Artículo Científico

Experiences with legumes as part of a ley pasture in a low input farming system of North-Eastern Pará, Brazil

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Introduction

The traditional agriculture of small farmers in the Bragantina region in northeastern Pará is based on the exploitation of the regenerative potential of the secondary vegetation ("Capoeira"). A fallow period is followed by slashing and burning the accumulated biomass to fertilize the soil for the subsequent cropping phase (Sommer, 2000). The traditional cycle consists of one and a half years of maize (or upland rice) and cassava; some farmers plant beans between the maize and cassava. The cropping phase is followed by 3 to 7 years of Capoeira (Denich et al., 2005). In recent decades cattle production has also become important among smallholders in the region, and as pastures are established, the corresponding land is taken out of the traditional slash and burn cycle (Veiga, 1993; Billot, 1995).

Experience in the Amazon shows that extensively used pastures enter into a process of degradation if not adequately managed. The main reasons are weed invasion, soil fertility decline, and, in the particular case of *Brachiaria* pastures, insect pests (Serrão et al., 1979; Serrão and Nepstad, 1996; Dias-Filho, 2003). Once degraded, pastures are difficult to recuperate and farmers run the risk of losing these areas for agricultural use for a long time (Uhl et al., 1988).

Research on tropical pastures has shown that through the inclusion of legumes, soil fertility can be improved and animal production enhanced (Schultze-Kraft and Peters, 1997). However, replacing the secondary vegetation by a legume pasture means a noticeable decline in biodiversity. As phytodiverse plant communities are assumed to represent a better use of natural resources by e.g. substitutory, compensatory or complementary growth (Ewel, 1986; Altieri and Nicholls, 2004), a combination of different legume species was seen as more promising.

For the humid tropics, among the most promising and productive herbaceous legume species are *Arachis pintoi* Krapov. & W.C. Gregory, *Centrosema pubescens* Benth., *Desmodium ovalifolium* Guill. & Perr., *Pueraria phaseoloides* (Roxb.) Benth., and *Stylosanthes guianensis* (Aubl.) Sw. The most promising and productive legume shrubs for the acid soils that prevail in the humid tropics are *Cratylia argentea* (Desv.) O. Kuntze, *Albizia lebbeck* (L.) Benth., *Calliandra calothyrsus* Meisn., and *Flemingia macrophylla* (Willd.) Kuntze ex Merr. (Gutteridge and Shelton, 1994; Shelton, 2001; Peters et al., 2003; FAO, 2004). Another option is a bushy form of *Chamaecrista rotundifolia* (Pers.) Greene, which had shown excellent results in the Bragantina region (Cruz et al., 1999a). Based

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on the N-fixing potential of legumes it was hypothesized that the unproductive phase of woody fallow could be replaced by a productive grass-legume pasture to intensify land use, thus converting the traditional fallow/crop pattern into a ley-farming system.

This study tests whether through the inclusion of three promising legume species on smallholder pastures the restorative function of a fallow phase can be replaced by a grass–legume pasture, which improves forage biomass and quality for livestock production at the same time.

Materials and methods

This hypothesis was tested in a researcher-managed on-farm experiment, located in the municipality of Igarapé-Açu (State of Pará, Brazil; 47°30' W, 1°2' S). The soil was a sandy brown Latosol of the Tertiary Barreiras formation, characterized by high acidity (pH 5.5 in 0-10 cm and 4.7 in 50-100 cm depth) and low nutrient contents, especially plant available phosphorus (~5 g/kg in the topsoil, Mehlich-I method). The climate is characterized as humid warm tropics (Lauer and Frankenberg classification) with a mean annual temperature of 26.7°C and annual rainfall of 2469 mm, and an extended dry season between August and December (Figure 1).

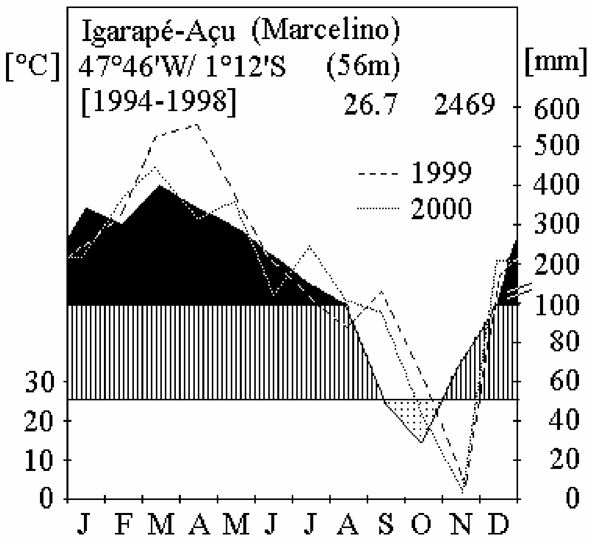


Figure 1. Walter-Lieth diagram of the station "Marcelino" in Igarapé-Açu, complemented by 1999 and 2000 rainfall curves.

The experimental plots were established on a 1.1-ha field, which had been cropped (maize, cassava) for 1.5 years preceded by the slash-and-burn of a 12-year old fallow. Three legume species were chosen for pasture enrichment: the shrubs *Cratylia argentea* cv. Veraniega (BRA 000167) and *Chamaecrista rotundifolia* var. *grandiflora* (BRA 000183), and the herbaceous *Arachis pintoi* cv. Amarillo (BRA 013521), due to their known excellent adaptation to the environment and positive experiences in the region (Fisher and Cruz, 1994; Pizarro and Rincón, 1994; Queiroz and Coradin, 1996; Cruz et al., 1999b). *Brachiaria humidicola* (Rendle) Schweick. (Quicuio-da-Amazônia was chosen as the forage grass due to its ecological adaptation and common use in the region (Camarão et al., 1998). It was planted in 50-cm distances in 5 m broad strips, alternating with *A. pintoi* strips. *Arachis pintoi* was sown in a spacing of 0.5 m x 0.5 m (three seeds per point). Due to insufficient seedling survival, *A. pintoi* was resown four times in the greenhouse and transplanted to the field (Table 1). *Cratylia argentea* and *Ch. rotundifolia* seedlings were also grown under greenhouse conditions in 0.5- and 1-l plastic cups, respectively, containing a mixture of 50% topsoil, 25% of woody splints and 25% chicken manure. Both were transplanted to the field, ten weeks after sowing. While *Ch. rotundifolia* was planted on the *Brachiaria* strips in 1-m distances, *C. argentea* seedlings were planted in a line in the middle of the *Arachis* strips. Late planting was due to difficulties in procuring seed from Costa Rica and delays of the importation process. The legumes were watered on average every three days in the first dry season and initially fertilized with triplesuperphosphate (46% P_2O_5) applied around each plant (P = 3 kg/ha for woody legumes, 8 kg/ha for *A. pintoi*).

Three 1.5-year old cross-bred steers (165-250 kg) were used for each pasture phase and rotated between the three repetitions. Shelters against sun and rain were built, with troughs for salt supply (50 g salt/head/day, water ad lib). The grazing

Table 1. Chronology of pasture establishment and management activities.

Date	Activity
08/03/99-05/04/99	cassava harvest
24/03/99-05/04/99	first weeding, removal of cassava and palm stems
06/04/99-19/04/99	planting of *B. humidicola*
04/05/99	first sowing of *A. pintoi* into the plots
17/05/99-21/05/99	second weeding
01/06/99	sowing of *Ch. rotundifolia* in the greenhouse
14/07/99	first mapping of complete *A. pintoi* establishment
21/07/99-22/07/99	first re-sowing of *A. pintoi* in the greenhouse
11/08/99-17/08/99	transplanting of *Ch. rotundifolia* into the plots
19/08/99-29/12/99	watering of legumes every three days
24/08/99-10/11/99	second transplanting of *A. pintoi* into the plots and third sowing
31/08/99-01/09/99	third weeding
10/09/99-16/09/99	application of insecticide
16/11/99	sowing of *C. argentea* in the greenhouse
16/11/99-17/11/99	elimination of grasses and weeds around *Ch. rotundifolia*
23/11/99-25/11/99	elimination of *B. humidicola* and weeding of *Arachis* strips
03/01/00-04/01/00	third transplanting of *A. pintoi* and fourth sowing in the greenhouse
05/01/00-06/01/00	transplanting of *C. argentea* into the plots, fourth weeding
25/01/00	watering of *A. pintoi*
02/02/00	fertilization of legumes
10/02/00-15/02/00	fourth transplanting of *A. pintoi* into the plots
22/03/00	introduction of cattle on the pasture
01/07/00-03/07/00	fifth weeding
11/07/00	second mapping of complete *A. pintoi* plots
15/08/00	reduction of stocking rate (dry season)
15/01/01-17/01/01	sixth weeding

periods endured 23 and 18 days in the first and second phase, respectively, so that resting periods lasted 46 resp. 36 days. In the beginning of the dry season, stocking rate was adjusted by withdrawing the lightest animal from each treatment. The average stocking rate was 1.48 LU/ha/year (1 LU = 450 kg liveweight) in the first and 1.23 LU/ha/year in the second pasture phase.

Nodule production of the legumes was measured in January 2001 by collecting nodules from the roots of six average plant individuals per plot. For this, soil volume samples were dug out and examined for nodules: For *C. argentea* bushes soil samples of 0.075 m^3 (50 x 50 x 30 cm), for *Ch. rotundifolia* bushes 0.125 m^3 (50 x 50 x 50 cm), and for *A. pintoi* 0.027 m^3 (30 x 30 x 30 cm) were taken according to the different sizes of the plants. The nodules were examined for active N-fixation by checking for internal color shift (Sarrantonio, 1991), dried (62 °C) and weighed (0.01 g precision).

The establishment and development of the three legumes and the forage grass were measured in four 5 m x 20 m permanent observation subplots per plot. Two subplots were allocated in the *Arachis* strips and two in the *Brachiaria* strips in a 10-m distance to the border of the plots. Average heights of all individuals of the woody legumes were measured in these subplots. For *C. argentea*, additionally the number of basal shoots and leaves per plant were counted from all sampled bushes (n = 49), at the beginning (22/03/99) and end (28/08/01) of the grazing experiment. Development of *Ch. rotundifolia* bushes was evaluated by measuring the volume (height x length x width) of twenty individuals in the subplots at 11 sample times. On 20/03/00, the number of all well established bushes was determined. Establishment and persistence of *A. pintoi* were evaluated on 14/07/99 and 11/07/00, i.e. 10 and 62 weeks after sowing, respectively, by mapping the soil cover in 2 m x 2.5 m quadrats along the whole length of all four strips per plot. The soil cover by *A. pintoi* was classified as low (< 33% soil cover), medium (33-66%), and high (> 66%). Furthermore, in the *Arachis* strips the soil cover of all legume species (including new *Ch. rotundifolia* plants that invaded in 2000), *B. humidicola*, weeds, and bare soil was estimated in six fixed sub-subplots, of which two were placed at the borders of the subplots, two in the centre and two in between. Samples were taken in March, May, June, August, September, November and December 2000, and monthly from June to October 2001. Additionally, the soil cover of the forage grass was estimated in the *Arachis* and *Brachiaria* strips in the fixed subplots in February and June 2000, and in January and July 2001.

Results

Nodule production

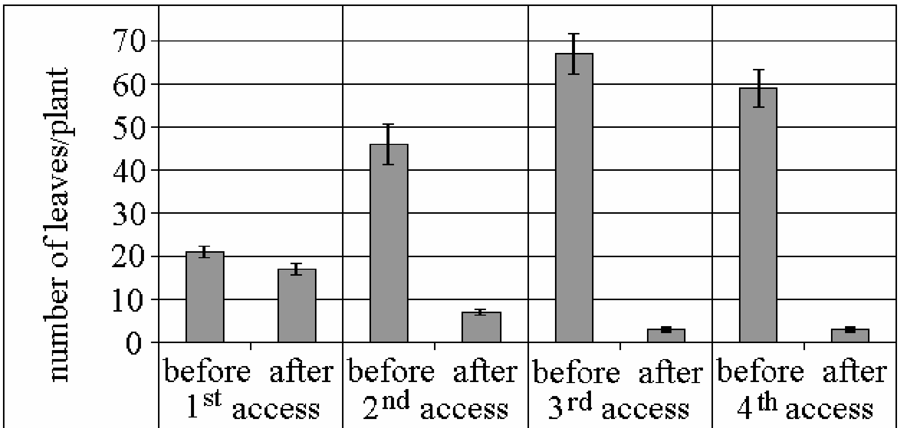
After one year of grazing, the three legume species showed poor total nodule production, especially active nodules (data not shown). There were almost no active nodules on *C. argentea*. *A. pintoi* produced some small active nodules but all measurements showed nodule weights smaller than 1 g DM/plant. *Ch. rotundifolia* had produced a relatively large amount of nodules but active nodules were small (< 1 mm diameter) and weights were less than 1 g DM/plant.

Cratylia argentea

Cratylia argentea bushes did not develop into an important forage resource due to early defoliation by cattle. In the greenhouse, *C. argentea* had high germination (88%) and good initial growth. After transplanting to the field, seedlings persisted well and five months after sowing in the greenhouse they produced on average a basal shoot number of 1.7 (se = 0.02, n = 49) per plant and showed an average height of 41 cm (se = 0.2). Although plants were ignored by livestock in the first months, as was expected from the literature (Argel et al., 2001), they were "discovered" by the animals four months after the start of grazing, and all plants were completely defoliated whenever cattle had new access to the plots (Figure 2). Nevertheless, *C. argentea* regenerated fast after the animals were withdrawn, producing each time a higher number of leaves than before defoliation. The resting period was sufficient to recover but frequent back setting did not allow the plants to produce an important foliage biomass for animals. This was also reflected in the number of shoots stagnating at 1.9 (se = 0.02) and in the low average bush height of 57 cm (se = 0.7), 22 months after sowing. Thirty-three percent of the bushes died during that time. *C. argentea* was evergreen, even at the end of the dry seasons in December 2000 and 2001.

Chamaecrista rotundifolia

Although *Ch. rotundifolia* produced large amounts of biomass, the contribution to animal nutrition was probably very low as plants were little palatable. It showed high germination rates and a good early growth in the greenhouse (data not shown). Also



# examined bushes	105	152	69	123	131	114	114	97

Figure 2. Mean leaf number (+standard error) of *Cratylia argentea* bushes before and after cattle access to the plants (n = 905).

establishment in the field was good, as only 2% of the 1240 transplanted individuals had not survived until the start of grazing in March 2000. By that time, *Ch. rotundifolia* bushes had reached an average height of 92 cm (se = 0.3, n = 44). Plants continued growing vigorously and many bushes reached their maximum height after one year of growth and then stagnated at an average height of 152 cm (se = 0.4, n = 44). All twelve *Ch. rotundifolia* strips in the experiment showed a very dense growth with average volumes of 4.6 m^3 (se = 0.02) two years after transplanting. The large bushes even shaded out the forage grass in the second year. Due to profuse seeding in the second year, *Ch. rotundifolia* spread all over the pasture plots, suppressing the forage grass also in other parts of the plots, e.g. in the *Arachis* strips (Figure 3). In the middle of the second dry season in 2001, the height and volume of the bushes started to decline, bushes dropped their leaves and died not much later, ending their biannual life cycle.

Arachis pintoi

Was highly palatable and contributed to the cattle diet in the rainy season but was quickly defoliated in the dry season so that it did not contribute much during this critical time. *Arachis pintoi* seeds germinated well after direct sowing in May 1999 into the plots, and after one week 5 cm high plantlets were almost evenly distributed. But two months later, major losses of plantlets occurred, especially on plots 6 and 7 (Figure 4), so that the above described re-planting was initiated. Low persistence was probably due to insect pests such as leaf cutting ants (*Acromyrmex* spec.: Formicidae, Myrmicinae) or crickets like *Grilo toupera* (Grilotalpidae). But neither the four re-plantings nor the application of an insecticide led to the expected high soil cover as the pest could not be controlled completely. One year later, the situation had improved, especially on plot 6 (July 2000 in Figure 4), but still 40% of the total area showed low cover. Defoliation by cattle and leaf losses during the dry season also contributed to the rather poor development (Figure 3). *Arachis pintoi* did not invade noticeably the adjacent *Brachiaria* strips.

Brachiaria humidicola

Despite the relatively high stocking rates, the forage grass showed a satisfactory production in the first year but dropped to a critical level in the second dry season (Figure 3). Averaged over the two years of grazing, it showed a soil cover of 90% in the *Brachiaria* strips and 28% in the *Arachis* strips, respectively. At the beginning of grazing, grass soil cover averaged about 90% in the former and 20% in the latter.

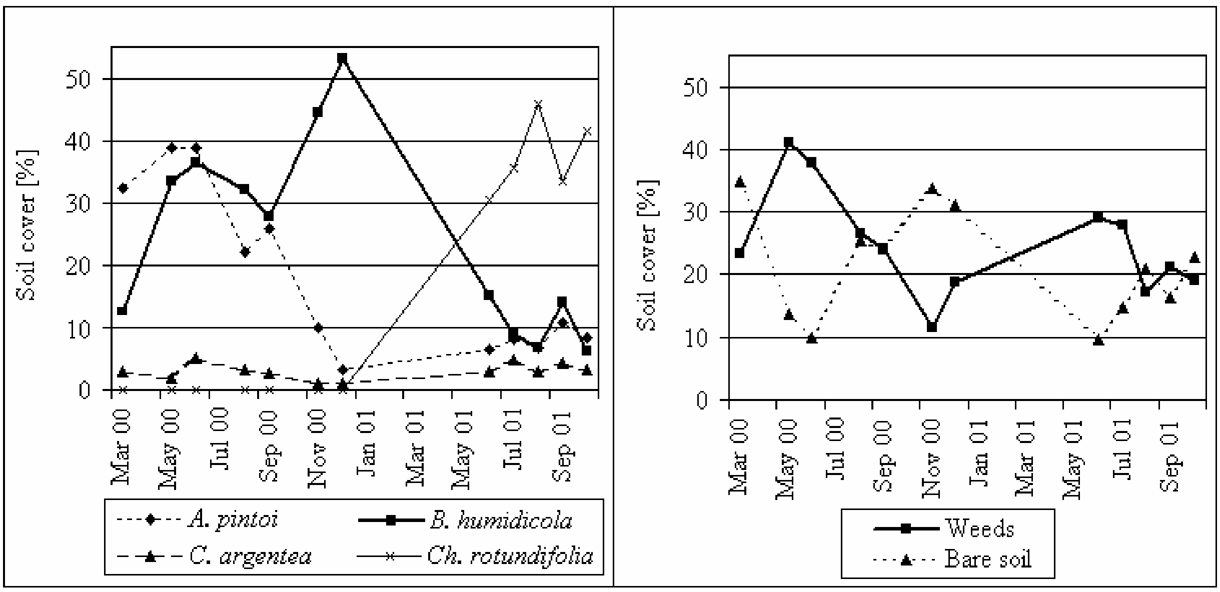


Figure 3. Average soil cover percentage of forage legumes and forage grass (left) and weeds and bare soil (right) on 24 subplots (1 m^2) during the grazing time (n = 2010).

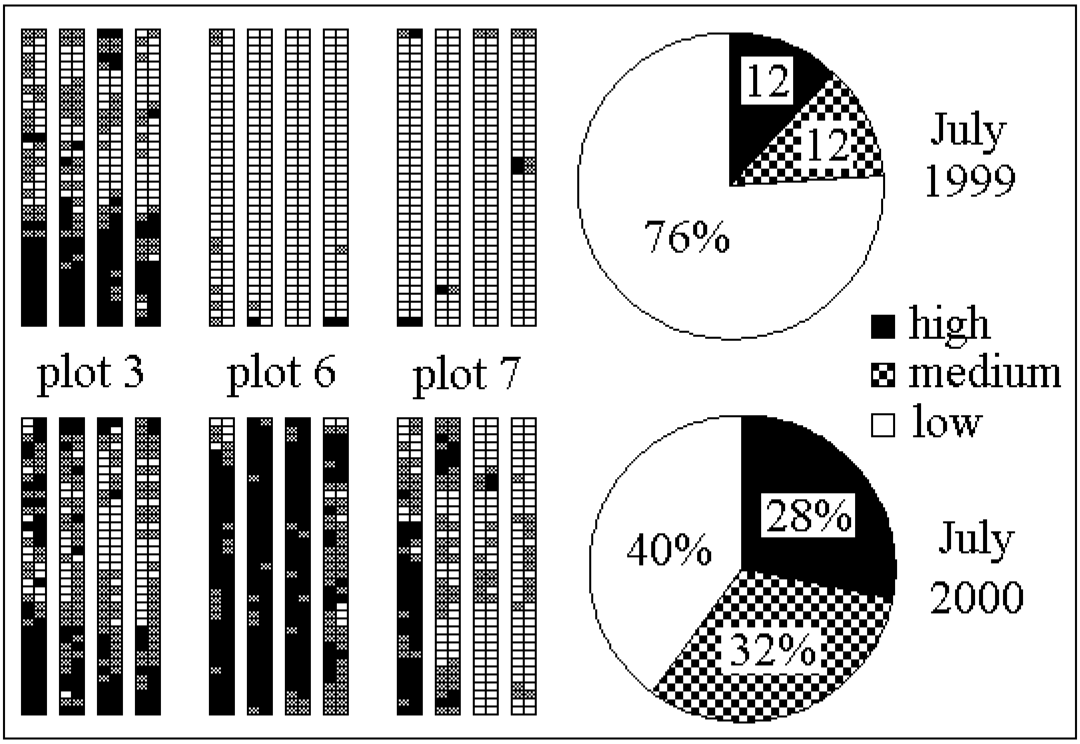


Figure 4. Soil cover of *Arachis pintoi* ten weeks (07/99) and sixty-two weeks (07/00) after sowing on the four 5 m wide strips on the three grass-legume pasture plots (high: >66%, medium: 33-66%, and low: <33% soil cover).

During the establishment year, the grass invasion from the planted *Brachiaria* strips into the *Arachis* strips was so strong that it had to be controlled to reduce competition with *A. pintoi. Brachiaria humidicola* produced high biomass in the first grazing year (data not shown), probably due to the relatively long establishment time of one year. Soil cover remained high even in the first dry season. Only in the beginning of the second dry season, the grass cover of the *Brachiaria* strips got scarcer and dropped to 58%, probably due to the relatively high stocking rates. On the *Arachis* strips, *B. humidicola* increased to a maximum of 60% after one year, before dropping to the minimum of 15% in the second dry season.

Weed infestation

Generally, weed infestation, reflected by the total soil cover percentage by woody and herbaceous weeds, showed a strong seasonal variation (Figure 3). The maximum value of 41% was reached in the rainy season of the first grazing year in May 2000. Thereafter, soil cover decreased constantly until November 2000 when it dropped to 12%. Then weed soil cover started to increase again at the end of the dry season from December 2000 onwards. It reached a new peak (29%) in June 2001, which was considerably lower than in the first grazing year. Subsequently, the weed cover decreased slightly and stabilised at an approximate level of 20% in the following dry season. Inversely, bare soil showed minimum values during the rainy seasons, i.e. 9.8% in July 2000 and 9.6% in July 2001 (Figure 3), while during the dry season it reached maximum values of 35% in November 2000 and 34% one year later. One herbaceous weed that particularly affected establishment and development of *A. pintoi* was bushmint, *Hyptis atrorubens* Poit. (Portuguese: Hortelã brava; Spanish: Marubio oscuro; Lamiaceae). In the first dry season, carpets covering up to 6 m² were observed. Forty-five of the quadrates in the six *A. pintoi* subplots (5% of the area, cf. Figure 4) showed a high cover (> 66%) of this weed. Another important, though less frequent competitor was whitetop sedge *Dichromena ciliata* Pers. (Portuguese: Capim estrela, Spanish: Cortadera estrellita; Cyperaceae). In contrast to *H. atrorubens*, it invaded only bare patches and vanished when *A. pintoi* took over.

Discussion

The overall performance of the grass-legume pasture was rather disappointing and the pasture will probably not be able to fulfil the goal of soil improvement for a subsequent cropping phase. Given the poor nodule production observed in all legumes, it is unlikely that an increased N content in the soil will be achieved. Poor active nodule production of *C. argentea* and *A. pintoi* was possibly due to the lack of inoculation. Furthermore, the biomass production of the more palatable forage legumes was poor and did not contribute much to cattle nutrition. Thus, the hypothesis that the inclusion of three promising legume species in the pasture would replace the soil-restorative function of a fallow phase, and contribute to cattle nutrition at the same time, could not be confirmed.

Poor legume establishment might have been partly due to delayed planting, in the case of *A. pintoi,* i.e. too close to the dry season, and in the case of *C. argentea,* too close to the start of grazing. Also, high mortality of *C. argentea* bushes can be explained by trampling and defoliation of young, small and fragile plants. Thus, the two species should be sown or planted much earlier, if possible even during the preceding cropping phase (e.g. together with cassava) in the rainy season, so that they would reach an advanced stage of establishment before grazing. This would also allow them to develop a stronger root system to withstand the first dry season. Insufficient establishing time was also due to the fact that the grass-legume pasture was simultaneously tested against other alternatives within the major research project (see Hohnwald, 2002), and a delay in the start of grazing of the grass-legume pasture would have prohibited a direct comparison with the other options. Although *C. argentea* and *A. pintoi* are known to have a slow initial growth, legume establishment would probably have been more successful if planting had been done earlier.

Although measurements of the botanical composition of faeces revealed that *Ch. rotundifolia* var. *grandiflora* contributed 15% in the first grazing year and 13% in the second grazing year to cattle diet (Camarão et al., 2003), the individual plants showed only few signs of cattle browsing. The species seems to be of relatively low palatability. This cannot be explained by antinutritive factors such as high tannin content. The tannin content of 31.5 g/kg DM was below the critical level of 50 g/kg, which would negatively affect the nutritive value (Camarão et al., 2004).

Chamaecrista rotundifolia var. *grandiflora* was evidently well adapted to the environmental conditions as could be expected from earlier studies (Cruz et al., 1999a). Its low palatability and early, prolific seed production turned the legume into an aggressive pasture weed in the second grazing year. Poor consumption by cattle could be acceptable if the vigorous growth had led to an increased fixation of nitrogen, which –judging by the poor production of active nodules– was not the case. Thus, the shrubby *Ch. rotundifolia* should better be replaced by another legume species.

A disadvantage of *B. humidicola* within the envisaged long-term ley farming system in which the pasture area is supposed to be turned back into a crop field after six to nine years, is its stoloniferous growth habit: Once established, *B. humidicola* is highly competitive and difficult to eradicate, especially on soils of somewhat higher fertility. Repeated uprooting and ploughing, although expensive, would be the only way to get rid of the grass for the subsequent cropping period. Some stolons might survive in the soil and would lead to higher labour inputs for weeding in the crop fields. Other, somewhat less aggressive grass species should be chosen for this special production system. Maintaining *A. pintoi* on the crop fields could provide atmospheric N for both the pasture and the cropping phases (Fisher and Cruz, 1994). However, well established *A. pintoi* could also develop into a prolific weed, especially on recently sown fields, and would have to be frequently controlled.

Sustaining a well-balanced and productive grass-legume mixture demands appropriate management practices, in particular the adjustment of stocking rates to forage availability. The latter is a problem for many of the Bragantina smallholders as they are predominantly crop farmers and often use cattle as a liquid asset (Siegmund-Schultze, 2002). Frequent sales and purchases of cattle lead to imbalanced stocking rates ranging from 0.37 to 3.53 LU/ha on smallholder farms (Rischkowsky et al., 2003). Poor pasture management has been identified as the most important reason for pasture degradation on smallholdings (Veiga, 1993). Thus, legume-based pastures might be more an option for small dairy farmers in the surroundings of the larger cities or for those, who are explicitly interested in more intensive beef production.

The problems with legume establishment indicate that there is still a need for research on lower-input technologies. Legume research, to be beneficial for smallholdings, has to focus to a greater extent on the feasibility of technology adoption by the farmers. This can only be achieved in close co-operation with the smallholders, who will then decide which management activities are too sophisticated or too risky, and which are adequate. However, an intensification process in agriculture is already taking place in the Bragantina region, where in contrast to other regions in the Amazon, land resources are getting scarce. To make leguminous pastures an option for smallholders in the Bragantina region, the approach of combining various legume species should be pursued.

Conclusions

It is concluded that for a more successful establishment of a grass-legume ley system, the following conditions should be met:

- legume species should be sown or planted much earlier, if possible even during the preceding cropping phase in the rainy season;
- inoculation of legumes with the respective *Rhizobium* seems necessary;
- one criterion in the choice of legume and grass species needs to be ease of eradication after the pasture phase;
- legume species should neither be of high nor of low palatability to assure persistence and a good balance with the forage grass.

Summary

In the Eastern Amazon, extensive pasture management by smallholders often results in degradation processes leading to unproductive and eventually even abandoned agricultural areas. To avoid lengthy and cost-intensive restoration of such areas, ley systems with alternating cropping and pasture phases might be a promising solution. Due to their ability to fix atmospheric nitrogen, the inclusion of legumes is seen as a suitable method to maintain and improve soil fertility during the pasture phase. As mono-cultures seem not to be appropriate, given the phyto-diverse climax vegetation in the humid tropics, a combination of various shrub and herbaceous legume species was proposed in this study. This paper tests whether three promising legume species, in mixture with the pasture grass *Brachiaria humidicola*, have the potential to replace the restorative function of a fallow phase on smallholdings, and at the same time improve forage biomass for livestock production. To test this hypothesis a researcher-managed on-farm experiment was set up at Igarapé-Açu (47°30' W, 1°2' S). The legumes *Cratylia argentea*, *Chamaecrista rotundifolia* var. *grandiflora* and *Arachis pintoi* were planted in association with the grass on 0.3-ha plots. The plots were rotationally grazed at above-average stocking rates (1st year: 1.48 LU/ha/year; 2nd: 1.23 LU/ha/year). Legume nodulation, establishment, and growth were evaluated during the first two years of the pasture phase. Results indicate an unsatisfactory performance of the grass-legume pasture. All legume species showed poor nodule production and did not contribute much to cattle nutrition. Establishment of *A. pintoi* was very poor and even repeated replanting did not result in a full cover. *Cratylia argentea* was heavily grazed at a much earlier stage than expected. Both legumes did not provide much forage biomass, especially during the dry seasons. In contrast, *Ch. rotundifolia* established easily and bushes grew vigorously, as they were not very palatable. Furthermore, due to prolific seeding young plants spread all over the pasture plots even suppressing the forage grass. In conclusion, the grass-legume mixture tested in this study was not fully suitable for the envisaged ley system, and improvements are necessary.

Resumen

En la Amazonía Oriental de Brasil el manejo extensivo de pasturas en fincas de pequeños productores puede resultar en procesos de degradación que conllevan a la aparición de áreas improductivas que muchas veces son abandonadas. Una alternativa posible para evitar una larga y costosa rehabilitación de esas áreas, consiste en la implementación de un sistema de rotación con fases alternadas agricultura-pasturas. Debido a la habilidad para fijar nitrógeno atmosférico, la inclusión de leguminosas en pasturas es considerado un sistema posible para mantener y mejorar la fertilidad del suelo. En el trópico húmedo la vegetación primaria se caracteriza por una alta fitodiversidad y consecuentemente las pasturas monofíticas no son la opción más adecuada. Por lo tanto, en este estudio se probó la hipótesis siguiente: con el uso de tres leguminosas forrajeras (dos arbustivas y una herbácea) es posible substituir la función mejoradora del suelo que tiene una fase de barbecho y al mismo tiempo suministrar forraje a los animales en fincas de pequeños productores. El experimento se realizó en una finca ubicada en Igarapé-Açu en la Zona Bragantina (47°30'W/ 1°2'S) en Brasil. Se utilizaron las leguminosas *Cratylia argentea*, *Chamaecrista rotundifolia* var. *grandiflora* y *Arachis pintoi,* previamente sembradas en invernadero antes de ser plantadas en el campo en asociación con la gramínea *Brachiaria humidicola* en parcelas de 0.3 ha. Las pasturas fueron sometidas a pastoreo en rotación con una carga animal relativamente alta para la región (en el primer año: 1.48 UA/ha y en el segundo: 1.23 UA/ ha). La nodulación y el crecimiento de las leguminosas fueron evaluados durante 2 años. Las leguminosas mostraron una baja nodulación. El establecimiento de *A. pintoi* fue difícil y sólo después de varias resiembras se logró una adecuada cobertura. *Cratylia argentea* no se estableció bien, ya que antes de lo esperado fue intensamente consumido por los animales. Las especies de leguminosa no contribuyeron significativamente a la producción forrajera y la población de *A. pintoi* se redujo drásticamente durante la época seca. Aunque el establecimiento de *Ch. rotundifolia* fue fácil, las plantas presentaron una baja palatabilidad para los animales y se convirtieron en vigorosos arbustos; además, debido a su abundante producción de semilla se extendió por todo el área afectando, incluso, el crecimiento de la gramínea. Como conclusión, la asociación gramínea/ leguminosas estudiada no cumplió su función en el sistema visualizado de 'ley-farming' y la respectiva tecnología requiere ser mejorada.

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