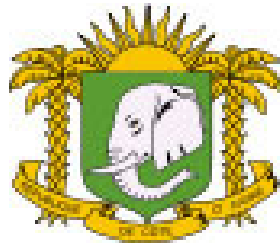


Country Pasture/Forage Resource Profiles

CÔTE D'IVOIRE



by

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1. INTRODUCTION

The Republic of Côte d'Ivoire (sometimes referred to as the Ivory Coast), which lies on the Gulf of Guinea, with an area of 322 462 km², borders Liberia and Guinea to the west, Mali and Burkina Faso to the north, Ghana to the east, and the Gulf of Guinea and the Atlantic Ocean to the south (Figure 1). The coast, which extends from 7° 30' to 3° 7' W and has a length of 380 km, forms an arc of which the convexity turns slightly to the north; neither bay nor promontory breaks the regularity of its outline. The watershed runs roughly from 9° N. in the west to 10° N. in the east, and is marked by a line of hills rising to about 198m.

Except for the prolongation of the Guinea Highlands in the northwest (from Man to Odienné), with peaks rising up to 1 219 and 1 524 m, most of the Côte d'Ivoire is vast plateau, tilted gently towards the Atlantic. Côte d'Ivoire has a minimum altitude of sea level (Gulf of Guinea) and maximum height of 1 752 m (Mt Nimba). It is drained by four major rivers running roughly parallel from north to south, the Cavally (on the Liberian frontier), Sassandra, Bandama and Comoé.

The land area is 318 000 km², of which 21.8% is cultivated/arable land, permanent crops occupy 13.8%, pasture lands 41% and forest 22%, while water occupies 4 460 km² (1.4%) (Rosenberg, 1997). Fifty-two percent of the total land area is considered agricultural land or slightly over 3.6 ha per capita. Land use is arable land 9.75%; permanent crops 13.84% and others 76.41% (World Factbook, 2001). The land falls into two distinct agricultural regions:

- i. the forest region (about 140 000 km²) in the south; and
- ii. the drier savannah region (about 180 000 km²) in the north where economic growth is generally slower.

The forest region, with higher and more reliable rainfall and better soils, produces most of the export crops. Rainfall in the savannah averages about two-thirds of that in the forest region and is unreliable; the soils are generally light and range from medium to poor quality; so agricultural yields are low.

The country gained independence on 7 August 1960; its population, which was 15 366 720 in 1998, was estimated at 18 373 060 in 2008. The World Factbook estimate for July 2009 is 20 617 068 with a growth rate estimated at 2.133% (World Factbook)

The official language is French; 80 languages are listed for Côte d'Ivoire and of those 78 are living and two extinct (Gordon, 2005). Around 24% of the population speak Baoulé. Only 18% of the population speak village languages. This is surprising because 40% of the people who practise their traditional religion do not even practise their own language. The two other main spoken languages are Malinké and Senoufo. Around 10% of each of these languages is spoken in this country.

Côte d'Ivoire is a republic with a strong executive power vested in the President. Until 1993, it was led by Félix Houphouët-Boigny and was closely associated economically and politically with its West African neighbours, for example, through the formation of the Conseil de l'Entente. The country maintained close ties to the West, especially to France, which helped its economic development and political stability. The country, through its production of coffee and cocoa, was an economic powerhouse during the 1960s and 1970s in West Africa.

As a result of the economic crisis in the 1980s, the country experienced a period



Figure 1: Political Map of Côte d'Ivoire

Source: *World Factbook*

of political and social turmoil, but it maintained close ties to the West, especially to France, which helped its economic development and political stability. At the end of Houphouët-Boigny's rule, the country's problems were exacerbated by two coups d'état (1999 and 2001) and a civil war in 2002. The crisis ended after a political agreement on 4 March 2007 that led to power sharing with Laurent Gbagbo as President and Guillaume Soro as Prime Minister.

The country is divided into 19 regions and 58 departments (Figure 2). The regions are (1) Agnéby; (2) Bafing; (3) Bas Sassandra, (4) Denguélé; (5) Dix-Huit Montagnes; (6) Fromager; (7) Haut-Sassandra; (8) Lacs; (9) Lagunes; (10) Marahoué; (11) Moyen-Cavally; (12) Moyen-Comoé; (13) N'zi-Comoé; (14) Savanes; (15) Sud-Bandama; (16) Sud-Comoé; (17) Vallée du Bandama; (18) Worodougou and (19) Zanzan. Figure 2 shows the map of the 19 administrative regions.

Yamoussoukro is the capital while Abidjan is the administrative and commercial centre. The biggest cities are Abidjan with 3 000 000 inhabitants; Bouaké in Central with 850 000; Daloa in the west, with 300 000; San-Pedro in the southwest with 250,000; Korhogo in the north with 250 000 and Yamoussoukro in the centre with 250 000 inhabitants.

The population consists of more than 60 ethnic groups. Major ethnic groups include: Baoulé; Sénoufo; Bété; Lagoon peoples; Agni (Anyi); and Mandé cluster of groups, including Juula, Bambara, and Malinké; and also non-Ivoirian Africans, Lebanese, Asians and Europeans

Houphouët-Boigny promoted his own group, the Baoulé, which account for 23% of the population. The succession of Konan Bédié, another Baoulé, annoyed many groups, the Bété in particular. Aliens include groups from Burkina Faso, Mali, Ghana and Guinea. In addition, there are small numbers of Lebanese and French. Figure 3 presents population distributions in Côte d'Ivoire.

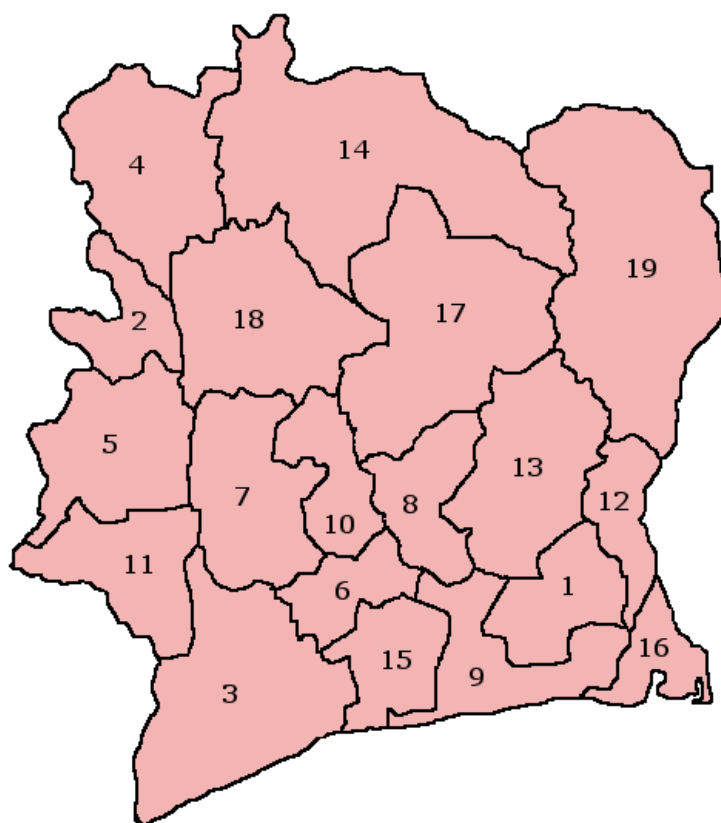


Figure 2. Administrative regions of Côte d'Ivoire

Source: Wikipedia

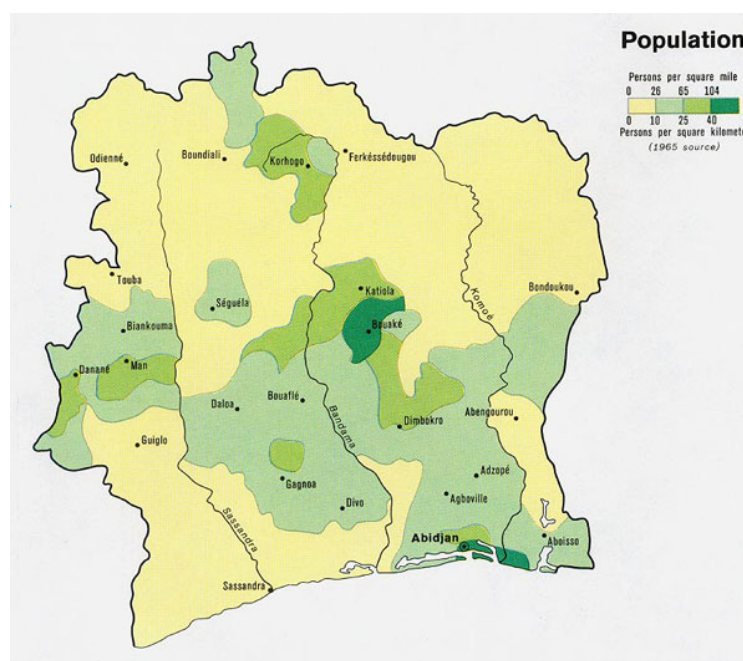


Figure 3. Population distribution in Côte d'Ivoire

Source: Perry-Castañeda Library. Map Collection. Cote d'Ivoire (Ivory Coast) Maps

Some 12% of the population is Christian; 25% Muslim and 63% traditional beliefs. While only about 12% of the people practise Christianity and Roman Catholicism, the largest Christian church in all of Africa, called Our Lady of Peace, is in Yamoussoukro and people from far away sometimes go there to worship their Lord. Many beliefs are practised. The majority practise traditional religions involving ancestor worship. They believe that the dead are transformed into spirits and remain in constant contact with the living; through various rituals, the living seek their blessings and protection. Magic is also common, and good magic keeps evil spirits away.

Medicine men or juju priests dispense charms, tell fortunes and give advice on how to avoid danger. They also bless grisgris necklaces of charms that ward off specific evils. The Senoufo in particular have held very strongly to their traditional beliefs. Children are instructed over many years in the history and social mores of the Senoufo and are then secretly initiated.

Economic activities – agricultural sector

Despite a considerable industrial sector, Côte d'Ivoire is essentially an agricultural country. Most of the population is engaged in agriculture, forestry and livestock rearing; only about 11% of the labour force are wage earners (Ounissi, 2008).

The market-based economy relies heavily on agriculture, with smallholder cash crop production being dominant; it relies on two major products: cocoa and coffee, of which the country has been respectively the first and fifth exporter. Cash crop products (including timber and palm oil) have formed the core of a development strategy that was later reinforced by secondary agricultural export crops such as bananas, pineapples and other – from the post-1965 diversification policy.

The agricultural subsector that produces the main export crops (coffee, cocoa, timber) provides the industry with human resources, financial flows and raw materials for processing. Cocoa, coffee and timber and also palm oil export earnings have over the years risen (Traoré, 1990). The main staple and export crop products are: bananas, cassava, yams and sugar; cocoa, coffee, cotton, oil palm; timber and rubber, respectively. Table 1 presents some major staple food and export crops from 1998 to 2007.

Côte d'Ivoire is among the world's largest producers and exporters of coffee, cocoa beans and palm oil.

Figure 4 presents economic activities (cocoa and coffee growing areas and locations for other agricultural products, minerals and industries). Growth was negative in 2000–03 because of the difficulty of meeting the conditions of international donors, continued low prices of key exports and severe civil war. France, the USA, Germany, the Netherlands, Italy and Japan are the main trading partners.

Other natural resources are petroleum, natural gas, diamonds, manganese, iron ore, cobalt, bauxite, copper, gold, nickel, tantalum, silica sand, clay and hydropower. Commercially extracted minerals include uranium, diamonds and manganese and there is a possibility of mining gold, bauxite, lithium and colombo-tantalite.

Table 1. Production statistics of some major staple foods and export crops (tonnes)

Staples	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cassava	2 127 517	2 113 892	2 100 354	2 086 903	2 073 538	2 060 259	2 074 064	219 7985	2 110 000F	2 110 000F
Bananas	283 114	316 300	305 300	310 544	319 726	311 264	319 779	270 000F	235 000F	235 000F
Sugar	1 081 134	1 453 899	1 672 050	1 652 806	1 544 172	1 264 310	1 456 321	1 430 184	1 100 000F	1 100 000
Yams	4 219 287	4 336 165	4 456 280	4 579 723	4 706 585	4 836 961	4 996 019	5 160 307	4 851 000F	4 900 000F
Pine-apples	213 974	252 000	238 000	248 890	227 501	243 242	215 989	195 294	250 000F	240 000F
Others										
Cotton	337 097	365 002	402 367	287 000	396 239	396 417	300 000F	321 286	336 200	290 000F
Rubber	105 363	118 860	123 398	127 900*	123 000*	129 000F	136 776	134 802	130 000F	128 000*
Cocoa	1 201 119	1 163 025	1 401 101	1 212 428	1 264 708	1 351 546	1 407 213	1 286 330	1 254 500*	1 300 000*
Coffee	311 000	307 331	380 000	301 127	182 001	140 027	154 081	95 569	166 200	171 000*
Oil palm (kernels)	1 228 200	1 325 400	1 133 606	993 438	1 160 122	1 029 141	1 311 035	1 350 000F	1 413 000	1 448 000F

* = Unofficial figure

F = FAO estimate

Source: FAOSTAT [FAO Statistics Division 2009] Viewed on 15 March 2009

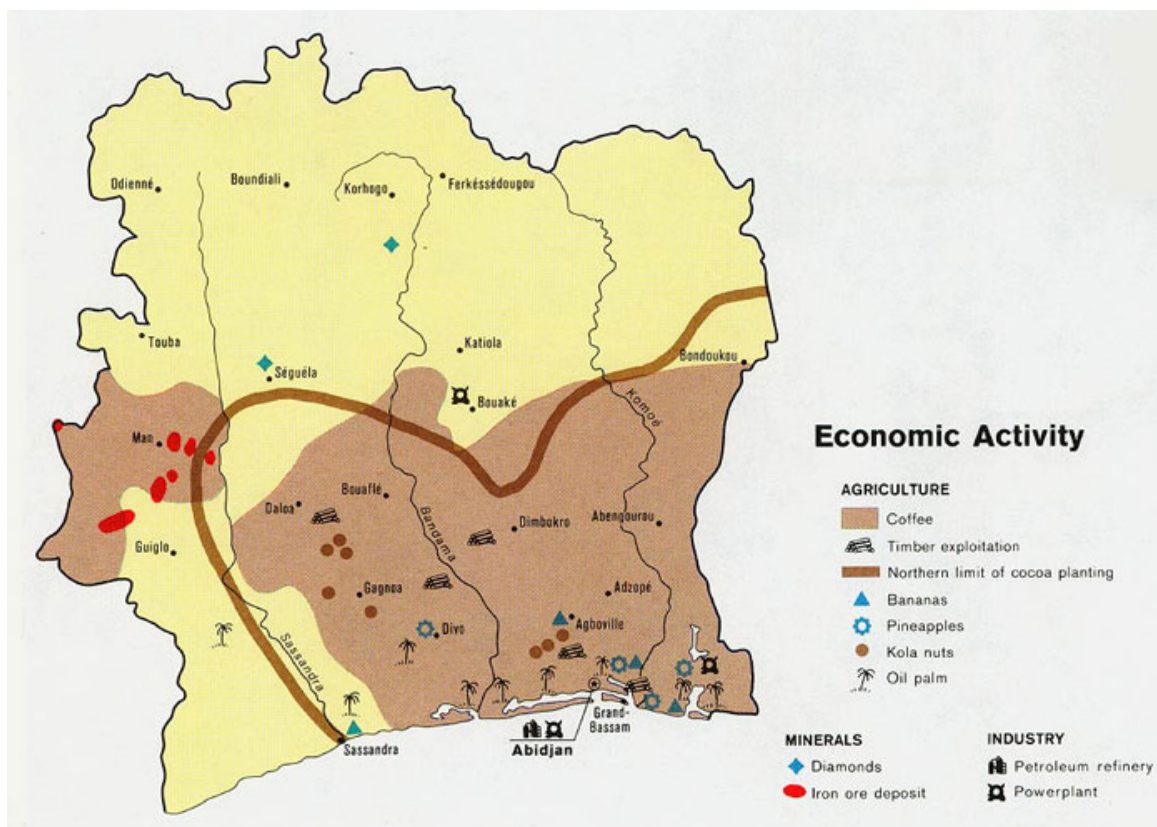


Figure 4: Economic activities (cocoa and coffee growing areas and locations for other agricultural products, minerals and industries)

Source: Perry-Castañeda Library Map Collection. Cote d'Ivoire Maps

Côte d'Ivoire has some industrial and mining companies such as the Société Ivoirienne d'Aquaculture Lagunaire, the Société de Développement de la production Sucrière, the Société des plantations d'hévéa du Grand Béréby, the Société de Distribution des Eaux de Côte d'Ivoire, the Société de Développement des Forêts, the Société Géologique de Côte d'Ivoire, the Société Ivoirienne de Raffinerie, the Société des Mines d'Ity, the Société des Mines de l'Afferma, the Société du Développement Minier, the Société d'Exploitation Pétrolière (PETROCI). Some important foreign companies such as Blohorn, Nestle, Hydrochem, Rhône-Poulenc and Sofaco also settled in the country. Tertiary industries count approximately 650 businesses employing 100 000 people.

Livestock sector

In 1985 there were approximately 843 000 cattle, mostly small, humpless local breeds. There were also 1.5 million sheep, 430 000 swine, 1.5 million goats, and 16 million poultry. In 1987 the livestock sector contributed about 6% of agricultural output. About half of that came from poultry and egg production, about a quarter from cattle and the remainder from sheep and goats. Although virtually all poultry consumed in Côte d'Ivoire was produced locally, domestic beef production met only about 40% of demand. The remainder entered as live cattle from Mali and Burkina Faso or as slaughtered meat from Western Europe, Argentina or Southern Africa. In the 1980s, the government sought to strengthen livestock production by providing education and training in modern animal husbandry and by introducing large-scale cattle fattening centres near Bouaké and Abidjan (Handloff, 1988).

2. SOILS AND TOPOGRAPHY

Soils

The study of soil types provides information and the goal of determining their possible adaptation to utilization (Aubert, 1985). There are a large number of soils reflecting different kinds and degrees of soil forming factors and their combination (Figure 5).

Savannah soils are generally light and range from medium to poor quality, so crop yields are low (Handloff, 1988). In the Sudanian and the Guinea zone the soils of the bas-fonds (thalwegs) have developed on a mix-substrate of colluvial alluvial origin with a little clay.

On a regional level the rocks and the coarse grain content determine the sandy and silty division of the valley soils while granitic to migmatitic rocks obtain larger sandy fractions than the Precambrian schists, which are richer in silt. The ratio of clay remains below 20% in the lower horizons of the valley bottom soils and hardly reaches 16% in upper horizons. The maximum value with 44% of clay is found in the topsoil of the schist region in the north, the minimum value with 8.5% of clay in neighbouring granitic regions of the north. The more clayey to loamy soils that are classified as perfect for the irrigated rice cultivation are only found in rare special geologic sites.

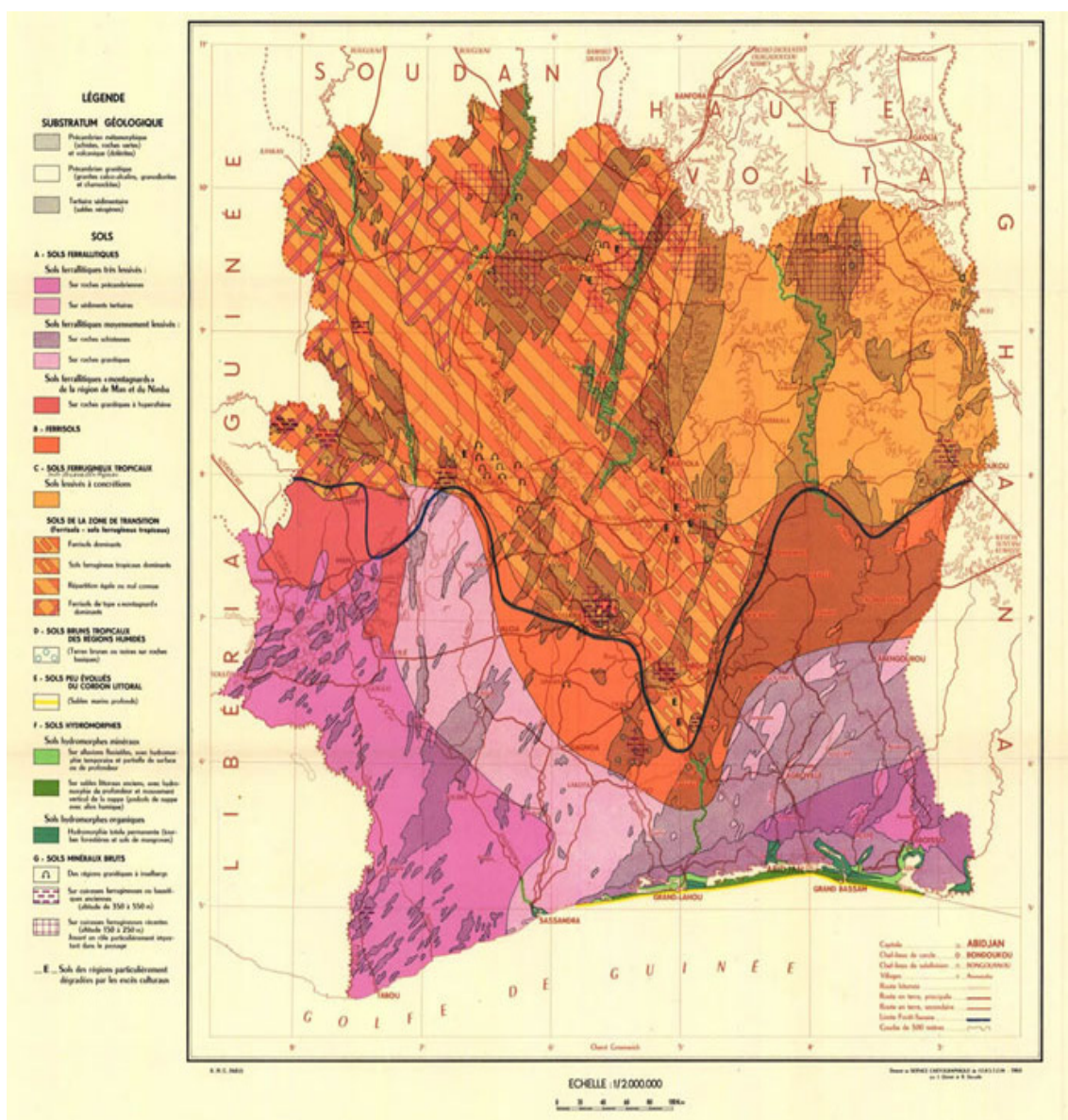


Figure 5. Map of soil and topography (Carte Pédologique de la République de Côte d'Ivoire)

Source: Dabin, B., Leneuf, N., Riou, G. (1960). ORSTOM, Paris. EuDASM

The skeleton content of the upper soils reaches more than 5% as a consequence of the dissolution of the pisoliths under reduced soil conditions in the inundated valley floors. This induces a high permeability of valley soils and precludes long water retention in the irrigated rice lands.

According to the FAO world soil legend the most frequent soil types of the bas-fonds (thalwegs) are the Dystric and Umbric Gleysols, followed by the Gleyic or Ferralic Arenosols along the banks of valleys as well as on the lower slopes. Typical paddy soils, with a gleyic plough horizon, do not appear in the only slightly cultivated valley bottoms in the Côte d'Ivoire (Mund, 1999; 2001).

In most areas the typical bas-fond soils are geomorphologically and hydrologically suitable for smallholder rice production. A large portion of sand and a very low clay content of the extremely sandy Gleysols of the granite, migmatite and gneiss regions occur over more than 65% of the country.

The more suitable loams, rich in clay and silt, are found only in schist-regions and in specific geological sites like alkaline vulcanites. Biologically induced accumulations of calcium carbonate have been found inside orthox soils, under and around the native iroko tree *Milicia excelsa* in Biga (Cailleau *et al.*, 2004). The nature of these accumulations and their origin studied in two soil profiles, directly under the tree and at a distance of 30 cm from the trunk, demonstrated that calcite precipitation is facilitated by the oxidation of oxalate by soil bacteria that contributes to the increase in pH in Biga soils, and three conditions were necessary for biologically induced precipitation of calcium carbonate in orthox soils associated with trees: the presence of a large amount of oxalate (originating from the tree and fungi), the existence of an oxalotrophic flora for oxalate oxidation into carbonate, and a dry season (Cailleau *et al.*, 2004).

Morphology and soils of the bas-fond

Since the 1970s, multidisciplinary attempts at classifying the tropical inland-valleys in West Africa have been made by Avenard (1971), Gillet (1973), Thomas (1974) and Raunet (1985). Bas-fonds are flat valleys with broad (> 300 m) bottoms and a low longitudinal slope in the area of the midstream and valley head of the dendritically branched tributaries. The proper valley bottom soil consists of a mixture of colluvial and alluvial deposits, which overlap the widespread saprolitic crust, the weathered front of the basement rocks. Valley bottom soil is modified by processes of alluvial sedimentation or erosion, especially along their lower part. Due to the very low longitudinal slope, a steep incised river course with pronounced terrace deposits is extremely rare. The valley fringes are quite shortly developed with slope inclinations of 2–5° and they transfer gradually into the steep side slopes (Mund, 1999, 2001).

On the mid-side slopes steps with inclinations over 10° occur frequently, due to indurated plinthis layers developed in dryer times of the Pleistocene (Mund, 2001). Frequent flooding, which occurs on a few days during a year, is significant for this type of valley in the southwest; the groundwater level is near the soil surface (< 50 cm) (Mund, 1999, 2001).

In the valley bottoms stagnic to umbric gleysols are mixed with gleyic arenosols, with a very low gravel content (Gerold, 1997). Soil texture varies from sand to silt and its stratification can hardly be a result of its alluvial to colluvial origin. Because of hydromorphic conditions, with low soil aeration and wetness throughout the year, the decomposition rate of plant remnants is low and the humic topsoils have high organic-matter content. The pH-values fluctuate between 4.3 and 5.5 under prolonged waterlogged conditions.

Towards the foot-slopes and on valley fringes colluvial ferralic arenosols with very low CEC rates are associated with low base saturated gleyic arenosols. The side slopes are dominated by a distinct interdigitation of plinthic ferralsols and plinthic cambisols with high contents of iron concretions. Deeply weathered and strongly leached ferralsols with a high plinthic content are the characteristic soil types on crests and upper slopes in southwest Côte d'Ivoire (Mund, 1999).

Topography

The terrain of Côte d'Ivoire is mostly flat to undulating plains with mountains in the northwest. It consists of flat to rolling plateaus that slope gently southward to the Gulf of Guinea (lowest point) and rarely attains more than 460 m above sea level. The only significant uplands occur along the Western borders, where Mount Nimba (highest point) reaches 1 752 m. Long narrow sand bars, backed by lagoons, fringe the eastern half of the coast; the rest is marked by low rocky cliffs (Howstuffs.com, 2008).

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Côte d'Ivoire has a forest and Guinean climate south of the eighth parallel with two rainy seasons from May to mid-July and October to November and an annual rainfall between 1 200 and 2 400 mm. In the north, the climate is Sudano-Guinean with a single rainy season from July to November and an annual rainfall between 1 100 and 1 600 mm. The climate is tropical along the coast, semi-arid in the far north and there are three seasons: warm and dry (November to March), hot and dry (March to May), hot and wet (June to October).

Generally the climate is warm and humid and is, overall, transitional from equatorial to tropical. Seasons are more clearly distinguishable by rainfall and wind direction than by temperature. Continental and maritime air masses, following the apparent movement of the sun from north to south, determine the cycle of the seasons that is associated with heat and cold farther from the equator.

Two climatic zones are created by the alternating wind patterns. In the north, tropical conditions delineate two major seasons; heavy rains fall between June and October, averaging 110 cm annually. Along the coast equatorial conditions prevail; some rain falls in most months, with an average of 2 000 mm annually, but four seasons are generally distinguishable; heavy rains fall between May and July in most years and shorter rains in August and September; the minor dry season still brings sparse rain during October and November, followed by the major dry season from December to April.

Temperatures and humidity generally follow the same pattern, with average temperatures between 25 °C and 30 °C and ranges from 10 °C to 40 °C. Temperatures are higher in the south but may exceed 30 °C even in the far north. Annual and daily ranges of both temperature and humidity are small along the coast but increase progressively toward the north. Average relative humidity is 85% in the south and 71% in the north.

There are three main climatic regions: the coast, the forest and the savannah. The highest rainfall 2 032 –3 048 mm and the least range of average temperature, 23 °C to 26.6 °C occur in the coastal region, which has a long dry season from December to April, followed by the great rains in mid May to mid July. The short dry season is from mid-July to October and the short rains in October and November.

In the central forest region, rainfall is high 1 346–2 540 mm, humidity continuous, and the seasons less clearly marked. The earlier, shorter dry season (November to mid-March) is followed by a short wet season (mid-March to mid-May), a short dry season from mid-May to mid-July and the great rains for mid-July to mid-November. Temperatures reach their maximum in the northern savannah at between 32 °C and 24.4 °C; the minimum is around 14 °C. There is a long wet season from June to October and the dry season extends to six or seven months.

During the first half of the year the warm maritime air mass pushes northward. Ahead of it, a low pressure belt, or inter-tropical front, brings warm air, rain and prevailing winds from the southwest (Handloff, 1988). As the solar cycle reverses at mid-year, the continental air mass moves southward over the nation and this permits the dry northeast harmattan to dominate. Surface winds are gentle, seldom exceeding 15–20 km/hour,

Agro-ecological zones

There are three geographic regions roughly parallel to the coast – the lagoon region, the forest region, and the savannah region – and the vegetation of Côte d'Ivoire (Figure 6) is distributed among the three geographical regions. These ecosystems are often transformed directly or indirectly by humans into agro-ecosystems that furnish food, fibre and other products such as textiles, wood and oil.

The lagoon region

The lagoon region, a narrow coastal belt extending along the Gulf of Guinea from the Ghana border to the mouth of the Sassandra River, is a strip of low, sandy islands and sandbars built by the combined action of heavy surf and ocean currents. These sand barriers have almost closed the rivers flowing into the gulf. The resulting series of lagoons ranges in width from about 100 m to 7 or 8 km and seldom rises more than 30 m above sea level, leaving the area subject to frequent flooding during rainy seasons.

Most of the lagoons are narrow, salty, shallow and run parallel to the coastline, linked to one another and the gulf by small watercourses or canals. Where large rivers empty into the gulf, broad

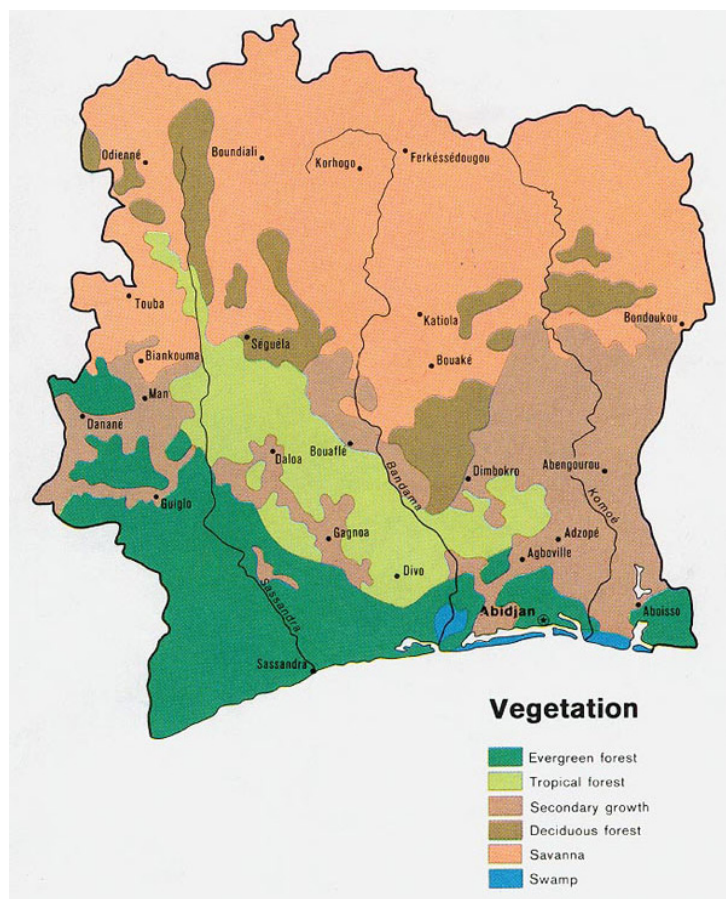


Figure 6. Vegetation of Côte d'Ivoire

Source: University of Texas

estuaries extend as much as 10–20 km inland. The sandy soil supports the growth of coconut palms and salt-resistant coastal shrubs. The dense rainforest that once came down to the water's edge along the continental side of the lagoons has been largely supplanted by clearings for farms and towns and by secondary woodlands. In the few remaining undisturbed areas, dense mangrove thickets appear along the edges of marshy inlets.

The forest region

The forest zone has a great variety of plants, from large trees to shrubs, vines, and herbs, including giant dracaenas, bombax, climbing palms, oil palms and many species yielding natural rubber. Native trees of commercial value include kola, West African coffee, and African mahogany and cedar. Oil and coconut palms thrive on the coast, while orchids, ferns and aroids cover the forest floor. The forests belong to the humid, tropical region of Africa, and the climate can be classified as subequatorial; from the viewpoint of plant geography, they belong to the Guinea-Congo forest massif. Figure 7 presents typical forest covers in the Côte d'Ivoire forest region.

A broad belt of dense forest covers nearly one-third of the country, extending north of the lagoon region in the east and reaching the coast in the west between the Sassandra River and the mouth of the Cavally River. Its northern boundary stretches from the city of Man in the west to Bondoukou in the east, dipping down in the centre of the country to the confluence of the Bandama Blanc and Bandama Rouge rivers. This boundary marks the transition from forest to grassy woodlands where plantation agriculture and burning have encroached on the forest. From the border with Ghana west

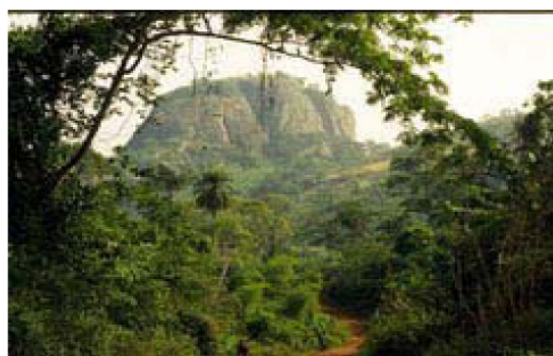


Figure 7. Typical forest covers

Source: Richard Desomme

to the Sassandra River, the gently rolling relief of the forest region is broken by small hills. West of the Sassandra, the Dan Mountains and the Toura Mountains reach 1 300 m elevation. Mt. Nimba, near the border with Liberia and Guinea, reaches 1 752 m.

The savannah

The northern half of the nation is characterized as savannah. Vegetation varies from woodlands to grasslands and occasional patches of dry scrub in the far north (Figure 8). Narrow gallery forests extend along watercourses and drainage lines. The southern portion of the savannah is sometimes referred to as the transition zone (and the northern portion as the Sudanian zone) although the entire region is transitional between the narrow belt of forest paralleling the coastline and the Sahara. The gently rolling plains are broken occasionally by granite inselbergs or small hill masses, the most extensive being the Komonos Hills. In the northwest, a number of peaks exceed 800 m.

Plant biomass and productivity in the savannah are largely dependent upon soil type and climate. The life-forms and phenological cycles of herbs, shrubs, grasses and trees reflect the constraining factors of the environment (Menaut, 1996). Productivity of a humid grass savannah determined at the Lamto site operated in collaboration with CNRS (Centre Nationale de Recherche Scientifique) – École Normale Supérieure, Paris, France, estimated that the total net primary production (NPP) of the grass savannah of Côte d'Ivoire was 2 150 g/m²/yr, of which 1 320 g/m²/yr (61%) was underground production (Menaut, 1996).

Rivers

Four major river systems follow meandering courses from north to south, draining into the Gulf of Guinea. From west to east these are the Cavally, Sassandra, Bandama and Comoé, all relatively untamed rivers navigable only short distances inland from the coast. In the north, many smaller tributaries are dry streambeds between rains.

The Cavally River rises in the Nimba Mountains of Guinea and forms the border between Côte d'Ivoire and Liberia for over half its length. It crosses rolling land and rapids and is navigable for about 50 km inland from its exit to the sea near Cape Palmas.

The Sassandra River Basin rises in the high ground of the north, where the Tiemba River joins the Férédougouba River, which flows from the Guinea highlands. It is joined by the Bagbé, Bafing, Nzo, Lobo and Davo rivers and winds through shifting sandbars to form a narrow estuary, which is navigable for about 80 km inland from the port of Sassandra.

The Bandama River, often referred to as the Bandama Blanc, is the longest in the country, joining the Bandama Rouge (the Marahoué), Solomougou, Kan and Nzi Rivers over its 800-km course. This large river system drains most of central Côte d'Ivoire before it flows into the Tagba Lagoon opposite Grand-Lahou. In the rainy season small craft navigate the Bandama for 50–60 km inland.

Easternmost of the main rivers, the Comoé, formed by the Leraba and Gomonaba, rises in the Sikasso Plateau of Burkina Faso. It flows within a narrow 700-km basin and receives the Kongo, and Iringou tributaries before winding among the coastal sandbars and emptying into the Ebrié Lagoon near Grand-Bassam. The Comoé is navigable for vessels of light draft for about 50 km to Alépé.

Large dams were built in the 1960s and 1970s to control the major rivers. These reservoirs, now referred to as lakes bear the names of the dams: Buyo on the Sassandra, Kossou and Taabo on the Bandama and Ayamé on the small Bia River in the southeast. Lake Kossou is the largest of these, occupying more than 1 600 km².



Figure 8. Lamto grassland site, Côte d'Ivoire
(The track shows the tropical ferruginous soil. Note also the grass layer and palm trees).
Source: Photograph taken by Dr. P. Mordelet (July 1989), CESBIO, France (Cited by Menaut, J.C. 1996).

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

There are clearly defined livestock (especially cattle) zones defined by tsetse fly presence, which, so far, has made it impossible to keep Zebu cattle in the south. Almost 90% of the cattle are north of the eighth parallel in the Sudan-Guinean zone, grazing the natural savannah in an extensive system. The north, being less affected by tsetse fly, is the great cattle zone, whence there is a considerable trade in cattle to the south. Sedentary crop-farmers do not take readily to cattle-keeping.

Côte d'Ivoire imported about 145 000 head of cattle and 200 000 head of sheep and goats each year, not all of which are from Mali (FAOSTAT). According to Diakaté (2001), Côte d'Ivoire accounted for 83% of Mali's official cattle exports of 129 000 head in 1999. By 1986, self-sufficiency had been virtually achieved in poultry and pig-meat production (Tchoume, 1982).

There are five main cattle breeds or types – Baoulé (Savannah West African Shorthorn), N'Dama, Méré (Zebu x humpless), Lagune (Dwarf West African Shorthorn) and Zebu (Sudanese type from Mali and Upper Volta). The national census of 1978 estimates for cattle was 516 000; while the estimates for sheep and goats in 1975 were 722 000 and 568 000, respectively (ILCA, 1981). In 1985 there were approximately 843 000 cattle, most of which were N'dama. There were also 1.5 million sheep, 430 000 swine, 1.5 million goats, and 16 million poultry (FAO, 1988). Table 2 presents cattle numbers and breeds. However estimates since then have been variable. Anon (*undated*) estimate for cattle was 5 582 000; sheep 2 432 000 and goats 4 968 000.

The Nord region accounts for nearly 80% of the national herd, 23% of which are Zebu and the remaining majority humpless. The distribution of cattle according to the three vegetation zones – the northern savannah including the five northern departments, the central savannah including eight departments and the forest region with thirteen departments shows that the cattle population was 463 500 in 1981. The 1981 figures are lower than those of 1978 and 1985.

De Troyes (1997) reported that production of meat in Côte d'Ivoire more than doubled between 1975 and 1995, amounting to 53 700 tonnes in 1995, or 53% of national meat consumption. Table 3 presents cattle, sheep, goat and human populations (in 1999 units) from FAOSTAT (1999).

Projections of the livestock subsector generally are estimates (Table 4a); data for meat and milk production, live animal and milk/milk product imports are presented in Table 4b (from FAO database, 2009).

Cattle play an important social role and are often slaughtered for traditional, religious or family feasts. They are also a form of saving and commercial offtake is low. The commonest cattle production system is a sedentary one, with humpless cattle owned by farmers. Some transhumance or semi-transhumance is practised by Peulh with Zebu herds that come from neighbouring countries. Table 5 presents cattle distribution in Côte d'Ivoire according to breed and vegetation zone.

In the Centre, cattle of a Baoulé village are often herded together by hired Peulh herdsmen whose role is very important as the farmers who own the cattle do not supervise them and may not even be able to identify which animals are theirs. Herdsmen generally receive a salary plus all or part of the milk from the herd, but their social status is precarious and they are often dissatisfied with their

Table 2. Cattle numbers and breeds in Côte d'Ivoire

Region	Departments	Zebu	Humpless	Total
Nord	Odienné	7 800	28 400	36 200
	Boundiali	45 000	34 100	79 100
	Korhogo	32 500	86 800	119 300
	Ferkéssédougou	22 000	35 900	57 900
	Bouna	-	58 800	58 800
Sub-Total		107 300	244 000	351 300
Centre		-	43 400	43 400
Ouest		-	29 100	29 100
Centre-Ouest		-	13 700	13 700
Est		-	12 800	12 800
Sud		-	13 200	13 200
Total		107 300	356 200	463 500

Source: Côte d'Ivoire, Ministère de la Production Animale Cited by ILCA (1981)

Table 3. Cattle, sheep, goats and human populations (1999 units)

Cattle	Sheep	Goats	Human population	Livestock units per capita
1 377 000	1 416, 00	1 111 000	15 685 000	0.9

Source: FAOSTAT (1999); assumes one bovine or five small ruminants equal one livestock unit.

Table 4a. Data on ruminant livestock population (head)

Livestock species	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle	1 280 229	1 308 030	1 336 442	1 365 478	1 392 787	1 420 642	1 449 054	1 478 035	1 500 000	1 500 000
Goats	1 072 455	1 093 904	1 115 782	1 138 098	1 160 860	1 184 077	1 207 759	1 231 914	1 192 000	1 192 000
Sheep	1 364 942	1 392 241	1 420 086	1 448 488	1 477 458	1 507 007	1 537 147	1 567 890	1 523 000	1 523 000
Asses	-	-	-	-	-	-	-	-	-	-
Horses	-	-	-	-	-	-	-	-	-	-
Camels	-	-	-	-	-	-	-	-	-	-

- = No data

Source: FAOSTAT data (FAO Statistics Division 2009) Accessed 13 March 2009

Table 4b. Statistics for meat and milk production (tonnes), live animal (head) and milk imports for the period 1998–2007

Products	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Beef and veal	33 326	33 268	33 232	32 243	27 713	26 279	28 445	29 612	5 1786	52 000
Sheep meat.	7 839	7 704	7 472	7 534	7 112	7 131	8 050	8 424	4 980F	5 000F
Goat meat.	3 018	2 984	2 919	2 949	2 823	2 840	3 147	3 279	4 300F	4 300F
Game meat.	101 515	104 865	108 326	111 900	115 593	119 408	123 348	127 418	13 000F	13 000F
Total milk.	25 349	25 899	26 462	27 036	27 577	28 129	28 691	29 265	25 000	25 000F
Live cattle imports nos.	154 100	140 988	146 477	135 705	1 100 000	72 172	88 759	96 058	100 000	-
Live sheep imports nos.	164 492	148 972	127 025	123 937	89 447	83 296	153 061	151 515	130 000	-
Live goat imports nos.	88 572	80 216	68 398	66 735	48 164	44 851	72 725	81 585	-	-
Whole milk evaporated imports (,000 MT)	7 775	10 404	6 796	8 198	6 964	8 454	473	967	692	-

F – FAO estimates

Source: FAOSTAT data (FAO Statistics Division 2009) Accessed 13 March 2009

terms of employment so there is often rapid turnover among herdsmen and the health and well-being of the animals tends to suffer. There seems to be a good deal of crossbreeding going on in the north. Most often Zebu and Baoulé, are crossed, but also Zebu and N'Dama.

Pasture development and cattle extension by SODEPRA-Centre

From 1976 until the late 1980s SODEPRA-

Centre (Société de Développement de la Production Animale) was involved in a considerable programme of improvement of cattle-rearing with village and private herds, pasture improvement and pasture survey. At the onset of the work most cattle-owners did not take many pains with their cattle, which remained unproductive. Cattle were usually herded by hired Peulh who took them to graze where they would; the cattle were usually in a small, dirty pen overnight. Extension began with the basics: control of epizootic diseases – in collaboration with the veterinary department; better night-pens and installation of crushes to facilitate vaccination and parasite control; provision of mineral blocks (Suttie and Janssens, 1980a).

The work progressed to improving overall management, nutrition and in some cases, better sires. Both village and private herds were eligible for such work; progress with villages was very slow, largely due to negative propaganda by Peulh herders; the cattle-owners did not recognize their own stock although they might know their colour – the SODEPRA ear-tagging of stock would have made it much more difficult to cheat the owners. Herd and pasture development was very popular with private (usually relatively prosperous) individuals.

At that time as part of its policy to increase local meat production, the Government would supply basic herds of 15–20 breeding cows and an N'Dama bull (*noyeaux d'élevage*) to people who wished

Table 5. Cattle distribution according to breed and vegetation zone

Vegetation zone	N'Dama	Baoulé and Méré	Zebu	Total	%
North savannah	27 000	217 000	160 000	404 000	78.3
Central savannah	40 000	50 000	-	90 000	17.4
Forest region	3 000	19 000a	-	22 000	4.3
Total	70 000	286 000	160 000	516 000	100.0
Percentage of herd	13.6	55.4	31	100.0	

a. Including a few Lagune cattle from the coastal region.

Source: Côte d'Ivoire, Ministère de la Production Animale, Cited by ILCA (1981).

to enter cattle production. They had to have access to adequate land and meet certain standards of infrastructure; the cattle were a loan that was to be repaid in kind over ten years. Private cattle-owners usually had some Baoulé stock that could be upgraded with N'Dama. The Baoulé breed is very well adapted to grazing in wooded pastures and on coarse vegetation.

Land that is neither cultivated nor built on is "undeveloped" and belongs to the Government. The agriculture of the region is a very extensive form of shifting cultivation on a long rotation; entire villages may move for several kilometres, not returning to the original terrain for many years; much of the land is, therefore, uncultivated so undeveloped in official eyes although it may be subject to traditional rights.

Pasture survey

Those wishing to be considered for a basic herd or to develop a more modern form of cattle rearing and any subsidies thereto adhering applied to the SODEPRA for assistance and guidance. The proposed site was visited, accompanied by the owner, by a team comprising a pasture specialist and a zootechnician; the terrain is fairly difficult and even a simple survey requires time and much foot travel; most of the grazing land is treed savannah (*savane arborée*) or sparse forest (*fôret claire*) so line-of-sight is often under a 100 m; there are narrow, impenetrable gallery forests along drainage lines necessitating detours; the land is flat and without vantage points (Suttie and Monet, 1979).

Only sites of or over 1 km² were considered and survey was only completed where a suitable water point was identified. The site was sketched on to the 1:50 000 survey map and observations made on water points, soils and vegetation, access, the existing herd and the level of technical competence of the owner. The SODEPRA did not enter into questions of land tenure. For applications that met specifications, a plan at 1:10 000 was thereafter prepared showing the main features, water points, sites for night pens and vaccination crushes etc. and a concise workplan drawn up. The applicant could then submit an application to the veterinary department for approval and livestock. Successful applicants benefited from periodic advisory visits from SODEPRA specialists as well as having practical assistance with parasite control and vaccination (Suttie 1980).

In 1979–1980 alone some 57 sites were surveyed and planned involving 58 220 ha and 7 415 head of cattle (Suttie 1980).

Improved pasture and herd management

The first improvements were always to allow the stock to spend as long as possible at pasture each day and to take them further from the night camp; others included:

- subdivision of the pasture to allow better grazing management; usually natural boundaries or beacons sufficed except where there was a risk of stock reaching crops or straying on to the railway.
- development of water points to allow use of outlying pasture;
- siting night pens, where used, on the pastures;
- organizing burning in sequence to avoid all being burnt at once;
- use night pastures instead of night pens (see below).

Wooden posts last no time under local conditions. For long fences, suspension fencing with high-tensile wire and steel strainers was the cheapest and most successful. For short runs, night pens and crushes live posts were used; suitable species are: *Spoindias mombin*, *Newbouldia laevis*, *Ficus* spp., *Erythrina senegalensis*, *Lophira lanceolata* and *Moringa oleifera* (Suttie and Janssens 1980b).

Night pastures

Sown pasture would have been too expensive for total feeding of beef cattle but, using limited areas, it did have an important role: to provide supplementary high-quality feed for pregnant and young stock during seasons of scarcity; to provide night-time grazing so as to prolong the time stock could graze daily.

Pastures were installed at the request of owners who paid all costs. SODEPRA also had a fencing team, again at the owners cost.

Simple, cheap installation techniques proved very successful. Only relatively tree-free areas could be developed; SODEPRA did not go in for land-clearing along the lines followed by the cotton extension

scheme (bulldozers, root-ploughs, root-rakes, burn all woody waste so produced). On several sites SODEPRA developed abandoned cotton land since, once weeds come in, farmers found cotton-growing onerous. Full ploughing and seed-bed preparation was expensive and gave disappointing results; heavy rainstorms usually buried the seed. The most suitable method was to burn before the onset of the rains then scarify the soil surface with a heavy disc-harrow, working on the contour where possible and leaving uncultivated contour strips. Phosphatic fertilizer was advised; in practice diammonium phosphate was used since it was available at reasonable cost for the cotton campaign; it was spread either by hand or tractor spinner immediately before sowing. Seed was sown by manual rotary seeders, which were simple and rapid. No ideal sowing time was decided; in practice the installation team worked from the onset of the rains in late March until their end in late October without any notably "best" dates appearing.

Stylosanthes guianensis was the basic legume at 3–4 kg/ha; *Panicum maximum* was the preferred grass (2 kg/ha) but seed supplies were limited so *Brachiaria ruziziensis* (3 kg) was widely used. So long as the new pasture was frequently but lightly grazed almost from sowing to keep both regenerating and sown grasses under control, establishment was good and *Stylosanthes* dominated by the end of the dry season (Suttie and Janssens 1980b).

Ruminants – plantation crops integration

The advantages of combining livestock with plantation crops have been stressed (Ferguson 1985; Reynolds, 1980, 1988, 1995; McDowell and Hildebrand 1980; Plucknett, 1979; Rombaut, 1973). Côte d'Ivoire has cocoa, coffee and oil palm as plantation crops. A wide variety of natural plants grows under them, up to 70% of which are palatable (Wan Mohamed, 1978) and readily grazed by livestock (Rombaut, 1973; Asiedu *et al.* 1978).

Rombaut (1973) estimated 65–100 tonnes/ha per year of green natural forage under oil palm plantations less than 8 years old where *Axonopus compressus* alone accounted for 55 tonnes. *Axonopus compressus* and *Paspalum conjugatum* can withstand heavy grazing pressure and are shade tolerant. Forage production of 43–97 tonnes/ha have been recorded for plantations over right years (Rombaut 1973). *Centrosema pubescens*, *Pueraria phaseoloides* and *Calapogonium mucunoides* are the most important cover crops used under oil palm, rubber and coconuts and most of them are nutritious and readily acceptable to livestock (Rombaut, 1973).

Pastures grow well when oil palm trees are less than five years old, but from 8 to 25 years the canopy is dense and fodder production is greatly reduced (Rombaut, 1973); after 20 years the canopy thins and pasture growth improves. Rombaut (1973) observed that the human resources requirement for managing oil palms in Côte d'Ivoire could be reduced by 50% if plantations were grazed by cattle. It has been estimated that 65–100 tonnes/ha/year of cover crops, mostly leguminous creeping plants, are grown under plantation crops for soil conservation and improvement in fertility (Rombaut, 1973; Plucknett, 1979).

Water intake of livestock under tree crops is low due to absence of heat stress and the high moisture content (over 70%) of the forage (Asiedu, 1978). It was reported that N'dama and Baoulé cattle under oil palms in Côte d'Ivoire drank on average 5 litres of water a day (Rombaut, 1973). Daily weight gains of 350–400 g per day were obtained in grazing trials with N'dama and Baoulé cattle on natural pasture under oil palms. Also carrying capacities of above 180 kg liveweight/ha were observed in cattle herded by day under oil palms and confined in enclosures at night which lost weight (Rombaut 1973).

Cattle under oil palm and coconut plantations

Oil palm production in large commercial operations on heavy soils may not be adapted for livestock rearing; however SODEPALM has raised cattle under oil palm since 1973 and in 1977 it was grazing 4 000 head (Koua Brou, 1977). The vegetation beneath the palms is varied. Its most striking aspects are its vitality – phanerophyte and chamaephyte vegetation that is always green; flowering and fruiting is limited to a few herbaceous plants; its floristic composition, both heterogeneous and uniform depending on whether one considers isolated plots or the whole plantation area; and its gregariousness, which frequently allows local enrichment of the flora with a particular species, a characteristic that is most marked for certain herbaceous and ligneous species that propagate by means of suckers.

Clusters of the following species have been observed under oil palm plantations in Côte d'Ivoire: *Dissotis rotundifolia*; *Aspilia africana*; *Melanthera scandens*; *Eupatorium odoratum*; *Thaumatococcus*

daniellii; *Axonopus compressus*; *Commelina nudiflora*, *Commelina forskalasi*, *Commelina africana*, and *Commelina condensata*; *Imperata cylindrica*; *Rottboellia exaltata*; *Nephrolepis biserrata*; *Pteridium aquilinum*; *Anchomanes diffomis*; *Acroceras zizanioides*; *Paspalum scrobiculatum* var. *commersonii* and *Paspalum conjugatum*; *Panicum repens* and *Panicum brevifolium*; *Sporobolus pyramidalis*; *Borreria latifolia*; *Diodia rubricosa* and *Diodia scandens*; *Eleusine indica*; *Mariscus umbellatus* and *M. flabelliformis*, often mixed with *Cyperus sphacelatus*; *Palisota hirsuta*; *Asystasia gangetica*; *Selaginella myosurus*; *Scleria barberi*) and *Scleria naumanniana*; and *Setaria megaphylla* and *Setaria. chevalieri* (Tchoume, 1982).

Phytosociological, floristic and agrostological studies conducted to assess the suitability of palm groves for raising cattle led to the identification of species that have a high forage value by virtue of their palatability, biomass and position in stable and profitable associations.

The most important species are: *Axonopus compressus* and *Paspalum conjugatum*; *Eleusine indica* and *Sporobolus pyramidalis*; *Asystasia gangetica* and *Commelina* spp. (*Commelina nudiflora*, *Commelina forskalaei*, *Commelina benghalensis*, etc.); and *Diodia rubricosa* and *Desmodium adscendens* (Tchoume, 1982).

Assessment of the biomass and regeneration of the vegetation within various associations indicated that for young plantations (1–7 years old) the often large amount of green matter per unit area (nearly 100 tonnes/ha in certain cases) diminishes considerably with increasing plantation age. Likewise, the regrowth of the vegetation, vigorous at first, becomes practically nil when the canopy closes. The vegetation under palm groves from 8 to 18 years old is increasingly sparse and poor. It recovers progressively with the clearing of the woodland vault after the eighteenth year (Tchoume, 1982). Many factors other than age affect the composition and physiognomy of the vegetation under oil palms; among these are human activities, climate, and the degree and type of herbivory.

Cattle rearing in palm groves, although possible in terms of available palatable plant species, seems only worthwhile on a large scale and even then it would require bringing in a substantial quantity of additional feed. This is especially true for older plantations where regeneration of the vegetation is very slow and difficult (Tchoume, 1982).

In the forest zone the need for food crops, on the one hand, and the shortage of protein on the other, have tended to encourage consideration of complementary uses of large forest plantations. The use of the adventitious vegetation in oil palm plantations as forage for cattle as well as the introduction of food and cash crops among the trees is practised. Palatable species have been identified in the vegetation, and some crops, such as cocoa offer promise as intercrops (Tchoume, 1982).

Ranching

Ranching is a recent development, in the Guinean savannahs; cattle are raised on fenced natural pastures where they graze day and night or are herded by day and kept in pens at night. Carrying capacity varies from 2 to 5 ha/head, and the savannah is burnt every year. Cattle usually have access to mineral salt licks and are dipped or sprayed 2 to 4 times a month, which is the only contact with people for the animals raised on fenced pastures. The herds are separated according to sex and age categories. Ranch sizes vary considerably from a few hundred to 25 000 animals (ILCA, 1979b).

Breeds

N'Dama

The N'Dama, a humpless trypanotolerant breed, is found in the northwest, in Odienné, Touba, Biankouma and Man Departments, which border the original breeding area of the Guinean type. N'Dama are kept on three government ranches and on a number of private and government stud farms. The government extension services distributed N'Dama sires among sedentary herds in the north in an attempt to improve the Baoulé stock. Results have been mixed. Large herds of N'Dama are also maintained on government ranches. Sipilou and Abokouamekro ranches have reached their full stocking capacity of 5 000 and 4 000, while La Marahoué Ranch, with 3 000 N'Dama is still growing.

The technical annual report of SODEPRA (Société de Développement de la Production Animale) (1984) gave data for reproduction parameters and mortality rate of the N'Dama cattle under village conditions and for ranches or breeding stations (see Tables 6 and 7, respectively).

N'Dama were introduced on palm plantations by SODEPALM with the aim of absorbing the Baoulé. They also are the most suitable breed for draught. The use of draught oxen is a fairly recent innovation, linked to cotton cultivation. As of 1977, there were about 15 000 draught oxen used in the cotton-growing area.

Baoulé

The Baoulé breed, which accounts for about half of the cattle in the country, are humpless, trypanotolerant shorthorns that predominate in the savannahs, except in the west and northwest where the N'Dama are more numerous. They are found in forest clearing areas in small isolated groups. In 1967, the Baoulé were estimated at about 75% of the national herd, but their numbers have decreased due to crossbreeding with Zebu (ILCA, 1981).

Baoulé are kept almost exclusively under traditional village conditions. However, a few herds have been established under improved conditions by Société d'Etat pour le Développement du Palmier à Huile (SODEPALM) on palm tree plantations where they appear to have adapted very well to the new environment. In a survey supervised by the extension services in Nord Region, it was observed that among the Lobi people of Bouna the village children looked after the cattle. Milking in this area was rarer than elsewhere in the region because fewer than half of the herds were milked at all and only 25% were milked every day (Godet, 1977).

A survey of Baoulé herds in Bouna, Dabakala and Korhogo from a sample of 761 animals found that an average herd composition was of 31% males and 69% females. There were very few males over two years (only 6 adult bulls) and virtually no steers (Poivey and Seitz, 1977).

Landais and Poivey (1981) quoted a mortality rate of 18.3% for 0–1-year-old Baoulé calves under village conditions, including 4.2% dying before they were a month old and following a sample survey in 65 pens operated by SODEPRA Nord 1.3% for calves dying within three days of birth. Godet *et al.* (1981) estimate milk yield of between 130 and 150 kg for a 210-day lactation period. Hoste *et al.* (1983) gave a milk yield of 400 kg for a 210-day lactation period for cows at CRZ (Centre de Recherche Zootechnique) Bouaké. Average daily weight gain under village conditions for various ages in Affouvassou, Centre region reported by CRZ Khorogo is presented in Table 8.

Méré cattle

In the areas where Zebu and humpless cattle are kept together there are crossbreds or Méré but it is difficult to estimate their numbers, especially as they include a variety of intermediate types. There are an estimated 36 000 Méré or 10 to 15% of the group classified as Baoulé or Méré in Côte d'Ivoire. Crossbreeding between Zebu and the humpless breeds is extensive in the northern areas. Camus (1977) reported that out of 1 016 herds observed in the SODEPRA-Nord area, 283, or 27.8%, had a Zebu or crossbred bull or some evidence of crossbreeding. Out of 578 herds observed in Korhogo and Boundiali-Ferké areas, 250, or 43.2%, showed some crossbreeding. Estimates of weights of the 4 200 males in the herds from measurements of heart girth is presented in Table 9.

Table 6. N'Dama reproduction traits and mortality rate under village conditions (1984 data)

	SODEPRA-North	SODEPRA-Centre
Fecundity rate (%)	48	48.3
Mortality rate (%)		
– Overall	-	3.3
– 0–1-year-old calves	10.2	-
– Adults	3	-

Source: SODEPRA (1984); ILCA (1981)

Table 7. N'Dama reproduction traits and mortality rate, ranch-reared, 1984

	Marahoué	Abokouamekro	Sipilou
Fertility rate (%)	60.3	53.3	47
Fecundity rate (%)	64.6	55.9	47.6
Mortality rate			
Overall	7.3	15.1	11.1
Calves	7	26	10.1
Females			
Heifers	8.12	12.8	8.6
Breeding heifers	2.96	12.8	7.7
Cows	4.94	7.2	17.3
Males			
Male calves	8.4	12.8	15.5
Steers	9	12.8	15.5
Bulls	5.6	7.2	8.7

Source: SODEPRA (1984); ILCA (1992).

Table 8. Average daily weight gain (g/d) for Baoulé calves in Affouvassou

	Age (months)						
	1	2	3	4	5	6	6–12
ADG (g/d)	203	137	107	110	127	180	76
Numbers	32	32	32	32	32	32	32

Source: CRZ, Khorogo (1980); ILCA (1981).

Lagune cattle

There are still a few Lagune cattle in the coastal and forest areas. Their numbers have often been overestimated. Keita (1973), for example, reported 7 000 head, but they probably represent no more than 10% of the total cattle population in Sud Region, or about 1 000 in all. Lagune cattle, which are dwarf, of low productivity but very trypanotolerant, are kept in areas where farmers do not traditionally keep cattle and are rarely herded.

Table 9. Weights of male cattle estimated from heart girths

	Baoulé		Méré (Zebu x Baoulé)		Zebu	
	no	kg	no	kg	no	kg
2 Teeth	1 229	148	146	186	38	204
4 Teeth	593	168	108	212	67	239
6 Teeth	305	187	61	234	31	268
8 Teeth	189	204	55	260	57	309

Source: Camus, (1977); ILCA (1981).

Dairying and milk production

Except for the Peulh, most Ivoiriens do not consume milk nor milk products so cattle are not milked unless they are owned or herded by Peulh. The milk yield of Baoulé cows is generally low, sufficient for their calves.

Tidori *et al.* (1975) estimated 309 kg of milk produced from a sample of Baoulé cows during the first 120 days of lactation based on calf weights. Godet (1977) reported a milked-out yield of about 400 g/day in the dry season and about 700 g/day in the rainy season under village conditions.

Jersey x N'Dama crossbred study

The Centre de Recherches Zootechniques (CRZ) started a selective breeding programme of the N'Dama in 1955. The milk production of the N'Dama cow is just sufficient to feed the calf up to a certain stage of growth. Therefore a crossbreeding programme of Jersey x N'Dama cattle started and an N'Dama crossbred was produced with Jersey, Abondance and Fleckvieh in the Centre de Recherches Zootechniques, Minankro, Bouake (Hoste, 1983; FAO, 1984). These crosses were kept indoors, given careful management and protection from parasites and fed on improved fodder as described by Letenneur (1983). Encouraging milk production was obtained under station conditions. (Letenneur, 1983; FAO, 1984). When the crossbreeds were raised under field conditions, however, even with qualified owners and good care, they proved to be highly susceptible to streptotrichosis and have not become established.

Small ruminants

Small ruminants are the livestock that are traditionally integrated into the cropping system. They do not suffer from any sociological constraints. Their meat is well liked and they provide a regular source of cash income. National estimates in 1975 were 722 000 sheep and 566 000 goats, but FAO (1988) estimated one million sheep and one million goats in 1976 (ILCA, 1992).

Information on the size of household flocks suggested averages of four to five small ruminants in Côte d'Ivoire (ILCA, 1979a). Small ruminants appear to be the most appropriate domestic animals to allow a real integration of the agricultural and livestock subsectors at the present time (Barry, 1985).

Sheep

Sheep in the Côte d'Ivoire are mainly of the Djallonké breed (there are some Sahelian sheep in the North). Two types may be distinguished: the dwarf sheep found in forest areas, and the larger Savannah sheep in the north. Besides grazing, crop residues are fed to Djallonké lambs during periods of forage shortage especially in the dry season period (Kondombo and Niannongo 2001). Table 10 presents the performance of sheep under different production systems while

Table 10. Productivity estimates of sheep under different production systems

Parameter	Production environment	
	Village	Village simulation
Ewe viability (%)	84	38
Lambing percentage	175	206
Lamb viability to one year (%)	50	50
Lamb weight at five months (kg)	11.5	14
Productivity indexa per ewe per year (kg)	10.9	20.9
Ewe weight (kg)	23	23
Productivity indexa per 10 kg ewe maintained per year (kg)	4.7	9.1

aTotal weight of five-month-old lamb produced. Source: Country visit information (ILCA, 1981).

Table 11 present average daily gains and conversion ratios of male lambs in two different feeding programmes.

Commercial sheep production has evolved in a few cases from modified village production. Farmers who have improved their husbandry have found their flocks increasing to such an extent that they have moved their animals from the villages and established farms specializing in livestock production, where goats and cattle are also usually kept.

The reproduction traits and mortality rate for West African dwarf sheep under improved village conditions and under pastoral management is presented Table 12. These two animal husbandry systems are more specific to the north of the country. In the first type of system the sheep are given supplementary feed (Bassewitz 1983).

Data on the reproductive performance and mortality rate of West African dwarf sheep under ranch or breeding station conditions are given in Table 13, while Table 14 presents the average daily gains for male lambs.

Disset (1986) observed a fertility rate of 106%, a lamb mortality rate of 3.7%, an adult mortality of 2.4% and an overall mortality rate of 6.1%.

Sheep management

Bassewitz (1983) described flock management in northern Côte d'Ivoire and classified flock management under four systems: urban production, Peulh pastoral production, improved traditional management and free-range.

Urban livestock production is the most intensive of the traditional systems but involves only 5% of the sheep. The animals, mainly Sahelian x West African dwarf crossbreeds, graze freely by the roadside and on residues during the day, returning at nightfall to be locked up in mud huts. They are given regular supplementary feed of maize, maize bran and salt. This type of husbandry is practised more for prestige and as investment rather than for commercial reasons.

Pastoral management became important following the sedentarisation of the Peulh in Côte d'Ivoire in 1972. An estimated quarter of the sheep population in the north are managed thus. Flocks

Table 11. Weight gains and conversion ratios for young male sheep

	1976 Trial	1977 Trial	
	Fodder + Concentrates	Straw + Concentrates	Savannah + Concentrates
Animals	young males	6-month-old males	7-month-old males
Trial period	182 days	90 days	90 days
Weight at start (kg)	12.2	15.4	15.6
Weight at end (kg)	25	23.8	25.5
Average gain (g/day)	70	93	110
Conversion ratio	8.2	7.4	-

Source: Ginisty (1976, 1977).

Table 12. Reproductive traits of West African dwarf sheep under improved village and pastoral management (weighted arithmetic means: 1980/81)

	Improved village conditions	Pastoral conditions
Number of lambings surveyed	207	362
Fertility rate (%)	122	151
Prolificacy rate (%)	107	109
Mortality rate (%)		
Global	21	24
Males	16	30
Females	25	19

Source: Bassewitz (1983).

Table 13. Reproductive traits and mortality rate of West African dwarf sheep under ranch or breeding station conditions.

	(*) 1	2	3	4	5	6
Fertility rate (%)	80	121	138	106	200	142
Prolificacy rate (%)	113	109		132	124	
Mortality rate (%)						
Global	10		28.1	6.1		7.5
Young		15.6	13.8	3.7	21.4	7.9
Adults		6.8		2.4	11	2.7

Sources:(*)

1: CRZ, Bouaké (1982).2: Herds managed by SODEPRA-Nord (SODEPRA, 1984).3: Badikaha Seed Farm (SODEPRA, 1984).4: National Sheep Breeding Centre (Disset, 1986).5: Sud Forestier Project (SODEPRA, 1984).6: Toumoudi Sheep Production Scheme (Disset and Rombaut, 1986).

Table 14. Average daily gains for male lambs

	0-30 days (g/day)	0-60 days (g/day)	30-120 days (g/day)	0-120 days (g/day)	Weight at 4 months (kg)
Improved conditions at SOCIABE Station	125-145	110-125	90	100	14
Village conditions	70-95	50-65	50-55	55-60	9-10

Source: Ginisty 1976.

are herded during the day by the owner's children and kept in an enclosure of thorn branches at night; a typical Sahelian practice introduced by the Peulh. Flocks are generally large and are given little or no supplementary feed. Traditional health care is provided. Flocks are raised for commercial purposes.

Almost 70% of the sheep in the north of the country are managed under **improved traditional management**, mainly by the Senoufo in the north and northeast. Its main features are night penning, organized distribution of supplements, health care and herding by hired herdsmen or family members.

The **free-range** system is of minor importance in the north but widely practised in the Guinea savannah and forest region. The animals, which are considered as an investment, live as commensals and are given no health care while being allowed to roam the village, grazing by the roadside and on household refuse. Consequently, they cause considerable damage to crops, resulting in conflicts between farming and pastoral communities.

Goats

There is scant information on goat production in Côte d'Ivoire, but general observation suggests that goats tend to weigh slightly less than sheep in the same area, that prolificacy is higher among goats than among sheep (more frequent twinning), and that growth among goats is slower than among sheep. Goats of the West African Dwarf or Guinea type are found throughout the country; there are some Sahelian goats in the north.

5. THE PASTURE RESOURCE

The specific contribution of most forages remains approximately constant throughout the annual cycle in natural savannah. The floristic composition of a given formation at the peak of its development varies substantially, depending on whether all the vegetation or only the first two strata are considered (Cesar, 1975, 1986). There appears to be a lower grazing level on sandy soil than on sandy-clayey soil, even if the initial biomass of the vegetation is identical in the two cases.

Fodder species

A list of useful forage species for the humid tropics, taking into account dry matter production, ease of establishment, length of growing season, quality of dry-season feed provided, and in some cases ease of eradication, has been documented (Messenger 1976 and 1977, Crowder and Chheda 1977 and Ruthenberg 1974). Among the grasses, recommended species include *Brachiaria ruziziensis*, *Brachiaria mutica*, *Cynodon plectostachyum*, *Cynodon nlemfluensis*, *Panicum maximum* and *Pennisetum purpureum*, as well as their hybrids with *Pennisetum typhoides*, *Chloris gayanus* and *Cenchrus ciliaris*.

The grasses cultivated in the Côte d'Ivoire are *Brachiaria ruziziensis* and *Panicum maximum* its ORSTOM K 187B, G 23 and T 58 clones in particular. These were developed at Adiopodoumé and tested by the CRZ at Minankro-Bouaké (Guerin, 1977). These plants are ecologically very flexible and well adapted to the Côte d'Ivoire and can be utilized directly by grazing or by cut-and-carry, or for making silage. The method advocated is alternating grazing with cutting and carrying (Audru, 1980).

Brachiaria ruziziensis can persist for 3 to 5 years or more. During the first 3 to 5 years the plantations planted are treated as a forage crop. Extracts are offset by fertilization. After 3 or 5 years the areas may be regarded as improved pasture. Fertilization should be used only as a spur to development, and nitrogen only is used.

Panicum maximum, especially, is a grass suitable for extension, for the following reasons: a) it adapts very well to dry-land cropping; b) it manages well with moderate fertilization; c) it can be maintained by burning off; d) it is resistant to competition, especially from ligneous plants; e) it is highly resistant to temporary overstocking; and f) mechanical methods can be used for planting, on account of its perennality (Audru, 1980).

An area planted with *Panicum maximum* may similarly be considered as a forage crop for the first 1 to 5 years and treated as such. From year 5 onwards it may be managed as an improved pasture until the 10th year, and treated the same as *Brachiaria*.

Axonopus affinis (Carpet or mat grass, narrow leaf carpet grass) and *Axonopus compressus* (Carpet or mat grass, broadleaf carpet grass) are widespread natural pasture grass under coconuts and oil palm that thrive well on a range of soil conditions and are grazed by cattle in Côte d'Ivoire.

Recommended legumes include *Pueraria phaseoloides*, *Centrosema pubescens*, *Stylosanthes hamata* cv Verano and *Stylosanthes guyanensis*.

Stylosanthes was also one of the legumes used in Côte d'Ivoire Borget (1971). *Stylosanthes hamata* cv Verano has a 180- to 210-day growing period in Côte d'Ivoire just as in other humid agro-ecological zones (AEZ) of West Africa (ILCA, 1988). A number of studies were carried out (for example, a study at Bouake of cultivars of Verano, Cook, *S. humilis*, Endeavour, Schofield and Oxley ranked them in order of declining seed yield (Guerin, 1977), yields for hand-harvested crop seed ranged between 600 and 1 750 kg/ha and Cadot (1969, 1971) undertook various grazing and seed production studies). *Stylosanthes guianensis* was widely used for pasture improvement until it was severely attacked by anthracnose (*Colletotrichum* sp.) in the late 1980s.

Palatable trees and shrubs

Browse species known to be suitable for cattle are used on sheep farms and cattle fattening projects (Audru, 1980). The legumes to be used are browse or fruit producers. These include mainly *Prosopis chilensis*, *Pithecellobium saman* and *Albizia flavovirens*. (Audru, 1980). The following also may be used: *Ficus gnaphalocarpa* (leaves and fruit; *Ficus capensis* (leaves), *Ficus glumosa* (leaves), *Ficus thonningii* (leaves) and *Ficus vallis-choudae* (fruit). For cover crops or in strips, or for non-arable areas *Leucaena leucocephala* can be used as the leaves and young pods are palatable (Audru, 1980). For the humpless cattle breeds the most palatable species are *Parinari curatellifolia* (leaves and fruit) and *Daniellia oliveri*; *Lophira lanceolata* young leaves; *Trema* (leaves) (Audru, 1980).

Shrubs and trees are particularly valuable as a source of feed during the dry season. Species such as *Griffonia* spp. and *Baphia* spp. remain leafy throughout the dry season with a crude protein (CP) content of 15 to 20% (Fianu *et al.*, 1972). Messenger (1977) reported a CP content of 10% for a legume pasture at the end of the dry season, which was the lowest value recorded over a year.

A report on the selective effect of grazing and its role in the evolution of organic matter in two types of soil with mixed pasture of *Loudetia arundinacea*, *Schizachyrium sanguineum* and various *Andropogons* demonstrated that grazing animals preferred *Andropogon* and *Hyparrhenia* species over *Loudetia arundinacea* in the two locations studied.

In Zone I (centre section) on sandy-clayey soil, no edaphic difference appeared between the grazed and rejected areas. On the other hand, on sandy soil (Zone XI, Gofabo section) the gritty structures under the rejects were particulate and loose for the grazed species. Here grazing gave rise to local weakening of the structure, a phenomenon that would not occur if the soil was sufficiently rich in clayey elements.

Moreover, Zone I (centre section) displays locally, in similar ecological conditions, adjoining exclusive populations of *Loudetia arundinacea* and *Schizachyrium sanguineum*. The sandy texture of the soil is identical in both cases, but the structure of the first horizons is markedly more resistant under *Schizachyrium sanguineum*. Table 15 shows the floristic composition of heavily grazed areas on the one hand and of clusters of rejects on the other hand.

Local replacement of *Schizachyrium sanguineum* by *Loudetia arundinacea*, probably due to overgrazing, was accompanied by a weakening of the structure, and gave grounds for thinking that the higher organic matter content is essential for the retention of *Schizachyrium sanguineum* and unimportant for *Loudetia arundinacea*.

Table 15. Comparison of the floristic composition of grazed areas and rejects

Floristic composition	Centre Zone 1		Gofabo Zone XI	
	Grazed areas	Rejects	Grazed areas	Rejects
<i>Hyparrhenia diplandra</i>	41	14	48	7
<i>Andropogon schirensis</i>	13	4	20	0
<i>Schizachyrium sanguineum</i>	36	43	12	21
<i>Loudetia arundinacea</i>	3	18	4	72

Source: Cesar (1975)

6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

Coulibali *et al.* (2000) observed that poor pastoral management and overstocking have been responsible for localized and generalized degradation of farmlands. Their opinion was that the depletion of the herb-grass stratum was compounded by the regression of the rooting system on light soils, which is the source of soil organic matter and secondly, having been inadequately nourished in organic matter, degradation and low supply of the humiferous environment of the soil usually led to a drop in soil fertility. However, on a more clayey soil, pastoral degradation through 'bush growth' is less serious and may, in some cases, have some favourable effects on the environment by accelerating reforestation.

However, with a more rational management of farmlands and the provision for restoring affected areas followed by a controlled use, fodder production can increase and the fertile land can be preserved. Coulibali *et al.* (2000) suggested several techniques depending on the degree of intensification to improve pasture resources. These techniques are: natural fallow in *Andropogon gayanus*; improved fallow through over-sowing of *Stylosanthes hamata*; and cultivated permanent pasture associated with *Panicum maximum* and *Stylosanthes hamata*. These techniques have been studied for their productivity and farming modalities.

In order to intensify the production systems, the Côte d'Ivoire placed a strong emphasis on the integration of agriculture with livestock production; the Société pour l'Aménagement de la Vallée du Bandama (AVB), with headquarters at Bouaké, developed agricultural production systems based on rotation with fodder crops (*Stylosanthes* spp.). Emphasis was originally placed on a cattle-*Stylosanthes* mini-farm system (Barry, 1985), however, the methods used in the past to achieve this goal were not always successful and results obtained so far proved disappointing. It was then considered that animal traction would provide the answer to integrating the two subsectors and at the same time a forage rotation system would restore soil fertility.

Herbage seed production

There is a considerable amount of information on the suitability and performance of herbage species, both indigenous and introduced. Sumberg (1985) reported seed production of *Gliricidia sepium*. Seed-related activities were not initially available in Côte d'Ivoire, however substantial efforts were made to set up a domestic seed industry and it was the first francophone West African country to implement a pilot scheme on pasture and pasture seed development (Anon, 1971).

SODEPRA had a large scale, mechanized, seed production farm at Badikaha during the 1970s and 1980s; its main output was *Stylosanthes guianensis* until that legume was wiped out by anthracnose (*Colletotrichum* sp.). Other products included *Brachiaria ruziziensis*, *Panicum maximum* and *Stylosanthes hamata*. The seed was mainly used by SODEPRA ranches and projects.

There are a wide range of grasses and herbage legumes that are suitable for commercial use in pasture development, but not established as a domestic herbage seed production industry (Jutzi, 1985). This indicates that available grass and legumes species if well managed can provide feed resources for the ruminant population in Côte d'Ivoire.

Herbage productivity

Among the grasses, *Brachiaria* spp. appear to remain green at the beginning of the dry season for a longer period than native species, such as *A. gayanus*, probably making better use of the sparse rains and residual soil moisture available at that time (Messenger, 1977).

Average annual yields of 13 tonnes dry matter/ha for *P. maximum*, 10 tonnes for *Brachiaria mutica* and 8 tonnes for *Stylosanthes guyanensis*, while *Andropogon gayanus* yielded 4 t dry matter/ha and *Cenchrus ciliaris* 4.2 tonnes over three years were recorded by Messenger (1977). It was observed that the growing season for legumes is one to two months longer than for grasses, and, if kept as standing hay, legumes retain their feed value longer. Table 16 shows reductions in annual pasture yields from first to third year of establishment in Côte d'Ivoire.

Table 16. Reductions in annual pasture yields from first to third year of establishment

Species	Annual yields (tonnes dry matter/ha)	
	first year	third year
<i>P. maximum</i>	19	9
<i>B. mutica</i>	15	8
<i>S. guyanensis</i>	10	5

Source: Messenger (1977).

Pasture fertilization

Messenger (1977) observed that fertilization, particularly with nitrogen, has a dramatic effect on tropical pastures, but not so much in raising overall yield levels as in maintaining the level achieved during the first year of establishment over successive years. Fertilization has been used to boost annual levels of *P. maximum* and *B. mutica* yields to 24 tonnes dry matter/ha with annual averages over three years as high as 32 tonnes. The fertilization of *Andropogon gayanus* and *Panicum maximum* with 150 kg nitrogen/ha and 120 kg nitrogen/ha also resulted in yields of 7 tonnes dry matter/ha and 12 tonnes dry matter/ha, respectively.

At Bouaké, Cathou (undated; cited in ILCA, 1979b) found that with the application of 300 kg nitrogen, 100 kg phosphorus and 400 kg potassium annually the production of 20 tonnes dry matter/ha of good quality forage could be maintained. However, Messenger (1977) reported 33% drops in the yields of *Cynodon* spp. with or without fertilization.

Grazing or cutting strategies

Most recommendations on intervals between grazing and cutting pasture grasses aim at maximizing forage production and quality and assuring the regrowth of the plants. Somewhat shorter intervals of four to five weeks have been found ideal and recommended for *P. maximum*, at least during the growing season, and somewhat longer intervals for *Stylosanthes* spp. in Côte d'Ivoire conditions (Messenger, 1977; ILCA, 1979b).

Barring extremes, the height of cutting does not seem very important. For example the optimum cutting height for *Stylosanthes* spp. is 10 cm in the first year of establishment, rising gradually to 25 cm in the third year. For *P. maximum*, fairly low cuts at 10 cm twice during the growing season are preferable to more frequent cuts at 25 cm (ILCA, 1979b). *Stylosanthes* spp., and *Hyparrhenia rufa* should be cut at gradually increasing heights.

Messenger (1977) found that *P. maximum* gave an offer-residue rate of 78% when grazed at four-week intervals, while the rate dropped to 35% when the pasture was grazed at six-week intervals and to 18% with grazing at eight-week intervals.

In general, heavy stocking during a short period will result in an offer-residue rate close to 60%, while continuous stocking at a lower level results in a rate of 34 to 40% independent of pasture species. Messenger (1977) found that *P. maximum* gave an offer-residue rate of 78% when grazed at four-week intervals, while the rate dropped to 35% when the pasture was grazed at six-week intervals and to 18% with grazing at eight-week intervals.

Constraints: threats and solutions

With some exceptions, tsetse fly infestation limits livestock production in savannah regions as does the absence of forage in the forest zone. There are few pastoral groups in Côte d'Ivoire, and the country's livestock population is unable to meet domestic needs.

Crop residues and agro-industrial by-products seem not to play a major role in ruminant livestock production. Farmers should be introduced to their use especially in areas short of forage in both wet and dry seasons.

Due to these constraints, the following government ministries and organs were established in Côte d'Ivoire to find solutions to ruminant livestock production; pasture and forage availability and sustainability.

Ministère de la Production Animale, which includes among other sections a Direction des Services Vétérinaires, a Direction de la Production Animale and a Service d'Agrostologie et de Production Fourragère. The Direction de la Production Animale has an office in each region and department. The Ministry also created a Société de Développement de la Production Animale (SODEPRA), which is responsible for breeding, extension and development activities (ILCA, 1992).

Under the Ministère de la Recherche Scientifique, animal production research activities are confined essentially to the Centre de Recherches Zootechniques de Minankro-Bouaké. Cattle fattening and sheep breeding trials are carried out in collaboration with that Centre.

The Département de Zootechnie also carries out research on mineral nutrition and small ruminants under the framework of the Ecole Nationale Supérieure d'Agronomie (ENSA).

The SODEPRA works on forage and fodder crops.

Parallel with the genetic improvement project, the Centre de Recherches Zootechniques (CRZ) conducted a programme for the intensive production of forage and fodder crops, thus providing a basis for the feeding system. Also the CRZ conducted research to facilitate the technical transformation of various stock farms for accelerated sound management of the savannah, livestock upgrading techniques and the intensive production of forage and fodder crops outside the scheme of crop rotation, and seed production.

In each of these various fields there were definite and important possibilities. Since Côte d'Ivoire has an abundance of agro-industrial by-products useful for feed (Letenneur, 1983) there should be the continued utilization of other feed resources.

The government should strengthen livestock production by providing education and training in modern animal husbandry and also introduce large-scale cattle fattening centres near Bouaké and Abidjan.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Several institutions in Côte d'Ivoire carry out research and promote the development of ruminant livestock production and forage. These include the government ministries and departments; parastatals, agencies and academics in higher institutions and private organizations.

Category	Supervising agency	Executing agency	Research focus
Government	Ministère de l'Enseignement Supérieur et Recherche Scientifique	Centre de Recherche Agronomique (CNRA)]	Crops, livestock, fisheries, forestry
	Ministère de l'Agriculture	Laboratoire National d'Appui au Développement Agricole(LANADA)	Livestock
		Laboratoire Central de Nutrition Animale (LACENA)	Livestock
		The Institut des Savanes (savannah areas)	Pasture
		Office de la Recherche Scientifique et Technique Outre Mer	Soils and plants
Higher Education	Institut National Polytechnique Félix Houphouët-Boigny	École Supérieure Agronomique (ESA)]	Crops and livestock.

The Centre de Recherches Zootechniques de Minankro-Bouaké (CRZ) (B. P. 1152, Bouaké)

The Société de Développement de Productions Animales (SODEPRA) (B. P. 1429, Abidjan)

The Société pour le Développement du Palmier à Huile (SODEPALM) (B. P. 2049, Abidjan) (cattle production on its palm plantations.

The Opération d'Encadrement de l'Élevage Sédentaire au Nord Côte d'Ivoire (known as SODEPRA-Nord), with headquarters at Korhogo (B.P. 24, Korhogo)

Institut des Savanes (IDESSA)

Tié B Tra. – National institute of technology FHB, Yamoussoukro, Ivory Coast

Ayé mou Assa. – University of Cocody, Abidjan, Ivory Coast

Francis Akindès – Université de Bouaké and Institut de Recherche pour le Développement (ex-ORSTOM), Bouaké, Côte d'Ivoire

Aman, S. – Institut des Savanes, Route de Sakassou, B. P. 635, Bouaké, Côte d'Ivoire

Tchoume, T. – Laboratoire de Botanique Agricole, Ecole Nationale Supérieure Agronomique d'Abidjan, Abidjan, Côte d'Ivoire.

Olivier Girardin. – Swiss centre for scientific research, 01 BP 1303, Abidjan, Côte d'Ivoire

Ake Séverin – Editor in Chief; Agronomie Africaine, Association Ivoirienne des Sciences Agronomiques (AISA), 20 BP 703 Abidjan 20, Côte d'Ivoire

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