaching and research purposes. Nevertheless, it is proposed that the project relies on its own resources to prepare the needed land of about 20 has before the Field Station is erected. A nursery, office and store, a propagation frame, and accommodation for one technician, will be the major requirements.

H. Transport

The project will involve intensive travelling within Kenya in search of germplasm material and also in conducting experiments. Moreover, since Kibwezi is 220 km from Kabete, the site of the University, and a number of staff members of the University will be participating in the project, provision has been made for a 4-wheel drive Subaru S/W.

I. Plant Introduction

Kenya, Tanzania and Uganda have for a long time been governed by the same regulations of plant introduction and protection. It is therefore proposed that the initial stock of the germplasm bank constitutes material collected from these countries alone. However, since many new varieties of Leucaena and other desirable species may occur elsewhere, it will be necessary to obtain such materials from their source. Material from other countries will be introduced in collaboration with the Plant Quarantine Station, Muguga, Kenya.

J. Information Dissemination/Exchange and Training

Dissemination of agricultural and forestry research findings in Kenya

is the responsibility of the national Departments of Agriculture and Forestry. The project will establish working relations with these departments. In addition to consultative coordinating meetings attended by collaborating scientists and departments to review the progress of the project, reports, and research results will be published. Although the medium of information will be English, results of direct benefit to the farmer will be published in Swahili.

Moreover provision is made for scientists participating in the project to attend seminars and workshops on the methodologies employed in the project and on the significance of research results. One such seminar will be attended by other scientists in East Africa working in the field of agroforestry in semi-arid regions.

IMPLEMENTATION OF THE PROJECT

Kenyan Involvement

The project will be administratively located in the Department of Soil Science, Faculty of Agriculture, University of Nairobi, Kenya.

The University of Nairobi [illegible] was a constituent college of the University of East Africa until 1970 when it became an autonomous University. The University is made up of nine faculties and five institutes. The Kenyatta University College is a constituent college of the University of Nairobi.

The 8-year old Faculty of Agriculture is situated at Kabete approximately 16 km west of the main University campus. It consists of 6 departments, three of which will participate actively in this project. These are Soil Science, Crop Science and Forestry.

Most of the field experiments carried out by the academic staff of the faculty have previously been sited at the Field Station located 1½ km north-east of the Faculty of Agriculture building. Since Kabete is situated in the high rainfall area and the project will be concerned with marginal rainfall areas, all field studies will be conducted [illegible] recently acquired University land at Kibwezi nearly 220 km south-east of [illegible] Kibwezi is located in the semi-arid zone of Kenya and should therefore provide the correct environment

for the studies. Subsequently, studies may be extended to other similar sites in the country. General information on the climate and soils of the Kibwezi area, to the extent available, is given in Appendices II and III respectively.

The threee participating departments of the Faculty of Agriculture have, with minor exceptions, adequate basic research facilities including well equipped laboratories and libraries, computer services and glasshouses which are all located at Kabete. Furthermore, should there be need, co-operation is possible with non-participating departments of the Faculty of Agriculture, National Agricultural and Forestry research centres, and other institutions. This assumption is based on the experience of similar projects undertaken at the faculty which have been successful in this respect.

Because the project is multi-disciplinary in design, various scientists with different specializations will participate. The Department of Soil Science will provide a microbiologist, a chemist and an horticulturalist, while the Department of Crop Science will contribute a pasture agronomist, and the Department of Forestry, a silviculturalist. It is also planned at a later stage to invite the assistance of an economist from the Department of Agricultural Economics. Further scientific expertise will be available from the Departments of Animal Production and Agricultural Engineering.

The Department of Soil Science which will contribute the largest number of scientists and which has already initiated a similar programme on black wattle (Acacia mearnsii de Wild.), will be the administrative centre of the project.

The scientific Staff include the Project leader, a project co-ordinator, a soil chemist, a pasture agronomist and a silviculturist. In addition to the scientific staff, there will be technical, administrative (clerical) and supporting staff.

The head of the Department of Soil Science, University of Nairobi will be the project leader and administrative authority for the Project. This will be an additional responsibility for him and his salary shall continue to be paid by the University.

The project co-ordinator who will be a full time staff member of the project will be responsible for the routine work concerned with the Project. The project co-ordinator and project leader will work in close collaboration with a member of the core staff of ICRAF, fifty per cent of whose services will be assigned to the project.

The other co-operating scientists (Soil chemist, Pasture Agronomist, and Silviculturalist) will continue to be paid by the University, except that the expenses in connection with the project such as travel and experimental facilities will be met from the project funds.

External Staff

As the University possesses well qualified staff to undertake this project, external staff inputs will be minimal. ICRAF will assign six man months per year to this project, from its Headquarters staff. This project liaison officer will co-ordinate those activities of the project that are related to the donor organization and ICRAF, and that are germane to external travel, education and training etc. He will also be the channel of communication between ICRAF and the project with respect to scientific and technical information.

Support Staff

The custody of project funds released by ICRAF for disbursement in Kenya will be vested in the University of Nairobi. The University's Chief Accountant, assisted by at least one Assistant Accountant/ Accounts Assistant will be responsible for the project funds.

ICRAF Involvement

Recruitment

As has already been noted, six man months per year of ICRAF core staff will be assigned to this project. ICRAF will, in addition, recruit the consultants indicated in Appendix I. ICRAF will also be responsible for paying their salaries and allowances.

Project Monitoring

ICRAF's core staff will provide technical and scientific advice and support to the field staff. Visits of ICRAF core staff will be made, when considered necessary, to the site. In addition, periodic monitoring and evaluation exercises will be undertaken by ICRAF (in collaboration with the University scientists) and six monthly intervals in the first eighteen months of the project. Thereafter, evaluation and monitoring exercises will be carried out at yearly intervals in conjunction with project planning exercises.

Project Revision

ICRAF will organize teams to examine project progress at one yearly intervals. Based on a study of the recommendations of the review teams, ICRAF will consult with the University and decide on modifications and/extensions.

PROPOSED BUDGET

Donor Contribution

The donor contribution, which will be channelled through ICRAF is US$674,200 or US$224,730 annually for 3 years. There is a small capital budget of $43,000, the bulk of the expenditure (US$331,400) being taken up by research personnel and scientists. The training component is $67,000.

University Contribution

The contribution of the University to the project is US$70,300, all of which is accounted for by salaries and allowances to scientists and support staff.

APPENDIX 1

PROPOSED BUDGET

ICRAF CONTRIBUTION

OPERATIONAL BUDGET

Salaries and Allowances	YEAR 1 US$	YEAR 2 US$	YEAR 3 US$	TOTAL US$
1 Project Co-ordinator	13,500	14,000	14,500	42,000
1 Liaison Scientist (½ time)	32,500	35,000	37,500	105,000
1 Senior Technician	8,000	8,400	8,800	25,200
2 Nursery men	5,000	5,300	5,600	15,900
1 Clerk/Typist (part time)	1,000	1,100	1,200	3,300
2 x 2 months constultancies	42,000	46,000	52,000	140,000
	102,000	109,800	119,600	331,400
Research Expenses				
Labour	8,000	8,500	9,000	25,500
Fencing	5,000	-	-	5,000
Hand tools	500	-	-	500
Tractor	2,000	-	-	2,000
Pesticides, fertilizers, seed, etc.	4,000	4,200	4,400	12,600
Laboratory equipment	900	800	500	2,200
Office supplies	1,100	1,200	1,300	3,600
	21,500	14,700	15,200	51,400
Transport and Travel				
International	2,000	3,000	4,000	9,000
Local	12,000	13,500	14,200	39,700
	14,000	16,500	18,200	48,700

	YEAR 1 US$	YEAR 2 US$	YEAR 3 US$	TOTAL US$
Training, Workshops, etc.	28,000	-	28,000	56,000
2 x 2 week seminars	28,000	-	28,000	56,000
2 Publications	-	5,000	6,000	11,000
	28,000	5,000	34,000	67,000
	165,500	146,000	187,000	498,500
Contingencies (10%)	16,600	14,600	18,700	49,900
	182,100	160,600	205,700	548,400

CAPITAL BUDGET

Construction (Garden house, propagation house)	15,000	-	-	15,000
Office equipment and furniture	5,000	3,000	-	8,000
Vehicle	20,000	-	-	20,000
	40,000	3,000	-	43,000

ICRAF BUDGET SUMMARY

Operational	182,100	160,600	205,700	548,400
Capital	40,000	3,000	-	43,000
	222,100	163,600	205,700	591,400
ICRAF service charge (14%)	31,100	22,900	28,800	82,800
	253,200	186,500	234,500	674,200

APPENDIX 1

PROPOSED BUDGET

UNIVERSITY OF NAIROBI CONTRIBUTION

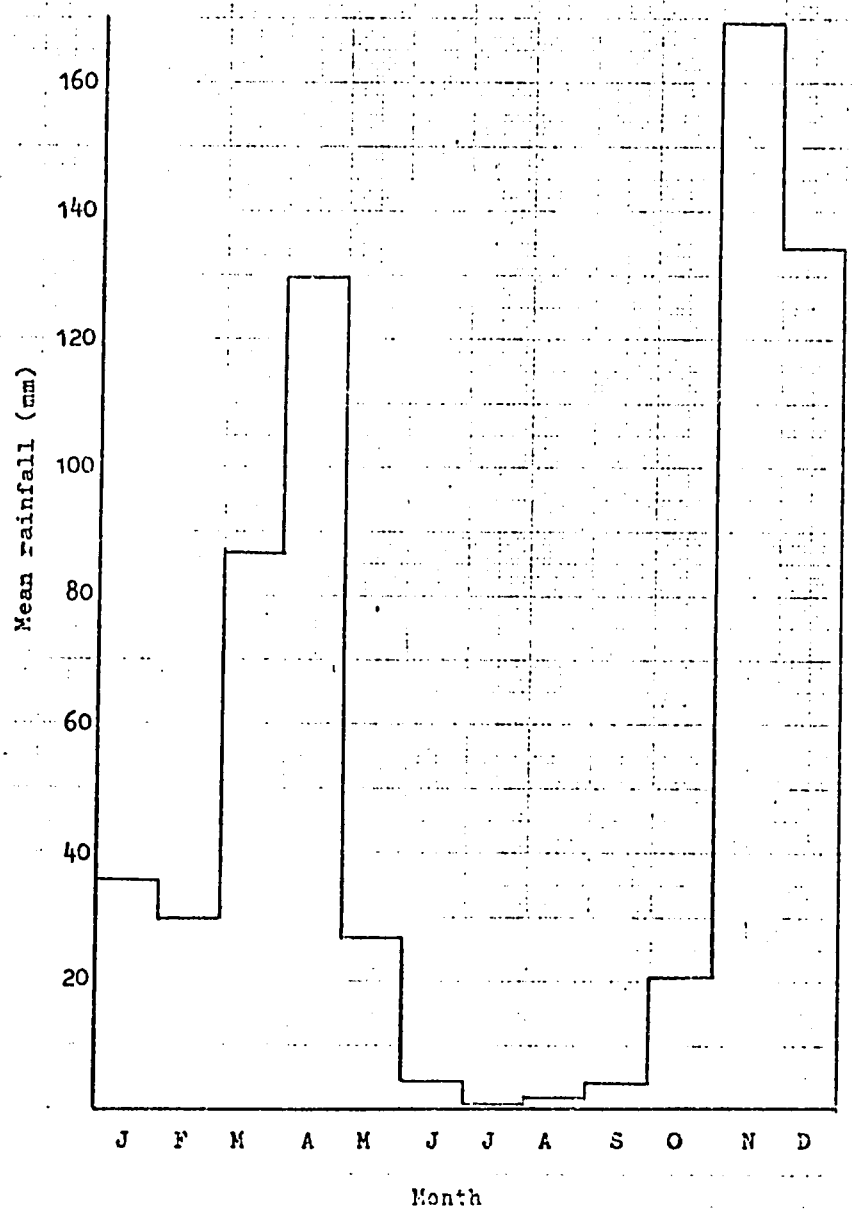
OPERATIONAL BUDGET

Salaries and Allowances	YEAR 1 US$	YEAR 2 US$	YEAR 3 US$	TOTAL US$
Project Leader and Microbiologist (20% of time)	3,000	3,300	3,600	9,900
1 Pasture Agronomist (20%)	2,800	3,100	3,400	9,300
1 Silviculturalist (20%)	2,800	3,100	3,400	9,300
1 Soil Chemist (20%)	2,800	3,100	3,400	9,300
1 Accountant (25%)	3,000	3,300	3,600	9,900
1 Accounts Assistant (50%)	1,400	1,500	1,600	4,500
2 Technicians (20%)	3,000	3,300	3,600	9,900
1 Driver (25%)	500	500	600	1,600
2 Clerks/Typists (25%)	2,000	2,200	2,400	6,600
	21,300	23,400	25,600	70,300

UNIVERSITY OF NAIROBI BUDGET SUMMARY

Operational Budget	21,300	23,400	25,600	70,300
Capital Budget	-	-	-	-
	21,300	23,400	25,600	70,300

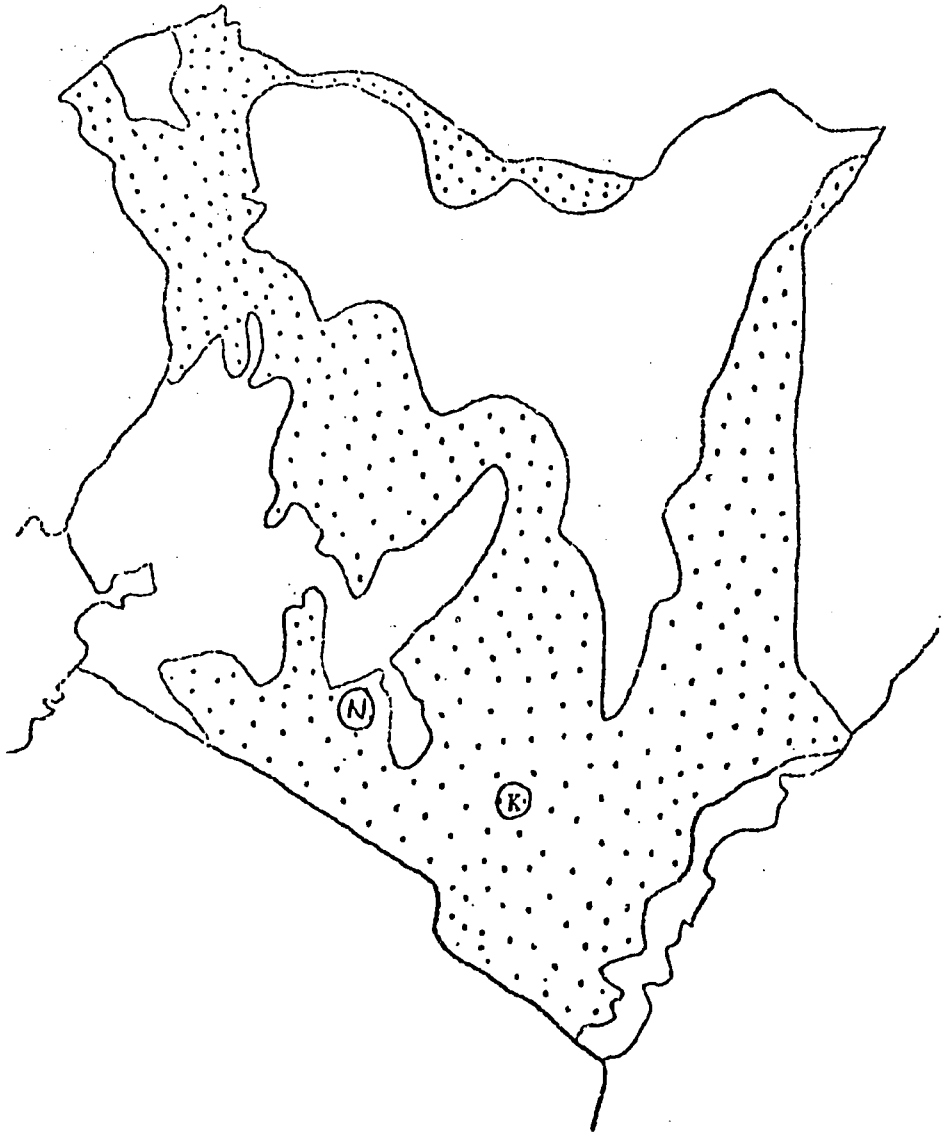
Mean monthly rainfall at Dwa Plantations Ltd., Kibwezi for 59 years up to and including 1977



Mean annual rainfall = 636.8 mm

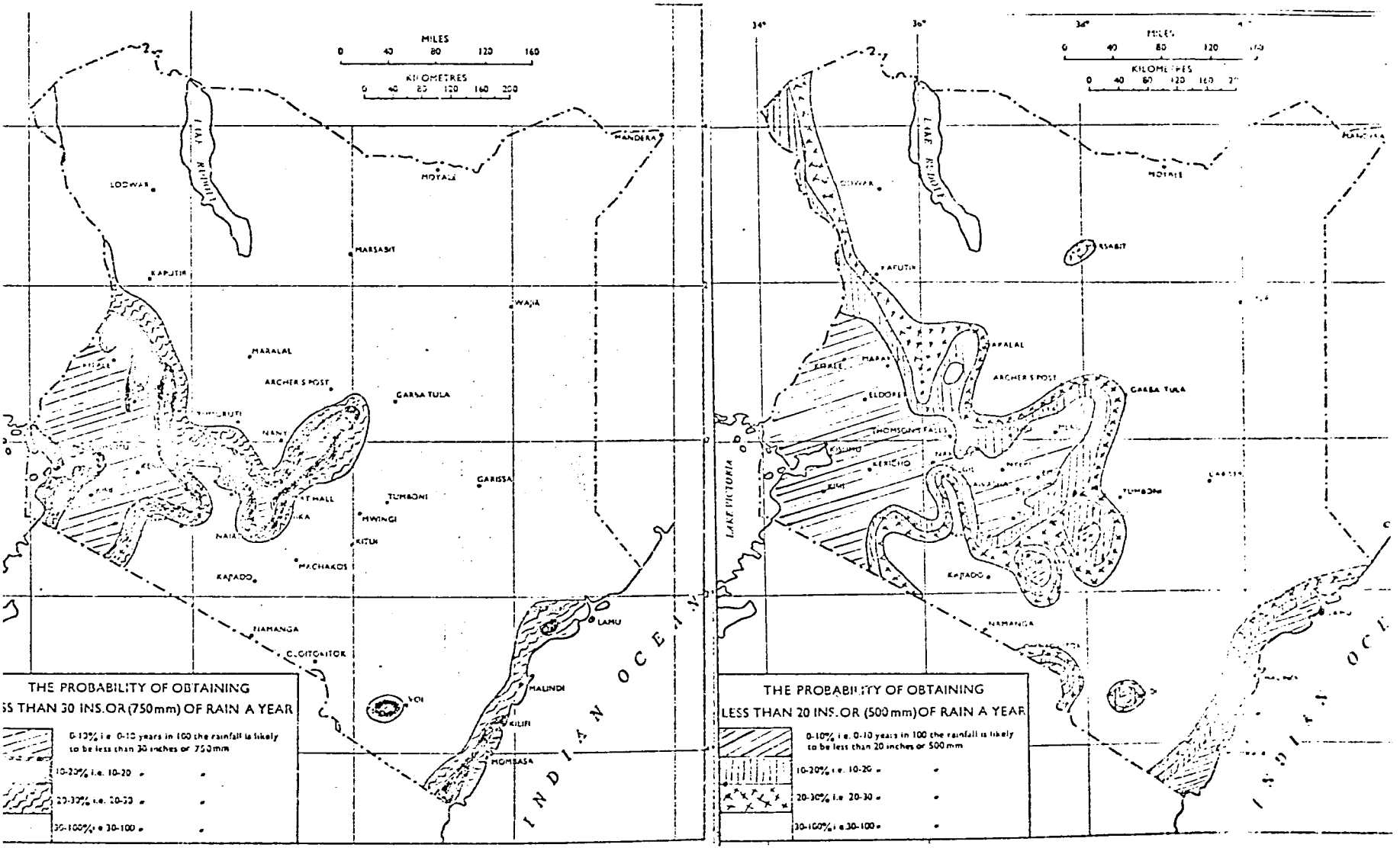
APPENDIX II - 2

Marginal rainfall areas (shaded) of Kenya receiving 250–750 mm of rain per annum



(K) = Kibwezi

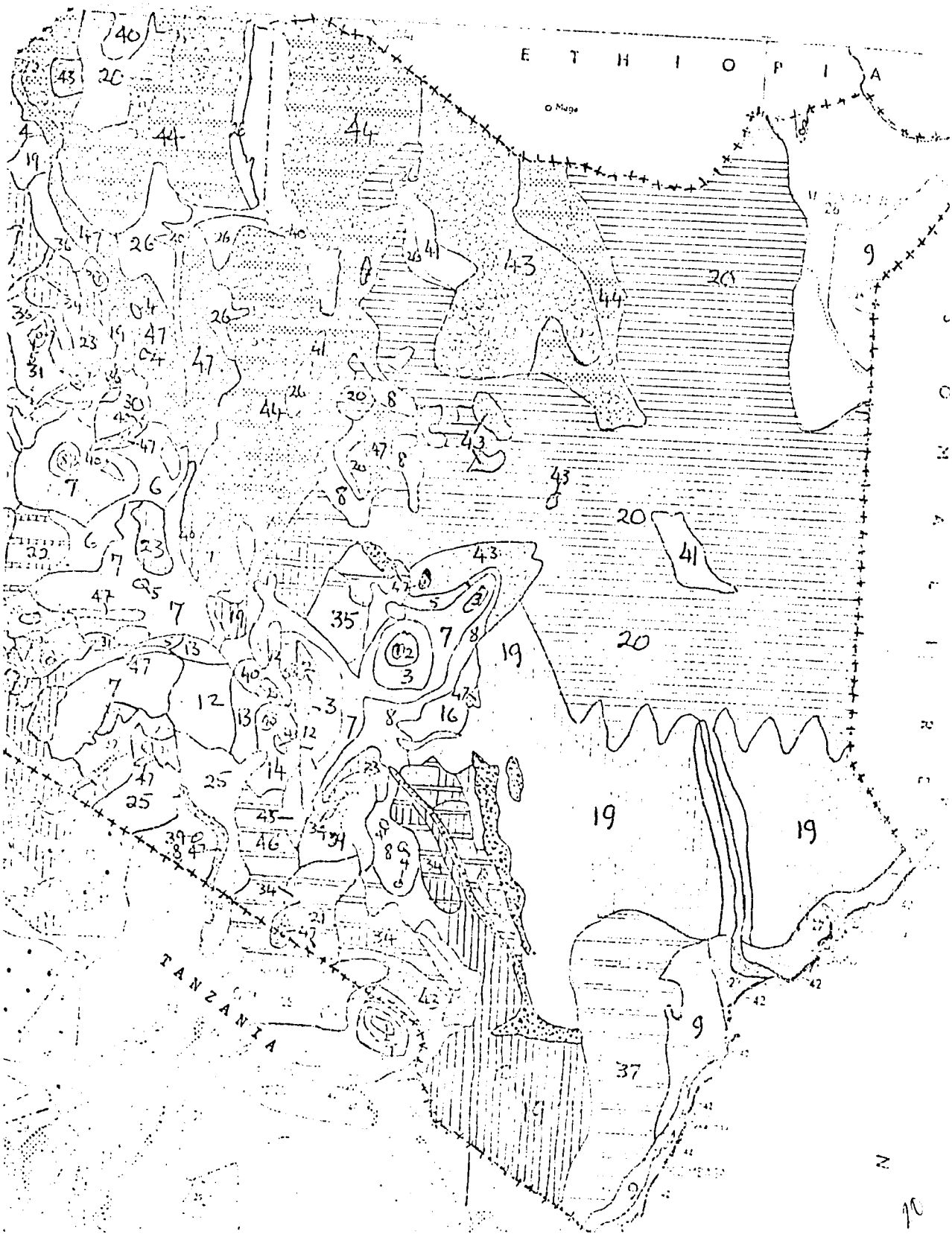
(N) = Nairobi



Rainfall probability in Kenya

APPENDIX III

GENERALIZED SOIL MAP OF KENYA
(BASED ON PHYSIOGRAPHIC FEATUTES)



KEY TO THE SKETCH MAP ON SOILS OF KENYA

SOIL TOPOGRAPHY ASSOCIATIONS

The numbers in the map refer to the soil types.
The different shadings refer to topography types.
(After R.M. Scott, 1967).

I WELL DRAINED SOILS

A. HUMID REGIONS:

1. Strong brown loams (ando-like)
2. Dark brown soils (ando-like)
3. Reddish-yellow sandy clay loams (latosolic)
4. Yellow-red sandy clay loams (latosolic)
5. Dark red friable soils (latosolic)

B. SUB-HUMID REGIONS:

6. Red friable clays (latosolic)
7. Dark red to red loamy sands (latosolic)
8. Red to yellow-red, gritty sandy clay loams (latosolic)
9. Yellow-red loamy sands

C. SEMI-ARID REGIONS:

10. Dark to dark brown calcareous clay loams (Chestnut soils)
11. Dark greyish brown calcareous clay loams (rendzinic soils)
12. Dark red sandy clay loams (latosolic)

D. ARID REGIONS:

13. Brown calcareous sands and sand dunes (Desert soils)
14. Dark red/reddish brown calcareous sandy clay loams (Red Desert soils)

II SOILS WITH SLIGHT SEASONALLY IMPEDED DRAINAGE

15. Brown clay loams to clays
16. Dark reddish brown todark brown clay loams
17. Light yellowish brown to reddish yellow, gritty, sandy clay loams
18. Red to dark red friable clay, with a lateritic horizon
19. Red to yellow red sandy clay loams with a lateritic horizon
20. Strong brown to pale yellow loamy sands with a lateritic horizon

III SEASONALLY WATERLOGGED SOILS

21. Light grey to white mottled loamy sands with a lateritic horizon (ground water laterite)

IV SOILS WITH IMPEDED DRAINAGE

22. Black to dark grey clays (grumosolic soils)
23. Dark brown clays (grumosolic soils)
24. Brown clays (grumosolic soils)

V POORLY DRAINED SOILS

25. Dark greyish brown to very dark brown loams (Alpine meadow soils)
26. Dark brown mottled clays (Gley soils)
27. Dark grey to greyish brown compacted loamy sands (solodized solonetzic soils)
28. Very dark brown clays with light textureed topsoil (planosolic soils)
29. Saline and alkaline clays (Solonchak)

VI LITHOSOLS AND REGOSOLS

30. Alluvium, recent lacustrine deposits and peaty swamps
31. Coastal sands
32. Coral rag
33. Ash and pumice soils
34. Lava boulders
35. Shallow stony soils with rock outcrops
36. Rock and ice
37. Rock and stones

SOILS ON LEVEL TO TOPOGRAPHY:

38. Soil types 19 and 28, with 28 occuring in valley bottom
39. Soil type 22
40. Soil type 30 in dissect of river valleys
41. Soil type 29

SOILS OF REDISSECTED TOPOGRAPHY

42. Soil type 32
43. Type 34 on hill tops and 23 in valley
44. Type 34 on plateau and 35 on edge of plateau or dissect
45. As above, followed by 12 where slope evens out
46. As above but type 10 in place of 12 on gentle slope
47. With type 35 soil on serrated hill sides
48. On a catenary type sequence of types 19, 5, 18, 19, 30, 19, 18, 5, 35,etc.

NOTES ON SOME OF THE PROPOSED WOODY SPECIES FOR USE IN THE PROJECT

Acacia albida

A thorny leguminous tree growing up to 18 m in height and 1 m in diameter. It occurs in the dry savannas of Africa, where rainfall is 400-600 mm growing best on sandy or silty soils. It sheds its leaves during the wet season and comes into leaf at the end of the rainy season and remains green during the hot dry season, a habit which makes it extremely valuable as a shade and fodder tree.

Leucaena leucocephala

(i) It is a good source of forage (containing about 25% protein in the leaves) wood (for pulp and paper and construction work) and fuel (firewood or charcoal).

(ii) Being a leguminous plant, it enriches soils by atmospheric nitrogen fixation.

(iii) Its canopy structure allows transmission of sunlight and is therefore useful as a shade tree for shade tolerant crops.

(iv) It can withstand conditions of drought and wide range of soil conditions including moderate salinity.

(v) It is reasonably resistant to pests and diseases and is quick-growing.

(vi) Leucaena has been established successfully in other parts of the world having similar agroclimatic conditions as that of Kenya. (e.g. Malawi, Mexico).

Prosopis cineraria

The tree has been the subject of some research in India which clearly indicates its suitability for intercropping. It has been introduced to Africa and establishes well in Senegal and Kenya. Its advantages are:

(i) it can be lopped recurrently for a palatable and nutritive fodder without detriment to its growth or subsequent leaf yield'

(ii) soil fertility with respect to organic matter and available macro- and micro-nutrients is significantly higher under P. cineraria than on bare sites or under other dry zones species of Acacia and Prosopis.

(iii) due to its deep root system the water balance of the upper soils is largely independent of the transpiration of the tree and therefore regulated by the shallow rooted ground cover;

(iv) dry herbage yields of several range grasses are considerably increased under P. cineraria.

(v) P. cineraria nodulates with Rhyzobia of the cowpea group; and

(vi) the wood has a high calorific value.

Prosopis juliflora (Swartz) DC

A small evergreen thorny tree or shrub from Central and South America with a short trunk of 50 - 100 cm diam., and a height of 1 - 10 m. The crown is formed by crooked branches with dark green leaves, similar to those of many Acacia species. The fleshy pods are straw coloured when ripe and they are 4 -8 inches long, each containing 10 - 20 hard seeds.

The pods or beams give a sweet pulp, containing about 25% grape sugar, together with up to 17% protein. The pods are good livestock feed and they can be ground into a coarse flour which is baked, after picking out the seeds. The wood can be used for fuelwood, fenceposts and light carpentry work.

The tree grows on poor sandy and rocky soils and in areas characterized by an annual rainfall of 150 - 700 mm and high temperatures, provided the rootgrowth is not impeded. P.juliflora will not grow on badly drained soils.

Growth of this tree is relatively fast (50 - 60 cm height-growth/year for the first 10 years) and it starts yielding pods between the second and fourth year. Often two crops per year can be produced. The trees can yield between 4.5 to 20 tons of pods/ha/year.

P. Felker. (1978)
Mesquite (Prosopis spp.) - A leguminous tree for increasing food, fuel and soil fertility in semi-arid climates
In " New Agricultural Crop"
Ad. G. A. Ritchie. Amer. Assoc. Adv.
Sci.. Proc. of a Symp. Vol. 38.

R.R.B. Leakey & F.T. Last. (in the Press) - See Annexure 5

M.T. Chandler. (1979)
Prosopis, weed or wonder?
Sylva Africana (July issue), 9 - 11.

Azadirachta indica, Juss.

Azadirachta indica, or neem, is a large evergreen tree, 12 - 18 m high with straight trunk and long spreading branches. In drier areas, it may be deciduous. A tree of the drier zone of India and Burma it has naturalized successfully in the different climate zones of Somalia, usually around the towns and inhabited areas.

The neem plant does very well as a shelter belt species. The seeds yield on oil, mainly used for lighting purposes and in small quantities for soap making and for medicical purposes. It can be purified and used for the manufacture of soaps, disinfectants and emulsifying compositions for insecticidal sprays. The residue obtained is a good fertilizer. The oil content of the kernel is 40 - 45%.

It stands maximum shade temperatures as high as 49° C., thrives best in drier climates with normal rainfall of 450 - 750 mm, but it also grows fairly well in areas with a much higher or a lower rainfall.

It grows on all kinds of soils, even saline soils, and thrives better than most other species on dry, stony and shallow soil with a waterless subsoil.

Twigs and topleaves of the plant can be harvested in the third year, seeds can be collected from the 5th year and fuelwood from the 10th year. It produces up to 17 - 25 tons of fruits/ha/year. The dried seed can be stored for 4 - 6 months in well-ventilated godowns.

See S. Radwanski, (1977) Neem Tree
World Crops & Livestock. Mar/Apr issue 62 - 66
May/June 111 - 113
Jul/Aug 167 - 168
Sept/Oct 222 - 224

Acacia cyanophylla Lindl.

A tall shrub, up to 7 m, native to southwest Australia. Grows well in arid/semi arid regions with winter rainfall of 300 - 1000 m. Flourishes on sandy soils and tolerates high pH. Grows from seed very rapidly (2- 3 m in 3 years) and coppices freely.

Very drought resistant and is excellent for sand-fixation. The plant is evergreen and the leaves provide excellent fodder.

Seeds have up to 30% or so crude protein and can be used as a high protein feed for animals.

This species is now being very extensively planted throughout the Mediterranean, Near East and other arid regions.

Zizyphus mauritiana (Lam.)

Zizyphus mauritiana, or Jujuba, is a shrub or tree, 3 - 12 m high usually with a very well-developed root system. The branch are often thorny with small leaves highly variable in form.

Originally a plant of Mongolia, N. China, Turkestan, India, Pakistan and Afghanistan, it is now found widespread through the Mediterranean countries and the arid and semi-arid zones of Africa.

Fruits are eaten fresh and contain Vitamins A and C. Mashed fruits give a fresh beverage. On drying, the pulp surrounding the fruits, becomes farinaceous and can be used fro preparing porridge and bread. The leaves can be eaten by livestock. The trees are used in some regions as a windbreak.

Jujuba grows in areas characterized by high temperatures and very dry periods. It grows where there is average annual rainfall of only 300 - 500 mm (and high air humidity is detrimental).

The plant grows best in sandy or gravelly soils with a pervious subsoil and with a ground water level at no more than 2 - 3 m. It will not grow on heavy clay or compacted soils.

Other species of Zizyphus e.g. Z. lotus (which is from N. Africa) and Z. nummularia (Sahel, Arab Peninsula and Jordan) will also be work trying. Z. spina-christi (syn. Z. hamur) is indigenous to Somalia and its more widespread encouragement is well worth-while.

See P. Munier (1973) Le jujubier et sa culture
Fruits 28, 337-388

V.A. Evreinoff (1964) Notes sur le jujubier
J. Agr. Trop. Bot. Appl. 11, 177-87