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DEVELOPMENT OF IMPROVED GRAZING SYSTEMS IN THE SAVANNAS OF TROPICAL AMERICA

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1. Introduction

The savannas of tropical America constitute one of the largest, almost untapped, land resources of the world. High solar radiation, ample rainfall and soils of excellent physical properties as well as sociopolitical and economic pressures have made the development of appropriate land use systems for this region a major challenge.

This paper addresses some of the problems to be faced and presents strategies developed to overcome them.

2. Natural Resources

About half of tropical America is covered by Oxisols and Ultisols which occupy 850 million ha and extend from southern Mexico to northern Paraguay. Throughout the subcontinent, these soils are acid (pH 4 to 5), of medium to high in Al saturation (25-90%), low fertility (P 5 ppm; low in K, Ca, Mg, S, Zn) but have good physical characteristics. On a country-by-country basis they represent anywhere from 2% (Mexico) to 84% (Trinidad) of the area and therefore agricultural development on these soils is assigned varying priorities.

Natural grasslands (savannas) cover approximately 300 million ha and the remainder is forest. Land settlement and development have in general, advanced more in the savannas than in the tropical forest region. Two major types of savannas exist; the "Cerrado" type vegetation with varying shrubby to woody cover and grasses which occupy 180 million ha in Brazil, and the open savannas or plains in Bolivia, Brazil, Colombia, Guyana, and Venezuela. The majority of the latter savannas are located in the Orinoco basin and their colonization was described by Parsons (1980).

Cattle production systems have developed mostly in the savannas, but ongoing settlement of the Amazonian forest has also led to cattle production in that ecosystem. In the remainder of this paper, attention will be focused on existing and potential ranching systems in the savannas.

3. Cattle Production Systems in the Savannas

3.1 The Savanna

The climate of the savannas and Cerrado ecosystems is dominated by well-defined rainy (6-9 months) and dry (3-6 months) seasons.

Biomass production during the rainy season is quite high (Table 1) while it varies greatly in the dry period. Lowland or flooded savannas make an important contribution to dry-season forage supply both in quantity and quality in the Orinoco basin, while shrubs and woody vegetation play a similar role in the Cerrados (Medina, 1980; Rodriguez *et al.*, 1979).

Grasses are the main contributors to both biomass production and cattle diet; the _Trachipogon_ spp. savannas predominate in the well drained soils of the Orinoco basin (Blydenstein, 1967), while _Paspalum notatum_, _Paspalum_ spp., _Panicum_ spp. and _Aristida_ spp. dominate the grass cover of the Cerrado (Rodriguez _et al._, 1979). Legumes contribute only a small proportion of the total vegetation although many species are native to the region, some of which have been used commercially.

The nutritional value of most native pastures is low, particularly in the Orinoco basin, and management practices to improve their value such as burning have only short-term effects (see 3.2). As a consequence of poor forage quality year-round and low dry season productivity carrying capacities are very low and thus very extensive ranching systems predominate.

3.2 Cattle Production Systems

Traditional cow-calf ranching systems of the region have been studied in detail (Vera and Seré, 1983). Ranches tend to be large (1500-3000 ha), in inverse proportion to land value (US$30 - 230/ha). Average herd size is about 600 head and therefore stocking rates vary between 0.1 to 0.2 AU/ha. The availability of other resources varies between countries due to different agricultural policies. Heavy subsidies in Brazil stimulated the introduction of well-fertilized cash crops, mostly rice, leading to heavier use of labour, fertilizers and machinery. Low (subsidized) costs of mechanization, infrastructure and fertilizers in Venezuela, led to heavy use of machinery and the planting of well-fertilized and high nutrient-requiring grasses such as Digitaria decumbens, while use of costly labour remained low. On the other hand, in the Colombian plains the existing ranching systems are least intensive due to the high cost of all inputs, low land values and lack of specific development policies.

Animal productivity in all three countries is low (Table 2) and is clearly associated with poor, year-round nutrition. Nevertheless, physical productivity of the system is substantially higher in Brazil and Venezuela due to the presence of annual crops and, in the latter country, of limited milk production. Not surprisingly, the economic performance is modest (Table 3) and heavily influenced by crop production.

Options for improving cattle productivity without the use of external inputs are extremely limited. Despite fairly high rainy season forage yields from native vegetation, rapid deterioration of nutritional quality (Table 4) makes much of the forage effectively unavailable (Paladines and Leal, 1979). Temporary improvements in forage quality and animal productivity can be obtained by sequential burning of the savannas but not through rotational grazing, and other management practices (Paladines and Leal, 1979). Nevertheless, these improvements in weight gain (40 vs. 80-90 kg/head year in unburned and sequentially burned savanna respectively) can only be realized if animals are consistently supplemented with mineralized salt, a high-cost input which in the Colombian plains accounts for 65% of the value of all purchased inputs in traditional systems. Case studies conducted on ranches applying various "improved" management practices, have clearly shown that techniques such as the use of subdivisions, controlled mating, separation of different animal categories and others do not result in improved production per animal or per hectare, at present nutritional levels (Habich and Kleinheisterkamp, 1983). On the other hand, improvement in nutrition brought about by introduction of sown pastures and more diversified forage resources may be responsible for the apparent higher returns to management observed in ranches of the Brazilian Cerrado (Minhorst and Weniger, 1983; Seré, Carrillo and Estrada, 1983). In view of the above, and considering the limitations of existing introduced grasses (see 4.2), new forage species are required which are adapted to acid, infertile soils, have higher nutritive value, and are compatible with existing level of resources and management.

4. Improved Cattle Production Systems

4.1 Supplementation with Legumes (Protein Banks)

The use of pure legume pastures is not a new idea, but it is especially attractive for savanna ecosystems due to the low quality of the native grasses and low opportunity cost of land. Weed and grass invasion is controllable. Under these conditions some exotic legume species such as Pueraria phaseoloides and possibly Desmodium ovalifolium persist with low fertilizer inputs. An experiment has shown that the availability of 2000 m^2 of Pueraria phaseoloides per head as a supplement to the regularly burned savanna results in increases in weight gain ranging from 6 to 24% per head and 58 to 168% per hectare (Table 5). The effect of the legume on animal performance is especially marked during the dry season, during which, and contrary to what is observed in the wet season, animals showed a marked selectivity towards the legume. Legumes that remain green longer into the dry season are being investigated both in the Orinoco basin and the Cerrados by CIAT (1981) and others (Vera _et al._, 1981). In the latter region, legume pastures may play an additional role in restoring soil fertility to rice stubbles, while benefiting from the residual effect of fertilizer and lime applied to the crop; in this case the range of adapted legumes is larger.

These simple protein bank-savanna systems have also produced attractive economic results. Internal rates of return between 13 and 24% p.a. were obtained in whole-farm-simulations of _Pueraria phaseoloides_ - savanna systems using experimental results (Estrada and Seré, 1982). The same concept applied to cow-calf systems is currently being tested, while its use for milk production in dual-purpose systems also resulted in 10-20% increases in individual performance and 60-80% in production per hectare (Paterson _et al._, 1981) during the dry season. This concept is especially attractive for milk production since in traditional dual-purpose systems milking is discontinued during the dry season, the period of the year when milk prices are highest. In some cases, dry season production determines the year-round milk delivery quota.

Implications of the above results in a whole-system context have yet to be fully analyzed. It is unlikely that steers could be finished in these simple systems, but it is reasonable to anticipate that weaners could be raised successfully to 250-280 kg liveweight in less than two years for later transfer to a finishing pasture. Extrapolation of the available results to the rearing of replacement heifers suggests that age at mating could be diminished by about one year. Assuming no other improvements in reproductive performance, the use of such a supplement would result in a 25% increase in calf production per cow over its lifetime. It remains to be established what, if any, are the effects of protein banks on the fertility of breeding cows, a subject currently under investigation.

While savannas are burnt the traditional way in conjunction with the use of protein banks, another strategy is to introduce the legume in strips in the native pasture without burning to improve the degree of utilization of the forage produced by the savanna thus making possible increases of stocking rates. This approach is at a very early stage of experimentation but early results are very promising.

4.2 Introduced Grasses

The introduction of improved grass species in the savannas of tropical America has a long history. With some species, such as *Digitaria decumbens* or *Panicum maximum*, success has depended heavily on the intensive use of fertilizers. Otherwise very few species have persisted in the Oxisols and Ultisols; in the Cerrados and parts of Central America, *Melinis minutiflora* and *Hyparrhenia rufa* are naturalized, while they have persisted without spreading in the Orinoco basin.

More recently, *Brachiaria decumbens* has spread rapidly in the Brazilian Cerrados where it is planted following rice. Case studies of farms in that region (Minhorst and Weniger, 1983) have shown that it is the main sown species and covers 10-15% of the area; it is estimated that 1 million ha exist in Brazil alone. It has also spread successfully in the Orinoco basin where it represents 3-4% of the area in parts of the Eastern Plains of Colombia (Habich and

Kleinheisterkamp, 1983; Seré and Estrada, 1983) and 10-12% in the Venezuelan Plains (Plessow, 1983). It is frequently planted without fertilizers and therefore its productivity is limited. Problems such as its susceptibility to spittlebug, lack of compatibility with available legume cultivars and occurrence of the photosensitization syndrome in cattle have led to the search for other species. The recent release of Andropogon gayanus in several countries is the product of its adaptation to acid soils, good resistance to the dry season, resistance to spittlebug and greater potential compatibility with legumes.

Both grasses have shown roughly similar productivity levels (100-120 kg/head and 300-350 kg/ha) (Tergas et al., 1982; CIAT, 1981), and additionally offer farmers the opportunity of fattening their own steers rather than having to sell store cattle. Returns to fattening are high throughout the region; specialized fattening operations obtain between 17% and 28% p.a. of return to total capital (excluding land). Due to transportation costs, highest returns are achieved at locations close to the main markets, thus explaining their concentration in regions like the Piedmont of the Colombian Andes which supplies 60% of the beef consumed by the city of Bogotá.

The use of these grasses for the breeding herd in late pregnancy and during the mating season have led to significantly reduced calving intervals, improved weaning weights, and increased calving percentages while still allowing access to improved pastures of other animal categories (CIAT, 1983) during the remaining six months.

4.3 Grass-Legume Pastures

Productive and persistent legume cultivars adapted to acid, infertile soils have been difficult to identify, although several species are native to the region.

The introduced Pueraria phaseoloides has been successful as a protein bank as well as in association with Brachiaria decumbens and Andropogon gayanus. The native Stylosanthes capitata associates well with Andropogon gayanus while several Centrosema spp., Desmodium ovalifolium and others are promising.

Results available so far for sown grass-legumes pastures have shown increases over straight-grass pastures both in terms of weight gain per head and per hectare. Thus, average weight gains over a four-year period in a B. decumbens pastures were 145 kg/head and 250 kg/ha while in association with P. phaseoloides the gains were 183 and 294 kg respectively (Tergas et al., 1984). Differences between the grass-alone and the grass-legume pastures became larger in the fifth year (114 vs 196 kg/head respectively) which, although still subject to confirmation, may be due to an incipient process of degradation of the former. Similar trends have been observed in associations with A. gayanus. This makes legume-grass pastures particularly attractive where cattle are expensive relative to land such as is the case in most of the Latin American savannas. On the other hand the incremental production due to the legume has to offset the additional costs of legume seed, additional fertilization and weeding in some locations as well as the requirement of more careful management. Persistance of the legume component in legume-grass associations is still not fully understood and quantified. Simulation analyses have shown the high sensitivity of the return on pasture investment to persistence of pastures of less than six years, particularly for the Colombian Eastern Plains.

On-farm trials have shown highly favorable biological and economic results following the introduction of improved grass-legume pastures in cow-calf systems. Over a four year-period, the carrying capacity of a ranch increased 30%, calving rates increased from 50% to 63%, liveweight of weaners at 9 months of age increased from 109 to 160 kg, and the adjusted weight of dry, empty, 5-year-old breeding cows rose from 280 to 330 kg when 6% of the farm was planted to grass-legume pastures. These changes have also, for the first time, allowed selection among the available replacement heifers and culling of breeding cows for fertility. Therefore, further improvements in reproductive performance are expected, as well as changes in the structure of the animal population. Economic performance is difficult to quantify in these systems at the present stage, due to limited availability of empirical evidence on pasture persistence, maintenance fertilization needs and other maintenance requirements as well as herd production coefficients beyond the first few years. During the initial years, the main benefits are increased weight of culled cows and calves; over time, increased reproductive efficiency and carrying capacity gradually become more important.

On-farm trials have up to now, emphasized the use of grass-legume pastures for the breeding herd. Pioneer farmers, using associated pastures, are integrating steer-fattening and cow-calf operations, and in some cases, even dual purpose milk production, thus maximizing economic gains from the improved pasture technology.

5. Outlook and Perspectives for Savanna Development

Land is not a scarce resource in Latin America as a whole. Historically, pressure to colonize the savannas has been low and when effective, it was determined more by sociopolitical reasons than economics. The low productivity of native pastures and the serious limitations to crop growth impose a very low ceiling to the population density that the region can support.

The last few decades have seen a series of changes in this formerly static scenario. Population growth has increased pressure on land in more fertile areas displacing livestock with crops. This has led to rising beef prices and thus pressure on policy makers to promote beef production. The discovery of oil and minerals in the savannas has made the development of transportation infrastructure more attractive in some areas of Venezuela and Brazil. The location of Brasilia, in the midst of the Brasilian savannas, has greatly stimulated the development of productive farming systems in that ecosystem. The identification and in some cases actual exploitation of lime and rock phosphate mines in or near savanna regions have further enhanced the prospects for their development. In response to this changing setting, national and international development agencies have launched ambitious research projects; some initial results have just been presented.

Range improvement is a long-term process all over the world. In the Latin American savannas this process is just starting. Its potential is impressive but requires a persistent steady research effort only achievable through continuous support by far-sighted policy markers.

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Table 1. Above-ground production in the tropical savannas of America.

Country	Type of Savanna	
Brazil[a]	Cerrado, well drained savannas, at stocking rates of	g DM/m^2.year
	0.2 AU/ha	195
	0.3	153
	0.4	118
Colombia[b]	*Trachypogon*, well-drained savannas	210 – 310
Venezuela[c]		g OM/m^2.year
	Trachypogon, well-drained savannas	200 – 570
	Flooded savannas	430 – 910
	Paspalum fasciculatum savannas	1000 – 2500

a/ Vilela, H. (1982).

b/ Paladines and Leal (1979). Available DM, average of 3 stocking rates.

c/ Medina, E. (1980).

Table 2. Animal productivity of existing cow-calf systems in the tropical savannas of America[a].

Production Parameter	Brazil	Colombia	Venezuela
Average SR, AU/ha[b]	0.23	0.17	0.32
Heifer weight at 36 mo, kg	283	255	290
Age at 1st. conception, mo.	40	35	38
Weaning rate, %	57	45	52
LWG, kg/AU.year	65	58	50
LWG, kg/ha.year	12	12	32

a/ Seré, C. and R. Vera (1983).

b/ Unweighted means.

Table 3. Economic performance of prevailing cow-calf systems in the savannas of tropical America (US$/AU.year).

	Brazil	Colombia	Venezuela
Gross income			
Cattle	60.3	38.0	100.0
Crops	139.7	0.0	0.0
Total	200.0	38.0	100.0
Expenses			
Purchased inputs			
Mineral salts	1.95	3.97	1.25
Animal health	1.19	1.34	1.71
Fertilizers	27.79	0.12	2.56
Fuels	10.95	0.0	0.0
Others	30.19	0.67	1.88
Total purchased input	72.07	6.10	7.40
Labour	22.32	7.67	24.21
Depreciations	18.01	5.90	35.66
Total expenses	112.60	19.67	67.27
Net income	87.40	18.33	32.73
Farm capital	1262	442	1490
Rate of return, %	7	4	2

Source: Vera, R. and Seré, C., 1983.

Table 4. Nutritive value of the native vegetation in the savannas of tropical America.

Brazil - Cerrado[a]

	CP, %	IVOMD, %
March	10.08	29.8
May	10.03	35.8
July	9.66	41.1
August	10.85	30.2

Colombia - Eastern Plains[b]

Days of regrowth	CP, %	P, %	Zn, ppm
10	10.5	0.21	30
20	8.0	0.16	22
35	6.4	0.11	19
90	6.4	0.09	17
365	4.4	0.06	12

a/ Rodriguez *et al.* (1979).

b/ Paladines and Leal (1979); Vera (unpublished).

Table 5. Productivity of savannas with and without complementary grazing of legumes.

	kg/an	kg/ha
Savanna, best management	95	19
Complementary grazing of Kudzu (*Pueraria phaseoloides*) at stocking		
rate of 0.25 an/ha	118	30
0.50 an/ha	101	51

Sources: Paladines and Leal, 1979 (means of 5 years)
Tergas *et al.*, 1983 (means of 4 years)

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