Initial evaluation of some introduced forage plants for herbage productivity at two sites in Ghana

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SUMMARY

A preliminary evaluation of some recently-released forage species obtained from (Centro Internacional de Agricultura Tropical (CIAT) and International Livestock Centre for Africa (ILCA) was undertaken at two subhumid sites in Ghana. The forage germplasm from CIAT comprised 21 herbaceous legumes, six shrub legumes and eight grasses. Those from ILCA were made up of 20 herbaceous legumes. In the evaluation of the CIAT species carried out at only one site, it was found that in the herbaceous legumes, *Aeschynomeme histrix, Centrosema macrocarpum* var. 5452 and 5713. *Desmodium ovalifolium and Stylosanthes guianensis* var. *Pucallpa* and *Pauciflora*, produced the greatest soil cover (28.3-58.4 %) and dry matter (DM) yields (up to 2.25 t/ha in 6 months). *Brachiaria brizantha* and *Panicum maximum* varieties and *Brachiaria decumbens* cv. Basilisk performed best among the grasses (up to 3.7 t/ha in 6 months) and *Leucaena leucocephala* and *Cajanus cajan* produced the greatest heights and DM yields among the leguminous shrubs. In the ILCA species, *Macrotyloma axillare, Stylosanthes guianensis* ILCA 4, *S. hamata* ILCA 167, *Lablab purpureus, Rhynchosia minima* and *Stylosanthes scabra* ILCA 140 and 441 showed high potential in herbage yield (up to 3.3 t/ha in 6 months) among the legumes evaluated at two sites.

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RÉSUMÉ

BARNES, P. B. & ADDO-KWAFO, A.: *Une évaluation initiale de quelques plantes fourrageuses introduites pour la productivité d'herbage à deux endroits au Ghana.* Une évaluation préliminaire de quelques espèces de fourrage récemment délivré est obtenu de Centro Internacional de Agricultura Tropical (CIAT) et ILCA, a été effectuée en deux terrains moins humide au Ghana. Le fourrage germplasme de CIAT composé de vingt-et-un légumineuses herbacées, six légumineuses arbustes et huit graminées et ceux de ILCA étaient composés de vingt légumineuses herbacées. Au cours de l'évaluation des espèces de CIAT exécutée à un seul endroit, il a été découvert que dans les légumineuses herbacées, *Aeschynomeme histrix, Centrosema macrocarpum* vars 5452 et 5713, *Desmodium ovalifolium* et *Stylosanthes guianensis* vars. Pucallpa et Pauciflora ont produit la plus grande couverture du sol (28.3-58.4 pour cent) et les rendements de matière sèche (jusqu'à 2.25 t/ha en 6 mois). *Brachiaria brizantha* et les variétés, *Panicum maximum* et *Brachiaria decumbens* cv. Basilisk, ont été les meilleurs parmi les graminées (jusqu'à 3.7 t/ha en 6 mois) et *Leucaena leucocephala* et *Cajanus cajan* ont produit les plus grandes hauteurs et les rendements de DM parmi les arbustes légumineux. Parmi les espèces de ILCA, *Macrotyloma axillare, Stylosanthes guianensis* ILCA 4, *S. hamata* ILCA 167, *Lablab purpureus, Rhynchosia minima* et *Stylosanthes scabra* ILCA 140 et 441 ont montré un potentiel élevé en rendement herbageuse (jusqu'à 3.3 t/ha en 6 mois) parmi les légumineuses évaluées en deux endroits.

Introduction

The range of improved forage species on which is based the small area of cultivated or improved pastures in Ghana is quite small. Recent forage evaluation studies conducted in Pokoase, Ghana (Barnes, 1985) showed that a wide range of forage species developed in northern Australia are adapted to that site.

In recent times, many more forage species adapted to tropical savanna regions have been developed by international research centres notable among them Centro Internacional de Agricultura Tropical (CIAT) based in Columbia.

This initial evaluation study is based on newly-released forage germplasm from CIAT and International Livestock Centre for Africa (ILCA) with a view to select adaptable and productive species to widen the range of forage species available for

forage cultivation in Ghana.

Materials and methods

Trial 1: Evaluation of CIAT forage species

Experimental site and field operations. The trial was conducted at Pokoase Agricultural Station, lat. 5°40'N, which lies in a transition between forest and coastal savanna zones. The soil in the site has medium fertility with the following parameters: soil *p*H, 5.80 to 6.35; P, 2.00 ppm; N, 0.025 per cent. Annual rainfall at Pokoase has a 30-year average of 1050 mm but was 1216 mm in 1991 and 632 mm in 1992 (Table 1). The main rainfall period is between April and November with a short dry spell in August.

TABLE 1

Monthly Rainfall Totals (mm) and Raindays for 2 Years (1991) and (1992) for Pokoase and Nyankpala Agricultural Stations

Month	Pokoase		Nyankpala	
	1991	*1992*	*1991*	*1992*
January	30.8(2)	0.0	0.0	0.0
February	4.4(1)	0.0	47.7(2)	0.0
March	21.4(3)	32.6(3)	30.2(2)	12.6(1)
April	109.7(7)	30.5(4)	91.2(6)	69.3(5)
May	500.7(14)	123.4(4)	256.6(13)	45.4(6)
June	154.8(10)	31.3(5)	97.8(7)	96.6(9)
July	251.7(9)	28.9(8)	180.4(11)	127.2(9)
August	37.6(7)	6.6(3)	364.2(13)	74.7(5)
September	22.5(5)	183.2(7)	255.0(13)	234.3(11)
October	50.2(5)	67.4(10)	102.7(9)	30.8(4)
November	27.6(6)	128.6(7)	0.0	45.6(4)
December	4.5(2)	0.0	0.0	0.0
Total	1215.9	632.5	1425.7	736.4

The experimental design used was randomized complete blocks with three replications. In all, 35 forage species made up of 21 herbaceous legumes, six shrub legumes and eight grasses were sown (Table 2).

Plot dimensions were 5 m × 2.5 m. Sowing of the herbaceous legumes and grasses was done in four rows per plot at row spacing of 50 cm and scarified seed was drilled in continuous flow in the rows. Shrub species were sown by scarified seed in individual spots 50 cm apart also in four rows. Sowing of all plots was carried out on 22 Aug 91 on cultivated seedbeds. Sample areas on plots comprised 4.0 m^2 (4 m × 1 m) of two central rows of plants.

Establishment period evaluation. Establishment assessments were done at 8 and 12 weeks after sowing using a 1 m^2 quadrat which was subdivided into 25 squares each square with 20 cm sides. Soil cover percentage was estimated with these 25 squares and then total cover was estimated at the two specified times for herbaceous legumes and grasses.

For the shrubs, plant height at 8 and 12 weeks were assessed to measure establishment performance. The dates for the measurements were 22 Oct 91 for the 8-week period and 5 Dec 91 for the 12-week period.

Production period evaluation (primary growth). Primary growth assessments of all the 35 entries were done 6 months after establishment on 24 Feb 92. Herbage material was harvested at 5-10 cm for prostrate species, at 10-15 for erect species and at

TABLE 2

Soil Cover Percentage of Herbaceous Legumes and Grasses and Plant Height of Shrubs at 12 Weeks after Sowing and Dry Matter Yield (t/ha) of All Entries after Six Months Growth (primary growth)

Species/ Accession (herbaceous legumes)	*CIAT No. or Variety*	*Percent soil cover at 12 weeks*	*Dry matter yield (t/ha) (at 6 months)*
Aeschynomene histrix	9690	52.5	2.25
Arachis pintoi	17434	11.0	0.33
Cassia rotundifolia	Wynn	30.5	1.00
Centrossema acutifolium	Vichada	37.5	0.75
Centrosema acutifolium	5568	45.5	1.33
Centrosema brasilianum	5234	59.8	1.25
Centrosema macrocarpum	5452	55.6	1.67
Centrosema macrocarpum	5713	58.4	1.53
Centrosema pascuorum	Cavalcade	39.6	1.42
Centrosema pubescens	5172	40.9	0.83
Desmodium ovalifolium	13089	18.1	1.67
Desmodium strigillosum	13155	2.0	-
Stylosanthes capitata	Capica	27.9	0.38
Stylosanthes guianensis	Pucallpa	48.4	2.03
Stylosanthes guianensis	Pauciflora	28.3	1.92
Stylosanthes hamata	Verano	33.1	0.42
Stylosanthes hamata	147	66.8	1.00
Stylosanthes macrocephala	1281	14.5	0.32
Stylosanthes sympodialis	1044	47.6	0.83
Zornia glabra	8279	42.5	0.92
Zornia latifolia	728	11.5	-
	SE (mean)	(± 5.0)	(± 0.21)

Table 2 contd.

Species/ Accession (grasses)	*CIAT No. or Variety*	*Percent soil cover at 12 weeks*	*Dry matter yield (t/ha) (at 6 months)*
Andropogon gavanus	Carimagua	16.3	0.43
Brachiaria brizantha	La Libertad	31.4	3.67
Brachiaria brizantha	Marandu	18.0	0.83
Brachiaria decumbens	Basilisk	45.5	2.67
Brachiaria dictvoneura	Llanero	12.0	0.50
Brachiaria humidicola	6379	20.6	0.83
Panicum maximum	673	46.0	1.42
Panicum maximum	T58	43.8	2.00
	SE (mean)	(± 6.2)	(± 0.05)

Legume shrubs	*CIAT No. or Variety*	*Plant height (cm) at 12 weeks*	*Dry matter yield (t/ha) (at 6 months)*
Cajanus cajan	18700	130.4	0.70
Cratylia argentea	18516	32.5	0.42
Codariocalyx gyroides	3001	20.9	0.30
Desmodium velutinum	33138	-	-
Flemingia macrophylla	17403	18.6	0.22
Leucaena leucocephala	17502	55.3	0.50
	SE (mean)	(± 2.2)	(± 0.11)

20-30 cm for shrubs on 24 Feb 92. Fresh weight was recorded in the field after the harvests. The harvested samples were sundried for 4 days after which weights were recorded for dry matter on 28 Apr 92.

Trial 2: Evaluation of ILCA species

This evaluation was conducted at two sites, namely, Pokoase (already described) and Nyankpala. Nyankpala (lat. 9° 40'N) lies in the guinea savanna zone has a mean annual rainfall of 1081 mm.

Twenty forage legumes (Table 2) were the entries for evaluation at the two sites. A randomized complete block with four replications was used. The plot sizes were 1 m × 3 m and each was separated by a 1 m path and blocks were separated by 2 m paths. Scarified seed was sown in the 3 m^2 plots in two central rows at 40 cm apart in the length direction of each plot. The Pokoase trial was sown on 1 Jun 92 and the Nyankpala one was sown on 17 Jul 92. Harvesting of herbage for yield assessments was carried out in Pokoase on 16 Dec 92 and at Nyankpala on 10 Dec 92 and these two harvest times coincided with full vegetative development in most entries. One harvest was taken in the centre of each plot with a 1 m^2 quadrat and at between 5-10 cm height. The dry weights of the samples were determined after the samples were dried in laboratory ovens for 48 hours at 60 °C.

Results

Trial 1

Rainfall from August 1991 the start of the trial to the end of the year was high and well distributed (Table 1).

In Table 2 are presented soil cover percentage for grasses and herbaceous legumes and plant height of shrubs and dry matter yields of herbage of all entries. In soil cover percentage (an index of rate of establishment) it could be seen that among the herbaceous legumes, the entries which achieved the most pronounced cover were *Stylosanthes hamta* 147, *Centrosema brasilianum, C. macrocarpum* 5713 and 5452 and *Aeschyomene histrix.* The entries which registered the lowest soil cover were *Desmodium strigillosum, Arachis pintoi, Zornia latifoli, Stylosanthes macrocephala* and *Desmodium ovalifolium.*

In dry matter yields after 6-7 months of primary growth among the herbaceous legume entries, it could be discerned that *Aeschynomene histrix, Stylosanthes guianensis* (Pucallpa), *S. guianensis* (Pauciflora), *Centrosema macrocarpum* 5452 and 5713 and *Desmodium ovalifolium* produced the highest dry matter yields. Corresponding to their low soil cover percentages there were low dry matter yields in *Arachis pintoi, Zornia latifolia, Desmodium strigillosum.*

Among the grasses soil cover percentage was highest in *Brachiaria decumbens* cv. Basilisk and *Panicum maximum* cultivars. The high soil cover values reflected in high dry matter yields in the same entries. However, *Brachiaria brizantha* cv. La Libertad registered the highest dry matter yield with its medium soil cover percentage of 31.4 per cent.

In the leguminous shrubs *Cajanus cajan* produced the greatest height followed by *Leucaena leucocephala.* There was positive relationship between plant height and dry matter yields in all entries.

Trial 2

Overall, there were higher herbage yields for most entries at Pokoase than at Nyankpala because of probably better distribution of rainfall and also a one-and-half months longer growth period in the former site (Table 3).

At Pokoase, the highest dry matter yield entries were *Macrotyloma axillare, Stylosanthes hamata* 167 and 75, *Rhynchosia minima, Lablab purpureus, Stylosanthes guianensis* 4, and *S. scabra* 140 and 441. *Centrosema brasilianum, Centrosema pascuorum* and *Chaemacrista rotundifolia* failed to establish well for no known cause (Table 3).

At Nyankpala, the highest yielding entries were *Stylosanthes scabra, Centrosema brasilianum, Macrotyloma axillare* and *Lablab purpureus* similar to highest yielding species at Pokoase (Table 3).

At both sites, the entries *Zornia latifolia, Chaemacrista rotundifolia* and *Desmodium uncinatum* established poorly or yielded herbage poorly.

Discussion

The forage materials evaluated in Trial 1 were developed by the Tropical Pastures Program,

TABLE 3

Dry Matter Yields after 6 Months Primary Growth of Forage Legumes Entries used in Trial 2 at Two Sites, Pokuase (lat. 5° 40 'N, av. rainfall, 1050 mm) and Nyankpala (lat. 9° 40'N, av. rainfall 1080 mm)

Entry (Species/Accession)	*ILCA No.*	*Dry matter herbage yields (t/ha)*	
		Pokoase	*Nyankpala*
Centrosema brasilianum	6773	-	2.20
Centrosema pascuorum	6774	-	1.60
Centrosema pubescens (Centro)	219	2.41	1.75
Chamaecrista rotundifolia	9288	-	-
Clitoria ternatea	9291	2.33	1.43
Desmodium intortum (Greenleaf)	104	2.12	-
Desmodium uncinatum (silverleaf)	6765	0.82	0.45
Lablab purpureus	147	2.89	1.98
Macroptilium atropurpureum (Sirato)	69	2.26	1.88
Macrotyloma axillare (Archer)	6756	3.29	2.08
Neonotonia wightii (Tinaroo)	6761	2.21	0.18
Rhynchosia minima	13935	2.94	1.45
Stylosanthes guianensis (Cook)	4	2.87	1.33
Stylosanthes guianensis	163	1.94	1.37
Stylosanthes hamata	75	2.73	1.50
Stylosanthes hamata	167	3.07	1.33
Stylosanthes scabra (Seca)	140	2.79	-
Stylosanthes scabra (Fitzroy)	441	2.64	3.40
Vigna unguiculata	9333	-	-
Zornia latifolia	172	-	0.57
	SE (mean)	(±0.55)	(±0.33)

Centro Internacional de Agricultura Tropical (CIAT), Columbia. This trial established that among the herbaceous legumes, *Aeschynomene histrix, Centrosema macrocarpum* varieties, *Desmodium ovalifolium* and *Stylosanthes guianensis* varieties produced the greatest DM in primary growth. For their fast growth these legumes could thus be established for fodder for cut and carry system of feeding ruminants. In Trial 2, fast-growing and high-herbage-yielding herbaceous legumes like *Lablab purpureus, Macrotyloma axillare, Stylosanthes scabra, S. guianensis* and *S. hamata* could also be recommended for cultivation for zero-grazing.

In a study involving the effect of cutting intervals on herbage yields of some legumes in the coastal savanna of Ghana, Adjei & Fianu (1985) found that *Aeschynomene americana* and *Cajanus cajan* produced the highest dry matter yield among the legumes evaluated which included *Stylosanthes humilis, Macroptilium lathyroides, M. atropurpureum, Centrosema pubescens* and *Desmodium intortum.*

In evaluation of *Centrosema* spp. in Puerto Rico, Ramos & Tergas (1990) found that *Centrosema brasilianum, C. pubescens* and *C. macrocarpum* accessions produced the best average soil cover up to 73-84 per cent after 16 weeks from 35 per cent at 12 weeks after establishment. These findings corroborate the observations in the current study. Among the grasses evaluated, *Brachiaria brizantha* (La Libertad). *Brachiaria decumbens* cv. Basilisk and *Panicum maximum* varieties showed the highest DM yields. Heering (1989) evaluated a number of *Brachiaria* species in Zwai, Ethiopia for features like leafiness, plot cover vigour, spread and plant height. He found that accessions of *B. decumbens, B. ruziziensis* and *B. brizantha* showed the best performance for these features. This finding confirms the results in the present study.

Establishment and primary growth of the forage shurbs *Leucaena leucocephala, Gliricidia sepium* and *Cajanus cajan* are very successful in many areas in West Africa (Cobbina *et al.* 1990; Adjei & Fianu, 1985). Primary growth herbage yields of 7 t/ha and 5 t/ha have been obtained in stands of *Leucaena and Gliricidia* after 12 months (Cobbina *et al.*, 1990). The present study also confirmed the fast growth and high productivity of *Leucaena* and

Cajanus cajan.

Forage shrubs evaluated for the first time by the Animal Research Institute in Ghana and which seem to have high potential in herbage production are *Cratylian argentea* and *Codariocalyx gyroides*. In a dry matter yield study of some native legumes and *Codariocalyx gyroides* in Belize, Central Ameria, Lazier (1981) found that *C. gyroides* was the most successful legume among legume entries from the genera *Centrosema, Desmodium, Calopogonium* and species like *Macroptilium lathyroides, Rhynchosia minima* and *S. guianensis*.

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