AFRICAN FEED RESOURCES NETWORK

(AFRNET)

3-P-90-0185 PHASE I

FINAL REPORT - VOLUME 2

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1. INTRODUCTION

In June 1994, a report of the African Feed Resources Network - IDRC Project 3-P-90-0185 covering major activities and achievements of the network from 1st April 1991 to 31st March 1994 - was submitted to ILCA and IDRC managements. The report was qualified as final as the 31st March 1994 was the project 1st phase official completion date. However, by that date thirty collaborative research projects were still being implemented in 15 sub-Saharan Africa countries following the renewal of their research grants for 1994-1995 cropping season (Annex 1). Due to the continuation of activities beyond 31st March 1994, IDRC approved the extension of the date for completion to 29th February 1996.

Among the projects being continued in 1995, was the Napier and Pennisetum hybrids multi-locational research project carried out since 1992/1993 at 10 sites in 9 sub-saharan Africa countries and aimed at evaluating the agronomic performance and nutritive value of nine napier and Pennisetum hybrids introduced from the SADCC/ICRISAT breeding program. With the generous support of the International Livestock Research Institute (ILRI), a workshop was organised in Addis Ababa, Ethiopia in December 1995 to discuss progress of this particular project and plan future activities. The major achievements of the workshop are highlighted in this report.

The monitoring of the projects by the coordination unit continued in 1994 and 1995 and the reports submitted provided solid scientific information. With the support of ILRI, the network was able to share some of that information with colleagues and partners through the AFRNET Newsletter which continued to be published in 1994 and 1995 on a quarterly basis.

This report is complementary to the June 1994 report highlighting scientific information gained from the collaborative research activities in 1994 and 1995.
2. HIGHLIGHTS OF AFRNET COLLABORATIVE RESEARCH, 1994-1995

2.1. Identification of promising forage species and their management

2.1.1. Napier and Pennisetum hybrids project

a. Results from the agronomic trials

A multilocational evaluation of napier and Pennisetum hybrids project was initiated in 1992/1993 to evaluate local and nine promising napier accessions and hybrids. (*Pennisetum purpureum* x *Pennisetum thyphoides*) introduced from the SADCC / ICRISAT breeding program.

The material introduced from ICRISAT included 5 napier accessions supplied by ILRI gene bank, ILRI nos 15743, 16786, 16791, 16797 and 16798 and the Pennisetum hybrids ILRI nos. 16834, 16835, 16837 and 16838. At each of the sites, the ICRISAT material was compared with the most promising locally grown varieties.

The evaluation was carried out at 10 sites in 9 sub-Saharan Africa countries namely: Bouaké (Côte d’Ivoire), Dschang (Cameroon), Holetta (Ethiopia), Kumasi (Ghana), Kakamega (Kenya), Kajansoa (Madagascar), Makurdi (Nigeria), Morogoro and Tanga (Tanzania) and Kabanyolo (Uganda). The sites covered a wide range of agro-climatic conditions in the sub-humid (Tanga, Kabanyolo, Morogoro, Bunda), humid (Bouake, Kumasi, Kajansoa) and highland (Kakamega, Holetta, Dschang) ecological zones. The altitudes covered by the sites range from 66 m a.s.l at Tanga to 2400 m at Holetta. Annual rainfall at the sites ranges from 900 mm at Morogoro to 1900 at Kakamega all in a bimodal pattern except at Bunda which rain is unimodal. Frosts are occurring at Bunda and Holetta at some nights during the dry season.

The first phase of the project aimed at the evaluation of the agronomic performance particularly in terms of dry matter yield while the second phase is planned to develop feeding packages for smallholder dairy farms using the most promising accessions/lines from the agronomic trials.

The methodology for the agronomic evaluation was standardised across sites. The accessions/hybrids were planted in a randomized complete block design at an inter-row spacing of 0.75 m and within row spacing of 0.40 m. Each accession was planted on lines 6m long and the harvesting was to be done on the middle 2m length when the plants had reached 1.5 m height or at the end of the first growing season. In subsequent rainy seasons, harvests were to be carried out in two sub-plots when plants were 1.0m and 1.5m tall. Fertiliser was to be applied at 40 kg of P and N ha⁻¹ at planting on all plots. Subsequent N dressings followed local recommendations and application of K was depending on soil type.
The data collected included rainfall, date of planting, days to flowering, plant height at intervals of 20 days, dry matter yield, crude protein, NDF content, leaf:stem ratio and number of tillers per plant at harvesting.

Results from the agronomic performance at Kakamega (A. Orodho), Morogoro (N. Urio), Tanga (S. Bitende), Bunda (G. Kanyama Phiri), Kumasi (A.K. Tuah), Holetta (S. Bediye) and Bouake (B. N'Guessan) are reported.

**i. Results from Kakamega**

At Kakamega, the evaluation included the 9 accessions and (3 hybrids from ICRISAT and 6 local napier accessions (e.g. Bana grass, Uganda hairless, French Cameroon, Bajra, Clone 13 and Ex-Matuga).

Planted in June 1993, five harvests were carried out: in November 1993 at the end of the first rainy season, in February 1994 at the peak of the dry season, in April 1994 when the long rains had set, in August 1994 at the end of the long rains and in October 1994 at the peak of the short rains. The harvests were done when the plants were 1 m tall, leaving a stubble height of about 5cm above ground.

Dry matter yield (in tons ha\(^{-1}\)) indicated differences (P< 0.05) at the different dates and there were significant interactions between the various napier accessions/hybrids and cutting dates. The April 1994 harvest (3rd) gave the highest yields while the February 1994 (2nd) showed the lowest yields, indicating that yields vary according to the rainfall pattern with the highest yields obtained during the long rainy season.

Based on the total accumulated dry matter yield from the five harvests, the local accession Clone 13 showed the highest dry matter yield with 27.5 t DM ha\(^{-1}\) followed closely by the acc. 16791 with 27.0 tons ha\(^{-1}\). The two accessions which did not show significant difference (P > 0.05) were followed in the decreasing order by the commercial variety French cameroon, Uganda hairless and hyb. 16837 with yields ranging between 23 and 25 tons ha\(^{-1}\) (P > 0.05). Their performance was however significantly higher than that of hyb. 16835, acc. 16798 and ex-Matuga which showed similar yields of around 22.5 t ha\(^{-1}\). The hybrids 16743 and 16840 showed overall dry matter yield around 11 tons of DM ha\(^{-1}\) (P < 0.05).

In terms of leaf : stem ratio, differences (P< 0.05) were observed between napier accessions/hybrids lines and cutting dates. The interaction between napier varieties and cutting dates were not significant. Acc. 15743 (Cv. Mott) had the highest leaf: stem mean ratio with 1.06 followed by the hybrids 16840 (0.87) and 16838 (0.63). The varieties with the lowest ratios were French Cameroon (0.34), 16835 (0.36) and 16791 (0.37). The acc. 16791 showed the highest growth rate and was tallest compared to all the other accessions/lines evaluated.
ii. Results from Morogoro.

A total of 17 accessions including the nine accessions / hybrid lines from ICRISAT, three sorghum accessions (Sorghum sudanense) ILRI nos. 17318, 17319 and 17320, two new Pennisetum hybrids ILRI nos. 17321 and 17322 and three local acc. named Kikundi (no.4), Kilakala (no.11) and Kihonda (no.14) were established in April 1994. The first harvest was carried out 12 weeks after planting (July 1994) and three additional harvests were carried out when plants had attained 1.5 m, in November 1994 and February and May 1995 respectively. Chemical analysis of the material included CP, in vitro DM digestibility, Ca and P.

The highest dry matter yields were observed in May 1995 with an overall mean of 13.4 t ha$^{-1}$, after vigorous regrowth during the long rains. Hyb. 16837 showed the highest dry matter yield with 28.7 tons DM ha$^{-1}$ followed in the decreasing order by acc. 16798, 4, 16786, 11 and 16791 with 26.0, 23.3, 21.3, 20.7 and 20.0 tons ha$^{-1}$ respectively. At that time, the regrowth has received more than 650 mm rainfall.

The lowest yields were observed at the second cut (overall mean of 2.2 t ha$^{-1}$; 131 mm rainfall) towards the end of the dry season, measuring therefore the dry matter productivity during the dry season; the highest yields observed during that particular season were 4.2, 3.6 and 3.3 tons ha$^{-1}$ obtained from acc. 16786, hyb. 16838 and acc. 16798 respectively. The acc. 16786 and 16798 were therefore among the top performers during both seasons.

Considering the productivity per year (a total of the four harvests), high yields around 40 t ha$^{-1}$ were observed from the accession 16798 and the hybrid 16837. The two were followed by the acc. no.4 (38.0 t ha$^{-1}$), 16786 (37.0 t ha$^{-1}$), 16791 (36.7 t ha$^{-1}$) and 11 (33.6 t ha$^{-1}$). Yields above 20 tons DM ha$^{-1}$ were also obtained from the acc. 14 (27.1 t ha$^{-1}$) as well as from sorghum accessions 17319 (23.3 t ha$^{-1}$), 17320 (22.6 t ha$^{-1}$) and the hybrid 16838 (22.0 t ha$^{-1}$).

The lowest yields were observed for hybrids 16834 (9.3 t ha$^{-1}$), 16840 (8.0 t ha$^{-1}$) as well as from the commercial variety 15743 (7.6 t ha$^{-1}$). The hybrids no.17321 and 17322 did not regenerate after the first harvest indicating that they are annual.

Despite its low productivity, the acc. 15743 showed the highest leaf:stem ratio (average: 2.5) and the highest protein content (average of 8.8 % DM). The highest yielding accessions nos. 16798, 16786, 11, 16837, 16791 and 4 showed average leaf:stem ratios above 1.0 and crude protein content between 6.0 and 8%. They seem to have good nutritive value compared to other grass species.

The hyb. 16835, 16838, 16838, and the sorghum acc. no.17318 and 17319 showed low leaf:stem ratios while their crude protein content was ranging between 6 and 8% DM. The sorghum acc. 17320 and the hyb. 17321 and 17322 showed very low leaf:stem ratios (below 0.5) and low crude protein content (below 6%) indicating that they are too stemmy.

Most of the accessions/hybrids contained between 0.23 and 0.33 % DM of Ca and 0.14 to 0.21 % DM of P which are within the expected limits for these minerals in tropical forages. These data do not however indicate superiority of any of the accessions in this respect.
iii. Results from Tanga.

The trial was established during the long rains of May 1994 involving the 9 accessions and Pennisetum hybrids as well as a local acc. TAI 124. The data were collected from May to November 1994 covering a wet period during which a rainfall of 887 mm. The driest months were June, August and October with respectively 47, 60 and 92 mm respectively indicating that there was no serious dry spell during the evaluation period. Plant heights were measured at 6 and 9 weeks of age and dry matter yield were recorded for the first time when the plants had reached 1.5 m, and thereafter when the regrowths had reached 1.0 and 1.5 m respectively.

Accessions reached 1.5 m height at different ages ranging from 9 weeks for the hyb. 16834, 16835 and 16838 to 12 weeks for TAI 124. The acc. 16786 and the hyb. 16837 were harvested at 10 weeks while the acc. 16791 and 16798 reached 1.5 m height after 11 weeks.

The first regrowth reached 1 m height from 4 weeks for the hybrid 16837 to 6 weeks for the hybs. 16834, 16835 and 16838 and for the napier accessions 16791 and 16798. The accession TAI 124 and 16786 reached 1 m after 5 weeks. The second regrowth reached the 1.5 m harvesting height after a period ranging from 5 weeks for the acc. 16837 and 8 weeks for the acc. 16798. All the other accessions/hybrids were harvested after 7 weeks.

The highest DM yields (overall average of 10.2 t. DM ha\(^{-1}\)) were recorded at the third cut when the regrowths were harvested at 1.5 m height. At that time, the highest yields were obtained from TAI 124 with 15.6 t. DM ha\(^{-1}\) followed by the hyb. 16838, the acc. 16791 and 16786 with respectively 12.1, 11.2 and 10.3 t. DM ha\(^{-1}\). The hyb. 16835 and the acc. 16798 showed good yields of respectively 9.7 and 9.6 t. DM ha\(^{-1}\) while the lowest yields were shown by the hybs. 16837 and 16834 with 6.9 and 5.9 t DM ha\(^{-1}\) respectively.

The lowest yields represented regrowths of 1 m height (average of 6.1 t. DM ha\(^{-1}\)) while the yields recorded when the plants had reached 1.5 m after planting were intermediate (average of 7.9 t. DM ha\(^{-1}\)) but with acc. TAI 124 and 16798 yielding up to 10 tons ha\(^{-1}\).

The annual yields (total of the 3 harvests) recorded were high as the local acc. TAI 124 yielded 34.8 tons followed by the napier acc. 16791, 16786, 16798 and the hybs. 16838 and 16835 yielding 28.5, 26.2, 25.6, 25.6 and 22.9 tons ha\(^{-1}\) respectively. The lowest annual yields were recorded from acc. 15743 with 8.4 tons. The hyb. 16837 and 16834 produced 16.3 and 12.8 ha\(^{-1}\) tons respectively.

iv. Results from Bunda.

The nine napier and Pennisetum hybrids and one local accession were evaluated at Bunda during 1993 unimodal rainfall season. The plant height was taken at 7 days intervals and the harvesting was done at the end of the growing season using a 15 cm stubble cutting height.

Hyb. 16838 gave the highest dry matter yield with 16.8 tons ha\(^{-1}\) but this was not significantly different from the accession or hybs. nos. 16835 16791, 16798, 16786, 16834 and 15743 which produced 14.3, 10.2, 9.7, 8.4, 7.9 and 7.3 tons ha\(^{-1}\) (P > 0.05)
respectively. The two hybs. 16838 and 16835 gave significantly higher dry matter yields than the hyb. 16837, the acc. 16840 and the control with 5.2, 6.2 and 5.6 tons ha\(^{-1}\) respectively.

A correlation matrix between plant height, stool circumference, number of live tillers per stool indicated a negative correlation between plant height and number of tillers per stool or stool circumference. There was a positive correlations (P< 0.01) between clone circumference and number of tillers per stool. The positive correlations between clone circumference, dry matter yield, dry matter yield and number of tillers per clone were not significant.

v. Results from Kumasi.

The nine napier and Pennisetum hybrids and one local accession were planted at the UST Dairy/ Beef Cattle station and at the Livestock Farm of the Department of Animal Science at Kumasi in December 1994, during the dry season. The plots were watered regularly until the beginning of the rainy season (March 1995). The harvesting was done in July 1995 (210 days after planting) at the Dairy/Beef Farm and after 110 days at the Livestock Farm.

Dry matter yield of the hyb. 16835 was 8.2 tons ha\(^{-1}\) and was significantly higher than the yields of all the other accessions or hybrids except the hyb. 16834 which ranked 2\(^{nd}\) with 8.1 tons ha\(^{-1}\). The yields of the acc. 16791 (1.9 t ha\(^{-1}\)) and 15743 (2.3 t ha\(^{-1}\)) were lower (P<0.05) than the yields of all other varieties except hyb. 16837. Yields ha\(^{-1}\) of accession or hybs. 16786, 16840, 16798, local, 16838 and 16837 were 5.8, 5.8, 5.7, 5.3, 4.1 and 3.7 respectively (P > 0.05).

At the Livestock Farm, hyb. 16840 gave the highest dry matter yield with 16.0 tons ha\(^{-1}\) which was similar to the one of hyb. 16835, acc. 16786, hyb. 16838, Local and acc. 16798 with 13.7, 12.8, 11.8, 11.4 and 10.4 tons ha\(^{-1}\) respectively (P>0.05).

The yields of 16840, 16835, 16838, Local, 16798 and 16834 (9.1 t ha\(^{-1}\)) were not different (P>0.05) but they were greater (P<0.05) than the yield of 15743 (4.5 t ha\(^{-1}\)).

The yields of 16840, 16835, 16786, 16838 and Local were greater (P< 0.05) than the yields of 16834, 16791(7.9 t ha\(^{-1}\)), 16837 (7.1 t ha\(^{-1}\)) and 15743. The yields of 16798, 16834 and 16791 were greater (P < 0.05) than the yield of 15743. The yield of 16837 and 15743 were not different (P> 0.05) and similar to the yields of 16798, 16834, 16791 and 16837 (P> 0.05).

vi. Results from Holetta.

Eight accessions and hybrids and two local napier accessions including acc. no. 14984 and LH were established at 2400 m altitude during the rainy season in June 1994. The data recorded include the dry matter yield after two cuts carried out respectively in October (12 weeks after planting) and December 1994 (8 weeks regrowth) as well as frost tolerance scoring as temperature below zero was recorded for 20 days between October and December 1994. Chemical composition (CP, NDF) and \textit{in vitro} dry matter digestibility was analysed.
At the first harvest, the mean plant height was 94 cm with the hyb. 16835 showing peak height (131 cm). The dry matter yields varied from 0.73 to 2.23 tons ha\(^{-1}\) with a mean of 1.49 tons ha\(^{-1}\). The four accessions or hybrids that had the highest yields in descending order were 16835, 14984, 16786 and 16838.

At the second cut which was done after frost occurrence, the mean plant height was 103 cm with the hyb. 16834 showing highest plant height (128 cm). The dry matter yield varied from 1.1 for acc. 15743 to 7.2 tons ha\(^{-1}\) for acc. 14984, which was followed by accessions or hybs. 16835, 16791, 16834 and 16838 with yields of 6.8, 6.7, 6.1 and 5.5 tons DM ha\(^{-1}\) respectively.

The overall yields recorded from the two harvests indicate that the locally selected acc. 14984 gave the highest yield with 9.2 tons ha\(^{-1}\) followed by the accession or hybs. 16835, 16791, 16834 and 16838 with yields of 9.1, 8.1, 7.6 and 7.1 tons ha\(^{-1}\) respectively. The lowest yield was obtained from the LH, the hyb. 16837 and the acc. 15743 with 4.2, 3.0 and 1.8 tons ha\(^{-1}\) respectively.

Frost tolerance was recorded on a 0 - 10 scoring scale indicating increasing tolerance. The hybs. 16837 and 16834 and acc. 14984 showed the top tolerance with scores above 8, while the hybs. 16835 and 16838 and the acc. 16786 scores below 5. The rest of the accessions or hybrids having intermediate tolerance.

Preliminary evaluation of the crude protein content, the IVOMD and the NDF content suggested that the acc. 15743, 16786 and 14984 and the hybs. 16835, 16837 and 16834 showed the highest nutritive value.

\textit{vii. Results from Bouake.}

The material evaluated at Bouake included the hyb. 16834, 16835, 16837, the napier acc. 16786, 16791 and 16798 as well as 4 local accessions named L1, L2, L3, L4. The trial was established with a 80 x 40 cm spacing. Data were collected for 2 years, with the 2\textsuperscript{nd} year evaluation carried out after a standardization cut. The data collected during the first year included a morphological description of the evaluated material and one dry matter harvest after the material had reached 1m height. During the second year, the data collected included the dry matter yield of 3, 6, 9 and 12 week old regrowths during the rainy season.

Acc. 16786 gave the highest dry matter yield with 14.3 tons ha\(^{-1}\) which was higher (P < 0.05) than the yield obtained from the next best accessions L1, L3, and 16798 which showed a similar yields of 10.8, 9.5 and 9 tons ha\(^{-1}\) respectively (P > 0.05).

The lowest yields were observed from the hybs. 16835, 16837 and 16834 with 3.8, 3.7 and 1.3 tons ha\(^{-1}\) respectively. Their yield was not different (P > 0.05). The yields observed from the other acc. L4, L2 and 16791 was respectively 6.6, 5.2 and 5.0 t ha\(^{-1}\) and were not different.

The leaf:stem ratios observed during the first year are very high, ranging from 1.2 in acc.16835 to 4.7 in 16837. The accessions 16786, L1 and 16798 with high dry matter yield showed respective leaf:stem ratio of 3.4, 3.3 and 2.6 indicating that they are very promising as animal feeds in the Bouake area.
The growth rates observed up to 60 days after planting in the first year were low due to unusually low rainfall. Peak plant heights were observed in hyb. 16834 (121 cm) and acc. L2 (120 cm).

In the second year, the accessions L1, L2, 19791 and the hyb. 16835 showed optimum dry matter productivity when regrowths were 9 weeks old while the accessions L3, L4, 16786 and 16798 and the hyb. 16837 show the optimum productivity at 12 weeks. The hyb. 16834 showed optimum yield at 6 weeks.

The highest yield observed from regrowths of 9 or 12 weeks was from L4 with a dry matter yield of 27 tons ha⁻¹ after 12 week regrowth, which was highest (P< 0.05). L4 was followed in the decreasing order the accessions 16798, 16791, L1, L3 and the hyb. 16837 but then; yields were similar (P> 0.05) with 14.5 (12 w.), 14.3 (9w), 14.3 (9w), 12.1 (12 w) and 11.1 (12w) tons ha⁻¹ respectively.

The lowest yields were observed in 16786, L2, 16834 and 16835 with 8.5 (12w), 8.4 (12w), 7.1 (6w) and 6.2 (9w) tons ha⁻¹ respectively (P > 0.05).

Compared to first year results, the cutting regime of the second year improved the overall productivity with increments ranging from 125% (L3) to 508% (16834). Acc. 16786 behaved differently as its yield decreased by 50%.

Leaf:stem ratios in the second year were highest at 6 weeks for most of the accession and hybrids ranging between 1.7 for 16835 and 8.6 for 16798. Ratios decreased significantly to 0.9 for 16835 and 2.3 for 16786 at 9 weeks and to 0.8 for L1 and 1.5 for 16798 at 12 weeks regrowths. At 12 weeks, leaves and stems reached unity in most of the material.

viii. Results from Kabanyolo.

During 1992/93 cropping season at Kabanyolo of the nine napier accessions and Pennisetum hybrids were evaluated for dry matter productivity and acc. 16798, 16786, 16791 and the hyb. 16837 were the most promising. The three accessions and the hybrids were planted in May 1993 for further evaluation to be compared with local KW4.

The plants were cut back in September 1993 and the dry matter yield was recorded in three cuts, the first when the regrowths were 3 months old and had reached over 2m height on average. The second and third harvests were done when regrowths reached 0.5 m in April 1994 and 1.5 m in August 1994.

Highest yields were obtained in the first cut as the mean yield for the 5 accessions or hybrid was 32.6 tons DM ha⁻¹ against 19.8 and 15.2 tons ha⁻¹ for the 3rd and 2nd cuts respectively. The overall performance per year (total of the 3 cuts) ranged from 55.4 tons DM ha⁻¹ for the hyb. 16837 to 72.4 tons DM ha⁻¹ for KW4. The local accession was followed in the decreasing order by 16786, 16798, 16791 and 16837 with 71.4, 70.4, 65.8 and 55.4 tons DM ha⁻¹ respectively. These high yields were due to the high rainfall at Kabanyolo, a site very close to the Equator.
b. Identification of the accessions or hybrids for the feeding trials.

In order to identify the most promising accessions or hybrids to be further evaluated for nutritive value through chemical composition and animal feeding experiments, table listing the frequency of occurrence of each of the accessions or hybrids in the top three performers from the 8 sites (Bouake, Morogoro, Kakamega, Tanga, Bunda, Kumasi, Holetta, Kabanyolo) in respect of dry matter yield, the leaf:stem ratio, the tillers count and the plant height was established. (Table 1). It shows that accessions 16798, 16791, 16786 and the hyb. 16835 were among the three highest yielders at a majority of the sites with the acc. 16798 being the best. Thus, those materials are promising in most of the agro-ecological environments where they have been evaluated.

Table 1. Frequency of occurrence for dry matter, leaf:stem ratio, plant height and tillers.

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<th>Acc. no.</th>
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They were therefore selected for inclusion in the nutritive value planned evaluation and feeding experiment as a follow up; it was decided that each of them will be evaluated at least at four sites using a standardized methodology.

The sites will be Bouake, Morogoro, Marondera, Kakamega, Tanga, Bunda, Kumasi, Holetta and Kabanyolo. Scientists at each site are requested to evaluate 4 accessions and hybrids. Table 2 lists the selected accessions or hybrids to be included in the evaluation at each of the sites as agreed by participants to a workshop held in Addis Ababa in December 1995.

Table 2: Selected accessions/hybrids for animal feeding experiments per site.

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c. Methodology for feeding trials.

After the participants to the Addis Ababa workshop agreed on the accessions and hybrids to be involved in the research for development of feeding packages for smallholder dairy farmers, the methodology previously recommended for the experimentation was updated.

Discussing the issue of the supplementation recommended in the original protocol, it was stressed that the first step of the evaluation should be to compare the nutritive value of the selected accessions through digestibility studies before the start of the feeding trials to establish for each of them the appropriate level of supplementation required to develop cost effective feeding packages.

It was therefore recommended that the feeding trials be carried out in two separate phases with a first phase aimed at the assessment of the nutritive value of each of the material selected for each site in terms of degradability, intake and the digestibility studies before the start of the second phase which is aimed at the development of feeding packages for lactating cows.

i. Nutritive value experiments.

The data to be collected will be as follows:

- Agronomic performance of the accession/hybrid (yield; leaf:stem ratio etc..). Depending on the environment, the material will be harvested 6 to 8 weeks after. The scientist should follow closely the growth pattern and judge the optimum age for harvest optimising both dry matter productivity and nutritive value. The height and leaf:stem ratio at harvesting should be indicated and a chemical analysis: (CP, NDF, DM and Ash) done.

- Intake using six to ten sheep following a fixed protocol:
  - adaptation period : 14 days
  - measurement period : 7 days
  - level of offer : ad libitum (20% excess with frequent adjustments)
  - feeding material chopped at 5 cm length
  - intake data to be converted to metabolic body weight.
- *In vivo*/*In vitro* OM digestibility; *in vitro* gas production.

- Rumen degradability: OM and N.

Report on the nutritive value assessment with be sent to the co-ordinator for compilation of the results across sites.

**ii. Methodology for the feeding packages development**

Experiments on feeding packages will be implemented in collaboration with scientists of the Cattle Research Network (CARNET). The objective is to determine for each site the effect of feeding the four recommended napier accessions and Pennisetum hybrids either as silage or fresh fodder on cattle milk yield and composition.

The experiments will be carried out as follows:

- **Experimental design.**

  Randomized Complete Block Design with four treatments (4 accessions or hybrids) in five replications (i.e. 5 cows/treatment).

- **Treatments.**

  **Trial 1: Feeding with fresh fodder in the wet season.**

  The treatments will be as follows:

  A = Acc./hybr. no.1 + Dairy concentrate
  B = Acc./hybr. no.2 + Dairy concentrate
  C = Acc./hybr. no.3 + Dairy concentrate
  D = Acc./hybr. no.4 + Dairy concentrate

  **Trial 2: Feeding with silage in the dry season.**

  The treatments will be as follows:

  A = Acc./hybr. no.1 + Dairy concentrate
  B = Acc./hybr. no.2 + Dairy concentrate
  C = Acc./hybr. no.3 + Dairy concentrate
  D = Acc./hybr. no.4 + Dairy concentrate

  In both trials, salt licks will be provided to all cows *ad libitum.*

- **Feeding**

  The feeding period for each experiment is 120 to 150 days.
- **Concentrates.**

The dairy concentrate will be compounded from a **bran** (e.g. maize bran) and **oil seed cake** (e.g. cotton seed cake). The crude protein content of the concentrate should be 16%. Use the Pearson’s Square to estimate mixture of components.

Example: Wheat bran (14% CP), Cotton seed cake (36% CP). For a mixture of 16% CP, the wheat bran should constitute 36 - 16 = 20 parts, while the cotton seed cake should constitute 16 - 14 = 2 parts. Total : 22 parts. Therefore, the proportion of wheat bran in the mixture should be: \( \frac{20}{22} \times 100 = 90.9\% \) while the proportion of cotton seed cake in the mixture should be : \( \frac{2}{22} \times 100 = 9.1\% \)

One kg of concentrate should be fed per every 2 litres of milk produced. Thus, if a cow is producing 8 litres of milk, then it should be fed 4 kg of concentrate. From the example above, the cow will receive \( 0.909 \times 4 = 3.64 \) kg of wheat bran and \( 0.09 \times 4 = 0.36 \) kg of cotton seed cake.

The concentrate should be fed at the time of milking. This implies that if two milkings per day are practised, concentrate should be fed twice dairy.

- **The fodder.**

Freshly cut fodder should be chopped into pieces of 5 cm before feeding. The fodder will be harvested when 6 to 8 weeks old during the rainy season. For practical purpose, divide the plot for each accession/hybrid into 42 subplots, if the harvesting is to be done on 6 weeks regrowths. After a standardization cut of one at the time for 42 subsequent days, each subplot will be harvested to feed the dairy animals in the treatment at the right maturity of 42 days following the appropriate rotation system until the entire plot is harvested and harvesting can again begin in the same order. The same system can be applied if the 8 weeks maturity interval applies. In that case, the plot will be divided into 56 subplots. Each day, the animal should be fed *ad libitum.*

- **The silage.**

The material for silage should be harvested at the same stage of maturity as the fresh fodder. Ensile the herbage without additives. However, if the moisture content is too high, the fresh forage can be wilted before making silage. The feeding of silage to lactating animals should be *ad libitum.*

- **Animals.**

- State the breed that is used
- For each experimental cow, start data collection on milk yield at the beginning of the lactation.
- Distribute animals to treatment making sure that the effect of lactation number is evened out.
- Report incidence of disease especially mastitis.
- Provide water to animals *ad libitum.*
- **Milking**

Practice total milking. Calves should be fed by hand.

- **Parameters to be measured.**

- Intake of fodder and silage where it applies.
- Milk yield
- Chemical composition of fodder and silage: DM; OM; CP; *In vivo* digestibility; degradability of DM, OM and N. For the silage, state how dry matter was determined i.e. toluene distillation or oven drying and determine the following parameters as much as possible: pH, lactobacilli, total volatile fatty acids, ammonia nitrogen, colour, smell, feel (whether slimy or not).
- Composition of milk: Protein; solids; solids-not-fat; fat.
- Economic data: labour input; market price of milk; price of manure; value of calf.

**2.1.2. Evaluation of *Gliricidia sepium* (jacq.) walp. as a fodder tree/shrub for ruminant production in Uganda**

The evaluation of *Gliricidia sepium* (Jacq.). Walp. as a fodder tree/shrub legume for ruminant production was assessed in four experiments whose main objectives were: to determine the effects of age and various pruning regimes on the productivity and nutritive value; to assess its compatibility of intercropping with elephant grass and its hybrids and to assess the effect of the legume supplementation on feed intake and digestibility by sheep. The experiments were conducted at Makerere University Agricultural Research Institute Kabanyolo (MUARIK) starting from April 1992 using Gliricidia seed (ILG 50) which was obtained from ILCA, Addis Ababa, Ethiopia.

Dry matter yield and chemical composition of Gliricidia with advancing stages of maturity were studied in Experiment I. Total biomass and leaf DM yield increased with advancing stages of maturity. Advancing maturity reduced CP and Ash but increased NDF in leaves. *In vitro* DMD tended to increase with advancing stages of maturity up to 10 months from planting and then decreased significantly (P<0.05) up to 12 months of age. Regression analysis indicated that IVDMD of Gliricidia decreased in a curvilinearly with age of the plants. Based on the results of total DM yield and the *in vitro* DMD obtained in this study, it was recommended that in the Lake crescent area of Uganda, Gliricidia could be harvested for fodder at 10 months of age from time of planting.

The effect of cutting interval (CI) and cutting height (CH) on DM yield was studied in Experiment II. The results showed that an increase in CI and higher CH significantly (P<0.001) increased DM production. Biomass DM yield during the dry season was lower than during the rainy season, especially on the more frequently cut plants due to reduced growth vigour of the plants. Increase in CI and decrease in CH reduced CP content while it increased Ash and NDF content of the edible material. However, increasing CH had no significant (P>0.05) effect on the ash content. Increasing CI and
CH significantly increased IVDMD. From the results, a 12-week CI and 100 cm CH was recommended for this tree/shrub legume for ruminant fodder production.

In experiment III, the compatibility of *Gliricidia sepium* as an intercrop with elephant grass and its hybrids (*Pennisetum purpureum* x *P. typhoides; KW₄, P₉₉, P₈₁ and the local) was tested. Grass and Gliricidia DM production was significantly (P<0.05) lower in the mixtures than in the combined grass and tree monoculture treatments. Within the mixtures, there was no significant difference in the DM yield of Gliricidia intercropped with KW₄, P₈₁ and the local but was significantly (P<0.05) lower in the P₉₉ intercrop. Generally, the total edible dry matter productivity in the tree/grass mixture was higher than in the grass and tree monoculture. The leaf CP content of Gliricidia was not significantly affected in the mixtures of KW₄, P₈₁ and the local but was significantly reduced in the Gliricidia/P₉₉ mixture. However the CP yield in the control was significantly higher than in the mixtures. The results indicated that *Gliricidia* can be intercropped with elephant grass for increased DM yield and nutritive value. The recommended hybrids for intercropping with Gliricidia were P₉₉ and KW₄.

2.1.3. Effect of cutting intervals on performance and chemical composition of *Arachis glabrata* benth a Dschang, Cameroon

The yield and chemical composition of *Arachis glabrata* Benth were studied at intervals of cutting of 30, 45, 60, 75 and 90 days at Dschang.

The dry matter yield increased up to 3 804 kg/ha at 60 days cutting intervals and declined at 75 and 90 days. Dry matter content was slightly higher and increased with cutting intervals from 26% at 30 days to 32% at 90 days. The organic matter content was relatively high and the maxima of both 90% were obtained at 45 and 75 days of cutting intervals in both leave and in stems; but were not significantly superior (P>0.05) to those at 60 days of cutting interval. The crude protein content declined with the maturity of the legume from 19.4% to 17.1%. The low level of NDF in leaves compared to the NDF content in stems is an indication that the leaves can be used as an appropriate ingredient of feeding packages of monogastric animals.

The optimum interval of cutting ensuring optimum nutritive value of *A. glabrata* as a livestock feed was estimated to be 45 days.

2.1.4. Performance of forage germplasm in the *Borassus aethiopum* savannah at Toumodi, Côte d'Ivoire

Twenty two accessions/varieties of tropical forage species (7 grasses, 7 herbaceous legumes and 6 fodder trees) were evaluated for their performance during the establishment and production phases in 1992 and 1993 in the rainy and dry seasons.

Among the six fodder tree species only four were evaluated for their establishment while three for dry matter productivity. The experiment was carried out in a *Borassus aethiopum* savannah at Toumodi, Côte d'Ivoire.
Results from the experiment indicate that DM of the grass species yield was significantly lower in the second rainy season compared to the first rainy season particularly for those species that performed best during the first year. It appears that *Andropogan gayanus* cv. hairless and *Brachiaria brizantha* CIAT 26646 showed the highest dry matter yields.

Yields of Herbaceous legume species dry matter decreased also in the second year rainy season but to a lesser extent grasses. *Stylosanthes guianensis* L348, L359 and IRI 1022 showed the highest yields, outyielding the control *S. guianensis* CIAT 184. In general, the *Stylosanthes* outyielded the other species.

The local fodder trees showed low growth rates compared to exotic species indicating that their introduction and sustained utilisation into farming systems might not be easy. The exotic species also also showed low dry matter yields.

### 2.1.5. Performance of forage germplasm at Moso, Burundi

At the Burundi Agricultural Research Institute (ISABU), an evaluation of 7 forage grasses, 14 herbaceous legumes and 4 fodder trees species introduced from CIAT was carried out at Moso to assess their adaptability to the environment. The dry matter production was assessed during the rainy season on regrowths of 3, 6, 9 and 12 weeks old and after a cutting frequency regime of 3, 6, 9 and 12 weeks during the rainy season.

The trial was carried out over two years and from the observations, it appears that during the rainy season, the dry matter yields increase with the increasing regrowth age for all materials.


Dry matter yield produced from regrowths indicate that with 12 weeks old regrowth, *B. doctyoneura* outyielded the six other accessions with 13.1 tons DM ha\(^{-1}\) followed in the decreasing order by *A. gayanus* CIAT 621, *B. decumbens* CIAT 606 and, *B. brizantha* CIAT 26646 producing 10.2, 8.7 and 8.3 t DM ha\(^{-1}\) respectively. *P. maximum* CIAT 673 showed the lowest yield with 4.9 t ha\(^{-1}\).

Among the herbaceous legumes, *Centrosema macrocarpum* CIAT 5713 was the best performer with 7.3 t DM ha\(^{-1}\) followed in the decreasing order by *Aeschynomene histrrix* CIAT 9690, *C. macrocarpum* CIAT 5452, *C. acutifolium* CIAT 5568 and *Stylosanthes guianensis* CIAT 184 with 6.6, 5.5, 4.9 and 4.7 tons DM ha\(^{-1}\) respectively. The lowest yields were observed from *C. acutifolium* CIAT 5277, *Stylosanthes sympodium* CIAT 1044 or *S. capitata* CIAT 10280 with respectively 2.1, 2.2 and 2.6 t DM ha\(^{-1}\).

With 3, 6, 9 and 12 weeks cutting frequencies achieved from January to June 1994 (rainy season), the highest yields were achieved with a 12 weeks cutting frequency. With this regime, *A. gayanus* CIAT 621 showed the highest yield of 16.7 t DM ha\(^{-1}\).
followed by *B. dictyoneura* CIAT 6133, *B. brizantha* CIAT 26646 and *B. decumbens* CIAT 606 with respectively 16.2, 13.6 and 13.0 t DM ha\(^{-1}\). The lowest shown by yield was shown by *B. brizantha* CIAT 6780 with 6.6 t DM ha\(^{-1}\) but produced 7.5 t DM ha\(^{-1}\) with the 3 weeks cutting frequency.

With the 6 weeks cutting frequency, *A. gayanus*, and *B. brizantha* CIAT 26646 produced respectively 11.7 and 9.7 t DM ha\(^{-1}\) indicating, the 6 weeks cutting frequency management can be recommended to balance high dry matter yield, with high quality forage. Among the herbaceous legumes, the highest yields occurred in a 12 weeks cutting frequency regime and *C. macrocarpum* CIAT 5713 yielded best with 11.7 t DM ha\(^{-1}\) followed in the decreasing order by *C. macrocarpum* CIAT 5452, *C. acutifolium* CIAT 5568, *Stylosanthes guianensis* CIAT 10136 and *S. guianensis* CIAT 184 with 9.1, 7.5, 7.3 and 7.2 t DM ha\(^{-1}\) respectively. The lowest yields were from *S. sympodialis*, *S. capitata* CIAT 10280 and *S. macrocephala* CIAT 1281 with 3.2, 3.5 and 3.9 t DM ha\(^{-1}\) respectively.

With the 6 weeks cutting frequency regime, *S. guianensis* CIAT 184, *C. macrocarpum* CIAT 5452 and *C. macrocapum* CIAT 5713 produced 5.6, 5.5 and 5.2 t DM ha\(^{-1}\). The fodder trees shrubs species evaluated were *Cratylia argentea* CIAT 18516, *Codariocalyx gyroides* CIAT 3001, *Desmodium velutinum* CIAT 33158 and *Flemingia macrophylla* CIAT 17403. They were harvested one year after a standardisation cut. The dry matter yields observed indicated that *C. argentea* is the most productive with 4.0 t DM ha\(^{-1}\) followed in the decreasing order by *C. gyroides*, *F. macrophylla* and *D. velutinum* with 1.3, 1.1 and 0.6 t DM ha\(^{-1}\) respectively.

**2.1.6. On farm evaluation of forage germplasm in Coastal Benin**

The herbaceous forage legume *Stylosanthes hamata*, the fodder shrubs *Flemingia macrophylla*, and *Glicidia sepium* and the fodder grasses *Panicum maximum* T58 and *Brachiaria humidicola* CIAT 6379 were evaluated for their dry matter productivity during the rainy and dry seasons in 1994 at 3 villages of coastal Benin (Houton, Dadohou and Kpola). After a standardisation cut on 3, 6, 9 and 12 weeks regrowths were harvested during the rainy season, and on 6 and 12 weeks regrowth during the dry season.

Dry matter yield of the two species increased with the regrowth age during the rainy as well as in the dry season. In both seasons, *Panicum maximum* outyielded *Brachiaria humidicola* at all three sites. At Kpola *P. maximum* yielded 9.7 tons ha\(^{-1}\) on 9 weeks old regrowth against 4.6 t ha\(^{-1}\) for *B. humidicola* in rainy season and 2.7 tons ha\(^{-1}\) against 1.3 tons ha\(^{-1}\) during the dry season.

The performance of herbaceous and shrub species during the rainy season was also increasing with the regrowth age between 3 and 9 months. The highest yields were again observed at Kpola from *Flemingia macrophylla* with 6.7 tons ha\(^{-1}\) against 2.6 and 1.1 tons ha\(^{-1}\) for *Glicidia sepium* and *Stylosanthes hamata* respectively during the rainy season. In the dry season, *Flemingia macrophylla* was still the best with 0.6 t ha\(^{-1}\) on 12 weeks old regrowth.
2.1.7. Evaluation and management of forage germplasm at Gezira, Wad Medani, Sudan

At Wad Medani, Sudan, *Lablab purpureus*, *Clitoria ternatea* and *Vigna trilobata* were evaluated in 1994 for their dry matter productivity during the rainy season. When cut once after 18 weeks *V. trilobata* was the most promising species with 8.6 tons dry matter ha\(^{-1}\) against 5.6 and 5.7 tons for *Lablab purpureus* and *Clitoria ternatea* respectively. The crude protein content was respectively 22.9, 23.5 and 23.8% for *C. ternatea*, *V. trilobata* and *L. purpureus* respectively in plants cut at 6 weeks apart. Plants cut at 8 weeks age regrowth still had a high crude protein of 20.2, 20.5 and 20.6 for the three species respectively.

At the same site, *L. purpureum*, *C. ternatea* and *V. trilobata* and three cultivars of *Sorghum bicolor* (Sabeen, Hamam and Pioneer 877F) were sown in the dry season and were submitted to irrigation at 2, 3 and 4 weeks intervals. Dry matter yields indicated highly significant differences between the genotypes as well as between the irrigation intervals and there were significant interactions between genotypes and irrigation intervals. At all the irrigation intervals the yields of Sabeen and Pioneer 877E were comparably higher than that of the three legumes. Within the legume group, both *Lablab purpureus* and *Vigna trilobata* outyielded *Clitoria ternatea*.

Irrigation on weekly basis outyielded the other intervals with a mean yield from all the genotypes of 8.1 tons DM ha\(^{-1}\) against 4.5, 3.6 and 3.1 tons for 2, 3 and 4 weekly interval respectively. When the crops were irrigated weekly, Hamam showed the highest dry matter yield (12.5 t ha\(^{-1}\)) followed by Pioneer (9.1 t ha\(^{-1}\)). No significant differences were however observed among the other genotypes from which yields ranged between 6.1 for Clitoria to 7.1 t ha\(^{-1}\) for Sabeen. When irrigated every two weeks, Pioneer 877, Hamam and *V. trilobata* outyielded the other genotypes with respectively 6.1, 6.0 and 4.9 tha\(^{-1}\). When irrigated every 3 weeks, the three grass varieties and *V. trilobata* outyielded both *L. purpureus* and Clitoria. At four weeks irrigation intervals, Abu Sabeen and Hamam outyielded all the other genotypes with respectively 5.1 and 3.7 t ha\(^{-1}\). Unlike the other genotypes the dry matter yield of *V. trilobata* irrigated every two weeks was not significantly different from that of weekly irrigation.

Assessing the effect of variety and cutting frequency (2, 4, 6 and 8 weeks intervals) on the dry matter yield two varieties of Alfalfa, dry matter yields showed no significant differences between the two varieties but highly significant differences between the cutting intervals. Cutting every 4 weeks resulted in the highest mean yield with 15.9 t DM ha\(^{-1}\) while cutting every 2 weeks intervals resulted in the lowest mean yield with 9.3 t DM ha\(^{-1}\). Yields from 6 and 8 weeks cutting intervals resulted in similar yields of (13.2 and 11.5 tons DM ha\(^{-1}\) respectively. Highly significant interaction was also observed between variety and cutting frequencies.
2.2. Feeding rations and packages

2.2.1. The performance of djallonke sheep fed on diets containing various proportions of cocoa pod husk and 5% NaOH treated maize cobs at the University of Science and Technology (UST), Kumasi, Ghana

In three experiments, five diets which contained 0, 150, 300, 450 and 600 g kg\(^{-1}\) of cocoa pod husk (CPH) and 600, 450, 300, 150 and 0 g kg\(^{-1}\) of treated maize cobs were evaluated. The other ingredients were wheat bran, cotton seed cake, dicalcium phosphate, NaCl and a trace mineral and vitamin premix. The ingredients were milled through a 6 mm sieve. In the first experiment (growth rate studies) 50 yearling Djallonke females weighing 5-13 kg were allocated randomly to the five diets, and dry matter intake weight gain and feed conversion efficiency were determined. In a second experiment (metabolism studies) five young weaned Djallonke ram lambs weighing 5-11 kg were fed on each of the five diets in a Latin-square design. Feed intake, apparent digestibility coefficients of dry matter and organic matter and digestible dry matter and digestible organic matter intakes were measured. In a third experiment, the diets were given to five fistulated adult wethers (Djallonke x Sahel) in a Latin-square design, and rumen pH was measured from 1 to 12 h and again 24 h after feeding. In the growth rate studies, dry matter intake significantly (P<0.01) increased from 73 g kg\(^{-0.75}\) to a maximum of 101 g kg\(^{-0.75}\) as the proportion of CPH increased from 0 to 600 g kg\(^{-1}\) diet, but growth rates (ranging from 37 to 55 g per day) and feed conversion efficiency were not significantly affected by dietary treatments. In the metabolism studies, feed intake increased with increasing levels of CPH in the diet, but intakes of digestible dry matter and digestible organic matter were not significantly affected. The apparent digestibility coefficients of dry matter and organic matter were significantly affected by the dietary treatments with increase in CPH level reducing the values. The rumen pH, although low (perhaps because of the grinding of the ingredients), was not the cause of the low digestibility of the CPH-containing diets.

2.2.2. Effects of diet and stages of pregnancy on blood chemistry and hematology of djallonke sheep fed diets containing various cocoa pod husk (CPH)

Fifty gimmers of the Djallonke breed weighing between 5 and 13 kg were allotted in equal numbers to five diets containing 0, 150, 300, 450 and 600 g Kg\(^{-1}\) CPH or 10, 150, 300, 450 and 600 g Kg\(^{-1}\) 5% NaOH treated corn cob and fed individually for 150 days. Feed and water was provided ad libitum. Animals on the same dietary treatments were then grouped and a service ram was introduced to each of the five groups. Blood samples were collected by jugular venipuncture at 28-day intervals during individual and group feeding periods for determination of blood constituents. For non-pregnant animals dietary treatment decreased (P<0.01) sodium and increase potassium levels as cocoa pod husk in the diet increased, but all other blood constituents measured were not (P>0.05) affected. Dietary treatment had similar effects on blood sodium and potassium levels in pregnant animals as in their non-pregnant counterparts. Pregnancydecreased (P<0.05) total protein, globulin, haemoglobin, alkaline phosphatase, inorganic phosphorus and sodium levels whilst total leucocyte counts increased.
2.2.3. Forage intake and nutritive value of sheep and goat diets in south-eastern Kenya

The forage intake, botanical composition and nutritive value of diets selected by free-ranging sheep and goats grazing in common on the southern rangelands of Kenya were determined. Forage intake was estimated using chromium sesquioxide orally administered daily to the animals. Dietary botanical composition was determined using the microhistological faecal analysis technique, whereas quality of simulated diet samples was determined by chemical analysis for crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin, total ash and in vitro dry (IVDMD) and organic matter (IVOMD) digestibilities. Comparisons were made for these variables between sheep and goats within and among seasons using one-way analysis of variance and means separated by Duncan's Multiple Range Test at p=0.050 level of significance.

Dry matter intake (DMI, g/d) was the same (P>0.05) for sheep and goats within a given season, but significantly different (p<0.05) between seasons for each animal species. DMI averaged 471 g/day (2% of body weight) and 500 g/day (2.5%) for goats and sheep, respectively. Lowest levels of intake for both species (1.6% for goats and 2.0% for sheep) were found during the wet season. DMI in g/kg BMW and in g/kg BWT were similar for sheep and goats during the wet season but were lowerer (P < 0.05) for goats compared to sheep in the dry season. Overall, sheep consumed 53 g/kg MBW and 25 g/kg BWT while goats had an average intake of 43.6 g/kg MBW and 20 g/kg BWT.

Goats selected diets significantly (p<0.05) higher in CP than did sheep (16.4% and 13.5%, respectively) when averaged across the two seasons. Sheep diets had significantly (p<0.05) lower levels of lignin during the wet season but equal (p>0.05) lignin contents during the dry season as compared to goats. Goats, however, selected diets lower in NDF and ADF than did sheep.

IVDMD of simulated diets was similar (p>0.05) between goats and sheep (56.2% and 55.6% respectively). IVOMD also did not differ between the two species (55.1% and 56.5% for goats and sheep, respectively). Digestibility coefficients were higher (p<0.05) for the wet season diets than the dry season diets.

Goats' diets consisted mainly of browse (> 81%) while those of sheep comprised mainly grasses (>77%) during both seasons. Goats consumed very little forbs (> 2%) whereas browse was the least utilized forage category by sheep (<8%). Neither species showed change (p>0.05) in the proportions of grass, forbs or browse in their diets with change of season, and no single plant dominated the diets of either livestock species.

2.2.4. Performance of sheep on napier basal diet supplemented with Gliricidia hay at Kabanyolo, Uganda

A feeding trial was conducted to study the effect of Gliricidia hay supplementation of elephant grass hay on DM intake, digestibility and N retention by mature sheep. Four sheep were fed elephant grass hay ad lib supplemented with four levels of Gliricidia hay (0, 4, 8 and 12 g DM/kgLW/day) in a 4x4 Latin square design.
Increasing levels of Gliricidia supplementation led to a decrease ($P < 0.05$) in the amount of Pennisetum consumed. However, there was no significant difference ($P > 0.05$) of the total dry matter intake (DMI) and DM digestibility of the supplemented and unsupplemented diets. Gliricidia supplementation increased ($P<0.01$) total daily nitrogen intake, N absorption and N retention in the body of sheep but with no significant difference ($P<0.01$) in the total N intake and N retained between 8 and 12 g DM/kg BW$^{0.75}$ levels of supplementation. It was recommended that DM intake, and N retention by sheep fed Pennisetum hay diets could be improved by supplementing the animals up to 8 gDM/kgLW/day of Gliricidia hay. Higher levels of supplementation appear to lead to substitution.

It was concluded that Gliricidia could be used as a alternative protein supplement for feeding ruminants in areas where conventional proteins are expensive or not available. It was also found that its productivity and nutritive value is comparable with that of Leucaena and other potential browse species and hence could replace Leucaena which is badly affected by the psyllid insect.

2.2.5. Improving utilization of maize stover in small scale farming systems of Zimbabwe

At the University of Zimbabwe at Chinambora, an experiment aimed at improving the utilization of maize stover in small scale farming systems compared the efficiency of urea treatment against forage supplementation in utilization of maize stover by smallholder drought oxen. Sixty four pairs of oxen owned by smallholders were randomly allocated to one of 3 supplementary treatments offered at one kg per head per day and a control without supplement. The treatments were maize stover plus silverleaf desmodiumhay 2:1; urea treated maize stover (50 g urea/kg stover) and plain maize stover.

Animals fed plain maize stover or no supplements lost 6-7% of initial weight while those fed the other two supplements maintained their liveweight. Supplementation reduced time spent on feeding activities by 10%. Animals fed urea-treated maize stover or maize stover plus silverleaf hay ploughed at speed that were 29% faster than oxen non supplemented and covered 45% more area. Blood parameters indicated a deficiencient nitrogen intake throughout the dry season.

It was concluded that forage legumes can be used as supplements of good quality to improve the working ability of communal area oxen.

2.2.6. Calliandra leaf meal in goats rations: effect on protein degradability in the rumen and growth in goats. Namulonge Research Station, Uganda

A study was conducted at Namulonge Research Station to examine the effect of levels of substitution of Calliandra leaf meal (CLM) for Soya bean meal (SBM) on animal performance in relation to energy and nitrogen retention.

Thirty six young, intact male goats were used in a growth trial of 70 days. These were stratified according to body weight and randomly allocated to 6 dietary treatments: ad
Ad libitum elephant grass (diet 1); ad libitum elephant grass plus pure SBM (diet 2); 25:75 SBM/CLM (diet 3); 50:50 SBM/CLM (diet 4); 75:25 SBM/CLM (diet 5) pure CLM (diet 6).

Daily feed offers and refusals were weighed and sampled for subsequent chemical analysis. Animals were weighed at weekly intervals for 10 weeks. Thereafter 4 animals from each treatment group were selected randomly and fitted with faeces and urine collection harnesses. Total collection of faeces and urine were undertaken for 4 days following the period of adaptation (5 days). Samples (5%) of urine and faeces from each animal were taken and bulked across the days of collection for subsequent analysis. Samples of feed and faeces were analysed for DM, OM, N, (A.O.A.C, 1980); NDF, acid detergent fibre (ADF), lignin and fibre bound nitrogen (NDFN) (Goering and Van Soest, 1970).

Intakes components were calculated as difference between offers and refusals corrected for dry matter contents of the feeds. Digestibility was calculated as the proportion of dry matter intake not recovered in the faeces. Growth rates was calculated from regressions of weekly weights on days of feeding. Feed conversion efficiency was calculated as the ratio of intake per gram of body weight gain. These parameters were examined by least square Analysis of Variance. Means were compared by Duncan's Multiple Range Tests (Gomez and Gomez, 1984).

Results from the experiment indicate that average DM intake and average daily weight gain during growth differed (P<0.001) between diets. Goats fed on 75 and 100 percent CLM had the highest DM intakes. These values decreased progressively with increasing levels of SBM in the diet. With the exception of diet 2 (100% SBM) all supplements increases DMI (P<0.05) above the intake of control animals.

Average daily gain also differed between diets (P<0.001). All supplementations increased average daily gain a factor of by 1.5 to five. The highest daily gains were recorded in animals supplemented with diet 4 (50:50 SBM/CLM). The overall response indicated a strong quadratic trend. The differences in performance were also reflected in feed conversion efficiency (P<0.01), also showing a strong quadratic trend.

DMI (P<0.05), OMI (P<0.05) and N (P<0.001) differed significantly between diets. The highest DMI and OMI were observed in the control goats and those fed on diet 6 (100% CLM). The lowest DMI and OMI values were measured in the animals fed on diet 4 (50:50 SBM/CLM). A strong quadratic trend was also evident.

The highest N intakes were found in goats fed diets 2 and 6 (75 and 100% SBM respectively). Similar (P>0.05) but lower values occured in animals fed diets 3, 4 and 6 (25, 50 and 100% SBM respectively).

DMD and OMD and digestible organic matter intake (DOMI) did not differ between diets (P>0.05). All values were notably high (≥666 g/kg DM). However apparent N digestibility differed between diets (P<0.01) but no consistent trend was established. The lowest N retention values were obtained in animals fed the control diets 1 and 4 (no
supplement and 50% SBM respectively). Similar retention values were found in diets 2, 3, 5 and 6.

The experiment has confirmed that on its own, Calliandra can supply the N required to increase growth and possibly milk yields. However, the nutritional value can be improved by mixing with soya bean meal. However the association of enhanced growth rate and feed efficiency with lower N retention values was not expected. Possible explanations include, improved amino acid balance, partition of energy between fat and protein deposition, or specific tissue metabolism and development, notably of the gut, liver and skin muscles. These tissues have variable contributions to the total body pool of N and fractional synthesis rates. Indications of these required destructive sampling which was not done.

3. INFORMATION EXCHANGE AND DISSEMINATION

3.1. Workshop:

Napier and Pennisetum hybrids workshop

A workshop on the yield performance of napier and napier x millet hybrids (*Pennisetum purpureum* x *P. typhoides*) in humid, sub-humid and highlands zones of sub-Saharan Africa was held at ILRI, Addis Ababa, from 5th to 7th December, 1995. The workshop was attended by the principal investigators of the multilocational evaluation project launched by AFRNET in 1993 to identify new promising lines/accessions to improve feeding packages for small-holder dairy cattle. The second phase of the project includes AFRNET/CARNET collaborative research to develop feeding packages using the high yielding accessions/lines identified during the first phase. The evaluations were carried out at 10 sites in 9 countries namely: Bouaké (Côte d'Ivoire), Dschang (Cameroon), Holetta (Ethiopia), Kumasi (Ghana), Kakamega (Kenya), Kianjasoa (Madagascar), Makurdi (Nigeria), Morogoro and Tanga (Tanzania) and Kampala (Uganda).

The material evaluated includes nine napier accessions and hybrids received from the SADCC/ICRISAT breeding programme which were multiplied *in vitro* by the ILRI genebank together at each of the sites, the best of the available local or commercial varieties/accessions.

The workshop was attended by 15 participants including members of the AFRNET Steering Committee and scientists from Malawi (Kanyama Phiri), Tanzania (Stella Bitende), Ethiopia (Seyoum Bediye), Zimbabwe (C. Chakoma) as well as ILRI scientists (E. Olaloku, J. Hanson, M. Mih, M. van de Wouw and Kaburu M'ribu).

The major objectives of the workshop was to discuss results from the multilocational performance evaluation trials and select the accessions/lines to be utilised in subsequent feeding trials to develop feeding packages and to discuss and harmonise the research methodology.
Results from Bouake (Côte d'Ivoire), Holetta (Ethiopia), Kumasi (Ghana), Kakamega (Kenya), Morogoro and Tanga (Tanzania) were presented as well as data from Marondera Grassland Station (Harare). A paper on morphological and agronomic characteristics of nine accessions of napier grass was presented by M. van de Wouw on behalf of scientists of the ILRI genebank.

Four cultivars including three napier accessions (ILRI acc. no. 16798, 16791 and 16786) and one Pennisetum hybrid (ILRI no. 16835) appeared to be highly productive showing dry matter yields ranging from 10 to 20 t ha\(^{-1}\) year\(^{-1}\) at most of the sites. Each of them ranked among the three best performers in at least five out of the seven sites, indicating that they are promising in the major environments of sub-Saharan Africa, from sea level (Tanga) to the highlands above 2000 m a.s.l of altitude (Holetta). They were selected to be tested in animal performance trials in smallholder dairy production units at identified sites during the second phase of the project.

The participants decided that each accession/line will be evaluated in standardised feeding trials at minimally four sites; each site should evaluate no more than four line/accessions, including the best local line. Discussing the trial methodology it was decided that the feeding experiments be carried out in two phases. The first phase will focus on collecting data on intake, \textit{in vivo} digestibility, degradability and nutrient content whereas the second phase will focus on formulation of feeding packages through measuring animal performance. Detailed experimental procedures for each of the two phases were discussed and agreed upon.

3.2. Newsletters

Since 1st April 1994 up to 31st December 1996, seven volumes of the African Feed Resources Network Newsletter have been published. About 1200 of each of them were distributed free of charge to members affiliated institutions and other partners.
ANNEX

AFRNET ON GOING PROJECTS IN 1994-1995

Benin

1. **Title:** On farm introduction and evaluation of forage legumes  
   **Executing Scientists:** Dr. Claude Adandedjan  
   **Site:** Université Nationale du Benin, Cotonou

Burundi

2. **Title:** Introduction and evaluation of forage germplasm materials in Burundi  
   **Executing Scientists:** Oscar Ncamihigo and P. Braderlard  
   **Site:** MOSO

Cameroon

3. **Title:** Introduction and Evaluation of *Arachis glabrata*  
   **Executing Scientists:** Prof. R.M. Njwe et al  
   **Site:** Dschang University

4. **Title:** Forage legume seed multiplication in Cameroon  
   **Executing Scientists:** Dr. E.T. Pamo, et al  
   **Site:** Dschang University

5. **Title:** Evaluation of Napier and Pennisetum hybrids  
   **Executing Scientist:** E.T. Pamo  
   **Site:** Korhogo

Cote d'Ivoire

6. **Title:** Evaluation of Napier and Pennisetum hybrids  
   **Executing Scientist:** Bodji Ng'uessan  
   **Site:** Korhogo

7. **Title:** Evaluation of Napier and Pennisetum hybrids  
   **Executing Scientist:** Bodji Ng'uessan  
   **Site:** Bouake

Ethiopia

8. **Title:** Evaluation of Napier and Pennisetum hybrids  
   **Executing Scientist:** Seyoum Bedeye  
   **Site:** Holleta
Ghana

9. **Title:** Evaluation of Napier and Pennisetum hybrids  
   **Executing Scientist:** Prof. A.K. Tuah  
   **Site:** UST Kumasi

10. **Title:** Nutritional studies to determine the most suitable supplement to diets of grazing animals using crop residues, browse and poultry manure simulating village conditions  
    **Executing Scientists:** Prof. A.K. Tuah  
    **Site:** UST Kumasi

11. **Title:** Performance of small ruminants fed crop residues supplemented with tree leaves and shrubs  
    **Executing Scientist:** Dr. J.E. Fleischer  
    **Site:** University of Ghana, Legon, Accra

Kenya

12. **Title:** Evaluation of Napier and Pennisetum hybrids  
    **Executing Scientist:** Dr. A.B. Orodho  
    **Site:** Kakamega

13. **Title:** On farm legume seed production on smallholder farms in Western and Coastal Kenya  
    **Executing Scientists:** Dr. J.L. Wandera and Mr. M.N. Njunie  
    **Site:** KARI Mtwapa

14. **Title:** *Pennisetum purpureum/Clitoria* silage for dairy cattle feeding in Coastal Kenya  
    **Executing Scientists:** M.N. Njunie and Dr. R. Muinga  
    **Site:** KARI Mtwapa

15. **Title:** Forage intake and nutritive value of sheep and goat diets in South Central Kenya  
    **Executing Scientist:** Mr. J.N. Ndung’u  
    **Site:** University of Nairobi  
    **Status:** MSc thesis completed

Madagascar

16. **Title:** Evaluation of Napier and Pennisetum hybrids  
    **Executing Scientist:** Dr. J.H. Rasambainarivo  
    **Site:** Kiajansoa
Malawi

17. **Title:** Evaluation of Napier and Pennisetum hybrids
    **Executing Scientist:** Dr. G. Kanyama-Phiri
    **Site:** Bunda College of Agriculture

Nigeria

18. **Title:** Evaluation of Napier and Pennisetum hybrids
    **Executing Scientist:** Dr. E.C. Agishi
    **Site:** Benue State University, Makurdi
    **Status:** Discontinued

Sudan

19. **Title:** Evaluation of forage legumes in Sudan
    **Executing Scientists:** Dr. M.A.M. Khair et al
    **Site:** University of Khartoum

20. **Title:** Improvement of irrigated forage legumes in the Sudan
    **Executing Scientists:** Dr. M.A.M. Khair et al
    **Site:** Wad Medani

Swaziland

21. **Title:** Introduction and evaluation of Urea/Molasses for draft oxen
    **Executing Scientists:** Dr. B.J. Ogwang et al
    **Site:** University of Swaziland

Tanzania

22. **Title:** Forage legume seed production
    **Executing Scientist:** M.L. Kusekwa
    **Site:** LPRI-Mpwapwa

23. **Title:** Evaluation of Napier and Pennisetum hybrids
    **Executing Scientists:** Prof. A.N. Uri, et al
    **Site:** Sokoine University of Agriculture, Morogoro

24. **Title:** Evaluation of Napier and Pennisetum hybrids
    **Executing Scientist:** Mr. P.K. Kapenga/Stella Bitende
    **Site:** LRC Tanga
Uganda

25. **Title:** Evaluation of Napier and Pennisetum hybrids  
**Executing Scientists:** Prof. E.N. Sabiiti et al  
**Site:** Makerere  
**Status:** On going

26. **Title:** Integration of the best forage legumes into crop/livestock production systems  
**Executing Scientists:** Prof. E.N. Sabiiti et al  
**Site:** Makerere University  
**Status:** On going

27. **Title:** Calliandra leaf meal in goat rations. Effect on protein degradability in the rumen and growth in goats  
**Executing Scientist:** Dr. C. Ebong  
**Site:** Namulonge Research Station

28. **Title:** Evaluation of *Gliricidia sepium* as a fodder tree for ruminant production  
**Executing Scientist:** Mr. Dennis Mpairwe  
**Site:** Makerere University  
**Status:** MSc thesis completed

Zimbabwe

29. **Title:** Introduction and Evaluation of technologies on the utilization of crop residues on small scale farms  
**Executing Scientists:** Dr. L.R. Ndlovu  
**Site:** University of Zimbabwe, Harare  
**Funds received:** US$3,000

30. **Title:** Introduction and evaluation of forage germplasm  
**Executing Scientist:** Rosemary Muchadeyi  
**Site:** Marondera  
**Funds received:** US$3,000