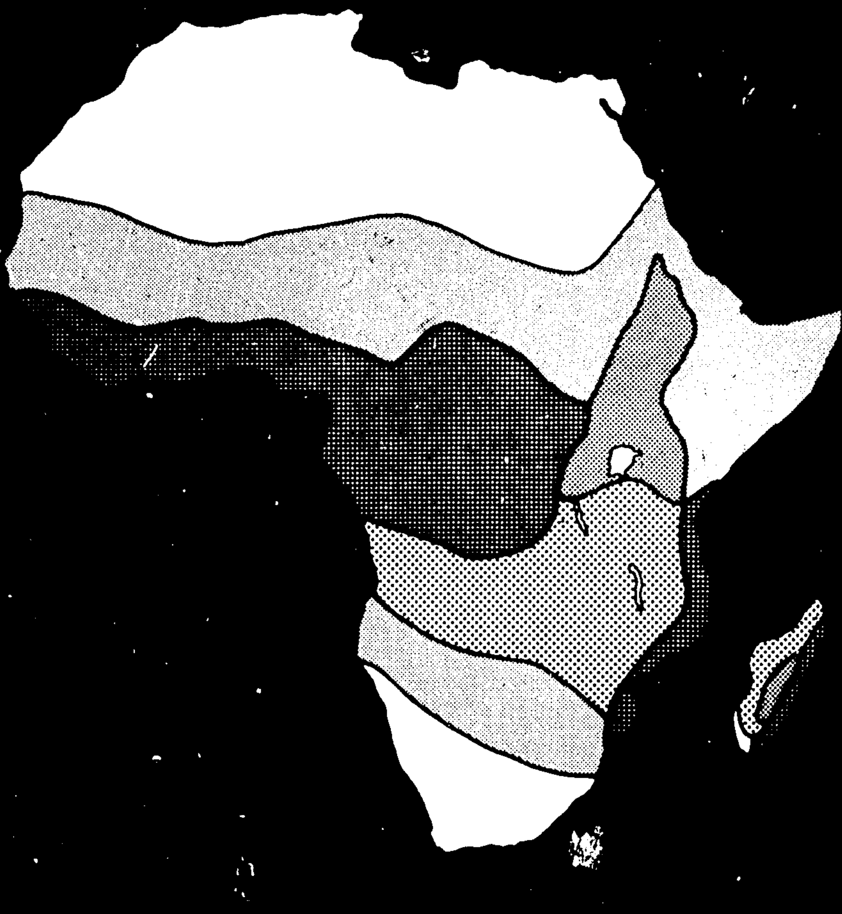

The map on the cover of this publication shows those parts of the four ecological zones to be included in the AFRENA Programme.

La carte sur la couverture de cette publication montre une partie des quatre zones écologiques devant relever du programme AFRENA.

semi-arid lowlands	Zone semi-aride de basse altitude
humid lowlands	Zone humide de basse altitude
unimodal (rainfall) plateau	Zone de plateau à régime pluviométrique unimodal
bimodal (rainfall) highlands	Zone de hautes terres à régime pluviométrique bimodal

INSTITUT DES SCIENCES AGRONOMIQUES
DU BURUNDI
ISABU

INTERNATIONAL COUNCIL FOR
RESEARCH IN AGROFORESTRY
ICRAF

AFRENA PROJECT BURUNDI
PROGRESS REPORT FOR THE PERIOD NOVEMBER 1988 TO FEBRUARY 1990

No. 29

Ekow Akyeampong
Jean B. Sabukwikopa

August 1990

TABLE OF CONTENTS

1.0 GENERAL INTRODUCTION

At the end of 1986, ICRAF launched an agroforestry research network for the highlands of East and Central Africa with USAID funds. The network is part of ICRAF's AFRENA programme, which encompasses three other ecological zones in sub-saharan Africa. The 2 main objectives of the AFRENA programme are:

1. To develop appropriate agroforestry technologies for land use systems within an ecological zone, and

2. To develop national/regional capacity to plan, formulate and implement agroforestry research.

An agro-ecological network approach was adopted because it enables complementarity in research on the basis of similarities in agroforestry potentials within an ecological context. Such complementarity between research conducted in the participating countries will lead to a more focused approach and to a saving in scarce research resources.

The East and Central Africa AFRENA network focuses on the highland areas above 1,000 m, with an average rainfall of over 1,000 mm. Four countries were initially included in the network namely Burundi, Kenya, Rwanda and Uganda. After conducting diagnostic studies to determine the potential role of agroforestry, research with sound applicability was initiated in all four countries in 1988.

In Burundi, the project works under ISABU, the lead collaborating institution. Its work is overseen by a National Steering Committee under the chairmanship of the Director General of ISABU. Other members of the steering committee are the Director General of the Institute for Nature and Environmental Conservation (INECN), the Dean of the Faculty of Agriculture, University of Burundi, the Director General, Ministry of Environment and Tourism, and the Director General, Department of Planning, Ministry of Agriculture and Livestock.

The project collaborates with Institut de Recherche Agronomique and Zootechnique (IRAZ), a research institute for the Great Lakes countries of Rwanda, Burundi and Zaire, and the Small Farming Research Project, a USAID funded project run by the University of Arkansas. Both projects are based in Gitega.

1.1 Areas of research

In agreement with other participating countries, the project conducts its research in land-use systems between 1,500 and 2,000 m. Currently, research is in three areas according to problems identified in the D&D exercise. Alley cropping is being studied in relation to ameliorating the low and still declining fertility of soils in the region. Animals are invariably found, to a varying degree, in all the land-use systems. However, the paucity of fodder in sufficient quantities and of adequate quality is a real and common constraint to animal production. In addition to alley cropping, technologies for the production of fodder on contour bunds are being studied. Finally, many potential woody species are being screened for their agroforestry potentials.

In this report are the results of work carried out between November 1988 and February 1990.

2.0 EXPERIMENTAL SITES

2.1 Location

Experiments were conducted at 2 sites in Burundi, Mashitsi and Karuzi. Mashitsi is located at latitude 3°22'S and longitude 34°51'E at an altitude of 1,600 m, and Karuzi at latitude 3°6'E, longitude 30°10'S at altitude 1,620 m.

2.2 Rainfall

Rainfall at both sites is bimodally distributed (Table 2.1). The long rainy season is from January to early May and the short rainy season from October to December. There are 4 dry months (precipitation <50 mm). At Mashitsi, total rainfall in 1989 exceeded the four year average (1986-89) due mainly to an exceedingly wet March.

2.3 Temperature

Temperatures are mild with the coolest months occur during the dry months (Table 2.2).

Table 2.1 Monthly rainfall (mm) data of 1989 and the average for 1986-89 for Karuzi and Mashitsi.

Month	Mashitsi		Karuzi	
	1989	1986-89	1989	1986-89
January	156	176	121	190
February	160	140	58	86
March	300	175	188	162
April	174	174	117	218
May	86	77	72	58
June	14	4	80	20
July	0	1	0	1
August	17	11	15	10
September	33	47	24	37
October	138	124	106	126
November	264	188	146	147
December	108	130	189	94
Total	1450	1247	1116	1149

Table 2.2 Monthly mean minimum and maximum temperatures (°C) data of 1989 and the average for 1986-89 for Mashitsi. Minimum data for Karuzi were not available.

Month	Mashitsi				Karuzi	
	1989		1986-89		1989	1986-89
	Max	Min	Max	Min	Max	Max
January	28	11	28	11	25	26
February	28	9	29	11	27	27
March	28	10	29	11	26	26
April	27	11	28	13	26	26
May			21	8	26	27
June	27	7	28	8	26	27
July	28	7	29	8	28	29
August	30	8	30	9	28	29
September	30	9	30	10	29	28
October	30	10	29	11	28	28
November	30	12	28	11	26	26
December	27	11	26	11	25	27
Mean	28	10	28	10	27	27

2.4 Soils

The Mashitsi site had two areas. The first (subsequently referred to as Area 1) had been cultivated and was under a 5 month old cassava crop. The second (Area 2) was under a Eucalyptus woodlot. At Karuzi, the land was under an Eragrostis pasture.

Soil characteristics are provided in Table 2.3. Physical and chemical characteristics are similar. All are sandy, acidic with very high aluminium saturation percentage and are very low in bases. They have been classified as ferralsols.

Table 2.3 Characteristics of the soils at the experimental sites

		Karuzi	Mashitsi	
			Area 1	Area 2
Particle sizes				
Clay	<0,002 mm	27.0	29.9	18.4
Silt	0,002-0,02 mm	1.7	1.8	12.2
Sand	> 0,02 mm	70.3	68.3	69.4
Organic carbon (%)		1.83	1.01	1.17
Organic nitrogen (%)		0.12	0.09	0.09
pH water		5.1	4.3	4.5
pH KCl		4.1	4.1	4.1
Exchangeable cations (meq/100 g)				
Ca		0.52	0.42	0.54
Mg		0.10	0.04	0.08
K		0.04	0.08	0.08
Na		0.02	0.02	0.02
Al		2.57	1.85	2.00
P (ppm)		23	23	25

3.0 FODDER PRODUCTION POTENTIAL OF DIFFERENT ASSOCIATIONS OF LEGUMINOUS TREES AND GRASSES ON CONTOUR BUNDS

3.1 Justification

In many areas of the East and Central Africa highlands, livestock is invariably a component of the land-use systems although its importance varies. The small land holdings in these areas do not allow for parcels of land for grazing. A major source of feed, in addition to crop residues, is the grass lines established on contour bunds against erosion. Not only is the quantity of fodder produced from these bunds low, the quality is also poor.

We have been studying the possibility of introducing a line/hedge of leguminous shrubs next to the grass line to provide protein-rich supplementary fodder as well as aid in stabilizing the contour bunds. Two experiments have been conducted in this regard, the results of which are presented.

3.2 Experiment I. The effect of time of planting of trees

3.2.1 Objectives

The objectives of this experiment were to study:

1. the best time of planting of the shrubs relative to the grass and the optimum tree spacing to use, and

2. the effect of the association on companion crops.

3.2.2 Materials and methods

3.2.2.1 Land preparation

This experiment commenced in November, 1988 at Karuzi. Site conditions are as described earlier (Section 2). Land was hoed to remove the Eragrostis pasture followed by a second hoeing to loosen the soil. Contours were laid at every 50 cm drop in elevation. Intervals between contours were between 10 and 15 m. Lime was applied at a rate of 2 tons per hectare and incorporated by a third hoeing. A bund of about 10 cm was raised at each contour. A cut-off-drain was dug immediately below each bund.

3.2.2.2 Treatments

A split plot arrangement was used. Main plots were a factorial combination of shrub species and 3 planting sequences: grass planted before shrub, shrub planted before grass or the grass and shrub planted simultaneously. Thus there were 6 main plots as shown in Table 3.1.

Subplot treatments were 3 within-row spacings of the trees - 25 cm, 50 cm and 1 m. A subplot was 5 m long and the main plot was 15 m. The shrub row was 25 cm from the riser and the grass row 50 cm upslope from the shrub row.

Table 3.1 Main plot treatments

Treatment designation	Date of planting November, 1988	February, 1989
T1	Pennisetum	Leucaena
T2	Leucaena	Pennisetum
T3	Pennisetum + Leucaena	------
T4	Pennisetum	Calliandra
T5	Calliandra	Pennisetum
T6	Pennisetum & Calliandra	-----

3.2.2.3 Management of trees and grasses

Two nitrogen-fixing shrubs, *Calliandra calothyrsus* (ex Guatemala) and *Leucaena diversifolia* (ex Murongwe) were used. The former was obtained from the Kenya Forestry Seed Centre, Muguga, Kenya, and the latter from a local collection in Murongwe an ISABU research centre 25 km from the experiment site. The grass used was *Pennisetum purpureum*, cuttings of which were obtained locally from farmers.

Three-month old shrub seedlings were used in the first planting. For the second planting seedlings from the same lot planted in November 1988 were used. By then the seedlings were quite big and were cut back to 40 cm. Two cuttings of Pennisetum (each with at least 3 nodes) were planted in an X fashion. Within-row spacing was 50 cm for the grass.

Pennisetum was harvested in June (first harvest) and November (second harvest) 1989. A third harvest in February, 1990 was discarded due to damage by stray livestock.

Calliandra from main plots T5 and T6 were harvested in October 1989. The second harvest of Calliandra for T5 and T6 and the first for T4 took place in February 1990.

At each harvest, plants were cut back to 50 cm. Harvests were from 4 m portions of each subplot. Samples of harvested materials were dried at 105°C for 48 hours. Prior to the first cut of Calliandra, height had been measured at regular intervals.

No crop has hitherto been grown.

3.2.3 Results

Growth and survival of leucaena were extremely poor due to damage by wildlife at the seedling stage. It's data will not be presented. Time of planting did not affect survival of neither Calliandra nor Pennisetum.

3.2.3.1 Growth and yield of Calliandra

Heights of Calliandra planted simultaneously with Pennisetum (T6) and those planted alone for 3 months before the introduction of Pennisetum (T5) were never significantly different from each other. However, at 11 months after planting, collar diameter of T6 (1.8 cm) was significantly lower than that of T5 (2.4 cm). Shrub heights were not affected by spacing. Time of planting (main plot) and tree spacing (subplot) interactions were not significant.

At the first harvest (October, 1989), but not at the next harvest (February, 1990) leaf and wood biomass production were significantly depressed by planting Calliandra simultaneously with Pennisetum (T6) in comparison with planting the Calliandra alone for three months (T5) (Table 3.2). T5 significantly out-yielded T4 in woody and total but not in leafy biomass. T4 produced more leafy biomass than T6 although their woody and total biomass were not significantly different. Note that the first harvest of T4 was at a different time and was after 12 months of growth whereas the first harvest of T5 and T6 were after 11 months of growth.

At the first harvest, yield of Calliandra spaced at 100 cm was significantly lower that yield from the other two spacings. This was not the case at the next harvest.

3.2.3.2 Yield of Pennisetum

At the first harvest, yield of Pennisetum, was in the order T4 > T6 > T5 (Table 3.2). However, T4 and T6 were not significantly different and these significantly out-yielded T5 as expected. Neither subplot nor main plot x subplot interactions were significant.

Total dry weight obtained from both grass and shrub were 691, 624 and 714 g/m for T4, T5 and T6 respectively. Evidently, the differences are not great. Of interest, however, are the fodder quality differences which is yet to be calculated.

Table 3.2 Effect of time of planting and spacing on the dry weights (g/m) of Calliandra and Pennisetum.

Treatment	First Harvest Leaf	First Harvest Stem	First Harvest Total	Second harvest Leaf	Second harvest Stem	Second harvest Total
A. Calliandra						
Main plots						
T4	65	28	93	--	--	--
T5	73	83	157	163	96	259
T6	41	40	81	133	68	201
LSD (0.05)	18	18	34	ns	ns	ns
Sub-plots						
25 cm	81	69	150	192	104	296
50 cm	61	61	122	155	86	243
100 cm	34	21	55	95	51	146
LSD (0.05)	18	18	29	65	ns	125
CV (%)	29	34	29	27	46	34

B. Pennisetum	First Harvest	Second Harvest
T4	348	250
T5	27	181
T6	246	186
LSD (0.05)	110	ns
CV (%)	37	35

3.3 Experiment 2. Screening of different associations

3.3.1 Objectives

The objectives of this experiment were to determine (1) the best, in terms of yield (and fodder quality), shrub/grass combination on contour bunds in terms of yield and fodder quality (2) the mutual effect of the grasses and trees on each other and (3) the effect of the different on associated crops.

3.3.2 Materials and methods

3.3.2.1 Land preparation

The experimental site at Mashitsi was under a Eucalyptus (Area 2) woodlot. Site conditions are as described earlier (See section 2.0). Trees were felled and stumped. Land was then hoed to remove undergrowth. During the second hoeing, lime was applied at a rate of 2 tons/ha. Contours and bunds were established as described above. Inter-bund spacing was about 10 m.

3.3.2.2 Treatments

Three woody species *Calliandra calothyrsus* (ex Guatemala), *Sesbania sesban* (ex India) and *Leucaena diversifolia* (ex Murongwe), and two herbaceous species - *Pennisetum purpureum* and *Tripsacum laxum* were combined in a full factorial arrangement to obtain 6 treatments. To these were added 5 pure grass or shrub plots to obtain a total 11 treatments which were arranged in a randomized complete block design and replicated three times.
Each plot consisted of a either 2 rows of the same species or a row each of grass and shrub. In the latter case the grass was planted about 25 cm from the edge of the riser and the shrub line 50 cm upslope from the grass line. Plots were 7 m long. Both the shrubs and the grasses were spaced 50 cm within the row and in a staggered fashion between the 2 rows. The shrubs and grasses were planted on the same day in March 1989.

Calliandra was obtained from Kenya Forestry Seed Centre, the Leucaena from ISABU centre at Murongwe and the Sesbania from Pratap Seed Nursery, India. Cuttings of grasses were bought locally from farmers.

3.3.3 Results

After 15 months, Sesbania has almost died out and its data was not included in the analyses. Early growth of Leucaena was faster than that of Calliandra but by December, both species had achieved similar heights (Table 3.4). At both times shrub heights were not significantly affected by associating them with grasses.

After 11 months of growth, biomass production of Leuceana and Calliandra in pure stands were not significantly different (Table 3.5). A single line of Leucaena in association with either Pennisetum or Tripsacum produced about half the leaf yield of two rows of leucana. Thus the competitive effect of the grasses was similar to a second row of Leucaena. A single row of Calliandra produced slightly more than half the leaf yield of two rows of Calliandra. When associated with Tripsacum, the leaf yield of Calliandra was significantly better than that of Leucaena.

Table 3.4 Height of shrubs at 3 and 8 months after transplanting (MAT) and collar diameter at 8 MAT.

Treatment	Plant height (cm) 3 MAT	8 MAT	Collar diameter (mm) 8 MAT
Leucaena	76	136	16
Calliandra	56	128	13
Leucaena + Pennisetum	75	127	14
Leucaena + Tripsacum	69	120	14
Calliandra + Pennisetum	50	121	12
Calliandra + Tripsacum	55	133	15
LSD (P=0.05)	8	ns	2
CV (%)	21	22	30

Biomass production of Tripsacum and Pennisetum harvested after 11 months were not significantly different. Whereas with Pennisetum, the yield of a single row when associated with either shrub was about a third of what was obtained from two rows, the yield of a single row was about half of the yield of two rows.

Table 3.5 Effect of association on dry weights (g/m) of shrubs and grass after 11 months of growth

Treatment	Shrubs Leaf	Stem	Total	Grass
Leucaena alone	257	284	541	-
Calliandra alone	337	251	588	-
Pennisetum alone	-	-	-	616
Tripsacum alone	-	-	-	743
Leucaena + Pennisetum	133	146	278	224
Leucaena + Tripsacum	98	78	176	325
Calliandra + Pennisetum	184	128	312	204
Calliandra + Tripsacum	230	181	184	386
LSD (0.05)	61	130	184	370
CV (%)	15	37	24	35

4.0 ROLE OF WOODY PERENNIALS IN THE AMELIORATION OF SOIL FERTILITY

4.1 Justification

Population pressure on agricultural land is a recognised problem in many parts of sub-saharan Africa. The highland areas of East and Central Africa have some of the highest population densities and growth rates in the continent. The result has been the disappearence of fallow land, small land holdings per family, and continuous cropping with little or no soil amendments which result in loss of soil fertility and poor yields.

The potential of alley cropping a technology for sustainable, continous cropping is explored. It may be particularly appropriate for the highlands of the East and Central Africa because the hedges could also serve as barriers against soil erosion.

4.2 Evaluation of *Calliandra calothyrsus*, *Cassia spectabilis* and *Sesbania sesban* alley cropping

4.2.1 Objectives

1. To select promising MPTS for alley cropping

2. To quantify biomass production potentials of MPTS under alley cropping management

3. To assess the effect of MPTS on companion crops

4.2.2 Materials and methods

4.2.2.1 Site preparation

Before the hedges were established on November 23, 1988 at Mashitsi (Area 1), the land was hoed to remove a 5-month old cassava crop. Site conditions are as described earlier (See Section 2).

4.2.2.2 Treatments

In this experiment, *Calliandra calothyrsus*, *Cassia spectabilis*, and *Sesbania sesban* were evaluated. There were respectively 3, 4, and 3 provenances of the species. *Leucaena diversifolia* was included to permit comparison with the second experiment (see below). A control plot (without trees) was also maintained. There were thus 12 treatments. All seeds except the *Leucaena diversifolia* and *Sesbania sesban* (ex ILCA) were obtained from the Kenya Forestry Seed Centre. *Leucaena diversifolia* was obtained from ISABU centre, Murongwe and *Sesbania sesban* from the Gene bank of the International Livestock Centre for Africa, Addis Ababa, Ethiopia. Species and provenances are listed in Table 4.1.

4.2.2.3 Experimental design

The experiment was laid out in a randomized complete block design and replicated three times. A plot consisted of 2 hedges 4 meters apart. Each hedge was 5 m long and the plants were spaced 0,50 m within the hedge. Two metres of plot was left on the non-alley side of each hedge giving a total plot width of 8 m.

4.2.2.4 Management of shrubs

Seedlings were raised in a nursery for about 3 months before they were out-planted. After a year of growth most species were cut back to 50 cm. Harvested biomass was divided into leaves and twigs, and stems. Leaves and twigs were cut into small pieces and hoed into the soil with 2 tons/ha of lime and 10 tons/ha of manure. Samples taken for dry weight determinations in the laboratory materials were dried at 105°C for 48 hours. Stems were arranged against the upslope side of the hedges as barrier against soil erosion.

Beginning in January 1989, plant height and root collar diameter were measured each month till the hedges were cut back in October 1989. The centre 4 plants of each hedge were measured, giving a total of 8 plants per plot. Plant height was measured with a graduated pole and collar diameter with calipers.

4.2.2.5 Management of crops

No food crop was planted during establishment season and the bean crop that was planted the following season (February 1989) failed. Prior to the planting of the beans, lime was applied at 2 tons/ha and incorporated into soil. Due to a combination of excessive rainfall and resultant diseases and use of a poorly adapted cultivar, this crop failed.

In October 1989, maize was planted at 80 cm x 40 cm. Maize row adjacent to the hedge were planted 40 cm away. The hedge, therefore, did not replace any row of maize. Beans were planted between the rows of maize at 20 cm spacing within the row. Upon emergence, both crops were thinned to 2 plants per hill. This crop also failed.

4.2.3 Results

Survival after 15 months of growth was over 90% for all entries except Sesbania (ex ILCA) where two plots were virtually without plants.

Height, diameter and biomass produced were in the order Sesbania > Calliandra > Cassia (Table 3.1). Provenance differences existed in Sesbania and Calliandra. Height growth of Sesbania (ex ILCA) was significantly lower than the other two at ten MAT. Sesbania (ex Kakamega) generally showed greatest height growth. Differences in collar diameters were variable. In Calliandra, Guatemala provenance always showed significantly greater height and diameter than the other two. Leucaena was similar to Calliandra (ex

Guatemala) at 2 MAT but at 10 MAT, Leucaena had significantly lower height and diameter.

Leaf dry weight relative to that of shoot varied among the species but were similar within a species. At that stage of growth, the quantity of Cassia harvested was predominantly leaf whereas the Sesbanias were about 30% leaf and the Calliandras about 40% leaf.

Table 4.1 Plant height, collar diameter and dry weights at 10 months after transplanting (MAT) of species evaluated

SPECIES (Provenances)	HEIGHT (cm)		BASAL DIAMETER (cm)		DRY WEIGHT (kg/ha)		
	2 MAT	10 MAT	2 MAT	10 MAT	Total	Leaf	Stem
Cassia spectabilis (Kibuye)	8.9	78.8	0.2	2.0	165	165	0
Cassia spectabilis (Embu)	7.6	71.5	0.2	1.7	234	234	0
Cassia spectabilis (Bugarama)	7.8	79.9	0.2	1.7	181	181	0
Cassia spectabilis (Machakos)	9.3	79.0	0.2	1.9	126	126	0
Sesbania sesban (ILCA)	47.5	272.2	0.5	3.2	1,024	171	853
Sesbania sesban (Mucururiati)	42.7	336.1	0.6	4.0	3,712	996	2,715
Sesbania sesban (Kakamega)	52.8	342.3	0.7	3.5	3,944	826	3,118
Calliandra calothyrsus (Guatemala)	29.6	208.6	0.5	3.3	2,131	1,020	1,111
Calliandra calothyrsus (Ruhande)	14.7	183.8	0.4	3.1	1,884	799	1,085
Calliandra calothyrsus (Kibuye)	15.0	164.5	0.4	2.6	1,471	588	833
Leucaena diversifolia (Murongwe)	26.3	179.2	0.4	2.7	935	320	614
LSD (0.05) CV (%)	5.1 38	28.1 26	0.1 28	0.5 30	1,487 48	422 40	1,450 71

4.3 Evaluation of *Leucaena diversifolia* and *Leucaena leucocephala* for alley cropping

4.3.1 Objectives

1. To select promising MPTS for alley cropping

2. To quantify biomass production potentials of MPTS under alley cropping management

3. To assess the effect of MPTS on companion crops

4.3.2 Materials and methods

The second experiment evaluated *Leucaena diversifolia* (4 provenances) and *Leucaena leucocephala* (3 provenances). *Cassia spectabilis* and *Calliandra calothyrsus* were included to allow comparisons with first experiment. With a pure crop (no hedge) plot serving as control, this experiment comprised a total of 10 treatments. Seed sources are shown in Table 4.2

Table 4.2 Provenances and sources of seed used in experiment

Species	Provenance	Source of seed
Leucaena diversifolia	Colombia	ILCA[1], Addis Ababa, Ethiopia
Leucaena diversifolia	Ruhande	ISAR[2], Ruhande, Rwanda
Leucaena diversifolia	Murongwe	ISABU[3], Murongwe, Burundi
Leucaena diversifolia	Kibwezi	KFSC[4], Muguga, Kenya
Leucaena leucocephala	Murongwe	ISABU, Murongwe, Burundi
Leucaena leucocephala	Kimberly	ILCA, Addis Ababa, Ethiopia
Leucaena leucocephala	Siaya	KFSC, Muguga, Kenya
Calliandra calothyrsus	Guatemala	KFSC, Muguga, Kenya
Cassia spectabilis	Embu	KFSC, Muguga, Kenya

1 International Livestock Centre for Africa
2 Institut des Sciences Agronomiques du Rwanda
3 Institut des Sciences Agronomiques du Burundi
4 Kenya Forestry Seed Centre

All other details including cultural practices and cropping are similar to experiment above. The two experiments were planted next to each other.

4.3.3 Results

Fifteen months after planting, survival was close to 100% in all treatments. In terms of height and diameter growth, the diversifolias out-performed the leucocephalas with the local variety (ex Murongwe) being the best (Table 4.3). The exception was *Leucaena diversifolia* (ex Kibwezi) which performed poorly. Calliandra was better than the best diversifolia. Cassia was intermediate between the diversifolias and leucocephalas. Relative difference in performance of the species was apparent as early as 2 months after transplanting.

Biomass yield of Calliandra was significantly higher than that of the diversifolias which in turn produced significantly higher biomass than the leucocephalas. Again the exception was *Leucaena diversifolia* (ex Kibwezi) whose biomass yield was not significantly different from the leucocephalas. Biomass yield of Cassia was not significantly different from the leucocephalas.

Table 4.3 Plant height, collar diameter and dry weights at 10 months after transplanting (MAT) of species evaluated

SPECIES (Provenances)	HEIGHT (cm)		BASAL DIAMETER (cm)		DRY WEIGHT (kg/ha)		
	2 MAT	10 MAT	2 MAT	10 MAT	Total	Leaf	Stem
Leucaena diversifolia (Colombia)	20.1	144.0	0.35	2.6	776	499	277
Leucaena diversifolia (Ruhande)	29.6	152.0	0.38	2.7	947	411	536
Leucaena diversifolia (Murongwe)	24.2	161.2	0.43	2.8	1,025	350	675
Leucaena diversifolia (Kibwezi)	15.8	33.5	0.35	1.3	18	0	18
Leucaena leucocephala (Murongwe)	12.1	27.1	0.25	1.3	60	0	60
Leucaena leucocephala (Kimberley)	13.0	50.41	0.36	1.8	269	179	60
Leucaena leucocephala (Siaya)	13.3	48.3	0.49	2.1	90	67	23
Cassia spectabilis (Embu)	8.5	80.1	0.23	1.8	173	0	173
Calliandra calothyrsus (Guatemala)	24.4	180.8	0.49	3.9	1,906	912	994
LSD (0.05) CV (%)	2.8 28	14.5 26	0.05 25	0.20 15	426 34	225 39	262 32

4.3.4 General discussion

Calliandra (ex Guatemala), Cassia (ex Embu) and *Leucaena diversifolia* (ex Murongwe) performed similary in both experiments making the experiments easily comparable. For all measured parameters, the species were in the order Sesbania > Calliandra and *Leucaena diversifolia* > Cassia > *Leucaena leucocephala.*

Growth of the Sesbanias was spectacular in the first year. Enthusiasm for Sesbania is tempered by its known inability to withstand regular cutting. With a low proportion of leaves, enough green matter as needed in alley cropping may not be produced. Also, the vigorous growth would be inimical to associated crops. However, the wood from Sesbania may serve as a barrier against erosion, if laid against the hedge, or as firewood. The ILCA provenance of Sesbania succumbed to nematode attack.

The Cassias were very slow growing and hitherto have generated very limited biomass to be incorporated into the soil. This slow growth may be an advantage as competition with crops may not be as high as would be found with Sesbania. All 4 provenance showed similar performance.

The leucocephalas were truly not appropriate for the site, even the Murongwe collection. They are quite stunted and whatever little growth they produced was lateral like creepers. The poor growth is due to a combination of high altitude (thuslow temperatures) and acid soil.

These preliminary results indicate that 1) Calliandra and *Leucaena diversifolia* have the best potential for the environment. An enlarged provenance trial of these 2 species is therefore needed; 2) for Sesbania to succeed, its cutting management requires further investigation; 3) Cassia has potential but its growth hitherto is quite slow; and, 4) *Leucaena leucocephala* is definetly not an appropriate species for the area.

4.4 Effect of varying levels of n applied through prunings of *Leucaena diversifolia* and/or fertilizer on the yield of crops in an alley cropping arrangement

4.4.1 Justification

Work in Nigeria and elswhere has shown that in alley cropping the prunings alone are usually not able to supply the needed nutrients for the associated crop. Additional nutrients are needed. Nitrogen is usually the most limiting nutrient and one that can be provided by N-fixing trees.

4.4.2 Objectives

The objectives of this trial are to study the effect of prunings alone or in combination with different levels of N-fertilizer on crop yield in alley cropping.

4.4.3 Materials and methods

Hedges were established in November 1988, next to the two experiments above. All details including land preparation, cultural practices and cropping are similar to the screening experiments above. The only exception was that spacing within hedgerow was 25 cm.

Seeds of *Leucaena diversifolia* were obtained from ISABU centre, Murongwe. Seeds were from same seed lot of this species used in the 2 experiments above.

4.4.3.1 Treatments

Treatments were full factorial combinations of 4 fertilizer levels - 0, 30, 60 and 90 kg N/ha and 2 cropping systems namely maize/bean intercrop, maize alone. These were grown in the alleys between hedges of Leucaena or in the conventional manner without hedges. A total of 16 treatments were thus obtained.

4.4.4 Results

Since hitherto no crops have been successfully cultivated as in experiments above, no results of crop performance can be provided.

One can only state that at first cutting done 10 months after establishment, when the fertilizer treatments had not been applied yet, an average of 1934 kg/ha of dry biomass was harvested. Of these, 30% was leaf. This yield was twice the yield obtained from this same Leucaena (ex Murongwe) in the two experiments above. Note that plant population in this experiment was twice those of the above.

5.0 PERFORMANCE OF POTENTIAL AGROFORESTRY TREE SPECIES IN THE HIGHLANDS OF BURUNDI

5.1 Justification

Agroforestry practices and systems are numerous and varied. The tree component for an agroforestry practice must have certain characteristics to provide the needed services or products of the system. Thus, for example, in the well-known practice of alley cropping, it is necessary that the woody component is fast growing and has good coppicing ability among others.

By examining the early growth habit, form and phenology of the tree or shrub, one could obtain an idea as to the system for which the tree may be used. In an on-going experimental programme many species are being screened based on early growth for their suitability with respect to different agroforestry practices.

Selection of tree species for screening was done based on the knowledge of their adaptation to the biophysical environment of the site. Sources of information included the ICRAF MPT database and published literature. Two experiments were conducted and both experiments were planted at Karuzi and Mashitsi.

5.2 Experiment 1a at Karuzi

5.2.1 Materials and methods

5.2.1.1 Land preparation

Land was hoed to remove the eragrostis pasture followed by a second hoeing to loosen the soil. Lime was applied at a rate of 2 tons/ha and incorporated by a third hoeing.

5.2.1.2 Treatments & experimental design

Species evaluated are shown in Table 5.1. Seeds of all species were obtained from the Kenya Forestry Seed Centre, Muguga, Kenya. Each plot was a row of 14 trees spaced 0.75 m. Two-metre bands were left on each side of the row of trees. A randomized complete block design was used and was replicated three times. Blocks ran across the slope.

5.2.1.3 Management of trees

Three-month old seedlings raised in polythene tubes were transplanted into field in November 1988, except *Cordia abyssinica* which was transplanted on 16 December, 1988.

Gapping was done in the first month of planting. The first planting of *Tipuana tipu* was destroyed by rabbits and was replanted in December 1989. By February, this second planting had also been cut. In March the cut stems started to resprout.

At regular intervals, height was measured by a graduated pole and basal diameter by calipers. In November 1989, a number of plants per plot was thinned to a spacing of 1.5 m within the row. Plants were cut at ground level. Four of the cut plants were used for dry matter yield analyses. Leaf and stem samples were dried at 105°C for 48 hours and weighed.

5.2.1.3 Management of crops

No crop was planted in the first season (November 1988). In March 1989, beans were planted at 40 cm x 20 cm. Due to excessive rains and resultant diseases, this bean crop failed. In October 1989, cuttings of cassava were planted but had to be uprooted 4 months later due to poor establishment.

5.3 Experiment 1b at Mashitsi

5.3.1 Materials and methods

5.3.1.1 Land preparation

The experiment site at Mashitsi was under a Eucalyptus woodlot (Area 2). Trees were felled and stumped. Land was then hoed to remove undergrowth. At a second hoeing, lime was applied and mixed in soil at a rate of 2 tons/ha.

5.3.1.2 Treatments and experimental design

Entries are listed in Table 5.2. *Croton megalocarpus* was not included for lack of seedlings. Three species were added viz *Erythrina sp.* (4 month-old seedlings), *Maesopsis eminii* (ex Kakamega) and *Grevillea robusta* (ex Murongwe). The last two were not in the Karuzi trial because seedlings were not ready for transplanting at that time. Seeds of *Erythrina sp.* were obtained from Pratap Seed Nursery, India, and *Maesopsis eminii* and *Grevillea robusta* from ISABU centre, Murongwe, Burundi. The rest were procured from the Kenya Forestry Seed Centre, Muguga, Kenya.

Plot layout and experimental design are as described above except that 3 m wide areas were left on each side of a row of trees. The trial was planted in March 1989.

5.3.1.3 Management of trees

Seedlings used were those left over after planting the Karuzi trial which were then about 6 months old. Gapping was done in the first month of planting. In February 1990, plants per plot were thinned to a spacing of 1.5 m within the row. Plants were cut at ground level. Four of the cut plants were used for dry matter yield analyses. Leaf and stem samples were dried at 105°C for 48 hours and weighed.

5.3.1.4 Management of crops

No crops was planted in the first season. In October 1989, cuttings of cassava were planted but had to removed because of a very low sprouting percentage.

5.3.2 Results

5.3.2.1 Experiment 1a

Two months after transplanting (MAT), heights of seedlings ranged from 12 cm in the Markhamias to about 22 cm in *Croton megalocarpus* (Table 5.1). A year after transplanting, Acrocarpus followed by Maesopsis had attained the greatest height due to high growth rates. Height growth of Erythrina was poorest but it with Cordia had the biggest diameter. Although Tipuana had twice been cut back to ground level by wildlife, it recovered and achieved high growth rates. Rapid height increment in Tipuana was not accompanied by a rapid diameter growth. Performance of the Markhamias were similar to each other.

High biomass yields were obtained from *Croton megalocarpus Acrocarpus fraxinifolius*, and *Maesopsis eminii* and the least from Tipuana (Table 5.1). Leaf production from *Erythrina abyssinica* was low but wood production was one of the highest. Biomass production was similar for the 3 provenances of Markhamia and were lowest except for Tipuana. *Croton megalocarpus* produced almost twice the biomass of *Croton macrostachyus*.

Table 5.1 Means and standard errors of plant heights, basal diameters and dry weights at 12 months after transplanting (MAT) of species evaluated

SPECIES (Provenances)	HEIGHT (cm)				BASAL DIAMETER (cm)				DRY WEIGHT (g/plant)					
	2 MAT		12 MAT		2 MAT		12 MAT		Total		Leaf		Stem	
Erythrina abyssinica (Nandi)	16.53	1.54	49.17	4.68	0.42	0.04	3.96	0.35	253.24	83.10	44.06	23.69	209.18	106.79
Acrocarpus fraxinifolius (Muringato)	14.60	0.81	134.33	6.97	0.25	0.01	3.28	0.17	396.48	59.46	175.71	28.02	220.77	32.31
Croton megalocarpus (Kikuyu)	21.77	1.24	96.15	3.48	0.40	0.02	3.09	0.23	404.08	41.33	185.75	30.65	218.32	13.34
Croton macrostachys (Kieni)	15.13	0.38	95.71	5.96	0.41	0.01	3.22	0.25	217.22	35.88	108.61	13.56	108.62	22.68
Maesopsis eminii (Murongwe)	15.27	0.61	128.29	5.22	0.26	0.01	3.15	0.17	366.68	38.54	149.68	17.96	217.01	21.53
Markhamia lutea (Kakamega)	12.27	0.35	87.57	4.48	0.34	0.01	2.48	0.12	178.88	35.48	113.97	24.80	64.91	10.90
Markhamia lutea (Osorongai)	12.47	0.35	94.29	5.22	0.33	0.10	2.19	0.01	158.19	20.87	98.85	16.74	59.34	5.35
Markhamia lutea (Kibuye)	12.37	0.44	78.30	4.21	0.36	0.09	2.35	0.01	137.92	19.96	93.94	13.20	43.98	7.08
Tipuana tipu (Nandi)	18.97	1.55	114.13	7.06	0.29	0.20	2.11	0.01	46.44	19.82	26.11	18.36	28.60	8.31
Cordia abyssinica (Meru)	17.63	0.94	101.84	3.85	0.40	0.22	4.01	0.02	290.80	29.61	112.69	12.04	178.11	17.66

5.3.2.2 Experiment 1b

One month MAT Tipuana and Maesopsis (ex Murongwe) were the top performers with heights twice that of Grevillea (Table 5.2). At 12 MAT, Grevillea was clearly superior. In second place were Maesopsis (ex Murongwe), Tipuana and Acrocarpus. At one month, height growth of *Erythrina abyssinica* was similar to Grevillea, but after 12 months, it had the lowest height. Performance of the 3 Markhamias was similar. The local Maesopsis (ex Murongwe) grew significantly better than the exotic (ex Kakamega). At 12 months, *Erythrina sp.* was doing better than *Erythrina abyssinica.*

Basal growth at 1 MAT was best in *Erythrina abyssinica* and, Cordia and Acrocarpus had the thinnest stem. At 12 MAT, diameter was largest in Grevillea and the two Maesospsis. Basal diameter of *Erythrina sp.* was significantly smaller than *Erythrina abyssinica.* Tipuana though among the tallest had the least basal diameter. Basal diameters of the two Maesopsis were similar at both measuring times and so were those of the Markhamias.

The tallest species, Grevillea, Acrocarpus and Maesopsis, produced the greatest biomass. Dry weight of Markhamia (ex Kakamega) was about twice that of Markhamia (ex Murongwe). As in plant height, the Maesopsis differ in dry weight per plant. *Erythrina abyssinica* produced slightly more biomass than *Erythrina sp.*

Table 5.2 Means and standard errors of plant heights, basal diameters and dry weights at 12 months after transplanting (MAT) of species evaluated

SPECIES (Provenance)	HEIGHT (cm)				BASAL DIAMETER (cm)				DRY WEIGHT (g/plant)					
	1 MAT		12 MAT		1 MAT		12 MAT		Total		Leaf		Stem	
Erythrina abyssinica (Nandi)	17.53	1.93	46.44	5.08	0.66	0.04	16.96	1.57	71.00	15.86	58.50	11.32	12.50	6.25
Erythrina sp. (India)	17.94	1.27	55.25	6.75	0.60	0.04	20.30	2.62	61.70	-	30.45	-	31.25	-
Acrocarpus fraxinifolius (Muringato)	22.11	1.21	146.43	9.82	0.26	0.01	25.96	1.43	425.95	146.30	273.70	88.55	152.25	57.75
Croton macrostachys (Kieni)	29.14	1.60	51.94	2.24	0.45	0.02	20.58	2.97	75.95	25.75	50.58	14.83	25.37	10.87
Maesopsis eminii (Murongwe)	40.08	1.38	147.76	5.94	0.39	0.02	32.77	1.61	438.70	34.76	175.46	17.46	263.25	20.30
Maesopsis eminii (Kakamega)	19.53	0.99	105.90	5.21	0.30	0.02	28.52	1.24	337.62	28.45	165.37	19.86	172.25	8.60
Markhamia lutea (Kakamega)	16.08	0.89	51.00	3.08	0.38	0.02	18.02	1.42	100.08	22.61	77.33	14.85	22.75	8.60
Markhamia lutea (Osorongai)	17.75	0.92	52.18	9.25	0.36	0.01	14.49	2.50	83.50	-	64.00	-	19.50	-
Markhamia lutea (Murongwe)	18.11	0.91	49.48	4.39	0.41	0.02	16.31	1.36	56.25	12.16	40.00	9.24	16.25	3.25
Tipuana tipu (Nairobi)	4.100	2.04	103.50	7.79	0.43	0.02	14.41	0.89	109.27	37.17	52.40	6.24	56.88	30.62
Cordia abyssinica (Meru)	27.00	1.28	57.95	4.34	0.65	0.02	24.12	2.67	56.73	15.74	36.89	10.27	19.83	5.67
Grevillea robusta (Murongwe)	21.28	0.95	195.43	7.50	0.36	0.02	37.94	1.60	874.55	87.07	494.55	60.97	380.00	43.87

5.4 Experiment 2a at Karuzi

5.4.1 Materials and methods

5.4.1.1 Experiment 2a

Species used are shown in Table 5.3. Land was prepared in November 1988, as in Experiment 1a above and planted with soybean. The experiment was planted in March 1989 in Karuzi after the soybean was harvested. No crops were interplanted the first season. A crop of cassava failed to properly established and was uprooted 4 months later.

In February 1990, plants per plot were thinned to a spacing of 1.5 m within the row. Plants were cut at ground level. Four of the cut plants were used for dry matter yield analyses. Leaf and stem samples were dried at 105°C for 48 hours and weighed.

Table 5.3 Entries in Experiment 2

Species	Provenance	Source of seed
Melia azaderach	Embu, Kenya	KFSC[1]
Maesopsis eminii	Wundanyi, Kenya	KFSC[1]
Casuarina cunnighamiana	Ruhande, Rwanda	ISAR[2]
Cupressus lusitanica	Murongwe, Burundi	ISABU[3]
Grevillea robusta	Murongwe, Burundi	ISABU
Grevillea robusta	Namanjalalo	KFSC
Alnus nepalensis	Nepal	
Melia azaderach	Embu, Kenya	KFSC[1]
Casuarina equisetifolia	Gede, Kenya	KFSC
Alnus acuminata	Guatemala	

1. Kenya Forestry Seed Centre, Muguga, Kenya.
2. Institut des Sciences Agronomiques du Rwanda.
3. Institut des Sciences Agronomiques du Burundi.

5.4.1.2 Experiment 2b

Species used are shown in Table 5.4. Species differences between this and Experiment 2a are explained by lack of seedlings in adequate numbers. The trial was planted in March 1989 at Mashitsi, next to Experiment 1b (Area 1) on land prepared as previously described. No crops were planted in the first season and the second season cassava crop failed.

As earlier experiments (Experiment 1), each plot was a row of 14 trees spaced 0.75 m apart with 3 meter wide areas on each side. A randomized complete block design was used and each experiment was replicated three times. Height was measured by a graduated pole and collar diameter by a calliper.

In February 1990, plants per plot were thinned to a spacing of 1.5 m within the row. Plants were cut at ground level. Four of the cut plants were used for dry matter yield analyses. Leaf and stem samples were dried at 105 °C for 48 hours and weighed.

5.4.2 Results

5.4.2.1 Experiment 2a

Except in Casuarina and Alnus, in which significant losses have occured due to termite attack, survivial is close to 100% in the rest. At one MAT, Cupressus and Casuarina showed the greatest and Melia the least height. This was maintained throughout the first year of growth (Table 5.4). Although Alnus had about the same height as Melia, at 1 MAT, by 12 MAT, the former was almost twice as tall. The exotic Grevillea (ex Namanjalalo) grew faster than the local (ex Murongwe). At 12 MAT, diameter growth was best in the Grevilleas followed by Cupressus and was least in Melia.

Generally, biomass production correlated with height growth. However, total biomass of Alnus was relatively low considering its height.

Table 5.4 Means and standard errors of plant heights, basal diameters and dry weights at 12 months after transplanting (MAT) of species evaluated

SPECIES (Provenances)	HEIGHT (cm)				BASAL DIAMETER (cm)				DRY WEIGHT (g/plant)					
	1 MAT		12 MAT		1 MAT		12 MAT		Total		Leaf		Stem	
Melia azaderach (Embu)	17.69	2.27	62.90	5.65	0.34	0.03	1.42	0.13	89.62	23.53	60.03	14.44	29.59	11.39
Maesopsis eminii (Wundanyi)	26.17	1.13	84.00	7.01	0.40	0.02	1.75	0.17	116.29	35.59	63.93	21.31	52.28	14.28
Casuarina cunnighamiana (Ruhande)	35.93	1.80	197.69	17.04	0.24	0.01	2.05	0.16	756.69	-	449.44	-	307.15	-
Cupressus lusitanica (Murongwe)	42.67	1.45	192.20	5.15	0.38	0.01	2.61	0.11	766.99	140.15	522.36	96.25	244.64	31.11
Grevillea robusta (Murongwe)	15.33	0.68	140.15	7.26	0.31	0.01	2.62	0.14	490.98	39.30	315.70	21.77	175.28	17.53
Grevillea robusta (Namanjalalo)	19.56	0.60	161.10	4.88	0.34	0.01	2.84	0.13	526.78	80.15	359.97	56.86	166.80	26.26
Alnus nepalensis (Nepal)	14.83	1.85	114.20	10.16	0.27	0.02	2.05	0.19	68.42	19.59	48.72	9.74	19.70	9.85

5.4.2.2 Experiment 2b

Survival was excellent. Where there have been mortalities, not more than 2 plants have died in a plot. A month after transplanting *Alnus acuminata* was the tallest but during the following 11 months, its growth rate was only half that of *Casuarina cunninghamiana*, which achieved the highest growth rate of about 18 cm per month (Table 5.5). As in the experiment above, Melia had the slowest growth. *Alnus acuminata* grew faster than *Alnus nepalensis*. Grevillea (ex Namanjalalo) was significantly taller than ex Murongwe. Height of *Casuarina cunnighamiana* is more than twice that of *Casuarina equisetifolia*.

In terms of diameter growth, the Grevilleas and *Alnus acuminata* are best. *Alnus nepalensis* is inferior to *Alnus acuminata*. Casuarina ranks fourth in terms of diameter growth.

Again, the taller the species the greater the biomass produced.

Table 5.5 Means and standard errors of plant heights, basal diameters and dry weights at 12 months after transplanting (MAT) of species evaluated

SPECIES (Provenances)	HEIGHT (cm)				BASAL DIAMETER (mm)				DRY WEIGHT (g/plant)					
	1 MAT		12 MAT		1 MAT		12 MAT		Total		Leaf		Stem	
Melia azaderach (Embu)	29.44	1.93	84.05	3.16	0.406	.019			89.42	25.67	50.75	15.11	38.67	11.86
Casuarina equisetifolia (Gede)	18.65	1.34	104.50	6.36	0.160	.010			214.33	22.42	157.17	15.35	57.17	8.19
Cupressus lusitanica (Murongwe)	37.12	2.37	191.19	8.10	0.360	.012			624.00	74.85	389.50	46.78	234.50	22.79
Grevillea robusta (Murongwe)	18.35	1.13	195.95	7.73	0.371	.021			662.83	37.68	366.73	28,77	296.00	6.25
Grevillea robusta (Namanjalalo)	28.31	1.25	207.14	6.15	0.451	.019			867.42	62.34	472.75	33.78	394.67	16.46
Alnus nepalensis (Nepal)	17.94	1.28	117.14	11.08	0.319	.019			97.67	7.84	113.97	24.80	73.35	32.57
Alnus acuminata (Guatemala)	49.28	2.87	157.62	7.09	0.506	.031			189.33	14.67	98.85	16.74	235.33	32.97
Casuarina cunnighamiana (Ruhande)	32.17	1.46	228.81	16.59	0.236	.014			530.17	42.18	334.50	48.52	195.67	16.36

5.5 General discussion

Relative performances of the species at the 2 sites were similar. At this stage, *Casuarina cunninghamiana, Cupressus lusitanica, Grevillea robusta* and *Acrocarpus fraxinifolius* are the outstanding species; they have shown good height and diameter growth. Tipuana has shown good height growth but stems are quite thin and weak, and have to be supported. Also, it has light canopy reflected in low biomass produced.

Growth of Maesopsis was surprisingly poor in Experiment 2a compared to its performance in the other experiments at the 2 sites. This may be the result of provenance difference. *Cordia abyssinica* is doing very well in Karuzi but not as well in Mashitsi.

Exhibiting slow height growth at both sites is *Erythrina abyssinica*. It grew quite fast in the nursery and during the rainy season (November-May) at Karuzi. It died back during the dry season (June-September) and recommenced growth at the onset of rains. However, it was not able to completely recover. At Mashitsi, *Erythrina abyssinica* was planted in March close to the onset of the dry season. It probably did not have much time to grow before the dry season.

Croton megalocarpus produced a total biomass quite significantly higher than *Croton macrostachyus. Croton megalocarpus* branches profusely and has dense foliage whereas *Croton macrostachys* has few branches and few large leaves.

Despite excellent growth, *Casuarina cunnighamiana* with *Alnus nepalensis* were quite susceptible to termite in Karuzi.

6.0 STAFF

Name	Position/background	Date joined
Ekow Akyeampong	Project leader/Agronomy	August 1988
Jean-Bosco Sabukwikopa	Researcher/Genie Rurale	January 1989
Jean-Marie Ndabemeye	Technician/Forestry	January 1989
Spès Kabwari	Technician/Forestry	September 1989
Daphrose Niyonizigiye	Secretary	March 1989
Stanislas Kaboneka	Driver	October 1988
François Ndikumana	Office assistant	November 1988

6.1 Staff participation in meetings/workshops

Meeting	Date	Venue	Staff member
COLLPRO Staff Meeting	September 1988	Nairobi Kenya	Ekow Akyeampong
First National AF Seminar	28 - 31 March 89	Bujumbura, Burundi	Ekow Akyeampong J-B Sabukwikopa
Eastern & Central Africa AFRENA Workshop	June 1989	Kampala, Uganda	Ekow Akyeampong J-B Sabukwikopa
COLLPRO Staff Meeting	October 1989	Nairobi, Kenya	Ekow Akyeampong
IDRC technicians course	November 1989	Nairobi, Kenya	J-M Ndabemeye
CIAT Kagera Region study tour	November 1989	Uganda, Rwanda Tanzania	Ekow Akyeampong
IBSRAM/ICRAF workshop	December 1989	Nairobi, Kenya	Ekow Akyeampong
SALWA training course	January 1990	Nairobi, Kenya	J-B Sabukwikopa