# MULTIPLE USES OF TROPICAL FORAGE LEGUMES FOR SUSTAINABLE FARMING IN THE MOIST SAVANNAS OF AFRICA

L. Muhr[1], S.A. Tarawali[2,3], M. Peters[2], U. Merkel[1], R. Schultze-Kraft[1] and D. Berner[3]
[1]University of Hohenheim (380), Stuttgart, Germany
[2]International Livestock Research Institute (ILRI), Ibadan, Nigeria
[3]International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria

**ABSTRACT**
Ensuring that farming in the moist savannas of Africa is maintained, despite increasing population pressure and agricultural demands, necessitates the sustainable integration of crop and livestock enterprises; a role that forage legumes can fulfill. The potential of eleven herbaceous and two shrubby species of forage legumes in an improved fallow or ley-farming system to provide dry season fodder and beneficial effects to a subsequent cereal crop were investigated. Fodder dry matter yields were highest for *Stylosanthes guianensis* (9.9 t/ha), *Centrosema pubescens,* and *Aeschynomene histrix*. Maize yield following *S. guianensis* was 138% higher than after natural fallow. Similar increases were obtained after *Calopogonium caeruleum*, *Arachis pintoi* and *Aeschynomene histrix*. Sixty accessions of *A. histrix* were tested for their ability to stimulate suicidal germination of *Striga hermonthica* and thirteen accessions were found to significantly increase germination of striga seeds; this could further enhance farmersí acceptability of this species in areas where this parasitic weed is a devastating problem.

**KEYWORDS**
Crop-livestock, *Striga*, trap crop, improved fallow, ley-farming, maize

## INTRODUCTION

The expansion of land used for cropping necessary to meet the food demands of an increasing population, and the sedentarisation of formerly nomadic pastoralists in traditionally agricultural regions, are main reasons for the emergence of crop-livestock systems in Africa's moist savannas (Jabbar, 1993). The resultant potential for a competitive coexistence of livestock and crop systems could be converted to a synergistic integration of both, if appropriate technologies are implemented. Forage legumes have an important role here, since they may contribute to both enterprises. However, few examples show the potential of forage legumes in crop-livestock systems (ESPGRN, 1994 in Mali; Gibson, 1987 in Thailand; Mohamed Saleem *et al*., 1985 in Nigeria; Sangakkara, 1989 in Sri Lanka; Thomson and Bahhady, 1995 in Syria). Forage legumes are more often studied for their value to either enterprise, but not both. Integration into the mixed farming systems could be facilitated by selecting plant material which benefits more than one farming activity. In an improved fallow or ley farming system, a range of legume species was therefore studied simultaneously for the forage potential and the effect on subsequent crop yields. In addition, the potential to stimulate suicidal germination of *Striga hermonthica* was studied for *Aescheynomene histrix*.

## MATERIALS AND METHODS

Eleven herbaceous (*Centrosema macrocarpum* CIAT 5713, C. *pubescens* I 152, *Stylosanthes guianensis* I 164/CIAT 184, *Pueraria phaseoloides*, *Mucuna pruriens, Desmodium ovalifolium* CIAT 13089, *Zornia glabra* CIAT 8279, *Dioclea guianensis* CIAT 7801, *Arachis pintoi* CIAT 17434, *Aeschnomene histrix* I 12463/CIAT 9690 and *Calopogonium caeruleum* CIAT 8123) and two shrubby (*Flemingia macrophylla* CIAT 17403 and *Cratylia argentea* CIAT 18516) legume species were established along with a natural fallow control in a RCB design with four replications at the beginning of the rainy season (May) 1994 at a farmer's field at Fashola (8°7' N and 3°20' E), Southwest Nigeria. Mean annual rainfall is 1200 mm with a major dry season from November until March. The soil is a Haplustoll with pH of 6.1 and low values for total nitrogen (0.05%), organic carbon (0.64%) and other elements. 30 kg P2O5/ha as SSP was applied to the legumes at planting. Plots (4m x 5m) were weeded after 3, 6 and 9 weeks and replanted where necessary. Forage was harvested in mid dry season (January) and the regrowth sampled at the beginning of the wet season. At this time (May 1995), the regrowth was incorporated into the soil and a low input hybrid maize was planted on ridges prepared by traditional hoe (55,555 plants/ha). Adjacent to the legume trial, maize was also established on plots of 4m x 4m (RCB with four replicates) which were demarcated the previous year and left with the natural fallow vegetation. This maize received 0, 30, 60, 90 and 120 kg N/ha as urea. All maize was given a basal dressing of 60 kg/ha of both $P_2O_5$ as SSP and $K_2O$ as muriate of potash, weeded once after five weeks and harvested in September 1995.

To test the ability of sixty accessions of *Aeschynomene histrix* to stimulate suicidal germination of *Striga hermonthica*, the method described by Berner *et al*. (1995) was used. Preconditioned seeds of *Striga hermonthica* were placed at different distances from root material of *A. histrix* and incubated with distilled water for 48 hours at 28°C. In two controls, a synthetic stimulant and distilled water only were used instead of roots of *A. histrix.* Percentage of seeds germinated was determined, integrated for all distances and statistically compared with a germination of 0%.

## RESULTS

Despite weeding, establishment differed considerably among the tested species with only *M. pruriens* (98%), *C. macrocarpum*, *S. guianensis* and *A. histrix* exceeding 50% soil cover 10 weeks after planting.

The dry matter production of forage 8 months after planting was highest for *S. guianensis* (9.85 t/ha) followed by *C. pubescens* (4.4 t/ha), *A. histrix*, *P. phaseoloides* and *C. macrocarpum* (all more than 3.0 t/ha) (Fig. 1). By this time the two shrubs as well as *Z. glabra*, *A. pintoi* and *D. ovalifolium* yielded less than 2.0 t/ha.

Regrowth four months later and two months after the first rains was highest for *F. macrophylla* (4 t/ha), but exceeded 2 t/ha also for *P. phaseoloides, C. macrocarpum, C. pubescens, S. guianensis* and *C. argentea* (Fig. 1).

After dry season forage utilisation, maize on seven out of the thirteen legume plots gave yields significantly ($P<0.05$) higher than the control with natural fallow (Fig. 2). The highest yields were obtained for *S. guianensis* (238%), *C. caeruleum* (232%), and *A. pintoi* (217%) when compared to the natural fallow control which yielded 1.99 t/ha (100%). In comparison with maize yields from the adjacent natural fallow plots, the highest contribution to maize was obtained by *S. guianensis* which was equivalent to 116 kg N/ha.

Out of sixty accessions of *A. histrix* tested, thirteen accessions caused *Striga* germination rates significantly higher than 0% ($P<0.05$). Highest germination rate was 28.5% for *A. histrix* accession CIAT 8487.

## DISCUSSION

Selecting forage legumes for multiple uses requires testing different properties with relevance for the respective end-uses. The contribution to a subsequent crop consists among others of an enrichment of the soil with nutrients, especially nitrogen fixed by rhizobia associated with the leguminous roots. Since the simultaneous use as source of fodder for cattle involves removing biomass (including nutrients) from the field, it could be surprising that, in the present study, *S. guianensis* gave the best results with respect to both forage production and fertility effect on subsequent maize. Equally, positive effects on maize grain yield showed species with medium (e.g., *A. histrix* and *P. phaseoloides)* as well as low forage yield (*F. macrophylla* and *A. pintoi*). After removal of forage at mid dry season, below-ground biomass (Ledgard and Steele, 1992) and, possibly more important, the biomass produced during the regrowth period prior to maize planting represent sources of nutrients readily available for the following crop cycle. This could be a reason for the outstanding performance of *S. guianensis*, which was also reported by Mohamed Saleem et al. (1985). Positive effects on maize grain yield, however, are not limited to nutrient accumulation, for example, *A. pintoi* and *C. caeruleum* had low yields of both forage and regrowth but resulted in high yields of subsequent maize. This could be due to effects others than nitrogen such as soil physical properties which could lead to improved root development of maize (Hairiah and Noordwijk, 1989). Differences in forage quality, its subsequent decomposition, and therefore effect on the soil are also important components to be considered.

From the present study, *S. guianensis* seems to be a species with high potential for both forage and fallow improvement. Of similar suitability with respect to both uses are also *C. pubescens, P. phaseoloides* and *A. histrix*, the latter additionally showing potential as a trap crop for *S. hermonthica.* Although the quality of the *Striga* test used as such was verified by field experiments with soybean (Alabi et al., 1994), the results for *A. histrix* should still be confirmed in a field study.

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**Figure 1**
Dry season forage yield and subsequent regrowth of selected forage legumes, January to May 1995.
(LSD*: for all treatments except *d. ovalifolium* and natural fallow)

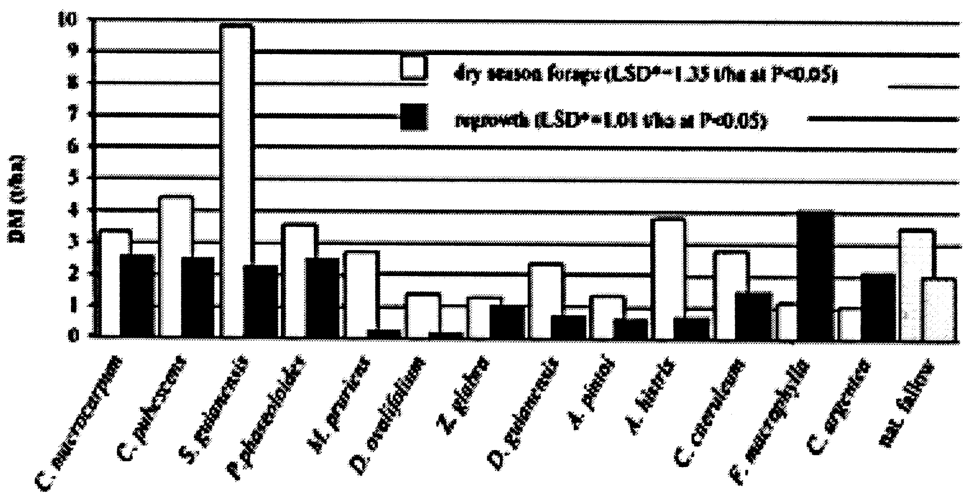


**Figure 2**
Maize grain yield after different forage legumes, main wet season 1995; N fertilizer equivalent indicated.