

# Country Pasture/Forage Resource Profiles

## COLOMBIA



by  
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## 1. INTRODUCTION

Colombia is located in the northern tip of South America with access to the Caribbean sea, and the Atlantic and Pacific oceans (Figure 1). Its geographic coordinates are: 4° 00' N, 72° 00' W. The land borders extend for 6 004 km and include, in decreasing order of length: Venezuela, Brazil, Perú, Ecuador and Panama. Its administrative divisions include 32 Departments and one capital district. Its land area is 1 141 748 km<sup>2</sup> and the 1993 population was 37 664 711 (Dane Censo, 1993), distributed between 73% urban and 27% rural. According to the World Factbook the July 2006 est. is 43 593 035. The population growth rate is 1.68% (2000 est.) and 1.46% according to the World Factbook (July 2006 est.). The labour force is 16 800 000, distributed between the following sectors: services 46%, agriculture 30%, and industry 24% (1990). Arable lands are estimated to cover 54 060 km<sup>2</sup>, some 0.16 ha/capita, although the potential is substantially higher. Croplands include 9.7% irrigated and 4% arid. Permanent grazing lands are 406 000 km<sup>2</sup>, equivalent to 0.88 ha/capita. Forest covers 48% of the surface area. The livestock



Figure 1. Map of Colombia, showing the main physiographic characteristics

**Table 1. Livestock numbers, meat and milk production, and cattle, beef and veal imports of Colombia for the period 1995-2005**

Years\Stocks	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle (,000)	25 551	26 088	25 674	25 764	24 363	24 364	24 510	24 765	24 800	24 950	25 000
Goats (,000)	965	963	1 006	1 050	1 115	1 185	1 136	1 105	1 150	1 180	1 200
Sheep (,000)	2 540	2 400	2 325	1 994	2 196	2 288	2 256	2 045	2 100	2 150	2 180
Horses (,000)	2 451	2 450	2 450	2 450	2 500	2 550	2 600	2 650	2 700	2 720	2 750
<b>Products</b>											
Beef + Veal (Mt) (,000)	702.3	730.0	763.0	766.0	716.0	745.0	700	675	670	730	750
Goat Meat (Mt)	3 650	4 350	6 100	6 270	6 300	6 670	6 435	6 250	6 515	6 594	6 673
Mutton + Lamb (Mt)	9 900	7 975	7 250	6 100	5 775	6 930	6 888	6 235	6 525	6 670	6 690
Milk total (,000) (Mt)	5 078	5 332	5 492	5 712	5 734	6 148	6 302	6 554	6 652	6 700**	6 770
Cattle imports (head)	6 350	31 223	6 785	3 433	2 557	307	961	1 161	1 719	114	n.r.
Cattle exports (head)	21 851	2 777	18 700	139 741	8 269	131	8,051	159	164	248 991	n.r.
Beef + Veal imports (Mt)	1 967	2 704	3 062	3 931	1 853	612	1 473	1 538	23	1 201*	n.r.

(n.r.: no record)

\* in addition some 156 Mt of beef preparations were imported

\*\* Imports of Milk Equivalents in 2003 and 2004 were 113 922 and 50 038 Mt, respectively compared with exports of 199 755 and 135 952 Mt for the same two years.

Source: FAO databases, 2006.

population of Colombia is large (Table 1), equivalent to 0.62 livestock units per capita. The topography is extremely varied and influences climatic conditions. Climate varies from desert in the northern border with Venezuela, to rainforest along the Pacific shore and the southern borders with Brazil, Perú and Ecuador.

The country is extremely rich in terms of renewable and non-renewable natural resources, including oil, emeralds, gold, numerous metals, coal, and a rich vegetation and fauna. Colombia's leading exports are oil and coffee. Despite long-term, and continuing, social disturbances, the economy is strong but investments have been lagging behind.

Agriculture accounted for 18% of Colombia's GDP in 1997. Table 2 shows how the breakdown of the agricultural GDP changed over the period 1990–1994, with coffee decreasing its contribution and livestock becoming relatively more important. It is likely that the trend shown in Table 2 continued during the second half of the 90s. Colombia's diverse climate and topography permit the cultivation of a wide variety of crops and forest products. Cacao, sugar cane, coconuts, bananas, plantains, rice, cotton, tobacco, cassava, and most of the nation's beef cattle are produced in the hot regions from sea level to 1 000 m. The temperate regions – between 1 000 and 2 000 m – are well suited for coffee, certain flowers, maize, vegetables, and fruit as well as dairy cattle. The cooler elevations – between 2 000 and 3 000 m – produce: wheat, barley, potatoes, cold-climate vegetables, flowers, dairy cattle, and poultry. Despite the variety of agricultural products, only a small fraction of the total land is available for farming. Of Colombia's nearly 115 000 000 ha, 13% is considered arable, and only 27% of that amount is under cultivation. About 20% of all cultivated land is under coffee.

From 1960, agriculture began to grow more slowly than the rest of the economy. While GDP grew at an average annual rate of 5.5% from 1960 to 1982, agricultural output increased by only 4.1%, indicating, among other things, the increasing importance of the manufacturing and service sectors.

Modern agricultural techniques are chiefly used in the inter-Andean valleys and the coffee growing region. Chemical fertilizers are widely used, and large tracts of flatter lands have been placed under irrigation.

Many farmers with small-holdings, especially in the mountains, however, cling to traditional farming methods. Land tenure patterns have remained remarkably unchanged since the initiation of agrarian

**Table 2. Composition of the agricultural GDP (%)**

	Crops			Livestock				Other
	Seasonal crops	Non coffee permanent crops	Coffee	Beef	Milk	Poultry	Swine	
1990	23.97	28.62	12.23	15.13	9.00	4.63	1.74	4.68
1994	19.77	32.42	9.73	15.81	9.49	5.67	1.87	5.25

Source: CEGA 1996

reform efforts in the 1930s; landholding remains highly concentrated. The national agricultural census of 1971 showed an obvious imbalance in land distribution: 10% of the farms, including ranches, encompassed 80% of the land, and the situation has not changed significantly since then.

**Table 3. Household expenditure on meat and milk**

	As % of expenditure on all foods		As % of household expenditure		
	Meat	Dairy products	All foods	Meat	Dairy products
1992	35.73	12.11	34.68	12.39	4.20

Source: CEGA, 1996

Cattle-raising areas stretch from the Andean highlands into the eastern plains. The cattle stock, amounting to 25 000 000 head (according to FAO data, but various sources put estimates between 22 and 26M), generates 5% of the GDP, accounts for 25% of the agricultural GDP and is present on 80% of the agricultural land (FEDEGAN, 2000). In 1994 it was estimated that 849 000 rural properties (from a total of 1 730 000) raised cattle. Some 40% of the land on which cattle are raised also supports some type of short-term or subsistence agriculture. Stock raising is a major activity and source of wealth, especially in the lowlands. The Sinú and San Jorge river valleys on the Caribbean lowlands, the savannahs of the Atlantic lowlands, and the Eastern Plains are the regions with most of the beef cattle. In the past two decades the approximate geographic distribution of cattle has been: 40% on the Caribbean Coast, 40% in the Andean valleys, and 20% in Eastern Colombia. Dairying is especially well developed on the high plateau of the Cordillera Oriental. Poultry raising has expanded quickly, as a result of the application of modern techniques, and has grown faster than other livestock enterprises.

Colombia ranks fourth among Latin American countries in cattle raising, with an average annual herd size of 24 to 26 million cattle in the 90s (depending upon price cycles and others). This places it behind Brazil, Argentina, and Mexico. Herd size has been relatively stable since 1970 although, during the past decade, rural insecurity has constrained the collection of reliable census data. 15% of the cattle are raised for dairy purposes and the remainder for meat. Colombia produced 5 445 million litres in 1999 (FEDEGAN, 2000) and 6 700 million litres in 2004 (according to FAOSTAT). Poultry and sheep constitute a large share of Colombia's livestock business. Poultry has been the fastest growing non-beef enterprise. From 1976 until 1985, sheep herds grew from approximately 2 000 000 to 2 700 000, but have probably declined since (according to FAOSTAT 2 180 000 in 2005); the wool produced is of inferior quality, however, and generally is not used in the textile industry except for local consumption.

Meat consumption in the country is high and numerous studies have indicated clearly that it will grow further if household incomes can be raised. Even so, purchase of meat and milk is responsible for a large share of household food expenditure (Table 3).

## 2. SOILS AND TOPOGRAPHY

In the rugged terrain of the Andes, rivers have historically conditioned human settlement and farming. The most important river system is the Magdalena; its basin, including that of its major tributary, the Cauca, covers 260 000 km<sup>2</sup>, a quarter of the country. Within it are found most of the nation's socio-economic activities and more than three-fourths of its population. The Magdalena flows northward between the Central and Eastern Andes for 1 600 km to empty into the Caribbean near the city of Barranquilla. The catchment to the East of the Andes is subdivided into two sections, waters flowing into the Orinoco and the Amazon rivers respectively, which carry them to the Atlantic Ocean. Main tributaries of the Orinoco are the Arauca, Meta, Vichada, Inírida, and Guaviare. Among the streams that flow into the Amazon are the Vaupés, Caquetá, and Putumayo. The rivers that flow into the Pacific are short, descending rapidly from the Cordillera Occidental to the sea. They carry large volumes of water, however, because they drain areas of extremely heavy rainfall, as high as 7 000 mm/year in some areas.

The extremely varied soils reflect the climatic, topographic, and geologic conditions. Those best suited to mechanized agriculture are the alluvia in the principal river valleys, such as the Magdalena, Cauca, Sinú, Cesar, and Ariguaní. The former lake beds of some of the inter-Andean basins, notably the Sabana de Bogotá and the Ubaté and Chiquinquirá valleys, also fall into this category. Elsewhere,

soils of volcanic origin, especially in the coffee-growing districts of the Cordillera Central, can be exceptionally productive if protected from erosion. The Quindío department (part of the coffee region), west of Bogotá, is renowned for its rich soils. On the other hand, soils East of the Andes are typically highly leached, low pH, ultisols and oxisols. For information on soils refer to Cochrane *et al.* (1985) and see Table 6.

### 3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Colombia can be divided into four geographic regions: the Andean highlands, consisting of the three Andean ranges and intervening valley lowlands; the Caribbean lowlands coastal region; the Pacific lowlands coastal region, separated from the Caribbean lowlands by swamps at the base of the Isthmus of Panama; and eastern Colombia, the great plain that lies to the east of the Andes and that includes the Amazon portion of the country. The majority of the population is concentrated in the Andean highlands and valleys, followed by the Caribbean lowlands. The density of population along the Pacific coast and in the Eastern Plains and Amazon regions is extremely low. The Andean region is the centre of national political and economic power, with most of the country's population and large cities, including Bogotá, Medellín, and Cali, the three most populous. The Cauca valley, with its vast tract of alluvial soil, the Sabana de Bogotá, and the Antioquia highlands are perhaps the most dynamic centres of economic activity and growth.

Because of the country's proximity to the Equator, its climate is tropical and isothermal but annual precipitation is variable. Climatic differences are related to altitude and the displacement of the inter-tropical convergence zone between the two major air masses from which the northeast and southeast trade winds originate.

The climate of the tropical rainforest in the Amazon region, the northern Pacific coast, and the central Magdalena valley is marked by an annual rainfall of over 2 500 mm and annual average temperatures above 23 °C. A tropical monsoon climate, marked by one or more dry months but still supporting rainforest vegetation, occurs along the southern Pacific coast, on the Caribbean coast, and at places in the interior- the Quindío Department and near Villavicencio, Meta Department.

Tropical savannahs with alternating wet and dry seasons constitute the predominant feature of the Atlantic lowlands; the dry season is from November to April, and the wet season (broken by dry periods) from May to October. This climate is found also in the Eastern Plains or Llanos region and in part of the upper Magdalena valley. It is characterized by an annual rainfall of 1 000 to 1 800 mm and annual average temperatures usually above 23 °C. A drier savanna climate prevails on the Caribbean littoral. There rains normally occur in two brief periods (in April and in October-November, respectively) but rarely exceed 760 mm annually. The average temperature is 27 °C, with the daily range greatest where the humidity is low. This type of climate also occurs in the deep gorges of such rivers as the Patía, Cauca, Chicamocha, and Zulia and in parts of the upper Magdalena valley. The climate reaches near-desert conditions in the far northern department of La Guajira, bordering Venezuela.

Temperature is directly related to elevation. Average temperature decreases uniformly by about 0.6 °C per hundred metres of ascent. Popular terminology recognizes distinct temperature or thermal floors (*pisos térmicos*), which are sometimes referred to as *tierra caliente* or hot lands up to about 900 m, *tierra templada* (temperate lands, corresponding to the coffee region) 900 to 2 000 m, and *tierra fría* (cold lands) 2 000 to 3 000 m above sea level.

As indicated above, the majority of the population is in the Andean region between 900 and 3 000 m. The temperate region has moderate rainfall and temperatures between 18 and 24 °C. In the highlands the capital, Bogotá, at 2 640 m. has an average of 223 days of precipitation, an average rainfall of 1 000 mm and mean temperature of 14° C. The climate of the high mountain regions or *páramos* that range between 3 000 and 4 600 m, is characterized by average temperatures below 10 °C.

## 4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Ruminant production systems are closely associated with the respective agro-ecological zones and are thus discussed in relation to the ecological characteristics of each zone.

### Cattle production in the Eastern Savannahs

Production systems in the eastern savannahs have been the subject of detailed and long-term studies by the International Centre for Tropical Agriculture (CIAT, by its Spanish acronym) in cooperation with ICA, the Colombian National Research Institute (Vera and Seré, 1985).

The eastern savannahs have a low carrying capacity and the natural herbage has a low nutritional value. Carrying capacities range from four ha per animal unit in the flat savannahs to ten or more in the undulating savannahs. Unsurprisingly, ranches tend to be large, anywhere between 500 and 10 000 ha, most commonly in the 1 000–2 000 ha range. Digestible energy is the major nutritional constraint (Lascano, 1991), as the digestibility of native vegetation is low, even in fresh regrowth following fires (a common management tool), seldom exceeding 55–60% digestible dry matter. Protein is generally also a limiting factor, frequently below 8%. Given the low fertility of soils, numerous mineral deficiencies occur, the most notable of them being that of phosphorus. Mineral supplementation is, therefore, essential but its contribution to improved performance is modest unless the native savanna is supplemented with sown grasses.

Throughout the eastern savannahs the predominant system is extensive beef breeding although ranches close to all-weather roads tend to include fattening of steers and cull cows if sown grasses are available. Typically, beef breeding herds are subject to minimal management while grazing large savanna paddocks (>100 ha each); thus, mating is nearly continuous, and cattle are yarded two or three times a year for different operations. Under these conditions, typical calving rates are 50–55%, and weaning weights of calves seldom exceed 130 kg at 9 months of age.

In areas closer to roads, and therefore on higher-priced lands, intensification is generally synonymous with introduction of sown grasses. Percentages of areas sown to these grasses vary from over 50% in regions close to markets, to less than 5%. Nevertheless, it has been shown through on-farm research that 10% of the area sown to introduced, and well-managed grasses, can nearly double carrying capacity of a ranch while simultaneously increasing reproductive performance of the beef breeding herd (Vera, Seré and Tergas, 1986)

Sown grasses include, in decreasing order of importance *Brachiaria decumbens*, *Brachiaria humidicola*, *Brachiaria dictyoneura* (currently reclassified as *B. humidicola*) and *Andropogon gayanus*. These species have almost completely replaced *Hyparrhenia rufa* and *Melinis minutiflora* originally introduced in the 1940's. Despite many years of research, the adoption of well tested forages legumes such as *Stylosanthes capitata*, *Desmodium ovalifolium* and *Arachis pintoi* has been minimal. Regardless of species, their farm use require the application of fertilizers, mainly P, but also K and S. Although commonly used at establishment, application of maintenance doses is relatively uncommon. This fact, together with the low content, and transient nature of organic matter in soils induces N and other deficiencies that have been blamed for widely known process of pasture degeneration. If, however, sown pastures are well managed and maintained, they are capable of substantially increasing beef production (Table 4).

A recent alternative emerged with the development of adapted varieties of rainfed rice for the well-drained savannahs (Vera *et al.*, 1992). This allows the establishment of pasture grasses undersown in rice; the well fertilized crop is harvested within 120–140 days of planting at which stage it leaves the pasture almost fully established. The crop pays for 60–80% (depending on input and output prices) of the overall cost and uses any residual fertilizers left by rice. A similar strategy, albeit with substantially higher fertilizer inputs, can be followed with the use of acid-soil tolerant maize cultivars.

**Table 4. Performance of steers grazing well managed Brachiaria-based pastures versus native vegetation in the Eastern Plains of Colombia**

Pasture	kg/animal/year	kg/ha/year
Well managed native savanna	75	20
<i>Brachiaria humidicola</i>	90	180
<i>Brachiaria decumbens</i>	120	240
<i>B. decumbens</i> + <i>Pueraria phaseoloides</i>	160	320

Source: Lapointe & Miles (1992) and Lascano (1991).

### Cattle production in the Andean valleys

Cattle production systems in the inter-andean valleys are more variable than in the eastern savannahs, reflecting a different endowment of resources and a different socio-economic context. Farm and ranch properties tend to be significantly smaller, although in the 1990s there has been an as yet incompletely documented process of consolidation into larger properties, possibly associated with rural insecurity and related social phenomena. Also the cattle stock of at least part of the Andean valleys has regrouped into a belt that runs across the Centre-North of the country, well endowed with urban markets, and it has been suggested that this process may relieve the pressure on more marginal areas (Suárez, 1996).

Throughout the valleys, cattle production, although pasture-based, is more intensive than in eastern Colombia. As shown in Table 5 cattle production relies almost exclusively on sown grasses, the remaining being naturalized grasses and crop stubbles. As in the eastern savannahs, *Brachiaria decumbens* is an important introduced grass; in the lower parts of the topography *Cynodon nlemfuensis* is frequently grown; *Brachiaria humidicola* is frequently found in wetter areas and *Andropogon gayanus* and *Panicum maximum* in drier regions, whereas the slopes of the valleys are most frequently colonized by *Hyparrhenia rufa*. Part of the area overlaps with coffee growing, where there is an incipient process of adoption of the forage legume *Arachis pintoii* as cover crop; it is thus possible that in some time the legume will also be found in surrounding pastures since areas where coffee is an important crop generally also support more intensive cattle operations. Depending on the altitude, and therefore temperature, specialized intensive dairy farms can be found, based on Holstein or Brown Swiss cattle (Rivera *et al.*, 1999).

Dual purpose cattle predominate; these are crossbred (Zebu x Holstein, Brown Swiss and/or Creole) cow herds generally mated to crossbred or pure bulls (in the latter case, Holstein or Brown Swiss). Lactating cows are milked once daily, with calf at foot. Calves are weaned and sold at weaning, 7–9 months of age, or kept for fattening. There are many variations of this system (Pulido *et al.*, 1999), sometimes with more emphasis on beef production for the production of calves, or even fattening, sometimes biased towards milk. Milk is generally sold fresh milk or for industrial purposes, since processing plants are abundant in the region. The system just described is of low risk and relatively low inputs, although demands by processing plants for increased quality and reliability in milk deliveries are forcing the system towards management and input intensification. Supplementation with crop stubbles, cut-and-carry elephant grass (*Pennisetum purpureum*), sugar cane tops, maize silage and commercial concentrates has, therefore, increased. Lastly, dual purpose systems employ large amounts of family labour and provide an almost daily source of cash for small landholders.

### Cattle production in the Caribbean lowlands

The northern coast of Colombia equals the inter-andean valleys in importance in terms of its stock of cattle, but production systems are more diversified than elsewhere in the country. Production systems along the northern coast of Colombia share many of the characteristics described for the eastern plains and the interandean valleys, since extensive beef breeding operations coexist with dual purpose systems. In the coastal Department of Bolivar 86% of the cattle systems are dual purpose, and 12% beef fattening systems. Altogether, grasslands cover 36% of the agricultural lands and cattle systems account for 35% of rural employment.

Pastures, both sown and natural, differ considerably from those in the other regions of the country and a great diversity of species can be found, depending on soil drainage and fertility. The most important species include *Bothriochloa pertusa* and *Bouteloua repens* which have become extensively naturalized in the drier areas, and introduced *Dichanthium aristatum* and *Dichanthium annulatum*, generally found in the lower lying areas. *Panicum maximum* is also extensively used in well drained areas.

**Table 5. Grasslands and cattle production systems in the interandean valleys of Colombia**

Valley	Land area, ha	Grasslands, % of area	Dual purpose system, % of grassland
Magdalena	3 830 905	69	69
Cauca	334 519	45	100
Patia	127,519	75	100
Total valleys	4 292 943		
Valleys, % Colombia	4		

Source: Pulido *et al.* (1999)

Native herbaceous legumes are abundant, including *Centrosema* sp., *Stylosanthes* sp., *Desmodium* sp., *Rhynchosia* sp. and *Calopogonium* sp. Small areas of sown *Clitoria ternatea*, alone or associated with *Dichanthium* spp. are also found.

### **Cattle production systems in the Andean plateaux**

As indicated above under Soils and Topography, the Andean plateau near Bogotá (Sabana de Bogotá) is characterized by fertile soils with abundant organic matter. The area is used for high value crops, such as flowers and horticulture, but also for intensive, pasture-based dairying with high grade Holstein cattle. This system does not differ significantly from those found in the temperate regions of the northern hemisphere and it is generally based on strip grazed or rotationally grazed *Lolium perenne* (perennial and hybrid ryegrasses) pastures. *Trifolium repens* (white clover) has naturalized and its frequency depends on the rates of nitrogen applied to pastures. These paddocks frequently alternate with stands of *Pennisetum clandestinum* (Kikuyu grass) which is also naturalized and invades many areas; it is also intensively grazed.

### **Cattle production systems in the Amazon basin**

As consequence of the agrarian reform of the 1960s, 18 000 km<sup>2</sup> were initially assigned for settlement in the Caquetá Department, Colombian Amazon. The Colombian institute for agrarian reform settled landless peasants from the Andean valleys and provided them with cattle (Durán, 1990). In the early 1990s it was estimated that over 15 000 km<sup>2</sup> were deforested, largely for pasture establishment. After 1974, and following the establishment of milk collection points by national and multinational companies, dual purpose production systems evolved based almost exclusively on pastures, currently dominated by *Brachiaria decumbens* which alternates with degraded paddocks with a variety of low quality naturalized grasses

## **5. THE PASTURE RESOURCE**

Colombia has one of the largest plant biodiversities in the world, associated with its complex pattern of climate, soil, and topography. Vegetation includes the mangrove swamps of the Pacific coast, the desert scrub of La Guajira, the savanna grasslands and gallery ecosystems of the Atlantic lowlands and the Eastern Plains, the rainforest of Amazonia and the *Chocó* (Pacific basin) region and the diverse and complex montane ecosystems of the Andean slopes. Human intervention that began with the indigenous population has vastly altered the original vegetation of the Atlantic lowlands and the Andean region. Forests probably covered most of the area but today they are restricted to the most inaccessible slopes. Elsewhere pastures, croplands, and stubbles have replaced the original cover of broad-leaved evergreen trees. Among the grasses, introduced African species are conspicuous and several of them, including *Melinis minutiflora* and *Hyparrhenia rufa*, are naturalized, a process sometimes called africanization of the grasslands.

From the point of view of ruminant production based on native pastures, the savannahs are particularly important.

### **The savannahs**

The savannahs of the New World, or neotropical savannahs, have been extensively reviewed, most notably by Sarmiento (1983, 1994, 1996). The Colombian savannahs are part of the approximately 3 000 000 km<sup>2</sup> that extend from Mexico in the North to Paraguay in the South of the continent, but it is in Colombia, Venezuela and Brazil that they cover the largest area and have the largest economic importance. Neotropical savannahs are characterized by a continuous herbaceous cover with scattered shrubs, trees, and palms, supported by low fertility, generally deep, ultisols and oxisols, among other soil orders. There is no general agreement as to the precise origin of this formation in the absence of large native herbivores, but a widely shared view supports the notion that they originate from a combination

of occasional accidental, and also intentional fires, low fertility and grazing. In Colombia, the savanna formation is particularly important in three regions: the Eastern Plains located in the Orinoco basin; the plains that border the Caribbean sea in North Colombia, and savannahs along the interandean valleys (Hernández and Sánchez, 1994).

### Eastern savannahs of Colombia

Eastern Colombia covers 630 000 km<sup>2</sup> equivalent to three-fifths of the country, but it is home to about 2% of the country's population. Two main vegetation types are encountered: forest, including Amazon rainforest, cover 460 000 km<sup>2</sup>, and the remaining 170 000 are savannahs (Sánchez and Cochrane, 1985). The latter are in turn subdivided into 120 000 km<sup>2</sup> of well-drained savannahs, South of the Meta river, and 50 000 km<sup>2</sup> of poorly drained savannahs North of that river. The generic name for the whole area of savannahs is Eastern Plains or Llanos. Despite its name, only a fraction of the area is true plain, so a number of different landscapes are recognized as follows (Sánchez and Cochrane, 1985).

- (i) Flat savannahs (Altillanura plana) is a long strip of 35 000 km<sup>2</sup> that runs parallel and South of the Meta river. Its average width is 60 km and consist of Old Pleistocene deep alluvial sediments. Most of the area has slopes of under 1%, and soils classified as isohyperthermic, Typic Haplustox. These soils, although of very low chemical fertility (Table 6) are easily tilled, but can also compact quickly. The only all weather road that links the Andean region to the Venezuelan border runs along this area which is therefore used for cattle raising more intensely than the rest.
- (ii) Undulating, hilly savannahs (Serranía) cover 64 000 km<sup>2</sup>, and are located South of the flat savannahs. They have varied topography, with slopes as high as 30%. In the higher part of the landscape, soils are very superficial and include many small rocks and plinthite. Depending upon soil depth, vegetation can be very sparse, and only the small valleys between the abundant hills can be mechanized.
- (iii) Poorly drained savannahs cover nearly 50 000 km<sup>2</sup> North of the Meta river, and are based on old alluvial sediments with slow drainage. During the rainy season, extending from April to November, 50–70% of the area can be flooded; limiting cattle to the remaining land located a few centimetres above the rest. Overall, soil fertility is somewhat better than in the previous two types of savanna (Table 6).
- (iv) Andean Piedmont or foothills cover 9 250 km<sup>2</sup> with a variable topography in which strong slopes alternate with relatively flatter areas. Soils are alluvial, have better fertility than the average for the savannahs and contain the second most important rice growing area of the country (together with v, below), which alternates with cattle fattening.
- (v) Alluvial terraces cover 12 000 km<sup>2</sup>, of variable drainage and acid soils, most suitable for rice growing.

Overall, 75% of savanna soils classify as oxisols, 10% as ultisols and 15% others.

Based on species composition, ten main types of savannahs or plant communities have been identified (Blydenstein, 1964), with many species in common among them. Species diversity is large, although lower than that of the Brazilian savannahs or Cerrados. Recent studies have identified 158 and 173 species in the flat and undulating savannahs respectively (Rippstein, personal communication), with 89 species common to both. In general, the Poaceae are dominant; important species include *Trachypogon vestitus*, *T. plumosus*, *Paspalum pectinatum*, *Mesosetum pitieri*, *Andropogon leucostachyus*, *Andropogon bicornis*, *Paspalum carinatum*, *Leptocoryphium lanatum*, and *Rhinchospora confinis*.

The above savannahs are contiguous, towards the South, with the Amazon rainforest within which small areas of savanna based mostly on sandy, superficial soils (regosols) can also be found, although they are of very limited economic importance.

**Table 6. Characteristics of some savanna soils**

Landscape	Depth of A horizon, cm	pH	OM, %	P, ppm	AI saturation, %
Flat, well drained savanna	0–20	4.05	3.70	1.6	93
Undulating savanna	0–25	4.70	0.60	0.8	93.1
Old, fertile alluvial soils	0–10	4.60	3.80	15.7	29
Alluvial terraces	0–14	4.50	4.50	4.2	64
Andean piedmont	0–11	4.72	1.30	4.2	58

Source: Sánchez & Cochrane, 1985

### **The Caribbean savannahs**

The Caribbean lowlands region is in roughly the shape of a triangle, the longest side of which is the coastline. Caribbean savannahs are generally found below 200 m, and are subject to a megaisothermic regime, with mean temperatures of 28 °C, and rainfall of about 2 040 mm on average. Large extensions are covered with a sub-humid, sub-xerophytic shrub and tree formation. Among the taller trees *Pithecellobium saman* and *Bactris guineensis* are very characteristic (Hernández and Sánchez, 1994). The area is home to one-fifth of Colombia's population, partly concentrated in Barranquilla, Cartagena, and Santa Marta, the country's principal Caribbean ports. Cattle raising and mixed agriculture are the traditional economic activities, but large-scale commercial farming, especially of rice, cotton, and bananas, has been successful. Irrigation has expanded since the mid-twentieth century, especially in the valleys of the Sinú and Cesar rivers. Bananas are grown for export in the Urabá region.

### **The interandean savannahs**

The interandean savannahs are the most variable, as they correspond to a broken physiography. In general, mean temperatures range between 24 and 28 °C, and annual rainfall between 1 100 and 1 700 mm (Hernández and Sánchez, 1994). Soils are variable and tend to be of higher fertility than those of the previous two types of savannahs.

## **6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES**

The country's research institutions have a long tradition of quality research on ruminant production systems and a considerable stock of technical knowledge is therefore available. Nevertheless, it is clear that it will not be put into use until the pressing social problems (e.g. rural insecurity, land tenure and distribution issues) are overcome and policies which encourage a sustainable intensification of the sector are made available.

From a purely technological point of view it is thought that intensification of ruminant production systems in the tropical lowlands (Eastern Colombia and Caribbean Coast mainly) still requires considerable research on the animal genotype-environment interaction. Numerous well intentioned projects to raise animal genetic potential may be significantly constrained by mediocre feeding strategies. Similarly, efforts at pasture improvement would yield better results if animals of higher genetic potential were available. A recent symposium on the subject, referring specifically to milk production in the tropical lowlands, explicitly addressed the above hypothesis (Vaccaro and Pérez, 1998).

Improvements in animal breeding and in feeding strategies require more enlightened management practices than used heretofore. This issue in turn raises the need for the development of improved management capacities among farmers and ranchers, and also the need for decision support systems. These requirements are further compounded if environmental and natural resources conservation issues are to be taken into account.

On the pasture side of the equation, a major concern is the rapid expansion of *Brachiaria decumbens* pastures based on a single genotype of the species. This is seen as a major risk and calls for continuing efforts in the development of superior and diversified forage germplasm alternatives. Regardless of forage genotype, the almost exclusive reliance on grass-only pastures, as opposed to grass-legume mixtures, or other means of maintaining productive and long-term pastures, continues to be a major research and policy challenge.

## 7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Producer groups constitute a major force behind private sector coordination of agricultural policies and programmes. The larger producer organizations such as the national cattlemen's federation, FEDEGAN, provide statistical support, finance applied research and extension activities, lobby programmes, and other services to influence agricultural policy. Cattlemen contribute dues established by law to a parastatal fund, used to finance many of the above activities. FEDEGAN partially finances and contributes to the coordination of a national cattle development programme which involves universities, CORPOICA (see below), the Ministry of Agriculture and others. Another important association related to the livestock sector is the Colombian Association of Seed Producers (Asociación Colombiana de Productores de Semillas-Acosemilla); nevertheless, most of the forage seed supply is imported from Brazil. There are also numerous breed associations.

The national agricultural research institute was partially privatised in the early 1990s, to become a mixed public-private corporation, CORPOICA, which still depends heavily on government monies to finance its activities. It does not have a pasture research programme, but forage research is carried out within existing animal science programmes. Government-financed extension activities were decentralized to municipal level during the 1989–1993 period with a mandate to concentrate on small farmers. Numerous public universities carry out R&D activities in their respective region of influence. Similarly, several NGO's are active in rural development and natural resources conservation initiatives. An international research institution, CIAT, has significant research activities in Eastern Colombia and in one of the interandean valleys.

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