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# 1979
# Tropical Pastures Program
# Annual Report



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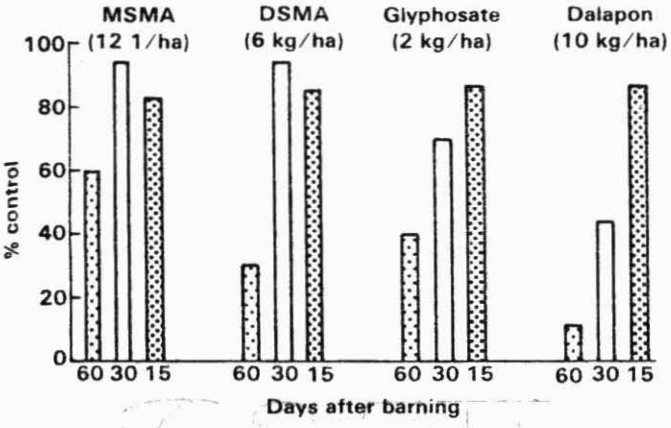


Figure 41. Effect of delaying the application of herbicides after burning on control of native savanna vegetation.

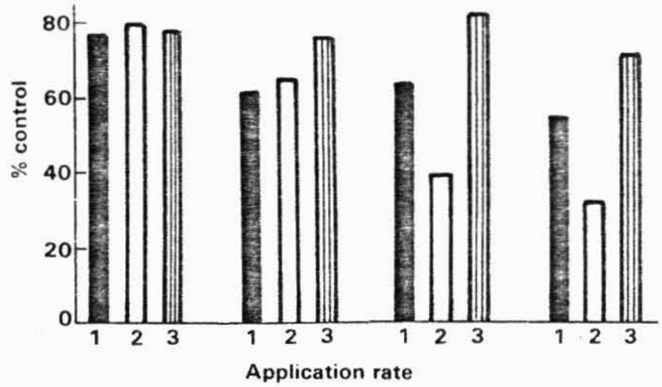


Figure 42. Effect of herbicide application rate on control of native savanna vegetation (1 = recommmended rate; 2 = twice the recommended rate; 3 = three times the recommended rate fitures in parenthesis are the recommended application rates.)



# PASTURE DEVELOPMENT IN THE THERMIC SAVANNAS (CERRADO)

The objectives of the Pasture Development section of the Cerrado are: (1) to develop efficient systems of establishing forage legumes and grasses appropriate for representative ecosystems in Cerrado type savannas of South America and (2) to determine establishment and maintenance fertilizer requirements for the most promising grasses and grass/legume associations for the area.

The pasture development strategy adopted at the Cerrado center was presented in the CIAT 1977 Annual Report. The research activities designed to fill the technological gaps for implementation of this strategy include: (a) identifying the most important edaphic factors limiting pasture establishment, with emphasis on legumes; (b) determining establishment and maintenance requirements of selected grass/legume associations for Cerrado soil conditions; (c) developing efficient systems for pasture establishment with emphasis on minimum inputs; (d) developing renovation techniques for degraded pastures.

## Identification of Nutrient Deficiencies

The main nutrient deficiency in the Cerrado soils is phosphorus. Other nutrients including K, Mg, Zn and Mo have been identified as limiting for some crops. Pasture species, especially the forage legumes, have specific nutrient needs to assure establishment, productivity and persistence. These requirements vary from soil to soil and among species.

Exploratory fertility experiments were initiated in 1978 on two important Cerrado soils, Yellow Red Latosol (LVA) and Dark Red Latosol (LVE), using *Centrosema pubescens* CIAT 438 and *Calopogonium mucunoides* as test forages. The experiments consisted of $2^8$ factorials in a fractional replication design that included Ca, Mg, K, S, Cu, Zn, Mn, Mo and B. All pots received basal application of P equivalent to 100 kg P/ha. The effect of levels of P and $CaCO_3$ were studied in a parallel experiment.

There was a significant response to 30 kg S/ha (CIAT Annual Report, 1978) with *Centrosema* in the LVE soil. *Calopogonium,* which responded to S, also responded to 500 kg $CaCO_3$/ha. Both legumes also responded to K in both soils. Mg was not as important as S, Ca and K, but interactions of Mg with S and Mo were detected. Based on the greenhouse results, a field experiment including similar treatments was established.

A parallel experiment with levels of 50, 100, 200, and 400 kg P/ha and 0, 100, 500, and 1000 kg $CaCO_3$/ha, showed the importance of Ca as a nutrient.

Ca and P content in *Calopogonium* plants varied with $CaCO_3$ and P levels, as shown in Figures 43 and 44. It is interesting to note that when no lime was applied to the LVA soil, *Calopogonium* plants contained less than 1% Ca, unless more than 200 kg of P as monocalcium phosphate were applied. On the other hand, when high levels of P were applied, plants contained more than 1% Ca even without lime. Plants grown in the LVE soil followed the same trend but seemed to require more $CaCO_3$ or phosphate to reach desirable tissue Ca values. This points out the importance of Ca and the possible need for additional Ca when a low Ca P-source, such as triple superphosphate (TSP) is used.

Plant Mg content decreased with increasing levels of $CaCO_3$ in both soils but more in the LVA than in the LVE, reaching extremely low values when 1000 kg $CaCO_3$/ha were applied. It is clear that a balanced supply of both Ca and Mg is required for optimum growth.

Field experiments are now under way to confirm these results and to determine optimum levels of Ca, Mg, K and S.

## Phosphate Requirements for Andropogon gayanus Establishment

A field experiment was initiated in 1979 to determine P requirements for establishment and early growth of *A. gayanus* and *S. capitata* and to evaluate different sources of P. Levels of 0, 60, 120 and 240 kg/ha of $P_2O_5$ were applied as triple superphosphate (TSP), Araxa rock phosphate and thermophosphate (a heat-treated rock phosphate). The basal application

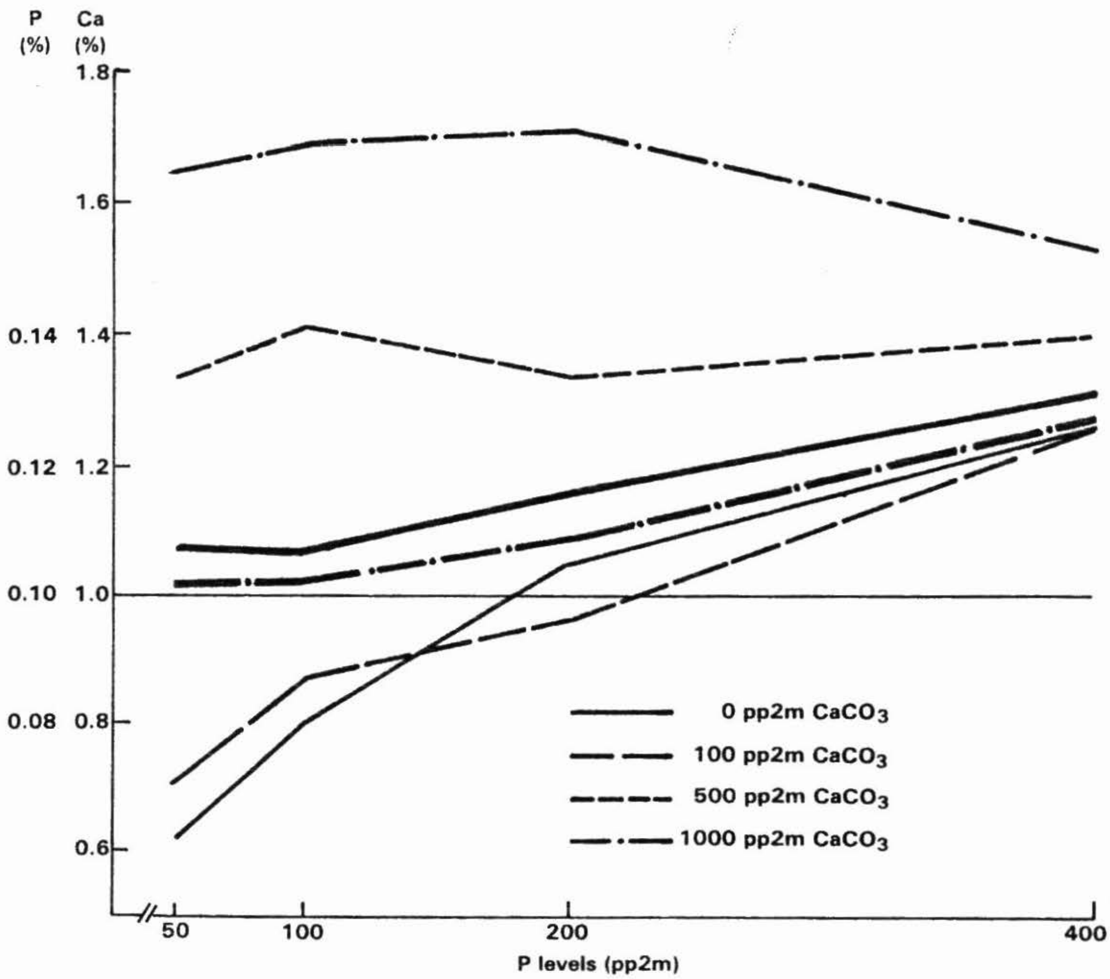


Figure 43. Effect of different levels of applied P and $CaCO_3$ on Ca and P contents in *Calopogonium mucunoides* plants grown on a LVA soil under greenhouse conditions.

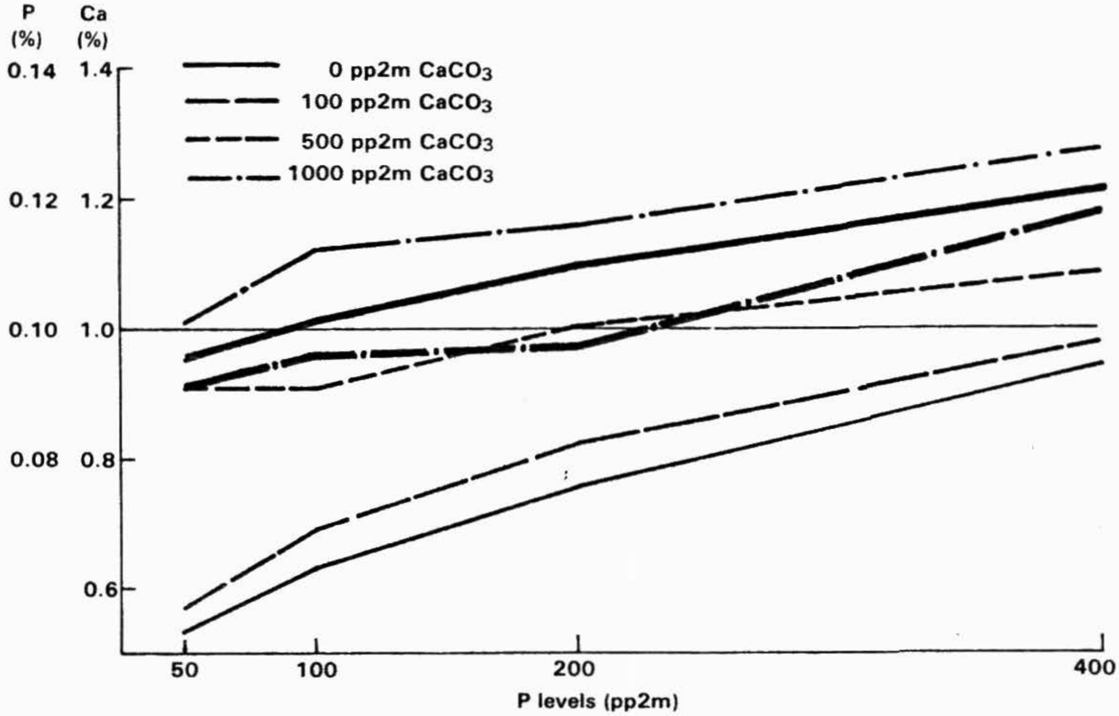


Figure 44. Effect of different levels of applied P and lime on Ca and P contents in *Calopogonium mucunoides* plants grown on a LVE soil under greeenhouse conditions.

consisted of 50 kg S/ha, 100 kg $K_2O$/ha, 5 kg Zn/ha, and 0.5 kg of ammonium molybdate/ha. A mixture of *A. gayanus* 621 and *S. capitata* 1078 was planted at seeding rates of 6 and 4 kg/ha, respectively, in recently prepared virgin land.

Good establishment was observed for both species as indicated by the number of plants/U.A. in all plots, except the checks. However, initial plant growth was very slow for all treatments. *S. capitata* did not produce high dry matter and by the time the pasture was cut at 15 cm height it was almost pure grass.

Figure 45 shows dry matter production as a function of P levels of three sources. With no added P there was no measurable growth reflecting the extreme P deficiency in this soil. Maximum dry matter production was obtained with 240 kg of $P_2O_5$/ha as thermophosphate, and the response was linear over the range of P utilized in the experiment. It appears that 240 kg $P_2O_5$/ha was too low for maximum growth in this soil. The TSP treatment produced less than thermophosphate at all but the lowest level (60 kg $P_2O_5$/ha) at which production was similar. Maximum production with this source was reached at 120 kg $P_2O_5$/ha with some decrease at a higher level. Araxa rock phosphate resulted in good response with production similar to TSP at the rate of 240 kg $P_2O_5$/ha.

The rapid fixation of water soluble P and the initial low availability of P from rock phosphate may explain these differences in plant performance. However, available P was very high at the highest level of applied TSP as shown in Figure 45. Plant analysis showed clearly that the main parameter associated with the higher production observed for thermophosphate was the Mg content in the plant tissues. Mg was considerably higher at all levels of applied thermophosphate (Table 43). Plant content of P was low for all treatments. However, P values were similar to or higher than at all levels of TSP which performed poorly. These results confirm the importance of Mg for pasture species in this soil and coincide with the results of the greenhouse experiment.

The effect of source and level of phosphate on P, exchangeable Ca, and Mg in the soil are shown in Figure 46. High levels of applied phosphate of all sources resulted in increased exchangeable Ca. Exchangeable Mg increased when thermophosphate was used but decreased when TSP or Araxa rock

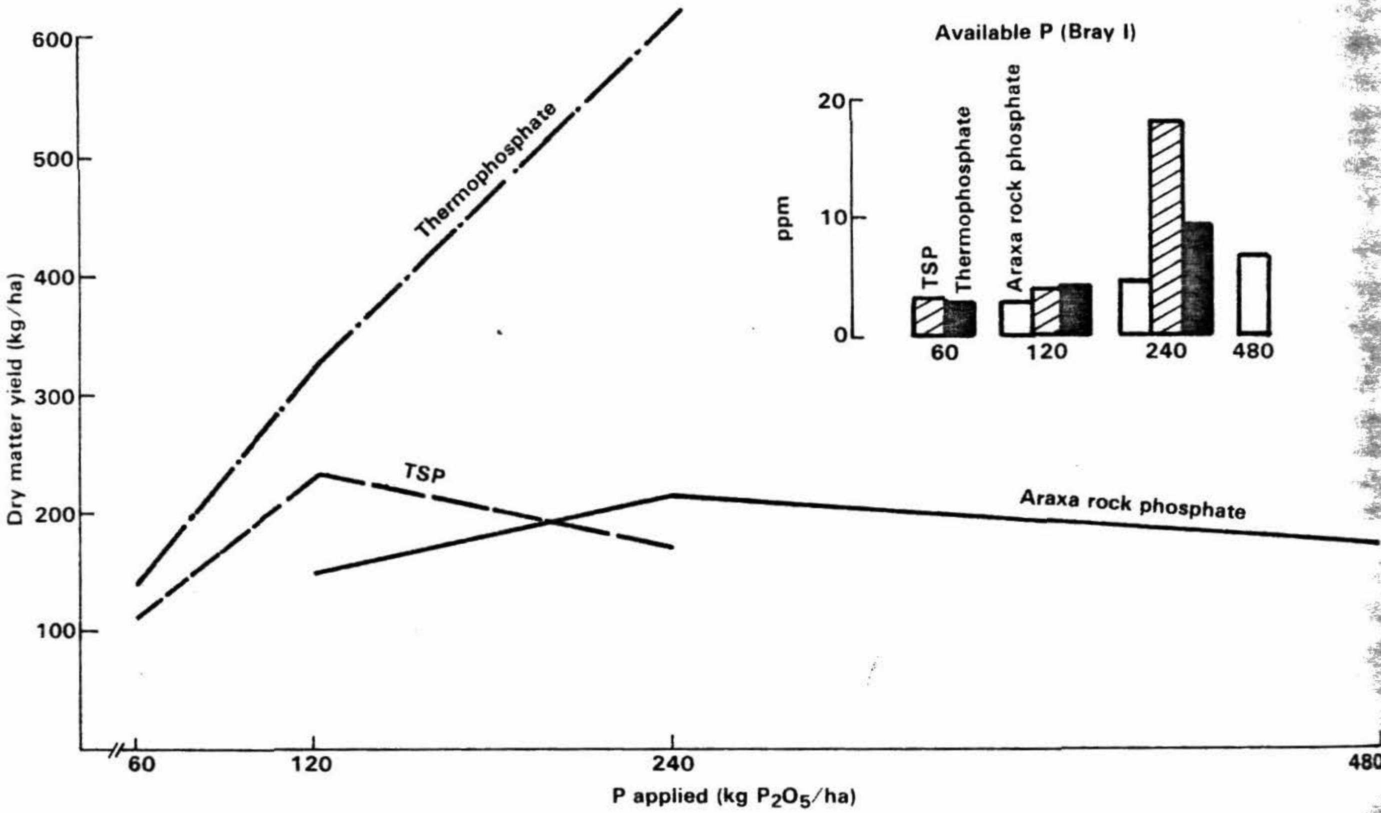


Figure 45. Effect of source and level of P on total dry matter of an *Andropogon gayanus/Stylosanthes capitata* pasture (first cut) and on available P in a LVA soil.

**Table 43.** Effect of three levels of applied P from three sources on content of P, Ca and Mg in Andropogon gayanus and Stylosanthes capitata (as percent of dry matter) grown in the field on a LVA soil in the Cerrado of Brazil. (Means of three observations.)

| P sources | 60 P | 60 Ca | 60 Mg | 120 P | 120 Ca | 120 Mg | 240 P | 240 Ca | 240 Mg |
|---|---|---|---|---|---|---|---|---|---|
| | Andropogon gayanus | | | | | | | | |
| TSP | 0.07 | 0.21 | 0.12 | 0.07 | 0.21 | 0.13 | 0.08 | 0.24 | 0.14 |
| Thermophosphate | 0.07 | 0.23 | 0.15 | 0.07 | 0.19 | 0.17 | 0.07 | 0.30 | 0.23 |
| Araxa rock phosphate | | | | 0.07 | 0.23 | 0.14 | 0.07 | 0.22 | 0.11 |
| | Stylosanthes capitata | | | | | | | | |
| TSP | 0.09 | 0.74 | 0.20 | 0.09 | 0.78 | 0.20 | 0.10 | 0.87 | 0.21 |
| Thermophosphate | 0.09 | 0.83 | 0.24 | 0.09 | 0.78 | 0.25 | 0.10 | 0.78 | 0.31 |
| Araxa rock phosphate | | | | 0.09 | 0.91 | 0.21 | 0.10 | 0.81 | 0.20 |

P applied (kg $P_2O_5$/ha)

LSD at 0.05 = 0.01 (P); 0.02 (Mg); 0.07 (Ca).

phosphate were used, thus supporting the hypothesis that the response to thermophosphate was due not only to P but to increased Mg availability as well.

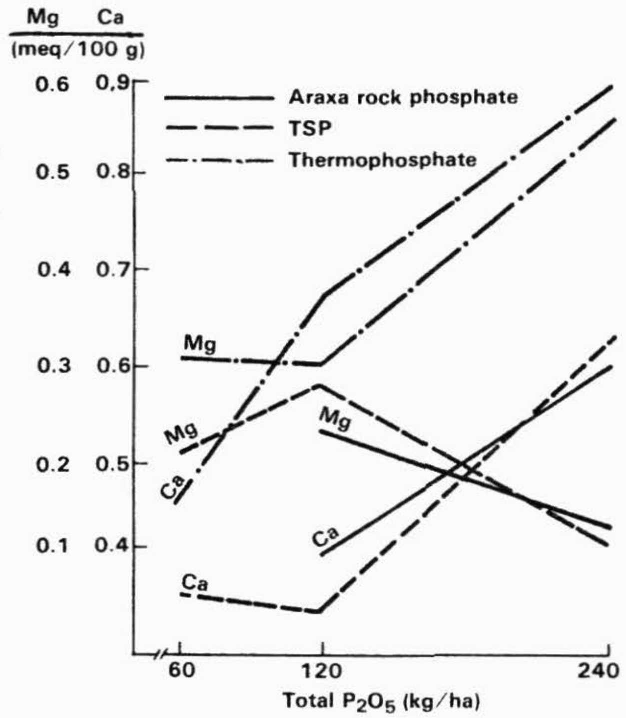


Figure 46. Effect of source and level of phosphate on exchangeable Ca and Mg in a LVA soil.

## Adaptability of Two Grasses to Varying Levels of P and pH

*Panicum maximum* var. Trichoglume is widely used in more fertile Cerrado areas or after high levels of lime and fertilizer have been applied. This high quality grass is known for its high productivity and drought tolerance. *A. gayanus* is less demanding than *P. maximum* and appears to be equally compatible with legumes. With the purpose of defining the optimum range of pH and available P for these two grasses in association with legumes, a trial was initiated on an old experimental site where a wide range of phosphate levels from different sources (0, 86, 345, and 1380 kg $P_2O_5$/ha) and lime (0, 1.5 and 4.5 t $CaCO_3$/ha) were applied in 1973. In 1978, the soil pH ranged from 4.1 to 5.7 and P levels from 0 to 130 ppm. No additional fertilizer or lime was applied.

The associations *P. maximum* var. *Trichoglume/Macroptilium atropurpureum* and *A. gayanus* 621/*S. capitata* 1078 were planted in a factorial arrangement in a split-block experimental design.

The initial development of both legumes was slow while the grasses generally exhibited vigorous early growth, accounting for most of the dry matter production.

Figure 47 shows the effect of $CaCO_3$ and phosphate levels on dry matter production of the two grasses. *A. gayanus* performed well, especially when lime was also applied. At higher levels of phosphate (345 kg $P_2O_5$/ha) no effect of lime was observed in *A. gayanus* production. This has been interpreted as a response to Ca rather than to lime *per se,* since phosphate application increased Ca in the soil but did not modify the pH. *P. maximum* responded to lime at all but the highest level of phosphate (1380 kg $P_2O_5$/ha) probably because of its lack of tolerance to high exchangeable Al levels.

Detailed soil sampling has been done as a basis for determining the optimum available P and pH ranges for growth and grass/legume ratio.

## Introduction of Legumes into Native Pastures

Native pastures are an important component of farming systems in the Cerrado. They are very low in both productivity and quality, especially during the dry season. The introduction of legumes into native pastures could increase their productivity due to increased N fixation and improved forage quality and consumption during the dry season.

A field experiment was initiated in 1978 to study establishment methods for three legume species. Establishment was better for those methods which included some soil disturbance like disking or sodseeding, independent of burning.

The methods investigated included oversowing undisturbed pasture, oversowing after light disking, and sodseeding in rows spaced 50 cm apart all with and without previous burning. Burning was done in December. Two controls, one with fertilizers alone and no tillage, and another with planting and disking plus 1 t $CaCO_3$/ha, were included.

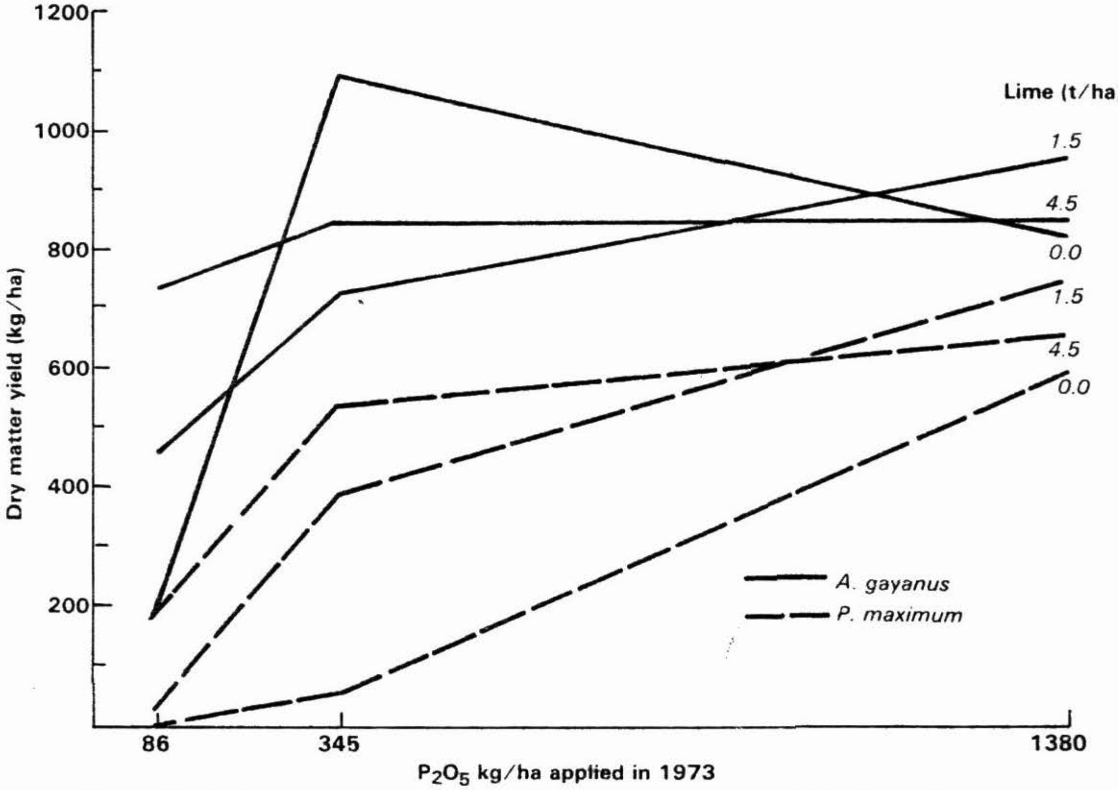


Figure 47. *Andropogon gayanus* 621 and *Panicum maximum* var. Trichoglume dry matter production as a function of levels of P and lime applied in 1973, in a LVE soil of the Cerrado of Brazil, 1979.

*Galactia striata, C. mucunoides* and *S. capitata* were seeded at 6, 9 and 4 kg/ha, respectively.

The effects of establishment method on stand counts have been reported (CIAT Annual Report, 1978). The effect on the native pastures can be observed in Table 44. Disking reduced dry matter production, especially when combined with burning. Sodseeding was as effective as disking in terms of established legume stand and had less effect on native pasture production. Burning did not improve legume establishment and severely decreased pasture productivity.

**Table 44.** The effect of tillage and burning and legume introduction on yield of native grasses after one year.

| Establishment method | | Native grass dry matter yield |
|---|---|---|
| Disking | Burning | (kg/ha) |
| - | - | 949 |
| - | + | 590 |
| + | - | 467 |
| + | + | 142 |
| Sodseeding | Burning | |
| + | - | 919 |
| + | + | 305 |

The initial growth of legumes was very slow. However, a reasonable number of plants survived and produced abundant seed during the first year. Growth during the second year was much more aggressive; *C. mucunoides* tended to dominate native vegetation and extend outside the plots. *G. striata* produced more harvestable dry matter due to its erect growth habit. The cutting height was 15 cm which missed most of the *C. mununoides*.

In treatments which resulted in poor growth of native grasses, legumes established well and significantly increased dry matter and protein production. By the end of the rainy season, crude protein of the grasses was as low as 4%; legumes ranged over 14%.

## Renovation of a Brachiaria Pasture

*Brachiaria decumbens* has been extensively planted in the Cerrado and is presently the most important cultivated grass in the area. Once P deficiency has been corrected, productivity of this grass depends mainly on soil N availability. N fertilizers are too expensive for use in beef production under Cerrado conditions.

*B. decumbens* is initially an aggressive grass which is difficult to associate with legumes. In the absence of legumes, organic soil N mineralization decreases with time and reaches a relatively low rate, severely limiting productivity. In addition, forage quality of grass swards decreases sharply during the dry season. The introduction of legumes into grass pastures could contribute to improved quality and increased availability of forage throughout the year and especially during the dry season.

An experiment was initiated early last rainy season in a 6-year old *B. decumbens* pasture, in which four methods of introducing three legumes were studied. Control plots with no legumes were fertilized with 0, 60 and 120 kg N/ha. The establishment methods tested were (a) oversowing with no seed bed preparation; (b) planting in 1.5 m wide strips with complete seed bed preparation; (c) oversowing after moderate disking; and (d) sodseeding. A basal application of 90 kg $P_2O_5$/ha, 100 kg $K_2O$/ha, 0.5 kg of sodium molybdate/ha and 4 kg Zn/ha was used. *C. mucunoides, Desmodium ovalifolium* 350 and *C. pubescens* 438 were planted at 4, 3 and 4 kg/ha, respectively.

*Calopogonium* establishment was good in all treatments except oversowing and competed strongly with the grass during the first year. *Centrosema* and *Desmodium* established reasonably well but growth was poor during the first year. Forage quality is being monitored throughout the year.

# PASTURE UTILIZATION

The Pasture Utilization section conducts its research activities at CIAT-Quilichao and Carimagua. Due to the specific conditions of each site, the more basic less location-specific studies, which require less land but intensive observation and sophisticated methodology, are carried out at CIAT-Quilichao. Large grazing experiments are located at Carimagua.

The section concentrates its efforts in (1) evaluating the nutritional value of new forage material, (2) studies on pasture grazing management, and (3) pasture evaluation measured by animal production potential.

## Nutritional Value of Promising Germplasm

The working program of the section includes mainly studies on intake and *in vivo* digestibility of grasses with emphasis on *Andropogon* and legumes, particularly *Desmodium ovalifolium* and *Stylosanthes capitata.*

More attention will be placed on measuring the nutritional value of forage under grazing conditions, since it is recognized that results obtained with confined animals are in certain cases misleading, as in the case of *D. ovalifolium,* which was well accepted by crated wethers (CIAT Annual Report, 1978, p. B-112), but apparently not palatable to the grazing animal.

At Carimagua, experiments with oesophageal fistulated steers were initiated to study selective grazing on different Category 4 legumes in mixtures with *A. gayanus.* Emphasis will be placed on the effect of the season of the year on the qualitative diet composition as compared to botanical composition of the available forage.

## Grazing Management of Grass/Legume Mixtures

At CIAT-Quilichao, there are two similar sets of experiments to evaluate *Centrosema pubescens* (hybrid) 438 and *D. ovalifolium* in association with three grasses *(A. gayanus, Brachiaria decumbens,* and *Panicum maximum)* in separate blocks within a grazing unit.

Each set of experiments includes rotational grazing at 4, 6, and 8-week intervals and two grazing pressures (6.5 and 13.0 kg dry matter/animal/day), as well as continuous grazing with fixed stocking rate.