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Overseas Development Administration

EMBU-MERU-ISIOLO PROGRAMME, KENYA  
FORESTRY PROJECT

SILVICULTURAL RESEARCH PROGRAMME, 1983-86

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1986

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Results to date - At September 1963 (age 4-5 yrs). Overall survival varied from 0 to 50% (*Callitris robusta*); best height growth demonstrated by *Eucalyptus subglobosa* Kimberly provenance (425 cm, survival 45%). Other promising species are *Garcinia glauca*, *Famarindia indica* and *Acacia albens*.

EMBU-MERU-ISIOLO FORESTRY PROJECT

Silvicultural Research Programme 1983/86

SUMMARY

This project record contains details of 9 trials established during the period 1983/85 with the intention of identifying the more suitable species/provenances for a range of site conditions occurring within the project area. Details of the site, planting material, trial design and summaries of the most relevant data are given. The main features are summarised below:-

Trial 1 Gangara Species Trial Established in April 1983 on a site within Siakago Division, Embu District. Soils are well drained, deep and slightly acidic clay loams. Classified as Ferralo-orthic Agrisols. Average rainfall about 930 mm. There was early losses following a period of drought and extensive replanting was done in 1983, but this planting is excluded from the main trial and regarded as fill-ins. Altitude 1 150 m.

Design A total of 27 species/provenances were included in the first planting, of which 17 were fully replicated in all 6 blocks. At the last assessment in September 1985, 19 species/provenances remained fully represented in all 6 blocks, a further 5 species being partly replicated. Plot size 16 trees in all cases.

Results to date At September 1985 (age 29 mths). Overall survival varies from 0 to 56% (Callitris robusta); best height growth demonstrated by Eucalyptus camaldulensis Kimberly provenance (426 cm, survival 47%). Other promising species are Cassia siamea, Tamarindus indica and Acacia albida.

Leucaena leucocephala, Prosopis juliflora, Grevillea robusta surprisingly performed poorly. Direct sowing of Acacia albida and Acacia polyacantha was not successful, although initial germination was good.

**Trial 2 Gategi Species Trial** Located near Karaba, Gachoka Division of Embu. The trial was originally planted in December 1983, but extensive replanting was carried out in October 1984. Soils are Black Cotton with a pH of 7.6-7.9. Altitude is 1 100 m, average rainfall about 850 mm.

**Design** Randomised Block, there originally being 6 replicates. Replicates 1-3 were established following deep mechanical ripping; replicates 4-6 received hand preparation only. Following early drought deaths, blocks 2, 3, 4 and 6 were replanted in October 1984 to leave blocks 1 and 5 from the original December 1983 planting. The effects of ripping can therefore be compared by Block 1 v Block 5 or Blocks 2 and 3 v 4 and 6.

In Blocks 1 and 5 (1983 replanting) 29 species/provenances had originally been planted in both blocks, a further 6 species being represented in only one of the two blocks i.e. a total of 35 species/provenances. At October 1985 three of these species had been lost.

For Blocks 2, 3, 4, 6 (1984 planting) the spread of species/provenances is:

24 species	planted in all 4 blocks
1 spp	" " " 3 blocks
17 spp	" " " 2 blocks
2 spp	" " " 1 block

44

Plot size was 16 trees in all cases.

**Results to date** There is a marked benefit from ripping for all species in terms of height growth. Survival of the 1984 planting has been good

following reasonable rainfall (81-100%). In October 1985 those species showing promise were Acacia cyanophylla, Acacia nilotica, A. polycantha, Atriplex nummularia, Atriplex semi-baccata, Cassia siamea, Eucalyptus camaldulensis (Petford, Kimberly, Wiluna and Gilbert provenances), E. microtheca (Walgett, Charleville provenances), E. occidentalis, E. tereticornis, (Kennedy provenance), Leucaena leucocephala, Parkinsonia aculeata and Ziziphus mauretiana.

**Trial 3 Marimanti Species Trial** Established within the EMI Goat and Sheep Project farm at Marimanti Location, Meru District. Soils are well drained, (slightly acidic) deep sandy clays. Rainfall on average is about 750 mm, altitude 590 m.

**Design** 6 blocks of which blocks 1-3 were planted following mechanical ripping in December 1983. Blocks 4-6 were planted with only hand preparation during November 1983. A total of 32 different species/provenances were originally included in the trial, most selected for their value as fodder producers. At the last assessment in November 1985 (24 months) the number of species still represented in the ripped plots was 24; of these 18 had been planted in all three blocks (1-3), the remaining 6 being represented in only two of the blocks. Three species only were still surviving in the unripped plots.

**Results to date** The overall growth and survival of the trial has been poor following early drought losses. Best survival is demonstrated by Acacia victoriae (46%), Prosopis juliflora (44%) and Ziziphus mauretiana (42%). Ten provenances of Leucaena leucocephala were included in the trial. K67 has demonstrated the best survival (33%) and K8 the best growth (230 cm).

**Trial 4 Kuani Species Trial** Located on Kuani Hill, Tigania Division, Meru District. The site is established at about 1,500 m altitude on soils classified as Eutric Nitisols - well drained, dark reddish brown clays of pH 6.5. Rainfall believed to be about 750 mm. Planting was carried out in November 1983.

Design A total of 26 species/provenances were included in the trial; 22 of these were fully replicated in all 6 blocks, the remainder being planted in either 1 or 2 blocks only, due to shortage of seedlings. Blocks 1-3 are located on the upper hill, blocks 4-6 on the lower hill on deeply gullied land. At the last assessment (November 1985, age 24 months) 23 species were still represented in the trial. Plot size 16 trees in all cases.

Results to date Eucalyptus camaldulensis (Petford) has demonstrated the best survival (86%) and growth (97 cm). Grevillea robusta is also promising (67%, 66 cm). Growth has been surprisingly slow throughout this trial and the reasons are unclear. The trial has demonstrated the importance of planting as early as possible after the start of the rains. For all species, survival varied from 53% for Block 1 progressively falling to 23% in Block 6, there being a 10 day variation between the commencement of planting of Block 1 through to completion of Block 6.

A direct sowing trial involving a total of 6 species demonstrated this technique would not be suitable. Only one species - Acacia albida - showed acceptable survival (69%), but growth was extremely slow.

Trial 5 Kuani Pine Species Trial Site conditions and location as for the previous trial.

Design 10 pine species were planted in 6 replicates on randomised block design. Blocks 1-3 were located on stable land on the upper hill, blocks 4-6 on gullied land. Plot size 16 trees for all plots. Date of planting, November 1985.

Results to date In April 1986 (age 6 months) all 10 species were still represented within the trial, the survival varying from 89% (Pinus brutia) to 49% (Pinus eldorica). Locally collected Pinus patula stock had a survival of 77%.

**Trial 6 Isiolo (Red Soil) Species Trial** This trial is located close to Isiolo Town on eroded red soils, classified as Ferric Luvisols. The soils are deep but very hard and represent an extreme site. Altitude is 1 150 m, average rainfall about 400 mm.

**Design** Originally planted in November 1983, using a total of 72 species/ provenances involving up to five replicates. Excessive drought losses necessitated some replanting in October 1984 including a further 22 additional species/provenances. Losses were again high and further replanting was carried out in November 1985 using 33 species/provenances that had shown some promise from the previous plantings. It is only this later trial which is of interest now. The 33 species/provenances were planted within four replicates (numbered I, I<sub>E</sub>, II and II<sub>E</sub>). However due to a shortage of seedlings the level of replication varies from 1 to 4.

**Results to date** Survival has been extremely low, considering the November 1985 plantings; in April 1986 (6 months) best survival was only 55% (Terminalia spinosa). Those species shown to have some tolerance of these harsh conditions include Acacia nilotica, A. senegal, A. tortilis, A. victoriae, Balanites aegyptiaca, Cassia sturtii, Eucalyptus camaldulensis (Petford), Leucaena leucocephala (K8), Melia volkensii, Parkinsonia aculeata, Prosopis chilensis, Tamarindus indica, Terminalia spinosa and Ziziphus mauretiana. Many of these species are native.

**Trial 7 Isiolo (Black Soil) Species Trial** The trial is located on Black Cotton soils which are strongly alkaline and sodic. The site is close to Isiolo Town and the previous trial. Altitude is 1 110 m, rainfall about 400 mm. The trial was originally planted in December 1983 but had to be extensively replanted in October 1984.

**Design** Four blocks were located on land previously ripped by mechanical means. One further block was positioned on ground which had not been ripped. Replication was however not complete for all 53 species/

provenances represented in the two plantings. Plot size was 16 trees in all cases.

Results to date At the last assessment (May 1986) only one species still survived - Atriplex nummularia - (53% survival), indicating the severity of the site. Atriplex is known to be tolerant of arid, saline conditions.

Trial 8 Merti Irrigated Species Trial Located at Merti, Merti Division, Isiolo. Altitude is 960 m, rainfall approximately 200 mm but extremely unreliable. The soils are believed to be Vertic Gleysols - imperfectly drained, very deep cracking clay, moderately saline and sodic. Planting was carried out during August-October 1985.

Design A total of 21 species was included in the trial, planted within 4 blocks, but the level of replication is not constant. Four different irrigation treatments have been imposed on the trial:

- Block 1 being watered weekly
- " 2 " watered every 4 weeks
- " 3 " watered every 12 weeks
- " 4 " no watering after initial establishment phase.

Results to date Too early to draw any conclusions although there have been very early losses of Populus ficifolia, a native poplar.

Trial 9 Maranga Species Trial This trial was planted within Maranga Hill Forest Reserve, Runyenjes Division, Embu District. The altitude is 1 420 m, average rainfall believed to be between 900 and 1 000 mm. The soils are deep, well drained loams. Planting was carried out in April/May 1984, using 23 different species/provenances.

Design Five blocks were laid out across the hill, but the level of replication was not constant for all species:-

- 16 species - 5 replicates
- 4 species - 4 replicates
- 3 species - 1 replicate only

Results to date The last assessment was carried out in September 1985 (i.e. at age 17 months). One species - Albizzia falcataria - had not survived; the remaining 22 species showed a survival of 88% to 6%. Best height growth has been demonstrated by Acacia mollissima (582 cm). Those other species showing acceptable growth and survival to date include Leucaena leucocephala, Cassia spectabilis, C. siamea, Eucalyptus grandis x tereticornis hybrid, E. maculata, E. saligna, E. paniculata, Acacia cyanophylla and A. auriculiformis.

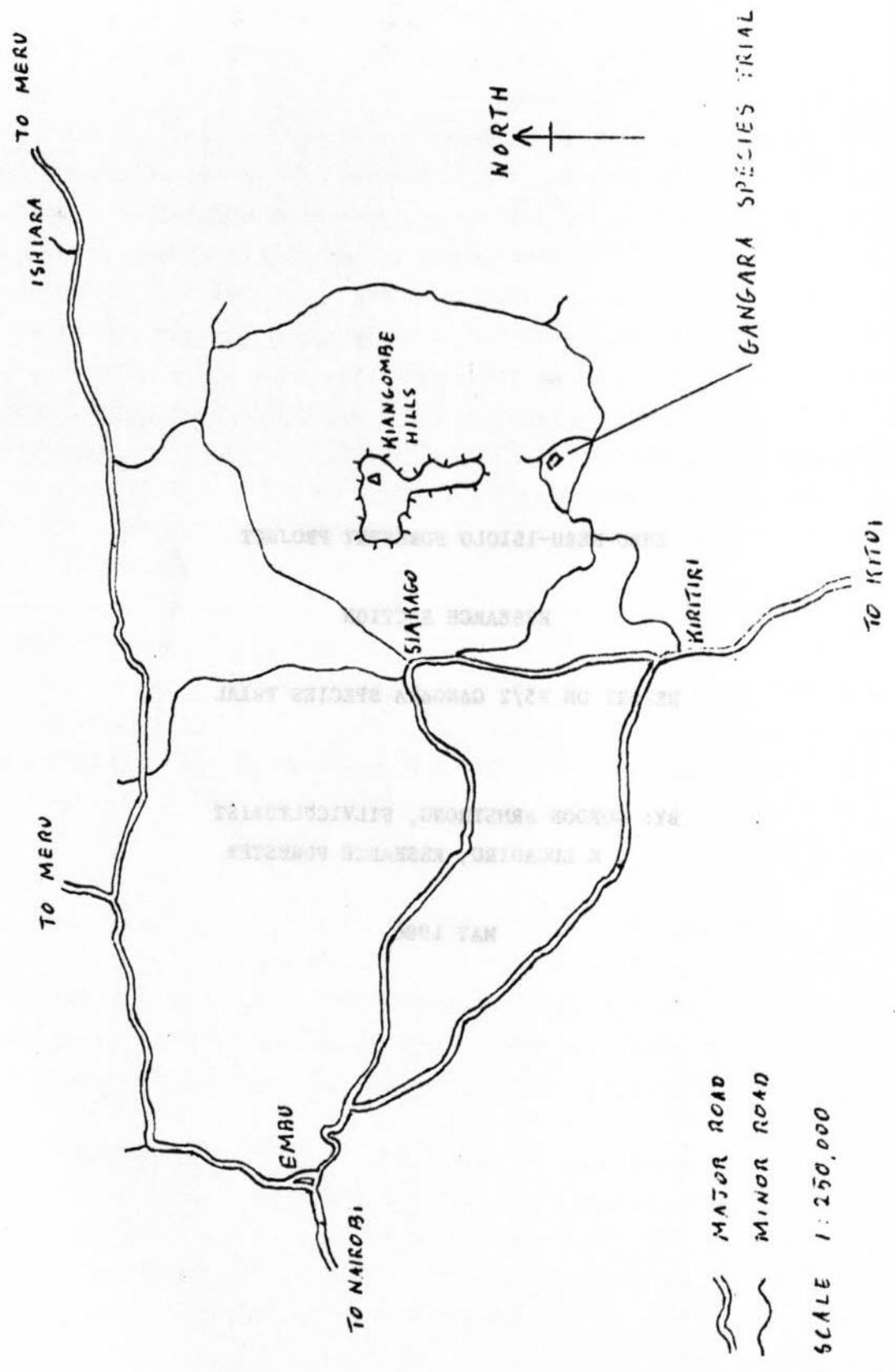
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Trial 10 Tube-Size Trials Seedlings were raised in black polythene tubes of six different sizes, namely, circumference 4 ins by 6 ins depth, 8 x 6 ins, 10 x 6 ins, 10 x 8 ins, 10 x 10 ins and 10 x 12 ins. The standard Forest Department tube of 8 x 6 ins in clear plastic was also included as a control. The stock was planted out as 7 different trials using 4 different species. Three of the trials were full randomised block designs with 5-6 replicates.

Results to date There would appear to be no significant difference between the field survival for all the different tubes except that there was a very slight indication that survival could be reduced with the smallest size. One trial (at Gategi) has been maintained to see if there are long term effects; the remaining trials have been written off.



Fig. 1 LOCATION OF GANGARA SPECIES TRIAL



## AIM:

The aim of the trial is to compare survival and growth of 28 different species/provenances ( and in the case of Acacia albida, two methods of establishment) at this semi-arid site in Embu district. This is the first of a series of species trials established at different sites within Embu, Meru and siolo districts, with the overall objective of identifying suitable tree species to be grown in these areas.

## Location:

The trial is located in 1.8 hectares of Land belonging to Gangara Primary School, Nthawa Location, Siakago Division, Embu District and leased to the Forest Department for a period of 10 years. Latitude is 0° 37' South and longitude is 37° 43' East. This is located on Survey of Kenya 1:500,000 scale sheet 136/1, map reference CK 571 308. The accompanying sketch map ( Fig. 1 ) shows the site's location in relation to major towns and roads.

The site is approximately 70 metres west of the nearest school building and is 65m by 280m in extent, as shown in Figure 2. A watchman, Mr. Samuel N. Njuki is employed to look after the trial.

## Site Description:

The trial is situated on the West-Southwest facing slope of a ridge running approximately North-Northwest to South-Southeast. Altitude varies from 1,150m a-s-l at the northern corner of the plot to 1,140m in the south.

The soils are described as well drained, deep, brownish yellow, slightly acidic, sandy clay loams. A detailed description including analyses, was undertaken by Macharia and Kimotho of the Kenya Soil Survey ( see Appendix I).

The local vegetation is classed as Wooded Bushed Grassland. Dominant tree species are Acacia tortilis, Melia volkensii and Tamarindus indica. Other tree species are Acacia nilotica, Adansonia digitata, Combretum molle, Grevillea robusta ( introduced ), Terminalia brownii, Mangifera indica and Vitex keniensis. The dominant grasses are Eragrostis caespitosa, Hyparrhenia rufa and Cymbopogon excavatus.

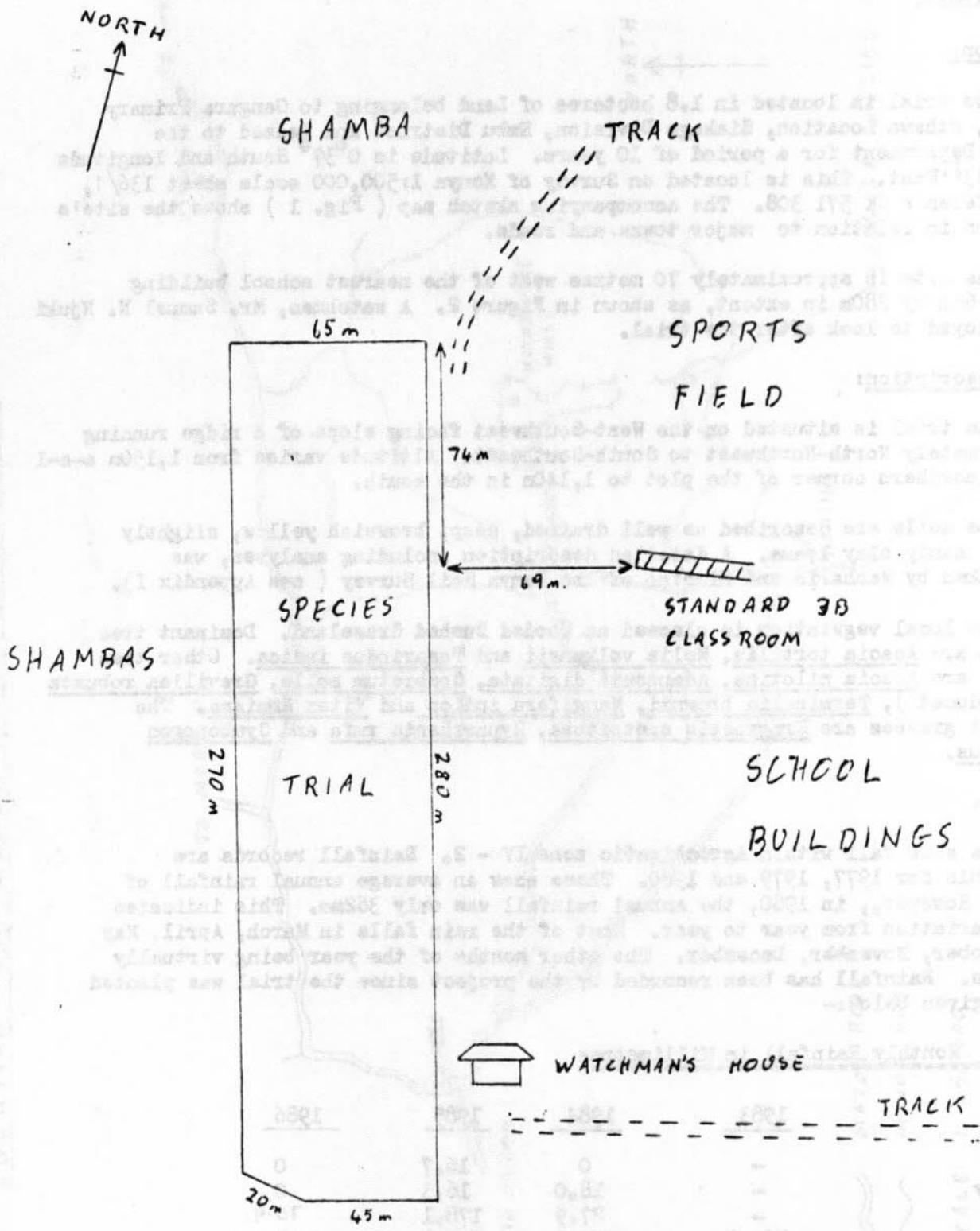
## Climate:

The site falls within Agroclimatic zone IV - 2. Rainfall records are available for 1977, 1979 and 1980. These show an average annual rainfall of 933mm. However, in 1980, the annual rainfall was only 362mm. This indicates great variation from year to year. Most of the rain falls in March, April, May and October, November, December. The other months of the year being virtually rainless. Rainfall has been recorded by the project since the trial was planted and is given below:-

Table I Monthly Rainfall in Millimetres

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
January	-	0	16.7	0
February	-	18.0	16.3	0
March	-	27.9	178.1	70.9
April	264.2	174.2	305.1	310.4
May	27.9	0	39.6	
June	0	0	0	
July	0	0	0	
August	0	0	0	
September	0	9.7	0	
October	51.1	388.4	48.3	
November	125.2	249.2	186.2	
December	99.8	81.5	106.4	
		<u>948.9</u>	<u>896.6</u>	

**Fig. 2 SITE OF GANGARA SPECIES TRIAL**



Site Preparation:

The bush was cleared using hand tools and the branches removed from the site. The grass was slashed. A seven strand barbed wire fence was erected around the site and a watchman's house/store was erected nearby. Pits ( 30cm x 30cm ) were dug at 2m x 3m spacing according to the trial design. Soil was dug out to 30cm depth and then the top 15cm of soil replaced to give a good planting medium.

Species:

The following species were raised specifically for the trial at Ishiara nursery by direct sowing standard 10cm x 15cm ( layflat/polythene tubes. A code of three colours was painted on the tubes to enable easy identification of each species/provenance.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SOURCE</u>	<u>NO. IN TRIAL</u>
BBG	Acacia albida	Baringo (780-005)	2	96
BBW	Acacia cyanophylla		3	96
BBP	Acacia cyclops		2	96
WPY	Albizia falcata		2	32
WPG	Cassia siamea	Ishiara	1	96
RRR	Eucalyptus camaldulensis	L. Albacutya (BN 10666)	4	96
RRY	Eucalyptus camaldulensis	Kimberly (BN 12346)	4	96
RRB	Eucalyptus camaldulensis	Petford (BN 13159)	4	96
RRW	Eucalyptus camaldulensis	Katherine (BN 12182 )	4	96
RRG	Eucalyptus camaldulensis	Ord River (BN 12352)	4	96
RRP	Eucalyptus maculata	Muguga (455-026)	2	96
RYG	Eucalyptus microtheca	W. Coolarnebri (BN 11604)	4	96
RYY	Eucalyptus paniculata	Kirinyaga (474-018)	2	96
RYB	Eucalyptus sideroxylon	Staliel (BN 10729 )	4	96
RYY	Eucalyptus tereticornis	Gede (506-008)	2	96
GRB	Leucaena leucocephala	K8	5	80
GGR	Prosopis cineraria	Oman	6	48
GGB	Prosopis juliflora	Hola	2	96
WY	Robinia pseudoacacia		3	32

NOTE: For list of Seed Sources see Appendix 2

The following species were collected from stock already growing in tubes at various nurseries.

<u>CODE</u>	<u>SPECIES</u>	<u>NURSERY</u>	<u>NO. IN TRIAL</u>
G	Callitris robusta	Ishiara, Embu	32
C	Cassia spectabilis	Ishiara, Embu	32
A	Casuarina equisetifolia	Ishiara, Embu	96
H	Conocarpus lanifolius	Kositei, Baringo	16
D	Cordia abyssinica	Tunyai, Meru	32
B	Grevillea robusta	Ishiara, Embu	96
F	Melia azedarach	Embu, Town	32
E	Tamarindus indica	Tunyai, Meru	32

The following two species were sown directly into the pits at the same time as the others were planted.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SOURCE</u>	<u>NO. OF SEEDS PER PIT</u>	<u>NO. OF PITS</u>
J	Acacia albida	Baringo (780-005)	2	2	32
I	Acacia polyacantha	Ena, Embu	1	4	32

Trial Design:

The trial was laid out in 6 blocks aligned at right angles to the slope. Within each block 16 tree plots ( 4 x 4 ) of each species/provenance were allocated at random. ( A randomised block design ). Most species occur in all 6 blocks ( giving a total of 96 trees ), but some species ( normally those for which insufficient seedlings were available ) do not occur in all blocks. A plan of trial as planted in April 1983 is given in Figure 3.

Trial History:

The trial was planted on 8th and 9th April, 1983. Rainfall that season was about average for the site. This was followed by a period of drought, both the October/November 1983 and March/April 1984 rains seasons being very poor. It was not until October 1984 that rainfall returned to more normal levels. By April 1984, 40 of the 16-tree plots were empty ( i.e. all the originally planted trees had died ). These plots were replanted with standard nursery stock of various species but are not considered part of the trial. The design of the trial after this replanting is shown in figure 4.

The trees have been regularly clean weeded in 'spots' around each seedling, and the grass growing between the 'spots' has been slashed. The height of each tree has been measured twice per year, at the end of each dry season.

Results:

Summaries of the results of each assessment are given in tables 2-6. The species provenances are ranked according to survival rates. As would be expected most mortality occurred during the first dry season after planting. However the 1983/84 drought caused significant further mortality up to October 1984. Growth rates were also depressed till October 1984.

Discussion:

Although it is too early to draw final conclusions from the trial, a number of species are showing themselves to be well adapted to the site. This is in spite of the drought during 1983/84 which depressed both survival and growth rates. Promising species are Eucalyptus camaldulensis ( in particular the Kimberly provenance ), Cassia siamea and Callitris robusta. Tamarindus indica and Acacia albida have acceptable survival rates but low growth rates. Species such as Cassia spectabilis, Casuarina equisetifolia and Grevillea robusta might have been expected to perform better had conditions not been so unusually severe, as there are specimens of these trees growing satisfactorily in the locality.

*fastest*

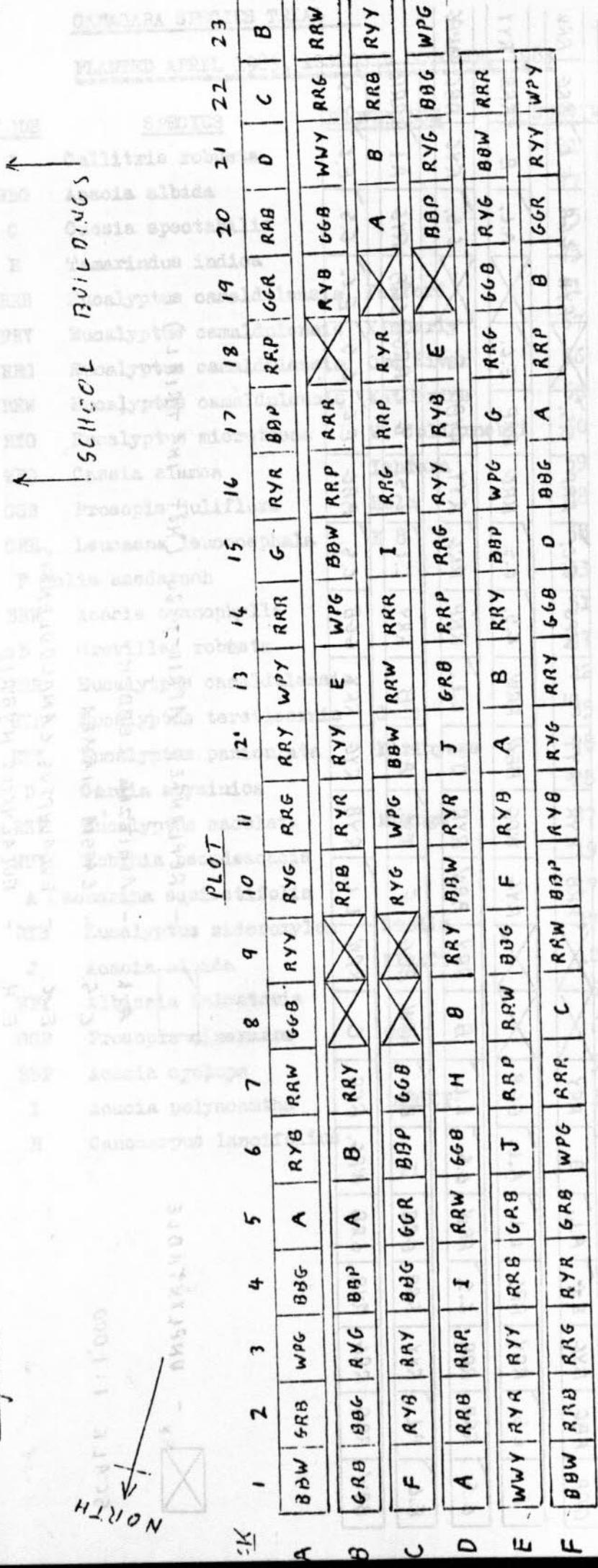
The ~~first~~ fastest growing trees are those of the Kimberly provenance of Eucalyptus camaldulensis which by September 1985, had an average height of 4.26 metres. The tallest tree was 7.99 metres. It was observed that the primary cause of death in this species was not the lack of moisture itself but termite attack.

Two species which have performed surprisingly poorly are Leucaena leucocephala and Prosopis juliflora. At first, it was thought that the poor performance of Leucaena was due to lack of nodulation but careful inspection of the roots of some individuals showed nodules to be present. These nodules had a grey-pick colour inside indicating active nitrogen fixation. It is probable that the acidity of the soil is an inhibiting factor as Leucaena has only grown well on neutral to alkaline soils within the project.

Other project trials have shown that the provenance of Prosopis juliflora used in this trial was very poor so it is likely that different provenances would have done better. The importance of provenance selection in Eucalyptus camaldulensis is demonstrated by the very poor survival of the Lake Albacutya provenance compared to the others.

DESIGN OF GANAGARA SPECIES TRIAL

Fig 3



NOTES

- 1. EACH PLOT CONTAINS 16 (4 x 4) TREES PLANTED AT 2 M. X 3 M. SPACING.
- 2. KEY TO SPECIES CODES WITHIN TEXT.

- UNPLANTABLE



SCALE 1:1,000  
( 1 MILLIMETRE = 1 METRE )

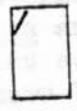
DESIGN OF GANDAK SPECIES TRIAL AFTER REPLANTING APRIL 1924

Fig 4



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
B&W	GRB	GRB	WPG	BEG	E.C.	C.S.	RAW	C.S.	RYY	RYG	RRG	RRY	WPY	RRR	G	RYR	E.C.	E.C.	L.L.	RRB	L.L.	E.H.	B
G&R	B&G	RYG	E.C.	A.L.	B	RRY	RRY	RRY	RYR	RRB	RYR	RYY	E	WPG	E.C.	RRP	E.C.	RYB	G&B	E.C.	RRW	RRG	RRW
F	C.S.	RRY	B&G	L.L.	A.L.	G&B	RRY	RRY	RRY	RYG	WPG	B&W	RRW	C.S.	C.S.	RRG	RRP	E.C.	A.L.	B	RRB	RYY	WPG
C.S.	RRB	RRR	RRR	C.S.	RRW	C.S.	L.L.	B	RRY	B&W	RYR	J	L.L.	RRP	RRG	RYY	RYB	E	C.S.	RYG	B&G	WPG	WPG
E.C.	A.L.	RYY	RRB	RRB	J	E.C.	RRW	B&G	F	E.C.	A	B	RRY	L.L.	C.S.	G	RRG	G&B	RYG	A.L.	RRR	RRR	RRR
B&W	RRB	RRG	RYR	GRB	WPG	RRR	C	RRW	L.L.	RYB	RYC	RYC	RYC	RRY	G&B	B&G	E.C.	C.S.	E.C.	C.S.	E.C.	C.S.	C.S.

- REPLANTED APRIL 1924 (NOT IN TRIAL)



- ALBIZIA LEBDEK
- CASSIA SIAMEA
- EUCALYPTUS CANALDULENSIS
- EUCALYPTUS HYBRID
- LFVLAENA LEUCOCEPHALA

- UNPLANTABLE

SCALE 1:1,000

PLANTED APRIL 1983, ASSESSED OCTOBER, 1983

CODE	SPECIES	PROVENANCE	% SURVIVAL	AV. HT.
G	<i>Callitris robusta</i>		81	28cm
BBG	<i>Acacia albida</i>		77	35cm
C	<i>Cassia spectabilis</i>		75	15cm
E	<i>Tamarindus indica</i>		75	11cm
RRB	<i>Eucalyptus camaldulensis</i>	Petford	71	46cm
RRY	<i>Eucalyptus camaldulensis</i>	Kimberly	67	62cm
RRG	<i>Eucalyptus camaldulensis</i>	Ord River	66	45cm
RRW	<i>Eucalyptus camaldulensis</i>	Katherine	65	55cm
RYG	<i>Eucalyptus microtheca</i>	W. Colborneii	60	41cm
WPC	<i>Cassia siamea</i>	Ishiara	59	23cm
OOB	<i>Prosopis juliflora</i>	Hola	58	27cm
GRB	<i>Leucaena leucocephala</i>	K 8	58	15cm
F	<i>Melia azedarach</i>		53	22cm
BBW	<i>Acacia cyanophylla</i>		51	28cm
B	<i>Grevillea robusta</i>		47	12cm
RHR	<i>Eucalyptus camaldulensis</i>		42	50cm
RYR	<i>Eucalyptus tereticornis</i>	Gede	35	37cm
RYY	<i>Eucalyptus paniculata</i>	Kirinyaga	28	36cm
D	<i>Cordia abyssinica</i>		28	32cm
RRP	<i>Eucalyptus maculata</i>	Muguga	27	24cm
WWY	<i>Robinia pseudoacacia</i>		19	5cm
A	<i>Casuarina equisetifolia</i>		17	42cm
RYB	<i>Eucalyptus sideroxylon</i>	Stolie	17	29cm
J	<i>Acacia albida</i>	DIRECT	12	5cm
WPY	<i>Albizia falcataria</i>		6	17cm
QGR	<i>Prosopis cineraria</i>	Oman	6	16cm
BBP	<i>Acacia cyclops</i>		5	17cm
I	<i>Acacia polyacantha</i>	DIRECT	3	4cm
H	<i>Canocarpus lancifolius</i>		0	0

GANGARA SPECIES TRIAL

TABLE 3

PERCENT SURVIVAL AND HEIGHT GROWTH AT 20/3/81.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>% SURV.</u>	<u>AVERAGE HGT. (cm.)</u>
E	<i>T. arindus indica</i>	Turyai	69	17
G	<i>Callitris robusta</i>	Ishiana	66	45
REG	<i>Acacia alba</i>	Baringo	60	33
RRW	<i>Eucalyptus camaldulensis</i>	Kathorine	58	125
RRY	<i>Eucalyptus camaldulensis</i>	Kimberly	53	122
REB	<i>Eucalyptus camaldulensis</i>	Petford	50	80
REG	<i>Eucalyptus camaldulensis</i>	Ord River	54	92
RYU	<i>Eucalyptus microtheca</i>	W. Callaruebri	51	67
GRS	<i>Leucosena leucocephala</i>	KB	46	30
WFG	<i>Cassia siamea</i>	Ishiana	45	45
C	<i>Cassia spectabilis</i>	Ishiana	41	51
F	<i>Melia azadirach</i>	Embu	34	25
QGB	<i>Procopsis juliflora</i>	Hola	30	18
BSW	<i>Acacia cyanophylla</i>	SINROPA	23	45
RYH	<i>Eucalyptus tereticornis</i>	Gedo	22	75
RRR	<i>Eucalyptus camaldulensis</i>	L. Albeoutya	20	100
RRY	<i>Eucalyptus paniculata</i>	Kiritaga	15	61
B	<i>Grevillea robusta</i>	Ishiana	15	30
A	<i>Casuarina Equisetifolia</i>	Ishiana	9	61
RYB	<i>Eucalyptus sideroxylon</i>	Satial	6	37
RRP	<i>Eucalyptus maculata</i>	Nuguga	4	30
RRR	<i>Procopsis cineraria</i>	Qmen	2	12
J	<i>Acacia alba</i> - DIRECT SOWN		0	0
WRY	<i>Robinia pseuacacia</i>		0	0
I	<i>Acacia polyantha</i>	DIRECT SOWN	0	0
D	<i>Cordia abyssinica</i>	Turyai	0	0
RRP	<i>Acacia cyclops</i>		0	0
WRY	<i>Albizzia falcataria</i>		0	0

ASSESSED 4/10/84.

CODE	SPECIES	SURVIVAL %	AV. HEIGHT.
G	Callitris robusta	59	58cm.
RRW	Eucalyptus camaldulensis -KATHERINE	51	170cm.
RRY	Eucalyptus camaldulensis -KIMBERLY	51	121cm.
E	Tamarindus indica	50	22cm.
RRB	Eucalyptus camaldulensis -PETFORD	47	119cm.
BBG	Acacia albida	44	23cm.
RRG	Eucalyptus camaldulensis-ORD RIVER	43	131cm.
RYG	Eucalyptus microtheca	40	101cm.
WPG	Cassia siamea	39	89cm.
F	Melia azedarach	34	29cm.
C	Cassia spectabilis	31	97cm.
GRB	Leucaena leucocephala	31	40cm.
BBW	Acacia cyanophylla	15	66cm.
RRR	Eucalyptus camaldulensis -L-ALPACUFYA	13	157cm.
RYY	Eucalyptus paniculata	9	92cm.
GGB	Prosopis juliflora (?)	7	23cm.
RYR	Eucalyptus tereticornis - CREDE	5	103cm.
A	Casuarina equisetifolia	3	91cm.
B	Grevillea robusta	3	50cm.
RYB	Eucalyptus sideroxylon	2	55cm.
RRP	Eucalyptus maculata	2	55cm.
GGR	Prosopis cineraria	0	0
J	Acacia albida - DIRECT SOWN	0	0
WVY	Robinia pseudoacacia	0	0
I	Acacia polyacantha - DIRECT SOWN	0	0
D	Cordia abyssinica	0	0
BBP	Acacia cyclops	0	0
WPY	Albizia falcataria	0	0

GANGARA SPECIES TRIAL - PLANTED APRIL 1983.

TABLE 5

PERCENT SURVIVAL AND HEIGHT GROWTH AT 19/3/85

CODE	SPECIES	PROVENANCE	AVERAGE	
			% SURVIVAL	HT (cm)
G	Callitris robusta		56	81
RRY	Eucalyptus camaldulensis	Kimberly	49	330
RRW	Eucalyptus camaldulensis	Katherine	47	269
E	Tamarindus indica		47	26
RRB	Eucalyptus camaldulensis	Petford	43	191
RRG	Eucalyptus camaldulensis	Ord River	43	235
BBG	Acacia albida		38	34
WFG	Cassia siamea		38	159
RYG	Eucalyptus microtheca		33	143
F	Melia azedarach		31	29
C	Cassia spectabilis		28	162
GRB	Leucaena leucocephala		18	51
RRR	Eucalyptus camaldulensis	L Albacoutya	11	246
BBW	Acacia cyanophylla		10	162
RYR	Eucalyptus tereticornis		6	182
RYT	Eucalyptus paniculata		5	141
A	Casuarina equisetifolia		2	132
RRP	Eucalyptus maculata		2	56
B	Grevillea robusta		2	110
OCB	Prosopis juliflora		2	21
RYB	Eucalyptus sideroxylon		1	70
OCR	Prosopis cineraria		0	0
J	Acacia albida	<u>Direct Sown</u>	0	0
WVY	Robinia pseudoacacia		0	0
I	Acacia polyacantha -	<u>DIRECT SOWN</u>	0	0
D	Cordia abyssinica		0	0
BBP	Acacia cyclops		0	0
WEY	Albizzia falcataria		0	0

GANGARA SPECIES TRIAL

TABLE 6

PLANTED APRIL, 1983 ASSESSED SEPTEMBER, 1985

CODE	SPECIES	PROVENANCE	% SURVIVAL	AV. HT
G	Callitris robusta		56	150 cm.
RRY	Eucalyptus camaldulensis	Kimberly	47	426 cm.
E	Tamarindus indica		47	29 cm.
RRW	Eucalyptus camaldulensis	Katherine	46	338 cm.
RRG	Eucalyptus camaldulensis	Ord River	41	300 cm.
RRB	Eucalyptus camaldulensis	Petford	41	222 cm.
WPG	Cassia siamea		38	203 cm.
BBG	Acacia albida		35	38 cm.
F	Melia azedarach		31	33 cm.
RYG	Eucalyptus microtheca		30	186 cm.
C	Cassia spectabilis		28	194 cm.
GRB	Leucaena leucocephala		11	107 cm.
BBW	Acacia cyanophylla		8	83 cm.
BRR	Eucalyptus camaldulensis	L. Albacutya	6	359 cm.
RYR	Eucalyptus tereticornis		5	227 cm.
RYY	Eucalyptus paniculata		4	95 cm.
A	Casuarina equisetifolia		3	121 cm.
B	Grevillea robusta		2	172 cm.
RRP	Eucalyptus maculata		2	46 cm.
GGB	Prosopis juliflora		0	0
RYB	Eucalyptus sideroxylon		0	0
J	Acacia albida	DIRECT SOWN	0	0
WWY	Robinia pseudoacacia		0	0
J	Acacia polyacantha	DIRECT SOWN	0	0
D	Cordia abyssinica		0	0
BBP	Acacia cyclops		0	0
WRY	Albizzia falcatoria		0	0

The attempt to establish Acacia albida and Acacia polyacantha by direct sowing of seeds at the planting site obviously failed. Although germination of both species was good very few seedlings survived the first dry season and all had died by March 1984.

The trial is now beginning to have a demonstration effect. Local farmers have started to request seedlings of the types growing well in the trial. In October/November 1985 over 1,500 seedlings of Eucalyptus camaldulensis, Callitris robusta, Cassia siamea and Grevillea robusta were distributed from the trial site.

GANGARA SPECIES TRIAL      APPENDIX 1

PROFILE DESCRIPTION NO.2

General site information

Soil classification : ferralo\*-orthic Acrisol  
 Agro-climatic zone : III - IV  
 Observation No./Date : 136/1-2, 24/1/84  
 Location/Altitude : Embu District; 0°38'S 37°43'E  
 Local petrography : Undifferentiated Basement System rocks  
 Physiography : Upland  
 Relief, macro : Undulating to rolling, slope 5-8%  
 Land use : Tree trials (formerly under grazing)  
 Rockiness/stoniness : Fairly stony  
 Internal drainage : Well drained

Profile description

Ap	0-20cm	Brown to dark brown (10YR 4/3, 10YR 3/3 moist); sandy loam; moderate, fine subangular blocky structure; loose when dry, friable when moist, slightly sticky and non plastic when wet; many fine and medium pores; very few fine and very fine roots; pH 5.9; clear, smooth transition to: (sample no. 136/1-2a)
Bu	20-35cm	Dark yellowish brown (10YR 5/4, 10YR 4/3 moist); sandy loam; moderate, medium subangular blocky structure; loose when dry, friable when moist, slightly sticky and non plastic when wet; many fine and very fine roots; pH 5.8; diffuse, smooth transition to: (sample no. 136/1-2b)
Bt <sub>1</sub>	35-80cm	Brownish yellow (10YR 6/8, 7.5YR 5/8 moist); sandy clay loam; moderate, fine subangular blocky structure; slightly hard when dry, friable when moist slightly sticky and slightly plastic when wet; many fine and medium pores; very few very fine, fine and medium roots; pH 5.3; diffuse, wavy transition to: (sample no. 136/1-2c)
Bt <sub>2</sub>	80-120cm+	Brownish yellow (10YR 6/8, 7.5YR 5/8 moist); sandy clay loam; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and medium pores; no roots observed; few iron and manganese concretions; pH 4.9 (sample no. 136/1-2d).

GANGARA SPECIES TRIAL      APPENDIX I CONTD.

- 23 -

LABORATORY DATA OF PROFILE DESCRIPTION No. 2

Observation no: 136/1-2      Mapping unit: GANGARA      Soil classification: ferral<sup>h</sup>-orthic  
ACRISOL

Laboratory no.	B4	282	283	284	285
Horizon		Ap	Bu	Bt1	Bt2
Depth (cm)		0-20	20-35	35-80	80-120
pH-H <sub>2</sub> O (1:2½ v/v)		5.9	5.8	5.3	4.9
pH-KCl 1:2½ "		5.0	4.7	4.2	4.2
EC (µmho/cm) 1:2½ "		0.05	0.04	0.02	0.05
CaCO <sub>3</sub> (%)					
CaSO <sub>4</sub> (%)					
C (%)		0.31	1.29	0.49	0.69
N (%)					
C/N					
CEC (me/100g), pH 8.2		2.4	3.1	6.7	6.9
CEC " " pH 7.0					
Exch. Ca (me/100g)		1.2	1.4	1.0	1.2
" Mg "		0.41	0.84	0.56	0.72
" K "		0.52	0.50	0.14	0.20
" Na "		0.52	0.41	0.30	0.44
Sum of cations		2.65	3.15	2.0	2.56
Base sat. %, pH 8.2		100+	100+	30	37
" " %, pH 7.0					
ESP at pH 8.2					
<u>Texture (limited pretreatment)</u>					
Gravel % (>2.0mm)					
Sand % (2.0-0.05mm)		78	76	64	60
Silt % (0.05-0.002mm)		12	10	8	10
Clay % (0.002-0mm)		10	14	28	30
Texture class		SL	SL	SCL	SCL
<u>Fertility aspects</u>		0 - 30 cm			Laboratory no. 903
<u>General</u>		<u>Available nutrients</u>			
pH-H <sub>2</sub> O (1:2½ v/v)			Na (me/100g)	0.04	Mn (me/100g) 0.10
Exch. acidity (me/100g)			K "	0.88	P (ppm) 20
C %	0.049		Ca "	0.8	P-Olsen (ppm) 5
N %	0.06		Mg "		
<u>Remarks:</u>					

APPENDIX 2 SEED SOURCES.

I. Local collection.

2. The Seedsman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74  
Kikuyu  
KENYA.
3. Setropa Ltd.,  
P.O. Box 203  
BUSSUM 1400 AE  
HOLLAND.
4. C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
5. Dr. J.L. Brewbaker  
Department of Horticulture  
University of Hawaii  
Honolulu  
Hawaii 96822  
U.S.A.
6. Dr. R. Lawton  
P.O. Box 467  
Muscat  
OMAN.

MAY 1986

LABORATORY REPORT OF SOIL ANALYSIS

Observer

Labo	284	285
Hori		
Depth	0-10	10-20
pH-H <sub>2</sub> O	5.2	5.3
pH-KCl	4.8	4.7
EC (mhos/cm)	0.28	0.35
CaCO <sub>3</sub>		
CaSO <sub>4</sub>		
C (%)	0.71	0.67
N (%)		
C/N		
CEC (meq/100g)	2.4	2.3
CEC		
Exch.	1.2	1.2
"	0.47	0.73
"	0.12	0.20
"	0.22	0.44
Sum c	2.01	2.54
Base		
"		
ESP a		
Textu		
Grave		
Sand	73	60
Silt	12	10
Clay	10	30
Textu	SL	ML
Perti		
Gener		
pH-H <sub>2</sub> O	5.2	5.3
Exch.	0.28	0.35
C %	0.71	0.67
N %		
Remark		

The aim of the trial is to compare survival and growth of 57 different species/progenies at this semi-arid, black cotton soil site in Embu district. It is one of a range of species trials established at different sites within Meru and Isiolo districts with the overall objectives of identifying suitable tree species for rural afforestation in these areas.

The trial is located on 1.0 hectares of land belonging to Gategi Secondary school, Karaba location, Gashaka Division, Embu District, and leased to the Forestry Department for a period of ten years. Latitudes 0° 45' South and longitudes 37° 20' East. This is located on Survey of Kenya 1:50,000 scale sheet 240172. Figure 1 shows the sites location in relation to major towns and roads.

The site is immediately west of the school compound and south of the Karaba road. Details shown in the accompanying sketch. (Fig 2). A Tube-Dial trial is located on the same site.

**EMBU-MERU-ISIOLO FORESTRY PROJECT**

**RESEARCH SECTION**

**REPORT ON B5/3 GATEGI SPECIES TRIAL**

**BY: GORDON ARMSTRONG, SILVICULTURIST**

**MAY 1986**

The site has previously been cultivated and maize and sorghum raised. The vegetation in the area consists of bushy grassland dominated by the following species: *Themeda danthonioides*, *Stylosanthes* spp., *Leucaena leucocarpa*, *Acacia drepanolobium*, *Acacia senegal* and *Latirus sennegalensis*. The vegetation in the area has been cleared for cultivation and the landscape is virtually treeless.

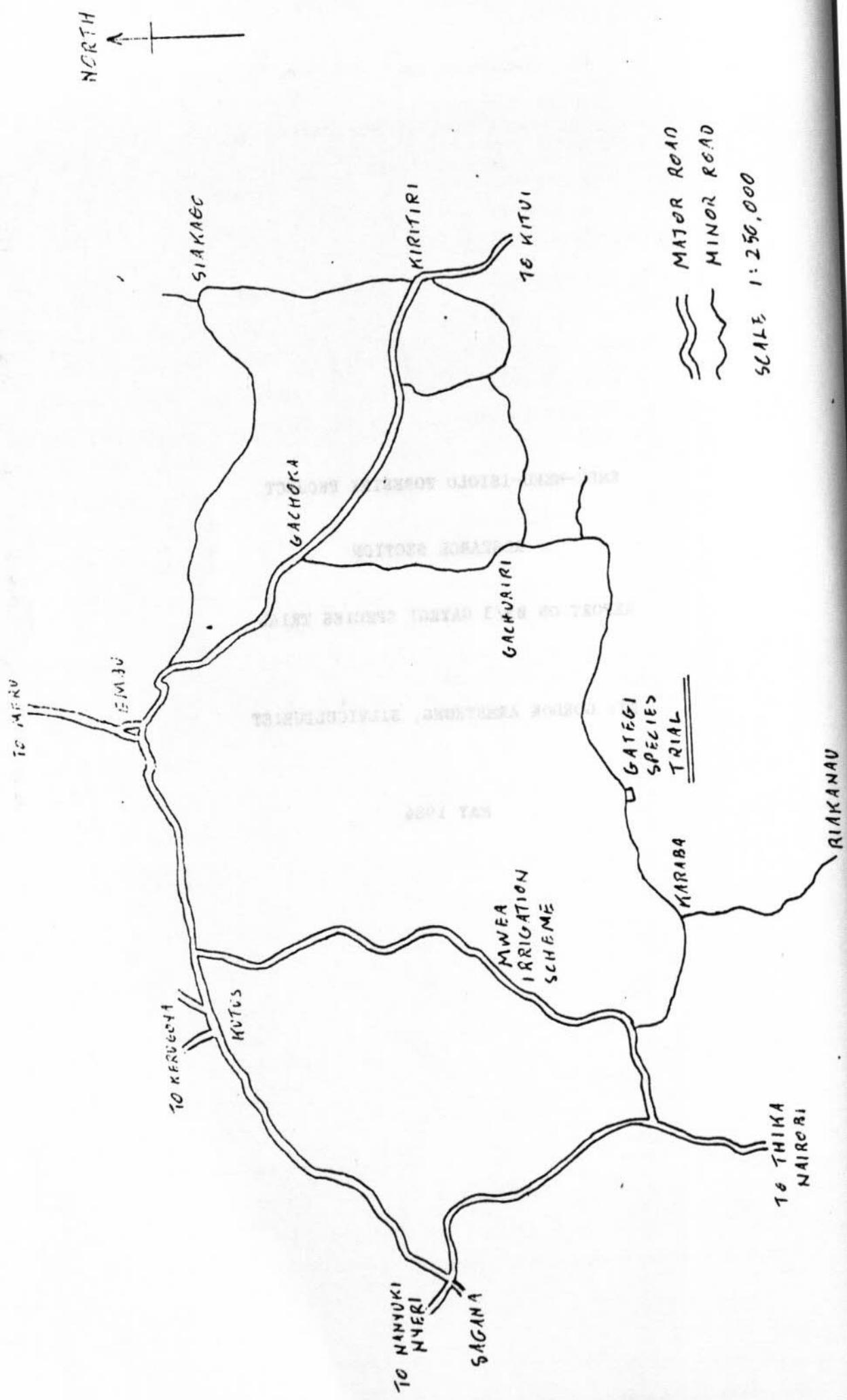
There are no rainfall records for Gategi. The average annual rainfall nearby Karaba is 200mm. The average at Gategi is probably around 500mm. A rain gauge was installed at the site in late 1983 and in 1984 the total rainfall was only 520mm. Data for the period October 1985 is given in the table below.

Table 1: Monthly Rainfall in Millimetres.

	1983	1984	1985	1986
Jan	0	11.7	18.5	0
Feb	0	0	74.4	0
Mar	0	0	110.0	190.0
Apr	106.2	106.2	129.3	340.1
May	0	0	79.7	0
Jun	0	6.6	0	0
Jul	0	0	0	0
Aug	0	18.6	0	0
Sep	36.8	197.4	41.7	0
Oct	5.1	194.3	157.7	0
Nov	36.5	34.0	0	0
Dec	0	0	0	0
<b>Total</b>		<b>560.1</b>	<b>671.0</b>	

FORESTRY DEPARTMENT  
 ISIOLO DISTRICT OFFICE  
 ISIOLO

FIGURE 1  
LOCATION OF GATEGI SPECIES TRIAL



## AIM.

The aim of the trial is to compare survival and growth of 57 different species/provenances at this semi-arid, black cotton soil site in Embu district. This is one of a range species trials established at different sites within Embu, Meru and Isiolo districts with the overall objectives of identifying suitable tree species for rural afforestation in these areas.

## LOCATION.

The trial is located on 3.0 hectares of land belonging to Gategi Secondary Schhol, Karaba Location, Gachoka Division, Embu District and leased to the Forest Department for a period of ten years. Latitude is  $0^{\circ} 45'$  South and Longitude is  $37^{\circ} 25'$  East. This is located on Survey of Kenya 1:50,000 scale sheet 135/2, map reference CK 240172. Figure 1 shows the sites location in relation to major towns and roads.

The site is immediately west of the school compound and south of the Karaba Gategi road as shown in the accompanying sketch. ( Fig. 2 ). A Tube-Size trial is also located on the same site.

## SITE DESCRIPTION.

The site is virtually flat black cotton soil, with a only a very gentle slope to the north-west. The soils are described by Macharia and Kimotho of the Kenya Soil Survey as follows:- " Imperfectly drained, very deep, very dark grey, clay soils with an ABC horizon sequence. They have angular blocky structures; vertic properties, e.g. wide cracks. They swell when wet and shrink when dry causing the cracks". The pH is 7.6 to 7.9. Details of the soil description are given in Appendix L. The altitude is 1,100 metres above sea level.

The site had previously been cultivated and maize and sorghum raised. Natural vegetation in the area consists of bushed grassland dominated by the following shrubs and herbs: Sonchus scheinfurthii, Acacia drepanolobium, Abutilon mauritianum, Balanites aegyptiaca and Maytenus spp. The main grasses are Digitaria scalarum, Sorghum sudanensis and Latipes senegalensis. Most of the natural vegetation in the area has been cleared for cultivation and the landscape is virtually treeless.

## CLIMATIC.

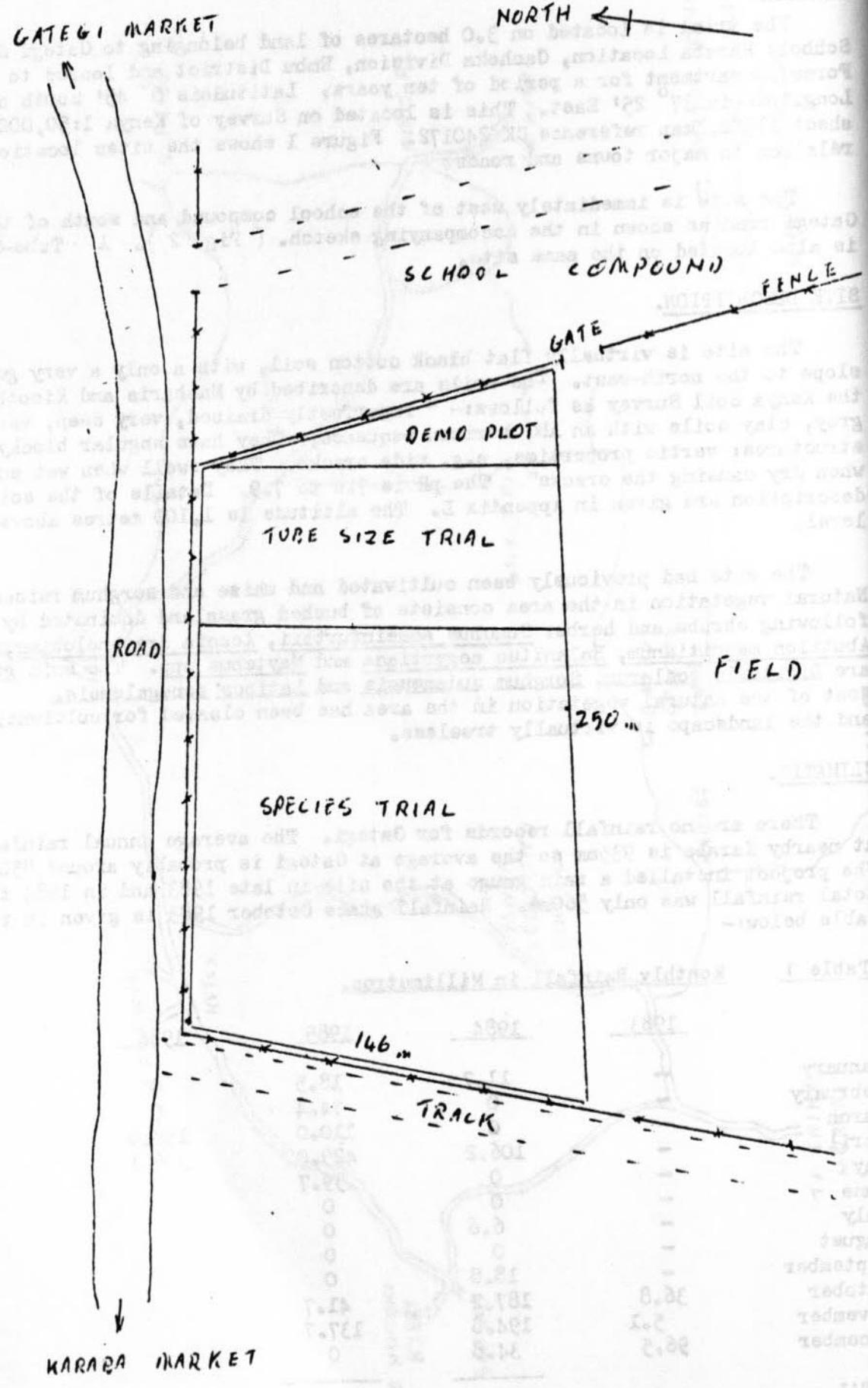
There are no rainfall records for Gategi. The average annual rainfall at nearby Karaba is 935mm so the average at Gategi is probably around 850mm. The project installed a rain gauge at the site in late 1983 and in 1984 the total rainfall was only 560mm. Rainfall since October 1983 is given in the Table below:-

Table 1 Monthly Rainfall in Millimetres.

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
January	-	11.7	18.5	0
February	-	0	74.4	0
March	-	0	110.0	158.0
April	-	106.2	429.0	346.1
May	-	0	59.7	
June	-	0	0	
July	-	6.6	0	
August	-	0	0	
September	-	18.8	0	
October	36.8	187.2	41.7	
November	5.1	194.8	137.7	
December	96.5	34.8	0	
TOTAL		<u>560.1</u>	<u>871.0</u>	

FIGURE 2

SITE OF GATEGI RESEARCH TRIALS



As can be seen, most of the rain falls in two seasons; March, April, and October, November December but quantity and duration of rainfall vary greatly from season to season. The site falls within Agroclimatic zone V - 2.

### SITE PREPARATION.

The northern half of the trial site was deep cultivated by bulldozer (i.e. cross ripped with a 3 - tyre ripper penetrating to approximately 70cm.). The aim of this was to break the hard clay layer occurring approx. 10cm below the surface of the soil, to facilitate water and root penetration.

Apart from slashing the weed and grass growth the southern half of the site was left as it was found, i.e. previously shallow cultivated for growing sorghum and maize.

The fence around the field was improved and increased to seven strands of barbed wire. A watchman hut was erected and Paul Sendi Kyanginga employed to look after the trial.

### TRIAL DESIGN .

The trial was laid out in six replicate blocks aligned parallel to the northern side of the site. Three blocks are on the ripped ground and three on the un-ripped. Within each block, 16-tree plots ( 4 x 4 ) of each species provenance are allocated at random, and planted at 2m by 2m spacing. The design is shown in Figure 3.

### TRIAL HISTORY.

Blocks I, II, III, V and VI were originally planted in December 1983. The rains that season were very late and low in quantity, and the following rains in March/April 1984 were also very poor. Consequently, survival in Blocks II, III and VI was very poor with only a few individual seedlings remaining alive by June 1984. However, survival in the first two blocks to be planted ( Blocks I and V ) was reasonable. It was therefore decided to leave blocks I and V and to replant blocks II, III, IV and VI. This was done in October 1984. Any survivals from the first planting left in these blocks were uprooted, with the exception of 2 seedlings of BGW, Acacia cambagei in Block II which were the only survivals of that species.

Although nearly all the species included in the first planting were included ~~in the first planting were included~~ in the repeat planting it was not always possible to raise seedlings of the same seed lot. Figure 3 and the species table reflect the situation after the partial replanting in October 1984.

The trial has been regularly weeded by 'spot' weeding ( i.e. completely cleaning the soil to about 0.5 metre radius around each tree ) and by slashing weed growth between the 'spots'. The height of each tree has been measured twice per year, at the end of each dry season.

### SPECIES

The following species were raised specifically for the trial at Rikmanau nursery by direct sowing into 10cm x 15cm ( layflat ) black polythene tubes. A code of three colours was painted on each tube to enable easy identification of each species / provenance.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SUPPLIER</u>	<u>NO. PLANTED</u>	
				1983	1984
BGW	Acacia cambagei	Winderak ( BN 13487)	3	32	-
BBW	Acacia cyanophylla		4	32	-
FGP	Acacia cyanophylla		5	-	32
BBB	Acacia nilotica	India (205-005)	4	32	-
FGW	Acacia nilotica		5	-	32

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANTED	
				1983	1984
BWR	Acacia pendula	Charleville (BN 13482)	3	16	32
WPP	Acacia polyacantha	Siakago	1	32	64
PWY	Acacia senegal		5	-	64
GWP	Acacia segal	Isiolo	1	-	16
PWB	Albizzia lebbek		5	32	16
WBW	Atriplex semi-baccata		4	32	64
WBP	Atriplex nummularia		4	-	64
PPG	Azadirachta indica	Kinna	1	32	-
WPG	Cassia siamea	Ishiara	6	-	48
PRP	Cassia sturtii	Israel	3	16	-
WRG	Casuarina cristata	Eidsvold (BN 13132)	3	32	32
WRB	Casuarina glauca	Wardell (BN 13137)	3	32	64
WYR	Casuarina torulosa	Muguga	2	32	32
RPR	Eucalyptus alba	Mt. Molloy (BN 12993)	3	16	32
RPY	Eucalyptus astringens	Dryandra (BN 12842)	3	16	-
RRR	Eucalyptus camaldulensis	L. Albacutya (BN 10666)	3	32	-
RRB	Eucalyptus camaldulensis	Petford (BN 13159)	3	32	64
RYW	Eucalyptus camaldulensis	Gilbert (BN 13564)	3	32	-
BRR	Eucalyptus camaldulensis	Njukiini	1	32	64
BRY	Eucalyptus camaldulensis	Petford (BN 12964)	3	-	64
RYP	Eucalyptus camaldulensis	Kimberly (BN 12346)	3	-	64
RBG	Eucalyptus camaldulensis	Wiluna (BN 13433)	3	-	64
RBW	Eucalyptus camaldulensis	Ord R. (BN 12352)	3	32	-
RNG	Eucalyptus camaldulensis	Hughenden (BN 12939)	3	-	64
RPG	Eucalyptus citriodora	Mt. Garnet (BN 13628)	3	32	64
BYY	Eucalyptus citriodora	Wilcannia (BN 12775)	3	32	32
YRB	Eucalyptus largiflorens	Monto (BN 6164)	3	32	64
YRW	Eucalyptus maculata	Kununurra (BN 13359)	3	32	64
YYR	Eucalyptus microtheca	Charleville (BN 12935)	3	32	64
YPR	Eucalyptus microtheca	De Grey R. (BN 12524)	3	32	32
YPG	Eucalyptus microtheca	Cooper (BN 13200)	3	32	32
YFB	Eucalyptus microtheca	Laura R. (BN 13360)	3	-	64
YPY	Eucalyptus microtheca	Walgett (BN 12172)	3	32	32
BYB	Eucalyptus microtheca	Katanning (BN 9902)	3	-	32
YYY	Eucalyptus occidentalis	Scuddan (BN 12476)	3	16	32
BYG	Eucalyptus occidentalis	Norseman (BN 9910)	3	-	64
YYB	Eucalyptus oleosa	Quilpie (BN 11733)	3	16	64
YWB	Eucalyptus populnea	Mt. Martin (BN 9919)	3	32	-
YYP	Eucalyptus salmonophloia	Gede (506-008)	2	-	64
RYR	Eucalyptus tereticornis	Kennedy (BN 12947)	3	32	64
RGW	Eucalyptus tereticornis	K8	6	-	64
GYG	Leucaena leucocephala	Ena	1	-	64
GYP	Leucaena leucocephala	Isiolo	1	32	-
WGR	Parkinsonia aculeata		5	32	-
GWR	Prosopis cineraria		5	32	32
GNY	Prosopis juliflora		4	-	32
GGY	Prosopis juliflora		6	-	32
PYY	Ziziphus mucronata	Baringo	6	32	-
PYR	Ziziphus mauretiana	Baringo	6	32	32

Full address of seed suppliers are given in Appendix 2.

The following species were collected from stock already growing at other nurseries.

CODE	SPECIES	PROVENANCE	NURSERY	NO. PLANTED	
				1983	1984
A	Azadirachta indica	Mombasa	Kathara	-	32
B	Balanites aegyptiaca	Mutonga	Kathara	-	64
C	Grevillea robusta	Embu	Riakanau	32	-
D	Grevillea robusta	Embu	Riakanau	-	-

SCHOOL

PLANTED  
10<sup>TH</sup> - 11<sup>TH</sup> DEC. 1983

PLANTED  
26<sup>TH</sup> - 27<sup>TH</sup> OCT. 1984  
(\* 12<sup>TH</sup> DEC 1983)

PLANTED  
22<sup>ND</sup> - 23<sup>RD</sup> OCT. 1984

RIPPED  
UNRIPPED

PLANTED  
24<sup>TH</sup> - 25<sup>TH</sup> OCT. 1984

PLANTED  
8<sup>TH</sup> - 9<sup>TH</sup> DEC. 1983

PLANTED  
28<sup>TH</sup> - 29<sup>TH</sup> OCT. 1984

RRR	YPB	D	RPR	GWR	YVB	WRG	WPG	RWB	ARR	WFR	RRB	GYG	WRB	WTP	YRB
YYY	YRW	YPR	RRV	YPT	YTG	RRG	YTR	RRR	RYW	RPG	RYR	PYR	WYR	RRB	GWR

YVR	RDW	RRP	YYP	WRP	PYY	BYA	WPP	YVB	WYR	BIG	RRG	YRB	RGW	WRB	AYW
BWR	GYP	GYY	YRW	RPY	YPR	BGW	GYG	YPG	WRW	RYP	C	YPB	BYB	WGR	RBG

PAP	WRP	YVB	BYW	RYP	C	YPY	RYW	GYG	YYY	RGW	WGR	PGP	RPR	YPG	YYP	GYP
PWY	B	RAG	YRB	BYB	WYR	YPB	WPP	WBW	YVR	WPG	RRG	YPR	PGW	PYR	A	RBW

GYY	BYA	RYP	WFP	AWR	YPG	C	BYG	BYB	RAG	YRB	YRW	YWB	WRB	RGW	RPY	WGR
PGW	GYP	WRP	PWY	GYG	PRP	RYW	RBG	Y4R	PYY	WRW	RBW	PWB <sup>14</sup>	WYR	YPB	YYP	YPR

RPG	RGW	RPR	RPY	YRW		GNY	PPG	WRB	BBW	YYP	PYR	Y4R	Y4Y	ARR	RYR
GYG	WPG	YPG	WYR	RRB	GWR	YPR	YPY	WPP	D	ABB	WRW	PWB	RYW	YPG	YRB

PGP	PWY	WYR	PGW	WGR	RGW	A	GWP	RBG	RPR	GYP	CYG	WBW	RYP	YRB	BYY	Y4R <sup>11</sup>
YPR	WPP	C	WPG	WRP	YYY	YPG	YPB	YYP	YPY	RRG	RAW	RYW	BYB	B	YYB	PYR

I

V

J

I

All seedlings of Eucalyptus spp and Casuarina spp were protected from termite attack by treating them with three weekly watering of Aldrex 48 solution in the nursery, prior to planting out.

RESULTS:

Summaries of the results of the most recent assessments are given in tables 2 and 3. Note that the results for the 1983 planting refer only to the two surviving blocks and not to the five blocks originally planted. The species/provenances are ranked according to overall survival rate. The summaries have been sub-divided between the ripped (cultivated by bulldozer) and un-ripped blocks.

DISCUSSION.

The first point to emerge from this trial is the great difference in survival ratings between the 1983 and 1984 plantings. In the 1983 planting only 5 species have survival rates greater than 50% - and that is from the best blocks only; the remaining 3 having been replanted in 1984. From the 1984 planting only 2 of the 42 species/provenances have survival rates less than 50% one year after planting; and 31 species/provenances have survival rates greater than 90%. These survival differences can be attributed to the major differences in rainfall during the first two rainy seasons after each planting, i.e. 256.3mm for the 1983 planting and 1127.2mm for the 1984 planting. Neither of the years can be regarded as 'typical' but between the two plantings, the trial should give a good indication both of species able to tolerate severe conditions and also of species able to perform well under favourable conditions.

The 1983 planting also demonstrated the critical importance of planting as soon as the soil is moist enough. 50.5mm of rain fell during 6th - 10th December 1983. Planting started 8th December in block V, followed at 2-day intervals by blocks I, III and II and VI. No further rain fell till 26th December. By June 1984 the percentage survival of all the seedlings of all the species planted in each block was as follows:-

BLOCK	DATE PLANTED	% SURVIVAL
V	8-11 DEC. 1983	31.8
I	10-11 DEC. 1983	21.2
III	12-13 DEC. 1983	5.2
II	14-15 DEC. 1983	4.6
VI	15-16 DEC. 1983	0.2

Blocks III, II and VI were later abandoned and replanted in 1984. Obviously time of planting is not so critical when rainfall is good.

Half of the blocks are on ground cross ripped by bulldozer and the favourable effect of this treatment is already beginning to show. Although ripping has not had a significant effect on initial survival, nearly every species/provenance is showing a considerably faster growth rate on the ripped ground. This is even true for the 1984 planting which took place over the year after the ground was ripped. Ripping by bulldozer is obviously not a treatment available to local farmers and it remains to be seen whether higher growth rates can justify the high costs involved.

Although the species chosen for the trial were selected as being likely to tolerate heavy cracking clay soils it is surprising that there is no evidence, so far, of death due to root damage by soil cracking. During the dry seasons deep cracks up to 30mm wide appear throughout the site. Also, no trees have been killed by the occasional water logging that occurs after heavy downpours.

TABLE 2

CATEGI SPECIES TRIAL

PLANTED DECEMBER 1983 ASSESSED OCTOBER 1985

CODE	SPECIES	PROVENANCE	% SURVIVAL			AV. HT ( cm )		
			RIPPED	UN RIPPED	TOTAL	RIPPED	UN RIPPED	TOTAL
BBB	Acacia nilotica	India	50	88	69	223	196	205
PYR	Ziziphus mauritiana	Kositei	50	81	66	150	124	86
WBN	Atriplex semi-baccata	Setropa	50	75	63	45	47	46
YPR	Eucalyptus microtheca	Charleville QLD	44	63	53	237	163	194
WPP	Acacia polycantha	Siakago	44	56	50	190	153	140
RFB	Eucalyptus camaldulensis	Petford QLD	50	44	47	271	179	223
YRB	Eucalyptus largiflorens	Wilcannia NSW	31	63	47	108	103	105
YYP	Eucalyptus salmonophloia	Martin WA	-	44	44	-	99	99
PWB	Albizzia lebbek	Timmers + Leyer	31	56	44	104	80	99
YFG	Eucalyptus microtheca	De Grey R.WA	6	75	41	230	159	165
YTR	Eucalyptus microtheca	Kununurra WA	6	75	41	160	157	157
RYW	Eucalyptus camaldulensis	Gilbert QLD	44	31	38	257	242	251
GYG	Leucaena leucocephala	K8	69	6	38	250	200	240
YPY	Eucalyptus microtheca	Laura WA	6	63	34	210	154	159
YPB	Eucalyptus microtheca	Cooper SA	6	44	25	180	167	169
BRR	Eucalyptus camaldulensis	Njukiini	31	13	22	268	135	230
RQR	Eucalyptus camaldulensis	L. Abactya Vic	19	-	19	433	-	433
YYI	Eucalyptus accidentalis	Kataning WA	6	31	19	380	282	298
BEW	Acacia cyanophylla	Setropa	0	31	16	0	200	200
PTG	Azadirachta indica	Kinna	6	25	16	170	70	90
WPG	Cassia siamea	Ishiara	25	0	13	230	0	230
WYR	Casuarina torulosa	Muguga	25	0	13	153	0	153
RPG	Eucalyptus citriodora	Hughenden QLD	19	0	9	178	0	178
YRW	Eucalyptus maculata	Monto QLD	13	0	6	180	0	180
WRG	Casuarina cristata	Eidsvold QLD	6	-	6	170	-	170
D	Grevillea robusta	Riakanau	0	13	6	0	55	55
BWR	Acacia pendula	Charleville QLD	6	-	6	50	-	50
GWY	Prosopis juliflora	Timmers + Leyer	6	0	3	50	0	50
RYY	Eucalyptus tereticornis	Cede	6	0	3	320	0	320
RPR	Eucalyptus alba	Molloy QLD	6	0	3	150	0	150
WRB	Casuarina glauca	Wardell NSW	6	0	3	80	0	80
GWR	Prosopis cineraria	Timmers + Leyer	6	0	3	40	0	40
BCW	Acacia cambagei	Winderak QLD	-	0	0	-	0	0
RPY	Eucalyptus astringens	Drgandra WA	-	0	0	-	0	0
YYB	Eucalyptus oleosa	Norseman WA	0	0	0	0	-	0

Assessed October, 1925

Planted October, 1924

CODE	SPECIES	PROVENANCE	RIPPED	% SURVIVAL	UNRIPPED	TOTAL	RIPPED	UNRIPPED	TOTAL
RYP	Eucalyptus camaldulensis	Petford, QLD	100	100	100	100	233	143	188
RBG	Eucalyptus camaldulensis	Kimberly, WA	100	100	100	100	190	157	173
RBW	Eucalyptus camaldulensis	Wiluna, WA	100	100	100	100	202	123	162
BYE	Eucalyptus microtheca	Walgett, NSW	100	100	100	100	173	129	151
GYP	Eucalyptus leucocephala	Ena	100	100	100	100	221	71	146
YFG	Eucalyptus microtheca	De Grey R. WA	100	100	100	100	144	118	131
WBP	Atriplex nummularia	Setropa	100	100	100	100	124	106	115
PYR	Ziziphus mauretiana	Kositei	100	100	100	100	118	99	108
YFY	Eucalyptus microtheca	Laura R. QLD	100	100	100	100	114	84	99
WGB	Azadirachta indica	Mombasa	100	100	100	100	96	80	88
RPR	Eucalyptus alba	Mt. Molloy QLD	100	100	100	100	105	64	85
YAB	Eucalyptus populnea	Quilpie QLD	100	100	100	100	94	63	78
GYC	Leucaena leucocephala	K8	100	97	98	98	105	127	163
PCW	Acacia nilotica	Timmers + Leyer	100	96	98	98	199	145	157
RCW	Eucalyptus tereticornis	Kennedy QLD	100	94	97	97	167	163	197
RYN	Eucalyptus camaldulensis	Gilbert QLD	100	94	97	97	230	151	161
WPP	Eucalyptus polyacantha	Siakago	100	96	97	97	170	114	135
YPR	Eucalyptus microtheca	Charleville QLD	94	97	97	97	154	114	133
WPG	Cassia siamea	Ishiera	100	100	100	100	152	112	123
PYI	Ziziphus mucronata	Kositei	100	94	94	94	134	55	65
WBM	Atriplex semi-baccata	Setropa	97	94	97	97	74	59	64
WGR	B Parkinsonia aculeata	Isiolo	100	91	95	95	69	150	169
BYI	Eucalyptus citriflora	Gornett QLD	97	92	95	95	187	111	145
YRB	Eucalyptus largiflorens	Wilcannia NSW	100	88	94	94	175	80	92
BYG	Eucalyptus occidentalis	Scuddan WA	88	100	94	94	101	131	190
PGP	Acacia cyanophylla	Timmers + Leyer	100	88	94	94	240	117	154
YPB	Eucalyptus microtheca	Coober SA	-	94	93	93	196	66	113
GWP	Acacia seyal	Isiolo	91	96	91	91	154	72	72
YYP	Eucalyptus microtheca	Kummurra WA	88	94	88	88	133	104	119
REG	Eucalyptus camaldulensis	Ord River	94	88	88	88	176	128	151
GGY	Prosopis juliflora	Setropa	81	94	88	88	165	118	143
YVI	Eucalyptus occidentalis	Katanning WA	97	78	88	88	241	176	206
YYP	Eucalyptus salmonophloia	Mt. Martin WA	97	75	88	88	93	69	82
C	Eucalyptus robusta	Riakanau	100	69	69	69	50	41	45
YRW	Grevillea robusta	Monta QLD	94	69	69	69	177	101	146
BWR	Acacia pendula	Charleville QLD	100	94	100	100	63	28	48
RFY	Eucalyptus ostrogens	Dryondra WA	100	50	50	50	128	82	113



As far as species selection is concerned it is still too early to draw conclusions. Survival and growth of all the species planted in 1984 are such that none of the species/provenances can yet be selected as being unsuitable for the site. However, the following species are worth mentioning as showing promise at this early stage. Acacia cyanophylla, Acacia nilotica, Acacia polyacantha, Atriplex nummularia, Atriplex semi-baccata, Cassia siamea, Eucalyptus camaldulensis, (Petford, Kimberly, Wiluna and Gilbert provenances), Eucalyptus microtheca (Walgett and Charleville provenances), Eucalyptus - occidentalis, Eucalyptus tereticornis (Kennedy provenance), Leucaena - leucocephala, Parkinsonia aculeata and Ziziphus mauritiana. It is also worth noting that Eucalyptus occidentalis, a species not widely used in artificial plantations is currently the fastest growing species in the 1984 planting.

The trial is now beginning to have a demonstration effect. There is an acute local shortage of firewood and other forest products and the trial is virtually the only block of trees to be seen for miles around. Local people are now beginning to realise that trees can be grown without irrigation. During the past two rainy seasons over 4,000 seedlings have been distributed from the trial site to local farmers, and the demand is growing. Eucalyptus - spp, Cassia siamea and Acacia cyanophylla are the most popular species.

# GATEGI SPECIES TRIAL

APPENDIX 1

- 22 -

## PROFILE DESCRIPTION NO.1

### General site information

Soil classification : chromic VERTISOL  
Agro-climatic zone : IV - V  
Observation No./date : 135/2-1, 26/1/84  
Location/Altitude : Embu District, 0°45'S, 37°25'E  
Local Petrography : Undifferentiated Basement System rocks  
Physiography : Plain  
Relief, macro : Flat to very gently undulating slope 0 - 2%  
Relief, micro : Few gilgai, 20 cm high  
Land use : Under tree trials  
Erosion : Slight rill erosion  
Flooding : Occasionally  
Internal drainage : Moderately well drained.

### Profile description

- 0-30cm very dark greyish brown (10YR 3/2 moist); clay; moderate, medium angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few cracks 2-4cm wide; few fine pores; very few fine and very fine roots; pH 7.6; diffuse irregular transition to:  
(sample no. 135/2-1a)
- 30-60cm very dark grey (10YR 3/1, moist); clay; strong medium angular blocky structure; hard when dry; firm when moist, sticky and plastic when wet; few (3-6mm wide) cracks; few fine pores; very few very fine roots; many fine calcium carbonate concretions; few faint slickensides; moderately calcareous; pH 7.9; diffuse, irregular transition to:  
(sample no. 135/2-1b)
- 60-80cm+ very dark grey (10YR 3/1 moist); clay; moderate medium to coarse angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine pores few faint slickensides; no roots observed; strongly calcareous; pH 7.8;  
(sample no. 135/2-1c)

GATEGI SPECIES TRIAL

APPENDIX I CONT'D

LABORATORY DATA OF PROFILE DESCRIPTION NO. 1

Observation no: 135/2-1 Mapping unit: GATEGI Soil classification: Chromic AB1

Laboratory no.	/84	290	291			
Horizon		Ap	B <sub>1</sub> k			
Depth (cm)		0-30	30-60			
pH-H <sub>2</sub> O (1: 2½ v/v)		7.6	7.9			
pH-KCl	"	6.7	7.0			
EC (mmho/cm)	"	0.40	0.30			
CaCO <sub>3</sub> (%)						
CaSO <sub>4</sub> (%)						
C (%)		0.77	0.63			
N (%)						
C/N						
CEC (me/100g), pH 8.2		22.0	26.0			
CEC " " pH 7.0						
Exch. Ca (me/100g)		29.0	41.0			
" Mg "		7.20	10.0			
" K "		0.32	0.20			
" Na "		0.70	1.50			
Sum of cations		37.22	52.7			
Base sat. %, pH 8.2		100+	100+			
" " %, pH 7.0						
ESP at pH 8.2			5.0			
Texture (limited pretreatment)						
Gravel % (>2.0mm)						
Sand % (2.0-0.05mm)		36	36			
Silt % (0.05-0.002mm)		18	18			
Clay % (0.002-0.001mm)		46	46			
Texture class		C	C			
Fertility aspects		0 - 30 cm		Laboratory no. 555		
General		Available nutrients				
pH-H <sub>2</sub> O (1: 2½ v/v)	8.1	Na (me/100g)	1.02	Mn (me/100g)	0.45	
Exch. acidity (me/100g)		K "	0.16	P (ppm)	10	
C %	0.72	Ca "	23.0	P-Olsen (ppm)		
N %	0.08	Mg "				
Remarks:						

APPENDIX 2, SEED SOURCES.

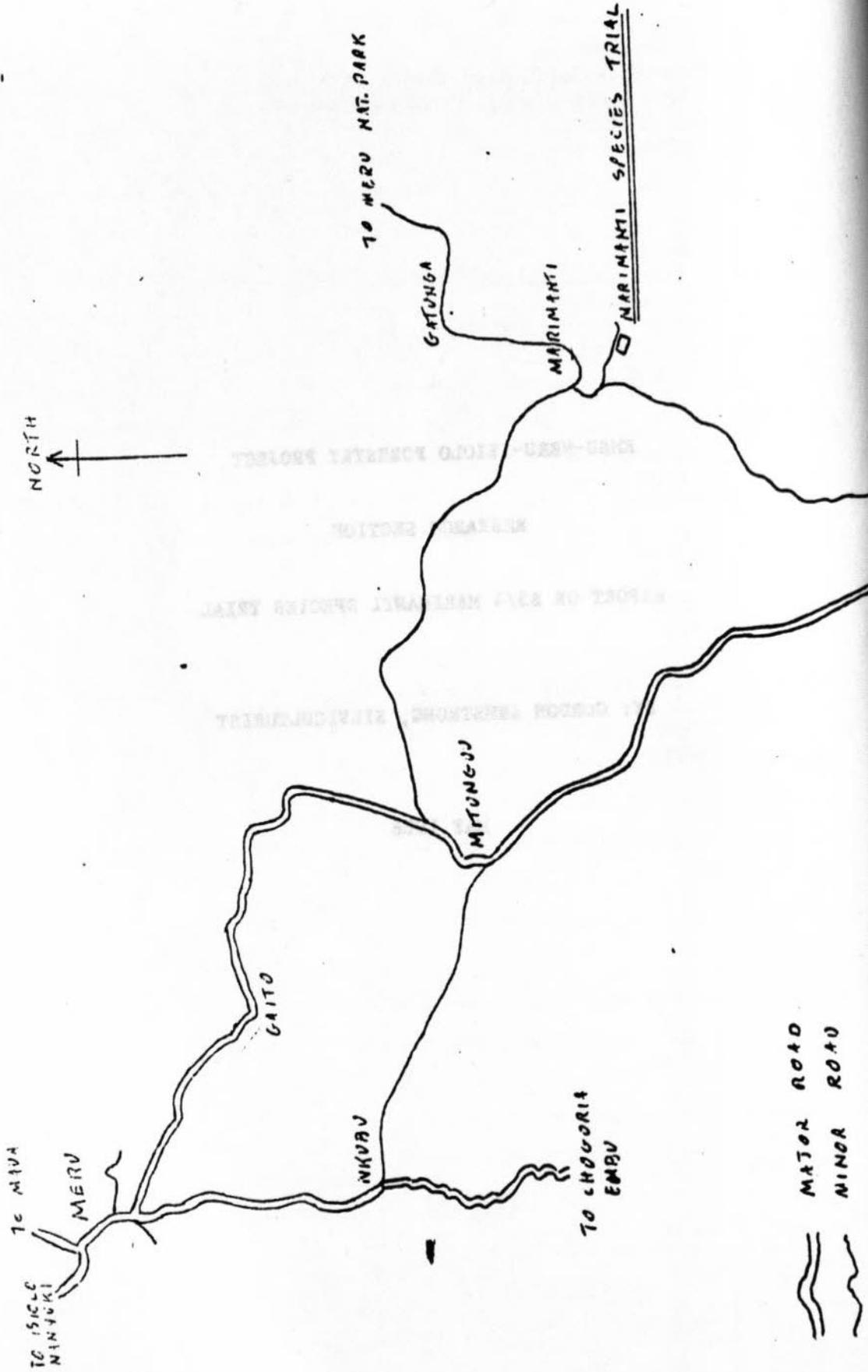
1. Local collection
2. The Seedman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74,  
KIKUYU.  
KENYA.
3. C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008,  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
4. Setropa Ltd.  
P.O. Box 203,  
Bussum 1400 AE  
HOLLAND.
5. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND.
6. Mr. Edmund Harrow  
East Pokot Agricultural Project  
P.O. Marigat  
KENYA.

MAY 1966



LOCATION OF NARIMANTI SPECIES TRIAL

FIGURE 1



The aim of the trial is to compare survival and growth of 32 different species/provenances at this semi-arid site in Meru district. This is one of a range of species trials established at different sites within Embu, Meru and Isiolo districts with the overall objection of identifying suitable tree species for rural afforestation in these areas. The trial is situated within E.M.I. Goat and Sheep Project farm so the species included are mainly those with a high potential fodder production.

LOCATION

The trial is located on 2.5 hectares of land within the E.M.I. Goat and Sheep Project, Marimanti Location Tharaka, Division, Meru District. Latitude is 0° 10' South and Longitude is 37° 58' East. This is located on Survey of Kenya 1:50 000 scale sheet 122/2, map reference CK 861815. The accompanying sketch map (Fig.1) shows the sites location in relation to major towns and roads.

The trial is situated on the south-east side of the road leading from Marimanti town to the project station, approximately 1km from the main gate, as shown in Fig.2.

SITE DESCRIPTION

The site slopes gently (5%) to the south-west down towards a valley. On the upper half of the site the land is unbroken but a number of gullies occur on the lower (south-western) half of the site. Also on the lower half there was much less vegetation cover and severe soil erosion had occurred. The soils are described by Macharia and Kimotho of the Kenya Soil Survey as follows:- "Well drained, deep yellowish red to reddish brown sandy clay soils. Consistence is loose when dry, friable when moist, sticky and slightly plastic when wet. They have an A B C horizon sequence. The soil reaction is slightly acid (pH 6.5). The soil is deficient in nitrogen (0.10%). The organic matter content is low (0.40%)".

The altitude is 590m. above sea level.

The general physiognomy is Bushed Woodland with the dominant trees and shrubs being Acacia senegal, Acacia tortilis, Combretum spp. and Commiphora spp. Others are Adansonia digitata, Indigofera sp., Sida ovata, Tamarindus indica, Tephrosia villosa, Terminalia brownii and Terminalia prunioides. Tree cover comprises 15% shrubs cover 5%, grasses 45% and herbs 20%.

CLIMATE.

There are no long term rainfall records for Marimanti. A rain gauge was installed at the Goat and Sheep Project station in 1984 and the average annual rainfall over 1984 and 1985 was 748.6mm. Most of the rain falls in two seasons - March, April, May and October, November, December, but quantity and duration of rainfall vary greatly from season to season. Marimanti falls within Agroclimatic zone IV - 1. Rainfall figures for 1984 and 1985 are given in the table below.

SCALE 1 : 250,000

TABLE I MONTHLY RAINFALL AT MARDANTI IN MILLIMETERS

	<u>1984</u>	<u>1985</u>
January	0	4.9
February	0	4.5
March	0	199.5
April	88.8	259.5
May	0.8	22.8
June	0	0
July	0	0
August	0	0
September	0	0

FIGURE 2

SITE OF MARIMANTI SPECIES TRIAL

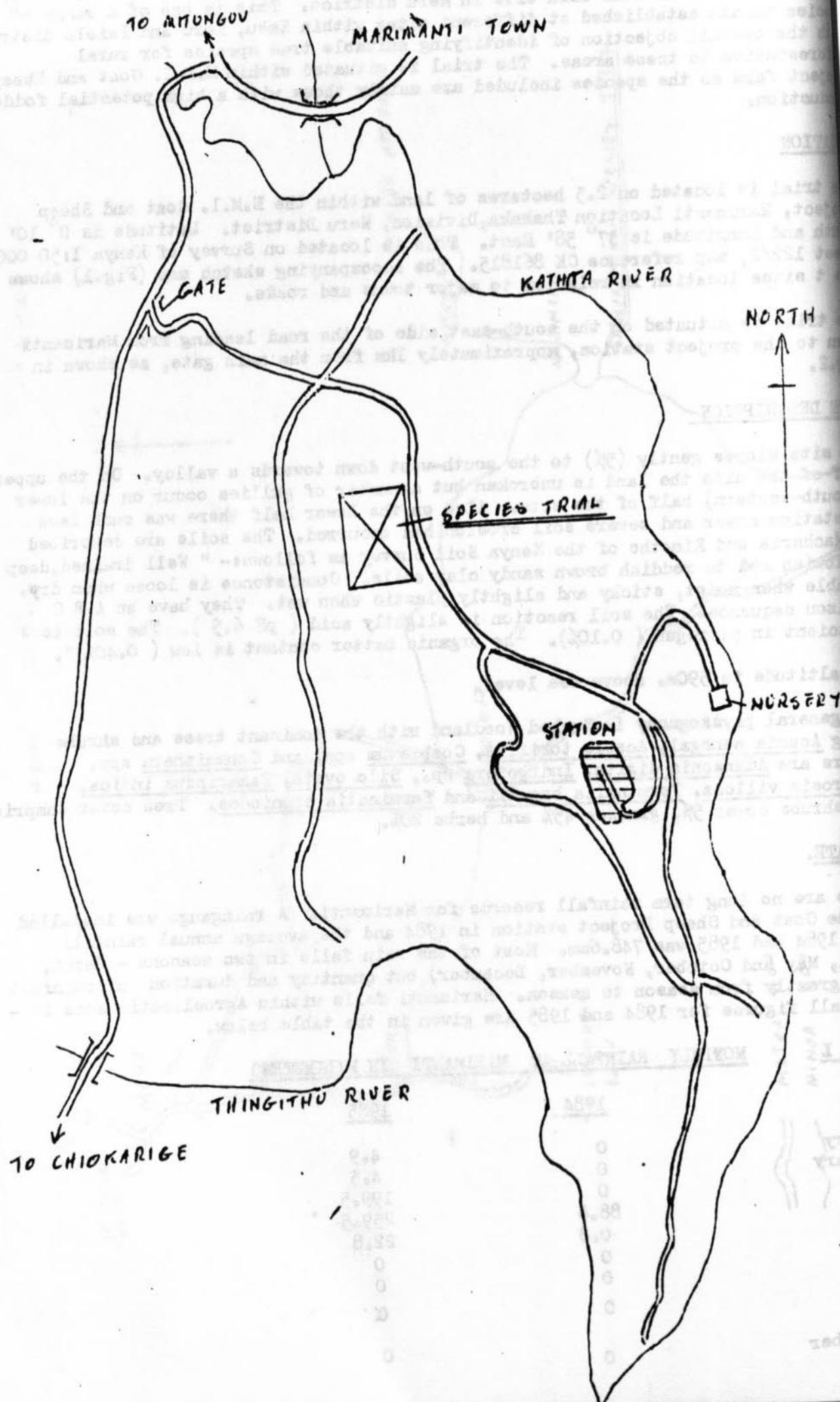


TABLE I

RAINFALL AT MARIMANTI IN MILLIMETERS

	<u>1984</u>	<u>1985</u>
October	172.1	105.5
November	214.9	198.5
December	166.8	58.7
<u>Total</u>	<u>648.4</u>	<u>853.9</u>

SITE PREPARATION.

The north-eastern ( upper ) half of the trial site was deep cultivated by bulldozer ( i.e. ripped along the contour with a 3-type ripper penetrating to approximately 50cms.). No cultivation was carried out on the south-western ( lower) half of the site. Instead pits, each 30cm x 30 cm x 30cm were dug according to the trial design and ' microcatchments ' prepared for each pit. The 'microcatchments' consisted of two small furrows approximately 1 metre in length and directed outwards from opposite sides of the pit and slightly up the slope. The design varied slightly according to the micro-topography around the pit but the aim was to direct runoff water into the pit.

No separate fencing was erected around the trial but Goat and Sheep Project stockmen were instructed not to let their animals browse on the trial.

TRIAL DESIGN

The trial was laid out in six replicates blocks aligned parallel to the road. Three blocks are on the ripped ground and three on the un-ripped. Within each block, 16 tree plots ( 4 x 4 ) of each species/provenances are allocated at random and planted at 2.5m by 2.5m spacing. The design is shown in figure 3.

TRIAL HISTORY

Blocks IV, V and VI were planted on 7th and 8th November 1983. Planting of Blocks I, II and III was delayed one month till 6th and 7th December 1983 due to the late arrival of the bulldozer to carry out the ripping. The rains that season were very late and low in quantity and the following rains in March/April 1983 were very poor. Consequently, survival was very poor, particularly in the un-ripped section ( Blocks IV, V and VI). However, sufficient seedlings survived in the ripped section ( Blocks I, II and III) to enable comparisons between species to be made so no replanting was under-taken.

The trial has been regularly weeded by 'spot' weeding ( i.e. completely cleaning the soil to about 0.5 metre radius around each tree ) and by slashing weed growth between the 'spots'. The height of each tree has been measured twice per year, at the end of each dry season.

SPECIES

The following species were raised specifically for the trial at Marimanti nursery by direct sowing into 10cm x 15cm ( layflat) black polythens tubes. A code of three colours was painted on each tube to enable easy identification of each species/provenances. The addresses of seed suppliers are given in Appendix I.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SUPPLIER</u>	<u>NO. PLANTED</u>
BBG	Acacia albida	Baringo (780-005)	2	96
BBG	Acacia aneura	Kookynie (BN 13276)	3	48
PGW	Acacia arabica		4	96
BBP	Acacia cyclops		2	96
BGY	Acacia cyanophylla	Collie (BN 13506)	3	32
BWR	Acacia pendula	Charleville (BN 13482)	3	32
BBY	Acacia tortilis	Hola	2	48

FIGURE 3 MARINANT SPECIES TRIAL

	PGW	PWA	GGP	GYH	BPY	GYG	GGY	RGW	BAP	YPP	WPG	ARR	GYB	GRB	GYR
GWY	GRY	GYP	GYW	GRP	PYR	BBY	GRW	PRP	BWR	BBG	PRW	WBW	ARR	GRG	BGY

VI

PLAN  
7<sup>th</sup> - 1

PRP	GYH	BPY	GRB	GGP	RRB	PGW	BAP	GYB	GRW	WBW	PRW	GYG
BBG	RGW	GWY	PYR	GRW	GRG	GYW	GYW	GGG	YPP	PWB	WPG	GGY

PITS

NOV  
1923

BPY	GYR	RRB	GWY	GYP	WPG	GRB	GYG	GRW	PRP	GYH	BPY	ARR	GGP	YPP
	BBG	PGW	BBY		GGY	GRG	PYR	RGW	PRW	GYB	GYW	WBW	GRP	GRY

ROATCHMENTS

IV

GYB	PWB	GYP	GRP											
GYR	PRP	PGW	GGP						YPP	GRW		BBP		

III

PLANTED

6<sup>th</sup> - 8<sup>th</sup>

PPED

DEC.

1923

GRW	GGP	GWY	BBY											
BBG	GGY	BPY	GRY	GYH	YPP	PWB	PYR	GRW	GRB	GRP	RGW	WPG	PRW	PGW

II

GWY	GRP	GGY	RGW											
GYB	GRG	GYG	RRB	GYW										

I

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANTED
		Dujarra (BN 13494)	3	96
BPY	Acacia victoriae		4	96
PWB	Albizzia lebbek		5	96
WBW	Atriplex semi-baccata		6	64
PRW	Balanites aegyptiaca	Baringo	1	64
WPG	Cassia siamea	Ishiar	6	96
PRP	Cassia sturtii	Israël	3	80
RFB	Eucalyptus camaldulensis	Petford (BN 13159)	1	80
BRR	Eucalyptus camaldulensis	Njukiini	7	96
YPP	Eucalyptus hybrid	Champ 119, Choma	3	96
RGW	Eucalyptus tereticornis	Kennedy (BN 12947)	8	96
CYR	Leucaena diversifolia	K 156	6	80
GYG	Leucaena leucocephala	K8	5	96
GRY	Leucaena leucocephala	"Peru"	8	96
GRG	Leucaena leucocephala	K 28	8	96
GRW	Leucaena leucocephala	K 29	8	96
GRP	Leucaena leucocephala	K 67	8	96
GYI	Leucaena leucocephala	K 341	8	96
GYP	Leucaena leucocephala	K 500	8	80
GRB	Leucaena leucocephala	K 8	2	80
GYW	Leucaena leucocephala	Gede (817-007)	1	96
GYV	Leucaena leucocephala	Ena	6	96
GQP	Prosopis chilensis	India	4	96
GRK	Prosopis cineraria		5	96
GGY	Prosopis juliflora		4	80
GRY	Prosopis juliflora		5	16
GGW	Prosopis tamarago		6	80
PYR	Ziziphus mauretiana	Baringo		

**RESULTS**

Summaries of the February 1984, October 1984 and November 1985 assessments are given in Tables 2,3 and 4. The summaries have been sub-divided between the ripped and un-ripped blocks. No assessment was done of the unripped blocks in October 1984.

**DISCUSSION**

The 1983/84 drought had a major effect on this trial. There is no doubt that had rainfall, been closer to the average in the year following planting, survival and growth rates would have been much higher. In addition to the low rainfall, goats managed to enter the trial on a number of occasions and inflict considerable damage on the young seedlings. So it is surprising that any seedlings managed to survive at all. As it is, the trial gives a very good indication of these species/provenances which can survive the severest of conditions and then respond when conditions become more favourable. The trial does not show the establishments and growth rates that might pertain during 'normal' years.

Even though the ripped plots were planted one month later than the un-ripped plots, the favourable effects of the ripped treatment can clearly be seen. By November 1985, 199 trees were alive on the ripped area compared to only 14 on the un-ripped area. Bulldozers would obviously not be available for most 'on farm' planting. However the benefits obtained from deep cultivation would warrant further investigation of simpler ripping tools drawn by wheeled tractors or even oxen.

As regards the performance of individual species, Acacia tortilis showed by far the best survival until it was unfortunately weeded out in October 1985 (being a native species, the workers evidently did not recognise it as a planted tree!). Initial growth was, however, slow. In addition to Acacia tortilis; Acacia victoriae, Prosopis juliflora, Ziziphus mauretiana, Leucaena leucocephala, Albizzia lebbek, Prosopis chilensis, Balanites aegyptiaca, Acacia arabica, Acacia anaura, Eucalyptus tereticornis, and Cassia sturtii, would all appear to be worthy of further observation.

TABLE 2 MARITIME SPECIES TRIAL

PERCENT SURVIVAL AT END FEBRUARY 1984.

CODE	SPECIES	PROVENANCE	RIPPED	PITS	TOTAL
GYP	Leucaena leucocephala	Ena	98	56	77
GGY	Prosopis juliflora	Setropa	94	56	75
BBY	Acacia tortilis	Hola	93	66	74
PRP	Cassia sturtii	Israel	92	56	74
GRG	Leucaena leucocephala	K 28	94	46	70
PYR	Ziziphus mauretiana	Kositei	91	56	70
FWB	Albizzia lebbek	Timmers + Leyer	96	40	68
GRP	Leucaena leucocephala	K67	94	31	63
BPY	Acacia victoriae	Dajana, Australia	88	38	63
GRY	Leucaena leucocephala	Peru	75	44	59
GYB	Leucaena leucocephala	K 500	83	29	56
GGP	Prosopis chilensis	Kositei	85	25	55
BGG	Acacia aneura	KoRynie, Australia	79	19	55
GRB	Leucaena leucocephala	K8 ( Hawaii )	97	25	54
GYG	Leucaena leucocephala	K8 ( Kositei )	75	35	51
RGW	Eucalyptus tereticornis	Kennedy, Australia	85	9	47
PGW	Acacia arabica	Timmers + Leyer	73	15	44
GRW	Leucaena leucocephala	K 29	60	27	44
RRB	Eucalyptus camaldulensis	Petford, Australia	84	15	43
GYI	Leucaena leucocephala	K341	81	2	42
PRW	Balanites aegyptiaca	Kositei	84	17	36
WBW	Atriplex semi-baccata	Setropa	63	8	35
WPG	Cassia siamea	Ishiarra	79	19	32
GYR	Leucaena diversifolia	K 156	62	2	30
GYW	Leucaena leucocephala	Gede	53	13	29
YPP	Eucalyptus hybrid	Zambia	56	0	28
GWY	Prosopis juliflora	Timmers + Leyer	48	6	27
GWR	Prosopis cineraria	Oman	40	15	27
EBG	Acacia albida	Baringo	44	8	25
BWR	Acacia pendula	Charleville, Australia	38	0	19
BRR	Eucalyptus camaldulensis	Njukiini	13	3	6
BBP	Acacia cyclops		0	0	0
GGW	Prosopis tamarugo	Setropa	-	0	0
BGY	Acacia cyanophylla	Collie, Australia	0	0	0

TABLE 3

MARIMANTI SPECIES TRIAL

PERCENT SURVIVAL AT OCTOBER 1984

Assessed November 1985  
Planted December 1982

CODE	SPECIES	PROVENANCE	% SURVIVAL
BBY	Acacia tortilis		93
PYR	Ziziphus mauretiana		69
BPY	Acacia victoria		58
PRP	Cassia sturtii		54
GGY	Prosopis juliflora		54
QYY	Leucaena leucocephala	K 341	49
GRP	Leucaena leucocephala	K 67	48
BGG	Acacia aneura		42
PWB	Albizia lebbek		29
PGW	Acacia arabica		23
GRG	Leucaena leucocephala	K 28	23
RRB	Eucalyptus camaldulensis		22
GYP	Leucaena leucocephala	Ena	21
GOP	Prosopis chilensis		21
RGW	Eucalyptus tereticus		17
GRB	Leucaena leucocephala	K 8	16
PRW	Balanites aegyptiaca		16
BBG	Acacia albida		15
GRY	Leucaena leucocephala	Peru	13
GRW	Leucaena leucocephala	K 29	13
GYG	Leucaena leucocephala	K 8	13
GWY	Prosopis juliflora		10
GYB	Leucaena leucocephala	K 500	10
GYW	Leucaena leucocephala	Gede	6
BWR	Acacia pendula		6
WPG	Cassia siamea		6
GWR	Prosopis cineraria		4
GYR	Leucaena dwersifolia	K 156	2
GGW	Prosopis tamarugo		-
WBW	Atriplex semi-baccata		0
YPP	Eucalyptus hybrid		0
BRR	Eucalyptus camaldulensis		0
BBP	Acacia cyclops		0

RIPPED PLOTS

All other species have no survivors in the Ur-ripped plots.

TABLE 4 MARUMANI SPECIES TRIAL

Planted December: 1983

Assessed November: 1985

RIPPLED PLOTS

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>% SURVIVAL</u>	<u>AV. HEIGHT</u>
BPY	Acacia victoriae	Dajarra	46	75cm.
GGY	Prosopis juliflora		44	114cm
PYR	Ziziphus mauretiana	Baringo	42	152cm
GRP	Leucaena leucocephala	K67	33	69cm
GYG	Leucaena leucocephala	K 341	29	55cm
GYP	Leucaena leucocephala	Ena	25	122cm
PWB	Albizzia lebbek		25	102cm
GGP	Prosopis chilensis	India	23	96cm
GRG	Leucaena leucocephala	K28	21	79cm
PRW	Balanites aegyptiaca	Baringo	21	40cm
PGW	Acacia arabica		19	148cm
BGG	Acacia aneura	Koobyne	17	59cm
GRW	Leucaena leucocephala	K29	15	92cm
RGW	Eucalyptus tereticornis	Kennedy	13	203cm
GYC	Leucaena leucocephala	K8	13	79cm
PRP	Cassia sturtii	Israel	13	66cm
GRB	Leucaena leucocephala	K8	9	230cm
GRY	Leucaena leucocephala	Peru	8	94cm
BBG	Acacia albida	Baringo	7	75cm
RFB	Eucalyptus camaldulensis	Petford	6	169cm
GYB	Leucaena leucocephala	K 500	6	33cm
GWY	Prosopis juliflora		4	59cm
GYR	Leucaena diversifolia	K 156	4	47cm
GWR	Prosopis cinerarra		4	23cm
GYW	Leucaena leucocephala	Gede	0	0cm
BWR	Acacia pendula	Charleville	0	0
WPG	Cassia siamea	Ishiara	0	0
WBW	Atriplex semi-baccata		0	0
YPP	Eucalyptus hybrid	Choma 119, Choma	0	0
BRR	Eucalyptus camaldulensis	Njukini	0	0
BBP	Acacia cyclops		0	0
BBY	Acacia tortilis	Hola	0*	0*

\* NOTE: BBY Acacia tortilis accidentally weeded out since last assesement when survival was 94%

UN-RIPPED PLOTS.

PYR	Ziziphus mauretiana	Baringo	15	128cm
GGY	Prosopis juliflora		13	120cm
GRG	Leucaena leucocephala	K28	2	32cm

All other species have no survivors in the Un-ripped plots.

.../4  
All except E. tereticornis have potential fodder value.

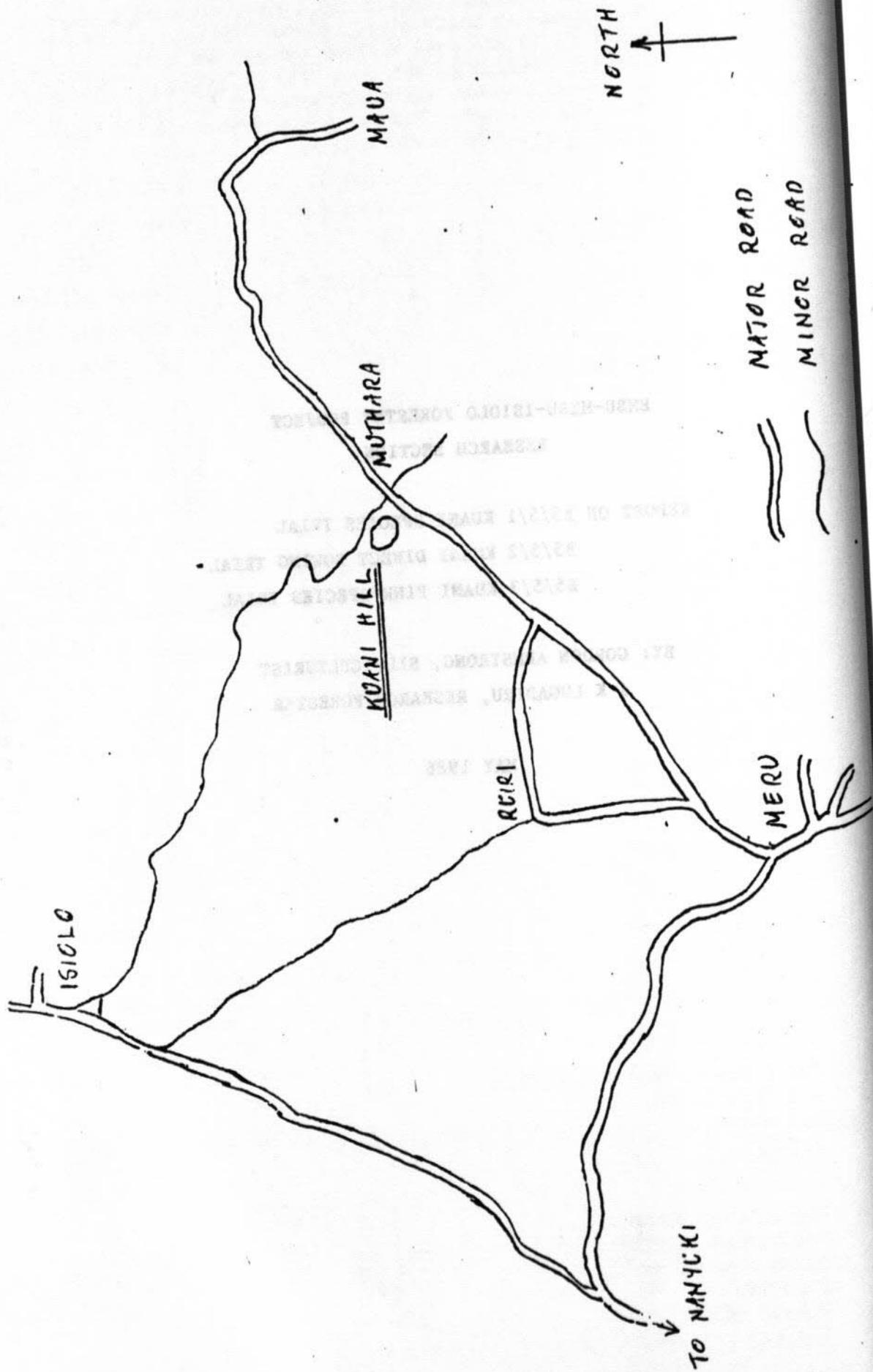
The importance of selecting the right provenance or variety has been demonstrated. Ten different varieties of Leucaena leucocephala were included and there is obviously a great difference in performance between the best and poorest varieties. In terms of survival, K 67 is the best whereas one of the batches of K8 shows the highest growth rate. Similarly, two seed lots of Prosopis juliflora were included and the difference between the performance of the best (GGY) and the poorest (GWY) is very significant. Further provenance trials of this species and also Prosopis chilensis should be undertaken.

Appendix I      SEED SOURCES

1. Local collection
2. The Seedsman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74,  
KIKUYU - KENYA.
3. C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
4. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
Holland
5. Setropa Ltd.  
P.O. Box 203  
Bussum 1400 AE  
HOLLAND.
6. Mr. Edmund Barrow  
East Pokot Agricultural Project  
P.O. Marigat  
KENYA.
7. Chief Forest Research Officer  
P.O. Box 22099  
Kitwe  
ZAMBIA
8. Dr. J.L. Brwebaker  
Department of Horticulture  
University of Hawaii  
Honolulu  
Hawaii 96822  
U.S.A.



FIGURE 1 LOCATION OF KUANI RESEARCH TRAILS



# TRIAL B5/5/1 KUANI SPECIES TRIAL

## AIM

The aim of the trial is to compare the survival and growth of 26 different species at this semi-arid hill site in Meru district. It is one of a range of species trials established at different sites within Embu, Meru and Isiolo Districts with the overall objective of identifying suitable tree species for rural afforestation in these areas.

Kuani hill is one of a number of similar hills in the lower Nyambene range set aside for future afforestation by Meru County Council. There is a high local demand, for fuelwood, both for home consumption and for the tobacco and tea industries, so the primary objective of this trial is to identify fast-growing fuelwood species. A secondary objective is to control the severe gully erosion occurring on the lower half of the trial site.

## LOCATION.

The trial is located on 2.2 hectares of land on the northern side of Kuani Hill which is trust land administered by Meru County Council. The hill is adjacent to the main Meru-Maua road near to Muthara village, Tigania Division, Meru District. Latitude is  $0^{\circ} 13'$  North and Longitude is  $37^{\circ} 47'$  East. This can be found on Survey of Kenya 1:50,000 scale sheet 108/4, map reference CL 638237. The accompanying sketch map (Fig. 1) shows the site's location in relation to major towns and roads.

The site can be reached by a small track which runs north from the Meru - Maua road along the foot of the hill (Fig. 2). A Direct sowing Trial and a Pine Species trial are also located on the same site.

## SITE DESCRIPTION.

The site is on a steep ( $> 37\%$ ) north facing slope. Altitude is 1500 metres above sea level. The soils are derived from volcanic lavas and are described by Macharia and Kimotho of the Kenya Soil Survey as follows:- "Well drained, deep, dark reddish brown clay soils. They have an ABC horizon sequence with diffuse, smooth to wavy transitions and subangular blocky structures. The topsoil is severely overwashed on the lower and middle parts of the site". The pH is 6.5. Details of the soil description are given in Appendix 1.

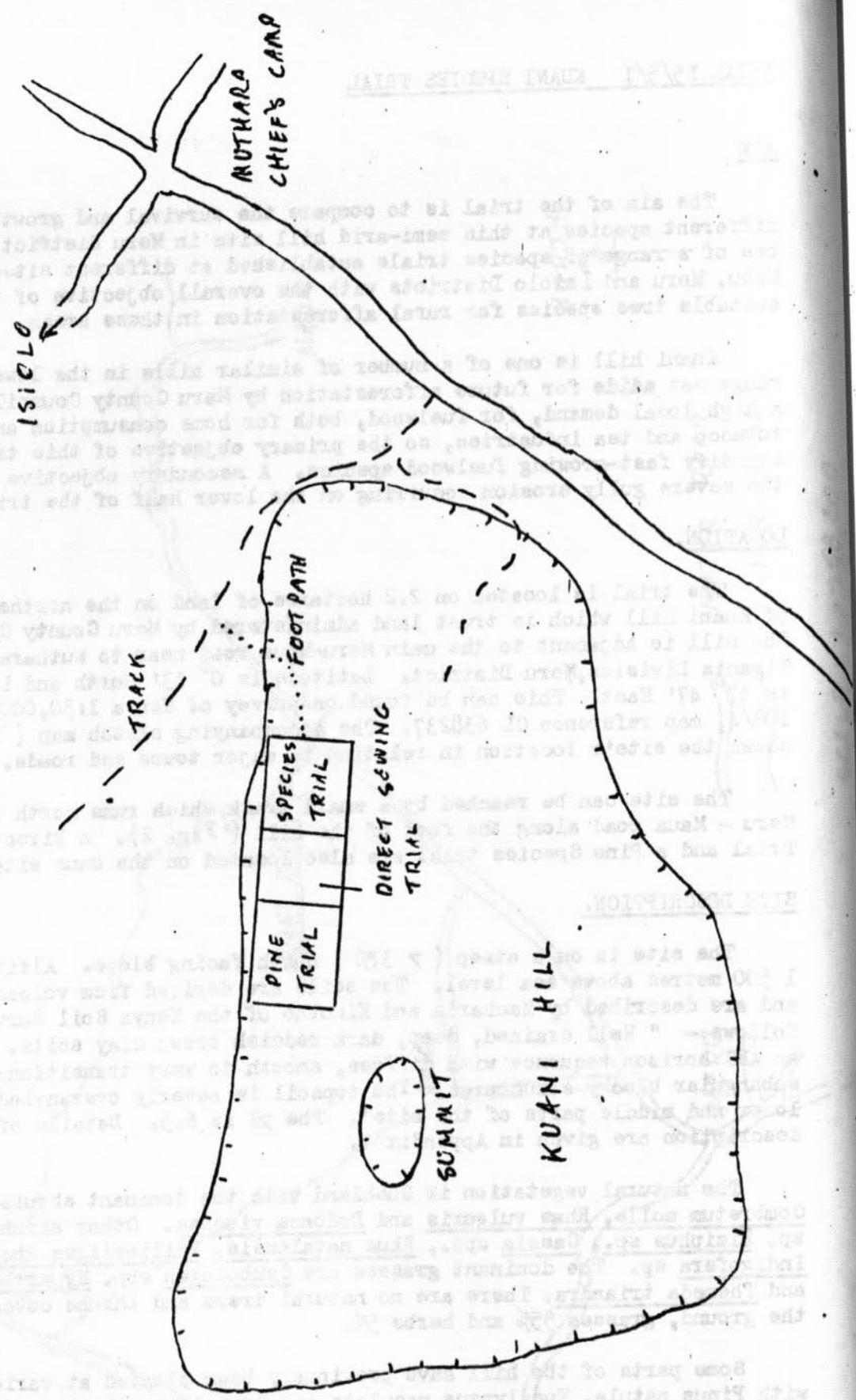
The natural vegetation is Bushland with the dominant shrubs being Combretum molle, Rhus vulgaris and Dodonea viscosa. Other shrubs are Acacia sp., Ziziphus sp., Cassia spp., Rhus natalensis, Philiostigma thoningii and Indigofera sp. The dominant grasses are Cymbopogon spp., Hyparrhenia filipendula and Themeda triandra. There are no natural trees and shrubs cover 35% of the ground, grasses 55% and herbs 5%.

Some parts of the hill have previously been planted at various times with Pinus patula, Eucalyptus maculata and Grevillea robusta. Most of this planting has been neglected and is either suppressed or failed due to non-weeding, fire, browsing and drought. Many of the lower slopes of the hill are badly eroded with deep gullies and large landslips. The soil erosion has apparently been caused by overgrazing of livestock in the past. Euphorbia tirucalli has been planted across the gullies in an attempt to control erosion and a large cut-off drain dug around the summit. The tree planting and soil conservation measures were carried out under various Rural Development Fund projects.

SITE OF KUANI RESEARCH TRIALS

NOT TO SCALE

FIGURE 2



The hill is currently being afforested again by the Nyambene Tea Company and the Forest Department mainly with Eucalyptus saligna, Eucalyptus globulus and some Eucalyptus maculata at a rate of approximately 10 hectares per season since April 1983.

#### CLIMATE.

There are no rainfall records for Kuani. In late 1983 the project installed a rain gauge at Muthara tree nursery which is 3km. to the north East of the trial. In 1984 the total rainfall was 803.5mm and in 1985 the total rainfall was 670.1 mm. Most of the rain falls in two seasons- March, April, May and October, November, December but both quantity and duration vary greatly from season to season. Monthly rainfall at Muthara nursery since October 1983 is given in Table 1. The site falls within Agroclimatic zone IV - 3.

#### SITE PREPARATION.

The only site preparation measure carried out before planting was the digging of pits at 2.5m x 2.5m spacing according to the trial design. These pits were 30cm x 30cm wide and 30cm deep. They were half refilled with loose soil before planting.

#### TRIAL DESIGN.

The trial was laid out in six replicate blocks aligned approximately parallel to the contours of the hill. The upper three blocks (I - III) are on reasonably stable ungullied land, whereas the lower three blocks (IV-VI) are on unstable, deeply gullied land. Within each block, 16 tree plots (4x4) of each species are allocated at random and planted at 2.5m x 2.5m spacing. Most species occur in all the replicates but with a few species insufficient seedlings were available so these could not be planted in all the replicates. The design is shown in Figure 3.

#### TRIAL HISTORY.

The trial was planted between 1st and 11th November 1983, block I being the first planted and block VI the last. The rains that season were very poor and so were the following rains in March/April 1984. This caused quite high mortalities particularly in the later planted blocks. However, survival of a number of species has been acceptable and no replanting has been carried out. Direct sowing of the seed in the pit was tried with Acacia mearnsii but this failed completely.

The trial has been weeded as required by 'spot' weeding (i.e. completely cleaning the soil about 0.5metre radius around each tree). The trial was not fenced but a watchman is employed to prevent grazing by livestock.

By March 1985, it was becoming apparent that growth rates of all species were rather low, even allowing for the 1983/84 drought. It was therefore decided to apply fertilizer to one complete replicate to test whether this would significantly improve growth. Granular fertilizer (20:20:0) was applied at the rate of 20gm. per tree in block I only in early March 1985.

#### SPECIES.

The following species were raised specifically for the trial at Muthara nursery by direct sowing into 10cm x 15cm (layflat) black polythene tube. A code of three colours was painted on each tube to enable easy identification of each species.



KUAMI SPECIES TRIAL

FIGURE 3

PLANTED 1<sup>ST</sup> - 11<sup>TH</sup> NOVEMBER 1963  
 ('C' SOWN 26<sup>TH</sup> NOVEMBER 1963)

↑  
TOP HILL

I

YBB	BRR	BPB	RYY	C	A	YWP	RRB	B	RPP	YGG	RYR	APG
GYG	BRV	YPP	PPR	YRP	PWB	YRR	WAA	RPA	RRP	WPG	WRP	

II

PWB	RPP	WRP	BRA	RYR	C	YWN	YGG	B	APB	RYY		WRR
	YWP	RPP	YRR	WPG	RRB	YAB	YPP	GYG	RPR	A	BRV	APG

NO GULLIES

III

RPR	PWB	YGG	WAA	C	RPR	BRV	A	RYR	YAB	YRR	WRP	RYY
RPP	BRA	YPP	YGB		APB	WPG	RRB		GYG	YWP	RPG	B

IV

YPP	BRA	WRP	RPR	YAR	B	YAB	RPP	WAA	WPG	GYG	RRB	
C	RPR	RYR	YGG	BRV	RPG	PPR	RYY	PWB	BPB	YWP		A

V

	RPG	YAP	WAA	YAR	PWB	BRA	BPB		WRP	A	RPP	YAB
RPR	GYG	RAA	BRV	YWP	YPP	C	RPR	RYR	RYY	WPG	B	YGG

GULLIES

VI

RYY	B	RPR	BRA	YGG	WAA	RYR	YAB	BPB				C	RRB
RPP	WRP	PWA	YPP	YWP	YAR	WPG	GYG	YRP	RPG	RPR	BRV	A	

BOTTOM HILL

↓

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SOURCE</u>	<u>NO. PLANTED</u>
BFB	<i>Acacia mearnsii</i>	Eldoret (201-003)	2	96
PPR	<i>Arocarpus fraxinifolius</i>	Embu	1	32
PWB	<i>Albizzia lebbek</i>		4	96
WPG	<i>Cassia siamea</i>	Ishiara	1	96
WRR	<i>Casuarina cunninghamiana</i>	Mareeba (BN 13515)	3	96
WRP	<i>Casuarina littoralis</i>	Jilatten (BN 13376)	3	96
RPR	<i>Eucalyptus alba</i>	Mt. Molloy (BN 12993)	3	96
BRR	<i>Eucalyptus camaldulensis</i>	Njukiini	1	96
RRB	<i>Eucalyptus camalsulensis</i>	Petford (BN 13159)	3	96
RPG	<i>Eucalyptus citriodora</i>	Hughenden (BN 12939)	1	96
WGB	<i>Eucalyptus cloeziana</i>	Mento (BN 13543)	3	16
RPP	<i>Eucalyptus crebra</i>	Torrens (BN 11958)	3	96
YGG	<i>Eucalyptus drepanophloia</i>	Thinoomba (BN 13578)	3	96
BRY	<i>Eucalyptus globulus</i>	Meru	1	96
YRR	<i>Eucalyptus gomphocephala</i>	Mylup (BN 12307)	3	96
YPP	<i>Eucalyptus hybrid</i>	Comp 119, Choma	5	96
RRP	<i>Eucalyptus maculata</i>	Nyeri (455-026)	2	96
YRP	<i>Eucalyptus melliodora</i>	Castlereagh (BN 11787)	3	32
RYY	<i>Eucalyptus paniculata</i>	Kirinyaga (474-018)	2	96
HYR	<i>Eucalyptus tereticornis</i>	Gede (506-008)	2	96
YWW	<i>Eucalyptus terminalis</i>	Julia (BN 11966)	3	16
YWP	<i>Eucalyptus tessellaris</i>	Mareeba (BN 12967)	3	96
YBB	<i>Eucalyptus urophylla</i>	Mt. Mondiri (BN 12895)	3	96
GYG	<i>Leucaena leucocephala</i>	K8	6	96

Full addresses of seed suppliers are given in Appendix 2.

In addition, the following species were collected from stock already growing at Muthara nursery.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>NO. PLANTED.</u>
A	<i>Grevillea robusta</i>	Muthara	96
B	<i>Eucalyptus saligna</i>	Muthara	96

Also, the plots marked C in the plan were direct sown with pre-treated seeds of *Acacia mearnsii* (Eldoret, Kenya) at the rate of 4 seeds per pit on 26 th November 1985.

All seedlings were protected from termite attack by treating with three weekly waterings of Aldrex 48 solution in the nursery, prior to planting out.

### RESULTS.

Summaries of the results of the assessments carried out in October 1984 and November 1985 are given in tables 2 and 3. The species are ranked according to overall survival rate.

### DISCUSSION.

It is too early to draw firm conclusions on the best species. The most promising so far are *Eucalyptus camaldulensis* (Petford) and *Grevillea robusta*. These two species have performed much better than the *Eucalyptus maculata*, *Eucalyptus globulus* and *Eucalyptus saligna* currently being planted on the hill. It would certainly be worth introducing *Eucalyptus camaldulensis* and *Grevillea robusta* into the planting programme. It would also be worth carrying out a full provenance trial of *Eucalyptus camaldulensis*. Other species worth mentioning as showing promise at this stage are *Eucalyptus alba*, *Eucalyptus crebra*, *Eucalyptus hybrid* and *Eucalyptus citriodora*. *Casuarina littoralis* and *Casuarina cunninghamiana* have both performed reasonably well and could provide an opportunity for growing softwood timber.

TABLE 2

## KUANI SPECIES TRIAL

## PERCENT SURVIVAL AND AVERAGE HEIGHT OCTOBER, 1984

CODE	SPECIES	PROVENANCE	% SURVIVAL	AV. HT.
RRB	<i>Eucalyptus camaldulensis</i>	Patford QLD	85	45 cm.
RPR	<i>Eucalyptus alba</i>	Mt. Molloy QLD	85	24 cm.
RPP	<i>Eucalyptus crebra</i>	Torrens QLD	78	34 cm.
YWW	<i>Eucalyptus terminalis</i>	Julia Creek QLD	75	33 cm.
A	<i>Grevillea robusta</i>	Muthara	73	27 cm.
YWP	<i>Eucalyptus Tesselaria</i>	Moreeba QLD	70	21 cm.
RPG	<i>Eucalyptus Cetriodera</i>	Hughenden QLD	68	33 cm.
YPP	<i>Eucalyptus hybrid</i>	Zambia	67	36 cm.
WRP	<i>Casuarina letteralia</i>	Julatten QLD	65	24 cm.
YGG	<i>Eucalyptus drepanoloba</i>	Thinookba QLD	65	30 cm.
YBB	<i>Eucalyptus trophylla</i>	Mt. Mondri IND	63	30 cm.
WPG	<i>Cassia siamea</i>	Ishiara	60	10 cm.
BRB	<i>Eucalyptus camaldulensis</i>	Njukini	56	38 cm.
PWB	<i>Albizia lebbek</i>	T + L	55	7 cm.
WRR	<i>Casuarina cunninghamiana</i>	Moreeba QLD	51	39 cm.
RRP	<i>Eucalyptus maculata</i>	Muguga	50	22 cm.
YRP	<i>Eucalyptus melliodora</i>	Castlereagh NSW	50	28 cm.
GYG	<i>Leucaena leucocephala</i>	K 8	46	6 cm.
RYY	<i>Eucalyptus paniculata</i>	Kirinyaga	33	26 cm.
BRY	<i>Eucalyptus globulus</i>	Meru	27	28 cm.
RYR	<i>Eucalyptus tereticornis</i>	Gede	26	28 cm.
B	<i>Eucalyptus saligna</i>	Muthara	20	27 cm.
BFB	<i>Acacia mollissima</i>	Eldoret	17	11 cm.
YRR	<i>Eucalyptus gomphocephala</i>	Mylap WA	9	16 cm.
PPR	<i>Acrocarpus fraxinifolius</i>	Embu	6	6 cm.
YGB	<i>Eucalyptus cloeziana</i>	Monto QLD	6	10 cm.
C	<i>Acacia mollissima</i>	-- DIRECT SOWN	0	0 cm.

TABLE 3

## KUANI SPECIES TRIAL

PLANTED NOV. 1983

## PERCENT SURVIVAL AND AVERAGE HEIGHT, NOVEMBER, 1985

CODE	SPECIES	PROVENANCE	% SURVIVAL	AV. HT.
RFB	<i>Eucalyptus camaldulensis</i>	Petford, QLD	86	97 cm
RPR	<i>Eucalyptus alba</i>	Mt. Molley QLD	83	43 cm
RPP	<i>Eucalyptus crebra</i>	Torrens, QLD	68	47 cm
A	<i>Grevillea robusta</i>	Muthara	67	66 cm.
YWP	<i>Eucalyptus tessellaris</i>	Morreba, QLD	63	36 cm
YPP	<i>Eucalyptus hybrid</i>	Zambia	60	53 cm.
RPG	<i>Eucalyptus citriodora</i>	Hughenden, QLD	58	66 cm
YGG	<i>Eucalyptus drepanophloia</i>	Thinooomba, QLD	56	35 cm
BRR	<i>Eucalyptus camaldulensis</i>	Njukiini	54	65 cm.
YBB	<i>Eucalyptus urophylla</i>	Mt. Mondri, IND	51	51 cm.
WRP	<i>Casuarina littoralis</i>	Julatten, QLD	51	45 cm.
YRP	<i>Eucalyptus melliodora</i>	Castlereagh, NSW	48	55 cm.
RRP	<i>Eucalyptus maculata</i>	Muguga	46	33 cm.
PWB	<i>Albizia lebbek</i>	T + L	43	8 cm.
WRR	<i>Casuarina cunninghamiana</i>	Moreeba, QLD	41	51 cm
WPG	<i>Cassia siamea</i>	Ishiara	26	13 cm
RYY	<i>Eucalyptus paniculata</i>	Kirinyaga	25	45 cm.
BRY	<i>Eucalyptus globulus</i>	Meru	17	57 cm.
RYR	<i>Eucalyptus tereticornis</i>	Gede	14	47 cm.
GYG	<i>Leucaena leucocephala</i>	K8	11	11 cm.
B	<i>Eucalyptus saligna</i>	Muthara	9	47 cm.
BPB	<i>Acacia mollissima</i>	Eldoret	5	39 cm.
YRR	<i>Eucalyptus gomphocephala</i>	Mylap, WA	1	91 cm.
PPR	<i>Acrocarpus fraxinifolius</i>	Embu	0	-
YGB	<i>Eucalyptus cloeziana</i>	Mounto, QLD	0	-
YWW	<i>Eucalyptus terminalis</i>	Julia Creek, QLD	0	-
C	<i>Acacia mollissima</i>	DIRECT SOWN	0	-

The general initial slow growth of all species is somewhat puzzling. Levels of available N, P and K in the soil are equal to or higher than the other species trials and there do not appear to be any limitations to rooting depth. Trees at the Gangara trial site in Embu which has had similar rainfall have grown nearly three times as fast. Competition from grass may have had an effect but the trees have been kept well 'spot' weeded and again, other trial sites have worse grass growth. On recent visits to the site it did appear that the growth of the trees was becoming more vigorous.

The poor performance of Leucaena leucocephala can probably be attributed to the acidity of the soil.

The importance of planting as soon as the soil is moist enough has been shown by the survival rates of all the seedlings planted in each block. 53 millimetres of rain fell during 28th - 30th October 1983. Planting started on 1st November 1983 with Block I and continued at 2 day intervals through to Block VI. During the whole of the month of November only another 53 millimetres of rain fell. Percent survival at November 1985 of all the seedlings of all the species planted in each block is shown below.

<u>BLOCK</u>	<u>DATE PLANTED</u>	<u>PERCENT SURVIVAL</u>
I	1-2/11/83	53%
II	3-4/11/83	48%
III	5-5/11/83	46%
IV	7-8/11/83	41%
V	9-10/11/83	27%
VI	10-11/11/83	23%

PROFILE DESCRIPTION NO.6

General site information

Soil description : eutric ITISOL  
 Agro-climatic zone : III  
 Observation No./Date : 108/4-5, 27/1/84  
 Location/Altitude : Meru District, N<sup>o</sup>13'N 37<sup>o</sup>47'E  
 Local petrography : Upper Nyambene Volcanics (lavas)  
 Physiography : Hill  
 Relief, macro : Hilly, slope 30- 35%  
 Land use : Under tree trials  
 Erosion : Gully erosion in uncovered ground  
 Internal drainage : Well drained

Profile description

Ah 0-40cm Dark reddish brown (2.5YR 4/6 dry, 2.5YR 3/4 moist); clay; moderate, medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine and medium pores; many very fine, fine, medium and few coarse roots; pH 6.5; diffuse, smooth transition to:  
 (sample no. 108/4-6a)

Bu 40-60cm Dark reddish brown (2.5YR 4/6 dry, 2.5YR 3/4 moist); clay; moderate to strong, fine subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine pores; many very fine, fine, medium and few coarse roots; pH 6.0; diffuse, wavy transition to:  
 (sample no. 108/4-6b)

Bt<sub>1</sub> 60-80cm Dark reddish brown (2.5YR 3/4 moist); clay; moderate to strong medium subangular blocky structure; slightly hard when dry; friable when moist, sticky and plastic when wet; few fine clay cutans, many very fine, fine, medium and few coarse roots; pH 6.1, clear wavy transition to:  
 (sample no. 108/4-6c)

Bt<sub>2</sub> 80-120cm+ Dark red (2.5YR 4/8, 2.5YR 3/3 moist); clay; moderate, to strong medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few fine cutans; many fine pores; few very fine, fine and wavy few medium coarse roots; pH 5.3;  
 (sample no. 108/4-6d)

# KUANI SPECIES TRIAL

- 31 -

## LABORATORY DATA OF PROFILE DESCRIPTION NO.

Observation no: 108/4-7 Mapping unit: KUANI Soil classification: eutric NITISOL

Laboratory no.	278	279	280	281	
Horizon	Ah	Bu	Bt <sub>1</sub>	Bt <sub>2</sub>	
Depth (cm)	0-40	40-60	60-80	80-120	
pH-H <sub>2</sub> O (1: 2½ v/v)	6.5	6.0	6.1	5.3	
pH-KCl	5.4	5.1	5.3	5.5	
EC (mmho/cm)	0.09	0.09	0.05	0.06	
CaCO <sub>3</sub> (%)					
CaSO <sub>4</sub> (%)					
C (%)	1.26	0.46	0.69	0.54	
N (%)					
C/N					
CEC (me/100g), pH 8.2	20.0	13.2	15.4	15.4	
CEC " " pH 7.0					
Exch. Ca (me/100g)	4.8	2.0	3.9	4.8	
" Mg "	1.95	2.24	4.80	5.48	
" K "	1.98	0.81	1.25	1.38	
" Na "	0.38	0.24	0.41	0.82	
Sum of cations	9.12	5.29	10.36	12.54	
Base sat. %, pH 8.2	46	40	67	81	
" " %, pH 7.0					
ESP at pH 8.2					
<u>Texture (limited pretreatment)</u>					
Gravel % (>2.0mm)					
Sand % (2.0-0.05mm)	16	14	14	14	
Silt % (0.05-0.002mm)	16	16	14	12	
Clay % (0.002-0mm)	68	70	72	74	
Texture class	C	C	C	C	
<u>Fertility aspects</u> 0 - 30 cm Laboratory no. 302					
<u>General</u>		<u>Available nutrients</u>			
pH-H <sub>2</sub> O (1: v/v)	6.3	Na (me/100g)		Mn (me/100g)	0.66
Exch. acidity (me/100g)		K "	1.00	P (ppm)	12
C %	1.29	Ca "	1.4	P-Olsen (ppm)	
N %	0.15	Mg "			

Remarks:

Albizzia lebbek  
 Acacia mangium  
 Casia siamea

APPENDIX 2 SEED SOURCES.

1. Local collection
2. The Seedsman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74  
Kikuyu  
KENYA.
2. C.S.I.R.O  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
4. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND
5. Chief Forest Research Officer  
P.O. Box 22099  
Kitwe  
ZAMBIA.
6. Mr. Edmund Barrow  
East Pokot Agricultural Project  
P.O. Marigat  
KENYA.

AIM

The aim of the trial was to attempt to establish seedlings by the direct sowing of seeds at the planting site. If trees can be successfully established by this method then establishment costs would be greatly reduced by the elimination of nursery work. 12 different species were included in the trial.

LOCATION

The trial is located on 1.0 hectares of land adjacent to Trial B/5/5/1 Kuani Species Trial. A full description of the location is given in the report on that trial.

SITE DESCRIPTION.

See report on trial B/5/5/1 Kuani Species Trial.

CLIMATE

See report on trial B/5/5/1 Kuani Species trial.

SITE PREPARATION.

See report on trial B/5/5/1 Kuani Species trial.

TRIAL DESIGN.

The trial is laid out in six replicates blocks aligned approximately parallel to the contours of the hill. The upper three blocks (I - III) are on reasonably stable ungullied land, whereas the lower three blocks (IV - VI) are on unstable, deeply gullied land. Within each block, 16 tree plots (4x4) of each species are allocated at random and sown at 2.5m x 2.5m spacing. The design is shown in Figure 4.

TRIAL HISTORY.

The trial was first sown in April 1984. The rains that season were very poor and most seeds failed to germinate. Those that did germinate did not survive for more than a few months. Sowing was therefore repeated with exactly the same species in November 1984 when rainfall was good.

During October 1985 Blocks I and II were accidentally destroyed by workers preparing pots for the regular plantation programme.

SPECIES.

The following species were included in the trial. The seeds of those species requiring pre-treatment (Acacia spp., Albizzia lebbek, Cassia spp. and Leucaena leucocephala) were treated immediately prior to sowing by immersing in hot water and leaving them to soak overnight in the cooling water.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SOURCE</u>	<u>PER PIT.</u>
PGG	Acacia albida		4	2
GPR	Acacia aulacocarpa	Buckley (BN 13865)	3	1
GPY	Acacia auriculiformis	Springvale (BN 13861)	3	1
BPW	Acacia mearnsii	Nyambene	1	4
PWB	Albizzia lebbek		4	3
PPR	Acrocarpus fraxinifolius	Embu	1	4
WPG	Cassia siamea	Ishiara	1	4

KUANI DIRECT SOWING TRIAL

FIGURE

SOWN NOVEMBER 1984

↑  
TOP HILL

DESTROYED  
OCTOBER  
1985

I

GPR	PPR	GYP	PGG	BPW	Y
BRV	GPY	X	PWB	WPG	WGP

II

WGP	BRV	BPW	X	WPG	PGG
GYP	PPR	GPY	Y	GPR	PWB

NO GULLIES

III

X	BRV	PGG	WGP	BPW	GPY
PPR	Y	PWB	GYP	WPG	GPR

← SPECIES TRIAL

IV

GYP	BPW	GPR	WPG	WGP	BRV
X	PPR	PGG	Y	PWB	GPY

V

GPR	GPY	WGP	BRV	Y	BPW
X	PGG	WPG	PPR	GYP	PWB

GULLIES

VI

PGG	PPR	GPR	Y	WGP	GPY
X	BRV	WPG	BPW	PWB	BRV

↓  
BOTTOM HILL

...../

CODE	SPECIES	PROVENANCE	SEED SOURCE	NO. SEEDS PER PIT.
WGP	<i>Cassia spectabilis</i>	Embu	1	4
BRY	<i>Eucalyptus globulus</i>	Meru	1	10 approx.
X	<i>Eucalyptus saligna</i>	Muthara	1	10 approx.
Y	<i>Grevillea robusta</i>	Muthara	1	4
GYP	<i>Leucaena leucocephala</i>	Ena	1	4

Full addresses of seed supplies are given in Appendix 2 of the report on trial B/5/5/1 Kuani Species Trial.

RESULTS.

Initial germination was observed to be good for all species but by November 1985 many of the seedlings had died and the percentage of pits containing surviving seedlings is given in Table 4.

Table 4 Percent Pits containing Surviving Seedlings at November 1985

( One year after sowing )

CODE	SPECIES	PROVENANCE	PERCENT PITS WITH SURVIVING SEEDLINGS.
PGG	<i>Acacia albida</i>		69
PWB	<i>Albizia lebbek</i>		8
GPR	<i>Acacia aulacocarpa</i>	Buckley	3
GPY	<i>Acacia auriculiformis</i>	Springvale	1
Y	<i>Grevillea robusta</i>	Muthara	1

All other species had no survivals.

DISCUSSION.

The trial has shown that direct sowing is not a practical proposition for this site. Of the species tried, only *Acacia albida* can be considered to have established successfully. However, growth of the seedlings has been extremely slow ( most seedlings are less than 50cm tall ) and is much less than the growth rates achieved by planted seedlings. It is possible that other more drought - resistant species such as *Acacia nilotica*, *Acacia tortilis*, *Parkinsonia aculeata* or *Ziziphus mauritiana* could be established by this method but it is unlikely that there would be a demand for such species at this site, when much more productive species can be grown from planted seedlings.

AIM.

The aim of the trial is to compare the survival and growth of 10 different species/provenances of drought resistant pines, at this semi-arid site in Meru district. This is one of a range of species trials established at different sites within Embu, Meru and Isiolo districts with the overall objective of identifying suitable tree species for rural afforestation in these areas.

LOCATION.

The trial is located on 1.0 hectares of land adjacent to trial B/5/5/1 Kuani Species Trial and trial B/5/5/2 Kuani Direct Sowing Trial. A full description of the location is given in the report on trial B/5/5/1.

SITE DESCRIPTION.

See report on trial B/5/5/1 Kuani Species Trial.

CLIMATE.

See report on trial B/5/5/1 Kuani Species Trial.

SITE PREPARATION.

See report on trial B/5/5/1 Kuani Species Trial.

TRIAL DESIGN.

The trial was laid out in six replicates block aligned approximately parallel to the contours of the hill. The upper three blocks ( I - III ) are on reasonably stable ungullied land, whereas the lower three blocks ( IV - VI ) are on unstable, deeply gullied land. Within each block 16-tree plots ( 4 x 4 ) of each species/provenances are allocated at random and planted at 2.5m x 2.5m spacing. The design is shown in Figure 5.

TRIAL HISTORY

The trial was planted between 30/10/85 and 4/11/85. The rains that season were slightly below average but initial establishment has been satisfactory.

SPECIES.

The following species were raised specifically for the trial, initially at Meru Forest Nursery and later transferred to Muthara Nursery. The seed was sown direct into 10cm x 15cm (layflat ) black polythene tube. A code of two colours was painted on each tube to enable easy identification of each species.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>NO. PLANTED.</u>
RR	Pinus brutia	Cothisar, Turkey (66/79)	96
RY	Pinus brutia	Syria ( 64/79	96
RB	Pinus brutia	Antalya, Turkey (69/79)	96
RG	Pinus eldarica	Kabul, Atghanistan(98/78)	96
RW	Pinus eldarica	Azerbaijan, S. Russia ( 66/78 )	96
RP	Pinus halepensis	Turkey ( 71/79 )	96
YR	Pinus halepensis	Syria ( 65/79)	96
YY	Pinus Kesiya	Dalat, S. Vietnam (66/597/ OXON I )	96
YB	Pinus Kesiya	Baw Laung, Thailand ( 67/593/2)	96
YW	Pinus patula	Meru	96

KUAN HILL

PINE TRIAL

FIGURE 5

I

RR	YY	RB	RY	YR
YW	RW	RP	YB	RG

PLANTED 2/11/25

II

RY	RR	RB	YY	RG
RP	YB	YR	RW	YW

PLANTED 1/11/25

NO GULLIES

III

YY	RP	RR	YR	RY
RB	RW	YW	RG	YR

PLANTED 2/11/25

DIRECT  
SIVING  
TRIAL

IV

YR	RR	RG	RB	YB
YW	YY	RY	RP	RW

PLANTED 4/11/25

GULLIES

V

YW	RB	RR	RG	RW
YB	YY	RY	RP	YR

PLANTED 30/10/25

VI

YR	RG	RP	RW	RB
RR	RY	YY	YB	YW

PLANTED 30/10/25

BOTTOM HILL ↓

4W  
 Apart from ~~YW~~ Pinus patula which was collected locally all the seed was supplied by:

Oxford Forestry Institute  
 South Parks Road  
 Oxford OX 1 3RB  
ENGLAND.

RESULTS.

A summary of the results of the first assessment carried out in April 1986 is given in Table 5. The species/provenances are ranked according to overall survival rate.

DISCUSSION.

It is still far too early to draw any conclusions from this trial. Early establishment has been encouraging and gives hope that it may be possible to grow softwood timber on Kuani hill and the other similar hills in the area.

KUANI HILL PINE TRIAL

TABLE 5

Planted November 1985

Assessed April 1986

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>% SURVIVAL</u>	<u>AV. HT.</u>
RR	Pinus brutia	Cethisar, Turkey	89	14cm
RP	Pinus halepensis	Turkey	85	19cm.
YR	Pinus halepensis	Syria	81	13cm
RW	Pinus eldarica	Azerbaijan, S. Russia	80	16cm
YW	Pinus patula	Meru	77	17cm
RB	Pinus brutia	Antalya, Turkey	75	14cm
RY	pinus brutia	Syria	67	12cm
YB	Pinus kesiya	Baw Laung, Thailand	60	12cm
YY	Pinus kesiya	Dalat, S. Vietnam	53	13cm
RG	Pinus eldarica	Kabul, Afganistan	49	14cm

RR Pinus brutia Cethisar, Turkey (86/79) 89 14cm  
 RP Pinus brutia Turkey (85/79) 85 19cm  
 YR Pinus brutia Syria (81/79) 81 13cm  
 RW Pinus eldarica Azerbaijan, S. Russia (80/79) 80 16cm  
 YW Pinus patula Meru (77/79) 77 17cm  
 RB Pinus brutia Antalya, Turkey (75/79) 75 14cm  
 RY Pinus brutia Syria (67/79) 67 12cm  
 YB Pinus kesiya Baw Laung, Thailand (60/79) 60 12cm  
 YY Pinus kesiya Dalat, S. Vietnam (53/79) 53 13cm  
 RG Pinus eldarica Kabul, Afganistan (49/79) 49 14cm

The site of the trial is to comprise several hectares of land in Isiolo district. Our three trials are located on a hillside with a slope of about 15% and are planted with a mixture of species. The trials are located on a hillside with a slope of about 15% and are planted with a mixture of species. The trials are located on a hillside with a slope of about 15% and are planted with a mixture of species.

LOCATION

The trial is located on 6.6 hectares of land administered by Isiolo County Council. The land was formerly part of the Isiolo Holding Ground of the Livestock Department, Division of the Ministry of Agriculture but it is claimed that it was part of a proposed Forest Reserve in Garissa Hills. Latitude is 0° 15' S and Longitude is 37° 25' East. This is located on Survey of Kenya 1:50,000 scale sheet 100/1, a map reference UG 15000. The accompanying sketch shows the site location in relation to Isiolo town and the road to the west of the Game Department camp and at the end of an access road.

**EMBU-MERU-ISIOLO FORESTRY PROJECT**

**RESEARCH SECTION**

**REPORT ON B5/6/1 ISIOLO (RED SOIL) SPECIES TRIAL**

**BY: GORDON ARMSTRONG, SILVICULTURIST  
J K LUGADIRU, RESEARCH FORESTER**

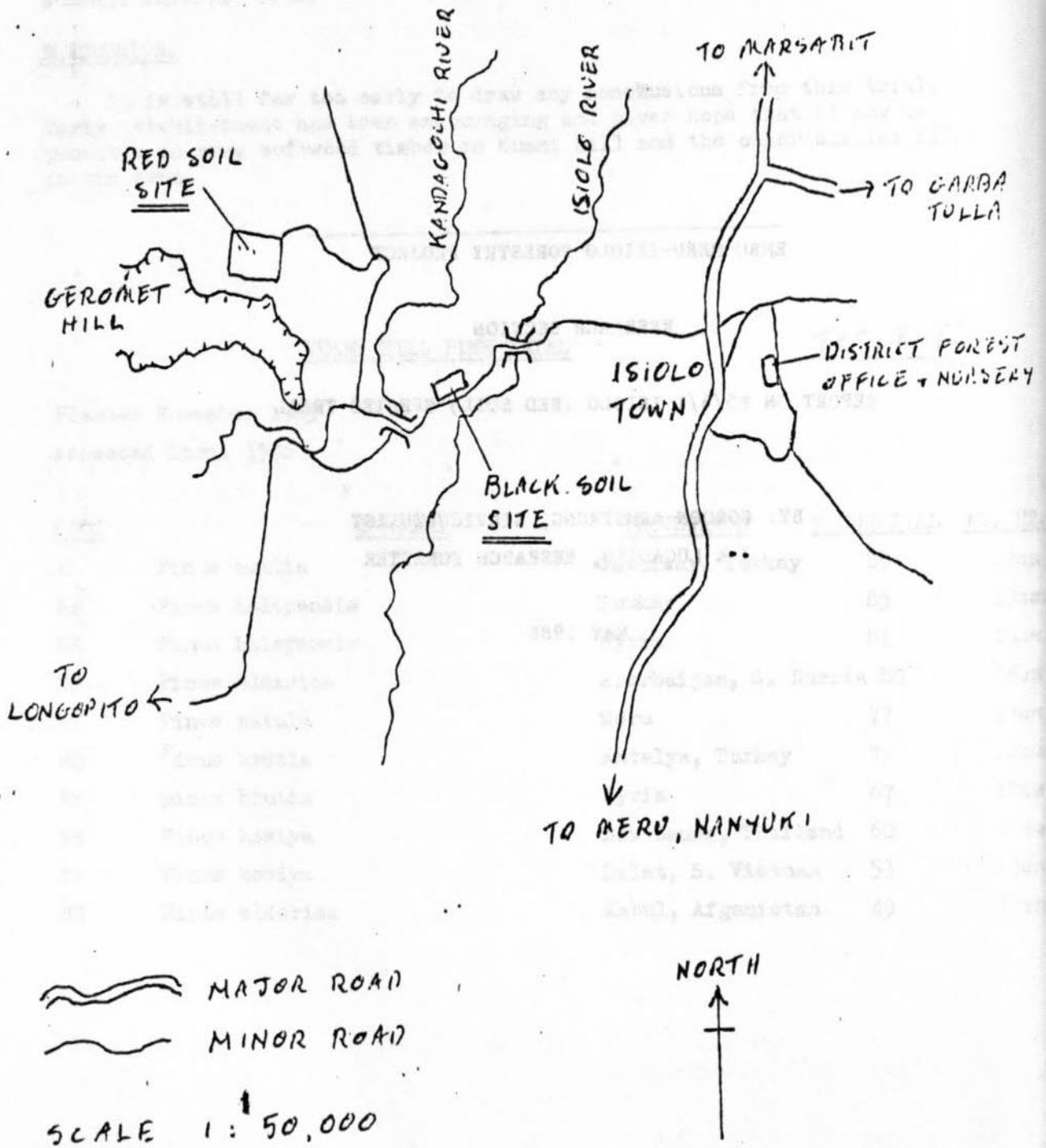
**MAY 1986**

There are no rainfall records for the site. In November 1985 the project increased a rain gauge at the site. The gauge is located in Isiolo town, about 10 km from the site. The rainfall recorded is given in the table below.

TABLE 1 MONTHLY RAINFALL IN HILLSTATION AT DISTRICT FOREST OFFICE, ISIOLO

Month	1985	1986	1987
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0	0	0
November	50.9	29.5	2.7
December	112.0	85.2	22.4
Total		407.5	112.2

FIGURE 1 LOCATION OF ISIOLO TRIAL SITES



## AIM.

The aim of the trial is to compare survival and growth of a large number of species/provenances at this arid, eroded site in Isiolo district. Over three seasons a total of 100 species/provenances have been planted. This trial is one of a range of species trials established at different sites within Embu, Meru, and Isiolo Districts with the overall objective of identifying suitable tree species for rural afforestation in those areas.

## LOCATION.

The trial is located on 6.6 hectares of land administered by Isiolo County Council. The land was formerly part of the Isiolo Holding Ground of the Livestock Marketing Division of the Ministry of Agriculture but it is planned that it should become part of a proposed Forest Reserve on Geromet Hill. Latitude is 0° 22' North and Longitude is 37° 33' East. This is located on Survey of Kenya 1:50,000 scale sheet 108/1, a map reference CL 385404. The accompanying sketch map shows the sites location in relation to Isiolo town (Fig.1) The site is on the lower northeast facing slopes of Geromet Hill to the west of the Game Department camp and at the end of an abandoned airstrip.

## SITE DESCRIPTION.

The site is a NE - facing, gently sloping (3-5%) hillside dissected by a number of deep gullies. The soils are described by Macharia and Kimotho of the Kenya Soil Survey as follows "Well drained, very deep, dark red sandy clay loam soils with an ABC horizon sequence with diffuse smooth boundaries. They are slightly alkaline. They have an eroded top soil and a fine to medium subangular blocky structure. The clay percentage increases with depth". Details of the soil description are given in Appendix 1.

The natural vegetation is classed as Bushland with the following small trees and shrubs being dominant: Commiphora riparia, Boscia coriacea, Commiphora schimper and Acacia senegal. Others are Grewia bicolor, Ipomea spp and Euphorbia spp. The dominant grasses are Tragus berteronianus and Aristida keniensis.

The site was previously used as a grazing area and had been severely over grazed, much of the site having no ground vegetation. This had led to serious roll and gully erosion.

The altitude is 1150 metres above sea level.

## CLIMATE

There are no rainfall records for the site. In November 1983 the project installed a rain gauge at the District Forest Office in Isiolo town which is about 4 kilometers east of the site. The rainfall recorded is given in the table below:-

TABLE I      MONTHLY RAINFALL IN MILLIMETERS AT DISTRICT FOREST OFFICE, ISIOLO.

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
January	--	0	0	0
February	--	4.1	11.9	0
March	--	41.9	82.3	110.7
April	--	61.2	99.1	194.6
May	--	0	0	
June	--	0	17.3	
July	--	0	0	
August	0	0	0	
September	--	6.9	1.8	
October	--	54.4	34.7	
November	90.9	269.5	75.7	
December	111.0	29.5	11.4	
<u>TOTALS</u>		<u>467.5</u>	<u>331.2</u>	

As can be seen, most of the rain falls in two seasons; March, April and October, November, December but the quantity and duration of rainfall vary greatly from season to season. The site falls within Agroclimatic Zone V-2 but is certainly at the lower rainfall end of that classification.

#### SITE PREPARATION.

10 blocks each 25 metre by 220 metres were laid out across the slope, with 10 metres strips between the blocks. Within each block the shrubs and small trees were cleared and the debris piled in the strips. Pits, each 30cm x 30cm x 30cm were dug according to the trial design and 'microcatchments' prepared for each pit.

The 'microcatchments' consisted of two small furrows approximately 1 metre in length directed outwards from opposite sides of the pit and slightly up the slope. The design varied according to the micro-topography around the pit but the aim was to direct runoff water into the pit. No work was done in the 10-metre strips between the blocks and they were left in their 'natural' state.

A seven-strand barbed wire fence was erected around the site.

#### TRIAL DESIGN.

The trial is laid out in 10 blocks. Within each block there are up to 35 16-tree plots (4x4) with pits at 2.5m x 2.5m spacing. The exact number of plots per block varies according to the area of unplantable gullies in each block.

#### TRIAL HISTORY

The trial was originally planted using a total of 72 different species/provenances during 11th -18th November 1983. Blocks I<sub>E</sub>, II<sub>E</sub>, III<sub>E</sub>, IV<sub>E</sub> and V<sub>E</sub> being planted entirely with Eucalyptus species/provenances and Blocks I, II, III, IV and V with either species, thus making five replicates. The rains that season were very late and low in quantity and the following rains in March/April 1984 were also very poor. This made conditions on what is already a very difficult site even more extreme. Consequently, by October 1984 there were only 14 surviving seedlings of 9 species. There were no survivors at all in Blocks IV, IV<sub>E</sub>, V and V<sub>E</sub> so these blocks were replanted on 22, 23/10/84 with 22 additional species/provenances. At the same time, direct sowing of the seed in the pit was tried with 11 different species. Also, on 2/11/84 most of blocks III and III<sub>E</sub> were replanted with general stock of various species from Isiolo nursery.

On 6, 7/11/85 Blocks I, I<sub>E</sub>, II and II<sub>E</sub> were replanted with 33 species/provenances which showed promise from the previous plantings. Any surviving seedlings from the original planting were not disturbed. A plan of the trial site showing the situation at March 1986 is given in figure 2.

The microcatchments of all surviving seedlings have been remade before each rainy season. The height of each tree has been measured twice per year.

#### SPECIES.

The following species were raised specifically for the trial at Isiolo district nursery by direct sowing into 10cm x 15cm ( layflat ) black polythene tubes. A code of three colours was painted on each tube to enable easy identification of each species/provenances.





Planted 11th - 18th November, 1983

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANTED
BBG	Acacia albida	Baringo	2	80
BGR	Acacia aneura	Alice Springs (BN 12482)	4	16
BGP	Acacia bevenosa	Cape Range (BN 11540)	4	64
BGW	Acacia cambagei	Winderack (BN 13487)	4	32
BBW	Acacia cyanophylla		3	60
BWG	Acacia holosericea	NT (BN 12331)	4	32
BGB	Acacia melanoxydon	Blundells (BN 12508)	4	60
PGW	Acacia nilotica		7	16
BWY	Acacia pruinocarpa	Wiluna (BN 7859)	4	64
BWB	Acacia pyrifolia	Bullora (BN 11537)	4	48
BWW	Acacia salicina	Roma (BN 13501)	4	60
BBY	Acacia tortilis	Hola	2	16
BPR	Acacia tumida	Cape Leveque (BN 11494)	4	32
BPY	Acacia victoriae	Dajarra (BN 13494)	4	16
WBW	Atriplex semi-baccata		3	60
PPG	Azadirachta indica	Kinna	1	60
PRW	Balanites aegyptiaca	Baringo	8	48
WPG	Cassia siamea	Ishara	1	32
PRP	Cassia sturtii	Israel	8	64
WRW	Casuarina decaisneana	Ayers Rock (BN 13202)	4	32
WRY	Casuarina equisetifolia	Port Douglas (BN 13375)	4	60
YBW	Eucalyptus argillacea	Learmonth (BN 12545)	4	48
RPY	Eucalyptus astringens	Dryandra (BN 12842)	4	60
YBP	Eucalyptus brassiana	Bamaga (BN 13415)	4	60
YGR	Eucalyptus brevifolia	Inverway (BN 9071)	4	16
RFB	Eucalyptus brookwayii	Norseman (BN 12952)	4	64
RRR	Eucalyptus camaldulensis	L. Albacutya (BN 10666)	4	60
RRY	Eucalyptus camaldulensis	Kimberly (BN 12346)	4	60
RRB	Eucalyptus camaldulensis	Petford (BN 13159)	4	60
RRG	Eucalyptus camaldulensis	Ord. R. (BN 12352)	4	60
RRW	Eucalyptus camaldulensis	Katherine (BN 12182)	4	60
RYW	Eucalyptus camaldulensis	Gilbert R. (BN 13564)	4	48
RBR	Eucalyptus camaldulensis	Buchanan (BN 13435)	4	16
RDB	Eucalyptus camaldulensis	The Olgas (BN 13192)	4	32
RBW	Eucalyptus camaldulensis	Wiluna (BN 13433)	4	60
RBP	Eucalyptus camaldulensis	P. Lincoln (BN 10885)	4	32
RGY	Eucalyptus camaldulensis	Silverton (BN 6930)	4	32
BRR	Eucalyptus camaldulensis	Njukini	1	48
RPG	Eucalyptus citriodora	Hughenden (BN 12939)	4	60
RPW	Eucalyptus cladocalyx	Gilgandra (BN 11834)	4	60
YPP	Eucalyptus hybrid	Comp. 119, Choma	9	60
YRY	Eucalyptus intertexta	St. George (BN 12933)	4	32
YWR	Eucalyptus melanophloia	Charleville (BN 13158)	4	32
YPY	Eucalyptus microtheca	Laura R. BN 13360	4	32
YWY	Eucalyptus ochrophloia	Charleville (BN 12507)	4	32
YB	Eucalyptus oleosa	Norseman (BN 9910)	4	60
YWG	Eucalyptus raveretiana	Kalopa (BN 13545)	4	60
YYW	Eucalyptus sargentii	Hines H. (BN 12406)	4	60
YBR	Eucalyptus sideraxylon	Dubbo (BN 12017)	4	32
RYR	Eucalyptus tereticornis	Gede	2	60
RGB	Eucalyptus tereticornis	Helenvale (BN 10961)	4	16
RGC	Eucalyptus tereticornis	Lakeland (BN 12946)	4	60
RGW	Eucalyptus tereticornis	Kennedy (BN 12947)	4	60
RGP	Eucalyptus tereticornis	Mt. Garnet (BN 12965)	4	60
RWR	Eucalyptus tereticornis	Cardwell (BN 13277)	4	32
RYY	Eucalyptus tereticornis	Mareeba (BN 13442)	4	60
RWB	Eucalyptus tereticornis	Morehead R. (BN 13444)	4	60
RWC	Eucalyptus tereticornis	Gladstone (BN 13544)	4	60
RWW	Eucalyptus tereticornis	Cardwell (BN 13446)	4	32
RWP	Eucalyptus tereticornis	Sirinumu (BN 13418)	4	16

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANT
YWP	<i>Eucalyptus tessellaris</i>	Mareeba (BN 12967 )	4	80
GYG	<i>Leucaena leucocephala</i>	K8	8	80
PPP	<i>Melia azedarach</i>	Isiolo	1	80
WWR	<i>Parkinsonia aculeata</i>		3	48
GGP	<i>Prosopis chilensis</i>	India	8	48
GWR	<i>Prosopis cineraria</i>		7	80
GGB	<i>Prosopis juliflora</i>	Hola	2	48
GWY	<i>Prosopis juliflora</i>		7	16
GCW	<i>Prosopis tamarugo</i>		3	16
PPW	<i>Schinus molle</i>	Isiolo	1	80
WPR	<i>Tamarindus indica</i>	Kitui	2	80
PYR	<i>Ziziphus mauritiana</i>	Baringo	8	80
PYY	<i>Ziziphus mauritiana mucronata</i>	Baringo	8	64

PLANTED 22, 23rd OCTOBER 1986

PGW	<i>Acacia nilotica</i>		7	128
PWY	<i>Acacia senegal</i>		7	64
BFP	<i>Acacia victoriae</i>	Alice Springs (BN 14117 )	4	16
PWB	<i>Albizia lebbek</i>		7	16
WBP	<i>Atriplex nummularia</i>		3	64
WQB	<i>Azadirachta indica</i>	Mombasa	1	16
WGG	<i>Cassia sturtii</i>	Israel	10	16
WGW	<i>Cassia sturtii</i>		3	32
PRP	<i>Cassia sturtii</i>	Israel	8	32
BRB	<i>Eucalyptus argophloia</i>	Ballon (BN 13713)	4	16
RRG	<i>Eucalyptus camaldulensis</i>	Ord R. (BN 12352 )	4	64
BRG	<i>Eucalyptus dunnii</i>	Kyogle (BN 13329 )	4	16
YRB	<i>Eucalyptus largiflorens</i>	Wilcannia (BN 12775)	4	16
YYR	<i>Eucalyptus microtheca</i>	Kununurra (BN 13359)	4	32
YPG	<i>Eucalyptus microtheca</i>	De Grey R. (BN 12524)	4	16
YPY	<i>Eucalyptus microtheca</i>	Laura R. (BN 13360)	4	64
YYP	<i>Eucalyptus salmonophloia</i>	Mt. Martin M. (BN 9919)	4	48
GYP	<i>Leucaena leucocephala</i>	B.A.T. Ena	1	64
GYG	<i>Leucaena leucocephala</i>	K8	1	64
GWB	<i>Prosopis chilensis</i>	Rhamu	11	64
GGY	<i>Prosopis juliflora</i>		3	112
WYP	' Mucavi'	Kiambere	1	32

PLANTED 6th, 7th NOVEMBER 1985

BR	<i>Acacia permatula</i>	Moreceli (17/83)	5	16
PWG	<i>Acacia Tortilis</i>	Riakanau	1	64
GWV	<i>Acacia victoriae</i>	Titree (BN 14489 )	4	64
WG	<i>Albizia lebbek</i>		3	16
WYW	<i>Balanites aegyptiaca</i>	Myrtonga	1	64
WPG	<i>Cassia siamea</i>	Ishiara	1	64
WGW	<i>Cassia sturtii</i>		3	64
BYW	<i>Eucalyptus argillacea</i>	Buchanan (BN 13942 )	4	16
YBP	<i>Eucalyptus brassiana</i>	Bamaga (BN 13415)	4	32
GBQ	<i>Eucalyptus camaldulensis</i>	Ord R. (BN 13931 )	4	32
GBR	<i>Eucalyptus camaldulensis</i>	Petford (BN 14338 )	4	64
GBW	<i>Eucalyptus camaldulensis</i>	Katherine (BN 13923 )	4	64
YRY	<i>Eucalyptus intertexta</i>	St. George (BN 12933 )	4	16
BYP	<i>Eucalyptus melanophloia</i>	Drummond (BN 13588)	4	16
GBY	<i>Eucalyptus tereticornis</i>	Townsville (BN 13447)	4	64
RWB	<i>Eucalyptus tereticornis</i>	Morehead R. (BN 13444)	4	16
GBP	<i>Eucalyptus tereticornis</i>	Kennedy (BN 14108 )	4	16
BY	<i>Haematoxylon brasiletto</i>	El Rancho ( 14/83 )	5	16
GRP	<i>Leucaena leucocephala</i>	K 67	1	16
GYG	<i>Leucaena leucocephala</i>	K 8	1	64
PWP	<i>Melia azedarach</i>	Embu	1	16

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANTED
YP	Melia volkensii	Kathera	1	4
WGR	Parkinsonia aculeata	Isiolo	1	4
BB	Pithecellobium dulce	Comagagua ( 27/84 )	5	64
GWB	Prosopis chilensis	Rhamu	11	64
GGP	Prosopis chilensis	India	8	64
BG	Prosopis juliflora	Cauca ( 20/82 )	5	64
BW	Prosopis juliflora	Veracruz ( 15/82 )	5	64
BP	Prosopis juliflora	Comayagua ( 49/83 )	5	48
GGY	Prosopis juliflora		3	64
PGB	Tamarindus indica	Mutonga	3	64
WW	Terminalia spinosa	L. Bogofia	6	64
WYP	' Mucavi '	Kiambere	1	64

The following species were sown directly into the pit on 27th October, 1984.

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO SEED PER PIT	NO. PLANTED
PGW	Acacia nilotica		7	3	64
PWY	Acacia senegal		7	2	64
PWG	Acacia tortilis	Riakanau	1	4	64
WYW	Balanites aegyptiaca	Mutonga	1	2	64
WYG	Erythrina abyssinica	Isiolo	1	4	64
GYP	Leucaena leucocophala	B.A.T. Ena	1	4	64
PWP	Melia azedarach	Embu	1	4	64
WGR	Parkinsonia aculeata	Isiolo	1	4	64
GGY	Prosopis juliflora		3	4	64
PGB	Tamarindus indica	Mutonga	1	2	64
WYP	' Mucavi '	Kiambere	1	2	64

Full addresses of seed suppliers are given in Appendix 2.

## RESULTS.

Summaries of the most recent assessments of survival of the 1983, 1984 and 1985 plantings are given in Tables 2, 3 and 4 respectively. The species/provenances are ranked according to survival rate. No seedlings were established in the Direct Sowing Trial sown in October 1984.

## DISCUSSION.

This trial site has extremely difficult conditions for afforestation. Not only are the climate conditions harsh but also the soil conditions are difficult. Most of the top soil has been eroded away leaving an exposed, indurated sub-soil. This soil is soft when wet but, on drying, quickly bakes hard into an almost impenetrable rooting medium. Crowbars were required for digging the pits. The site was deliberately chosen in order to identify those species which could tolerate such extreme conditions and perhaps be used in the rehabilitation of such sites.

Having said that, however, survival has been disappointingly low. Even in the 1984 planting when rainfall was above average, only 4 species showed survivors by March 1986. This indicates that soil factors are more important than climate in limiting tree establishment. Survivors from the 1983 planting tend to be found in favourable microsites ( e.g. near to runoff channels, in sites where sand has accumulated).

Another cause of mortality may be the soil used at Isiolo nursery where the seedlings were raised. Although the nursery soil is mixed with sand it still has a high clay content and also tends to bake hard when dry. This would hinder root growth of the seedling once planted.

TABLE 2      ISIOLO- RED SOIL      SPECIES TRIAL

Planted: November 1983

Assessed: March 1986

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SURVIVAL</u>	
			<u>NO.</u>	<u>PERCENT.</u>
PRP	Cassia sturtii	Israel	3	5%
RRB	Eucalyptus camaldulensis	Petford	2	3%
PYR	Ziziphus mauretiana	Baringo	2	3%
YWR	Eucalyptus melanophloia	Charleville	1	2%
YWG	Eucalyptus reveretiana	Kalopa	1	3%
RWW	Eucalyptus tereticornis	Cardwell	1	3%
RYR	Eucalyptus tereticornis	Gede	1	1%
YWP	Eucalyptus tessellaris	Mareeba	1	1%

All other species/provenances had no survivors.

TABLE 3      ISIOLO - RED SOIL      ADDITIONAL SPECIES TRIAL

Planted: October 1984

Assessed: April March 1986

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SURVIVAL</u>	
			<u>NO.</u>	<u>PERCENT.</u>
PWY	Acacia senegal		10	16%
PGW	Acacia nilotica		10	8%
GWB	Prosopis chilensis	Rhamu	2	3%
GGY	Prosopis juliflora		1	1%

All other species/provenances had no survivors.

TABLE 4    ISILO - RED SOIL    PROMISING SPECIES TRIAL

Planted: November 1985  
 Assessed: April, 1986

CODE	SPECIES	PROVENANCE	SURVIVAL	
			NO.	PERCENT
YW	<i>Terminalia spinosa</i>	L. Baringo	35	55%
YP	<i>Melia volkensii</i>	Kathera	2	50%
GYG	<i>Leucaena leucocephala</i>	K8	22	36%
WGW	<i>Cassia sturtii</i>		22	34%
WGR	<i>Parkinsonia aculeata</i>	Isiolo	14	29%
GGP	<i>Prosopis chilensis</i>	India	15	23%
WYW	<i>Balanites aegyptiata</i>	Mutonga	13	20%
PGP	<i>Tamarindus indica</i>	Mutonga	12	19%
PWG	<i>Acacia tortilis</i>	Riakanau	12	18%
GBR	<i>Eucalyptus camaldulensis</i>	Petford	11	17%
GNW	<i>Acacia victoriae</i>	Titree	7	12%
GBW	<i>Eucalyptus camaldulensis</i>	Katherine	6	9%
GGY	<i>Prosopis juliflora</i>		6	9%
WYP	'Mucavi'	Kiambere	6	9%
BG	<i>Prosopis juliflora</i>	Cauca	5	7%
BP	<i>Prosopis juliflora</i>	Comayagua	4	6%
GWB	<i>Prosopis chilensis</i>	Rhamu	4	6%
GBG	<i>Eucalyptus camaldulensis</i>	Ord River	2	3%
PWP	<i>Melia azedarach</i>	Embu	1	1%
GRB	<i>Leucaena leucocephala</i>	K67	1	1%
WG	<i>Albizzia lebbek</i>		1	1%
BW	<i>Prosopis juliflora</i>	Veracruz	1	1%
GBY	<i>Eucalyptus tereticornis</i>	Townsville	1	1%
WPG	<i>Cassia siamea</i>	Ishiarra	1	1%

The soil at the site does not absorb rainfall easily so runoff is very high. The presence of many deep gullies makes any mechanical cultivation virtually impossible so microcatchments were used to trap water and direct it to the pits where the seedlings were planted. Although generally successful, a problem was encountered in judging the size of the catchment to be built. If a small catchment is built, very little water is collected when rainfall is low. However, if a large catchment is built then, when rainfall is heavy the pits tend to fill with silt and overflow. In some cases seedlings were smothered by silt carried into the pit.

The 1985 planting is showing better initial performance than the previous two plantings. This may be attributed to a small change in planting procedure. In the 1983 and 1984 plantings the pits were half refilled with loose soil before planting. It was noticed that this practice both reduced the water storage capacity of the pit and made the pit more likely to fill up with silt, most of which was brought down by the first few showers of a season. In the 1985 planting the pits were not half refilled until the actual time of planting. This meant that the whole of the pit could be used to trap the runoff and silt from the first showers.

Although most mortality occurred during the first dry season after planting it was observed that considerable mortality also occurred during August and September in the second dry season. This indicates that the October/November rainy season is the best season for planting, mainly because the following dry season is shorter than the one following the March/April rains. However, seedlings which do survive one year can be regarded as established as almost no mortality has been observed in seedlings over one year old. (Note that the 1985 planting is not yet one year old.)

It is clear from the trial that unless drastic and expensive soil improvement measures are carried out, afforestation of such sites will be an extremely difficult and slow process. However the trial is beginning to indicate the toughest species which could be used on similar or less harsh sites.

These are Acacia nilotica, Acacia senegal, Acacia tortilis, Acacia victoriae, Balanites aegyptiaca, Cassia sturtii, Eucalyptus camaldulensis, (Petford), Leucaena leucocephala, (K8), Melia volkensii, Parkinsonia aculeata, Trogonis chilensis (India), Tamarindus indica, Terminalia spinosa, and Ziziphus. It will be noted that eight of these fourteen species are native. Acacia senegal is already present naturally on the site. It may be that rehabilitation of such sites could be more easily accomplished by encouraging regeneration of desirable native species from stumps and root suckers if these are present. Regeneration of Acacia senegal could be favoured by constructing microcatchments around selected coppicing stumps.

Further trials should be directed towards finding improved methods of site preparation and planting. Perhaps better establishment could be achieved by constructing larger pits and planting the seedling to one side (to avoid being submerged). Perhaps one or two waterings at the crucial periods at the end of the dry seasons would enable seedlings to get through the first year and become established. (I would not recommend regular watering as, apart from being very expensive, it does not encourage roots to grow deep into the soil so that trees die quickly when watering stops). Research is also required on the rooting behaviour of different species and the effect on establishment of the nursery soil planted with the seedling.

Finally, it should be stated that although tree establishment has been slow the site is definitely beginning to recover. The combination of fencing and construction of microcatchments has enabled grass to re-establish (particularly along the banks of the microcatchments) and site is now in a much better state than the surrounding land outside the fence.



PROFILE DESCRIPTION NO.5

General site information

Soil classification : ferric LUVISOL  
 Agro-climatic zone : V  
 Observation No./Date : 108/1-5, 26/1/84  
 Location/Altitude : Isiolo District, 0°22'N 37°33'E  
 Local petrography : Basement System rocks  
 Physiography : Upland  
 Relief, macro : Gently undulating to undulating, slope 3-5%  
 Land use : Grazing (formerly) under tree trials  
 Erosion : Rill erosion  
 Internal drainage : Well drained

Profile description

Ah 0-20cm Yellowish red (5YR 4/6 dry) reddish brown (5YR 4/4 moist); sandy clay; weak, coarse subangular blocky structure; slightly hard when dry, friable when moist, sticky and slightly plastic when wet; many fine pores; many very fine, few fine, and medium roots; pH 6.8; clear, wavy transition to;  
 (sample no. 108/1-5a)

Bu 20-50cm Dark red (2.5YR 3/6 moist); sandy loam; moderate, fine to medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and non plastic when wet; many fine and medium pores; few very fine, fine and very few medium and coarse roots; pli 6.1; diffuse, smooth transition to:  
 (sample no. 108/1-5b)

Bt<sub>1</sub> 50-85cm Dark red (2.5YR 3/6 moist); sandy clay loam; moderate, medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine pores; very few fine, very fine and medium roots; pH 5.9; diffuse, smooth transition to:  
 (sample no. 108/1-5c)

Bt<sub>2</sub> 85-130cm+ Dark red (2.5YR 3/6 moist); sandy clay loam; moderate, fine to medium subangular blocky, breaking into fine angular blocky structure; slightly hard when dry; friable when moist, slightly sticky and slightly plastic when wet; many fine and medium pores; very few fine, and medium roots; pH 6.2  
 (sample no. 108/1-5c)

# ISIOLO (RED SOIL) SPECIES TRIAL

- 29 -

## LABORATORY DATA OF PROFILE DESCRIPTION NO. 5 (RED SOIL)

Observation no: 108/1-6 Mapping unit: ISIOLO soil classification: ferric LUVISOL

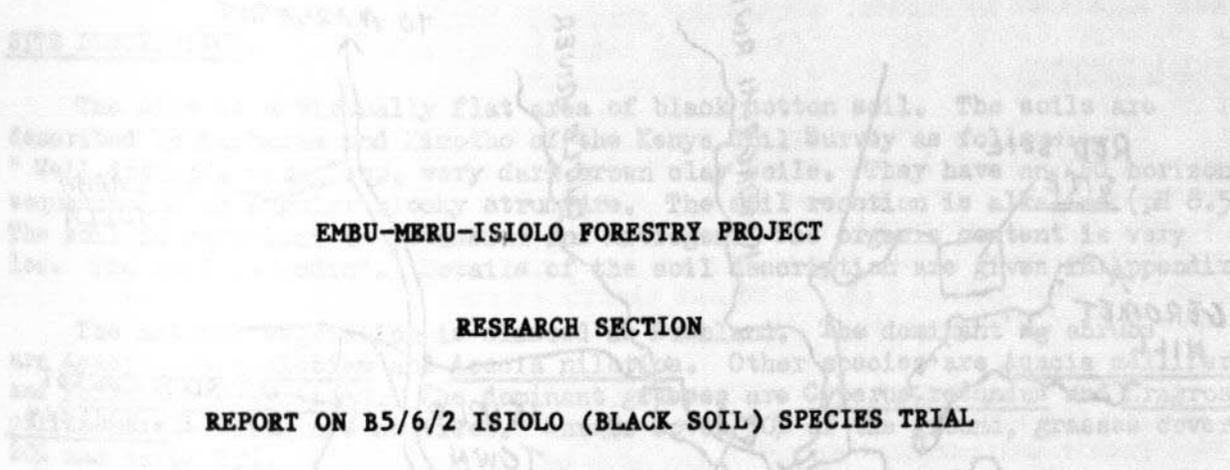
Laboratory no.	/84	295	296	297	298
Horizon		Ah	Bu	Bt <sub>1</sub>	Bt <sub>2</sub>
Depth (cm)		0-20	20-50	50-85	85-130
pH-H <sub>2</sub> O (1: 2½ v/v)		6.8	6.7	5.9	6.2
pH-KCl		5.9	4.8	4.4	4.6
EC (µmho/cm)		0.04	0.03	0.03	0.04
CaCO <sub>3</sub> (%)					
CaSO <sub>4</sub> (%)					
C (%)		0.98	0.66	0.51	0.37
N (%)					
C/N					
CEC (me/100g), pH 8.2		9.0	5.4	5.4	5.2
CEC " " pH 7.0					
Exch. Ca (me/100g)		2.8	2.8	2.4	3.0
" Mg "		1.74	1.60	2.0	2.24
" K "		0.40	0.44	0.30	0.30
" Na "		0.50	0.50	0.50	0.62
Sum of cations		4.84	5.34	5.2	6.16
Base sat. %, pH 8.2		54	99	96	100+
" " %, pH 7.0					
ESP at pH 8.2					
<u>Texture (limited pretreatment)</u>					
Gravel % (>2.0mm)					
Sand % (2.0-0.05mm)		85	80	76	72
Silt % (0.05-0.002mm)		8	4	4	4
Clay % (0.002-0mm)		6	16	20	24
Texture class		LS	SL	SCL/SL	SCL
<u>Fertility aspects</u>		0 - 30 cm		Laboratory no. 299 / 8	
<u>General</u>		<u>Available nutrients</u>			
pH-H <sub>2</sub> O (1: 2½ v/v)		Na (me/100g)	0.04	Mn (me/100g)	0.32
Exch. acidity (me/100g)		K	0.50	P (ppm)	
C %	0.20	Ca	1.1	P-Olsen (ppm)	
N %	0.05	Mg			
<u>Remarks:</u>					

1. Local collection
2. The Seedsman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74,  
KIKUYU.  
KENYA.
3. Setropa Ltd.  
P.O. Box 203  
Bussum 1400 AE  
HOLLAND
4. C.S.I.R.O.  
Division of Forest Research  
Quees Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
5. Mr. C. Hughes  
Oxford Forestry Institute  
South Parks Road  
Oxford OX 1 3RB  
ENGLAND.
6. Dr. A.R.D. Taylor  
University of Nairobi  
Department of Botany  
P.O. Box 30197,  
NAIROBI.
7. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND.
8. Mr. Edmund Barrow  
East Pokot Agricultural Project  
P.O. Box Marigat  
KENYA.
9. Chief Forest Research Officer  
P.O. Box 22099  
Kitwe  
ZAMBIA.
10. Arava Seed Suppliers  
P.O. Box 45109  
Haifa  
ISRAEL
11. Mr. Wayne Teel  
Mennonite Central Committee  
P.O. Box 11894  
Nairobi  
KENYA.

The aim of this trial is to compare the survival and growth of 53 species/provenances at this site... The trial is one of a series of trials... The overall objective of this trial is to identify suitable tree species for rural afforestation in these areas.

LOCATION

The trial is located on 2.5 hectares of land administered by Isiolo County Council and is reserved for afforestation. Latitude is 0° 21' North and Longitude is 37° 34' East. This is located on Survey of Kenya 1:50,000 scale sheet 100/1, map reference is 41983. The accompanying sketch map shows the site location in relation to Isiolo town (Fig.1). The site is adjacent to, on the north side of, the Isiolo - Moyale road, approximately 0.5km west of the bridge over the Isiolo river.



EMBU-MERU-ISILO FORESTRY PROJECT

RESEARCH SECTION

REPORT ON B5/6/2 ISILO (BLACK SOIL) SPECIES TRIAL

BY: GORDON ARMSTRONG, SILVICULTURIST

J K LUGADIRU, RESEARCH FORESTER

MAY 1986

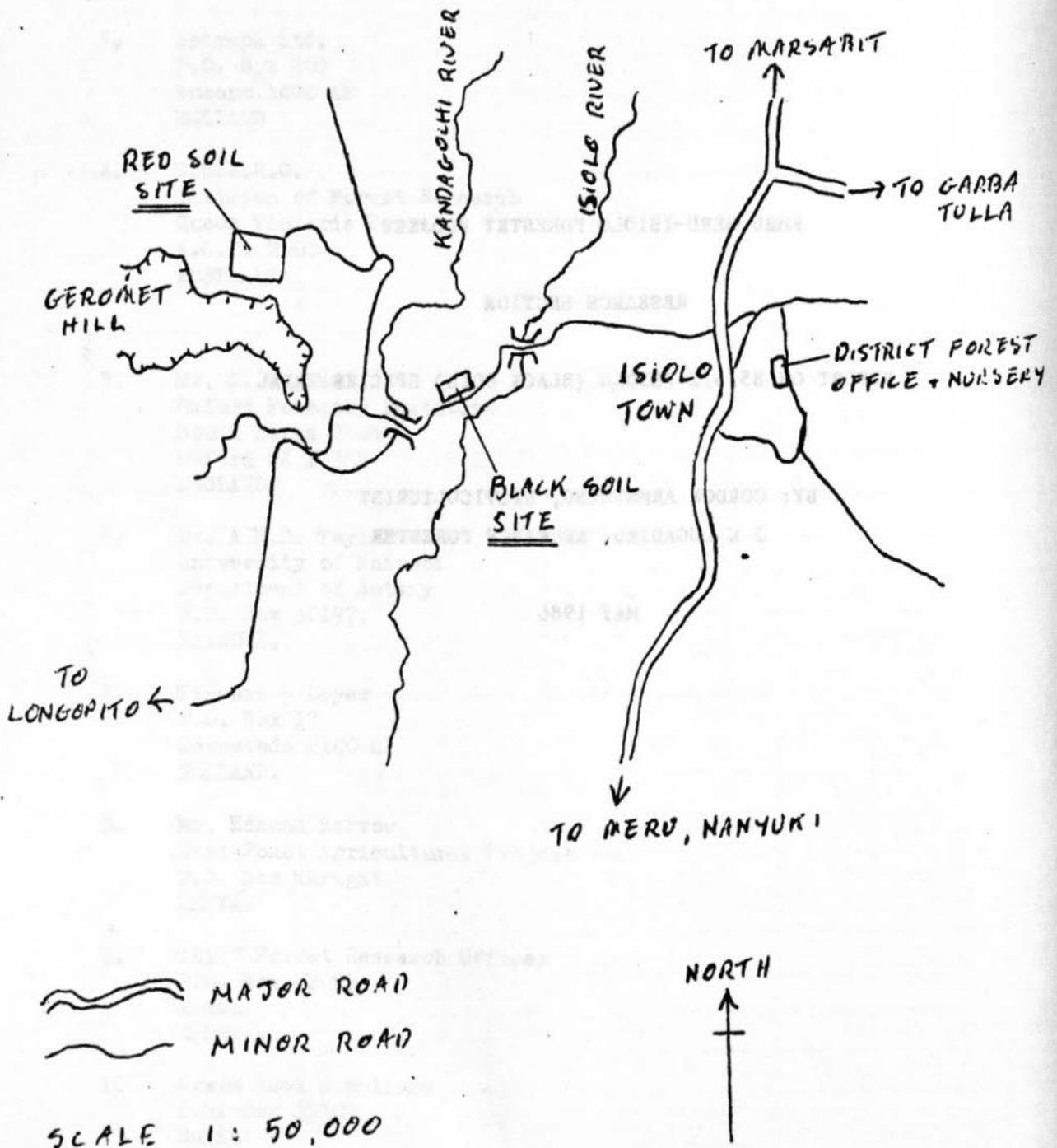
There are no rainfall records for the site. In November 1985 the project installed a rain gauge at the District Forest Office in Isiolo town which is about 3 kilometers east of the site. The rainfall recorded is given in table below.

TABLE 1. MONTHLY RAINFALL IN MILLIMETERS AT DISTRICT FOREST OFFICE, ISILO.

MONTH	1984	1985	1986
January	0	0	0
February	4.1	11.9	0
March	41.9	82.3	110.7
April	61.2	99.1	294.6
May	0	0	0
June	0	27.3	0
July	0	0	0
August	0	0	0
September	6.9	1.8	0
October	54.4	100.0	315.5
November	90.9	289.5	75.7
December	111.0	29.3	12.4
Total	-	467.3	219.9

As can be seen, most of the rain falls in two seasons; March, April and October, November, December, but quantity and duration of...

FIGURE 1      LOCATION OF ISIOLO TRIAL SITES



A.I.M.

The aim of trial is to compare survival and growth of 53 species/provenances at this arid, saline black cotton soil site in Isiolo district. The trial is one of a range of species trials established at different sites within Embu, Meru and Isiolo Districts with the overall objective of identifying suitable tree species for rural afforestation in these areas.

LOCATION

The trial is located on 2.8 hectares of land administered by Isiolo County Council and set aside for afforestation. Latitude is 0° 21' North and Longitude is 37° 34' East. This is located on Survey of Kenya 1:50,000 scale sheet 108/1, map reference CL 400393. The accompanying sketch map shows the sites location in relation to Isiolo town (Fig.1). The site is adjacent to, on the north side of, the Isiolo - Longopito road, approximately 0.5km west of the bridge over the Isiolo River.

SITE DESCRIPTION.

The site is a virtually flat area of black cotton soil. The soils are described by Macharia and Kimotho of the Kenya Soil Survey as follows:-  
" Well drained, very deep, very dark brown clay soils. They have an ABC horizon sequence and an angular blocky structure. The soil reaction is alkaline (pH 8.5). The soil is deficient in potassium and nitrogen. The organic content is very low. The soil is sodic". Details of the soil description are given in Appendix I.

The natural vegetation is classed as Bushland. The dominant shrubs are Acacia drepanolobium and Acacia nilotica. Other species are Acacia mellifera and Balanites aegyptiaca. The dominant grasses are Cyperus rotundus and Eragrostis-ciliensis. There are no trees. Shrubs cover 30% of the ground, grasses cover 20% and herbs 20%.

The site had previously been used as a grazing area. Severe gully erosion has taken place immediately to the west of the trial site.

The altitude is 1110 metres above sea level.

CLIMATE.

There are no rainfall records for the site. In November 1983 the project installed a rain gauge at the District Forest Office in Isiolo Town which is about 3 kilometres east of the site. The rainfall recorded is given in the table below.

TABLE I MONTHLY RAINFALL IN MILLIMETRES AT DISTRICT FOREST OFFICE, ISILO.

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
January	--	0	0	0
February	--	4.1	11.9	0
March	--	41.9	82.3	110.7
April	--	61.2	99.1	194.6
May	--	0	0	
June	--	0	17.3	
July	--	0	0	
August	--	0	0	
September	--	6.9	1.8	
October	--	54.4	31.7	
November	90.9	269.5	75.7	
December	111.0	29.5	11.4	
<b>Total</b>	--	467.5	331.2	

As can be seen, most of the rain falls in two seasons; March, April and October, November, December, but quantity and duration of rain...

from season to season. The site falls within Agroclimatic Zone V-2 but is certainly at the lower rainfall and of that classification.

#### SITE PREPARATION.

The site was cleared by bulldozer. The bulldozer was then used to cultivate (i.e. cross rip with a 3-tyre ripper penetrating to approximately 70cms) most of the site. A portion of the site on the northern side was left uncultivated.

#### TRIAL DESIGN

The trial was laid out in five replicate blocks aligned parallel to the southern side of the site. Four blocks were on the ripped ground and one on the un-ripped. Within each block, 16-tree plots (4x4) of each species/provenance were allocated at random, and planted at 2.5 metre by 2.5 metre spacing.

#### TRIAL HISTORY.

The trial was originally planted in December 1983. The rains that season were very late and low in quantity and the following rains in March/April 1984 were also very poor. By June 1984 it was obvious that mortality was going to be very high so seedlings were raised again and the trial replanted on 24th and 25th October 1984. Although nearly all the species included in the first planting were included in the repeat planting it was not always possible to raise seedlings of the same seed lot.

The trial has been regularly weeded by 'spot' weeding (re-completely cleaning the soil to about 0.5 metre radius around each tree) and by slashing weed growth between the 'spots'

#### SPECIES.

The following species were raised specifically for the trial at Isiolo district nursery by direct sowing into 10cm x 15cm (layflat) black polythene tubes. A code of three colours was painted on each tube to enable easy identification of each species/provenances.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SOURCE</u>	<u>NO. PLANTED</u>	
				1983	1984
BBW	Acacia cyanophylla		3	80	-
PGP	Acacia cyanophylla		5	-	44
PGW	Acacia nilotica		5	80	80
BWR	Acacia pendula	Charleville(BN 13482)	4	80	32
WPP	Acacia polyacantha	Siakago	1	80	80
PWY	Acacia senegal		5	-	80
GWP	Acacia seyal	Isiolo	1	-	80
BPY	Acacia victoriae	Dajarra (BN13494)	4	80	6
BPP	Acacia victoriae	Alice Springs	4	-	16
WBP	Atriplex nummularia		3	-	64
WBW	Atriplex semi-baccata		3	80	80
PWB	Albizia lebbek		5	-	16
PPG	Azedarachta indica	Kinna	1	80	-
WGB	Azedarachta indica	Mombasa	6	-	80
WYW	Balanites aegyptiaca	Mutonga	1	-	64
WPG	Cassia siamea	Ishiara	1	80	16
PRP	Cassia sturtii	Israel	7	-	16
WRG	Casuarina cristata	Eidsvold(BN13132)	4	32	-
WRB	Casuarina glauca	Wardell(BN 13137)	4	80	64
WYR	Casuarina torulosa	Muguga	2	-	48
RPR	Eucalyptus alba	Mt. Molloy (BN 12993)	4	-	48
BRR	Eucalyptus camaldulensis	Njukiini	1	64	-
RBW	Eucalyptus camaldulensis	Wiluna (BN 13433)	4	48	80
RRB	Eucalyptus camaldulensis	Petford (BN 13159)	4	32	-
RYP	Eucalyptus camaldulensis	Petford (BN 12964)	4	-	64
RBG	Eucalyptus camaldulensis	Kimberly (BN 12346)	4	-	64

CODE	SPECIES	PROVENANCE	SEED SOURCE	1983	1984
RYW	Eucalyptus camaldulensis	Gilbert R. (BN 13564)	4	-	64
RRG	Eucalyptus camaldulensis	Ord. R. (BN 12352)	4	-	16
RPG	Eucalyptus citriodora	Hugenden (BN 12939)	4	80	-
BYY	Eucalyptus citriodora	Mt. Gormet (BN 13628)	4	-	48
YRB	Eucalyptus largiflorens	Wilcannia (BN 12775)	4	64	-
YRG	Eucalyptus leucocoxylon	Rushworth (BN 9608)	4	32	-
YYR	Eucalyptus microtheca	Kununurra (BN 13359)	4	80	0 -
YFB	Eucalyptus microtheca	Coober Pedy (BN 13200)	4	32	-
YPY	Eucalyptus microtheca	Laura R. (BN 13360)	4	64	32
YPR	Eucalyptus microtheca	Charleville (BN 12935)	4	80	-
YPG	Eucalyptus microtheca	De Grey R. (BN 12524)	4	48	48
BYB	Eucalyptus microtheca	Walgett (BN 12172)	4	-	16
YYY	Eucalyptus occidentalis	Katanning (BN 9902)	4	48	16
BYG	Eucalyptus occidentalis	Souddan (BN 12476)	4	-	16
YYB	Eucalyptus oleosa	Norseman (BN 9910)	4	-	16
YWB	Eucalyptus populnea	Quilpie (BN 11733)	4	48	16
YYP	Eucalyptus salmonophoia	Mt. Martin (BN 9919)	4	-	16
RYR	Eucalyptus tereticornis	Gede	2	16	-
YBY	Eucalyptus torquata	Widgiemootha (BN 9930)	4	48	-
GYG	Leucaena leucocephala	K8	7	-	80
GYP	Leucaena leucocephala	Ena	1	-	32
GWR	Prosopis cineraria		5	48	-
GWY	Prosopis juliflora		5	80	-
GCY	Prosopis juliflora		3	-	16
FPW	Schinus molle	Isiolo	1	80	48
PYR	Ziziphus mauretiana	Baringo	7	80	64
PYY	Ziziphus mauretiana	Baringo	7	-	32

Full addresses of seed supplies are given in Appendix 2.

RESULTS.

Mortality has been extremely high at this site. By May 1986 only one species had any surviving seedlings. This is WBP Atriplex nummularia which had 34 survivors (53% of those planted). The average height of the seedlings was 67cm.

DISCUSSION.

The establishment of only one species (Atriplex nummularia) has shown the severity of the conditions at this site. The low rainfall and high temperatures are compounded by extremely difficult soil conditions. The soil is very alkaline and very saline, and obviously most of the species included in the trial were not able to tolerate these factors. The exception is Atriplex nummularia which has performed comparatively well. By May 1986 all the surviving seedlings were well established and healthy. Atriplex nummularia is a leafy shrub known for its tolerance of arid, saline conditions so it is not surprising that it is the only species to perform well at this site. Atriplex nummularia is also known as a high protein fodder species, both in its native Australia and in other countries where it has been introduced. It would therefore be worth establishing larger scale trial plantations. It is planned that the species trial site will be completely replanted with Atriplex nummularia. Seed (collected from bushes growing at the Gategi trial site, Embu) has been left with the nurseryman at Isiolo nursery in order to raise seedlings for planting in October/November 1986.

There are nearly 100 species within the genus Atriplex. Many of these have similar halophytic properties so a trial of a range of Atriplex species may bring out other species able to thrive on such harsh sites.

REFERENCES.

- 1/ Jones, R. ( editor ) ( 1970 ). The Biology of Atriplex. Report on Symposiam held in Deniliguu, N.S.W., 14-15 October, 198 1969. C.S.I.R.O.
- 2/ Kenya Soil Survey, (1980) Explaratory Soil Map and Agroclimatic Zone Map of Kenya.
- 3/ Macharia, P.N. and Kimotho, P.W. ( 1984 ) Soils and Vegetation of Embu, Meru and Isiolo Forestry Project Trial Sites. Kenya Soil Survey Site Evaluation Report No. P.70.

*[The following text is extremely faint and largely illegible due to bleed-through from the reverse side of the page. It appears to be a detailed report or abstract, possibly discussing the biology and ecology of Atriplex species in a semi-arid region. Key words that are faintly visible include 'Atriplex', 'soil', 'vegetation', 'forestry', and 'site evaluation'. The text is organized into paragraphs and possibly sections, but the specific content cannot be accurately transcribed.]*

PROFILE DESCRIPTION NO. 4

General site information

Soil classification : vertic CAMBISOL  
 Agro-climatic zone : V  
 Observation No./Date : 108/1-4, 26/1/84  
 Location/Altitude : Isiolo District, 0°21'N, 37°34'E  
 Geological formation : Basement System rocks  
 Local petrography : Intermediates (diorite)  
 Physiography : Plain  
 Relief, macro : Flat to very gently undulating, slope 0-2%  
 Land use : Cleared for tree trials  
 Rockiness/stoniness : Fairly stony  
 Flooding : Occasional  
 Internal drainage : Well drained

Profile description

Ap 0-10cm

Very dark grey (10YR 3/1 moist); clay; strong, medium and coarse angular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; many fine and medium pores; very few fine and very fine roots; pH 8.4; diffuse, smooth transition to:  
 (sample no. 108/1-4a)

Bu 10-60cm

Very dark brown (10YR 2/2 moist); few medium and coarse, faint dark brown mottles (10YR 3/3); clay; strong, medium angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine and medium pores, few faint calcium carbonate concretions, high reaction to HCl, pH 8.5; clear smooth transition to:  
 (sample no. 108/1-4b)

Bck 60-120cm+

Very dark brown (10YR 2/2 moist); few medium faint dark brown mottles (10YR 3/3); clay; strong, medium angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine pores, few faint calcium carbonate concretions, pH 8.4.  
 (sample no. 108/1-4c)

1510LO (BLACK SOIL) SPECIES TRIAL

APPENDIX 1 CONTD

LABORATORY DATA OF PROFILE DESCRIPTION No. 4  
(BLACK SOIL)

Observation no: 108/1-4 Mapping unit: 1510LO soil classification: vertic CAMBISOL

Laboratory no.	/ 84	292	293	294		
Horizon		Ap	Bu	Bck		
Depth (cm)		0-10	10-60	60-120		
pH-H <sub>2</sub> O (1:2½ v/v)		8.4	8.5	8.4		
pH-KCl	"	7.0	6.8	6.9		
EC (µmho/cm)	"	1.00	2.50	2.50		
CaCO <sub>3</sub> (%)						
CaSO <sub>4</sub> (%)						
C (%)		0.63	1.12	0.54		
N (%)						
C/N						
CEC (me/100g), pH 8.2		89.6	108.2	126.2		
CEC " " pH 7.0						
Exch. Ca (me/100g)		44.0	41.0	44.0		
" Mg "		20.0	16.4	14.2		
" K "		2.10	1.38	1.30		
" Na "		7.8	10.8	12.5		
Sum of cations		73.9	68.78	72		
Base sat. %, pH 8.2		100+	100+	100+		
" " %, pH 7.0						
ESP at pH 8.2		18.67	25.7	28.67		
<u>Texture (limited pretreatment)</u>						
Gravel % (>2.0mm)						
Sand % (2.0-0.05mm)		20	18	20		
Silt % (0.05-0.002mm)		14	10	6		
Clay % (0.002-0mm)		66	72	74		
Texture class		C	C	C		
<u>Fertility aspects</u>		0 - 30 cm			Laboratory no. 298 / 64	
<u>General</u>		<u>Available nutrients</u>				
pH-H <sub>2</sub> O (1:2½ v/v)	8.5	Na (me/100g)	4.90	Mn (me/100g)	Trace	
Exch. acidity (me/100g)		K "	0.18	P (ppm)	6	
C %	0.86	Ca "	2.4	P-Olsen (ppm)		
N %	0.12	Mg "				
<u>Remarks:</u>						

Appendix 2    Seed Source

1. Local collection
  
2. The Seedman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74  
KIKUYU  
KENYA.
  
3. Setropa Ltd  
P.O. Box 203  
Bussum 1400 AE  
HOLLAND.
  
4. C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA
  
5. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND
  
6. Dr. A.R.D. Taylor  
University of Nairobi  
Department of Botany  
P.O. Box 30197  
NAIROBI.  
KENYA
  
7. Mr. Edmund Barrow  
East Pokot Agricultural Project  
P.O. Marigat  
KENYA.

The aim of the trial is to compare survival and growth of 21 different species under irrigation regimes at this arid site in Isiolo district. This is one of a series of species trials established at different sites within Embu, Meru and Isiolo districts with the overall objectives of identifying suitable tree species for rural afforestation in these areas.

**LOCATION**

The trial is located on 1.8 hectares of land administered by Isiolo County Council at Kerti, Kerti Division, Isiolo District. Latitude is 1° 3' North and Longitude is 36° 40' East. This is located on Survey of Kenya 1:250,000 scale sheet M-100, map reference M 631. Figure 1 shows the site location in relation to major towns and roads.

The site is situated on the West of the Catholic Mission fruit and vegetable garden which is approximately 1km to the south-west of the Kerti settlement.

The site is situated on the old flood plain of the Ewaso Ng'iro river. The soil is a heavy, very deep, dark grey, very firm, slightly calcareous, silty clay with a slightly to moderate saline and sodic deeper subsoil. A detailed analysis of the soil is given in Appendix 1. The altitude is approximately 960 metres above sea level.

**EMBU-MERU-ISIOL FORESTRY PROJECT  
RESEARCH SECTION**

**REPORT ON B5/7 MERTI IRRIGATED TRIAL**

**BY: GORDON ARMSTRONG, SILVICULTURIST**

The natural vegetation on the site consisted of scattered trees of *Acacia senegal* and *Baludora veronica*. The rest of the ground was bare except for very tall, when short-lived grasses and herbs appeared.

The climate is semi-arid. Mean annual rainfall is probably less than 200mm, which is extremely unreliable. During 1983 and the first half of 1984 no rain fell. It is impossible to grow crops without irrigation, and the livelihood of the native Keri people is based on nomadic pastoralism. The site falls within agroclimatic zone VII/II.

**MAY 1986**

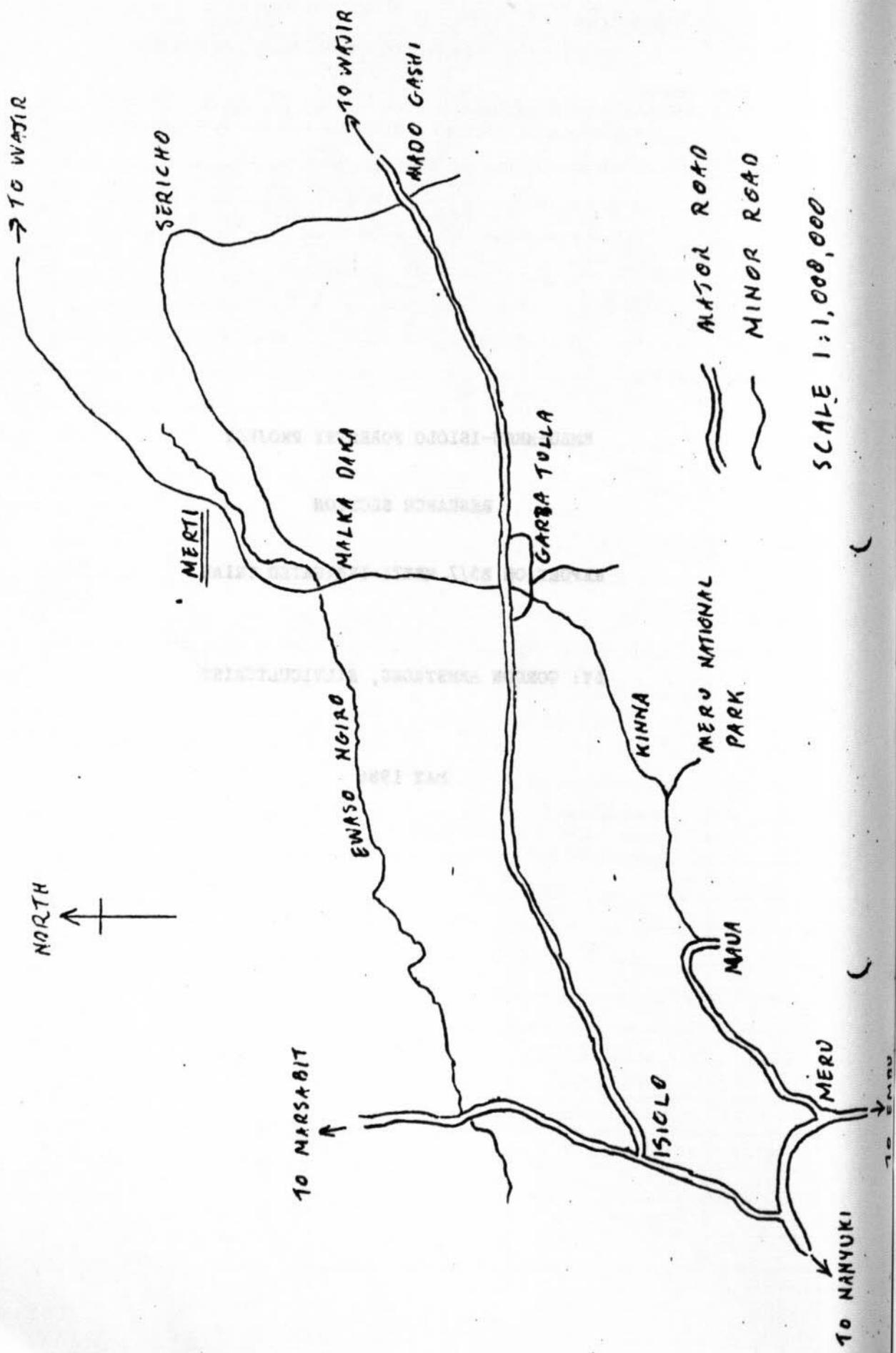
Eighteen acres were cleared from the site and the stumps removed. A simple wire fenced site fence was erected around the site. Small depressions were dug to accommodate irrigation water at each planting site according to the trial design.

The site was laid out in 4 blocks aligned parallel to the northern side of the site. Within each block 16 trees (4 x 4) of each species were planted at 7m x 7m spacing. The design is shown in Figure 1.

The trial was planted on the following dates: Block I - 28/8/85, Block II - 10/9/85, Block III - 19/9/85 and Block IV - 2/10/85. From planting till 23/10/85 the trees were all watered weekly. From 10/12/85 till 2/1/86 watering was done according to Table I. From 1/1/86 the trial received the following irrigation: Block I - weekly, Block II - every 4 weeks, Block III - every 12 weeks, and Block IV - no irrigation. At each irrigation, each tree received 3 water cans full of water (30 litres). The water was kindly supplied by the Mission from their borehole.

KERTI SETTLEMENT  
CATHOLIC MISSION  
EMBU-MERU-ISIOL FORESTRY PROJECT  
RESEARCH SECTION  
MERTI IRRIGATED TRIAL  
MAY 1986

FIGURE 1 LOCATION OF MERTI IRRIGATED SPECIES TRIAL



## AIM

The aim of the trial is to compare survival and growth of 21 different species under 4 irrigation regimes at this arid site in Isiolo district. This is one of a range of species trials established at different sites within Embu, Meru and Isiolo districts with the overall objectives of identifying suitable tree species for rural afforestation in these areas.

## LOCATION.

The trial is located on 1.8 hectares of land administered by Isiolo County Council at Merti, Merti Division, Isiolo District. Latitude is 1° 3' North and Longitude is 38° 40' East. This is located on Survey of Kenya 1:250,000 scale sheet NA-37-10, map reference DM 6316. Figure 1 shows the site location in relation to major towns and roads.

The site is adjacent and to the West of the Catholic Mission fruit and vegetable plot which is approximately 1km to the south-west of the Merti settlement. (see Fig:2).

## SITE DESCRIPTION.

The site is virtually flat old flood plain of the Ewaso Ngiro river. The soils are classified by the Kenya Soil Survey in the Exploratory Soil Map of Kenya as " imperfectly drained, very deep, dark grey, very firm, slightly calcareous, cracking clay, with a slightly to moderate saline and sodic deeper subsoil ( vertic GLEYSOLS, saline-sodic phase)". A chemical analysis of the soil is given in Appendix 1. The altitude is approximately 960 metres above sea level.

The only perennial vegetation on the site consisted of scattered trees of *Acacia tortilis* and bushes of *Salvadora persica*. The rest of the ground was bare except after heavy rain when short-lived grasses and herbs appeared.

## CLIMATE:

The climate is hot and dry. Mean annual rainfall is probably less than 200mm. and is extremely unreliable. During 1983 and the first half of 1984 no rain fell. It is impossible to grow crops without irrigation, and the livelihood of the native Boran people is based on nomadic pastoralism. The site falls within Agroclimatic zone VII - I.

## SITE PREPARATION.

Trees and shrubs were cleared from the site and the stumps removed. A seven strand barbed wire fence was erected around the site. Small depressions were dug to accommodate irrigation water at each planting site according to the trial design.

## TRIAL DESIGN.

The trial was laid out in 4 blocks aligned parallel to the northern side of the site. Within each block, 16-tree plots ( 4 x 4 ) of each species were allocated at random and planted at 2.5 m x 2.5 m spacing. The design is shown in Figure 3.

## TRIAL HISTORY.

The trial was planted on the following dates. Block I - 28/8/85, Block II - 10/9/85, Block III - 19/9/85 and Block IV - 2/10/85. From planting till 29/12/85, the trees were all watered weekly. From 30/12/85 till 2/3/86 watering was done according to Table I. From 3/3/86 the trial received the following irrigation:- Block I - weekly, Block II - every 4 weeks, Block III - every 12 weeks, and Block IV - no irrigation. At each irrigation, each tree received 3 water cans full of water ( 30 litres ). The water was kindly supplied by the Mission from their borehole.

SITE OF MERTI IRRIGATED SPECIES TRIAL

FIGURE 2

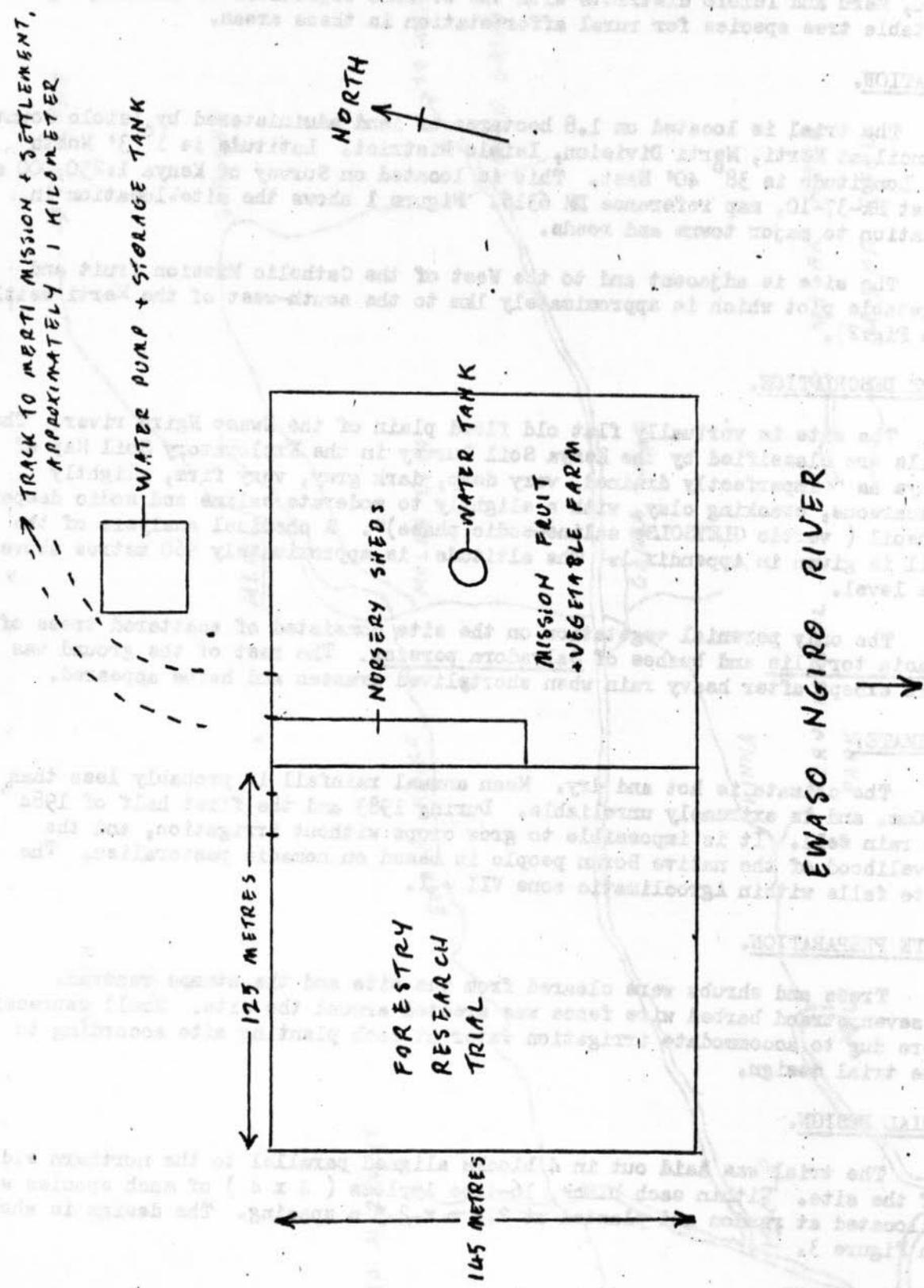


FIGURE 3

MERTI IRRIGATED SPECIES TRIAL

TRIAL DESIGN

VILLAGE MISSION

I  
II  
III  
IV

	PWP	GBR	GBB	GYG	GGY	WBP	YPP	WRG	PGB	WGW
	POP	YBB	PWB	GYP	YYY	WPG	GWB	ACR	GBY	WW

					ACR	PGB	PWP	GYG	GBB	GBY
					YPP	PWB	GYP	GGY	WPG	GWB

					WW	WPG	GWB	GYP	GGY	GBB
					YPP	PGB	GYG	PWB	GBY	ACR

	PGB		WBP	WW	GGY	WPG	BAG	GYP	PWB	GWB
		WRG	PWP	GBR	GBB	GYG	GBY	WGW	ACR	YPP

MISSION

FARM

given in Table 2. The species are ranked according to overall suitability. It was noted at the assessment that many of the seedlings had been damaged by browsing by hares and dikdik.

CONCLUSION.

Many of the trees have been damaged and their growth slowed by browsing by hares and dikdik. This is particularly the case with *Acacia saligna*, *Leucaena leucocephala*, and *Pearsonia peltata*. An early conclusion is that *Populus nigra* (a native poplar growing on the banks of the Swaco Ngizo) does not seem to be suitable for plantation forestry.

The harshness of the climate in the area makes any plantation forestry virtually impossible without irrigation or very substantial water harvesting structures. There is also no great need for plantations at present. The low human and livestock population, and the nomadic lifestyle of the Bama have assured that overgrazing and overexploitation of the bush has not occurred. The only places where plantations might be required are around the settlements such as Garba Fula and Merti and along the small agricultural irrigation schemes along the Swaco Ngizo river, such as Maba Daga and Godeben. At these places, local demand for fuelwood and poles may threaten the bush.

TABLE 1 WATERING REGIME - MERKI IRRIGATED TRIAL

	30/12/85 - 5/1/86	6/1/86 - 12/1/86	13/1/86 - 19/1/86	20/1/86 - 26/1/86	27/1/86 - 2/2/86	3/2/86 - 9/2/86	10/2/86 - 16/2/86	17/2/86 - 23/2/86	24/2/86 - 2/3/86	
BLOCK I	✓	✓	✓	✓	✓	✓	✓	✓	✓	THEN EVERY WEEK
BLOCK II	✓		✓		✓				✓	THEN EVERY 4 WEEKS
BLOCK III		✓		✓				✓		THEN EVERY 1 WEEKS
BLOCK IV		✓		✓				✓	✓	THEN STOP WATERING

.../ 4  
SPECIES:

The following species were raised specifically for the trial at the adjacent Mission vegetable farm, by direct sowing into 10 cm x 15 cm (layflat) black polythene tubes. A code of three colours was painted on each tube to enable easy identification of each species.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>SEED SUPPLIER</u>	<u>NO. PLANTED.</u>
BEG	Acacia albida	Baringo (780-005)	2	16
PWB	Albizzia lebbek		4	64
WBP	Atriplex nummularia		5	32
WPG	Cassia siamea	Ishiara	1	64
WRG	Casuarina cristata	Eidsvold (BN 13132)	3	32
GBR	Eucalyptus camaldulensis	Petford (BN14338)	3	32
YPP	Eucalyptus hybrid	Comp 119, Choma	6	64
BGG	Eucalyptus microtheca	Quilpio (BN 12819)	3	64
YYY	Eucalyptus occidentalis	Kataning (BN 9902)	3	16
GBY	Eucalyptus tereticornis	Townsville (BN 13447)	3	64
YBB	Eucalyptus urophylla	Mt. Mundin (BN 12895)	3	16
GYP	Leucaena leucocephala	Ena	1	64
GYG	Leucaena leucocephala	K8	7	64
PWP	Melia azedarach	Embu	1	48
GWB	Prosopis chilensis "	Rhama	8	64
GGY	Prosopis juliflora		5	64
POB	Tamarindus indica	Mutonga	1	64
WW	Terminalia spinosa	Bogoria	9	48

Full addresses of the seed suppliers are given in Appendix 2.

The following species were collected from stock already growing at other nurseries.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>NURSERY</u>	<u>NO. PLANTED.</u>
ACR	Acrocarpus fraxinifolius	Embu	Embu	64
WGW	Cassia sturtii		Marimanti	32
POP	Populus ficifolia	Malka Daka	Malka Daka	16

RESULTS:

The trial was assessed at the end of December 1985. This was at the end of initial establishment phase under weekly irrigation and before the separate blocks went on to separate irrigation regimes. A summary of this assessment is given in Table 2. The species are ranked according to overall survival rate. It was noted at the assessment that many of the seedlings had been damaged by browsing by hares and dikdik.

DISCUSSION.

The trial is not yet old enough to be able to draw many conclusions. Also many of the trees have been damaged and their growth slowed by browsing by hares and dikdik. This is particularly the case with Albizzia lebbek, Cassia sturtii, Leucaena leucocephala, and Tamarindus indica. One early conclusion is that Populus ficifolia ( a native poplar growing on the banks of the Ewaso Ngiro River ) does not seem to be suitable for plantation forestry.

The harshness of the climate in the area makes any plantation forestry virtually impossible without irrigation or very substantial water harvesting structures. There is also no great need for plantations, at present. The low human and livestock populations and the nomadic lifestyle of the Boran have assured that overgrazing and overexploitation of the bush has not occurred. The only places where plantations might be required are around the settlements such as Garba Tulla and Merti and at the small agricultural irrigation schemes along the Ewaso Ngiro River, such as Malka Daka and Garfossa. At these places, local demand for fuelwood and poles may threaten the bush.

**Table 2, MERTI IRRIGATED SPECIES TRIAL.**

Planted: August - October 1985

Assessed: December 1985.

<u>CODE</u>	<u>SPECIES</u>	<u>PROVENANCE</u>	<u>% SURVIVAL</u>	<u>AV. HT.</u>
GWB	<i>Prosopis chilensis</i>		100	103 cm
GGY	<i>Prosopis juliflora</i>		100	86 cm
WPG	<i>Cassia siamea</i>		100	68 cm
WBP	<i>Atriplex nummularia</i>		100	62 cm
WW	<i>Terminalia spinosa</i>		100	50 cm
GYP	<i>Leucaena leucocephala</i>	Ena	100	46 cm
BBG	<i>Acacia albida</i>		100	45 cm
PWP	<i>Melia azedarach</i>		98	52 cm
GYG	<i>Leucaena leucocephala</i>	K8	98	48 cm
GBB	<i>Eucalyptus microtheca</i>		97	85 cm
POB	<i>Tamarindus indica</i>		95	37 cm
GBR	<i>Eucalyptus camaldulensis</i>		91	112 cm
PWB	<i>Albizzia lebbek</i>		89	14 cm
WRG	<i>Casuarina cristata</i>		81	32 cm
GBY	<i>Eucalyptus tereticornis</i>		80	82 cm
YPP	<i>Eucalyptus hybrid</i>		77	75 cm
WGW	<i>Cassia sturtii</i>		75	54 cm
ACR	<i>Acrocarpus fraxinifolius</i>		66	57 cm
YBB	<i>Eucalyptus urophylla</i>		63	55 cm
YYY	<i>Eucalyptus occidentalis</i>		50	92 cm
POP	<i>Populus ficifolia</i>		6	12 cm

Also there may be a demand for fodder, particularly for feeding milky animals which have to be kept near the settlement.

As water supplies, including the Ewaso Ngiro River itself, are unreliable any planted trees would have to be able to tolerate periods without irrigation. However, as irrigation is expensive the trees would also have to be able to achieve high productivity. Establishment may be reduced by direct sowing of seeds at the planting spot. It had been hoped to carry out such a direct sowing trial but problems with the borehole pump prevented its implementation. Species planned for the direct sowing trial were:-

- Acacia mellifera, Acacia nilotica, Acacia senegal, Acacia victoriae, Azedarachta indica, Balanites aegyptiaca, Leucaena leucocephala, Parkinsonia aculeata, Prosopis chilensis, Prosopis juliflora, and Tamarindus indica.

REFERENCE:

Kenya Soil Survey, 1980, Exploratory Soil Map and Agroclimatic Zone Map of Kenya.

Chemical Test Results	Value	Unit
pH	7.8	
Ca m.e.g.	25.0	
Mg m.e.g.	7.4	
Mn m.e.g.	0.61	
P p.p.m.	250	
K%	0.18	
C%	0.70	
EC (mhos/cm)	23	(0.2)

Reduce the amounts of excess soluble salts by leaching the soil with irrigation water.

Leaching will be hastened through the application of manure/compost and improvement of both surface and internal drainage of the soil. An acidifying type of nitrogen fertilizer, e.g., sulphate of ammonia, is recommended.

Available phosphorus and potassium contents are satisfactory while total nitrogen organic carbon are in short supply.

This soil of moderately alkaline soil reaction (the soil may be sodic/alkaline). Electrical conductivity (EC), sodium, calcium and magnesium levels are very high.

(Toxicity Bracket) Deficiencies: Undershot 79102 and 0.9

Dr. A.R.D. Taylor  
 Director  
 Soil Chemist

# SOIL TEST REPORT

INWARD REF.: Letter of 17/9/84

NATIONAL AGRICULTURAL LABORATORIES

OUR REF.: SOIL/2/5/VIII/331

DEPARTMENT OF AGRICULTURE,

P.O. Box 14733,

NAIROBI.

DATE SAMPLE RECEIVED: 28/9/84

DATE SAMPLE REPORTED: 29/1/85

SAMPLE/S SENT BY: Mr. S.C. White

FROM (PLACE): Merti - Isiolo

Eastern Province

Soil & Water Conservation Engineer  
P. O. Box 4, EMBU.

Field Designation ..									
Lab. No. .. /84..	7282								
Depth .. ..									
Colour .. ..									

## Chemical Test Results

pH	7.6								
Na m. e. % ..	(2.55)								
K m. e. % ..	1.55								
Ca m. e. % ..	25.0								
Mg m. e. % ..	7.4								
Mn m. e. % ..	0.61								
P. p. p. m. ..	250								
N% .. ..	0.12								
C% .. ..	0.70								
Hp m. e. % ..	-								

EC mmhos/cm (2.5)

P-Olsen ppm 23

(Toxicities Bracketed) Deficiencies Underlined

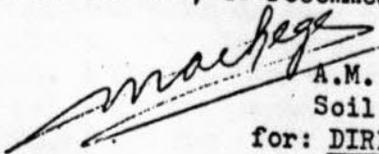
REMARKS.

Electrical conductivity (EC), sodium, calcium and magnesium levels are very high in this soil of moderately alkaline soil reaction (the soil may be sodic/laline)

Available phosphorus and potassium contents are satisfactory while total nitrogen and organic carbon are in short supply.

Reduce the amounts of excess soluble salts by leaching the soil with non-saline irrigation water.

Leaching will be hastened through the application of manure/compost and through improvement of both surface and internal drainage of the soil. An acidifying type of nitrogen fertilizer, e.g., sulphate of ammonia, is recommended.

  
 A.M. Chege  
 Soil Chemist  
 for: DIRECTOR.

Appendix 2      Seed Sources.

1. Local Collection
2. The Seedman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74,  
KIKUYU  
KENYA.
3. C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
4. Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND.
5. Setrepa Ltd.,  
P.O. Box 203  
Bussum 1400 AE  
HOLLAND.
6. Chief Forest Research Officer  
P.O. Box 22099  
Kitwe  
ZAMBIA.
7. Mr. Edmund Barrow  
East Pokot Agricultural Project  
P.O. Marigat  
KENYA
8. Mr. Wayne Teel  
Mennonite Central Committee  
P.O. Box 14894  
NAIROBI  
KENYA.
9. Dr. A.R.D. Taylor  
University of Nairobi  
Department of Botany  
P.O. Box 30197  
NAIROBI.  
KENYA.

The aim of the trial is to compare survival and growth of 21 different species/progenies at this moderate a rain/all site in Babu District. This is one of a range of species trials established at different sites within Babu, Maru and Isiolo Districts with the overall objective of identifying suitable tree species for rural afforestation in these areas.

LOCATION.

The trial is located on 1.5 hectares of land within the Maranga Hill Forest Reserve, Karungu South Location, Nanyunjei Division, Babu District. Latitude is 0° 30' South and Longitude is 37° 34' East. This is located on a survey of Kenya 1:50 000 scale about 122/3, map reference (K415451). The accompanying sketch map (Fig. 1) shows the site's location in relation to major towns and roads.

The site is approximately 500 metres West of the trigonometric station (T.S. 122 ST II) on the summit of Maranga Hill.

DESCRIPTION.

The site is on the north facing side of a ridge running west from the summit of Maranga Hill. The ridge is very steep at the top of the ridge but becomes very steep lower down.

**EMBU-MERU-ISILO FORESTRY PROJECT**

**RESEARCH SECTION**

The soil is a deep, well-drained brown soil derived from basaltic rocks. They are fertile and often referred to as 'coffee soils'.

**REPORT ON B5/8 MARANGA SPECIES TRIAL**

**BY: GORDON ARMSTRONG, SILVICULTURIST**

**MAY 1986**

There are no rainfall records for Maranga. The average annual rainfall is probably between 900mm-1000mm. Most of the rain falls in two seasons, March, April, May and October, November, December but quantity and duration of rainfall vary greatly from season to season. The site falls within agroclimatic zone III -3.

SITE PREPARATION

The site was prepared using the same 'taungya' system as is being used for the general reforestation of the reserve. Under this system, local farmers are allocated plots of land within the area to be afforested. The farmers then clear and burn the bush, cultivate the soil and plant an agronomic crop (in this case mainly beans). The tree seedlings are planted within the crop and the farmers tend the trees at the same time as they tend their crops. The farmers usually occupy their plot for two seasons (two year) before the trees become too large to permit farming between.

TRIAL DESIGN

The trial was laid out in five replicate blocks aligned across the slope. Within each block, 16 tree plots (4 x 4) of each species are allocated at random and planted at 2-5 m by 2-5m spacing. (Errors at the time of planting resulted in 6 plots having only 12 trees). The design is shown in Figure 2.

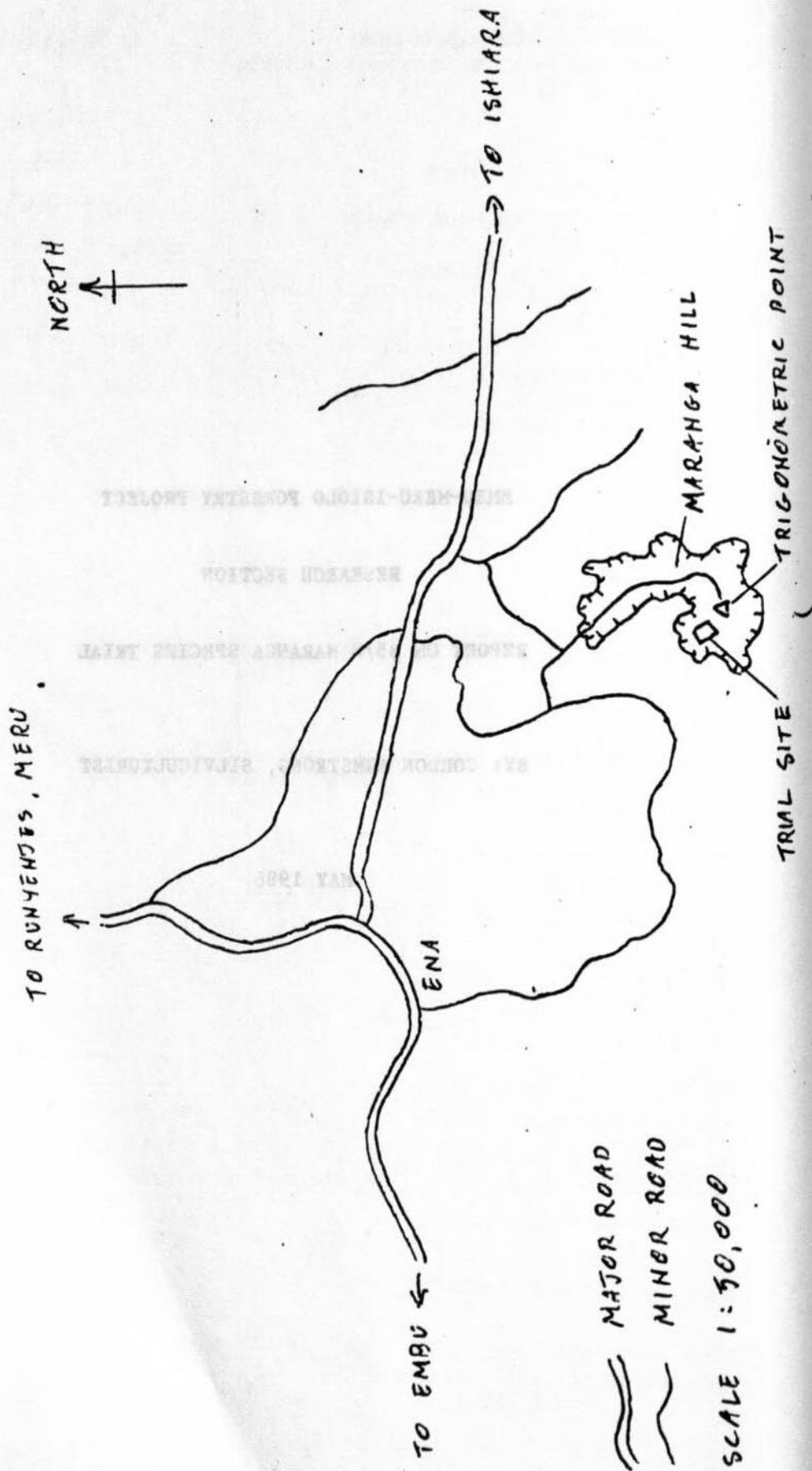
AMWT FILE

ABIC-OROWEITE BOIAT

12/10/86

12/10/86

FIGURE 1 LOCATION OF MARANGA SPECIES TRIAL



## AIM

The aim of the trial is to compare survival and growth of 23 different species/provenances at this moderate rainfall site in Embu district. This is one of a range of species trials established at different sites within Embu, Meru and Isiolo Districts with the overall objective of identifying suitable tree species for rural afforestation in those areas.

## LOCATION.

The trial is located on 1.5 hectares of land within the Maranga Hill Forest Reserve, Kagaari South Location, Runyenjes Division, Embu District. Latitude is  $0^{\circ} 30'$  South and Longitude is  $37^{\circ} 34'$  East. This is located on Surevy of Kenya 1:50 000 scale sheet 122/3, map reference CK415451. The accompanying sketch map (Fig. 1) shows the site's location in relation to major towns and roads.

The site is approximately 500 metres West of the trigonometric station (No. 122 ST II) on the summit of Maranga hill.

## SITE DESCRIPTION.

The site is on the north facing side of a ridge running west from the summit of Maranga hill. The slope is gentle near the crest of the ridge but becomes very steep lower down.

The soils are deep, well drained dark reddish brown soils derived from volcanic rocks. They are fertile and often referred to as 'coffee soils'. The altitude is 1420m.

The natural forest on the site had been cleared in the past and before 1920 being planted with the trial the site was covered with shrub regrowth dominated by Lantana spp.. The original natural forest is likely to have a mixed tree species such as Albizia gummifera, Cordia abyssinica, Croton megalocarpus, Combretum spp. and Markhamia hildebrandtii. The main crops grown on farms near the forest reserve are maize, beans, and coffee. The forest reserve is currently being re-afforested using mainly Eucalyptus saligna.

## CLIMATE

There are no rainfall records for Maranga. The average annual rainfall is probably between 900 and 1000mm. Most of the rain falls in two seasons. March, April, May and October, November, December but quantity and duration of rainfall vary greatly from season to season. The site falls within Agroclimatic zone III -3.

## SITE PREPARATION

The site was prepared using the same 'taungya' system as is being used for the general reafforestation of the reserve. Under this system, local farmers are allocated plots of land within the area to be afforested. The farmers then clear and burn the bush, cultivate the soil and plant an agricultural crop (in this case mainly beans). The tree seedlings are planted within the crop and the farmers tend the trees at the same time as they tend their crops. The farmers usually occupy their plot for two seasons (one year) before the trees become too large to permit farming between.

## TRAIL DESIGN

The trial was laid out in five replicate blocks aligned across the slope. Within each block, 16 tree plots (4 x 4) of each species are allocated at random and planted at 2-5 m by 2-5m spacing. (Errors at the time of planting resulted in 6 plots having only 12 trees). The design is shown in Figure 2.

FIGURE 2

MARANGA SPECIES TRIAL

BEACON

VALLEY

WYY <sup>12</sup>	C	BPB	GYP	BRY	BRW	X	X	E	D	X
WYR <sup>12</sup>	PPR	ARP	BYR	WPG	GPY	WYB	GPR	PRG	YPP	X

V

PLANTED 3/5/84

WYY	BRY			D	PPR	YPP	X	WWP	BYR	WYR
C	GPR	ARP	ARG	<sup>13</sup> GYP	WYB	A	WPG	BRW	E	GPY

IV

PLANTED 2/5/84

BRY <sup>12</sup>	WYY	PRG	B	WYR	PPR <sup>15</sup>	F	ARP	GPY	GYP	WPG	D
GPR <sup>12</sup>	A	BRW	YPP	E	X	X	X	ARY		WYB	APB

III

PLANTED 30/4/84

WPG	C	D	WYB	BYR	A	X	WYR	BPB	YPP	GPR
		BRW	ARP	GPY	WYY	E	PPR	ARY	B	PRG

II

PLANTED 28/4/84

E	BRY		WPG		GPR	B	PRG	PPR	APB	WYY
WYR	BRW	D	C	WYB	GPY	ARP	GPY	A	YPP	ARY

I

PLANTED 27/4/84



RIDGE

ROCK

ROCK

TRIAL HISTORY

The trial was planted between 27th April and 3rd May 1984. The rains that season were more than one month late in starting and were low in quantity. This resulted in higher initial mortalities than expected. Since then rainfall has been about average and growth rates normal. A few seedlings were killed soon after planting by being uprooted by baboons. Since being abandoned by the farmers the trial has been weeded as required. This weeding has been done by completely cleaning the soil to about 0.5 metre radius around each tree and by slashing weed growth in between. The height of each tree has been measured twice per year.

SPECIES

The following species were raised specifically for the trial at Kathera nursery by direct sowing into 10cm x 15cm ( layflat ) black polythene tubes. A code for three colours was painted on each tube to enable easy identification of each species. The addresses of the seed suppliers are given in Appendix I.

CODE	SPECIES	PROVENANCE	SEED SUPPLIER	NO. PLANTED
GPR	Acacia aulacocarpa	Buokley ( BN 13865)	2	76
GPY	Acacia auriculiformis	Springvale (BN 13861)	2	80
BPB	Acacia mollissima	Eldoret ( 201-003)	3	64
PPR	Acrocarpus fraxinifolius	Embu	1	80
WPY	Albizia falcataria		3	16
WPG	Cassia siamea	Ishiara	1	80
WYY	Casuarina cunninghamiana		4	76
WYB	Casuarina equisetifolia		4	80
WYR	Casuarina torulosa	Muguga	3	76
PRG	Cordia abyssinica	Embu	1	72
BRY	Eucalyptus globulus	Meru	1	80
YPP	Eucalyptus hybrid	Comp 119, Choma	5	80
BRP	Eucalyptus maculata	Nyeri	3	80
BYR	Eucalyptus paniculata	Nyeri	3	76
BRW	Eucalyptus saligna	Corsuelo (BN 13262)	2	80
WWP	Gmelina arborea	Gede	2	16
GYP	Leucaena leucocephala	BAT Ena	1	80

In addition the following species were collected from stock already growing at various nurseries.

CODE	SPECIES	PROVENANCE	NURSERY	NO. PLANTED.
A	Cassia spectabilis	Embu	Embu	64
B	Croton megalocarpus	Runyenjes	Runyenjes	64
C	Cupressus lusitanica	Runyenjes	Runyenjes	64
D	Eucalyptus saligna	Runyenjes	Runyenjes	80
E	Grevillea robusta	Runyenjes	Runyenjes	80
F	Acacia cyanophylla	Runyenjes	Kathera	16

RESULTS

Summaries of the results of the assessments carried out in September 1984 and Sept. 1985 are given in tables 1 and 2. The species are ranked according to survival rate.

DISCUSSION

The survival rates have been strongly influenced by the failure of the rains during the April/May 1984 planting season. Nearly all the mortality occurred during the first six months after planting, before the rains returned to normal in September 1984. The unusual nature of the conditions is shown by the poor establishment of the local Eucalyptus saligna. This is the main species used for the plantation programme on Maranga hill and in most seasons establishment is good.

MARANGA SPECIES TRIAL.

TABLE I

PLANTED 27/1/84 - 3/5/84.

ASSESSED 24/9/84.

CODE	SPECIES	SURVIVAL %	AV. HEIGHT.
A	Cassia spectabilis	92	16cm.
GYP	Leucaena leucocephala - Ena	88	13cm.
YPP	Eucalyptus hybrid	84	46cm.
BYR	Eucalyptus paniculata	84	35cm.
WPG	Cassia siamea	83	15cm.
BPB	Acacia mollissima	80	39cm.
E	Grevillea robusta	78	15cm.
WYY	Casuarina cunninghamiana	72	40cm.
GPY	Acacia auriculiformis	71	32cm.
BRP	Eucalyptus maculata	70	24cm.
BRW	Eucalyptus saligna - CONSUELO	69	26cm.
F	Acacia cyanophylla	69	25cm.
B	Croton megalocarpus	66	29cm.
WYR	Casuarina tomentosa	57	38cm.
WYB	Casuarina equisetifolia	56	35cm.
GPR	Acacia aulacocarpa	55	36cm.
FPR	Acrocarpus fraxinifolius	54	13cm.
BRY	Eucalyptus globulus	49	33cm.
D	Eucalyptus saligna - RUNYENJES	40	39cm.
PRG	Cordia abyssinica	39	13cm.
WWP	Gmelina arborea	25	16cm.
C	Cupressus lusitanica	11	28cm.
WPY	Albizzia falcatoria	6	7cm.

DISCUSSION

The survival rates have been strongly influenced by the nature of the rain during the April/May 1984 planting season. During all the rainfall recorded during the first six months after planting, the rain returned to normal in September 1984. The survival rates of the seedlings is shown by the bar chart of the local Marangia station. This is the only station used for the plantation program on Marangia Hill and its most recent assessment is 1984.

Planted: April / May 1984 Assessed: September 1985

CODE	SPECIES.	AV.HT. (cm)	% SURVIVAL
GYP	Leucaena leucocephala-Dna	261	88
A	Cassia spectabilis	307	83
WPG	Cassia siamea	193	80
YPP	Eucalyptus hybrid	374	80
BYR	Eucalyptus paniculata	310	78
BFB	Acacia mollissima	582	73
GPY	Acacia auriculiformis	262	70
B	Croton megalocarpus	147	66
BHP	Eucalyptus maculata	316	65
E	Grevillea robusta	167	65
BRW	Eucalyptus saligna-CONSUELO	348	58
WYY	Casuarina cunninghamiana	240	58
F	Acacia cyanophylla	379	56
WYB	Casuarina equisetifolia	202	45
GPR	Acacia aulacocarpa	260	43
PRG	Cordia abyssinica	235	42
WYR	Casuarina terulosa	269	41
FPR	Acrocarpus fraxinifolius	209	41
BRY	Eucalyptus globulus	296	35
D	Eucalyptus saligna RUNYENJES	360	35
C	Cupressus lusitanica	119	6
WWP	Gmelina arborea	147	6
WPY	Albizia falzataria	0	0

Most of the regular planting also failed in the April 1984 season. The drought conditions obviously favoured the more drought resistant species such as Leucaena leucocephala, Cassia spectabilis, Cassia siamea and Eucalyptus hybrid. The trial is therefore not a good indicator of establishment rates that might be achieved under normal conditions at this site. Most of the species in the trial would be expected to establish satisfactorily during most rainy seasons.

The trial does, however, demonstrate significant differences in initial growth rates between the different species. By far the forest growing species is Acacia mollissima ( sgn. Acacia mearnsii ) which by September 1985 ( 17 months after planting ) had achieved an average height per tree of 582 cm. ( and this during an initial 6 months of drought ). Between September 1984 and September 1985 the trees grew from 39cm to 582 cm. ( i.e. more than 5 metres per year ). The tallest tree was 8 metres tall. For fuelwood production it should be possible to manage this species on a 3 year rotation.

Also growing well are Acacia cymophylla, Eucalyptus hybrid and Eucalyptus saligna. The Eucalyptus hybrid comes from Zambia and is reported to be a hybrid between E. grandis and E. tereticornis. Most of the trees bear a strong resemblance to E. tereticornis but some individuals look very much like E. grandis and these may not be hybrids. Not only does this hybrid show a slightly higher growth rate than the local E. saligna but its survival rate is much better. This probably reflects the greater drought tolerance of the E. tereticornis parent.. This hybrid would merit further trial planting, especially on sites where lower rainfall makes conditions marginal for E. saligna.

Two provenances of E. saligna were included: the locally collected provenance from Runyenjes used in the main plantation programme; and a 'new' provenance from the Consuelo Tablelands in Queensland, Australia. The local provenance shows a slightly higher growth rate but the Consuelo provenance has a better survival. This probably reflects the site conditions at Consuelo which are reportedly drier than the main range of E. saligna. Further investigation of this provenance would be worthwhile for sites at the dry end of E. saligna range.

Many of the species included in the trial are suitable for farm forestry and one of the aims of the trial was to investigate the performance of these species in accordance with the rural forestry objectives of the project. Leucaena leucocephala has shown itself to be well adapted to the area. Similarly Cassia spectabilis is doing well and the native Cordia abyssinica is showing promise. The three species of Casuarina are showing satisfactory growth. These species could form the basis of 'on farm' trials to test their agroforestry potential.

Appendix I    Seed sources.

I.    Local collection

2.    C.S.I.R.O.  
Division of Forest Research  
P.O. Box 4008  
Queen Victoria Terrace  
A.C.T. 2600  
AUSTRALIA.
  
3.    The Seedman  
Forest Research Department  
Kenya Agricultural Research Institute  
P.O. Box 74  
KIKUYU  
KENYA.
  
4.    Timmers + Leyer  
P.O. Box 17  
Heemstede 2100 AA  
HOLLAND.
  
5.    Chief Forest Research Officer  
P.O. Box 220099  
KITWE  
ZAMBIA.

INDO-INDO-ISILOLO FORESTRY PROJECT

RESEARCH SECTION

REPORT ON 13/1 YOUNG SIEM TETAL

BY: GORDON ARMSTRONG, SILVICULTURIST  
J. K. LUCASINI, RESEARCH FORESTER

MAY 1965

The aim of the trials was to test the effect on establishment of varying seedlings in different sized tubes. The tubes were planted in a standard area of 8 inches diameter by 6 inches depth. It was expected that the tubes would be comparable in volume to the standard area. However, it was found that the tubes were not comparable in volume to the standard area. This was due to the fact that the tubes were not perfectly cylindrical and the soil in the tubes was not perfectly uniform. It was therefore decided to use a standard area of 8 inches diameter by 6 inches depth. This area was divided into four equal parts. Each part was planted with a different size of seedling. The results of the trials are given in Table 1.

Seedlings were raised in 6 different sizes of black polythene tubes ranging from 4 inches diameter x 6 inches depth to 10 inches diameter x 12 inches depth. The tubes were planted in a standard area of 8 inches diameter x 6 inches depth. The results of the trials are given in Table 1.

**EMBU-MERU-ISIOLU FORESTRY PROJECT**

**RESEARCH SECTION**

**REPORT ON B3/1 TUBE SIZE TRIAL**

**BY: GORDON ARMSTRONG, SILVICULTURIST**

**J K LUGADIRU, RESEARCH FORESTER**

**MAY 1986**

3x6	10x12	10x8	4x6	5T	10x6	10x10	A
10x2	5T	10x10	10x8	10x6	10x6	10x10	B

The results indicate that although there may be a slight trend of increased establishment rate with increased tube size, there is no significant difference between different sized tubes at least in the first year. The one exception is with the smallest tube size (4" x 6") as the establishment rate is lower than for the larger tubes. However, there is no evidence that the establishment rates would be significantly improved by using larger tubes than the standard currently in use (8" x 6"). It should be noted that the trials were planted during the 1983/84 planting season. It is expected that the establishment rates would be higher than those observed in the trials.

ST - STANDARD 8x6 INCH CLEAR POLYTHENE TUBES

## AIM.

The aim of the trials was to test the effect on establishment success of raising seedlings in different sized tubes. The Forest Department currently uses a standard sized tube of 8 inches circumference by 6 inches depth ( 4 inches x 6 inches, layflat, 10cm x 15cm layflat ). If smaller tubes could be used there would be considerable savings in factors such as nursery soil transport, nursery space occupied, nursery tending operations and seedlings transport. Conversely, if larger tubes gave much higher establishment rates, particularly in dry sites, then it may be worth switching to them.

## METHODS.

Seedlings were raised in 6 different sizes of black polythene tubes ranging from 4 inches circumference x 6 inches depth. ( 2" x 6" layflat ) to 10 inches circumference x 12 inches depth ( 5" x 12" layflat ). Also included were standard tubes of 8 inches circumference x 6 inches depth of clear polythene. These were planted in the following trials.

Kibaranyeke ( Meru ) - *Eucalyptus saligna*  
Maranga ( Embu - *Eucalyptus saligna*  
Maranga ( Embu ) - *Grevillea robusta*  
Kiangombe ( Embu ) - *Cassia siamea*  
Kiangombe ( Embu ) - *Eucalyptus camaldulensis*  
Gategi ( Embu ) - *Cassia siamea*  
Gategi ( Embu ) - *Eucalyptus camaldulensis*

The trials at Kibaranyeke, Maranga ( *E. saligna* ) and Gategi were laid out according to a randomised block design with 6 replicates of 16 tree plots at Kibaranyeke and Maranga and 5 replicates at Gategi. The other trials were not replicated. Estimated mean annual rainfalls at the four sites are Kibaranyeke - 1,200mm, Maranga - 1,000mm, Kiangombe - 900mm and Gategi - 850mm. The Kibaranyeke and Maranga trials were planted in December 1983 and the Kiangombe and Gategi trials were planted in April 1984. In both those seasons rainfall was below average. After reaching one year old ( i.e. when they could be considered to be established ) the trials at Kibaranyeke, Maranga and Kiangombe were abandoned as research plots. However the trials at Gategi have been maintained in order to observe any differences in long term growth patterns. A plan of the Gategi trial is shown in figure 1. And a full description of the Gategi site is given in the report on B5/3 Gategi species Trial.

## RESULTS.

Percentage establishment rates are given in Table 1.

## DISCUSSION.

The results indicate that although there may be a slight trend of increased establishment rate with increased tube size, there are not any significant differences between different tube sizes at most of the sites. The one exception is with the smallest tube size ( 4" x 6" ) at the driest site ( Gategi ). Here, establishment of seedlings raised in the smallest tubes is lower than for the larger tubes. However there is no evidence that establishment rates would be dramatically improved by using larger tubes than the standard currently in use ( 8" x 6" ). It should be noted that the trials were planted during the 1983/84 drought when rainfall was below average. In 'normal' seasons survival rates would be expected to be higher than those achieved in the trials.



The results indicate that, at higher rainfall sites, smaller tubes than the standard could be used with no adverse effects on establishment success. A small reduction in the size of tube used can result in considerable improvements in nursery efficiency so it has been recommended that 6 inch circumference x 6 inch deep ( 3" x 6" layflat ) tubes be used at high rainfall nurseries and these are now being introduced by the project

Further observations of the Gategi trials will determine whether there are any long term effects on growth patterns. Up to the present there are no significant difference in growth rates between seedlings raised in different sized tubes.

TABLE 1 Percentage Establishment by Tube Size

TUBE SIZE (CIRCUMFERENCE BY DEPTH IN INCHES )

<u>TRIAL</u>	<u>4 x6</u>	<u>STAND.</u>	<u>8 x6</u>	<u>10 x6</u>	<u>10 x8</u>	<u>10 x 10</u>	<u>10 x 12</u>	
Kibaranyeki: <i>Euc. saligna</i>	65	72	79	83	81	88		%
Maranga: <i>E. saligna</i>	79	86	84	89	89	95		%
Maranga: <i>G. robusta</i>	88	87		88	87	91		%
Kiangombe: <i>C. siamea</i>	92	86	86	91	92	100	100	%
Kiangombe: <i>E. camaldulensis</i>	82	90	100	100	94	95	95	%
Gategi: <i>C. siamea</i>	64	74	75	80	70	86	89	%
Gategi: <i>E. camaldulensis</i>	25	59	67	56	65	66	45	%

NOTE: STAND. = Standard 8 x6 inches clear polythene tube.