# Identifying *Chamaecrista rotundifolia* accessions and *Centrosema* species for bridging seasonal feed gaps in smallholder mixed farms in the West African derived savanna

A. LARBI, I.O. ADEKUNLE, A. AWOJIDE AND J. AKINLADE

*International Livestock Research Institute (ILRI), Humid/Subhumid Zone Programme, Ibadan, Nigeria*

## Abstract

Information is scanty on seasonal changes in the yield and quality of forage legumes adapted to the West African savannas. Two experiments were conducted from 1992–1994 in the derived savanna zone of West Africa to determine the dry matter (DM) yield and 48-h *in sacco* DM digestibility of 17 accessions of *Chamaecrista rotundifolia* (Experiment 1), and 22 accessions of 8 *Centrosema* species (Experiment 2) in the main-wet (April–August), minor-wet (September–November), and dry (December–March) seasons. Accessions varied significantly in DM yield and *in sacco* DM digestibility in both experiments. Based on the digestible DM yield, accessions were identified with the potential to provide greater quantities of high quality forage. These included: *Ch. rotundifolia* ILCA 14165; *Ce. acutifolium* ILCA 12182 and 12184; *Ce. macrocarpum* ILCA 15594; *Ce. pascuorum* ILCA 9; *Ce. schottii* ILCA 122 and 12401; and *Ce. plumieri* ILCA 200; for the wet season. Promising accessions for the dry season included: *Ch. rotundifolia* ILCA 14172 and 14174; *Ce. acutifolium* ILCA 15591; *Ce. arenarium* ILCA 12451; *Ce. brasilianum* ILCA 155; *Ce. macrocarpum* ILCA 15594; *Ce. plumieri* ILCA 194; and *Ce. schottii* ILCA 122. Of the *Ce. virginianum* accessions evaluated, ILCA 509 was the best in all seasons. The potential of the promising accessions to reduce seasonal deficiencies of high quality feed, especially during the dry season, and their multiple use for soil fertility maintenance, weed control, and pest management in mixed farming systems warrant further research.

Correspondence: A. Larbi, c/o L.W. Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, United Kingdom. e-mail: A.larbi@cgiar.com

## Introduction

In sub-Saharan Africa, smallholder crop-livestock farmers predominate. These farmers own few hectares of farm land, and produce a mixture of crops and livestock with minimum investment. Due to limitations of resources, the smallholder farmers are less likely to buy feedstuffs for their livestock and/or apply inorganic fertiliser on farm lands to improve crop yields. As a result, seasonal variation in feed quantity and quality, and low soil fertility, especially from nitrogen deficiency, are major constraints to livestock and crop production in the smallholder crop-livestock systems (Winrock 1992; Smith *et al*. 1997). One recommended means of overcoming these constraints is to incorporate nitrogen-fixing forage legumes into the farming systems. Such legumes can provide high quality forage for supplementing available low quality feed resources such as crop residues and native pastures (Thomas and Sumberg 1995). The forage legumes could also increase crop yields either through their direct contribution to soil fertility or by the application of better quality manure produced from feeding the legumes to livestock on farm lands. However, quantitative data on seasonal variations in yield and quality of adapted forage legumes are scanty. Such information is essential for developing strategies to bridge the seasonal gaps in feed quantity and quality for resource-poor farmers who cannot afford to purchase conventional supplements.

Recent reviews (Lazier and Clatworthy 1990; Thomas and Sumberg 1995) show that *Chamaecrista rotundifolia* and *Centrosema pubescens* are forage legumes adapted to the humid and subhumid tropics of West Africa. Most studies on the forage potential of these species in the region have been conducted in the northern Guinea savanna (Tarawali 1991, 1995; Peters *et al*. 1994). Little information is available on the performance of accessions of *Ch. rotundifolia* and *Centrosema* species other than *Ce. pubescens* in the derived savanna (Alghren *et al*. 1959; ILCA 1989; Cobbina 1992). This paper reports on a study conducted to determine the forage yield and digestibility of *Ch. rotundifolia, Ce. acutifolium, Ce. arenarium, Ce. macrocarpum, Ce. brasilianum, Ce. pascuorum, Ce. plumieri, Ce. schottii,* and *Ce. virginianum* accessions in the wet and dry seasons in the derived savanna zone of West Africa, as an aid in the selection of promising accessions which can be integrated into smallholder crop-livestock farming systems to reduce seasonal deficiencies in high quality feed and possibly to improve soil productivity.

## Materials and methods

### *Study site*

Two experiments were conducted simultaneously at Fashola, about 70 km from Ibadan (7° 30′ N, 3° 55′ E) in the derived savanna zone of southwestern Nigeria from 1992–1994. The derived savanna is intermediate between the humid forest and the Guinea savanna zones, and occupies about 10 M ha in West and Central Africa (Jagtap 1995). The vegetation is predominantly *Andropogon* spp., which is maintained by annual uncontrolled burning. The climate is subhumid and has 3 seasons: main-wet (April–August), minor-wet (September–November), and dry (December–March). Mean annual rainfall is about 1060 mm. Average rainfall during the study period was 602 mm for the main-wet season, 460 mm for the minor-wet, and 125 mm for the dry season. The soil at the experimental site is an Alfisol, with a pH ($H_2O$) of 6.6, organic carbon of 9.1 g/kg, total nitrogen of 0.5 g/kg, and available P of 13.7 mg/kg (Bray 1).

### *Treatments and design*

*Experiment 1*. Seventeen accessions of *Ch. rotundifolia* (Table 1) were used in a randomised complete block design with 3 replicates. A replicate consisted of a single row of each accession sown at a rate of 5 kg/ha into tilled strips of 1.5 m x 0.5 m. Strips were separated by 1-m paths and blocks were separated by 2-m borders of native vegetation. Seeds were scarified by soaking in warm water for 24 h, inoculated with the appropriate inoculum, and planted on May 17, 1992. Plots were hand-weeded. No fertiliser was applied. The plots were given a uniform cut at 10 cm above ground during the last week of November 1992. After the initial cut, regrowth was harvested during the last week of each season for yield estimation. At each harvest, forage from two 0.25 $m^2$ quadrats was cut at 10 cm above ground from each plot and bulked. Representative forage samples were oven-dried at 60°C for 48 h to determine dry matter (DM) yields.

*Experiment 2*. Twenty-two accessions of 8 *Centrosema* species (Table 2) were used. The design and methods were similar to those used in Experiment 1.

### *Nylon bag digestibility*

Dried forage samples from each harvest in Experiments 1 and 2 were ground to pass through a 2.5 mm screen for determination of *in sacco* DM digestibility. About 5 g of the ground sample was weighed into nylon bags (9 cm × 18 cm; 41 micron pores). Three bags of each accession were incubated for 48 h in the rumen of 3 rumen-fistulated N'Dama (*Bos indicus*) steers aged 3 years with an average liveweight of 250 kg. The steers grazed a 6-week regrowth of *Panicum maximum* as basal diet supplemented with wheat-bran at a daily rate of 2 kg/head. After incubation, the nylon bags were washed, dried at 60°C for 48 h and weighed, and DM digestibility determined. Digestible DM yield was calculated by multiplying DM yield by *in sacco* DM digestibility.

### *Data analyses and presentation*

Data for each season were analysed separately using the General Linear Model (GLM) procedures (SAS 1988). Preliminary analyses showed no significant accession × harvest interaction. Therefore, data for the 2 harvests of each season were pooled and means presented.

**Table 1.** List of the *Chamaecrista rotundifolia* accessions evaluated.

| Accession number | | | | | | |
|---|---|---|---|---|---|---|
| ILCA[1] | Other[2] | Origin | Altitude (m) | Rainfall (mm) | Latitude | Longitude |
| 6999 | CPI-16358 | Ghana | — | — | — | — |
| 9288 | N-77233 | Mali | — | — | — | — |
| 10916 | Q-10057 | Brazil | — | — | — | — |
| 10917 | Q-9862 | Brazil | — | — | — | — |
| 14161 | CPI-93018 | Brazil | 600 | — | 22° 00′ S | — |
| 14162 | CPI-93094 | Brazil | 600 | — | 16° 00′ S | — |
| 14163 | CPI-92931 | Brazil | 900 | — | 22° 00′ S | — |
| 14164 | CQ-1467 | Nigeria | — | — | — | — |
| 14165 | CPI-49713 | Brazil | — | — | — | — |
| 14166 | CPI-90809 | Mexico | 1300 | 1040 | 22° 55′ N | 104° 00′ W |
| 14168 | CPI-92968 | Brazil | 1100 | — | 24° 00′ S | — |
| 14169 | CPI-86178 | Mexico | 1000 | 850 | 19° 35′ N | 104° 25′ W |
| 14170 | CPI-34719 | Brazil | — | — | — | — |
| 14171 | CPI-86172 | Mexico | 20 | 1000 | 19° 15′ N | 104° 40′ W |
| 14172 | CPI-78916 | Nigeria | — | — | — | — |
| 14173 | CPI-78355 | Argentina | 80 | 1150 | 29° 00′ S | — |
| 14174 | CPI-52092 | Ghana | — | — | — | — |

[1]ILCA: International Livestock Centre for Africa.

[2]Other: CPI, Commonwealth Scientific and Industrial Research Organisation, Australia; CQ, Council for Scientific and Industrial Research (CSIRO), Queensland; Q, Department of Primary Industries, Queensland, Australia; N, ILCA, Mali.

**Table 2.** List of *Centrosema* species evaluated.

| | Accession number | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | ILCA[1] | CPI[2] | Origin | Altitude (m) | Rainfall (mm) | Latitude | Longitude |
| *Centrosema acutifolium* | 153 | 84626 | Brazil | 540 | 1740 | 15° 36′ S | 54° 08′ W |
| *Centrosema acutifolium* | 12182 | 94327 | Colombia | 130 | 2130 | 04° 53′ N | 68° 24′ W |
| *Centrosema acutifolium* | 12184 | 94311 | Brazil | 290 | 1580 | 08° 51′ S | 48° 20′ W |
| *Centrosema acutifolium* | 15591 | — | — | — | — | — | — |
| *Centrosema acutifolium* | 15593 | — | — | — | — | — | — |
| *Centrosema arenarium* | 12451 | 94324 | Brazil | 760 | 930 | 12° 26′ S | 41° 32′ W |
| *Centrosema brasilianum* | 10 | 55702 | Brazil | 150 | 1200 | 08° 00′ S | — |
| *Centrosema brasilianum* | 155 | 87993 | Brazil | 530 | 1030 | 12° 14′ S | 45° 02′ W |
| *Centrosema brasilianum* | 6733 | 55698 | Brazil | 380 | 400 | 09° 00′ S | — |
| *Centrosema brasilianum* | 12214 | 87995 | Brazil | 100 | 1850 | 12° 50′ S | 38° 24′ W |
| *Centrosema macrocarpum* | 151 | 83508 | Colombia | 130 | 2890 | 03° 44′ N | 73° 44′ W |
| *Centrosema macrocarpum* | 12146 | 83506 | Colombia | 240 | 2850 | 02° 47′ N | 72° 43′ W |
| *Centrosema macrocarpum* | 15594 | — | — | — | — | — | — |
| *Centrosema pascuorum* | 9 | 55697 | Brazil | 380 | 400 | 09° 00′ S | — |
| *Centrosema plumieri* | 194 | — | Belize | 7 | 1167 | 18° 03′ N | — |
| *Centrosema plumieri* | 200 | — | Belize | — | 1354 | 18° 14′ N | — |
| *Centrosema schottii* | 122 | 76014 | Mexico | 30 | 1150 | 20° 27′ N | — |
| *Centrosema schottii* | 263 | 76022 | Mexico | — | 1100 | 14° 44′ N | — |
| *Centrosema schottii* | 6772 | 55705 | Brazil | — | — | — | — |
| *Centrosema schottii* | 12401 | 87848 | Mexico | — | — | — | — |
| *Centrosema virginianum* | 508 | 94265 | Brazil | — | — | — | — |
| *Centrosema virginianum* | 509 | 83843 | Brazil | — | — | — | — |

[1]ILCA: International Livestock Centre for Africa.

[2]Commonwealth Scientific and Industrial Research Organisation, Australia.

## Results

*Experiment 1.* There were considerable variations in DM yield, DM digestibility, and digestible DM yield among accessions and among seasons (Table 3). Only 5 accessions of *C. rotundifolia* (ILCA 14165, 14169, 14168, 10917 and 14171) yielded more than 4000 kg/ha during the main-wet season. Four of these (ILCA 14165, 14168, 14169 and 14171) produced well in the minor-wet season, with ILCA 14165 and 14169 yielding well in the dry season.

Averaged over accessions, DM digestibility varied between 399 g/kg in the main-wet and 598 g/kg in the minor-wet with considerable variation. The lowest digestibility was noted for ILCA 14166 (549 g/kg) in the minor-wet season, ILCA 14171 (379 g/kg) in the dry season, and ILCA 14172 (346 g/kg) in the main-wet season. Digestible DM yield also varied widely tending to favour ILCA 14165, 14168 and 14169.

*Experiment 2.* Within each of the *Centrosema* species except *Ce. virginianum* there were high yielding accessions (Table 4). Overall, *Ce. macrocarpum* was the highest yielding species averaging about 15 t/ha DM for the whole year, followed by *Ce. brasilianum* with annual DM yield of 11.5 t/ha and *Ce. plumieri* with 10.9 t/ha. Dry matter digestibility was generally higher in the minor-wet and dry seasons than in the main-wet. Total digestible DM yield also favoured *Ce. macrocarpum* and *Ce. brasilianum* overall, although *Ce. schottii* accession ILCA 122 performed very well.

## Discussion

The study identified a number of accessions of *Ch. rotundifolia* and 8 *Centrosema* species with the potential to provide greater quantities of high quality forage in the wet and dry seasons in the West African derived savanna and similar environs in the tropics based on digestible DM yield. This observation suggests that it is possible to select accessions to bridge seasonal feed gaps in smallholder crop-livestock systems in the West African derived savanna zone. The promising accessions can be effectively introduced into smallholder farming systems in a number of ways. They could be grown as pure stands in feed gardens, in fodder banks, and on fallow lands to replace native vegetation. They could also be sown under perennial tree crops, and as intercrops between rows of annual cereal crops. Farmers can cut-and-carry the forage to feed

**Table 3.** Seasonal variations in yields (kg/ha) of dry matter (DMY) and digestible dry matter (DDY), and 48-hour *in sacco* DM digestibility (DMD, g/kg) of *Chamaecrista rotundifolia* accessions in the main-wet (April–August), minor-wet (September–November) and dry (December–March) seasons in the derived savanna zone, Ibadan, south-western Nigeria. Values are averages of 6 observations: 3 replications and 2 harvests in 1992–1994.

| | Main-wet | | | Minor-wet | | | Dry | | |
|---|---|---|---|---|---|---|---|---|---|
| Accession | DMY | DMD | DDY | DMY | DMD | DDY | DMY | DMD | DDY |
| 6999 | 3173 | 370 | 1174 | 2127 | 592 | 1259 | 1519 | 463 | 703 |
| 9288 | 3039 | 433 | 1316 | 1760 | 567 | 998 | 1678 | 487 | 817 |
| 10916 | 2280 | 459 | 1322 | 1387 | 593 | 822 | 1200 | 512 | 614 |
| 10917 | 4053 | 416 | 1686 | 1386 | 653 | 905 | 1280 | 432 | 553 |
| 14161 | 3306 | 385 | 1273 | 1599 | 624 | 998 | 1333 | 459 | 612 |
| 14162 | 3147 | 473 | 1489 | 1707 | 653 | 1114 | 1359 | 470 | 639 |
| 14163 | 2746 | 389 | 1468 | 1492 | 607 | 906 | 1813 | 477 | 764 |
| 14164 | 2279 | 409 | 1341 | 1467 | 619 | 908 | 1413 | 481 | 680 |
| 14165 | 4480 | 367 | 1644 | 2506 | 603 | 1511 | 1760 | 460 | 809 |
| 14166 | 3839 | 422 | 1620 | 1813 | 549 | 995 | 1173 | 540 | 633 |
| 14168 | 4133 | 393 | 1624 | 2666 | 556 | 1482 | 1413 | 464 | 656 |
| 14169 | 4293 | 350 | 1502 | 2373 | 596 | 1414 | 1733 | 452 | 783 |
| 14170 | 3226 | 405 | 1307 | 1467 | 625 | 917 | 1039 | 427 | 444 |
| 14171 | 4026 | 442 | 1780 | 2400 | 568 | 1363 | 1386 | 379 | 525 |
| 14172 | 3466 | 346 | 1199 | 2133 | 558 | 1190 | 2160 | 468 | 1011 |
| 14173 | 2799 | 350 | 980 | 1517 | 594 | 900 | 1630 | 523 | 852 |
| 14174 | 3759 | 372 | 1399 | 1920 | 612 | 1175 | 2280 | 469 | 975 |
| Mean | 3508 | 399 | 1396 | 1865 | 598 | 1109 | 1527 | 468 | 716 |
| LSD (P = 0.05) | 783 | 8 | 303 | 419 | 26 | 246 | 511 | 12 | 239 |

**Table 4.** Seasonal variations in yields (kg/ha) of dry matter (DMY) and digestible dry matter (DDY), and 48-hour *in sacco* dry matter digestibility (DMD, g/kg) of accessions of 8 *Centrosema* species in the main-wet (April–August), minor-wet (September–November) and dry (December–March) seasons in the derived savanna zone, Ibadan, south-western Nigeria. Values are averages of 6 observations: 3 replications and 2 harvests in 1992–1994.

| | Main-wet | | | Minor-wet | | | Dry | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | DMY | DMD | DDY | DMY | DMD | DDY | DMY | DMD | DDY |
| *Ce. acutifolium* | | | | | | | | | |
| 153 | 3386 | 412 | 1395 | 2040 | 506 | 1032 | 2640 | 361 | 953 |
| 12182 | 3240 | 411 | 1331 | 4080 | 489 | 1995 | 1760 | 528 | 929 |
| 12184 | 3307 | 416 | 1376 | 3760 | 502 | 1888 | 2840 | 469 | 1332 |
| 15591 | 4934 | 517 | 2551 | 3120 | 478 | 1491 | 2146 | 548 | 1176 |
| 15593 | 4200 | 420 | 1764 | 2400 | 488 | 1152 | 2360 | 385 | 909 |
| Mean | 3813 | 435 | 1683 | 3080 | 493 | 1512 | 2349 | 458 | 1059 |
| *Ce. arenarium* | | | | | | | | | |
| 12451 | 1572 | 416 | 654 | 3320 | 510 | 1693 | 3640 | 506 | 1842 |
| *Ce. brasilianum* | | | | | | | | | |
| 10 | 4040 | 446 | 1801 | 3414 | 440 | 1502 | 2906 | 452 | 1314 |
| 155 | 4240 | 449 | 1904 | 3280 | 436 | 1430 | 4960 | 475 | 2356 |
| 6773 | 4214 | 416 | 1753 | 2587 | 453 | 1172 | 2746 | 453 | 1244 |
| 12214 | 5534 | 385 | 2130 | 4507 | 477 | 2150 | 3760 | 490 | 1842 |
| Mean | 4504 | 424 | 1897 | 3447 | 452 | 1564 | 3594 | 468 | 1689 |
| *Ce. macrocarpum* | | | | | | | | | |
| 151 | 3920 | 383 | 1501 | 7080 | 476 | 3370 | 2556 | 526 | 1345 |
| 12146 | 4680 | 446 | 2087 | 4840 | 497 | 2405 | 3840 | 461 | 1770 |
| 15594 | 4880 | 446 | 2176 | 8720 | 478 | 4168 | 4320 | 433 | 1871 |
| Mean | 4493 | 425 | 1921 | 6880 | 484 | 3314 | 3572 | 473 | 1662 |
| *Ce. pascuorum* | | | | | | | | | |
| 9 | 4427 | 445 | 1970 | 3493 | 458 | 1600 | 2065 | 408 | 843 |
| *Ce. plumieri* | | | | | | | | | |
| 194 | 4720 | 350 | 1652 | 4240 | 493 | 2090 | 2560 | 579 | 1482 |
| 200 | 3520 | 300 | 1056 | 5800 | 460 | 2668 | 960 | 678 | 651 |
| Mean | 4120 | 325 | 1354 | 5020 | 477 | 2379 | 1760 | 629 | 1067 |
| *Ce. schottii* | | | | | | | | | |
| 122 | 5600 | 427 | 2391 | 4660 | 508 | 2367 | 3200 | 422 | 1350 |
| 263 | 3480 | 460 | 1601 | 2600 | 459 | 1193 | 1600 | 415 | 664 |
| 6772 | 2427 | 460 | 1116 | 2706 | 489 | 1323 | 2080 | 458 | 953 |
| 12401 | 4600 | 460 | 1868 | 4134 | 461 | 1906 | 1760 | 442 | 778 |
| Mean | 4027 | 452 | 1744 | 3525 | 479 | 1697 | 2160 | 434 | 936 |
| *Ce. virginianum* | | | | | | | | | |
| 508 | 1520 | 368 | 559 | 3840 | 456 | 1751 | 1720 | 345 | 593 |
| 509 | 2920 | 504 | 1472 | 4360 | 427 | 1862 | 4280 | 488 | 2089 |
| Mean | 2220 | 436 | 1015 | 4100 | 441 | 1806 | 3000 | 416 | 1341 |
| LSD (P = 0.05) | 1557 | 30 | 1619 | 2253 | 47 | 1079 | 1836 | 32 | 971 |

penned or tethered animals and/or graze pure stands *in situ* for a few hours during the day as sources of home-grown supplements for low quality basal diets of crop residues and native pastures.

For the main-wet season, the promising accessions included: *Ch. rotundifolia* ILCA 14171, 10917 and 14165; *Ce. acutifolium* ILCA 15591; *Ce. brasilianum* ILCA 12214; *Ce. macrocarpum* ILCA 12146 and 15594; *Ce. pascuorum* ILCA 9; and *Ce. schottii* ILCA 122 and 12401. Accessions with potential for the minor-wet season included: *Ch. rotundifolia* ILCA 14165, 14168 and 14169; *Ce. acutifolium* ILCA 12182 and 12184; *Ce. arenarium* ILCA 12451; *Ce. schottii* ILCA 12401 amd 122; and all the accessions of *Ce. macrocarpum* and *Ce. plumieri*. High yielding accessions for the dry season included: *Ch. rotundifolia* ILCA 14172, 14173, 14174, 9288 and 14165; *Ce. acutifolium* ILCA 15591 and 12184; *Ce. arenarium* ILCA 12451; *Ce. brasilianum* ILCA 155 and 12214; *Ce. macro-*

*carpum* ILCA 15594; *Ce. plumieri* ILCA 194; and *Ce. schottii* ILCA 122. *Centrosema virginianum* accession ILCA 509 performed well in all seasons.

Our results support earlier studies showing wide variations in DM yield among accessions of *Ch. rotundifolia* (Strickland *et al*. 1985; Tarawali 1991, 1995; Larbi *et al*. 1993) and *Centrosema* species (Clements *et al*. 1984; Schultze-Kraft and Keller-Grein 1985; Grof 1986; Tarawali 1991; Peters *et al*. 1994). The ranges of DM yield in the current study are also comparable with those reported for accessions of *Ch. rotundifolia* (Tarawali 1991, 1995; Cobbina 1992; Larbi *et al*. 1993) and *Centrosema* species (Cobbina *et al*. 1992; Peters *et al*. 1994; Tarawali 1995). *Chamaecrista rotundifolia* ILCA 14165 from Brazil produced appreciable quantities of forage in all seasons, confirming comments on the passport data, which described the accession as 'extremely vigorous.'

Data on 48-h *in sacco* DM digestibility of *Ch. rotundifolia* accessions for comparison with our results are limited. Ahn *et al*. (1988) reported an *in vivo* DM digestibility of 555 g/kg for hay of *Ch. rotundifolia* cv. Wynn harvested at the half-bud stage. This value is slightly lower than the average for *Ch. rotundifolia* accessions in the minor-wet season, but higher than the averages for the main-wet and dry seasons in the current study. The average *in sacco* DM digestibility values for *Ce. brasilianum* accessions in the current study are generally lower than the *in vitro* DM digestibility values reported by Schultze-Kraft and Keller-Grein (1985). Their values are based on samples of leaf fraction, while a mixture of leaf and stem fraction samples was used in the current study. The significant variations in DM digestibility among the *Ce. brasilianum* accessions confirm earlier reports (Belalcazar and Schultze-Kraft 1986). The average 48-h *in sacco* DM digestibility for most accessions in the minor-wet season was generally higher than that in the main-wet season. This observation could be attributed to higher leaf: stem ratio and lower cell wall content of the minor-wet season forage as a result of the shorter regrowth period in the minor-wet season.

Forage yield and quality attributes are important in the evaluation of forages for ruminants because they determine animal output when the forage is fed as the sole diet (Mochrie *et al*. 1981; Moore *et al*. 1990). These attributes are also important in selecting forage legumes for soil fertility enhancement, because they could influence the rate and extent at which minerals are released from the forage to the soil (Cobbina 1992). Thus, in the search for forage legume accessions to solve the twin problems of seasonal feed shortages and low soil fertility in smallholder crop-livestock systems in sub-Saharan Africa, both yield and quality attributes should be considered. However, depending on the stage of evaluation, season, and the target farming systems, the relative importance of these attributes could vary (Mochrie *et al*. 1981). For example, variations in yield and seasonal distribution of edible DM among accessions could be more important than digestibility at the initial stages of evaluation because they give a better reflection of adaptation to the environment. Secondly, in most smallholder crop-livestock systems in sub-Saharan Africa, digestible edible forage yield could be of higher importance in the dry season than the wet season, because of the low availability of high quality feed resources in the dry season.

In conclusion, promising accessions of *Ch. rotundifolia* and *Centrosema* species could be used to develop improved feeding packages in smallholder crop-livestock farming systems in the West and Central African derived savanna zone. The potential of the promising accessions to reduce shortages in the amount and quality of feed for ruminants during the dry season warrants further research. Research is also needed on the performance of the promising accessions under grazing. We recognise that, in addition to providing feed for livestock, forage legumes could also be used for maintaining soil fertility, weed control, and pest management in smallholder mixed farming systems (Thomas and Sumberg 1995). Therefore, studies on the multiple use of the promising accessions are also recommended.

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