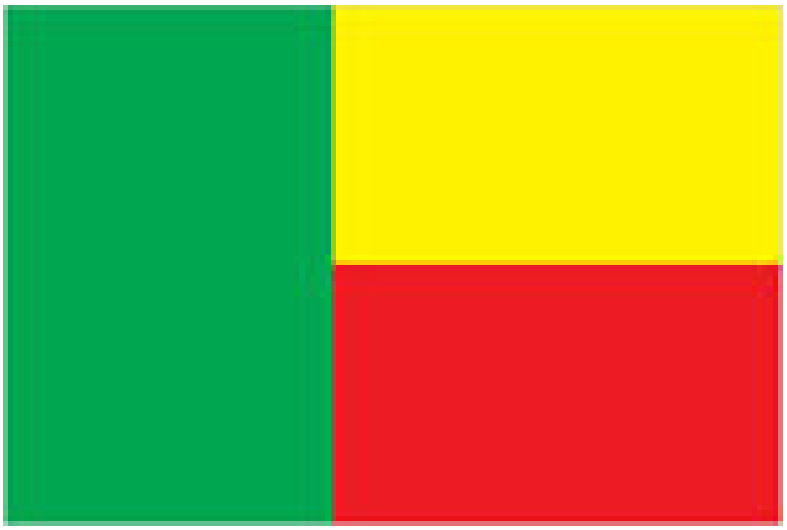
Country Pasture/Forage Resource Profiles

THE REPUBLIC OF BENIN



by
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1. INTRODUCTION

The present Republic of Benin was the powerful Kingdom of Dahomey, once known as the Slave Coast because of trafficking from there to the Americas. It became a French Colony in the late 1800s, gaining independence in 1960. The country's current name was adopted in November 1975.

Benin borders Niger to the north, Burkina Faso to the northwest, Nigeria to the east, Togo to the west and the Gulf of Guinea to the south (see Figures 1a and 1b). Benin extends from the Niger River in the north to the Atlantic Ocean in the south, a distance of 700 km. Its coastline measures 121 km; the country is about 325 km at its widest point. Benin's latitude ranges from 6°30′ N to 12°30′ N and its longitude from 1° E to 3°40′ E with an area of 112 622 km^2. The highest point is Mt. Sokbaro 658 m while the lowest point is the Atlantic Ocean sea level.

Benin has a population of 7 862 944 (8 791 832 [July 2009 est.] with a 2.977% growth rate according to the World Factbook). In 2006 GDP was USD5.92 billion; GDP growth rate, 4.2% and per capita GDP was USD749 (CIA – World Factbook Profile, 1993; 2007).

The major cities with their population estimates are; Cotonou 533 000, Porto Novo 317 000, Djougou 132 000, Abomey Calavi 126 000, Parakou 107 000 (1992). The capital City is Porto-Novo. Benin land use consists of: 31% forests; pastures 4%; agricultural-cultivated land 17%, and other 48% (CIA – World Factbook Profile, 1993; 2006). Pilot Analysis of Global Ecosystems (PAGE) calculations based on Global Land Cover Characteristics Database (GLCCD) (1998) indicated that Benin Republic has 93.1% grassland area, making it the country with the highest grassland area in sub-Saharan Africa.

The land area covered by vegetation represents an area of 11 million ha. This is distributed as follows: 25% (2 750 000 ha) is in afforested zones; 23.5% (2 585 000 ha) is arable land; 8% (880 000 ha) is in permanent crops; 4% (440 000 ha) is permanent pasture; while 39.5% (4 345 000 ha) is for other uses (open/fragmented land and other land cover). In 2006, 20% (2 200 000 ha) was cropped and of the cropped land 25% (550 000 ha) was used as the grazing zone for large herds of cattle. This, however, excludes 45% reserved forests occupying a surface area of 1 375 000 ha of which 14 000 ha are teak plantations. Of the available hectares of arable land, 2 200 000 ha were developed in 2006.

The low farming rate in Benin is attributed to:

- low mechanization of agriculture coupled with an almost total absence of large farms;
- lack of market outlets for farm produce at competitive prices; and

Figure 1a. Map of the Benin Republic
Source: World Factbook

Figure 1b. Political map of the Benin Republic
Source: World Atlas.com Inc

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

Staples	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Maize	662 227	782 974	750 442	685 902	622 136	788 320	842 626	864 698	671 949	900 000*
Millet	29 427	29 519	36 352	34 969	40 632	35 457	36 817	37 707	32 842	40 000*
Sorghum	138 429	126 440	155 275	165 342	195 468	163 276	163 831	169 235	156 333	200 000*
Yams	1 583 710	1 647 010	1 742 000	1 700 980	1 875 010	2 010 699	2 257 254	2 083 785	2 239 757	2 240 000F
Cassava	1 989 020	2 112 960	2 350 210	2 703 460	2 452 050	3 054 781	2 955 015	2 861 369	2 524 234	2 525 000F
Beans	75 452	74 237	85 613	78 353	100 462	81 823	93 789	104 564	80 178	80 500F
Groundnuts	99 160	101 943	121 159	125 377	146 214	124 979	151 666	140 329	99 382	130 000*
Others (export)										
Cocoa	200*	100*	100*	100*	100*	100*	100*	100*	100*	100*
Coffee	200F	200F	200F	150F	100F	60*	60F	60F	60*	60*
Cotton	364 127	375 586	339 909	393 060	485 522	420 000*	425 000*	341 000F	220 000F	313 500F
Palm kernels	220 000	220 000F	220 000	220 000F	220 000F	244 000F	244 000F	245 000F	245 000F	275 000F

** = Unofficial figure*
F = FAO estimate
FAOSTAT [© FAO Statistics Division 2009] viewed 15 March 2009

- the land tenure system, which until recently was based on customary rights.

In general, very little land is occupied in all of Benin. Yet, there are very fertile areas such as the Niger Valley, reputed to be the most fertile after the Nile Valley.

The principal food crops are maize, cassava, sorghum, yams, millet and beans. Important cash crops, produced mainly in the south, include cotton, cocoa, coffee, groundnuts and palm kernels. The herding of cattle, sheep, and goats predominates in the grasslands of the north. An exploding population (3.3% population growth or 2.977% according to the World Factbook is putting pressure on forests for firewood, agricultural clearing, pasture lands and housing (CIA – World Factbook Profile, 2006). Table 1 shows output of some major staple food and export crops from 1998 to 2007.

Palm oil was a major cash crop in Benin during the 1980s, but its cultivation was marginalized by the popularity of cotton, the only cash crop suited to small-scale farmers, making up 40% of the country's GDP and over 80% of export revenues. The country's fertile land has suffered environmental degradation as a result of the emphasis on production of cotton for export, and because 90% of all pesticides are used on cotton.

Benin is one of the poorest countries in Africa, with its economy dependent, as in colonial times, on an agriculture that is largely undeveloped, and reliance on subsistence farming and regional trade. Figure 2 shows subsistence farmers working on their farms. About two-thirds of the work force in Benin is engaged in agriculture, mainly subsistence farming. Much of the interior population is still dependent on subsistence farming; growing beans, maize and yams.

For administrative purposes, Benin is divided into 12 departments which are further subdivided into 77 communes (Figure 3). The land Divisions are Alibori, Atakora, Atlantique, Borgou, Collines, Kouffo, Donga, Littoral, Mono, Oueme, Plateau and Zou.

French is the official language of Benin but most people speak tribal languages, with 47% of the population speaking Fon, 12%.

FAO/17511/R Faidutti

Over half of Beninois are subsistence farmers

OBEPAB

Sunflowers are intercropped with organic cotton as a form of complementary pest control

Figure 2. Subsistence farmers working on their farms

Adja, 10% Bariba, 9% Yoruba, 5% Somba and 5% Aizo.

Traditional religious beliefs are professed by about 60% of the population. Voodoo originated in Benin and was introduced to Brazil and the Caribbean Islands by Africans. European missionaries brought Christianity to the south and central areas of Benin. Roman Catholicism is the religion of about 28.1%, the great majority of whom live in the south. Islam is the religion of about 24% of the people, most of whom live in the north. Most of the Muslims are of the Fulani, Bariba and Dendi tribes.

In the 2002 census, 43.9% of the population of Benin were Christian (28.1% Roman Catholic, 5% Celestial Church of Christ, 3.2% Methodist and 7.6% other Christian denominations); 24% were Muslim, 17.3% practice Vodun, 6.4% other traditional local religious groups, 1.9% other religious groups, and 6.5% claim no religious affiliation (USDS, 2008).

Figure 3. Administrative divisions
Source: Perry-Castañeda Library Map Collection Benin maps

Benin's political history since independence has been eventful. The first president, Hubert Maga, was ousted in 1963 by the army commander, and a series of four coups followed in the next six years. In 1970 a three-member presidential commission took power and suspended the constitution. The members, including former president Maga, were to serve as president successively. Maga held office first, succeeded in 1972 by Justin Ahomadegbe. Later that year, however, Major Mathieu (later Ahmed) Kérékou seized power, ending the commission form of government.

A new constitution, making the country a one-party state, was promulgated in 1977. Three former presidents, detained since the coup of 1972, were released in 1981. Kérékou was elected president by the National Revolutionary Assembly in 1980 and re-elected in 1984. Kérékou survived a military coup attempt four years later. In late 1989 he abandoned Marxism-Leninism and a transitional government established in 1990 paved the way for a revival of multiparty democracy. Prime Minister Nicephore Soglo defeated Kérékou in the presidential election of March 1991. In 1996 Kérékou defeated Soglo in the elections and was easily re-elected in March 2001. Term limits prevented him from running again. Kérékou stepped down at the end of his second term in 2006 and was succeeded by Thomas Yayi Boni in April 2006; a political outsider and independent assumed the presidency.

Benin witnessed a series of military coups, an association with Marxism, and the somewhat typical health and infrastructure problems common to its neighbours, and most West African countries. As a new democracy, the bright side is that Benin's economy is growing and tourism is on the increase, especially along the coastal areas and in the wildlife national parks of the north.

The majority of Benin's 7.86 million people live in the south. The population is young, with a life expectancy of 53 years. Around 99% of the population is African of 42 ethnic groups settled in Benin at different times and migrated within the country. The four largest, which constitute 54% of the population, are the Fon, the Adja, the Bariba and the Yoruba. The 42 groups can be divided into five broad cluster groups (1) the Voltaic, (2) the Sudanese, (3) the Fulani, (4) the Ewe and (5) the Yoruba. There is a small

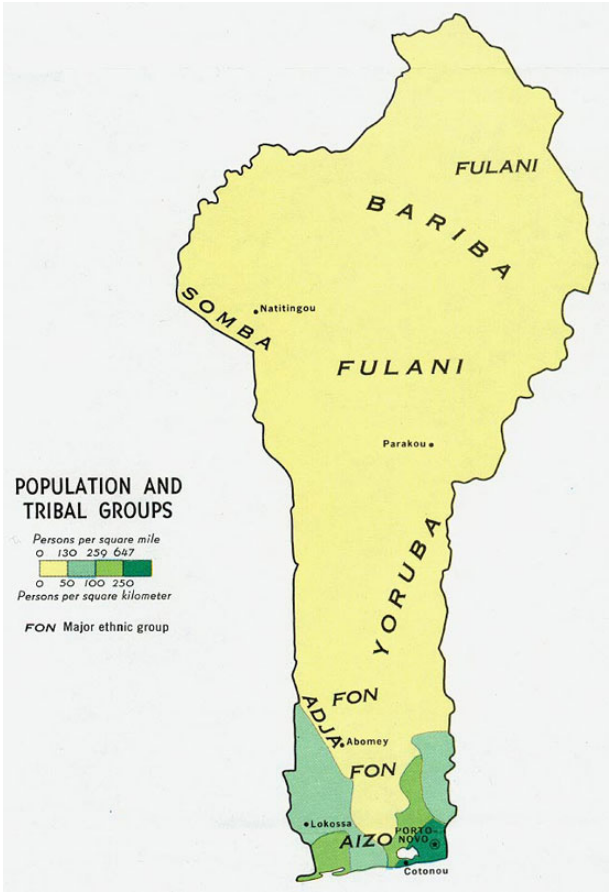


Figure 4. Population and tribal distribution
Source: Perry-Castañeda Library Map Collection Benin maps

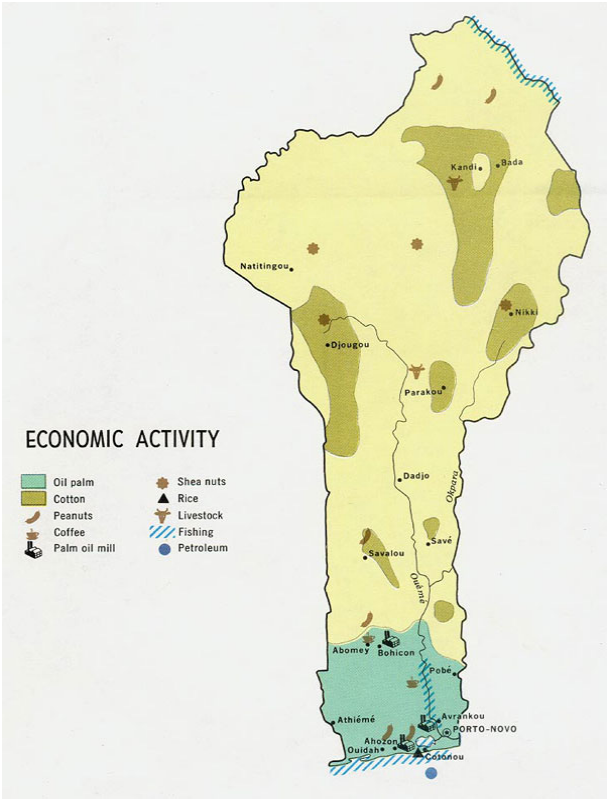


Figure 5. Economic activities
Source: Perry-Castañeda Library Map Collection Benin maps

European community, of which the French constitute the largest group. Figure 4 shows the population and tribal distribution of Benin Republic.

The Yoruba are found in the southeast (migrated from Nigeria in the twelfth century); the Dendi in the north-central area (came from Mali in the sixteenth century); the Bariba and the Fulbe (Peulh) in the northeast; the Betammaribe and the Somba in the Atacora Range; the Fon in the area around Abomey in the South Central and the Mina, Xueda, and Aja (who came from Togo) on the coast. Recent migrations have brought other African nationals to Benin which include Nigerians, Togolese and Malians. The foreign community includes many Lebanese and Indians involved in trade and commerce. The personnel of the many European embassies and foreign aid missions and of non-governmental organizations and various missionary groups account for a large number of the 5 500 European population.

Economic activities

Benin's economy is based on agriculture. Cotton accounts for 40% of GDP and roughly 80% of official exports. Also, there is production of textiles, palm products and cocoa. Corn, beans, rice, groundnuts, cashews, pineapples, cassava, yams and other various tubers are grown for local subsistence (Figure 5).

Major crops

The major cash crop is cotton with a production record of 427 000 tonnes during the 2004/2005 farming season. Its production however decreased to 191 000 tonnes during the 2005/2006 season. The future of cotton presently gives cause for concern in view of: (i) environmental degradation; (ii) the dysfunction in the structure stemming from reforms in the sector; and (iii) fluctuation in global prices that negatively impacts on rural revenues and the country's economy. Crops such as pineapple and cashew nuts whose production attained 110 000 and 40 000 tonnes respectively in the 2004/2005 farming season have been accorded some recognition. The production from oil palm went from 130 000 tonnes in 1994 to nearly 280 000 tonnes in 2005. These levels of production are largely inadequate to satisfy national and regional market needs (CIPB, 2007).

Food crop production largely consists of grain on nearly 1 100 000 ha of which 54% are devoted to maize. Production in 2005 was estimated at 841 000 tonnes for maize, 207 000 tonnes for sorghum and 73 000 tonnes for rice. Maize is the most profitable grain but its 2004 production level (going by an average consumption hypothesis) left a staple reserve of only 124 830 tonnes against 161 840 tonnes in 2005 (CIPB, 2007). This is not enough given that it is the base component in the manufacture of children's cereals and poultry feed.

Rice has become a strategic crop with growing importance in the national consumption pattern and trade between neighbouring countries (Niger, Nigeria and Togo). Although its level of production is increasing (from 16 045 tonnes in 1995 to 73 000 in 2005), there are significant imports (over 450 000 tonnes in 2004 and approximately 378 000 in 2005) to complement internal and re-exportation needs (CIPB, 2007).

As for root and tuber crops, particularly yam and cassava, production levels have remained constant in the course of this decade. Cassava has taken on a non-negligible significance as a food crop for the masses and accounts for 54% of the national production of roots and tubers. There has been no appreciable improvement in the quality of products owing to lack of consecutive infrastructural development to facilitate access to markets (CIPB, 2007).

Fisheries

The fishery subsector accounts for the livelihood of 50 000 fishermen and 20 000 fisherfolk (most of whom are women). It is a means of livelihood for approximately 70 000 people and accounts for 2% of the country's GDP. During the period 1998 to 2005, production stagnated around 40 000 tonnes/year and the importation of frozen fish increased from 20 000 tonnes in 2001 to 45 000 tonnes in 2005. Furthermore, the export of shrimps, once a potential source of revenue, fell from 1 000 tonnes to less than 700 tonnes in the same period (CIPB, 2007). The waterways are not judiciously exploited, while aquaculture and the halieutic production are still underdeveloped.

Forestry

The forestry subsector is characterized essentially by a continuous degradation of forest resources and of wild fauna as a result of human activity. The situation is all the more alarming because: an increasingly important fringe of the population lives under the threshold of poverty and has no other choice than to overexploit the natural resources to survive; needs in firewood and timber are increasing by the day due to population growth and to the development of economic activities (CIPB, 2007).

Animal production

Most projects that were designed to promote animal production through support to animal genetic resources (AGR), training, information, animal health, etc., have ended with no obvious indication for a continuation. One of the weaknesses of the system lies in the extension of the veterinary duties to private clientele. Ongoing efforts are focused on supporting modern and traditional raising of small ruminants and dairy production. However, the problem of safeguarding the zoological germplasm managed by various government-owned farms remains unresolved (CIPB, 2007).

The livestock subsector accounts for approximately 6% of the GDP. It is marked by traditional husbandry practices of bovine, goats, pigs and poultry despite conclusive results attesting to high production levels of modern breeding projects in the last decade.

Current estimates in 2004 were 1 826 300 bovines, 2 300 000 small ruminants, 293 200 swine and 13 200 000 birds, which are not enough to cover the country's needs in animal protein, particularly in meat, milk and eggs. The present level of imported frozen meat (8 800 tonnes in 2005) means that Benin in highly dependent on imports (CIPB, 2007). Furthermore, modern livestock breeding outlets that have developed in peri-urban areas for the production of eggs and of broilers face direct and stiff competition from the importers of frozen poultry and eggs sold at very cheap prices in the local market.

The raising of non-conventional species (snails, grass-cutters/bush rats, rabbits, etc.) is being increasingly developed but at a pace that has not yet compensated for the deficits, but which leaves room for possible development of food preferences here and there (CIPB, 2007).

Mineral resources

Benin began producing a modest quantity of offshore oil in October 1982. Production ceased in recent years but exploration of new sites is ongoing. Other mineral resources of Benin include iron ore, phosphates, chromium, rutile, clay, marble, diamonds and limestone. Limestone is produced for use in cement manufacturing, and industrial diamonds are recovered for export, but most other mineral resources are undeveloped.

A number of formerly government-owned commercial activities are now privatized, and the government, consistent with its commitments to the IMF and World Bank, has plans to continue on this path. Smaller businesses are privately owned by Beninois citizens, but some firms are foreign owned, primarily by French and Lebanese. The private commercial and agricultural sectors remain the principal contributors to growth (Bureau of African Affairs, June 2008).

2. SOILS AND TOPOGRAPHY

Soils

Benin soils vary significantly as much in nature as in fertility and geographical distribution. Total cultivable area accounts for 62.5% of the total surface area of the country, and only 20% of this area or 12.24% of the national territory is actually exploited. Five major soil types can be identified (Figure 6). These are:

(i) tropical ferruginous soils developed on granito-gneissic formations of central and northern Benin, and on the schists of the northwest. They occupy approximately 70% of the territory;

(ii) ferralitic soils formed on the Continental terminal and Cretaceous sandstone. These cover approximately 7 to 10% of the total surface area of the country;

(iii) hydromorphic soils. These cover between 5 and 8% of the country and can be found in the valleys, basins and alluvial plains;

(iv) vertic green soils. These cover approximately 5% of the land and are usually found in the Median Dip (i.e. between the northern and southern parts of the country); and

(v) rough and undeveloped mineral soils. These occupy between 5 and 7% of the land. They are usually found in coastal areas and rocky outcrops of Middle and Greater Benin (NAP/DC, 1998).

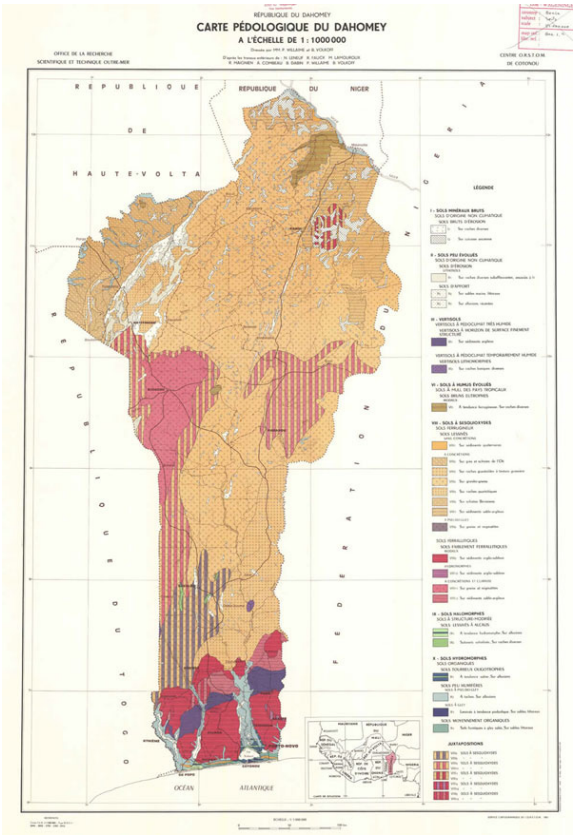


Figure 6. Map of soil types in Benin Republic
Source: Soil Maps of Africa. ORSTOM, Paris

Topography

The country can be divided into four areas from south to north. The lowlying, sandy, coastal plain (highest elevation 10 m) is at most 10 km wide. It is marshy and dotted with lakes and lagoons communicating with the ocean. The plateaus of southern Benin (altitude between 20 m and 200 m) are split by valleys running north to south along the Couffo, Zou, and Oueme Rivers. An area of flat lands dotted with rocky hills whose altitude seldom reaches 400 m extends around Nikki and Save.

A range of mountains extends along the northwest border and into Togo; this is the Atacora,

with the highest point, Mont Sokbaro, at 658 m. Two types of landscape predominate in the south. Benin has fields of long fallow, mangroves and remnants of large sacred forests. In the rest of the country, the savannah is covered with thorny scrub and dotted with huge baobab trees.

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate

Benin has a tropical climate (hot and humid) with two rainy and two dry seasons. The principal rainy season is from April to late July, with a shorter less intense rainy period from late September to November. The main dry season is from December to April, with a short cooler dry season from late July to early September.

By its location (between 06°10' and 12°25' N) Benin is in the inter-tropical zone. Its climatic condition is therefore typical of the West African climate, which alternates between the monsoon (from the ocean) during the cool and wet season, and the high thermal amplitude harmattan wind that blows daily during the dry season (from the Sahara). These two sets of powerful winds (Monsoon and Harmattan) recede alternately towards north and south. Their point of contact, called the Inter-tropical Front (ITF), is the central point of all precipitation that causes atmospheric disruptions.Temperatures and humidity are high along the tropical coast. In Cotonou, for example, the average maximum temperature is 31 °C; the minimum is 24 °C. Table 2 presents the climate chart for Cotonou.

Variations in temperature increase when moving north through savannah and plateau towards the Sahel. A dry wind from the Sahara called the harmattan blows from December to March. Grass dries up, the vegetation turns reddish brown, and a veil of fine dust hangs over the country, causing the skies to be overcast. It is also the season when farmers burn bush in the fields. The Republic of Benin climate is peculiar in some areas. For example CIPB (2007) reported that Benin has three climatic zones that comprise:

- A dry tropical zone between 90 and 120. Rainfall records range from 900 to 1 100 mm/year. The period of vegetative growth is less than 145 days during the rainy season.
- A dry savannah zone between 80 and 90 N. Average rainfall fluctuates between 1 000 and 1 200 mm/year. The period of vegetative growth is about 200 days during the rainy season.
- A subequatorial zone stretching from the Atlantic Coast to a line passing through Savé (7°30' N) where rainfall records vary between 950 to 1 400 mm/year; the period of vegetative growth is nearly 240 days.

The climatic zones are characterized by two rainfall patterns. From the coastal areas up to Save, presents a bimodal rainfall pattern (April to June and September to November). Rainfall in this region is rather unpredictable and difficult to harness especially with regard to non-perennial crops. Moreover, the annual rainfall is not sufficient to generate satisfactory production levels for crops such as oil palm, cocoa and coffee.

Table 2. Climate chart for Cotonou (60 35 N, 20 38 E, 29 feet [9 m] above sea level)

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Avg. temperature	81	83	84	83	82	80	78	77	78	80	82	82
	Avg. max temperature	88	90	90	89	88	85	83	82	83	85	88	89
	Avg. min temperature	77	78	79	79	77	76	75	75	75	76	77	77
	Avg.rain days	0	1	2	5	6	10	6	5	6	5	1	0
	Avg. snow days	0	0	0	0	0	0	0	0	0	0	0	0

Source: CIA- World Factbook Profile /Wikipedia

Beyond Savé and the further one goes north, a unimodal rainfall pattern emerges (from May to October). This zone is suitable for diverse food crops and for cotton production.

Azonal rainfall

As far as the rainfall pattern is concerned, Benin's azonality is remarkable both with regard to the total average rainfall level per annum, and its level on the rainfall scale. The total average rainfall levels per annum fall symmetrically into the following two: high rainfall level in the northwest (Djougou and surrounding areas) and southeast (Porto-Novo and surrounding areas) (1 500–1 400 mm); and low rainfall level in the north and northeast (the Niger valley) and low Mono valley in the southwest (1 000–850 mm).

Within these two extreme regions is a vast area including the Zou, Middle Ouémé and Central Borgou basins where annual average rainfall levels oscillate between 1 100 and 1 200 mm. The configuration of the annual isohyets shows an indigent rainfall zone located in the areas bordering the sea which extends diagonally inland towards the SW–NE in a downward curve.

Benin is characterized by the following two rainfall gradients; a littoral gradient extending from Sèmè (1 500 mm) towards the "thalweg" of the diagonal on the Grand-Popo-Bopa-Zagnanado axis, and a northern submeridian gradient extending from Djougou to the piedmont southeast of the Atacora mountain range (1 400 mm), towards Malanville in the Niger valley (900 mm) (DRP, Benin Republic, 1996). Between the 7° 30' and 9° parallels, a rainfall "marsh" extends with some localized "poles" onto the inselbergs (island-mountains) of the Idaca – Cabè country.

Rainfall patterns:

Depending on one's position on the latitude, the rainy periods combine in various ways to define the rainfall pattern. Thus, there is:

i. a bimodal pattern with four seasons including two dry and two rainy seasons to the south of parallel 7° 45';
ii. a unimodal pattern with two seasons, one of which is a dry season and the other a rainy season to the north of parallel 8° 30 ' and
iii. an intermediate pattern alternating between bimodal and unimodal between these two parallels.

All things considered, Benin presents two rainfall poles:

i. east of the Ouémé Delta in the southeastern part of the country; and
ii. the piedmont southeast of the Atacora Mountain range.

Classification of Beninois climates

The spatial analysis of the three major climatic parameters including temperature (thermal amplitude), rainfall (coefficient of concentration of seasonal precipitation) and rainfall variance (coefficient of variation of annual precipitations) made it possible to identify 12 climatic features in Benin (Figure 7). These can be classed under nine primary climate types, all of which are divided into two groups:

Group of climates with unimodal rainfall pattern

In this group are: (i) the Subsahelian climate of Northern Borgou in the Niger basin, characterized by strong thermal amplitude, a short rainy period (3 to 4 months), but with low variability in inter-annual rainfall level; and (ii) the Central Borgou Climate, which is a tropical transitional climate with a stronger thermal amplitude. The tropical transitional climate has a long rainy period and low variability in inter-annual rainfall.

Group of climates with bimodal rainfall pattern

In this group are: (i) the Inselberg climate of central Benin, which has the same characteristic as the Atacora climate; (ii) the Zou Middle Basin climate, especially the lower Okpara climate and the middle Zou climate; (iii) the Lower Northern Plateaux climate (to the north of the Lama dip), which is a variant of the tropical and submarine climate (low rainfall variability, maritime influences, long rainy period) the only difference being a slightly higher rainfall variability level; (iv) the Lower Southern Plateaux climate made up of the eastern plateaux and western plateaux climates; (v) the Lower Ouémé (or the Ouémé

Delta) climate which has two tendencies including the Porto-Novo area and the Cotonou area climates; and (vi) the Lower Mono and Lake Ahémé climates. This classification lays emphasis particularly on the climatic constraints to which rural communities' production activities are subjected.

Vegetation (agro-ecological zones)

In spite of the apparently favourable geographical position, Benin is not a forest country like neighbouring Nigeria, Ghana and Côte d'Ivoire. However, about 65% of the whole territory is covered by bushy vegetation. Out of this brushy vegetation, PAGE (Pilot Analysis of Global Ecosystems) calculations based on Global Land Cover Characteristics Database (GLCCD, 1998), indicated that Benin has 93.1% grassland area, making it the country with the highest grassland in sub-Saharan Africa. Generally, the types of natural formations found in Benin, depending on the various climatic conditions, are:

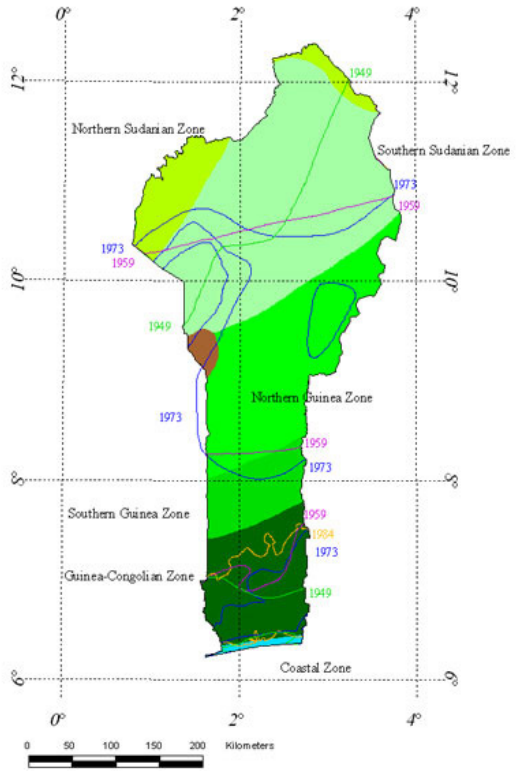
The South with its subequatorial type climate has a Brazilian-type *Ipomoea* lawn, that consists of *Remirea maritima, Ipomoea asarifolia* on the old offshore bar; a clear forest with *Lophira lanceolata* (false karité tree), *Carissa edulis, Byrsocarpus coccineus* on the old offshore bar; a marshy formation in the west made up of *Mitragyna inermis, Cola grandiflora, Ceiba pentandra, Lonchocarpus sericeus, Andropogon gayanus*, etc. In brackish areas, a mangrove formation made up of *Rhizophora racemosa* (mangrove), *Avicennia germinans* and *Dalbergia ecastaphyllum.* The disappearance of this woody vegetation gave way to *Paspalum vaginatum, Philoxerus vermicularis*, and *Sesuvium portulacastrum*; a marshy formation in the East made up of Raphiale (*Raphia hookeri, Raphia vinifera), Ficus congensis, Anthocleista vogelii, Alstonia boonei, Cyrtosperma senegalense, Cyperus papyrus, Eleocharis* spp*.,* etc; and a little everywhere, but more on clayey soil in *Elaeis guineensis* (oil palm) plantations.

North-central with the Guinea-Sudan type climate Located between parallel 8° Niger River (NR), the Savè–Savalou line, and parallel 9° 30 Niger River (NR), the Koura–Partago-Bori–Guinagourou line, this zone consists of: dry thick forests (between Savalou and Djougou) with *Isoberlinia doka, Isoberlinia tomentosa, Pterocarpus erinaceus, Afzelia africana, Antiaris africana, Chloptelea grandis, Milicia excelsa, Cola gigantea, Celtis zenkeri, Khaya senegalensis, Khaya grandifolia, Amblygonocarpus andongensis, Swartia madagascariensis, Erythophleum guineense;* clear forests and savannahs with *Anogeissus leiocarpa, Butyrospermum paradoxum*, *Daniellia oliveri, Isoberlinia doka, Parkia biglobosa, Combretum micranthum, Guieria senegalensis, Boscia salicifolia, Albizia chevaileri*; and forests galleries with *Ceiba pentandra, Milicia excelsa, Khaya senegalensis, Diospyros mespiliformis* and *Vitex doniana*.

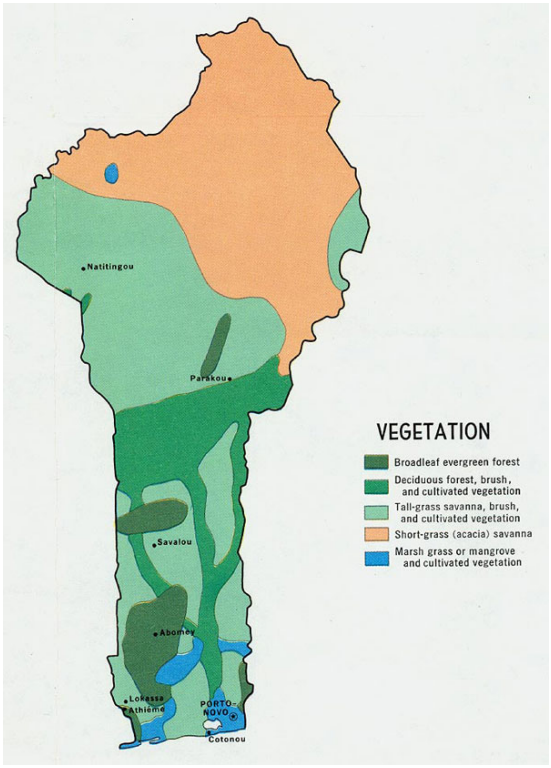
The North with its Sudan-Sahel type climate Located between 10° N and 12° 30' N, it has shrubby and wooded savannahs with *Lophira lanceolata, Acacia ataxacantha, Acacia.macrostachya, Butyrospermum paradoxum, Parkia biglobosa, Entada africana, Burkea africana, Terminalia* spp*, Combretum* spp*, Pterocarpus erinaceus, Detarium microcarpum, Sterculia tomentosa Acacia seyal, Balanites aegyptiaca, Guieria senegalensis*; clear forests with *Anogeissus leiocarpa* (deep soils) or with *Isoberlinia doka* (siliceous soils); and forest galleries with *Khaya senegalensis*, *Diospyros eliottiti*, *Kigelia africana, Diospyros mespiliformis, Vitex chrysocarpa, Cola laurifolia, Syzygium guineense, Mimosa pigra* and *Daniellia oliveri.*

The flora of Benin is sufficiently diversified; however it is unfortunate to note that forest cover becomes dangerously more sparse with each year that passes (DRP, 1996). Also a partly depleted thick forest on clay soil between the offshore bar and latitude 7° NR also exist but only a vestige of this remains in the form of scraps deep in the heart of the LAMA classified forest, botanical reserves, the INRAB Oil-palm Research Centre in Pobè, forest relics and/or sacred forests of all sizes and forms scattered along this strip. Species characteristic of this formation are: the *Afzelia africana* (ling), *Ceiba pentandra*, *Triplochidon scleroxylon* (samba), *Milicia excelsa* (Iroko), *Diospyros mespiliformis* (false ebony),. *Albizia glaberrima, Albizia ferruginea, Albizia zygia* and *Antiaris toxicaria.*

The vegetation in the Guinea Zones is dominated by moist woodlands and savannahs (Figure 8). The separation between a northern and a southern part coincide with the northern boundary of bimodal



Vegetation zones in Niger and Benin – present and past zonation
Source: Alexander Wezel, Brigitte Bohlinger and R. Böcker (1999)



Vegetation zones in Benin
Source: Perry-Castañeda Library Map Collection Benin Maps

Figure 7. Vegetation zones of Benin

Figure 8. Moist woodlands and savannahs
Source: Alexander Wezel, Brigitte Bohlinger and R. Böcker (1999). Vegetation zones in Niger and Benin - present and past zonation.

Figure 9. Coastal zone (mosaic of forests and savannahs)
Source: Alexander Wezel, Brigitte Bohlinger and R. Böcker (1999). Vegetation zones in Niger and Benin - present and past zonation.

rainfall in southern Benin. The Northern Guinea Zone is characterized by woodlands, tree and shrub savannahs with abundant *Isoberlinia* spp. and *Butyrospermum paradoxa* (Adjanohoun *et al.,* 1989).

In the Southern Guinea Zone moister types of woodland and savannahs with abundant *Daniella oliveri* are found. In the Guinea-Congolian and Coastal Zone a mosaic of forests and savannahs exists (Figure 9). In the two zones most of the original vegetation has been replaced by secondary grasslands or savannahs due to human impact. This fact was emphasized by vegetation studies on bush and grass fallows (Bohlinger, 1998).

The prevailing vegetation types in the Sudanian Zone are woodlands and savannahs. Along rivers, gallery forests can be found. In the Northern Sudanian Zone, vegetation is dominated by *Combretaceae* and *Mimosaceae* woodland or single trees with perennial grass layers of *Andropogon gayanus* (sandy soils), *Loudetia* spp. (laterite, glacis) and *Hyparrhenia* spp. (moister sites) (Peyre de Fabrègues, 1980).

The National Agricultural Research Institute of Benin (Anon, 1995) recognized five agro-ecological zones defined as Southern Zone, Transition Zone, Southern Borgou/Southern Atacora Zone; Northern Borgou zone and Atacora Zone (Vissoh *et al*., 2004). Table 3 presents the characteristics of the five agro-ecological zones of Benin.

Southern Zone

The Southern Zone covers approximately 13% of the total area of the country where more than 60% of the total population of Benin live. Production systems in the Southern Zone are characterized by a high population density estimated on average at 323 inhabitants km^2 (Table 3) according to the 'Institut National de la Statistique et de l'Analyse Economique' (Anon, 2003), resulting in a strong pressure on arable land (Brouwers, 1993). Animal husbandry is limited to small ruminants and poultry. Land is mostly inherited and extremely fragmented (Vissoh *et al*., 2004).

Transition Zone

Human population density in the Transition Zone, averaging 47 inhabitants km^2, is lower than in the Southern Zone, resulting in less pressure on arable land than in the Southern Zone (Anon, 2003). Apart from small-ruminant husbandry and poultry, there is an attempt to rear oxen by a few richer farmers in an attempt to use draught farming to expand their cotton area. As in the Southern Zone, agriculture is not associated with livestock (Vis soh *et al*., 2004).

Borgou-Atacora Zone

The production systems of the Southern Borgou-Southern Atacora Zone, the Northern Borgou Zone and the Atacora Zone are taken together as production systems of the Northern Zone because of the similarities among them, particularly with regard to soils and rainfall patterns.

The production system in northern Benin is characterized by an even lower population density than in the Transition Zone (on average 27 inhabitants km^2) (Vissoh *et al.,* 2004).

The rainfall pattern is unimodal. Over the period 1970–2000, the amount of rainfall per year has varied considerably, with a severe decrease in the third decade (1981–1990), averaging 1 000 mm in the Southern Borgou-Southern Atacora Zones and about 750 mm in the Northern Borgou Zone. Livestock is quite developed and is integrated in the arable farming activities. In addition to the implements used in

Table 3: Characteristics of the five agro-ecological zones of Benin

Agro-ecological zone	Relative area%	Annual rainfall (mm)	Climate	Soil type[1]	Natural vegetation	Main crops[2]	Land holding
Southern Zone	13	1 000–1 400	Subequatorial, with two rainy and two dry seasons	Ferralitic	Relics of forest	Maize, cassava, cowpea, oil palm, vegetables	Inheritance, purchased
Transition Zone	15	1 000–1 200	Transitional (no clear distinction between the two rainy seasons)	Tropical ferruginous	Woody savannah	Maize, cashew, cassava, cotton, groundnut, yam	Inheritance, rented
Southern Borgou Southern Atacora Zone	32	900–1 300	Sudano- Guinean. One rainyand one dryseason	Tropical ferruginous	Woody savannah	Sorghum, cotton, maize, yam	Inheritance
Northern Borgou Zone	24	600–800	Soudano-Sahelian. One rainy and one dryseason	Tropical ferruginous	Shrubby savannah	Cotton, maize millet, sorghum	Inheritance
Atacora Zone	16	900–1 200	Sudanian. One rainy and one dry season	Tropical ferruginous	Treed savannah	Sorghum, cowpea maize, millet	Inheritance

[1] *FAO classification*

[2] *Most important crop first, other crops in alphabetical order.*

Source: Anon, 1995, cited in Vissoh et al.*, 2004*

the other production systems, farmers use draught oxen or tractors to expand their areas and maximize profit (Vissoh *et al.,* 2004).

Besides the above-mentioned, the Council of Private Investors in Benin (CIPB, 2007) further reported eight agro-ecological zones for Benin in which various vegetables, animal, halieutic and agro-forestry activities are carried out. The eight agro-ecological zones comprise:

Zone 1

Zone 1 comprises the Karimama, Malanville and northern Kandi communities in the District of Alibori. There are two types of soils in this zone: the ferro-soil with a crystalline base and the very fertile alluvial soils of the River Niger. The zone is susceptible to high erosion.

The main crops found here are millet, sorghum and cowpea. In addition, cotton, maize, rice, beans, onions and vegetables are also grown along the Niger and Alibori Rivers.

Potato has only been recently introduced.

The major advantages are the vast expanse of arable land and the practice of animal drawn harnessed cropping. The land bordering the rivers allows for large-scale off-season market gardening such as pepper and tomato. Two large markets namely the Karimama and Malanville markets provide outlets for marketing agricultural products.

Zone II

Zone II covers Kerou and the northeast of Kouandé communities in the District of Atacora and Banikouara, Segbana, Gogounou and the south of Kandi communities in the Alibori District. The climate is tropical with only one rainy season (800 to 2 000 mm/year). The soil type is ferrosol on a crystalline base. The cropping of cotton is well-developed and adds some vibrancy to the socio-economic activities in the zone. The agro-economic conditions are conducive to the cultivation of a wide variety of crops such as cotton, maize, groundnut and sorghum, which are grown each year. The perennial crops are shea-butter and cashew-nut trees. The root crops are yam and cassava used for chips.

Zone III

Zone III covers the southern Borgou except the south of Tchaourou and extends from Pehunco, eastern Djougou in the District of Donga, to northern Tchaourou, Parakou and N'dali, Perere, Nikki, Dinende, Kalade and Bembereke all in the Borgou District.

It has a tropical climate with a monomodal rainfall pattern. The soil is tropical ferrosol and its fertility is variable and susceptible to leaching.

The vegetation is savannah shrub with a dominance of *Butyrospermum paradoxa* (shea-butter) species. The cropping system is mainly sorghum and yam with a high incidence of cotton and maize intercropping. Cassava, peanut, rice and legumes are also grown.

The numerous advantages of this zone are:

- an agro-ecology suitable for fruit and forest crops;
- land availability;
- easy access to agricultural inputs through the services of COBEMAG (Coopérative Béninoise de Matériel Agricole);
- possible access to agricultural services: labour, transport for harvested produce, and;
- a relatively developed livestock breeding sector.

Zone IV

Zone IV is made up of Ouake, Copargo, Boukoumbe, Tanguieta, Materi, Natitingou, Toukountouna, Kouandé, Cobly and the west of Djougou communities. The climate is tropical and tends towards the dry savannah with an irregular and fluctuating rainfall pattern. The soil type is ferrosol with a deep base and poor water reserve. These soils are scarcely fertile except the swampy areas.

The cropping system is dominated by millet, sorghum, fonio, Bambara groundnuts, cowpea and groundnut. The swamps and some water reserves offer the possibility of growing cocoyam, water yam, sweet potato, rice and off-season market garden produce.

Zone V

This zone is tropical guinea savannah with a high rainfall pattern (1 100 to 1 400 mm/year) and stretches from the Districts of Atacora, Borgou, Mono, Ouéme to the Zou with a large expanse of virgin land in Bassila in the Atacora District.

Yams, maize, cassava, groundnut, rice, citrus and cashew-nut are the main crops grown in this zone. Shea-butter, almonds and *Parkia* nuts as well as maize and groundnut are marketed in Djougou and Togo.

Zone V also covers the south of the subdistrict of Tcharaou in the Borgou District where food crops are cultivated. The Mono, the northern Aplahoue and Kloukanme, as well as the northeast of Lalo, have great potential for agricultural production of annual and fruit crops.

The Ouemé District is in the north of Ketou and the north of Pobé. This zone is very fertile and is suitable for growing maize, groundnut, cowpea, cassava, yam and cotton. The income-generating activities revolve around the collection and marketing of maize, cowpea and yam.

In the Zou District, zone V covers the subdistrict of northern Zou and Djidja.

The annual crops grown are yams, cassava, cotton, groundnuts, cowpea, maize and pepper.

Off-season farming such as off-season market garden produce and rice is undertaken in the swamps of Dassa, Glazoue and Savalou and the marketing of food crops and their derivatives is very developed.

Zone VI

This zone extends from the Plateau, Atlantic, Mono-Couffo and Ouemé to the Zou Districts and is characterized by a tropical guinea climate and a bimodal rainfall pattern.

The soil is hard pan profoundly degraded and easy to work on. The crops cultivated here are maize, peanut, cowpea, cassava, pepper, coffee, fruit trees (mangos, citrus and banana) and oil palm trees. Legumes, livestock breeding, aviculture and aquaculture are also practised.

Private irrigation initiatives from artisanal drillings or from waterways to support off-season legume farming and rice cultivation have started in this zone.

Zone VII

This zone covers the Atlantic, Mono, Ouemé and the Zou Districts. It is characterized by a tropical guinea climate with a bimodal rainfall pattern. Its humid and deep clayey soil is fertile but often hydromorphic and difficult to work on. The cropping system is dominated by maize (leading rotating crop), cowpea and vegetables, rice and forest trees, smallholder stock-raising and aviculture.

Zone VIII

It stretches from the Atlantic, Mono to the Ouemé Districts. The climate is tropical Guinean with a bimodal rainfall pattern. While the alluvial soil is very fertile, the sandy soil of the Littoral is marginally fertile. The cropping system is dominated by maize (lead rotating crop), cowpea and vegetables. Maize and cassava are the major crops grown on the sandy soils. The Atlantic and Littoral Districts encompass the urban towns of Cotonou, Ouidah and the Abomey-Calavi and So-Ava communities. Arable land is not readily available: off-season crop and vegetable cultivation is carried out in the valleys and includes fresh maize, tomato, pepper, vegetables. The vegetation zone (agro-ecological zones) classifications of the different authors vary, however, as they portray to a large extent temporal trends of the country.

Hydrographic network

Benin has many hydrographical networks including 3 048 km of watercourses.and 333 km^2 of water bodies (lakes and lagoons), located in the southern part of the country.

Three basins feed this network: the Niger basin, the Pendjari basin and the Coastal basin.

The Niger basin

The River Niger, one of the largest in Africa (4 206 km), serves as a 120-km border between Benin and Niger. The Niger Basin is made up of three rivers: Mékrou (410 km), Alibori (338 km) and Sota (250 km).

The Pendjari Basin

The Pendjari Basin in the west (380 km) takes its source from the Atacora mountain range in Benin, flows towards the northwest, moving towards the southwest into the Republic of Togo where it is known as Oti, before falling into the Volta River in Ghana. With the exception of the River Niger, all these rivers have the same tropical tide, rising during the rainy season (July–October) and ebbing towards the end of April.

The Coastal Basin

The Coastal Basin is made up of three rivers known as: Ouémé, Couffo and Mono. The Ouémé River is the largest in the country (510 km), and is the outlet of two major tributaries: Okpara (200 km) to the left bank and Zou (150 km) to the right bank. It is subject to the influence of the Sudan and subequatorial climates, but has a rather tropical tide. The subequatorial influence is weak and exists only in one small area towards the mouth of the river. It uses Lake Nokoué and the Porto-Novo lagoon as conduits in its path towards the sea. Couffo is a small coastal river of 190 km that takes its source from the Djami mountain range in Togo. It draws water and alluvia from Lake Ahémé.

Finally, more to the west, the Mono River (500 km) serves as the border between the Republics of Benin and Togo on the last 100 km of its course. It takes its source from the Alédjo mountain range in Togo, and falls into the Grand-Popo lagoon, which it uses as a conduit into the sea through the Avlo pass. The major water bodies are: (i) Lake Nokoué (150 km²); (ii) Lake Ahémé (78 km²); (iii) Lake Toho (15 km²); (iv) Ouidah Lagoon (40km²) (v) Porto-Novo Lagoon (35 km²); and (vi) Grand-Popo Lagoon (15 km²).

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Traditionally, livestock are a component in farming systems and also an important source of income for the poor in Benin, as in most developing countries. Animal production may produce higher returns than crop production. Animal production is a commodity with a high value added output, though accessibility is often limited by capital for purchase of livestock while potential use may be limited by cultural and religious preferences (Delgado *et al.,* 1999).

Livestock is important in livelihood strategies of the poor (savings, insurance, security, accumulation and diversification of assets, social and cultural functions).

The herding of cattle, sheep and goats predominates in the grasslands of the north. Service National de l'Elevage (1977) estimated cattle population at 726 000, sheep 881 000 and goats 848.00. In 1997 cattle were estimated at 1 350 000; sheep 634 000 and goats 1 087 000. However, the World Guide (undated) estimate for cattle was 1 438 000; sheep 645 000 and goats 1 183 000 goats. In 2003 there were 1 600 000 cattle, 670 000 sheep and 1 300 000 goats, (World Guide, undated). FAO figures for 2007 are as follows: cattle 1 900 000, sheep 811 200 and goats 1 439 600.

Detailed projections of the livestock subsector may be estimates (Table 4a); however, data for meat and milk production, live animal and milk/milk product imports are given in Table 4b (from FAO database, 2009).

Gruvel (1978) reported that the distribution of cattle breeds in Benin is complicated and in a constant state of change. The four cattle types in Benin are the Lagune, or Dwarf West African Shorthorn, the Somba, or Savannah Shorthorn, the Borgou, which is a Zebu x humpless crossbred, and the Zebu. Table 5 presents cattle distribution by breed types, while Table 6 presents distribution by provinces.

The table indicates that the largest breed group is the Zebu x Borgou crossbreed. This illustrates the absorption process of humpless cattle by Zebu. The 2 700 Somba recorded for Boukombé District may, however, be an underestimate. In the table the breed types are reduced to four groups with the approximate distribution of each.

There are two general types of traditional cattle production in Benin; (i) sedentary production in the Guinean region, which accounts for about 20% of the national herd, and (ii) transhumant production, which accounts for the other 80% (Atchy, 1976).

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

Livestock species	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle	1 370 780	1 438 140	1 487 160	1 584 380	1 635 060	1 689 010	1 744 750	1 800 000	1 850 000	1 900 000
Goats	1 113 628	1 175 891	1 234 409	1 250 000	1 270 000	1 300 000	1 350 000	1 380 000	1 410 000	1 439 600
Sheep	620 278	653 530	672 099	655 000	670 000	670 000	700 000	750 000	780 000	811 200
Asses	500	500	572	600	600	600	600	600	-	-
Horses	500	389	913	1 000	1 000	1 000	1 000	1 000	1 000	1 050
Camels	-	-	-	-	-	-	-	-	-	-

- Data not available
Source: FAOSTAT data (FAO Statistics Division 2009) Accessed 13 March 2009

Table 4b. Benin 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 prod.	19 800	18 920	17 983	19 173	19 783	20 438	21 109	21 780	22 000	22 570
Sheep meat prod.	2 315F	2 289F	2 355F	2 297F	2 349F	2 347F	2 452F	2 626F	2 930F	3 050F
Goat meats prod.	3 860	3 881	4 076	4 255	4 232	4 424	4 594	4 732	4 800	4 900F
Game meat prod.	6 000F	6 000F	6 000F	6 000F	6 000F	6 000F	6 000F	6 000F	6 000F	6 100F
Total milk prod.	25 075	26 995	29 875	31 245	32 130	33 150	34 322	35 325	36 360	37 200
Live cattle imports nos.	642	273	6 591	9 680	3 113	15 526	8 355	15 000	18 000	-
Live sheep imports nos.	17 000	20 300	35 000	49 500	45 800	21 000	22 200	20 000	15 514 R	-
Live goat imports nos.	13 200	11 000	30 000	56 348	52 137	56 348	40 000	35 000	35 000	-
Whole Milk evaporated imports (,000.MT)	1 549	2 369	2 025	925	1 248	1 059	2 037	1 648	1 623	-

R - Estimated data using trading partners database
F – FAO estimates
- No data
***Source**: FAOSTAT data (FAO Statistics Division 2009) Accessed 13 March 2009*

Table 5. Cattle distribution by breed type

Breed Type	Distribution	Number	% of National herd
Zebu	North of Borgou Province	55 200	7.7
Zebu x Borgou	Centre and south of Borgou Province	253 100	35.3
Somba	Boukombé District	2 700	0.3
Borgou x Somba	Atacora Province	104 600	14.6
Borgou	South Borgou and east Atacora	193 600	27.0
Borgou x Lagune	South and centre of country	81 700	11.4
Lagune	Lower valleys of Ouémé, Aplahoué and Abomey	26 500	3.7
Total		**717 400**	**100.0**

Source: Canard, P. and B. Striffling, quoted in Gruvel, 1978

Table 6. Cattle distribution by province

Province	Cattle					
	Numbers	% of National total	Lagune	Somba	Borgou and crosses	Predominantly Zebu
Borgou	482 600	66.5	-	-	a	a
Atacora	138 700	19.1	-	a	a	-
Zou	56 100	7.7		a	a	-
Ouemé	21 500	3.0	a	-	b	-
Atlantique	12 000	1.7	a	-	b	-
Mono	14 700	2.0	a	-	b	-
Total	725 600		20 000	75 000	500 000	130 000
%		100.00	3	10	69	18

[a]. Majority group; [b]. Minority group.
Source: Service National de l'Elevage, 1977.

Sedentary production systems

Sedentary production systems in the south can be grouped into three types. The first involves free grazing on flooded plains. When waters are low in tsetse areas from December to June, the animals are left to graze freely on fields demarcated by water. As the water rises, the animals are gathered together and kept on rafts and fodder is collected from outside the flooded area and brought to them every day by

boat. Animals belonging to village fishermen and farmers are combined in one herd that is tended by a hired herdsman. In other areas, farm households own two or three cows only, which they take out in the morning to graze tethered at the edge of the fields. They are brought back to the farms in the evening.

Most livestock production in the central and northern parts of the country is carried out by Fulani who look after their own animals (accounting for more than 50% of the total cattle population) or are hired to look after animals that belong to other people. The Fulani in Benin are relatively sedentary, but make brief seasonal migrations leaving the old people and a few cows that have recently calved at their winter camp, which is never moved.

In Borgou Province, the herds are brought in every evening and individual animals are tethered in a circular arrangement near the camp. The calves are tethered in the centre and the cows on the outside, with the bulls left free. The cows are milked twice a day.

Somba farmers in the northeast keep cattle in small family herds. They are herded during the cropping season, but after the harvest they are left to roam freely

Migratory livestock rearing

Transhumance generally occurs from the south to the north and from the west to the east. It is the pattern of regular movement between areas according to the season determined by the nutritional need and health of the livestock, and the social and economic needs of the pastoralists. Herds are moved in search of grazing land and water.

Transhumance takes place primarily towards the north–south of Benin for two reasons: (i) cattle rearers in the nation are concentrated mainly in the northern departments, especially the zones around Borgou, Alibori, Atacora and Donga, which alone account for 85% of national supply or about 1 200 000 cattle; and (ii) since the drought experienced in the 1970s and 1980s, transhumance of cattle from the bordering countries (Niger, Nigeria, Burkina Faso) increased significantly with nearly 200 000 head of cattle and 17 000 head of sheep found during the 1994–1995 dry season). Transhumant herders are confronted with growing competition for grazing resources.

However, the agro-pastoral and pastoral production systems established in these regions encouraged the migratory livestock farming system. The latter led to a space management system characterized by daytime pasture and two types of transhumance in particular:

– short transhumance for the rainy period;

– long transhumance during the dry season for a duration of about six months.

The reception zones for migrating cattle rearers and their herds are in Couffo, southern Zou, northern Atlantique and the Bonou plateau.

There is a third production system, in which cattle belonging to several owners are brought together in herds and tended by hired Fulani herdsmen under palm trees, coconut trees, on fallow land or on bush savannah. These herds are milked regularly and the milk is marketed in the towns. The animals are largely Borgou, and many suffer from streptothricosis.

Some cattle breeds

Lagune

Lagune cattle have a coat that is usually black, black with white spots, or black-and-white. Red or red-and-white animals are very rare. The mucosa, eyelids and hoofs are black and the average height at withers for a sample of 17 adult cows recorded by Striffling (1977) was 0.88 m.

The calving rate of Laguna cattle kept under village conditions is only 35 to 45% (Heinemann, 1963), while at Samiondji Station calving rate was 58% in 1976–77 (Lazic 1978). The Ministère du Développement Rural et de l'Action Coopérative gave a calving rate of 70% for cross-breeding operations ,which seems very high compared with the figures given in the other sources. For cross-breeding operations, the Ministère du Développement Rural reported mortality rates of 15% for calves up to one year and 7% for adult animals. At Samiondji Station, mortality rates recorded were 24% for calves up to one year and 5% for adult cows (Lazic, 1978).

Striffling (1977) reported average birth weights of 11 kg for 8 female calves and 10 kg for 5 males. At six months body weights were 53 kg for the same group of females and 47 kg for the males. The average weight of adult cows was 131 kg. Average weights for different age groups are presented in Table 7.

A summary of the estimates of the main production traits required for building up a productivity index covering the total weight of one-year-old calf plus the live weight equivalent of milk produced per 100 kg of cow maintained per year of the Laguna cattle is presented in Table 8. The productivity index was derived for meat production under the conditions of Samiondji Station in a medium tsetse challenge area.

Table 7. Average weights for Lagune cattle

	Females		Males	
	number	kg	number	kg
Birth	16	9.5	17	10
6 months	11	47.0	9	49
12 months	6	87.0	5	83
Adults	51	152.0	-	-

Source: Lazic, 1978

Table 8. Lagune productivity estimates

Parameter	Production environment
	Station/medium challenge/meat
Cow viability (%)	95
Calving (%)	58
Calf viability to one year (%)	76
Calf weight at one year (kg)	85
Annual milked out yield (kg)	-
Productivity indexa per cow per year (kg)	38.4
Cow weight (kg)	152
Productivity indexa per 100 kg cow maintained per year (kg)	25.3

[a]. Total weight of one-year-old calf plus live weight equivalent of milk produced.
Source: Lazic, 1978; ILCA, 1981

Table 9. Measurements from two samples of Somba cattle

Parameters	I	II
Number of animals	36	76
Sex and age	adult cows	over 5 years
Height at withers (m)	0.92	0.97
Scapulo-ischial length (m)	1.05	1.20
Heart girth (m)	1.30	1.37
Body weight (kg)	149	

Sources: For I, Striffling, (1977); for II, Domingo, (1976); cited in ILCA (1981).

Somba

The Somba cattle are stocky animals with good conformation for meat production in Benin. The height at withers is 0.90 to 1.00 m, and the coat is generally dark, either uniformly black, black-and-white, red-and-white or pied, usually with dark extremities (ILCA, 1981). Average measurements from two surveys reported by Striffling, (1977); Domingo, (1976) are presented in Table 9.

Borgou

The Borgou is a crossbreed between West African Zebu (main White Fulani Zebu) and West African Shorthorn. The coat is usually white or grey, or sometimes black-and-white and the mucosa are usually black. Height at withers ranges from 1.05 to 1.20 m among adult animals (Striffling, 1977). These animals are much more docile than the Lagune or Somba.

Striffling (1977) reported a calving rate under village conditions of 54.5% in Borgou Province, compared with 73% for a sample of 14 cows at M'Bétécoucou Station. The calving rate varies considerably according to the degree of trypanosomiasis infestation. Lazic (1978) recorded a calving rate at M'Bétécoucou of only 33% in 1976/77. At M'Bétécoucou, the mortality rate during 1976/77 was 28% for calves and 12% for adult cows (Lazic, 1978). The average weights of Borgou cattle at M'Bétécoucou Stations (a) and (b) are presented in Table 10.

Average weights for adult animals range around 250 kg. Striffling (1977) recorded an average weight of 244 kg for a sample of 81 adult cows under village conditions and 248 kg for a sample of 30 adult cows under ranching conditions; while Lazic (1978) reported an average weight of 226 kg for 73 adult cows at M'Bétécoucou Station. At Okpara Farm, an average weight of 307 kg was recorded in 1974 for a sample of 43 males over five years old (Striffling *et al*., 1975).

Viaut (1966) recorded an average dressing out percentage of 52% at the Parakou abattoir for 24 males and 8 females. The average live weight of the males was 265 kg and the average carcass weight 137 kg, while for the females average live weight was 227 kg and carcass weight 117 kg.

Lazic (1978) summarized estimates of the main production traits for Borgou cattle needed to build up a productivity index covering the total weight of one-year-old calf plus the live-weight equivalent of milk produced per 100 kg of cow maintained per year (see Table 11). The productivity index derived for meat production under these conditions was also at M'Bétécoucou Station in a medium tsetse challenge area.

Pabli

The existence of a Pabli breed in the Kérou area north of Kouandé in Atacora Province has been mentioned by several authors (for example Brémaud, 1967). However, the Kérou area north of Kouandé area is now

populated by typical Borgou cattle. The Pabli has effectively been absorbed by the Borgou.

Crossbreeds

There is great variety in appearance among crossbreeds in Benin depending on the original breeds that were crossed and the proportions of each. There are no precise data on the performance of the crossbreeds, but their values are generally similar to those obtained for the breeds that were crossed. The N'Dama breed was introduced on Okpara Farm near Parakou in Borgou Province and in the south at the SOBEPALH (Société Béninoise de Palmeraies d'Huile) palm plantation near Ouédo in Atlantique Province for crossbreeding purposes. There is little trace of N'Dama influence in village herds.

The size of cattle herds depends on the owners and the production system employed. Herds in the south tend to be small, while those in the north, particularly in Borgou Province, tend to average about 80 head (Striffling, 1977). Typical herd compositions for the two main livestock regions, Borgou and Atacora Provinces, and for the south, where the herds are chiefly composed of Lagune cattle, are presented in Table 12.

Small ruminants

Sheep and goats are owned by individual households and are generally kept in small numbers around the house. The animals of a village are never brought together in one flock. Most households keep sheep and goats together and have two to five animals in all. They are not given any veterinary attention or supplementary feeding. The most important disease affecting small ruminants in Benin is *peste des petits ruminants* (PPR). Many animals suffer from helminthiasis, which makes them weak and more susceptible to infectious diseases such as PPR (Anon, 2004).

Table 10. Average weights of Borgou at M'Bétécoucou Stations

Station (a)				
Age	**Females**		**Males**	
	number	**kg**	**number**	**kg**
Birth	15	16	26	17
6 months	16	66	18	86
12 months	17	112	12	130
Station (b)				
Age in months	**Females**		**Males**	
	number	**kg**	**number**	**kg**
Birth	26	15.6	29	16.4
6	19	71.5	19	90.9
12	17	116.7	11	125.9
18	13	151.7	10	163.6
24	9	206.7	9	199.5
36	2	197.0	3	225.6

Source: Lazic, 1978 (a); Striffling (1977) (b); cited in ILCA (1981)

Table 11. Borgou productivity estimate

Parameter	**Production environment**
	Station/medium challenge/meat
Cow viability (%)	88
Calving (%)	33
Calf viability to one year (%)	72
Calf weight at one year (kg)	119
Annual milked out yield (kg)	-
Productivity indexa per cow per year (kg)	30.1
Cow weight (kg)	226
Productivity indexa per 100 kg cow maintained per year (kg)	13.3

a. Total weight of one-year-old calf plus live-weight equivalent of milk produced. Source: Lazic (1978); cited in ILCA (1981)

Table 12. Herd composition in three areas (%)

	Borgou Province	**Atacora Province**	**Southern Area**
Male calves (< 1 year)	11.6	10.3	8
Young bulls (1-3 years)	9.5	8.8	4
Oxen and bulls	2.4	5.4	2
	-	3.4	3
Total males	23.5	27.9	17
Female calves (< 1 year)	12.2	10.9	11
Heifers	16.8	18.0	14
Cows	47.5	43.2	58
Total females	76.5	72.1	83

Sources: For Borgou and Atacora, (Striffling, 1977); for southern area, (Brémaud, 1967, cited in ILCA 1981

Sheep

The sheep breeds in Benin are the Sahelian (big) and the Guinean or Djallonké (Small). Most of the sheep in Benin are of the Djallonké breed (Figure 10). Guinean sheep are small (Figure 11); live weight is rarely more than 30 kg but with a high quality of meat and yield of about 48%. The Sahelian sheep are large and rather heavy (80 kg). They are butcher shop animals (40 to 50% of yield). In the north there are also Fulani sheep and crossbreds between the two types. Sheep in the north tend to be bigger than in the south (Anon, 2004).

Sheep are more or less resistant to pests but very sensitive to the gastro-intestinal parasites. There are more than 1.7 million small ruminants in Benin, with approximately the same number of sheep as goats for the country as a whole.

Table 13: Sheep and goats distribution by province

Province	Sheep		Goats	
	Numbers	% of National Total	Numbers	% of National Total
Borgou	367 500	41.7	284 000	33.5
Atacora	165 000	18.7	199 000	23.4
Zou	200 000	22.7	190 000	22.4
Ouemé	60 000	6.8	73 000	8.6
Atlantique	14 600	1.7	31 000	3.7
Mono	74 000	8.4	71 000	8.4
Total	881 100	100.0	848 000	100.0

Source: Service National de l'Elevage, (1977); cited in ILCA (1981)

In Borgou Province there are more sheep than goats, while in Zou and Mono Provinces the sheep and goat populations are about equal. There are more goats than sheep in the other southern provinces and Atacora Province (Table 13). Table 14 presents the productivity parameters of goats and sheep.

Arnaud (1977) quoted an annual birth rate of 1.74 lambs per ewe over two years at the Lycée Agricole de Sékou. The same author reported 10 months as average age at first lambing under village conditions and approximately 40% lamb mortality rate. Average weights for adult ewes in good conditions ranged between 20 and 25 kg, and for adult rams between 30 and 35 kg.

Table 15 gives summarized estimates of the major production traits required to build up a productivity index based on the total weight of five-month-old lambs produced per 10 kg of ewe maintained per year. This productivity index was derived for production under station conditions in a low to medium tsetse challenge area.

Figure 10. Djallonke sheep breed in Benin
Source: Gbangboche et al. *(2005).*

Figure 11. Guinean sheep breed in Benin
Source: Anon (2004).

Table 14. Productivity parameters for goats and sheep

Parameters	Goat	Sheep
Weights at birth (kg)	1.2	2.1
Weight at 90 day (g)	4.2	8.1
Weights at 90 day (kg)	11.1	14.1
Weighed productivity (kg)	5.3	9.7

Source: Anon (2004).

Goats

Goats are the most numerous species after poultry in all agro-ecological zones in Benin or (in the savannah area) sheep. Four types of goats, Long legged Sahelian (LLS), Long legged from North (LLN), Short legged but not dwarf (SLND) and Short legged dwarf like (SLD) (Figure 12) are found (Dossa *et al.,* 2006) indicating that the goats in Benin are mostly of the West African Dwarf type. Figure 13 shows goats under a traditional production system. Meat goats weigh about 15 to 20 kg but less than dairy Sahelian goats that have an adult weight of 35 kg. Goats are more popular than sheep in the South and are important in livelihood strategies of rural people (Dossa *et al*., 2008).

Dossa *et al*. (2008) observed that the ownership of goats was higher (91%) than sheep (35%) because goats are not affected by any ethnic or cultural restrictions. Goats are also perceived to be less risky to invest in compared to sheep. Women represented 71% of the keepers of goats in Benin Republic. The results showed that younger household members especially young women (60%) are more likely to own small ruminants. Owners of small ruminants are less likely to be involved in off-farm activities and would often have no access to credit facilities. Gender, ethnicity and perception of risk associated with species are the major factors affecting people's choice of species. They also observed that goats offer a strong opportunity for development programs to enhance

women's economic autonomy and to empower them. Women were more inclined towards goats than men. This is because goats present low risk in investment and are easier to keep.

They observed that there is a cultural bias against sheep in some ethnic groups. However, the potential of small ruminants, especially goats, as an effective and feasible way of enhancing livelihoods of the resource-poor people is still under-exploited.

Kitchen waste and herbage cut from fallow land are some major sources of feed for small ruminants, although sheep are often tethered

Table 15: Sheep productivity estimates

Parameter	Production environment
	Station/low to medium challenge
Ewe viability (%)	95a
Lambing (%)	174
Lamb viability to one year (%)	60
Lamb weight at five months (kg)	11.5
Productivity indexb per ewe per year (kg)	12.3
Ewe weight (kg)	22.5
Productivity indexb per 10 kg ewe maintained per year (kg)	5.5

a. Estimate, b Total weight of five-month-old lamb produced. Source: Arnaud, (1977); information from country visits (Cited in ILCA(1981).

Short legged dwarf-like

Long legged from the North

Short legged but not dwarf

Long legged from Sahelian countries

Figure 12. Four types of goats in Benin
Source: Dossa et al.*, 2006*

Figure 13. Goats under traditional production system
Source: Anon (2004) ILRI

and grazed. *Peste des petits ruminants* (PPR) appeared to be a major cause of small ruminant mortality. Constraints were identified relating both to the system of production and to the socio-economic environment. The former included disease, feed scarcity, lack of water and housing. Socio-economic constraints included an inadequate extension service and livestock theft. Management practices used for small ruminants are traditional and improved (confinement).

5. THE PASTURE RESOURCE

Natural pasture

Natural pasture is the feed of almost all ruminant livestock in Benin; the vegetation types have been described above. The country is covered with dense vegetation. Most pastoralists graze their herds on seasonal pasture lands (Brottem, 2006). The main feed sources available to grazing animals are natural pasture, cut forage from forests, some additional fodder and crop residues.

The presence of the grass *Andropogon gayanus*, and the dicotyledons *Indigofera secundiflora* (in Atacora) and *Chromolaena odorata* (in Savè) are recognized as indicators of fertile soil, whereas *Hyptis* spp., *Striga hermonthica* and *Spermacoce filifolia* (in Atacora) indicate infertile soils (Vissoh *et al*., 2004; Saïdou *et al*., 2004).

Oloulotan *et al*. (2008) investigated the productivity of native grasslands in Nikki-Kalale (northestern) Benin and observed that shrubby savannahs are grazed 63 to 69% more of the grazing time in dry season period while fallows are grazed 60% in the rainy season. Shrubby fallow and savannahs are equally grazed at the beginning of July. Fallows on humid soils in June had a carpet with 80% of grasses; and 78% of grasses are *Brachiaria falcifera*, *Schedonnardus paniculatus* and *Hyparrhenia diplandra*. At the end of May, the biomass was 685.2 kg/ha and has a carrying capacity of 3.1 ha/animal, dominated by *Imperata cylindrica*, *Brachiaria falcifera*, *Paspalum* sp, *Dactyloctenium aegyptium* and *Digitaria horizontalis*. In August, it was 4 964 kg/ha. They concluded that fodder production in Nikki-Kalale grasslands regularly grows and ranged from 1.98 tonnes/ha in May to 12.4 tonnes/ha in August with respective carrying capacities of 2.6 ha/beast and 0.73 ha/beast. Finally the production was slightly dependant on sites and soil types, while the carrying capacity of the area was high and it required a reduction of 104 133 beasts for a judicious exploitation of the targeted pastures. They concluded that rotation of the pastures, sedentary breeding and judicious use of bush fires should be alternatives to improve the pasture productivity in Nikki-Kalale (northestern) Benin.

Kreis *et al*. (2008) investigated the contribution of the agropastoral areas of the department of Borgou: districts of Kalalé and Nikki and reported that fallows were dominated by the grasses such as *Pennisetum polystachion*, *Digitaria horizontalis* (60% of recovery in the young fallow and 90% in the old one). *Ledermanniella ledermannii*, *Diheteropogon amplectens* and *Andropogon gayanus* dominated savannahs whereas *Sargassum brevifolium*, *Andropogon pseudapricus* and *Hyparrhenia diplandra* characterized depressions. The pastoral values of both districts ranged from 35 to 60%. The hollow formations (savannahs and fallow) as well as the old fallow (>5 years) on summits showed that the highest pastoral value of the series was 54.5–59.4% with a greater contribution of grasses and non-fodder species (49 to 78%). The optimal pastoral value varies and ranged from 0.5 to 0.88 which indicated adequate use of available pastures in the districts. They observed that for the whole dominant species, available energy from fodder species for the production of milk, contents of digestible proteins of the small intestine permitted by energy and those by nitrogen decreased along the active period of vegetation. The decrease was more for *Schyzachirium exile*, and *Pennisetum polystachion* fallow but higher in the young fallow. To improve the pastoral value of the fallow of *P. polystachion* they suggested that it was important to have leguminous plants to maintain a judicious sustainable exploitation of available pasture.

Houéhanou and Houinato (2006) studied pastoral management and the role of galactogenic woody species saved in the fields for dairy production and the effect of *Afzelia africana* on the quantity and

the quality of milk. They reported that *Afzelia africana* was recognized by 70% of herders as a fodder favoured for dairy production. *Afzelia africana* fodder appeared to be the preferred alternative by Peulh in the dry season as a feed for herbivores. *Afzelia africana* was more sought than other fodder. Sinsin (1993) investigated some soil factors and grassland-type relationships in the subhumid zone of northern Benin. Also Lejoly and Sinsin (1993) investigated fodder species composition, productivity, feed and grazing values of *Pennisetum polystachion* pasture utilized in northern-Benin for grazing.

Aschfalk *et al*. (2000) tested leaves from 10 selected West African trees and shrubs with varying tannin contents to determine their suitability as an alternative and supplementary browse feed to improve productivity of West African dwarf sheep in small-scale holdings in Benin and observed that dry matter intake per kg metabolic body weight (DM g/kg $W^{0.75}$) varied between the different browses and between the different trials and ranged from zero (*Leucaena leucocephala*) up to 26.7 DM g/kg $W^{0.75}$ (*Margaritaria discoidea*). The digestibility of the organic matter also varied between 58.9% (*Leucaena leucocephala*) and 68.2% (*Mallotus oppositifolius*). *Agelaea obliqua* showed the highest levels of total phenols (10.2%), tannin phenols (8.8%) and extractable condensed tannins (8.0%). Leaves from browses were a good and protein-rich supplementary fodder in addition to the grass *Panicum maximum* for sheep, but it was concluded that feeding of *Cnestis ferruginea* should be avoided due to toxic components.

Cultivated forages

Pasture production is traditionally unknown in Benin Republic, but forage cultivation is done on national farms (Gruber, 2008). Cultivated fodders have been experimented with but are of little importance in smallholder stock rearing. There are a number of grass and legumes species in Benin to support the nutrition of ruminant livestock. Some common pastures grasses and legume species and plant-communities are: Guinea grass (*Panicum maximum*); Elephant grass (*Pennisetum purpureum*), *Brachiaria ruziziensis, Andropogon gayanus* and *Hyparrhenia*; *Stylosanthes guianensis, Pueraria phaseoloides*, *Mucuna pruriens*, and *Centrosema*. Feeding them as single feed or as mixtures serves as feed resources for ruminant animals. Early in the rainy season, *Brachiaria ruziziensis* and *Panicum maximum* are the most common forage grasses grazed by most animals.

Kindomihou *et al*. (2006) subjected five tropical grass species (*Andropogon gayanus* var. *bisquamulatus*, *Elymandra androphila*, *Hyparrhenia subplumosa*, *Panicum maximum* var. C1 and *Panicum maximum* var. local) to various clipping treatments to examine whether silica concentration correlated to other leaf structural and chemical parameters in Benin Republic and found that defoliation increased silica concentration in three of five species (blades and sheaths), but the response was rarely strong and varied with clipping frequency. Defoliation also caused other changes in leaf structure, such as production of leaves with juvenile characters including higher specific leaf area (SLA), higher relative water content (RWC) and lower carbon concentration. Data obtained suggested that enhanced silica accumulation was not a very specific response to defoliation. Furthermore, silica concentration was observed to vary among species and was correlated to leaf structure and chemical composition. *Andropogon gayanus* var. *bisquamulatus* had the lowest silica concentration and the highest carbon concentration, while *Panicum maximum* showed the opposite combination of traits, suggesting that species with more sclerified leaves might be less silicified. Positive correlations between silica content and RWC, soluble ash and SLA suggest that variation in silica accumulation among species and treatments might be related to transpiration rate.

Gafari and Adandedjan (2008) carried out agronomic evaluation of several fodder ecotypes in Benin that consisted of 23 species (7 grasses; 11 herbaceous legumes and 5 woody legumes) in phase of establishment on Okapara ranch, and 19 species (7 grasses; 8 herbaceous legumes and 4 woody leguminous species) in phase of production of biomass on Calavi farm and observed that soil cover rate varies from one species to another and this increases as the plant grows in age. For the grass species, it ranged from 11% to 79.5%, exceeding 50% at the end of the establishment (12 weeks) except for *Brachiaria brizantha* 6780 (38%) while *Panicum maximum* 673 showed the highest rate (79.5%). *P. maximum* 673, *Andropogon gayanus* Samiondji and *Brachiaria ruziziensis* had higher recovery rates (>70%). Species at average recovery rates (50–70%) were *Andropogon gayanus* 621, *Brachiaria dictyoneura*, and *Brachiaria decumbens* while the species at low recovery rate (<40%) was *Brachiaria brizantha* Marandu. The speed at which the species colonize the soil was categorized into two groups

(i) report A>25% had *Brachiaria ruziziensis* (28%); while (ii) report A<15% were *Panicum maximum* 673, *Andropogon gayanus* Samiondji, *Brachiaria brizantha* 6780, *Brachiaria decumbens*, *Andropogon. gayanus* 621, *Brachiaria dictyoneura*.

For herbaceous legumes, the cover rate ranged from 31 to 97%, with an average rate higher than 50% except for *Arachis pintoï* (44%). *Mucuna utilis* showed the highest value (98.7%). Period of measurement and species were highly significant. Also the average recovery rate was better with leguminous species (73%) than grasses (63.7%). Vigorous species at high cover rates were distinguished from the least vigorous: (i) recovery rate was higher than 58% (*Mucuna utilis*: 70.7%; and *Dolichos lablab* 58.5%); (ii) recovery rate lower than 40% (*Aeschynomene histrix*: 38%; *Centrosema brasilianum*: 35.1%; *Stylosanthes hamata*: 33.5%; *Stylosanthes guianensis* 136: 32.5%; C*entrosema macrocarpum* 5452: 27.7%).

They distinguished three groups within the leguminous species: (i) report A>25%: *Mucuna*. *utilis* (31.2%); (ii) A<15% report: *Stylosanthes guianensis* 136, C*entrosema macrocarpum* 5452, C*entrosema brasilianum*, *Aeschynomene histrix*; (iii) A> 15% were *Dolichos lablab* (18.8%) *Stylosanthes hamata* (17.9%).

For woody leguminous species, they observed that the height of growth varied with species and increased with age. This ranged from 20.5 to 101.7 cm with an average of 41.7 cm. Among the woody legumes *Cajanus cajan* showed higher value (>101cm), while *Flemingia macrophylla* at 21 cm was the lowest. They also observed that the aerial biomass productivity varied with species and age. Biomass productivity of *Brachiaria dictyoneura* Lanero, and *Brachiaria humidicola* increased quickly and exceeded 4 605 kg/ha at the end of establishment (12 weeks) while *Panicum maximum* 673 at 23% had low biomass production from the sixth to the ninth week but reached 5 380 kg/ha at the end of establishment. *Brachiaria brizantha* la Libertad (980–1 969 kg/ha), *Brachiaria brizantha* Marandu (890–2 643 kg/ha) and *Panicum maximum* T58 (1 042–2 545 kg/ha) were also low in biomass productivity.

Herbaceous legumes showed an average productivity of 2 470 kg/ha as against 3 460 kg/ha for grasses. Herbaceous legumes were subdivided into 2 groups: (i) more productive and (ii) least productive. The more productive species were *Stylosanthes hamata*: (2 551 kg/ha); *Centrosema macrocarpum* 5 452 and *Centrosema macrocarpum* 5 713 (2 452 kg/ha), while the least productive were *Stylosanthes capitata*: (1 528 kg/ha); *Centrosema pubescens*: (1 420 kg/ha); *Stylosanthes sympodialis* (1 296 kg/ha); *Centrosema acutifolium* Vichada: (1 007 kg/ha) and *Centrosema acutifolium*: 980 kg/ha).

The woody leguminous species showed a variation from 900 to 2 991 kg/ha from 6 to 12 weeks, with the *Leucaena leucocephala was* the more productive with values that ranged between 1 059 to 2 991 kg ha while the lowest was *Flemingia macrophylla* at between 1 263 to 1 469 kg/ha from the 6th to 9th week, and decreased to 985 kg/ha in the 12th week.

Babatounde *et al.* (2008) investigated the grazing behaviour and fattening performances of 12 Djallonke sheep on two plots of pasture containing either *Andropogon gayanus* + *Aeschynomene histrix* (M1) or *Panicum maximum* var. C1 + *Aeschynomene histrix* (M2) during the rainy season (July, August and September) and was repeated during the dry season (October and November). They observed that in the pasture, the proportions of the time used by the various diurnal activities were distributed as follows: 64 to 85% for grazing, 3 to 12% per day for rumination and from 11 to the 25% per day for resting time. A clear difference was observed between the periods of time dedicated to grazing activities during the morning and the afternoon. The time%age devoted to grazing is not significantly influenced by the season ($p > 0.05$). They observed that season had no influence on rumination or the resting time when the sheep graze an M1 mixture. On the contrary, with the M2 mixture, the sheep rested more in the afternoons, especially at the beginning of the dry season. Voluntary intake varied between 31 and 79 g DM/kg LW. The highest values were registered during the rainy season and the animals operated a selection in favour of *Aeschynomene histrix* with regard to grass. The forage energy concentration varied between 0.73 and 0.84 UF (unité fourragère – obsolescent feed unit) and between 0.79 and 0.89 UF. The proportion DCP/UF varied between 140 and 150 g/kg of DM for M1 mixture and between 75 and 140 g/kg of DM for M2. These diets allowed forage fattening performance of 50 g/day/animal.

Grasses

The major cultivated fodders are grasses. Some prominent grass and fodder species such as Guinea grass (*Panicum maximum*), Elephant grass (*Pennisetum purpureum*) and *Hyparrhenia rufa* among others are available in Benin.

*Guinea grass (*Panicum maximum*)*

Panicum maximum is a perennial grass (Figure 14) native to Benin that is well eaten by all classes of grazing livestock, with particularly high intakes of young leafy growth. It is ideal for cut-and-carry and highly suited to growing with trees and shrubs due to its shade tolerance. Reasonably palatable when mature, providing good roughage for use in conjunction with foliage of browses and multipurpose trees. It combines well with twining legumes under light grazing. It spreads along watercourses and ungrazed roadsides.

Figure 14. Guinea grass, *Panicum maximum*
Source: Melifonwu et al. *(undated)*

*Elephant grass (*Pennisetum purpureum*)*

Elephant or Napier grass (*Pennisetum purpureum*) is native to tropical Africa but is now available throughout the tropics (Figure 15). It is a tall, clumped perennial that is planted in some places on bunds as a windbreak and to conserve the soil. Although the dry stems or canes are used for fencing and for house walls and ceilings, it is primarily grown for fodder. It is a very suitable fodder in a cut-and-carry production system. Elephant or Napier grass can grow in mixture with legumes. It has been observed that when it is intercropped with herbaceous legumes, cutting or grazing management can be adjusted to favour the legumes in order to maintain a satisfactory mixed sward. Elephant grass can also be grown as an alley crop with fodder legumes such as Leucaena (*Leucaena leucocephala*), calliandra (*Calliandra calothyrsus*), sesbania (*Sesbania sesban)* and gliricidia (*Gliricidia sepium*).

Andropogon gayanus is found on sandy soils in Benin while *Hyparrhenia rufa* is found in moister sites in Benin (Peyre de Fabrègues 1980).

Figure 15. Elephant or Napier grass planted using conventional methods
Source: Orodho A.B. (2006)

Cover crops

In order to minimize soil degradation associated with agriculture, Benin farmers are encouraged to use other cover crops such as *Pueraria phaseoloides* and *Centrosema pubescens* that also serve as feed for ruminants. Centro (*Centrosema pubescens*) and puero (*Pueraria phaseoloides*) are important forage legumes as protein and mineral sources for ruminant livestock and are also used as cover crops in forest plantations or in agroforestry systems (Lukiwati, 2005).

Cover crops are efficient sources of nitrogen (N). They improve soil structure and other properties, increase the soil's biological activity, and help to control pests and weeds. Cover crops can also be additional sources of food, feed and fuel for farm families. Leguminous plants contribute significantly to the maintenance of nitrogen levels, organic matter content and physical properties of soils in intensified cereal-based cropping systems. They also play important roles as feed.

Cover cropping, however, is not a stand-alone solution to the problems of low soil productivity. Cover crops can help to maximize the benefits derived from other low cost external soil amendments, such as rock phosphate. Where fertilizers are expensive and their quantity is limited, cover crops along with moderate amounts of externally derived nutrients (e.g. mineral fertilizer) are a cost-effective means for increasing the nutrients available in the soil and thereby increasing its productivity.

Velvet bean *(Mucuna pruriens)*. The main use of mucuna is as a short-fallow crop for soil fertility restoration and weed control, mainly *Imperata cylindrica*. However, its foliage and pods are also increasingly used as forage. In northeastern Benin, mucuna is, more than any other legume, used as forage (Carsky *et al*., 1998) and in 1999 there were >10 000 farmers in Benin using Velvet bean on a total area of approximately 1 000 ha (Elbasha *et al*., 1999). These figures, along with promising results from economic analyses indicate the impact and potential of Velvet bean as a multipurpose legume for resource-poor smallholders. *Velvet bean* is important mainly in the humid (derived savannah) zone of Benin. Animal studies with goats, sheep and dairy cows confirmed that Velvet bean is a high-quality feed for ruminants. Seed, husk and foliage were found to promote weight gain and sustain milk production without the ill effects (Eilittä *et al*., 2003). In the study by Muinga *et al*. (2003) dairy cows were supplemented with 8 kg of either fresh *Mucuna* forage or *Gliricidia sepium*, a recommended supplement for the region. The total dry matter intake (7.7–8.0 kg/cow/day) and milk yield (5.2–5.5 kg/cow/day^{-}) were similar for the two groups, although *Gliricidia* intake was higher than that of Velvet bean.

Chromolaena odorata was introduced in the Guinea zone in Bénin in the 1970s and its geographical distribution is widening. Among its benefits are its ability to control soil erosion, its healing and aesthetic virtues, and its soil fertility enhancement effect. According to Autfray and Gbaka (1998) *Chromolaena odorata* has a very high mineral content; "as high as that of leguminous forage crops when it comes to leaves". As far as its pastoral value is concerned, it is one of the most frequently refused plants in pastures degraded by severe weed infestation in the Guinea zone in southern Benin. Refusal dominance leads among other things, to lower productivity of forage species. One good illustration of such a situation is provided by the pasture of *Brachiaria ruziziensis* and *Chromolaena odorata* where the phytomass of *Brachiaria ruziziensis* (a good grass) dropped to 0.3 g DM a/m² as a result of the weight input by four refusals, especially by *Chromolaena odorata* (150 g DM/m²). In areas with a lower weight contribution by *C. odorata* (18 g DM/m²), the biomass of *Brachiaria ruziziensis* stood at 375 g DM/m². Animals move easily through the bushes of *Chromolaena odorata,* which they avoid. Access to the pastures is made difficult by the bushy growth of *Chromolaena. odorata* on old fallow lands, which are thus abandoned by the animals for younger fallows that they subject to high grazing pressure.

Stylosanthes guianensis is widely adapted to Benin (Borget, 1969; Borget *et al.,* 1969), but it does not survive long dry seasons. *Stylosanthes* species are used as a component of improved grass–legume pastures. The stylo technology was introduced in the late 1970s, and was primarily targeted to livestock production. However, the uptake of stylo has been relatively slow and modest in contrast to the faster rate of adoption of mucuna in southwestern Benin. Unfortunately *Stylosanthes guianensis* was wiped out by anthracnose (*Colletotrichum*) in the 1990s.

Crop residues

Appreciable quantities of crop residues and agro-industrial by-products are available and are important during the dry season. Crop residues includes all leaves, straw and husks left in the field after harvest, hulls and shells removed during processing of the crop at the mills. The waste from the agro-processing industries where the crop is prepared for consumption include rice husks/straw, maize stover, sorghum stalks; cottonneseed hulls, palm (palm kernel meal), coconut (coconut meal), ground nut, and coffee processing waste. Also included are foliage of shrubs, legumes and multipurpose trees. Kitchen waste and foliage cut from fallow land are also sources of feed for small ruminants, although sheep are often tethered and grazed.

Figure 16 shows a rice farm under cultivation in the Niger Valley; after harvest the straw will serve as feed for ruminant animals.

Figure 16: Rice farm under cultivation in the Niger Valley
Source: CIPB (2007)

6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

Increase in livestock production depends to a large extent on the availability of suitable feed resources. Feed shortages during the dry season, and sometimes even during the wet season, constrain livestock production in Benin. Even where feed is plentiful it may be low in nutritive value, may form an imbalanced diet lacking critical elements, or may be inefficiently converted into protein and energy by the animal. The use of *Leucaena* and *Gliricidia* as fodder banks is promising.

Forage resource development

Grasses such as *Panicum maximum, Pennisetum purpureum*, *Andropogon* and *Hyparrhenia* should be cultivated and used in a cut-and-carry-production system especially during the dry season of the year. There is also the need to investigate forage species, treatment of crop residues to increase digestibility, and improved storage qualities in forage. Another promising avenue of investigation is to provide supplemental fodder for small ruminants in mixed production systems

Planting leguminous and fodder trees

As technologies to counter declining soil fertility, alley farming with *Leucaena leucocephala* and *Gliricidia sepium*, annual short-season *Mucuna pruriens* var. *utilis* fallowing, and perennial *Acacia auriculiformis* fallowing were encouraged. With alley farming, timely pruning is a critical element for farmers.

However, an improved planted fallow of *A. auriculiformis* to regenerate exhausted soils grew a great deal in popularity because of quick regeneration of yields and a profitable bonus of good quality firewood. Figure 17 shows live mulch of *Mucuna* on fallow land. Further, farmers have been encouraged to use cover crops such as *Stylosanthes guianensis, Pueraria phaseoloides, Mucuna pruriens* and *Centrosema pubescens,* which in turn serve as feed resources for ruminant animals.

Figure 17. Live mulch of *Mucuna* on fallow land
Source: Melifonwu et al. *(undated) In: Weed Control in Cassava Farms. IPM Field Guide for Extension Agents*

Figure 18. Changes of land use and vegetation near the village of Houêto between 1981 and 1995 in BeninRepublic (High diversity of woody species)
Source: A. Wezel, B. Bohlinger and A. Floquet (undated) Changes of land use and vegetation near the village of Houêto between 1981 and 1995

Development of fallow vegetation in relation to land use intensity

The bush fallow communities are characterized by their high diversity of woody species (Figure 18), whereas in grass fallows a few grass species such as *Andropogon, Imperata* and *Hyparrhenia* dominate (Figure 19) the vegetation in Houeto, Benin. Figure 20 shows cropping intensity and the influence of fire on development of fallow vegetation in relation to land use intensity near the village of Houêto between 1981 and 1995.

The different fallow communities are indicators of increasing degradation from bush fallows (I) to grass fallows (III) in response to cropping intensity and the influence of fire. If cropping intensity is increased, bush

fallows (I) will change to grass-bush fallows (II) because certain woody species are no longer able to regenerate if they are cut too often or if bush fires for field clearing or unintentional bush fires are too frequent. If intensity of cropping and frequency of fires are very high, the physiognomy of the fallows will turn to grass fallows (III) where almost no shrubs or only fire resistant species (e.g. *Annona senegalensis*) are left.

Constraints: threats and solutions

A wide variability in statistical data related to livestock production and reproduction parameters, imports of livestock and their products and feed resources (grasses and legumes) is found in the different ecozones of Benin.

Furthermore information and data about forage resources are scant, and in many instances out of date. Data on the distribution and characteristics of natural pastures, fodder trees and shrubs and the areas they cover, estimation of available biomass, available stock and annual production fodder crops in the different ecozones of Benin are lacking. Grass is insufficient in quantity and of poor quality. The fodder production is insufficient leading to increasing feed prices

Government, through the extension department, should create awareness of

- rangeland management;
- establishment of fodder banks so as to ensure the availability of fodder;
- the production of stylosanthes seeds;
- training of ruminant farmers on hay/silage conservation and utilization of forage; and
- the use of urea to treat crop residue (rice straw and maize stover) for use as feed in the dry season.

Provide future opportunities to utilize the potential of Mucuna further including the collection and selection of germplasm with higher feed quality for ruminant and non-ruminant nutrition and enhancing medicinal utilization.

Grassland management programmes (livestock density control, bushfires, pastures resources improvement) should be implemented.

Some principal constraints to ruminant livestock production in Benin are:

- lack of quality feed; weight loss, mortality, abortion;
- pressure on the land and proximity of the fields to the villages and hamlets; and
- mortality of the animals.

Suggested solutions to overcome the observed constraints are:

- leguminous production on hedges or gardens to complement animal rations with leaves or seeds from *Cajanus cajan*, *Moringa oléifera*, *Mucuna pruriens;*
- constitution of feed reserves in flood zones;

Figure 19. Grass species such as *Andropogon, Imperata* and *Hyparrhenia* dominated most of the vegetation

Source: Wezel, Bohlinger and Floquet (undated)

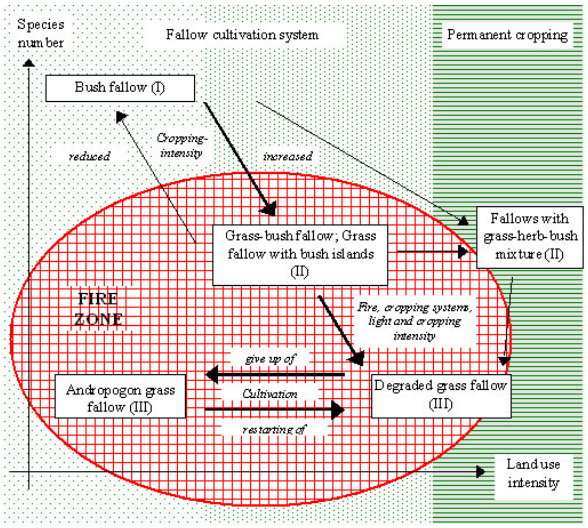


Figure 20. Cropping intensity and influence of fire on development of fallow vegetation in relation to land use intensity

Source: Wezel, Bohlinger and Floquet (undated)

- increased fodder production by the association of food crops and leguminous plants;
- use of crop residues and by-products of food processing (e.g. cassava and banana peels, rice straw, fresh corn leaf, etc.);
- mineral complement (licking blocks) on the basis of local products;
- provide programmes for improving milk production; and
- production of lactogenic plants and well-balanced rations.
- increase small ruminant size in local areas; improve small ruminant size by strategies avoiding negative selection by the farmers and development of the use of agricultural by-products in nutrition of small ruminants (Vidogben, 2004).

There is seasonal fluctuation in available water and grazing sources; and low production of milk from local cows. Animal breeding covers mainly six species, namely: bovines, goats, rams, pigs, rabbits and poultry; however, the level of production, which represented an average of 7.5% of the GDP from 1999–2003 was inadequate for the national requirement.

There is the need for the development and building of pasture reserves to overcome seasonal fluctuation.

Also the problems of troublesome weeds such as *Striga hermonthica*, *S. gesnerioides* and *Imperata cylindrica* should be addressed. Farmers should understand the biology of each weed as a basis for choosing appropriate measures. Early planting, crop rotation and intercropping and trap cropping are very effective means of reducing the effects of the three troublesome weeds.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

There are no livestock research centres as such in Benin, but the M'Bétécoucou and Samiondji Stations, are treated as research stations. However, there are several key institutions in Benin that carry out research and promote the development of pasture and forage production. These include government ministries and departments, parastatals, agencies, academics in higher education institutions and private organizations.

Centre Béninois de la Recherche Scientifique et Technique (CBRST)
Parent Ministry of Higher Education & Scientific Research
Sector Agricultural Research - General
Activities Biotechnology, Plant Production & Protection

Groupe de Recherche et d'Action pour la Promotion de l'Agriculture et du Developpement (GRAPAD)
Sector Agricultural Research - General
Activities Research and Development, Education and Training and Technology Transfer

National Institute of Agricultural Research - Institut National de Recherche Agricole du Bénin
Sector Agricultural Research - General
Stated Role To contribute to the development of the national policy of research in agriculture and other related fields

University of Parakou (North Benin) Faculty of Agronomy, Republic of Benin
Jean C. Ganglo. University of Abomey-Calavi, Faculty of Agronomy, Department of Environment Management, Benin Republic (West Africa)
Kouessi Aïhou, Institut National des Recherches Agricole du Bénin, Niaouli, Benin
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