

Harry Stobbs Memorial Lecture

Managing the grazing resource for animal production in savannas of tropical America

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Abstract

Research carried out to evaluate management options and animal production potential of native and improved pastures in savanna regions of tropical America is reviewed, with emphasis on Colombia's Eastern Plains. In areas with limited infrastructure native grasses are the main forage resource and weight gains of cattle grazing these native pastures with burning and mineral supplementation vary from 70 to 90 kg/hd and from 15 to 20 kg/ha. As infrastructure improves, the strategic use of grass-legume pastures to complement the native savanna, together with the use of mineral supplementation, could increase individual weight gains by 40 percent. In savanna areas with good infrastructure, improved grasses adapted to acid soils replace the native vegetation and, together with mineral supplementation and appropriate grazing management, increase animal production/unit area 10 times compared to native pastures. However, these pastures do not persist over time because of N deficiency and pests. The highest and more stable gains could be obtained with legume-based pastures, which, in turn, depend on high management inputs. On the acid soils of tropical American savannas, these legume-based pastures can play an important role in agropastoral systems.

Resumen

Se revisan las investigaciones realizadas para evaluar opciones de manejo y medir el potencial de producción animal de pasturas nativas y

mejoradas en regiones de sabanas de América Tropical, con énfasis en los Llanos de Colombia. En áreas con escasa infraestructura, la vegetación nativa es el principal recurso forrajero y las ganancias de peso de bovinos en estas pasturas nativas con quema y suplementación mineral varía entre 70 y 90 kg/animal y entre 15 y 20 kg/ha. A medida que mejora la infraestructura, el uso estratégico de pasturas de gramíneas/leguminosas para complementar la sabana nativa conjuntamente con el uso de suplementación mineral podrían aumentar las ganancias de peso individuales en 40%. En áreas de sabana con buena infraestructura, las gramíneas mejoradas adaptadas a los suelos ácidos reemplazan la vegetación nativa y junto con suplementación mineral y manejo del pastoreo adecuado, incrementan 10 veces la producción animal/unidad de área en comparación con las pasturas nativas. Sin embargo, estas pasturas no persisten a través del tiempo debido a deficiencia de N y ataque de plagas. Las mayores y más estables ganancias de peso a través del tiempo se pueden obtener con pasturas a base de leguminosas, las cuales, a su vez, tienen altos requerimientos de manejo. En los suelos ácidos de las sabanas tropicales de América, las pasturas a base de leguminosas pueden desempeñar un papel importante en sistemas agropastoriles.

Introduction

Savannas of Tropical America are among the major resources available in the continent for cattle production. These savannas, which cover approximately 200 million ha when considering Brazil, Colombia and Venezuela, have variable topography and natural vegetation (Tamia 1966; Blydenstein 1967; Eiten 1972). Common characteristics of tropical savannas are the extreme acidity and low fertility of the soils (Sánchez and Isbell 1979) and a well defined dry season, which varies in length from 4 to 6 months depending on the region (Cochrane 1986).

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The grazing resource and production systems in savanna regions vary with the degree of infrastructure (Vera and Sere, 1985). In areas of savanna with poor infrastructure, native grasses are the main forage resource for extensive low input cow-calf production systems. With the improvement of infrastructure the native herbaceous vegetation is being rapidly replaced by sown pastures, which allow an intensification of the production systems towards fattening and milk.

The objective of this paper is to summarize research carried out to evaluate management options and the animal production potential of native and sown pastures in savanna regions of Tropical America with different degrees of infrastructure and with emphasis on the Colombian Llanos.

The native grassland resource and animal production

The traditional management of native pastures in savanna regions includes burning at least twice a year (end of rains and end of dry season) and continuous grazing with low stocking rates (5-10 ha/hd) (Vera and Sere 1985). Cattle are supplemented with minerals, but in a very irregular manner. With this management animal production is low, as reflected by liveweight gains of 50-70 kg/hd/yr (Paladines and Leal 1979) and calving rates of 50% (Vera and Sere 1985). The low animal production in native pastures in savanna regions is mainly due to poor nutrition all year round, which in turn is associated with the low quality of the native grasses.

Nutritive value of grasses in savanna

The great variability of the vegetation of tropical American savannas makes it difficult to make general statements regarding the nutritive value of the plant species most commonly grazed by cattle. This is particularly true when comparing regions such as the Cerrados in Brazil and the Llanos of Colombia and Venezuela. In the Brazilian Cerrados a great diversity of vegetation is available and selected by grazing animals, including grasses, shrubs and trees (Ferreira *et al.* 1982). In contrast, in the Llanos of Colombia the

diet of the grazing animal is composed of grasses of different qualities depending on species (Hoyos and Lascano 1988).

In spite of the diversity of native grasses in tropical savannas one characteristic that is associated with native grasses is a rapid decline in quality following burning. This has been documented with species of the genus *Trachypogon* (Espinoza 1969; Huertas *et al.* 1978; Paladines and Leal 1979) and *Axonopus* (Huertas *et al.* 1978). The rapid decline in quality of native grasses adversely affects voluntary intake, as has been reported by O'Donovan *et al.* (1982) in Campo Grande, Brazil.

Research conducted in the Llanos of Colombia has indicated that mineral and energy deficiencies limit animal performance in native pastures. Lack of minerals in cattle grazing native savanna pastures has been associated with a reduced calf crop and reduced liveweight gains. For example, it has been shown that in the Llanos of Colombia by supplementing a cow-herd with a salt-mineral mix with 8% P, calving rates were increased from 43 to 61% and calf crop from 31 to 61% (Stonaker *et al.* 1987). Indications were strong that low calving rates of non-mineral-fed cows are more related to abortion losses than to conception failures.

A common generalization is that protein deficiency is the main limiting factor which affects performance of cattle grazing native savanna pastures, particularly during the dry season. This idea has been supported by low crude protein levels of the forage on offer following different dates of burning (Paladines and Leal 1979) or by improvements in the order of 30% in liveweight gain of steers or heifers grazing savanna complemented with a protein bank (Tergas *et al.* 1983; Zobby *et al.* 1989). However, other studies have shown that the diet selected by esophageal fistulated steers in native savanna pastures managed with fire is only marginal in protein (<6% crude protein) in parts of the dry season, whereas digestibility is low ($\leq 45\%$) throughout the year (Alvarez and Lascano 1987; Scheneichel *et al.* 1988a, b). As a result, liveweight gain has been poorly correlated with protein in the diet selected, but highly correlated with digestibility (Alvarez and Lascano 1987). In addition to the low digestibility of native savanna grasses, cattle tend to graze burnt areas where dry matter availability is as low 200-300 kg/ha, thus limiting intake of digestible energy (Alvarez and Lascano 1987).

In the Brazilian Cerrados, cattle have been found to select grasses in the wet season and leaves from shrubs and trees in the dry season (Ferreira *et al.* 1982). As a result of this seasonal selectivity, crude protein in the forage selected by esophageal fistulated steers was adequate throughout the year. In these studies in the Cerrados, differences in animal gain were best explained by including digestibility of the forage selected and voluntary intake in a stepwise regression model (Escuder *et al.* 1979).

Management options in native savanna pastures

Initial work carried out in the Llanos of Colombia during the seventies clearly showed that it was not possible to sustain animal production in native pastures, if these were not burnt. Furthermore, it was shown that with burning liveweight gains per animal were still low, varying from 70 to 90 kg/yr at stocking rates of 0.5 and 0.2 hd/ha, respectively (Paladines and Leal 1979). Different burning treatments of the native vegetation were also studied. For example, sequential burning of different areas of savanna every two months, resulted in 25 percent more liveweight gain than total burning of the area, but only at low stocking rates (Paladines and Leal 1979).

An attempt to control the regrowth of the vegetation after burning through rotational grazing resulted in lower gains than continuous grazing at a wide range of stocking rates (Paladines and Leal 1979). These results are not surprising and are consistent with observations made in native pastures in Australia and Africa (Mannetje *et al.* 1976).

In general, the research carried out in the seventies in the Llanos of Colombia indicated that for areas of savanna with little infrastructure the option to increase animal production from native pastures was mainly limited to mineral supplementation.

Options to complement native savanna pastures

With the emphasis placed during the eighties by the Tropical Pastures Program of CIAT (Centro Internacional de Agricultura Tropical) in Colombia and by RIEPT (Red Internacional de Evaluación de Pastos Tropicales) on selection and

evaluation of improved grasses and legumes for acid soils (Toledo 1985) new possibilities to improve production in savanna regions became available.

The idea of complementing savanna managed with burning with small areas of a grass-legume pasture (i.e. energy bank) was tested in the Llanos of Colombia, and compared with a pure legume stand (i.e. protein bank). Results indicated that the advantage of the energy bank over the protein bank in terms of animal liveweight gain varied from 29% at high stocking rate (0.5 hd/ha) to 52% at low stocking rate (0.25 hd/ha) (Lascano and Plazas 1990). The increased animal performance of steers grazing savanna complemented with an energy bank, was associated with higher digestibility of the forage selected by grazing animals in the energy bank as compared with savanna or protein bank, thus confirming the energy limitation of native savanna grasses.

The strategic use of small areas of sown grasses in association with legumes to complement native pastures was tested in a commercial farm in the Llanos of Colombia (Vera and Sere 1990). With 5% of the area of the farm sown with improved grass-legume pastures large increases were obtained in a 6 year period in terms of carrying capacity, which was doubled, and cow weight, which increased by 40%. Conception rates, even though variable between years, showed an upward trend, going from 50% in year 1 to 60% in year 6. Large increases in weaning weight were also observed.

The strategy of oversowing legumes in native savanna pastures, as a way to increase animal production was also tested in the Llanos of Colombia. In a first experiment, *Stylosanthes capitata* cv. Capica was oversown in a native pasture managed under continuous grazing with different stocking rates and without burning. Initial results indicated that carrying capacity could be increased to 1 hd/ha, which resulted in 3-4 times more production per ha than in savanna managed with fire (Hoyos 1987). However, one year after grazing the legume was grazed out, regardless of stocking rate. In a subsequent experiment, *Centrosema acutifolium* cv. Vichada in association with native grasses was evaluated under different stocking rates. Liveweight gains declined from 500 g/hd/d to 300 g/hd/d in a 3 year period, regardless of stocking rate (CIAT 1989). It was clear from this experiment that animals substituted the native grasses by the legume, as indicated by legume

selection indices above 1 in the wet and dry seasons. At a stocking rate above 0.7 hd/ha the availability of erect native grasses declined considerably in the 3 year period, suggesting that they do not withstand heavy grazing. It follows, that the strategy of oversowing legumes in native savanna pastures does not result in a sustainable system.

In general, small areas of improved grass-legume pastures as a component of cattle production systems with a native pasture base, seems to be a good alternative to increase animal production in areas where infrastructure is being developed. In fact, many commercial farms in the Llanos of Colombia are sowing grass-legume pastures, while still keeping native pastures as an important forage resource. With this alternative mineral supplementation is needed and fertilizer has to be applied for the establishment of the improved forage resource, which should provide good quality forage for lactating cows and weaned calves. The use of improved grass-legume pastures as a complement to native pastures could also be a suitable strategy to renovate degraded grasslands, without having to reduce the stocking rate of the system.

The improved pasture resource and animal production

In savanna regions with good infrastructure and where land prices are high, the main forage resource is improved sown grasses such as *B. decumbens*, *B. humidicola*, *B. brizantha*, *A. gayanus* that have replaced the native vegetation. A major limitation with sown grasses is nitrogen deficiency together with biotic pressures, e.g. spittlebug, and as a result pastures run-down (Toledo and Nores 1986).

One alternative to overcome the lack of persistence of sown grasses and to increase animal production is through legumes. For example, a long-term grazing experiment carried out in the Llanos of Colombia showed that liveweight gains were 40% greater in a grass-legume pasture than in the straight grass (Lascano and Estrada 1989). Furthermore, the results from this experiment indicated that while animal gains during the rainy season decreased over time in the grass pasture, they remained stable in the legume based- pasture.

Legumes selected for acid soils in association with grasses have also been shown to increase milk production by 20% in the rainy season and by 40% in the dry season (CIAT 1990).

Management of improved grass-legume pastures

The evidence available from the work carried out in the Llanos of Colombia has clearly demonstrated that animal production can be significantly increased through legumes in association with grasses. However, a challenge with grass-legume pastures is to maintain an adequate balance of the components over time.

Studies carried out in the Llanos of Colombia suggest that the grazing system may be as important as grazing intensity in keeping grass-legume balance over time. This is illustrated with two contrasting grass-legume pastures: (1) *Andropogon gayanus* cv. Carimagua, a bunch grass, in association with *Stylosanthes capitata* cv. Capica, an erect free-seeding bi-annual legume, and (2) *Brachiaria dictyoneura* cv. Llanero, a stoloniferous grass, in association with *Arachis pintoii* (CIAT 17434), a high quality legume with stoloniferous growth habit.

Experimental results indicate that when pastures of *A. gayanus*-*S. capitata* are grazed with 2 hd/ha or more, rotational grazing favors the grass whereas continuous grazing tends to favour the legume (CIAT 1986). However, even with continuous grazing a large proportion of *S. capitata* seedlings from the soil seed bank lack vigour, as result of competition with the established grass (Valencia 1985). It follows, that pastures of *A. gayanus*-*S. capitata* should be managed with a combination of continuous and deferred grazing, in order to favour grass recovery and legume seedling regeneration from soil-seed reserves. During the dry season the pasture could be managed with continuous grazing, with some adjustment of stocking rate based on forage availability. Once the rains start, the pasture should be spelled to favour grass recovery and legume seedling recruitment and development (CIAT 1990). The time required to get grass and legume recovery could be shortened by applying phosphate fertilizer to the pasture (CIAT 1990). Following recovery of the grass and legume, the pasture could be grazed continuously with the flexibility of adjusting stocking rate based on

grass availability. With this grazing strategy, the native pastures could act as a buffer, since in the early rainy season and following burning, the quality of the native grasses is relatively good.

The association of *B. dictyoneura*-*A. pintoii* has been very productive in the Llanos of Colombia (CIAT 1990), but it can become legume dominant if not properly managed. Selectivity studies using permanent intact steers indicate that animals select less legume than what is available in the forage on offer (Carulla 1990). As a consequence, pastures can become legume dominant if continuously grazed at moderate or high stocking rates. Some of the attributes of persistence of *A. pintoii* (high seedling recruitment from soil seed reserves, rhizomes and stolons) (Grof 1985) could also contribute to legume dominance if the pasture is not grazed with a flexible system involving some form of rotation to favour the grass, as has been proposed by Spain *et al.* (1985).

Future research on management of legume-based pastures in savanna regions will attempt to understand how pasture components compete for different resources of the environment (i.e. light, soil, nutrients, soil water), and how this competition may be modified by selective defoliation of the grazing animal and by fertilizer application.

The future role of pastures in savanna regions

A major theme in current pasture research in tropical savannas is sustainability. In savanna regions of Tropical America with good infrastructure and where the native vegetation has been replaced by sown grasses, pastures are in a process of rapid degradation. New lines of crops for acid soils are being developed, such as rice, soybeans and a rapid rate of adoption is expected, which could further contribute to soil degradation if continuous cropping is used. However, there is evidence that in acid soils tropical legume-based pastures may have an important role in sustainable agropastoral systems. For example, in the Llanos of Colombia, 3 t/ha of rice was harvested after 10 years of a grass/legume pasture, with no response to N or P (CIAT 1989). Rice yields after the grass alone pasture was also 3 t/ha, but with the addition of 40 kg/ha N application. In the native savanna the maximum yield of rice was only 2 t/ha with 80 kg/ha N and 50 kg/ha P

application. The extra ton of rice after the legume-based pasture compared with the native pasture suggests that the contribution of the legume to the soil was more than just increasing mineral supply.

Future research in savanna regions will concentrate in developing a mechanistic understanding of nutrient cycling in grazed pastures under different managements. This information should be useful to design appropriate sustainable pasture-crop rotation systems in tropical savanna regions.

Conclusion

Managing the grazing resource for animal production in savanna regions of Tropical America with emphasis in the Llanos of Colombia has been discussed in terms of infrastructure development. In areas with poor infrastructure annual liveweight gains of cattle grazing native pastures can be increased from 70 to 90 kg/ha in a sustainable manner through improved burning practices and mineral supplementation (Figure 1). As infrastructure develops, the native grassland is still the main grazing resource; however, with the strategic use of grass/legume pastures and mineral supplementation animal gains can increase by 40% (Figure 1). With this alternative small increases in production per unit land can also be obtained. Fertilizer application and some grazing management inputs are important components of the strategic use of improved pastures to achieve sustainable production.

In areas of savanna with good infrastructure the forage resource is mainly improved grasses adapted to acid soils. These improved grasses together with mineral supplementation and management input result in a 10-fold increase in production per unit land as compared with the native pastures (Figure 1). However, these pastures are not sustainable since they run down due to nitrogen deficiency and in certain cases pest attack. The largest sustainable increments in liveweight gains are obtained with legume-based pastures (Figure 1), which in turn are dependent on high management inputs. These pastures offer the opportunity of developing productive and sustainable agropastoral systems in savanna regions of Tropical America.

INFRASTRUCTURE

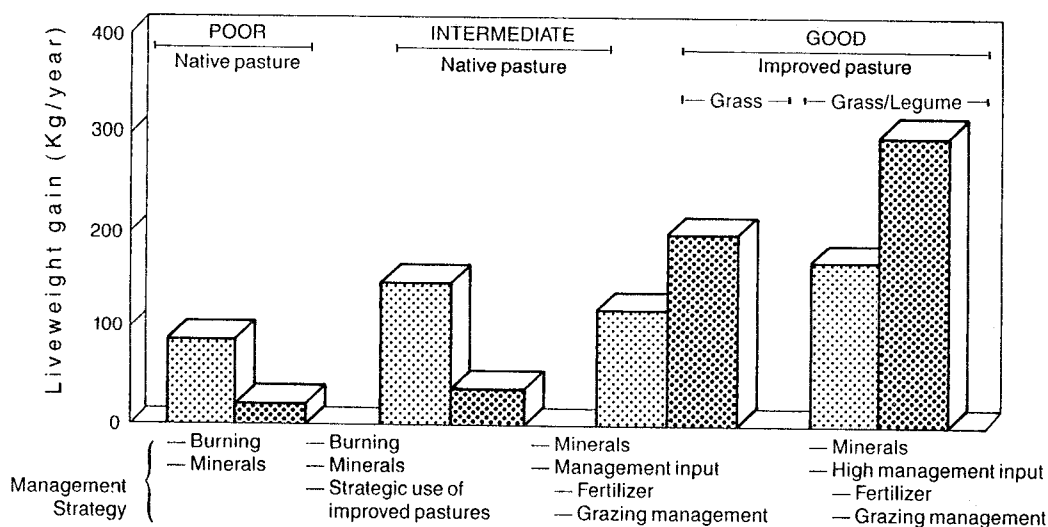




Figure 1. Potential liveweight gains (per head  ; per hectare ) in different pasture systems in savanna regions of Colombia with different degrees of infrastructure and management strategies.

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