Country Pasture/Forage Resource Profiles

NIGERIA

by

Eroarome Martin Aregheore

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1. INTRODUCTION

The Federal Republic of Nigeria is in West Africa between Latitudes 4 ° to 14° North and between Longitudes 2°2' and 14 ° 30' East. To the north the country is bounded by the Niger Republic and Chad; in the west by the Benin Republic, in the East by the Cameroon Republic and to the south by the Atlantic Ocean. The country takes its name from its most prominent river, the Niger. Nigeria has a land area of about 923 769 km^2 (FOS, 1989); a north-south length of about 1 450 km and a west-east breadth of about 800 km. Its total land boundary is 4 047 km while the coastline is 853 km. The Federal Ministry of Environment of Nigeria (FMEN, 2001) 1993 estimate of irrigated land is 9 570 km^2 and arable land about 35%; 15% pasture; 10% forest reserve; 10% for settlements and the remaining 30% considered uncultivable for one reason or the other. Boomie (1998) corroborated the irrigated land at 9 570 km^2 with arable land at 33%; permanent crops 3%; permanent pastures 44%; forests and woodland 12% and others 8%. Cleaver and Shreiber (1994) put the surface area of Nigeria as 91.07 million ha, 57% of which is believed to be either under crops or pastures while the remaining 43% is divided amongst forest, water bodies and other uses.

Nigeria is a country of marked ecological diversity and climatic contrasts. The lowest point is the Atlantic Ocean at sea level while the highest point is the Chappal Waddi at 2 419 m. Nigeria has diverse biophysical characteristics, ethnic nationalities, agro-ecological zones and socio-economic conditions. It has evolved over time and space in terms of administrative structures and nature of governance. It started as an amalgamated British colony in 1914, became a federation in 1963; then became independent in 1960 as a two-unit region comprising the Northern and Southern provinces. An additional Mid-Western region was created in 1963. Also in 1963, Nigeria was proclaimed a republic.

The three former regions (Western, Eastern and Northern) excluding the Midwest were later divided into 12 states in 1967 along with a number of sub-administrative divisions for each state. In 1976 the states were increased to 19, in 1987 to 21 and 30 in 1987 (Figure 1). Further changes in the administrative composition of the country include the redefining of the political regions as local government areas (LGAs) and the creation of the new Abuja Federal Capital Territory (FCT) on December 12 1991. With this, Lagos ceased to be the country's capital, a position that it held right from before independence. Thus today Abuja is the capital while Lagos is the largest city in terms of population and the main commercial centre. There are now 744 LGAs. The present 36 States structure emerged in 1996 during the time of erstwhile Babaginda, with the creation of 6 additional states namely Bayelsa, Ebonyi, Ekiti, Gombe, Nasarawa and Zamfara. Today Nigeria consists of 36 states and the Federal Capital Territory located at Abuja (Figure 1).

Nigeria is the most populous country in Africa with an estimated population of 131 859 731 inhabitants (July 2006 estimate, World Factbook). The average annual growth rate according to the 2006 estimate was 2.38%. Nigeria's population is divided among 478 different ethnic groups, some numbering fewer than 10 000 people. Of the different ethnic groups, ten (Hausa, Fulani, Yoruba, Ibo, Kanuri, Tiv, Edo, Nupe, Ibibio and Ijaw) account for nearly 80% of the population. Twenty-five percent of the population is in the former Western Region (12% of area), 21% in the former Eastern Region (9% of area), and 53% in the former Northern Region (79% of area). The

Figure 1. Map of Nigeria showing the different states

lowest population densities are in the northern regions, especially in Borno, Adamawa, Kebbi, Kwara, Taraba, Yobe and Zamfara States. Details of Nigeria's population density are presented in Figure 2.

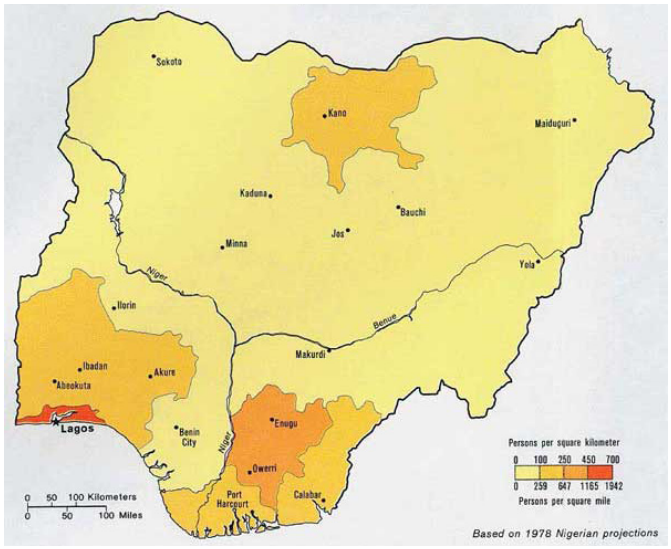


Figure 2. Map of Nigeria showing population density
Source: FAO (1993)

Nigeria's economy has been dominated since the late 1960s by the export of oil, a sector dominated by the Government. By the mid-1970s, about 75% of Federal revenue came from petroleum. The share of exports accounted for by fuel, mineral and metals continued to rise and stood at 96% in 1991 (World Bank, 1993). In 2004, the share of export commodities from petroleum and petroleum products was 95%, while cocoa, rubber and others contributed most of the remainder of exports. Nigeria's industrial production growth rate was 2.3% (2004 estimate) (CIA World Factbook, 2004). GDP growth rose marginally in 2004, led by oil and natural gas exports. The capital-intensive oil sector provides 20% of GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues (2004 estimate) (CIA World Factbook, 2004).

The development of the petroleum industry in the late 1960s and 1970s radically transformed Nigeria from an agricultural based economy to a major oil exporter. Increased earnings from petroleum exports generated high levels of real economic growth, and by the mid-1970s Nigeria ranked as the dominant economy in sub-Saharan Africa and as the continent's major exporter of crude petroleum. Notwithstanding the decline in world petroleum prices after 1981, the government became increasingly over-extended financially, with insufficient revenue from petroleum to pay the rising cost of imports or to finance major development projects. The decline in Nigeria's earnings of foreign exchange led to an accumulation of arrears in trade debts and of import shortages, which, in turn, resulted in a sharp fall in economic activity, with most of Nigerian industry struggling to operate without essential imported raw materials and spare parts. A series of poor harvests, an overvalued currency and a widening budget deficit compounded the problem.

The dramatic fall in international prices for petroleum in 1986, and reduced output in all sectors (except agriculture), kept the economy in the depths of recession, thus in July 1986 the government announced a two-year structural adjustment programme (SAP). This programme was aimed at expanding non-oil exports, reducing the import of goods that could be manufactured locally, achieving self-sufficiency in food and increasing the role of the private sector. The SAP included the abolition of import licenses and a reduction in import duties. Consequently in 1994, the SAP was abandoned, following a severe deterioration in political and economic conditions in the early 1990s. Economic instability was also reflected in a persistently high rate of inflation, which increased from an annual average of 24.0% in 1986–91, to a peak 72.8% in 1995.

Between 1996 and 1998, the Nigerian economy recorded impressive macroeconomic stability while it continued to show positive signs of growth (as reported by the Federal Ministry of Finance). These included the exchange rate and the rate of inflation. The improved performance of the economy in 1997 was as a result of the sustained implementation of a sound fiscal policy dovetailed into an anti-inflationary monetary stance. Indeed, inflation rate decelerated dramatically to reach a 7-year low of 8.5% by the end of December 1997.

The role of agriculture in the country's economy

Before Nigeria attained independence, agriculture was the most important sector of the economy, and accounted for more than 50% of GDP and more than 75% of export earnings. Consequently, with the rapid expansion of the petroleum industry, agricultural development was neglected, and the sector entered

Table 1. Agriculture – Production indices

Indices	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Agricultural Production (Export value at base year quantity (1000$)	613 602	549 512	456 341	398 473	469 088	330 198	413 574	397 916	602 804	-
Total food production (Export value at base year quantity (1000$)	287 436	347 407	285 344	302 309	404 829	235 292	271 467	293 470	514 817	-
Per caput	84.9	89.0	92.4	96.6	100	1004.4	96.6	102.8	104.7	104.9
Food per caput	97.8	99.5	100.4	102.0	102.7	100.3	97.0	97.5	97	94.8
Roots and Tubers total (MT) '000	56 667	57 391	59 450	62 953	65 429	65 164	65 942	68 386	66 629	66 629
Coarse grains total (MT) '000	19 549	18 496	18 519	18 667	19 027	17 999	17 311	18 821	19 432	19 432
Cereals total (MT) '000	22 512	21 665	21 853	22 040	22 405	21 370	20 114	22 090	24 257	24 457
Vegetables total (MT) '000	2 608	3 506	3 657	3 815	3 868	3 945	4 000	4 276	4 300	4 300

-- data not available.
Source: FAOSTAT data 2005. (accessed June 26, 2005)

a relative decline. Thus, between the mid-1960s and the mid-1980s, Nigeria moved from a position of self-sufficiency in basic foodstuffs to one of heavy dependence on imports. Under-investment, a steady drift away from the land to urban areas (cities), increased consumer preference for imported foodstuffs (particularly rice and wheat) and outdated farming techniques continued to keep the level of food production well behind the rate of population growth. Table 1 shows production indices for Agriculture from 1995–2004 and Figure 3 shows the distribution of economic activity.

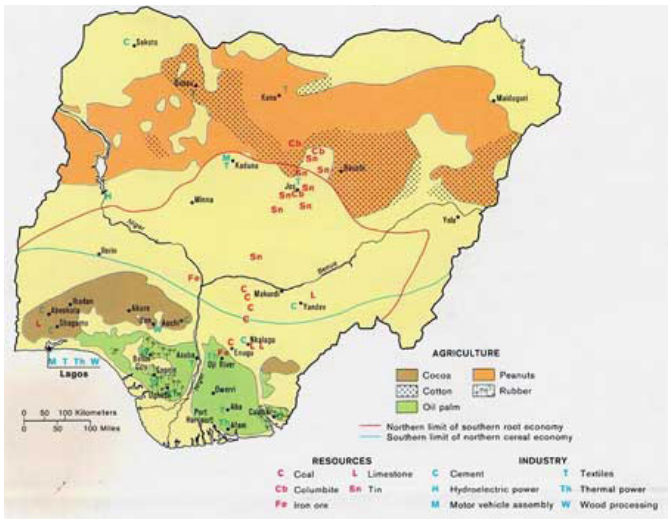


Figure 3. Economic activity

During the early 1970s Nigeria experienced growth rates of 8%–10% per annum, while the increase in agricultural production declined to around 4% per annum towards the end of the decade. The slow growth continued into the 1980s, with output rising by only 3.4% in 1981 and by 2.7% in 1982. The effects of drought and the government's austerity programme resulted in severe 9.4% fall in agricultural output in 1983. However, a succession of good harvests, higher producer prices, reductions in cereal imports and a resurgence of public and private investment in crop production resulted in a sharp recovery in production (FAO, 2001). Table 2 presents output of some major staple food crops from 1995–2004.

Food output showed the strongest growth, rising by 7% in 1984 and by an estimated 10% in 1985, while total agricultural output increased by 3.8%. Agriculture was the only sector to show any significant expansion in 1986, with an estimated increase in overall agricultural production of 2.1%. From 1981-94 the average annual growth of GDP was 2.3% compared to 4.6% for the earlier period 1970–80. Average growth from agriculture from 1980 to 1992 was estimated to be 3.6% and this compares favourably with an average of 1.7% for Sub-Saharan Africa. For the earlier period agricultural production in Nigeria declined by –0.1% (World Bank, 1993). Agriculture (including hunting, forestry and fishing) contributed 33.5% of GDP in 1993 and an estimated 63.7% of the labour force was employed in the sector in that year.

Agricultural output increased by an estimated 4.1% during 1993 compared to 1995 and 1996 with increases of 3.5 and 3.7%, respectively. The value of agricultural production constituted 38.7% of the nation's GDP. In spite of the continued satisfactory performance of the agricultural sector, it still fell

Table 2. Production statistics of some major staple foods (MT)

Staples	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Maize ('000)	6 931	5 667	5 254	5 127	5 476	4 107	4 620	4 934	5 150	5 150
Millet ('000)	5 563	5 881	5 902	5 956	5 960	6 105	5 530	6 100	6 100	6 100
Sorghum ('000)	6 997	7 084	7 297	7 516	7 520	7 711	7 081	7 704	8 100	8 100
Rice ('000)	2 920	3 122	3 268	3 275	3 277	3 298	2 752	3 192	4 952	4 952
Wheat ('000)	44	47	66	98	101	73	51	77	73	73
Cassava ('000)	31 404	31 418	32 050	32 695	32 697	32 010	32 586	34 476	33 379	33 379
Yam ('000)	22 818	23 201	23 972	24 768	25 873	26 201	26 374	26 849	27 000	27 000
Cocoyam ('000)	1 182	1 195	1 832	3 823	3 835	3 886	3 910	3 929	3 500	35 000
Sweet potato ('000)	1 168	1 478	1 493	1 560	2 451	2 468	2 473	2 503	2 150	2 150
Potato ('000)	95	99	103	107	573	599	599	629	600	600
Plantain ('000)	1 632	1 687	1 744	1 803	1 902	1 969	1 999	2 058	2 110	2 110
Other crops										
Groundnut ('000)	1 579	2 278	2 531	2 534	2 894	2 901	2 683	2 699	2 700	2 700
Soybeans ('000)	287	322	361	403	410	429	436	437	484	484
Melon ('000)	287	317	330	330	338	345	348	347	347	347
Tomatoes ('000)	569	569 100	650	810	879	879	879	889	889	889
Chilli/peppers ('000)	612	633	745	709	715	715	715	720	720	720
Onions ('000)	500	550	567	580	596	600	600	600	615	615
Pineapples ('000)	800	800	830	857	881	881	881	889	889	889
Mangoes ('000)	631	656	689	731	729	730	730	730	730	730
Papaya ('000)	648	662	675	751	748	748	748	755	755	755
Okra ('000)	630	650	612	638	719	719	719	730	730	730
Green corn ('000)	575	575	575	575	575	575	575	576	576	576
Carrots ('000)	198	203	210	225	231	231	231	235	235	235
Coconut ('000)	149	151	152	152	158	160	161	161	161	161
Kolanut ('000)	95	85	82	82	82	82	82	85	85	85
Cashew nut ('000)	95	110	125	152	176	184	185	186	186	186
Tobacco leaves ('000)	9 200	9 200	9 200	9 200	9 200	9 200	9 200	9 200	9 200	9 200

Source: FAOSTAT data 2005. (accessed June 26, 2005).

short of the 5.5% growth rate stipulated in the National Rolling Plan for 1997–1999 and to this date continued to decline because of lack of interest in farming by young people. The largely subsistence agricultural sector has failed to keep up with rapid population growth and Nigeria once a large net exporter of food, now must import food. According to 2004 estimate the value of agriculture production constituted 30.8%; industry, 43.8% and services 25.4%, of the nation's GDP, respectively. The nation's GDP real growth rate stood at 7.1% (CIA World Factbook, 2004).

Traditional smallholders, who use simple techniques of production and the bush-fallow system of cultivation, account for around two-thirds of Nigeria's total agricultural production. The number of state farms is relatively small, and of decreasing importance. Subsistence food crops (mainly sorghum, maize, taro, yams, cassava, rice and millet) are grown in the central and western areas of Nigeria, and are traded largely outside the cash economy. Cash crops (mainly palm kernels, cotton, cocoa, rubber and groundnuts) are grown in the east, west, mid-west and northern states of the country. It is estimated that Nigeria has about 71.2 million ha of available agricultural land and about half of which is currently being utilized. Increasing rainfall from the semi-arid north to the tropical rain forested south allows great crop diversity, from short season cereals, sorghum, millet and wheat in the north to cassava, yams and rice in the wetter areas. In the drier north cash crops include cotton, groundnuts and tobacco, while in the south cocoa, coffee rubber, oil palm, sugar and ginger are grown.

A steady growth has been observed in the agricultural production of both staple and cash crops since 1990 and the aggregate index of agricultural production increased by 4.1% in 1997 but declined in 1998. However, from 1999 all the major staples recorded significant increases over the proceeding years' level. The intensification of on-farm adaptive research by some relevant agencies, the supply of high quality seeds/seedlings and better usage of improved storage facilities contributed to the observed improvement in staple food production. Estimates of production output for principal staple crops in 2003 were maize (5.2 million tonnes), sorghum (8.0 million tonnes), millet (6.1 million tonnes) and rice (4.9 million tonnes). Others include cassava (33.5 million tonnes), yams (27.0 million tonnes), potatoes (6.0 million tonnes) and vegetables (9.1 million tonnes).

Table 3. Major cash crops production outputs (1 000 tonnes)

Crops	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Oil palm fruit ('000)	7 800	7 750	7 750	7 800	8 000	8 220	8 500	8 500	8 600	8 700
Palm kernels ('000)	543	548	545	545	562	577	579	608	610	610
Palm oil ('000)	860	776	810	845	896	899	903	908	910	910
Cocoa beans ('000)	203	323	318	370	225	338	340	340	361	366
Coffee	3 090	3 780	3 700	3 700	3 750	3 830	3 850	3 910	3 320	3 520
Rubber ('000)	125	130	120	120	107	107	108	112	142	142
Seed cotton ('000)	251	301	341	348	381	399	402	403	397	417
Cotton lint ('000)	95	116	130	135	145	147	148	150	140	140
Cotton seed ('000)	153	183	208	212	236	247	248	250	250	250
Sugar cane ('000)	589	615	675	675	682	695	705	747	739	776

Source: FAOSTAT data 2005. (accessed June 26, 2005)

Among the cash crops, only cocoa makes any significant contribution to exports. Nigeria was the world's fourth largest exporter of cocoa beans in 1990/91, with sales of 135 000 tonnes accounting for about 7.1% of world trade in this commodity. But Nigeria's share of the world cocoa market has been substantially reduced in recent years, owing to aging trees, low producer prices, black pod disease, smuggling and labour shortages. Recent emphasis has been placed on encouraging domestic cocoa-processing, to provide higher-value products for export. Table 3 presents major cash crops production outputs in Nigeria from 1995–2003. Nigeria was the world's leading exporter of palm oil, until overtaken by Malaysia in 1971. The production of oil palm products has increased somewhat since 2000 however the country is still heavily dependent on imports in order to satisfy domestic needs. Like other cash-crop sectors, output of palm products suffered from labour shortages, inefficient traditional harvesting methods, and lack of vital inputs and low levels of capital investment. However, a sharp reduction in imports and large-scale replanting resulted in a substantial increase in production during the mid-1980s. Trade liberalization and the exchange rate policies adopted in the 1980s have contributed to the improvement in palm oil production. Also there have been substantial investments in oil-milling facilities to produce vegetable oil for domestic use and since 2000 oil palm products continued to increase for the reasons stated above.

In 1990 Nigeria overtook Liberia as the largest rubber producer in Africa. Production rose from 60 000 tonnes in 1986 to 147 000 tonnes in 1990. It dropped to 125 000 tonnes in 1995 and 107 000 tonnes in 2000 but went up again in 2003 to 142 000 tonnes and remained at 142 000 in 2004. Benefits from a replanting programme in the eastern States, Edo and Delta states have yet to materialize, and local demand from tyre and footwear industries continues to outstrip domestic supply. A programme to increase output of rubber and palm kernels, with financial assistance from the World Bank, is being implemented. Also various state governments are encouraging farmers to increase rubber production by providing interested farmers with subsidies (FMEN, 2001). Compared to the previous years' production (1995–1997), cottonseed has continued to increase and some of the reasons for the increase were considerable public and private investment in the sector, as well as incentives for local textile companies and higher tariffs on imported cotton.

The supply of animal products has been declining over the past two decades, while demand has been increasing, as a result of increases in population and urbanization. Consequently, Nigeria has remained a net importer of livestock and livestock products. Restrictions placed on imports of animal products and foodstuffs in the 1980s coupled with the introduction of the Structural Adjustment Programme (SAP), which saw a massive devaluation of the Nigerian currency, initially reduced the imports of meat and dairy products. However, during the period 1995 to 1999, expenditure on the import of food and live animals (Table 4) continued to increase (FMEN, 2001).

Table 4. Importation of food and live animals from 1995 to 1999 (Nigerian naira (₦) × 10^6)

Item	1995	1996	1997	1998	1999
Food and live animals	88 349.9	75 954.6	100 640.3	102 165.1	103 489.9

Source: CBN (1999). US $ 1 = 129.51 Naira in May 2005

2. SOILS AND TOPOGRAPHY

Topography

The geology of Nigeria is dominated by igneous structures that form most of the highlands and hills. The rocks of the basement complex, mainly of igneous origin, are encountered in over 60% of the surface area. The landforms can simply be classified into highlands, plateaux, hills, plains and river valley systems. The landforms are more deeply dissected in the south than in the northern parts (Udo, 1970). Figure 4 presents dominant land classes while Figure 5 presents a simple relief map of Nigeria.

The topography of the country shows that Nigeria is highest along the eastern border and rises to a maximum of 2 040 m above sea level at Vogel Peak, south of the Benue river. The Jos plateau, that is located close to the centre of the country rises to 1 780 m at Sphere hill and 1 698 at Wadi Hill. The Plateau is also the watershed, from which streams flow to Lake Chad and the rivers Niger and Benue. The land declines steadily northward from the plateau and this area, known as the High Plains of Hausaland, is characterized by a broad expanse of level sandy plains, interspersed by rocky dome outcrops. To the south-west, across the Niger River similar relief is represented in the Yoruba highlands, where the rocky outcrops are surrounded by forest or tall grass and form the major watershed for rivers flowing northwards to the Niger and southwards to the sea.

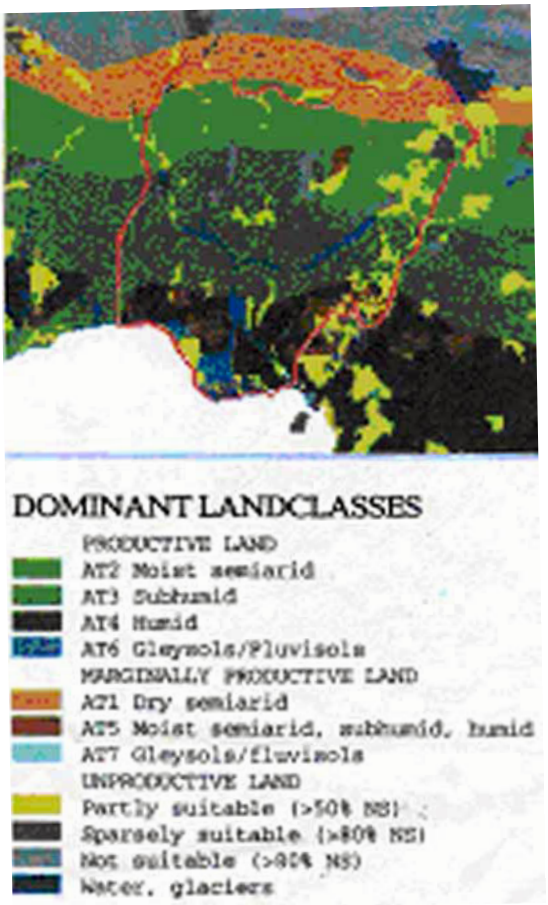


Figure 4: Map showing dominant land classes
Source: Agriculture: Towards 2010 – FAO, Rome 1993.

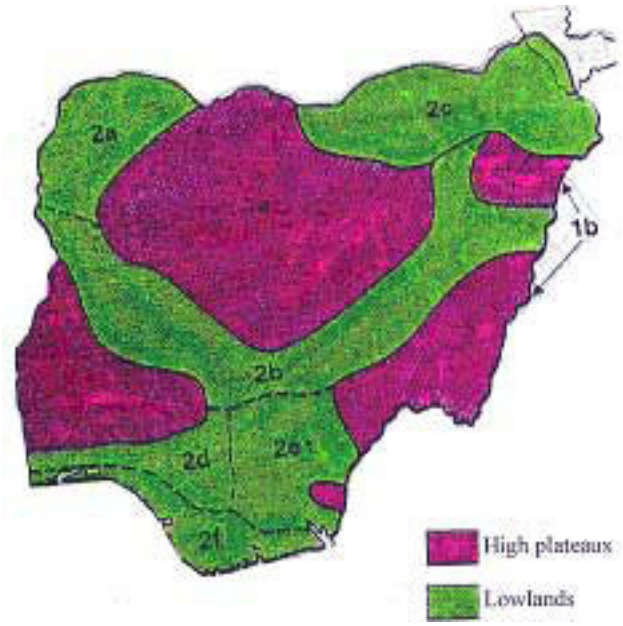
Elsewhere in the country, lowlands of less than 300 m stretch inland from the coast for over 250 km and continue in the trough-like basins of the Niger and Benue rivers. Lowland areas also exist in the Rima and Chad basins at the extreme north-west and north-east of the country respectively. These lowlands are dissected by innumerable streams and rivers flowing in broad sandy valleys.

The low-lying areas are generally below 300 m and these are found in the centre and the south (Iloeje, 2001). The Udi Plateau for instance attains a height of over 300 m, and this seems to break the monotony of the surface in the low lands.

Thus, Nigeria can be divided into:- (1) the high plateau; and (2) the lowlands (Iloeje, 2001) (Figure 6).

Figure 5: Map showing simple relief of Nigeria
Source:www:theodora.com/maps

(1) **The high plateaux**. The three tracks of the Niger-Benue river system cut across



1. *High Plateau*
a. The north Central Plateau
b. The Eastern and North-eastern highlands
c. The Western Uplands
2. Lowlands
a. The Sokoto Plains
b. The Niger/Benue trough
c. The Chad Basin.
d. The interior coastal lowlands of western Nigeria
e. The lowlands and scarplands of south-eastern Nigeria.
f. The coastlands

Figure 6: Map showing Relief zones of Nigeria
Source: http://www.sas.upenn.edu/African_Studies/Country_Specific/Nigeria.html)

the highland to form three blocks, i.e. the central Plateau in the north; the Eastern and North-Eastern highlands in the east; and the western Uplands in the west. It is important to highlight the fact that these highlands correspond roughly with the areas of volcanic rocks and uplifted areas of basement complex rocks. This goes to show that these areas were initially high and were able to resist erosion (Iloeje, 2001).

Based on the above description, the high plateau consists of:

(a) *The Northern Central plateau* – This plateau as the name suggests lies in the centre of northern Nigeria and covers nearly one-fifth of the area of the country. The surface is generally flat, but it is dotted here and there with some granite hills and ridges. The plateau is made up of two distinct platforms that lie at different levels: (i) the high plains of Hausaland forms the lower step. The average elevation stands at 750 m; (ii) the Jos plateau. Has a higher platform with an elevation of 1 500 to 1 800 m. It has a south-west steep scarp that overlooks the high plains from a height of about 1 600 m in the north-east, but falls to these plains rather gradually. The highest part is the Shere Hills north-east of Jos where the elevation exceeds 1 650 m above sea level (Iloeje, 2001).

(b) *The Eastern and North-eastern highlands* – These highlands consist of the Mandara Mountains (1 200 –1 500 m) and the Biu Plateau (600 – 900 m). The Mandara Mountains are a mass of basement complex exposure while the Biu Plateau is of basalt. In eastern Nigeria, the highlands are made up of two big granite spurs that are western prolongations of the Cameroon Mountains into the Cross River Plains (Iloeje, 2001). These spurs are the Obudu Plateau that stands at a height of over 1 200 m above the general level of the land and the Oban Hills with an average elevation of 1 200 m above sea level.

(c) *The Western uplands* – They cover an area of about half the size of the North Central Plateau. Most of the area lies between 300 to 600 m however the Idanre Hills, where the Plateau is highest are about 1 000 m above sea level (Iloeje, 2001).

(2) **The lowlands** lie mainly in the basins of the major rivers and fall roughly within the areas of sedimentary rocks lying in the basins of sedimentation.

(a) *The Sokoto plains* in the north-west – These extend over one twentieth of the area of Nigeria and have an average height of 150 m. They are monotonously flat. The main rivers that drain into this area are the Sokoto, Rima and Zamfara. They have flat-floored valleys that are flooded in the wet season only. The water recedes during the dry season and leaves a coating of alluvial soil behind. These seasonally flooded areas are called "fadamas" in Hausa (Iloeje, 2001).

(b) *The Niger/Benue* trough wrapping round the north-central plateau – This starts from the Sokoto plains in the North-west through Lokoja, and ends near Yola. The Niger/Benue trough is an

elongated bow-shaped lowland. It represents a previous arm of the sea, probably an extension of the Atlantic, into which sediments were deposited. Its surface generally lies below 300 m. It has been deeply disserted by erosion into tabular hills that are separated by gorge-like river valleys (Ileoje, 2001).

(c) *The Chad Basin* in the North-east extremity of the country – It consists of about one-tenth of Nigeria. It is a depressed basin composed of Territory rocks. It has an average elevation of about 45–60 m and is separated from the Benue valley by the Biu Plateau. Except for the sand dunes of the Hadejia, the surface is almost flat. These dunes are long narrow sand ridges of about 12–30 m high and 275–365 m wide and they vary in length between 800 m and 12 km. As a result of increased rainfall, they have been overgrown by vegetation and are thus fixed in their present position (Ileoje, 2001).

(d) *The interior coastal lowlands of Western Nigeria* – This area lies west of the Niger. Its boundary is marked in the north by the ridge of the basement complex of the western Highlands; in the South by Quaternary deposits of the coastal margin. Rocks found in this area are Secondary and Tertiary sedimentaries, which dip gently southwards. The South dipping surface has however, sunk to below 300 m and is cut into blocks by narrow parallel valleys cut by the north-south flowing rivers (Ileoje, 2001).

(e) *The lowlands and scarplands of South-eastern Nigeria* – The rocks in this area are made of sandstones, shales, clays and coal. With the exception of the coastal areas and the Eastern Highlands it covers the whole of the eastern section of Nigeria. This area is divided into three sub-units (i) The Cross Rive plains, east of Enugu; (ii) The Scarplands that lies west of the longitude of Enugu and (iii) The South-east Coastal Plains that are tertiary rocks and lie south of the Scarplands (Ileoje, 2001).

(f) *The Coastal Margins and swamps* that lie adjacent to the seas – These run along the coast from east to west in a strip of land below 30 m and are made up of recent deposits of sand, clays and mud. This area can be divided into two (i) the lagoon coast lies in the west where the strip is narrow. Sands predominate and sand-bars cut off east-west lagoons. The Lagos lagoon is partly made up of fresh water from the rivers and partly of sea-water stranded behind a sand-bar. (ii) The Niger Delta which consists mainly of muddy deposits pushed out by the Niger into a relatively tideless salt sea. The creeks and water channels of the coastland form important fishing grounds and provide highways in this marshy area (Ileoje, 2001).

Soils

Soil types in Nigeria are influenced by and follow very broadly, the climatic and vegetational zones of the country. This is expected because the degree of available moisture in the soil is an important factor in soil reactions and fertility and productivity. The soils of the humid tropical forests are quite different from those of the drier forests and the savannah zone, which in turn are different from the savannah zone (Oyenuga, 1967). The major soil types in Nigeria, according to FAO soil taxonomy legends are fluvisols, regosols, gleysols, acrisols, ferrasols, alisols, lixisols, cambisols, luvisols, nitosols, arenosols and vertisols. These soil types vary in their potential for agricultural use (Table 5).

None of the soils was rated as Class 1 with high productivity by the FAO. In-short over 48% of the Nigerian soils fall into class 4 and 5, which are mainly vertisols, alisols, acrisols, ferrasols and arensol. These soils usually have low productivity due to inadequate moisture retention capacity and low organic matter. Except for the ferrasols, they are the most dominant types found in the northern dry parts of the country.

The most systematic current information on Nigerian soils is based on the reconnaissance soil survey of the Nigeria project whose field-work was completed in 1985. The geology and geomorphological processes that shaped the landforms greatly influenced the soils.

Nigerian soils can be classified into groups made up of four (climatic) zones

Table 5. Productivity potential of Nigerian soils

Soil productivity grade	FAO Productivity Classes	Area	
		km²	% of total
High (1)		-	-
Good (2)	Fluvisols, Gleysols, Regosols	50.4	5.52
Medium (3)	Lixisols, Cambisols, Luvisols, Nitosols	423.6	46.45
Low (4)	Acrisols, Ferrasols, Alisols, Vertisols	289.2	31.72
Low (5)	Arenosols, Nitosols	148.8	16.32

Source: originally from FAO and reported in Adegbola, S.A. (1979). An Agricultural Atlas of Nigeria, Oxford, University Press, Oxford

that are soil associations. The groups are: (i) Northern zone of sandy soils (ii) Interior zone of laterite soils; (iii) Southern belt of forest soils; and (iv) zone of alluvial soils (Oyenuga, 1967; Iloeje, 2001) (Figure 7) and the soil types (classifications) are well distributed among the groups (Adegbola, 1979).

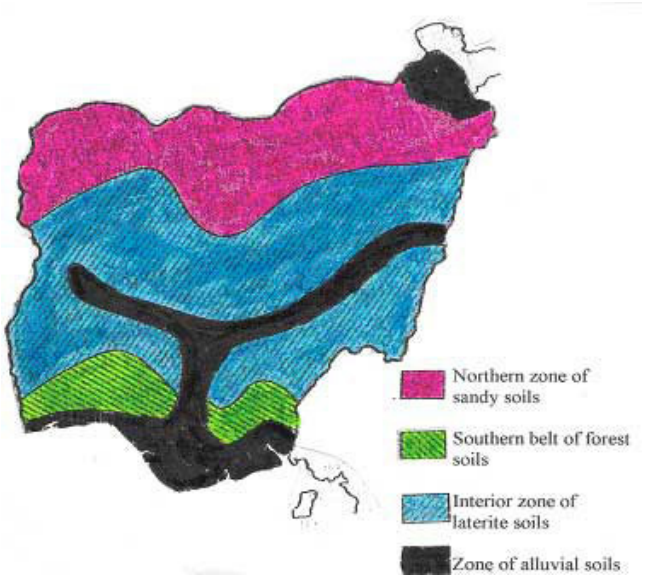


Figure 7. Map showing soil zones and types in Nigeria

(i) Northern zone of sandy soils: This area lies in the very northern parts of the country. In some areas like the Sahel savannah belt, the soils are true to type, being formed under aridity and by the deposition of sand by the wind. These soils might have been formed from wind-sorted desert sands that accumulated over long periods of time when the Sahara desert encroached several kilometres south of its present limits. The soils of this zone produce much of the groundnut crop, some of the sorghum, cowpeas and large quantities of millet. For instance in Kano, Northern Kaduna, Zamfara and Sokoto states they have fine sandy loam, friable and relatively easy to cultivate soils. The soil is little leached and therefore ideal for groundnut cultivation. Whereas in southern Kuduna is found a mixture of soils that disintegrated from local granite, and loess soils that were brought down by winds from the north. The soil is in fact not sandy. These soils are the Zaria loam that produces the largest yield of cotton in Nigeria.

(ii) Interior zone of laterite soils: This zone is made up of sands and clays. They are grey to black clays poorly drained and seasonally flooded forming the "fadama". Soil in this zone is deeply corroded, generally sticky and impervious to water and has low fertility. When the virgin forest on them is cleared it reduces the fertility further, thus making available soil of little agricultural value. When the soil is exposed to the surface, it become as hard as brick and for this reason, the soil here is most suitable for road paving and wall construction than for farming. However, not only laterite soils are found in this zone. The Biu Plateau has rich soil that is productive and offers prospects for the expansion of the areas of cotton production.

(iii) Southern belt of forest soils: Soils in this zone broadly represent those of the humid, tropical forest climate zones of the south where the wet season is long, the *harmattan* season short and forest cover is dense. Local soil types depend largely on parent rock. Where the underlying rocks are granite or clay, the soils is a rich clayey loam. The forest soils yield cocoa, oil palm, rubber and they are of considerable importance in Nigerian agriculture.

(iv) Zone of alluvial soils: These soils are found on the flooded plains of rivers or on deltas, or along the coastal flats. This zone extends from the coastal inland and runs along the valleys of the Niger and the Benue rivers, thus cutting across the vegetational zones. The soils found in this zone do not depend highly on climate and vegetation for their formation. The underlying parent rock is the most important factor in their formation. Soils in this zone are characteristic of fresh-water soil of grey to white sand, grey clay and sandy clay with humic topsoil. Another group consists of brownish to black saline mangrove soils, with a mat of rootlets.

Besides the above classification, Sobulo (1988) reported that Nigerian soils can also be broadly grouped into four major categories for management purposes and these groupings are:-

1. *Soils with a high base saturation under savannah vegetation* (*grassland*) – *Alfisols, Inceptisols, Vertisols, Cambisols.* These soils are formed from metamorphic, igneous rocks, volcanic and sedimentary parent materials. These parent rocks in return influence the chemical characteristics. These soils are found in the grain producing areas where water is not limiting and could be termed the Grain belt. The soils in the savannah grassland are generally low in organic matter,

total nitrogen, and available phosphorus. Soil management in this zone, would involve intensive cultivation provided suitable crop rotation or intercropping is practised.

2. *Soils with a high base saturation under forest vegetation* (Semi-arid tropics) – Alfisols, Inceptisols, Gleysols and Cambisols. The soils here have similar parent rock as (1), except for the high rainfall and therefore a higher organic matter. The nutrient status is very high, about twice or more. The length of cropping can be increased to two years before N and P fertilizer can be limiting. Trace elements are often not limiting on the soils in this zone. The soil in this zone can be easily eroded therefore nutrient losses through soil and water erosion is common. Good crop rotation and the use of mulch assist to control erosion.
3. *Soils under a low base saturation* (Humid tropical zone) – Oxisols and Ultisols under forest vegetation. This zone is confronted with multiple nutrient problems such as soil acidity, high exchangeable Al, very low exchangeable bases, and available micronutrients. Potassium, magnesium and phosphorus are often required to maintain yields but the soils have to be moderately limed to reduce Al toxicity. Crops that are used to low base saturation and low solar radiation such as upland rice, cassava, sweet potato, some grass and pasture legumes should be grown in this zone so as to achieve better utilization of the soil and inputs such as fertilizer.
4. *Soils in the semi-arid zone* – Inceptisols, Entisols and Andosols. Soils in this zone are derived from Aeolian sand and are often young soils (Entisols). Vertisols are sometimes found in this zone. The soils in general have a high base status and when saline, they can be reclaimed before use. If irrigation is used good crop yields are achievable.

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate

Nigeria, by virtue of its location, enjoys a warm tropical climate with relatively high temperatures throughout the year and two seasons – the rainy or wet season that lasts from mid- March – November in the South and from May to October in the north; and the dry season that occupies the rest of the year (Oyenuga, 1967). However, in a country like Nigeria, where the temperatures do not fluctuates regularly, constant elements such as relative humidity and rainfall are heavily relied on to differentiate between the season and climatic zones. The climate of the country is influenced by the interaction of two air masses:

(I) the relatively warm and moist tropical marine mass which originates over the Atlantic Ocean and is associated with Southwest winds in Nigeria, and
(II) the relatively cool, dry and relatively stable tropical continental air mass that originates from the Sahara Desert and is associated with the dry, cool and dusty North-East Trades (*harmattan*).

The seasonal pattern of the south differs from that of the north and the south has four seasons: (i) The long wet season that starts in mid-March and lasts till July is a season of heavy rains and high humidity. Plants and pasture are fresh and green, grasses and weeds grow rapidly and look attractive. This is the planting season. (ii) The short dry season. This is the August break and it starts from July to August and lasts for about one month. (iii) The short wet season. It follows the August break and lasts from September to October. During this period rainfall is not usually heavy compared to the first wet season and the total amount of rainfall is less; and (iv) The long dry or *harmattan* season which continues from November to mid-March. *Harmattan* mornings are usually cool and misty, however the mist disappears after sunrise. The afternoons are full of haze due to dust in the air brought by winds from the north. At this period of the year grasses die off and leaves of some trees turn brown and later fall (Oyenuga, 1967; Ileoje, 2001).

In the north, the long dry season starts earlier and ends later. Here there is nothing like the August break, therefore the two wet seasons become one. Therefore two seasons are prominent – a long dry season that spans from October to April, and a wet season for the remaining five months. (i) The long dry season: there is lack of rainfall and the dry conditions that prevail cause cracks to develop on clay soils. However, this season is welcomed because the nights are cool and the afternoon haze helps to wade off the sun's heat; and (ii) the wet season that is ushered in by frequent storms. This is the planting season in the north.

Rainfall varies from place to place and from season to season. In the wet season, the full effect of the tropical maritime air mass is the main reason that brings rainfall, while in the dry season the rainfall is less. The total annual rainfall decreases from the south to the north. The southern two-thirds of the country have double peak rainfall while the northern third has a single peak. Seasonal distribution and annual rainfall for selected towns are presented in Figure 8 and Table 6, respectively. For example Brass has 379 cm, Jos 143 cm, Sokoto 71 cm, and Maiduguri 63 cm (Iloeje, 2001).

July is the middle of the wet season and the relative humidity is usually high because of the warm wet air that prevails. The humidity is over 80% in the South and never goes below 60% in the north. Over 80% of the rains fall within the wet months of April – September. In the South the figure is above 70% and in the north nearly 100% of the rains are during these months (Table 6).

Temperature also varies from place to place and from season to season. It has been observed that there are considerable contrasts between the coastal areas and the interior, as well as between the high plateau and the lowlands. On the plateau, the mean annual temperature varies between 21 ^{0}C and 27 ^{0}C. In the Jos area, temperatures are between 20 ^{0}C and 25 ^{0}C. On the lowlands such as the Sokoto Plains, the Chad Basin and the Niger-Benue lowlands, the mean annual temperature is 27 ^{0}C. The coastal fringes have lower means than the interior. It appears therefore that altitude and proximity to the seas determine to a large extent the distribution of temperature in Nigeria. Generally, temperatures are high throughout the year because Nigeria lies within the tropics and the mean monthly figure could go above 27 ^{0}C, while daily maximum temperatures can go between beyond 35 ^{0}C – 38 ^{0}C depending on the location (Iloeje, 2001).

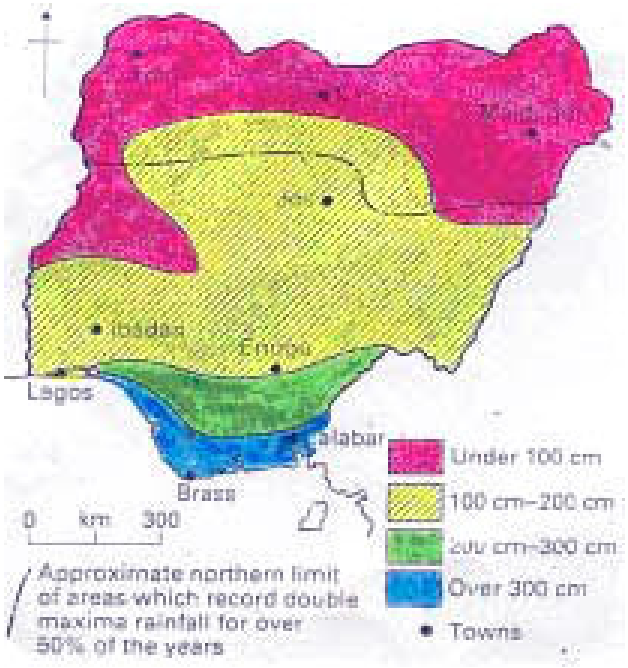


Figure 8. Total annual rainfall

Table 6. Seasonal distribution of rainfall in selected towns in Nigeria (North to South)

Towns	Lat. N	April–September		October–March	
		Amount	% of rainfall	Amount	% of rainfall
Maiduguri	11o 51'	63.3 cm	100	0.0 cm	0
Jos	9o 52'	135.1 cm	96	7.9 cm	4
Enugu	6o 27'	141.2 cm	78	39.9 cm	22
Brass	4o 19'	270.5 cm	71	108.4 cm	29

Source : Iloeje, N.P. (2001).

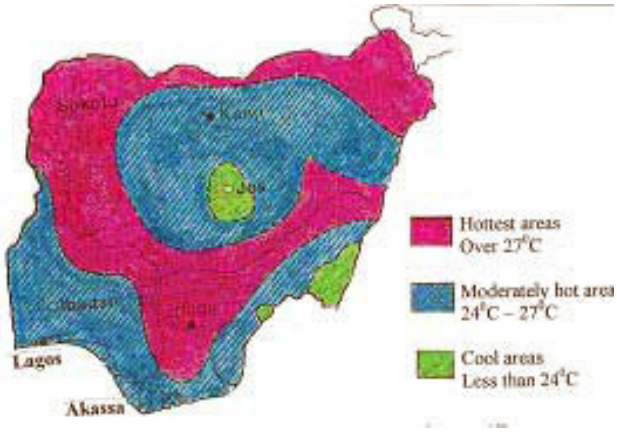


Figure 9. Mean annual temperature distribution

Figure 9 presents mean annual temperature distribution.

In general while there is hardly any dry season in the extreme southern tip of the country, the wet season hardly lasts for more than three months in the north-eastern part. Similarly annual rainfall totals range from 2 500 mm in the south to less than 400 mm in parts of the extreme north (FMEN, 2001).

Agro-ecological zones

A number of classifications of Nigerian vegetation have been published since the 1950s. The development of categories reflects changing perceptions of the significance and value of such

classifications**.** Combined effects of temperature, humidity and rainfall, and particularly, the variations that occur in the rainfall that govern the natural vegetation zones exerts a major influence on the types of indigenous plants that grow or the exotic types that can be introduced successfully into the country. Oyenuga (1967) reported that the humid, tropical forest zone of the south that has longer rains is capable of supporting a number of plantation crops such as cocoa, oil palm, rubber, coffee, cotton and staple crops like, yam, cassava, cocoyam, sweet potatoes, melon, groundnut, rice maize and cowpeas. However, in some parts of the east and many areas near the coast, the high rainfall has led to badly leached soils and severe erosion in some places.

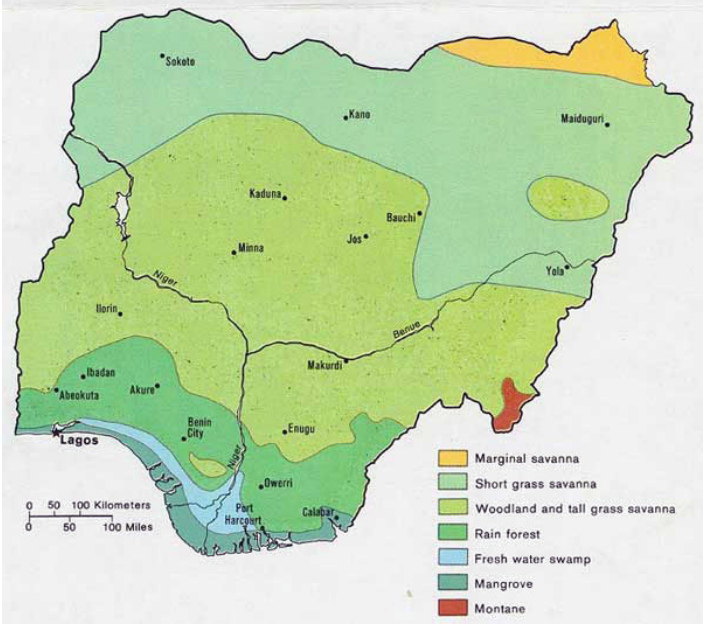


Figure 10. Vegetation zones of Nigeria

The North with its lower rainfall and shorter rainy season consists of savannah land, and this represents 80% of the vegetation zones of the country. The savannah land forms an excellent natural habitat for a large number of grazing livestock such as cattle, goats, sheep, horses, camels, and donkeys.

The natural vegetation zones resulted from the interaction of the climate, humidity and rainfall (Oyenuga, 1967), and soils (Iloeje, 2001). These factors have been modified by human activities and man's pattern of land use (Oyenuga 1967; Iloeje, 2001). Based on the above, Oyenuga (1967) classified Nigeria into nine (9) agro-ecological zones viz:- (i) The mangrove forest and coastal vegetation, (ii) the freshwater swamp communities, (iii) the tropical high forest zone, (iv) the derived Guinea savannah with relict forest, (v) the Southern Guinea savannah zone, (vi) The northern Guinea savannah zone, (vii) The Jos plateau, (viii) The Sudan savannah, and (ix) The Sahel savannah. However, Iloeje, (2001) grouped the country into (A) forests and (B) savannah zones. These two major zones were further sub-divided into three zones each such as (A) Forests that consist of (i) salt-water swamp, (ii) fresh-water swamp, (iii) high forest; and (B) Savannah zone that consist of (i) guinea savannah (ii) Sudan savannah, and (iii) Sahel savannah (Figure 10).

The mangrove forest and coastal vegetation: This occupies the coastal areas and consists of tidal swamps, interspersed with numerous creeks and lagoons. The mangrove swamp is noted for the mangrove species of trees (*Rhizophora*) that dominate the swamp and to a much less extent by *Conocarpus erectus* and *Laguncularia racemosa* (white mangrove). Among the *Rhizophora* spp. *Rhizophora racemosa* dominates, occupying an estimated 99% of the entire mangrove area. The coastal swamp area is not widely cultivated except for swamp rice in places where they are stabilized and non-saline.

The freshwater swamp communities: This area which originally occupied 18 130 km^2 lies immediately inland of the mangrove swamp but on a slightly higher ground. The lagoons or the rivers that overflow their banks in the wet season supply it with fresh water because the area is low lying, therefore it is flooded with rain water and lies under rain for sometimes eight or nine months of the year. The periodical flooding experienced gradually deposits new layers of alluvial soils on the surface of the land, a deposit that leads to the formation of more solid ground behind the swamp, where we find the beginning of the rain forest. This zone consists of a mixture of trees. Important among the vegetation of this zone are the various palm and fibre plants such as *Raphia* spp., *Raphia vinifera*, the wine palm and *Raphia hookeri*, the roof-mat palm. They are used for thatching mats and for providing rafter, poles and stiff piassava fibre for the production of brooms. Leaves of the pandanus palm (*Pandanus candelabrum*) are used for

preparing sleeping mats and baskets. Fishing and fibre-making are the important products of the fresh-water swamp community.

The tropical high forest zone: This zone is the major source of timber for all large constructional and cabinet making timber. Of all the zones it contains the most valuable species of vegetation. However due to human activities, this one-time forested area has been drastically reduced. Bush fallows, villages and farms are found scattered throughout the zone. Presently the drier end of its inland side is becoming reduced to derived guinea savannah because of felling and clearings. In the humid rain forest are found economic cash crops such as oil palm, (*Elaeis guineensis*), cocoa (*Theobroma cacao*), Rubber (*Hevea brasiliensis*) banana/plantain (*Musa* spp.) and cola nut (*Cola nitida*). Also found are some principal staple food crops such as yam, cocoyams, sweet potato, maize, rice, groundnut, cowpeas and beans as well as a number of fruits. This zone is also good for sylviculture. A number of timber trees such as the African mahogany (*Khaya ivorensis* and *K. grandifoliola*), the scented sapele wood (*Entandrophragma cylindricum*) and iroko (*Chlorophora excelsa*) to mention but three are found in this zone. This zone therefore is very important in terms of food production and timber for construction and cabinet making (Oyenuga, 1967).

The derived Guinea savannah with relict forest: This was originally the drier part of the high forest. Due to bush burning and overgrazing, cultivation and hunting activities over a long period in the zone, the high forest trees were destroyed and the forest that used to exist is now replaced with a mixture of grasses and scattered trees. However, along the streams and in wet low-lying areas were surface water accumulates there are still some traces of forests. The Guinea savannah is characterized by grasses such as *Pennisetum*, *Andropogon*, *Panicum*, *Chloris*, *Hyparrhenia*, *Paspalum* and *Melinis*. These tall grasses are characteristic of the Guinea savannah proper.

The Guinea Savannah: This zone consists of the larger part of the savannah zone and is sometimes divided into the southern Guinea savannah and northern Guinea savannah. It is the broadest vegetation zone in the country and it occupies almost half of its area. It is located in the middle of the country, extends southwards to southern Nigeria and pushes northward beyond Zaria (Figure 10). It covers an area that has 100–150 cm of annual rainfall and where the wet season lasts for 6–8 months. The false balsam Copaiba (*Daniellia oliveri*), used for carving mortars and pestles for pounding yam, *Terminalia, Lophira, Afzeila, Daniellia* and *Vitex, Khaya senegalensis* (the poor mahogany) are the species found in the southern Guinea savannah. In the northern guinea savannah species such as *Isoberlinia doka* and *I. tomentosa* form the bulk of the scattered woodland. Also found are locust bean tree (*Parkia filicoidea*), shea butter tree (*Butyrospermum parkii*) and mangoes (*Mangifera indica*). Comparatively, there are fewer trees in the northern Guinea savannah than in the southern Guinea savannah and the trees are not as tall as those found in the southern Guinea savannah. Most of the tall grasses found in the derived Guinea savannah, are also found in the Guinea savannah, however, they are less luxuriant. The appearance of this zone differs from season to season. During the rainy season, the whole zone is green and covered with tall grasses that grow and reach maturity rapidly and thus become fibrous and tough. In the dry season they tend to die and disappear and one can see for kilometres. This clearing is due to several periodical bush-burning that occurs during the dry season between November and April, carried out to either assist in farm clearance or hunting.

The Sudan savannah: This zone is chiefly associated with groundnuts, sorghum and millet cultivation. Grasses found in this zone are not generally as tall, coarse or thick on the ground as those found in the Guinea savannah zone. Here there is continuous grass cover of the short and feathery grasses on a large scale. The grass vegetation is interspersed with farms and thick bush trees such as shea butter tree (*Butyrospermum parkii*) and *Acacia albida*. The genus Acacia and *Combretum*, especially *Combretum micranthum* are well represented and prolific in the Sudan savannah zone. Also found in the zone are locust bean tree (*Parkia filicoidea*), tamarind tree (*Tamarindus indica*) and mango (*Mangifera indica*). A large portion of this zone falls within the tsetse fly free belt of West Africa and it is excellent for the rearing and breeding of ruminant livestock (cattle, goats, sheep, donkeys, horses and camels). The nomadic Fulani roam about this zone in search of fodder and water for their livestock.

The Sahel savannah: Occupies about 18 130 km^2 of the extreme northeast corner of Nigeria and is the last vegetation zone of the savannah type between the Sahara and the northern frontier of the Sudan savannah (Figure 10). The annual rainfall is low and the rainy season lasts between three to four months. Here the vegetation is not only sparse but the grasses are very short. This zone is characterized by plants such as *Cenchrus biflorus*, and *Acacia raddiana.* The shrubs that are predominantly scattered in the zone are African myrrh (*Commiphora africana*) and *Leptadenia spartum*. As a rule this zone is not cultivated without irrigation. The people found in this zone are the nomadic herdsmen, and they are careful not to burn the grass found because sparse as it is it provides the only pasture available for their grazing livestock.

Montane vegetation: There is no true montane type vegetation in Nigeria, but slight variations in the prevailing plant cover introduced by relief. For instance the Jos plateau, the Bauchi Highland and the Adamawa Plateau lie in the guinea savannah zone, however, the grasses found on these highlands are shorter and the trees are fewer than at lower level. The Fulani who live in great numbers in the area turn the available fields into good pasture for their grazing animals. Figure 11 presents photographs from some agro-ecological zones.

The main constraints on feed resources in all the zones are the destruction of perennial tree cover for firewood, bush fires caused by hunters; livestock rearers and overgrazing. These man-made constraints often lead to serious degradation of the pastoral resources and in some cases to an irreversible process of desertification, especially in the Sahel zone. The sub-humid zone (SHZ) has a high potential for ruminant production because of high rainfall and vast land area for forage production. However, the SHZ contains only 19.59% of the total national livestock (Otchere and Nuru 1988). This low percentage of total livestock unit in the Nigerian SHZ is attributed partly to tsetse infestation and high humidity.

Guinea savannah towards the end of the rainy season

Cattle rearing in Nigeria

Guinea savannah view just after the first rain

Rainforest from the air in Delta/Edo States

Market gardening on the Jos Plateau

Village settlement on the Jos Plateau

Figure 11: Photographs from some agro-ecological zones
(Source: Ileoje, 2001)

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Main production systems

Ruminants have a greater effect on ecosystems than other animal species. In Nigeria ruminant livestock are numerous and provide substantial quantities of animal protein. However, their production is based on age-old husbandry systems, which need to be gradually modified in order to meet the needs of consumers. In Nigeria, cattle, goats and sheep production systems are predominantly traditional or village systems; nomadic or pastoral systems; mixed farming and the peri-urban and modern ruminant livestock husbandry. In general production and management systems vary from free range in less populated areas to year round confinement and cut and carry feeding of grass and browse in densely populated areas.

Traditional or extensive or village systems

Traditionally managed stock is over 85% for all species (Tewe and Bokanga, 2001) and ruminant livestock under the extensive system rely on natural grass and forage legumes for subsistence. The traditional production systems include scavenging, cut-and-carry production systems; seasonal tethering, fattening and compound dairying. In short the livestock sub-sector is dominated by traditional systems of production, processing and marketing.

Scavenging: It is the most extreme low-input management system used by most subsistence farmers. The animals are allowed to roam freely in the villages and their environs, scavenging food scraps and crop residues. There is no notice taken of mating, pregnancy, disease or anything of relevance to the survival of the animal. In short these animals are not subjected to any routine management practices. The subsistence farmer keeps them on a side line operation to his crops and also as a hobby.

Cut-and-carry method/Seasonal tethering: As the population increased the extensive grazing systems are now becoming disruptive to crop production and new by-laws in the 1970s required that animals be tethered and fed by the cut-and carry method. Under this system the farmer houses his stock by seasonal tethering of individual animals in the compound or in areas where forages are available. These forages are harvested and fed to them. This system is carried out where the farmer has insufficient land and there are strict village laws against scavenging. The number of animals is usually small. For example among the Gbari south west of Kaduna, Bunaji cattle are bought from pastoralists and then stocked out throughout the dry season in systematic rotation so as manure to the fields in preparation for the coming wet season. Near Badagry, a similar system is used with Keteku to manure coconut plantations. This system is often used in conjunction with fattening for seasonal markets and the system is very common in most areas in southern Nigeria.

Fattening: Due to seasonal fluctuation in the availability of forage, most farmers buy animals from the north and build shelters in the village where the animals are stall fed throughout the year. The animals may be fattened for a short period of six months to take advantage of seasonal variations in stock prices. This system is promoted by government agencies in preparation for festive seasons.

Compound dairying: In this system milking animals are kept in the compound to supply the family with liquid milk while the excess is processed into other dairy products. This system has long been practiced among the Hausas and was first described in Kano in the nineteenth century. The transhumant Fulani pastoralists who generally take away most of their herd in the dry season will leave some animals in the homesteads to supply milk to their family. These animals are either stall-fed or grazed close to the compounds in the day and confined in the night.

Nomadic or pastoral systems

The traditional grazing pattern is that at the end of the dry season the animals are either near permanent villages feeding on dry forage and browse or far enough south to find range and water but not so far as to encounter the tsetse fly. The migration north begins and continues as long as the grass ahead is as green

as the pastures at hand. When the northernmost grass and water are consumed (usually in November or December), there is a slow movement southwards to the home range, where there should be crop stubble and a full growth of grass to carry the animals through the dry season (Clyburn 1974). Traditionally, the different clans or ethnic groups usually have their respective grazing areas, and, depending on their environment, they also tend to specialize in certain animals. For example, the Fulani in northern Nigeria are known for their cattle, while the Tuareg, who live north of the Fulani, rely more on camels. In times of drought all the herders tend to shift further south than usual.

Herding is a monumental task for the Fulani who are always trying to get the best grazing condition for their animals. Contrary to popular belief, moving with animals is not the delight of the pastoralists. The migrant Fulani in Nigeria move because they have no choice (Otchere *et al*., 1985). A survey (Iro, undated) reported that three-quarters of the mobile Fulani indicated that herding is not only toilsome, it is becoming more strenuous. Nevertheless, about ten percent of the Fulani, mostly those who are near dams and grazing reserves, say herding is becoming easier. Ninety-seven percent, including those who say herding is becoming less laborious, prefer raising animals within the precinct of the homestead. In general terms the pastoral systems practiced by the Fulani herders fall into three groups – Exclusively pastoralists; transhumant pastoralists and agro-pastoralists.

Exclusive pastoralists: These are mainly livestock producers who do not grow crops and therefore depend on the sales of live animals and dairy products to buy grains, other food items and other necessities. Most pastoralists under this system may move very long distances every year. It is a popular assumption that they wander from place to place without any logic; in general they have set migration routes and often long-standing arrangements with farmers to make use of their crop residues. It is only when there is drought, a failure of the pasture or the spread of diseases that they diverge from their existing patterns. The pastoralists in the Niger-Benue valley migrate very short distances between the wet and dry seasons. They use the same grazing areas and routes each year with the thatching on houses at each location repaired annually. Most of the pastoralists spend the dry season in the River Niger floodplains and only move to higher grounds before the flood rises during the rains.

***Transhumant pastoralists*:** Transhumance pastoralists in the drier north of the country rear a very high proportion of the cattle herd and many sheep and goats. Pastoralists under this production system have permanent homestead and base. Their animals depend on the natural forage legumes and grasses for subsistence but these are usually unavailable in the dry season. They move in response to seasonal changes in the quality of grazing and the tsetse fly challenges. The travelling unit is normally made of a common herd owned by close male relatives, father and son. Grain and other basic needs are purchased from sale proceeds of live animals (surplus male sheep, goats and cattle) by the men or selling of milk and other dairy products by the women in the local markets. They grow crops mainly for domestic use rather than for the market. The male folk take away the majority of the herd in search of grazing, however they leave older members of the community with the nucleus of lactating women. They return in the wet season to assist with crop cultivation. They do not have traditional grazing rights and often move to the south during the dry season to fatten their animals for sale (Aregheore, 2001). The animals move from their arid home range to the wetter southern parts where vegetation remains green and suitable for grazing.

Agro-pastoralists: These are semi-settled pastoralists and they are found in many parts of northern Nigeria. They cultivate areas sufficient to feed their families from their own cereal production. In Bornu most pastoralists fall into this category. They hold land rights, use their own or hired labour to cultivate land and grow crops such as yams and cassava in addition to the staple cereals such as sorghum, millet and maize. In the system, the average herd of cattle is small compared to other pastoral systems, because they no longer rely solely on cattle and the finite grazing area around their environs that can be reached in a day will limit herd size. Most pastoralists in this system have preferences for particular breeds.

Mixed farming (integrated crop/livestock)

This is a system conducted by households or enterprises where crop cultivation and livestock rearing are more or less integrated components of a single farming system. Increasing urbanization in Nigeria

is cause for alarm, however if this is coupled with income growth it will provide a growing market for livestock products for rural as well as peri-urban farmers. Mixed farming exists in many forms depending on external and internal factors. External factors are weather patterns, market prices, political stability, technological developments, etc. Internal factors relate to local soil characteristics, composition of the family and farmers' ingenuity. Even pastoralists practise a form of mixed farming since their livelihood depends on the management of different feed resources and animal species. For example, sedentary Fulani in Futh and the Mambilia plateau in Adamawa practice mixed farming. Furthermore, arable farming peoples like the Kanuri, Hausa, Borgu, Waja, Kibba, Chamba, Kaka and Mambilla often rear cattle and other animals and produce their own manure. With the rapid changes now taking place ethnic groups which were traditionally arable farmers are ready to acquire cattle and pastoralists are increasing their arable farming.

Mixed farming is one of the more subtle qualitative changes that have taken place within local systems of Agriculture in Nigeria (Bourn, *et al.,* 1994). For example, the marked reduction in pastoral nomads; the widespread sedentarisation of pastoralists and their adoption of crop cultivation in addition to keeping livestock; the uptake of animal husbandry and fattening of livestock by arable farmers; and the utilization of crop residues by livestock farmers in exchange for dairy products and/or manure (Van Raay, 1975; Bourn, *et al.,* 1994) are all indicative of a progressive and widespread trend towards mixed farming (FAO, 1983; and McIntyre *et al.,* 1992). Mixed farming is firmly established in Nigeria as a production system and the further integration of livestock production within local farming systems will definitely become one of the major strategic goals of livestock development in Nigeria (Bourn, *et al*., 1994). Mixed farming is practiced in almost all agro-ecological zones of Nigeria; from rainforests to the arid North. The principal objectives of this system are three fold: (i) complementary benefit from an optimum mixture of crops and livestock; (ii) Spreading income and risks over both crops and livestock production, and (iii) scope to adjust crop/livestock ratio to social and economic needs and opportunities. Most retirees from government services embrace mixed farming and the interest is growing because it uses space more efficiently and spreads risks more uniformly. This process is now firmly established in Nigeria and the further integration of livestock production with local farming systems is destined to become one of the major strategic goals of livestock development.

Peri-urban and modern ruminant livestock husbandry

This system could be referred to as the commercial or intensive production system. Wealthy urban businessmen, wealthy Fulani and government officials practice this system. These types of farms which were found only on the periphery of major towns in northern and central Nigeria are also found today in the south of the country. The rich individuals who own these farms capitalize on the potential of animals as investment, source of milk and meat for their family and also a status symbol. In this system, a farmer may decide to have only cattle or cattle with small ruminants inclusive. Trained personnel are hired and expected routine management practices carried out in most modern ranching operations are also seen in these farmers. In this type of intensive production system the use of crop residues and agricultural by-products are effectively and economically combined with grazing

Ruminant livestock

Livestock play a very important role in Nigerian agriculture contributing about 12.7% of the total agricultural GDP (CBN 1999). Nigeria is one of the four leading livestock producers in Sub-Sahara. In 1990 the livestock population comprised about 14 million cattle, 23 million goats and 13 million sheep (RIM 1990) however these figures have since increased to 15.2 million cattle, 28 million goats and 23 million sheep (see Table 7a, FAO, 2006). Other ruminant livestock species of economic importance are asses, horses and camels. Accurate statistics on livestock production and marketing are not easy to obtain and therefore, detailed projections of the supply and demand of the livestock sub-sector may be estimates (Table 7a); however data for meat and milk production, live animal imports and milk/milk product imports are given in Table 7b (from FAO database, 2006). It is noted that, while beef and veal, goat and game meat production have gradually increased over this period, the production of sheep meat has doubled from 1995 to 2004. Large numbers of live cattle, sheep and goats are imported as well as various milk products (to a value of US$ 250 M in 2003).

Table 7a. Data on ruminant livestock population

Livestock species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle ('000)	15 050	15 073	15 088	15 103	15 118	15 133	15 149	15 164	15 200	15 200
Goats ('000)	25 000	25 500	25 500	26 000	26 500	26 500	27 000	27 000	28 000	28 000
Sheep ('000)	14 000	19 500	20 000	20 500	21 000	21 500	22 000	22 500	23 000	23 000
Asses ('000)	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 050	1 050
Horses ('000)	204	204	204	204	204	205	205	205	206	206
Camels	19 105	18 000	18 000	18 000	18 000	18 000	18 000	18 000	18 000	18 000

Source: FAOSTAT data 2006. (accessed August 18th, 2006).

Table 7b. Nigeria statistics for meat and milk production, live animal and milk imports for the period 1996-2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004*	2005
Beef and veal prod. (,000 mt.)	280.0	294.0	297.0	298.0	279.0	279.0	279.5	279.5	280.0	280.0
Sheep meat prod. (,000 mt)	62.4	87.0	89.2	91.4	94.6	94.3	96.8	99.0	100.7	100.7
Goat meat prod. (,000 mt.)	127.0	133.4	133.4	137.2	139.5	139.7	142.2	142.2	147.1	147.1
Game meat prod. (,000 mt)	100.0	100.0	100.0	100.0	120.0	120.0	120.0	120.0	120.0	120.0
Total milk prod. (,000 mt.)	380.0	350.0	367.5	385.9	408.0	432.0	432.0	432.0	432.0	432.0
Live cattle imports nos. (,000)	340.0	350.0	300.0	280.0	320.0	380.0	465.0	425.0	420.0	n.r.
Live sheep imports nos. (,000)	300.0	300.0	270.0	230.0	350.0	426.5	347.0	200.0	200.0	n.r.
Live goat imports nos. (,000)	350.0	372.2	330.0	260.0	420.0	684.7	515.9	300.0	350.0	n.r.
Milk equiv. imports (,000 mt)	100.9	127.5	183.5	211.3	427.8	464.8	482.3	671.9	739.1	n.r.

Source: FAOSTAT 2006; n.r. no record
**Other meat production in 2004: chicken meat 211 000 tonnes.*

Cattle

Cattle are found throughout Nigeria but are commonest in the northern two-thirds of the country. Seasonal transhumance does take place but to a limited extent. Almost half the total cattle population is permanently resident in the sub-humid zone. Humped zebu breeds (including White Fulani, Sokoto Gudali, Red Bororo) are by far the commonest, but limited numbers of Keteku, Muturu and Kuri cattle occur in the south-western, southern and north-eastern parts of the country, respectively. Zebu breeds in Nigeria are mostly dual-purpose reared for both milk and meat, while N'Dama, Keteku and Muturu are strictly beef animals.

Figure 12 presents the seasonal relationship between cattle distribution and cultivated land in the Nigerian Sub-humid zone, while Table 8 shows the estimated intensity of land cultivation in the sub-humid zone of Nigeria in relation to the cattle population it can support. These gave projections of how many cattle the zone could support if any particular intensity of cultivation becomes typical. The projections peak when about 40% of the land is under cultivation, but even at 70%, if this intensity could be achieved, this zone in Nigeria could still support the 3.5 million head of cattle it is reported to be supporting at present (Milligan, 1982). These projections are based on cropping and livestock husbandry practices.

Figure 13 presents cattle distribution in both wet and rainy seasons. About 80% of the cattle, mainly the Zebu type, are concentrated in the savannah zones while the remaining 20% are found elsewhere and 10% of them in the South. Those cattle that naturally have habitats in the south are mainly members of the hump less breeds (beef cattle). The unequal distribution of cattle is due to geographical factors.

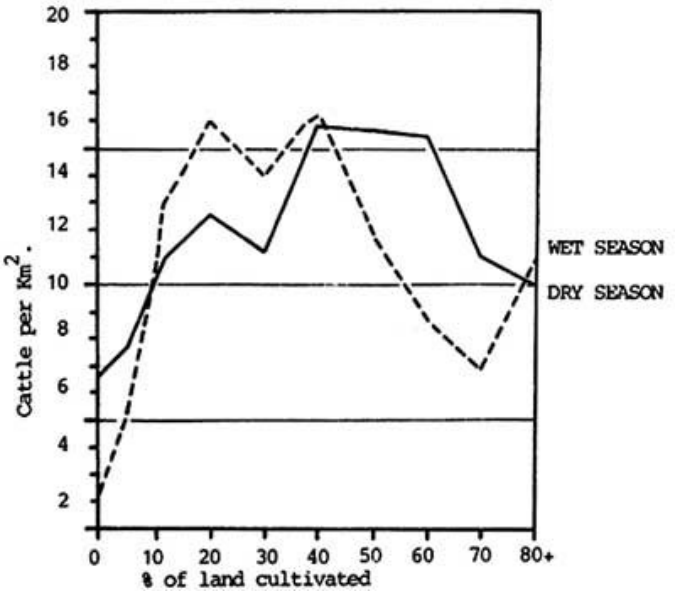


Figure 12. The seasonal relationship between cattle distribution and cultivated land in the Nigerian sub-humid zone
Source: Milligan, 1983

Beef cattle

Beef production in Nigeria is almost entirely extensive with low inputs. The traditional nomadic system of production results in low productivity due to poor nutrition. Animals receive the major part of their feed from overgrazed grasslands of poor quality (Olayiwole *et al.,* 1981). These pastures are declining due to agricultural development and other land uses. Although the traditional system of beef production is low yielding, it has over the years met the major demand for beef in Nigeria.

Intensive fattening of young cattle in which the edible carcass yield is increased by 30–40% during a short period of fattening seems to offer a means of increasing productivity rapidly. Intensive beef fattening plays a significant role in situations where range cattle are so undernourished and lean that a short period on a high plane of nutrition is necessary to increase their productivity and prepare them for the market (Olayiwole *et al.,* 1981; Aregheore, 2001). Except for the report of Olayiwole, *et al*. (1981) data on commercial feedlot operations in Nigeria are scant. Olayiwole *et al.* (1975) and Olayiwole *et al.* (1981) indicated that feedlot fattening was highly profitable, however the situation is a complex one because it is influenced by several factors such as purchase price of cattle and their condition, availability of feed and costs, marketing and marketing price of finished products.

Table 8. Approximate extent of various intensities of agricultural land use, present and projected cattle numbers at stocking rates typical for different levels of cultivation intensity in sub-humid zone of Nigeria

Land cultivated %	Land area		Present cattle nos.		Projected cattle nos.	
	km² ('000)	%	Dry	Wet	Dry	Wet
			(`000)		(`000)	
0 – 9	136	38	955	546	2 258	1 426
10 – 19	76	21	857	955	3 993	4 456
20 – 29	38	11	478	611	4 546	5 704
30 – 39	26	7	290	360	4 028	4 991
40 – 49	26	7	406	411	5 633	5 704
50 – 59	20	6	311	238	5 597	4 278
60 – 69	17	5	265	154	5 526	3 209
70 – 79	17	5	180	158	3 743	3 298
Total	356	100	3 742	3 433	35 324	33 066

Source: Milligan, 1983.

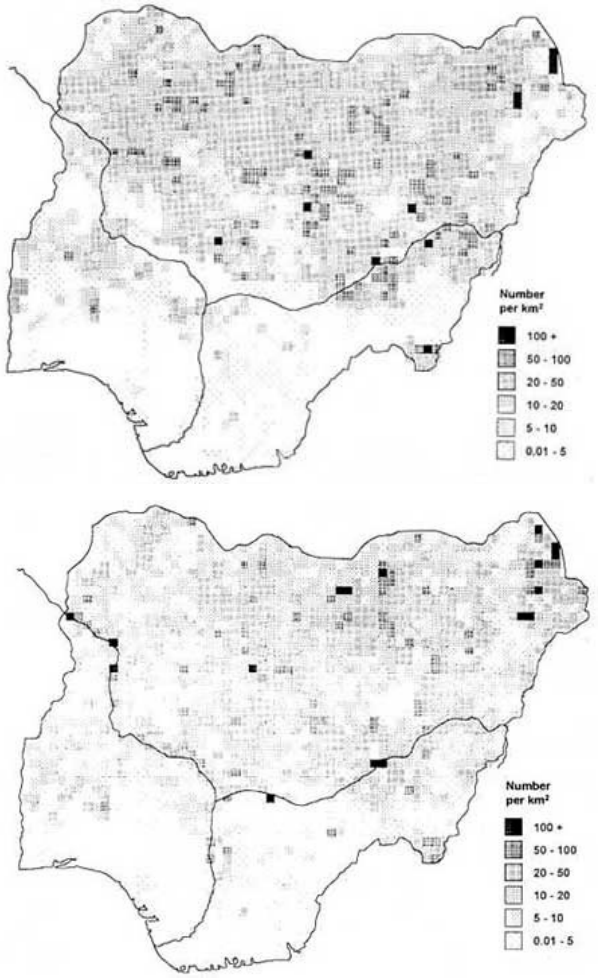


Figure 13. Wet and dry season distribution of cattle in Nigeria
Source: Bourn et al. *(1994)*

Beef cattle of the derived and guinea savannah

Keteku

Keteku is the most adapted breed of this area. It is highly susceptible to trypanosomiasis, but it has proved over the years that it can survive and produce in this area provided it is not subjected to long periods of starvation. Very few Zebu, notably White Fulani or Gudali are sometimes found in the derived and Guinea savannah (Adeniyi, 1973).

Muturu

These are cattle of the rainforest zone and are diminutive. The Muturu or West African Dwarf shorthorn were once well spread throughout southern Nigeria, but are almost everywhere in retreat (Bleach *et al*., 1988). Some years ago, many villages kept Muturu cattle for ceremonial purposes, and it was a common animal in villages and on roadsides. However, at the time of writing their numbers have declined or even totally disappeared. One of the major reasons cited in the literature is low productivity. RIM (1992) illustrated the considerable differences in basic productivity parameters of Muturu (Table 9). Muturu play a significant

role in the traditional society of people of the southern part of Nigeria. The decision to keep Muturu was not based strictly on economic parameters. Keeping Muturu was a prestigious activity associated with chiefs and senior men and off take associated with ceremonial cycles rather than the market. Thus in many traditional production systems, Muturu were never sold. They are able to digest a range of plant foods and survived the disease challenge represented by extremely high rainfall in southern Nigeria.

Table 9. Comparative productivity data for breeding Muturu females

Race/location	Breeding females (no.)	Mean age (months)	Mean age at first calving (months)	No. of previous parities	Calving intervals (months)
North-eastern Muturu	41	84.9	41.8	2.8	17.1
Jos Plateau Muturu	36	90.2	46.0	2.1	26.5
S. Muturu (savannah)	40	na	28.3	na	13.9
S. Muturu (Forest)	22	na	38.0	2.4	24.5

Source: RIM (1992, 11:115).

N'Dama

This breed, originally from Guinea, was introduced to the derived and Guinea savannah zone in the Western part of Nigeria long ago. Since then it has multiplied especially on government farms. The N'Dama breed is now the most important cattle of the Savannah. It is resistant to trypanosomiasis which is a major advantage. Also it is resistant to streptothricosis and has a tremendous capacity for surviving on sparse fodder and under conditions of stress which could kill other breeds.

Dairy development in Nigeria

The activities of the Nigerian dairy industry are centred on milk production, importation, processing, marketing and consumption and these have been going on for over 60 years. These activities are, however, unorganised except for the relatively few processing firms that produce and market reconstituted milk products from imported powdered milk. Despite the unorganised nature of the industry, the dairy industry represents an important component of the agricultural sector of the economy with great economic, nutritional and social implications (Olaloku, 1976; FAO, 1991; Yahuza, 2001). The industry provides a means of livelihood for a significant proportion of rural pastoral families in the sub-humid and semi-arid ecological zones of Nigeria. According to FAO (1988), an estimated 183 thousand rural households derived some income from the dairy industry in 1986. At present Nigeria has 1.8Million Cows (Whole, Fresh, Milk Animals - Head) FAOSTAT (2005).

Ninety six percent (96%) of all cattle in Nigeria are in the hands of the pastoral Fulani. This pastoral herd is the most important source of domestic milk. Only a few imported cattle breeds such as Friesians and Brown Swiss, and their crosses are kept in experimental dairy farms owned by government agencies. A few private commercial dairy farms, owned by companies and individuals, are known to exist. These farms, which constitute the organized dairy farms, produce an insignificant proportion of the domestic milk supply (World Bank, 1992; Yahuza, 2001). Four major production systems can be identified in the country. They include pastoral systems, usually carried out by the Fulani who control at least 96% of the cattle population. The Fulani are mostly semi-sedentary, moving to places where seasonal water supplies make pasture available during the dry season. However, some Fulani are nomadic and are constantly on the move in search of water and pasture. They keep large herds and depend on milk and dairy products for sustenance. Some settled Fulani however, also exist.

In the traditional system, the producers are generally peasants and are often at some considerable distance from urban centres and are generally scattered among traditional communities. They are usually of nomadic origin, and their production methods still bear the stamp of tribal past (Olalokun, 1973). They practice no selection or breeding for improvement of milk yield and other traits desirable in a good dairy animal. There is no milk recording and the production of their animals is often difficult to determine. They do not grow pasture therefore they rely on the grazing available. They usually follow their animals to fresh feeding grounds with a change of season. Feeding their animals is the greatest problem facing these producers. The availability of natural grazing land is determined by the length of the rainy season. Generally they feed no supplements to the cows which are not consciously maintained as dairy animals (Olalokun, 1973).

The production system, the cows and the facilities, are all very poor by modern dairying standards, however, there are thousands of such producing units and there are hardly enough to provide the basis

for a decent standard of living for those dependent on them. There are many people and relatively few dairy cows among the millions of cattle to be found under this system. Consequently, they account for approximately 80 – 90% of the total milk supplies in Nigeria (Olalokun, 1973). A study by ILCA (1976) showed that White Fulani or Bunaji cattle, under the traditional system of production, have calving intervals of 22 to 24 months or more. Age at first calving ranges from 48 to 50 months and milk production (i.e. milk drawn excluding that consumed by the calf is kg over a lactation period of 441 days (253 kg/year). Moreover, calf mortality can be as high as 28% (Yahuza, 2001).

Most of the national herd is in the hands of the pastoralists and the ILCA (1976) study, which was conducted with herds in the traditional system, seems to illustrate the productivity of the national herd. Based on the productivity of the cattle population under the traditional system of production it was estimated in 2001 that domestic milk production would reach 515.3 thousand tonnes. Table 10 shows the predicted size of the cattle population and the magnitude of milk production for the period between 2001 and 2005 (Yahuza, 2001), while Table 11 presents data on estimated human population and annual demand for and supply of milk from the national herd, 2000 to 2005. In addition to the supply of milk from the national herd, an insignificant quantity of milk is supplied by the commercial dairy farms. Several processed dairy products are imported into Nigeria. These include evaporated milk, powdered milk, butter, cheese and cream. Condensed milk and milk powder have dominated the Nigerian milk import trade for a long time (Yahuza, 2001).

Table 10. Estimated cattle population and milk production

Year	Cattle population*	Milking cows (head)	Milk production (tonnes)
2001	21 470 800	3 435 328	515 291
2002	22 329 632	3 572 741	535 911
2003	23 222 817	3 715 650	557 347
2004	24 151 729	3 864 276	579 641
2005	25 117 798	4 018 847	606 827

Source: Livestock Subsector Review Report No.102/92CP-NIR 49 SR/5/8/92.
**N.B. these figures are much higher than those in Table 7 (from FAO)*

Table 11. Estimated human population and annual demand for and supply of milk from the national herd, 2000 to 2005.

Year	Human population (x 106)	Demand (tonnes)	Supply (tonnes)
2000	110.00	990 000	495 479
2001	112.75	1 014 750	515 291
2002	115.56	1 040 004	535 911
2003	118.45	1 066 050	557 347
2004	121.42	1 092 780	579 641
2005	124.45	1 120 005	606 827

Source: Livestock Sub-sector Review Report No: 102/92 CP-NIR 49 SR 5/8/92.

The industry, through commercial dairy processing plants and marketing segments, provides employment and value. Currently, however, very few of the 63 known processing plants are operating. Those that are still functioning operate at less than 20% of capacity. At present, the market has been taken over by 'cottage' outfits that process and market yoghurt in urban areas. Most of these use milk powder to produce yoghurt.

Improvement of the living standard of Nigerians has been the major focus of various national development plans (first in 1962/68 and the fourth in 1981/85). Consequently, the dairy industry, through which better nutrition can be provided to the citizens, was given adequate attention in these development plans. In some selected areas, the government established dairy farms with local and imported breeds of cattle. In addition, milk collection centres including mobile collection points were established (Yahuza, 2001).

Before independence, dairying in Nigeria was influenced by the colonial experience, which placed complete reliance on large government farms to meet the growing demands of the cities. After the colonial era and as part of the government's strategy to encourage dairy industrial development, federal, regional or state governments established dairy-processing plants throughout the country. Among these were Madara Limited in Jos, Plateau State, and Agege Dairy Farm near Lagos. The first herd of indigenous cattle was upgraded with imported *Bos taurus* cattle, which by 1975 produced nearly 200 thousand litres of milk/year from 69 milking cows. Other government dairy farms were established at Ibadan, Kaduna, Maiduguri, Minna, Ilorin and Kano (Yahuza, 2001).

Perhaps, the major achievement of these interventions was the creation of awareness of the need for dairy development as part of overall efforts to improve on the performance of the livestock sub-sector. One of the direct results of this awareness has been the establishment of milk processing plants by both the private and public sectors, as a means of increasing domestic production. However, the availability of cheap imported milk powder in particular and other diary products in general has created a disincentive

for the development of a domestic dairy industry, particularly as the processing plants have completely neglected the appropriate pricing and milk collection aspects (NLPD, 1992). Since the introduction of the Structural Adjustment Programme in 1986, the processing plants have been operating at less than 20% of full capacity because the price of imported milk powder and butter oil has become prohibitive.

Traditional milk products

The wives of pastoralists usually process fresh milk into traditional milk products. These include *nono* (sour milk), *kindirmo* (sour yoghurt), *maishanu* (local butter), *cuku* (Fulani cheese) and *wara* (Yoruba cheese). These products are hawked around the local area by women or sold at specific locations, such as livestock markets in certain towns. Due to their short shelf life and the fact that hawking is carried out on foot these products are usually only available within walking distance of Fulani settlements. For the same reasons these products are also more readily available in the north of the country than the south (National Archives, 1934–48**;** Yahuza, 2001).

Small ruminants

Small ruminants, like cattle, are found almost everywhere in Nigeria. There are estimated to be a total of more than 51 million head, with goats out-numbering sheep. These animals are kept mostly for their meat and skins (goatskin production was some 23 000 tonnes of fresh skins in 2004). They are slaughtered for meat during festive occasions; and are slaughtered daily to augment the supply of meat in both urban and rural areas. Although some seasonal movement of pastoral sheep does take place, the great majority of small ruminants are sedentary village livestock and their patterns of distribution mirror those of human settlement. The traditional system of feeding goats and sheep in Nigeria is based on the use of kitchen wastes, agricultural by-products and browsing (scavenging). Figure 14 presents the distribution of goats and sheep in Nigeria.

Goats: There are three main breeds of goats in Nigeria: the West African Dwarf, the Sokoto Red and the long-legged or Sahel. Goats are renowned for their hardiness and can survive in most environments. West African Dwarf goats otherwise known as the Fouta Djallon are kept in the forest zones and in the Middle Belt; Sokoto Reds are kept throughout the north; and Sahel goats are a northern breed, restricted to a strip along the frontier with the Niger. They are reared principally for their meat and skin. Although pastoral Sahel goats are found in the northern semi-arid zone, most goats are kept in villages. The commonest production system is that of seasonal confinement. Northern goats are found to be markedly more productive than West African Dwarf goats, with lower ages at first kidding and shorter kidding intervals, although they produced fewer kids per kidding (Oyenuga, 1967; Bourn *et al*., 1994). Goats provide over 25% of total lean meat consumed in Nigeria (FAO, 1966; Mecha and Adegbola, 1980) therefore they are the small ruminants of choice.

Sheep: Sheep play an important role in the social economic life of the people of Nigeria. They also make a significant contribution to

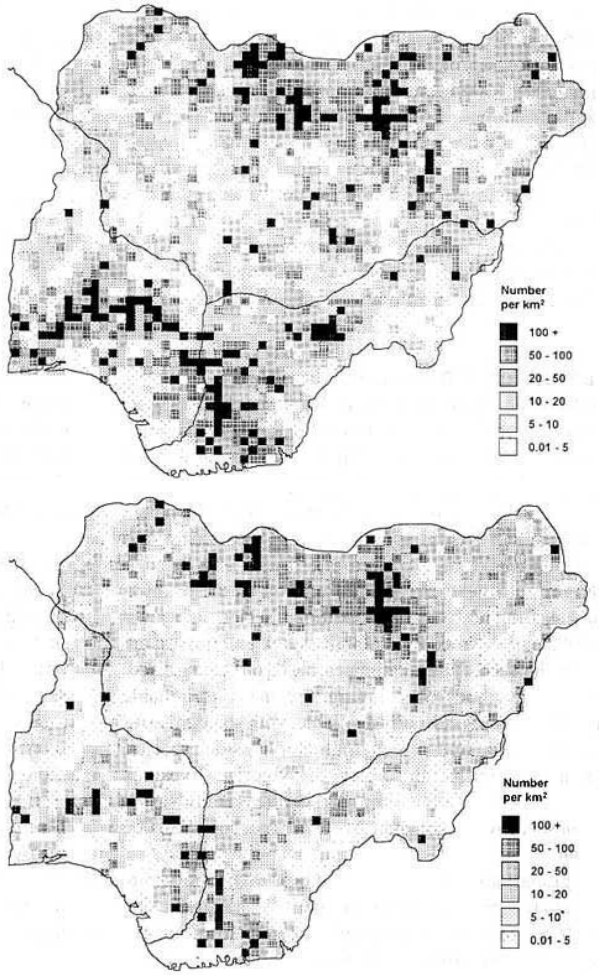


Figure 14. Distribution of goats and sheep in Nigeria
Source: Bourn et al. *(1994)*

the national economy. There are four main types of sheep native to Nigeria and these are Balami, Uda, Yankasa and West African Dwarf. Balami and Uda are kept in the semi-arid regions, West African Dwarf sheep in the south and Yankasa throughout the country (Bourn *et al*., 1994). These four breeds differ considerably in size, coat colour and other characteristics (Adu and Ngere, 1979). All indigenous sheep are hairy and can be broadly grouped into large, long-legged types and the dwarf type. Sheep are the second most numerous pastoral species, and small flocks accompany many cattle herds in the north and in the Middle Belt. A comparison of pastoral and village stock shows that pastoral animals are generally more productive. The productivity of West African Dwarf sheep was substantially lower than that of other breeds. All Nigerian sheep are used for meat and are rarely milked. In the north, they are eaten regularly and form part of the daily protein supply, but there is also a marked variation in demand coinciding with religious festivals. As a result, there are dramatic seasonal price fluctuations, and in some areas the household fattening of sheep for sale is a major economic activity.

5. THE PASTURE RESOURCE

With the current increase in crop production through massive land clearing, coupled with population growth and hence the development of more and larger towns and cities, the land-use pattern is changing and less land is available for crop and livestock production. Herbage forms the most important and cheapest feed for ruminant livestock. It is more economical to use grassland as a source of meat and milk because grass herbage cannot be used directly by man, only indirectly through animals that convert it to edible products. In Nigeria, pasture development has not been developed except on Government and University, experimental, teaching and demonstration farms. Consequently ruminant livestock depend on natural grasslands that are nutritionally poor. Most of the livestock population in Nigeria is under extensive systems and forage availability is an important nutritional factor.

The introduction of pasture crops into Nigeria started in the 1950s (Onifade and Agishi, 1988) and over the years pasture agronomists and ruminant livestock nutritionists have investigated pasture plants that could stand the variations of agro-ecological zones (De Leeuw and Brinckman, 1974; Olubajo, 1974 and Ademosun, 1974). Scientists in Nigeria have identified suitable pasture plants to meet the variations of the agro-ecological zones, therefore, different grasses and legumes are found in the different agro-ecological zones (Olubajo, 1974; Agishi, 1979; 1983 and Onifade and Agishi, 1988). Various grasses species at present exist in Nigeria and the notable ones include *Cynodon nlemfuensis*; *Andropogon* spp. (*Andropogon gayanus* and *A. tectorum*), *Panicum maximum*, *Pennisetum* spp. (with *Pennisetum purpureum* and *P. pedicellatum*), *Imperata cylindrica*, *Melinis minutiflora*, and *Setaria sphacelata.* Also a number of exotic plants such as *Cenchrus ciliaris*, *Anthephora nigritana* and others were successfully established (Oyenuga, 1967).

The legumes which include *Stylosanthes guianensis*, *Centrosema pubescens*, *Pueraria phaseoloides*, *Calopogonium mucunoides* have proved very valuable. *Desmodium* spp. and *Atylosia scarabaeoides* are found in the savannahs of the north. There are also a number of tree legumes and multipurpose trees such as *Leucaena leucocephala*, *Spondias mombin*, *Gliricidia sepium*, *Erythrina* spp. to mention but are few, that provide foliage for livestock at all seasons of the year (Aregheore, 1995; Aregheore and Yahaya, 2001). It will however, require social and cultural changes amongst the nomadic and livestock owners if they are to adopt the technologies that have been developed and to treat livestock ventures as commercial enterprises, not just a way of life. As part of the new technology in animal husbandry, improved pastures produce more dry matter of high nutritive value and lead to greater animal productivity than do native pastures (Nuru, 1996).

In the Sahel savannah where the rainy season lasts between three and four months of the year, the dominant grass species are *Aristida stipoides* and *Schoenefeldia gracilis.* The Sudan savannah zone which falls within the tsetse fly free zone belt of West Africa is excellent for rearing and breeding of ruminant animals (cattle, sheep, goats, horses, donkeys and camels). The grass species in this zone are the quick growing annuals that reseed easily. Browse trees also contribute to the fodder potential of the zone. The grass species found include *Cenchrus* spp., *Schoenefeldia gracilis*, *Eragrostis tremula, Aristida*

and *Loudetia* species, *Pennisetum pedicillatum*, *Andropogon gayanus* and *Andropogon pseudapricus*. Table 12 presents a summary of forage species found to be adapted in the different vegetation zones of Nigeria (Onifade and Agishi, 1988).

The northern Guinea savannah consists of open woodland and has the following grass species: *Hyparrhenia* spp., *Andropogon gayanus*, *Imperata cylindrica*, *Pennisetum pedicellatum*, *Digitaria* spp. and *Setaria sphacelata,* While the Southern Guinea savannah or the tree savannah zone that represents a transitional zone between forests and the savannah zones has the following grass species mainly: *Pennisetum purpureum*, *Andropogon tectorum*, *Panicum maximum* and some species found in the northern Guinea savannah zone. In general, the Guinea savannah zone is characterized by grass species such as *Pennisetum*, *Andropogon*, *Panicum*, *Chloris*, *Hyparrhenia*, *Paspalum* and *Melinis*. These tall grasses are replacement for the destroyed forest trees that are characteristic of the Guinea savannah proper.

The productivity, chemical composition and nutritive value of grasses and legumes found in Nigeria vary greatly according to species, the nature and fertility of the soil, water relations; seasons of the year, disease control and the stage of growth at which the grass species are cut or grazed. The effect of seasonality on ruminant livestock production is also very important. During the mid-wet season, forage biomass is higher in quality and quantity, with crude protein up to 9% in most of the native grasses. Natural grasses and legumes are rich and highly digestible at this period. As the dry season sets in the protein level drops and the roughage quantity increases. There is an increase in lignin content and voluntary intake decreases. This is a poor feed resource, resulting in weight loss and decreased fertility and milk yield for up to 4–5 months of the year. The severity and duration of low-quality feed is common to all parts of the country due to the rapid growth of pasture grass species. In the drier northern states of Nigeria where most of the ruminant livestock are concentrated, the prolonged dry season and high temperatures accompanied by rapid deterioration in quality (mostly proteins) of available pasture affects the productivity of animals.

Table 12. A summary of forages found to be adapted, and recommended for production on a large scale in the different vegetation zones of Nigeria

	Vegetation zones*				
Forage	**SDS**	**DS/SGS**	**NGS**	**SS**	**M**
Grasses					
Andropogon gayanus	X	X	X	X	
Andropogon tectorum	X	X			
Brachiaria decumbens	X	X	X		
Cenchrus ciliaris	X	X	X	X	
Chloris gayanus		X	X		
Cynodon dactylon	X	X	X		
Cynodon plectostachyus	X	X	X		
Digitaria decumbens	X	X	X	X	
Digitaria smutsil			X	X	
Hyparrhenia rufa	X	X	X		
Melinis minutiflora	X	X	X		
Panicum maximum	X	X	X		
P. maximum cv Gatton		X	X	X	
P. maximum var. trichoglume		X	X	X	
Pennisetum clandestinum					X
P. pedicellatum				X	
P. purpureum	X	X	X		
P. typhoides cv Maiwa			X	X	
Setaria anceps		X	X		
Sorghum alum			X	X	
Tripsacum laxum	X	X	X		X
Legumes					
Cajanus cajan	X	X	X	X	X
Centrosema pubescens	X	X	X		
Desmodium intortum		X	X		X
D. scorpiurus		x	X		
Gliricidia sepium	X	X	X		
Lablab purpureus	X	X	X	X	
Leucaena leucocephala	X	X	X		
Macroptilium atropurpureum		X	X	X	
Macrotyloma axillare			X	X	
M. uniflorum		X	X	X	
Neonotonia wightii		X	X		
Pueraria phaseoloides	X	X	X		
Stylosanthes guianensis cv Schofield	X	X	X	X	
S. guianensis cv Cook		X	X	X	
S. hamata cv Verano		X	X	X	
S. humilis		X	X	X	

**SDS – South of Derived savanna; NGS – Northern Guinea Savanna; DS – Derived Savanna; SGS – Southern Guinea savanna; SS – Sudan savanna, M – Montane*

Source: Onifade, O.S. and Agishi, E.C. (1988).

The marked seasonal changes affect the quality and quantity of forage (Aregheore, 1996). Under favourable conditions dry matter yield in the northern savannahs can reach as much as 2 000 kg per hectare, enough to support one to two ruminant livestock units per hectare. However, after the rainy season the quantity of forage declines rapidly and the lack of woody vegetation means that little forage

is available in the dry season. Given the short-term availability of high-quality pastures, movement of animals is eminently reasonable and ecologically sound during the dry season (Nuru, 1996; Aregheore, 2001; Aregheore, 1995).

The effect of seasonality on ruminant livestock production is also very important. In the mid wet season, forage biomass is higher in quality and quantity, with crude protein up to 9% in most of the native grasses. Natural grasses and legumes are rich and highly digestible at this period. As the dry season sets in, the protein level drops and the fibre increases. There is an increase in lignin and voluntary intake decreases which makes it a poor feed, resulting in weight loss and decreased fertility and milk yield for 4-5 months of the year. The severity and duration of low-quality feed differs from the south to the north within the states. To worsen the ecology and its available food resources further, there is widespread annual burning of native grasslands, thereby drastically reducing the amount of forage on offer (Nuru, 1996). A combination of the following factors - low-quality roughage and bush burning, which reduce the biomass available in quantity and quality – have been observed to lead to weight losses ranging from 300 to 400 g per head per day for cattle (Zemmelink 1974) and up to 15% of body weight in sheep (Otchere *et al.* 1977).

For example, the crude nitrogen content of *Cenchrus biflorus*, a characteristic Sahelian grass, can drop from 16% in growing plants during the rainy season to 4% in straw in November and only 2.6% in straw in April (Boudet 1975). For cattle a nitrogen content of at least 5% is required to prevent weight loss. Without supplemental feed, cattle under these conditions will clearly tend to lose weight and may not survive if they must be driven long distances to market.

Natural grassland

Nigerian grassland grows on uncultivated land on which animals have access for grazing. They are found along roadsides and fallow lands in the coastal forest zones of Nigeria. Most of the natural grassland/ rangeland assumes more important proportions in the open derived savannah zones of the country. Most farmers rely on natural grassland for their grazing animals. Carrying capacity of the natural grassland is very low compared to that of planted fertilized pastures. Productivity of natural grassland is affected by factors such as soil fertility, the amount of browse species available, density of canopy and management practices such as rotational grazing, stocking rate, fertilizer application, burning and the length of the resting period (Ademosun, 1974). Legumes are not generally common in natural grasslands therefore the contribution of fixed nitrogen is usually low to absent. Some of the commonest grasses in the natural grassland are *Andropogon gayanus, Imperata cylindrica*, *Pennisetum pedicellatum* and *Hyparrhenia* spp. They grow rapidly during the wet season, becoming fibrous and coarse and are undergrazed because of the large amounts that become rapidly available. Their quality declines further during the dry season when they become standing hay and are subject to overgrazing (Smith, 1992).

During the period of rapid growth the nutrient content of these natural grasses on average is about 25% dry matter; 10% crude protein; 6% ash and a fibre content of 35% crude fibre or 43% acid detergent fibre (ADF). As the dry season advances and conditions become severe, their nutritional quality declines to the extent that crude protein could fall to as low as 2%. Ash values also decline to about 3 – 4% as a result of translocation to the root system, while fibre content increases in response to the process of lignification, and sometimes the crude fibre could be as high as 50% or 60% ADF (Smith, 1992). These grasses cannot meet the nutrient requirements of grazing livestock for most of the year. Even during the rains they can only satisfy maintenance requirements (Smith, 1992).

Some of the browse species are *Adenodolichos* p*aniculatus*, *Desmodium velutinum* and *Sphenostylis schweinfurthii* (Omokaye, *et al.* 2001). During the dry season the most selected browse plants in natural grasslands by sheep and goats in subhumid Nigeria are *Khaya senegalensis, Adenodolichos paniculatus* and *Gmelina arborea* (Olayemi *et al.* 1998; Omokaye, *et al.* 2001).

Besides the savannah zones, natural grassland is found along road embankments and fallow lands in the tropical high forest zone. This is the grassland used by nomads who travel with their animals during the dry season to the south. In the high rainforest zone, grasses available in the natural grassland are *Panicum maximum*, *Cynodon nlemfuensis, Pennisetum purpureum,* some weeds and forbs (Aregheore, 2001). Also some trees such as *Spondias mombin* may be found on fallows. The low protein contents of most natural grassland is a constraint, however, legumes such as *Centrosema pubescens* and *Stylosanthes* spp. can be introduced. Dry matter yields of native pastures are relatively low but as can be seen from

Figure 15 the crude protein levels were higher than on native pasture when *Stylosanthes* was over-sown into natural grassland to improve the productivity of livestock.

The humid zones still have potential for development because they are stocked below their carrying capacity and are much more productive in terms of dry matter than the drier zones (Table 13).

The low nutritive value of natural forage is the major constraint to livestock productivity in the humid zones of West Africa (ILCA, 1979); protein has the most important influence on animal production. In general the crude protein (CP) content of forage rarely exceeds 6 percent for more than six months of the year and some form of supplementation is necessary if calving rates, milk yields and growth rates are to be raised (Milligan and Kaufmann, 1980). These supplements are in short supply owing to increasing demand from agricultural and industrial users.

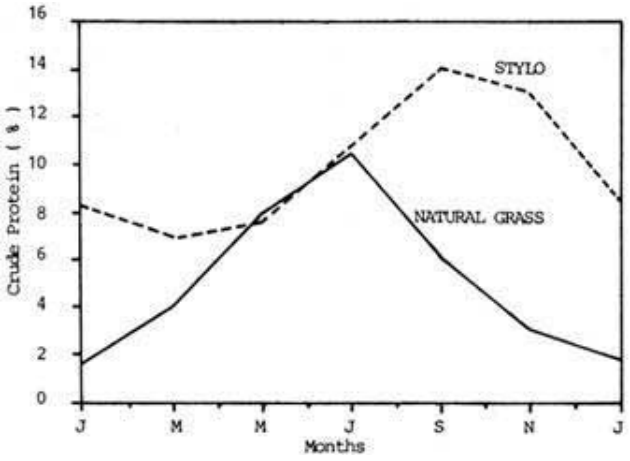


Figure 15. Annual crude protein (CP) profiles for native pasture and *Stylosanthes* grown in fodder banks
Source: FAO, 1983

Table 13. Estimated grassland productivity per season (dry matter)

Northern Sahel	1 082 kg/ha
Southern Sahel	1 742 kg/ha
Sudan	2 324 kg/ha
Northern Guinea	3 097 kg/ha
Southern Guinea	3 889 kg/ha

Source: Kowal and Kassam, (1978)

Improved pastures

As part of the new technology in animal husbandry, improved pastures produce more dry matter of high nutritive value and lead to greater animal productivity than do native pastures. Some forage species of promise that have been investigated in the derived savannah zone are *Andropogon gayanus* and *Panicum maximum*. Both proved very productive and palatable (Ademosum, 1976) and can stand close grazing provided they are well established before being grazed. At moderate stages of growth, *Pennisetum purpureum* is readily grazed and liked by animals. It is also a good forage for silage making when harvested at a height of 2 m and mixed with maize cut at milk stage. The tall grasses have high yield in terms of dry matter but when they get mature, they become coarse, fibrous and rough and the feed value reduces gradually. *Cynodon nlemfuensis,* a spreading perennial, has been used as an improved grass in the derived savannah zone. It can stand close grazing and trampling. It forms an excellent association with *Centrosema pubescens*. In association with *Panicum maximum* it tends to suppress its profuse tillering characteristics, but it provided an excellent soil cover around bunches of *Panicum maximum* (Ademosum, 1976). Besides the above some other cultivated forage species in the savannah zones are Rhodes grass, Digitaria, and Signal grass.

The use of highly productive good quality pasture grasses and legumes resulted in increased productivity in grazing animals in trials in Nigeria (Agishi, 1971, de Leeuw and Agishi 1978). Research data on both indigenous and exotic forage species in the savannah zones have been reported (Agishi, 1982; Agishi, 1983; Onifade and Agishi, 1988; Shehu and Akinola, 1995). Shehu and Akinola, (1995) evaluated the growth of two grasses [Buffel grass (*Cenchrus ciliaris* cv Biloela) and green panic (*Panicum maximum* var. *trichoglume*) and two tropical legumes [Caribbean stylo (*Stylosanthes hamata* cv Verano) and Townsville stylo (*S. humilis* cv Paterson)] in pure stands and grass legume mixture. Caribbean stylo-green panic swards gave the highest dry matter yields of 3.83tonnes/ha and 4.97 tonnes/ha in the first and second years. Caribbean stylo-buffel grass mixtures averaged over all harvesting dates produced the largest yields of 2.38 and 3.94 tonnes/ha for each year of the study. Also crude protein concentration varied from 18.22 to 5.94 in the legumes and 7.43–2.37% in the grasses. On the basis of crude protein they recommended 95 days after sowing and 90 days of re-growth for conducting hay harvest and livestock grazing on all swards.

The use of pasture legumes is advocated to reduce feed deficiencies and the low quality of available feed during the dry season period that constitute major constraints for optimum livestock production

from the savannah rangelands. The use of high yielding legumes as a sole crop or in mixture with grasses is one way of achieving year-round quality forage. Centro (*Centrosema pubescens*) in this regard has emerged as one of the best legumes for the derived savannah and forest zones following initial screening at Ibadan (in western Nigeria) and Shika (in northern Nigeria) (Omokaye, 2001). Thus, due to *C. pubescens* quality it was recommended for sown pastures as well as range improvement and /or rehabilitation (Agishi, 1983).

Omokaye (2001) also examined the effect of sowing date, phosphorus level and stage of maturity on herbage quantity/quality and chemical composition of *C. pubescens* in the year of establishment and reported that forage yields at the initial harvest, yields of regrowth and total yields decreased as planting date was delayed but increased with phosphorus application. Delay of the initial harvest to 14 weeks post planting dramatically increased forage yield while still providing a high quality product. The materials harvested from all treatments, at the initial harvest were high in quality. The N and Ca concentration in centro, even in the unfertilised material were above the critical levels of 1.8% N and 3.5% Ca suggested by Minson *et al*. (1976) for young beef cattle. Also the P concentrations were above the critical level of 0.12% suggested by Little, (1980).

6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES

Establishment of legumes

Under traditional grazing systems, the value of legumes as a source of nitrogen has not been fully exploited by most livestock farmers in Nigeria, however, it is common to find leguminous trees and shrubs growing together with non-leguminous species. Some of the nitrogen fixed by leguminous trees may be taken up by non-legumes. Inclusion of legumes in pasture mixtures offers considerable benefits because of their ability to fix nitrogen biologically. Legumes are normally established in mixtures with grasses, and are sufficiently low growing enough to be grazed by livestock. Also their dry matter yield in such an association depends largely on the system of management. Pasture legumes were first introduced into Nigeria in the 1940s but it was not until 1956 that large scale introductions were made at Shika and Ibadan (Agishi, 1983).

Over the years legumes have received a lot of research attention in Nigeria, involving seed germination, establishment, fertilizer requirements, and defoliation under cutting and grazing, and seed production. The general findings reported by Agishi (1983) are as follows:-

(i) Establishment – For most tropical legumes, seed treatment is necessary to improve germination and the hot water method of scarification has been found to be cheap and simple to carry out. Early seedling growth is slow, however once established legumes compete favourably with associated grasses and weeds. They can be established during the dry season under irrigation.

(ii) Fertilizer requirements – Most Nigerian soils are generally low in nitrogen and phosphorus. Therefore the addition of phosphorus fertilizer to the soil has resulted in marked increases in legume growth, and seed production. Results of trials at Shika showed maximum herbage yield responses of Stylo and Townsville stylo after 800 and 600 kg/ha of single super phosphate were applied. Also, once established only 100 kg/ha/yr of single super phosphate is required for maintenance.

(iii) Herbage yields – Legumes are generally established with grasses and their dry matter in such an association depends to a large extent on the system of management applied. The addition of high levels of nitrogen fertilizer may suppress the legume in favour of grasses. Also the addition of phosphate is more beneficial to legume growth (Agishi, 1983; Omokaye, 2001). Dry matter yield from legumes and legume/grass pastures and dry matter yield of some forage legumes under irrigation improved significantly after about 4 months of growth at Shika (Akinola, 1975).

(iv) Animal Production – A number of grazing trials carried out in Ibadan and Fashola on legume/grass mixtures demonstrated the benefits of inclusion of legumes to the growth of livestock

(Ademosun, 1974). Also at Shika, Haggar *et al*. (1971) obtained an increased live-weight gain of 28% over that from native pasture when animals were grazed on native grass over sown with Stylo. Also data from Shika demonstrated that the inclusion of Verano in buffel grass delayed commencement of weight loss.

(v) Seed Production – A trial carried out at Shika to determine the seed yield potential of *Stylosanthes guianensis* cvs Cook, Endeavour and Schofield, *S. hamata* and *S. humilis* demonstrated that seed production was greatly influenced by phosphate fertilizer application. Seed yields in the climbing legumes such as Sirato and Centro were also high, but indeed were due to excessive shattering.

Legumes have been successfully established by farmers and agro-pastoralists in grassland as "fodder banks" and in cropped areas on fallows, (Tarawali and Mohamed-Saleem, 1995) using low input techniques, developed by research institutes and extension agencies. In the savannahs of northern Nigeria where the technology was developed, the productivity of *Stylosanthes* fodder banks varied from 3 000 to 5 000 kg/ha and the legume composition from 50 to 70% (Mohammed-Saleem and Kaufmann, 1982) (Table 14).

Centrosema pubescens and *Stylosanthes gracilis* have proved very useful in improved pasture. Animals readily graze *C. pubescens* and it is one of the most used legumes in grass/legume mixtures. It is compatible with *Cynodon nlemfuensis*, *Digitaria decumbens* and *Panicum maximum* (Ademosun 1974). However, in the mid 80s, anthracnose (*Colletotrichum)* wiped out stylo throughout Africa and these forages were largely replaced by other species.More legumes have been identified for fodder banks in semi-arid regions. These include *Chamaecrista rotundifolia*, *Centrosema brasilianum*, *C. pascuorum*, *S. humilis* and *Aeschynomene histrix*. (Tarawali and Ogunbile, 1995). Synge (1981) reported improved production responses in white Fulani cattle due to supplementary feeding under traditional management (Table 15). Creeping legumes, such as *Calopogonium, Centrosema, Mucuna*, and *Pueraria*, have attracted much research attention (Agboola and Fayemi, 1971; Akobundu, 1993; Tarawali and Ogunbile, 1995).

Abayomi *et al*. (2001) carried out evaluation of selected legume cover crops for biomass production, dry season survival and soil fertility improvement in the southern Guinea savannah zone during the 1993-1996 cropping seasons. Field establishment, ground cover, above ground biomass production, and seed yields of the legume species were monitored during each cropping season. The majority of the legume species gave satisfactory ground cover, biomass production, and N contribution to the succeeding non-legume crop. Using the rank summation index, the order of adaptation of the legume species to the study location on the basis of their ground cover, biomass production, seed yield, dry season survival and N contribution to the soil was as follows: *Cajanus cajan* > *Aeschynomene histrix* > *Stylosanthes guianensis* > *S. scabra* > *Crotalaria ochroleuca* > *C. verrucosa* >*Clitorea ternatea* > *S. hamata* > *Pseudovigna argentea* > *Centrosema pascuorum* > *Pueraria phaseoloides* > *Lablab purpureus* > *Psophocarpus palustris* > *Chamaecrista rotundifolia* > *Macroptilium atropurpureum*.

Farmers who rely on burning to clear land in the forest zone have not adopted such legumes, as they do not

Table 14. Stylosanthes productivity and change of quality in fodder banks (1981/82 dry season)

Observation	Fodder Banks		
Type	Experimental	Pastoralists	Pastoralists
Place	Kurmin Biri	Abet	Kurmin Biri
Total DM (kg/ha)	6 824	4 900	4 191
% wt of stylo	56	63	68
Stylo CP% October	13.8	12.6	13.0
Stylo CP% December	10.6	11.3	10.4
Stylo CP% February	9.2	8.9	9.8
Stylo CP% April	5.8	7.2	7.9

Source: Mohammed-Saleem and Kaufmann, (1982).

Table 15. Production responses due to supplemental feeding of White Fulani cattle under traditional management

	Control herds	Supplemented herds
Mean Milk Yield (kg/day)		
Dry season	0.505	0.802
Rains	0.911	0.935
Whole year	0.708	0.869
Mean Milk Yield per Cow over a 3-year period (kg/day)*		
Dry season	0.183	0.413
Rains	0.300	0.450
Whole year	0.245	0.432

** All breeding females, not just those in milk*
Source: Synge, (1981).

suit their farming system. In mechanized systems in the savannah zone, where soil erosion and physical degradation pose a serious threat to system sustainability and where cattle have to be fed during the dry season (Hoefsloot *et al*., 1993), forage legumes may provide an acceptable alternative to weedy fallows.

Fodder legumes

During the dry season livestock feed supply is usually at its lowest especially in the Northern guinea and Sudan savannah zones of Nigeria. At this period animals feed exclusively on crop residues that are low in nutritive value. Also during the dry season leguminous crop residues such as groundnut haulms and cowpeas; and other residues such as sorghum, millet, rice, wheat maize and cotton are low in quality. These residues including groundnut haulms and cowpeas hays that are used throughout the zones do not meet total nutritional requirements of animals. Fodder legumes that have been used and show some value of conservation are groundnuts (*Arachis hypogaea*), soybeans (*Glycine max*), Cowpea (*Vigna sinensis*), Mucuna or Velvet bean (*Stizolobium deeringianum*) and Lablab (*Lablab purpureus*). These legumes when used properly with improved native pasture, sown pasture and browse plants assist to reduce the heavy liveweight losses that are common in the dry season (Agishi, 1983).

The production of quality fodder would permit the introduction of more productive crossbred animals into pastoral herds. Cropping within fodder banks is becoming an important issue because it is necessary to permit the accumulation of nitrogen and structure in the soil which requires some years. It is also essential, however, that the farmers who own the land benefit from permitting the use of their fallow land for forage production (Mohammed-Saleem, 1983). This is probably the key issue in promoting integrated crop/livestock systems where the livestock and land are owned by different people. Since the fodder banks average about 4 hectares and crop plots are usually less than a hectare it should be possible to rotate the crops within the fodder banks every 4 to 5 years (ILCA, 1979).

Also the evaluation of the mineral and trace element status of the local soils should provide data for further increases in dry matter production. At yields of around 5 tons/ha, however, 4 ha fodder banks will adequately supplement the nutrition of the 20 or so milking cows found in typical sedentary agro-pastoral herds. Indications are that fodder banks should be worthwhile investments provided that farmers do not reclaim them for farming in less than five years (FAO, 1983).

Some farmers and agropastoralists have successfully established leguminous pastures as fodder banks and in cropped areas as fallows. Research/demonstration work in the northern states of Nigeria has shown that herds with access to *Stylosanthes* supplementation increased in size compared to those that grazed natural pasture (Tarawali, 1991). Legume supplementation gives savannah farmers several advantages (Aguwuna,1983). They provide more lasting protective cover for soil than mulch, reduce the need for nitrate fertilizer and improve the quality of grazing land and provide high protein forage to complement the low quality natural pasture (Tarawali and Ogunbile, 1995).

Work with agropastoralists in northern Nigeria has shown that herds with access to *Stylosanthes* supplementation increased in size by 20% compared to cattle that were grazed on natural pasture(Boubacar Hussane, unpublished data). Conditions in Mali, Niger and Cameroon support higher herbage productivity and legume component. Performance should be even better and the new promising legumematerial with higher crude protein values should carry more animals for slaughter. Milk yields will also increase, providing more cash for women who control the dairy sector in traditional households in northern Nigeria. Crops such as maize, sorghum, millet and soybean in areas preceded by leguminous pastures produced more grain than after natural vegetation and in some cases the yield was double. Maize appeared to be the most responsive crop. For cereals such as sorghum and millet with very low nitrogen demands, reasonable yields were achieved within *Stylosanthes* pastures without applying any nitrogenous fertilizer (Tarawali and Ogunbile, 1995).

Leguminous browse and multipurpose trees

Browse in the form of trees and shrubs forms an integral part of ruminant production; feeding browse has become an essential practice especially in the dry season when herbaceous forages are scarce (Bamikole *et al*., 2004) and low in nutritive value (Aregheore, 2001). Forage legumes, especially browse plants, are important in the maintenance and survival of ruminants. Their relative importance in ruminant nutrition especially during the dry season spell cannot be over-emphasized. Improved animal agroforestry could

enhance livestock production in Nigeria through forage production. Large number of browse legumes and multipurpose trees have been tried experimentally and subsequently introduced to ruminant farmers (Mecha and Adegbola, 1980).

Browse legumes are shrubs and trees that are of considerable nutritional importance as livestock feed during the dry season of the year. Their leaves are green all year round and many are well known to herdsmen who frequently cut down their branches for stock feeding. Most nomads and smallholders know them and therefore use them for their livestock (Aregheore, 1996; Onwuka *et al.* 1992; Carew *et al*. 1980). The fruits of some form an important feed resource during the dry season. Many browses contain high levels of essential elements such as calcium, sodium and sulphur as well as critical micronutrients such as iron and zinc which have been shown to be deficient or borderline for productive purposes in many grass species (Olubajo, 1974). In long-term studies that were designed to evaluate the effects of browse supplementation on the productivity of sheep (Reynolds and Adediran, 1987) and goats (Reynolds, 1989), pregnant ewes and does maintained on a basal diet of *Panicum maximum* were supplemented with graded levels of a 1:1 (w/w) mixture of *Gliricidia sepium* and *Leucaena leucocephala* over two reproductive cycles. Supplementation with browse increased growth rate to weaning of both kids and lambs by 45%. Direct supplementation to kids and lambs doubled growth rate from birth to six months in both species. Also browse supplementation increased overall daily dry matter intake by the dams during the final two months of pregnancy and four months of lactation (Smith, 1992).

Browse legumes are found from north to south; and west to east in Nigeria. Examples are *Leucaena leucocephala, Gliricidia sepium, Acacia* spp. (*A. albida*, *A. nilotica*), *Albizia, Ficus elasticoides*, *Mangifera indica, Musa* sp.*, Spondias mombin, Cajanus cajan, Tamarindus indica,* and *Parkia clappertonian,* to mention but a few. Leucaena is widely accepted as the best browse legume and has naturalized in some parts of Nigeria.

Leucaena and *Gliricidia* foliage yields are higher in the wet season (Aregheore, 1995; Balogun and Otchere, 1995). Their leaves provide protein-rich supplements to traditional village diets to increase small ruminant productivity (Jabbar *et al.* 1977). Dry matter digestibility (DMD) of *Gliricidia* as a sole feed was found to be 54 – 57%, while the addition of cassava tubers (Ademosun *et al.,* 1985a) or cassava peel (Ifut, 1987) raised DMD to 70 - 74%. In a *Panicum maximum* plus *Gliricidia* diet, DMD fell as a proportion of *Panicum* in the diet increased (Ademosun *et al*., 1985 a, b, and Ifut, 1987). For a combination of *Panicum, Gliricidia* and cassava peel, DMD tended to increase as the level of consumption of cassava peel increased (Ifut, 1987). The presence of a fermentable energy source in the diet allows high nitrogen feed such as *Gliricidia* and *Leucaena* to be utilized more efficiently (ARC, 1980). Based on these experiences a small amount of sun-dried cassava peel (about 50 g/day) would be ideal as a supplement (Jabbar *et al*., 1997).

Bamikole *et al*. (2003) evaluated the feeding value of *Ficus religiosa* (FR) with West African Dwarf goats by feeding FR with *Panicum maximum* (PM) at different ratios of 0:100 (i.e. solely PM) 25:75; 50:50, 75:25 (which were mixtures of forages) and 100:0 (solely FR) in a 105 day trial during which intake, weight gain, digestibility and nitrogen utilization were monitored. Results demonstrated that feed intake, weight gain, digestibility and N utilization can be enhanced by feeding FR in mixture with PM and it can be used in diet mixtures up to 75% of DM fed. Yahaya *et al.* (2001) evaluated the nutritive value of three browse trees (*Ficus polita*, *F. sycomorus* and *Acacia sieberiana)* with sheep on dry matter and crude protein digestibility; and degradability of neutral detergent fibre and Acid detergent fibre. Results of the investigation demonstrated that *Acacia sieberiana, F. polita* and *F. sycomorus* can sustain sheep on a maintenance diet and could also be used as a supplementary feed during the dry season.

Development of aquatic resources

In a survey of aquatic environments Imevbore (1971) identified 52 macrophytes but only 14 of these were found useful for livestock production (Obot, 1984). Some aquatic plants can be processed as animal feeds. Even water hyacinth can be used in limited quantities in a mixture with other feeds by cattle, sheep, goats and other ruminants. Aquatic macrophytes used as fodder include *Vossia cuspidata, Leersia hexandra, Bracharia mutica, Echinochloa pyramidalis, Sorghum arundinaceum, Paspalum virgatum* and *Echinochloa stagnina*. About 7–9% of Lake Kainji has been reported to be covered periodically by plants.

Supplementation of crop residues and agro-industrial by-products with forage

Cereal residues (maize, rice, millet, sorghum and wheat) residues are low in nitrogen and one way of improving their nutritive value is to feed them to animals together with a variety of forage supplements that are potentially valuable to ruminants (Adebowale, 1988). Some of these forages include Siam weed (*Eupatorium odoratum*), cassava leaves (*Manihot esculenta*), *Gliricidia* leaves (*Gliricidia sepium*), *Leucaena leucocephala* and *Spondias mombin* foliage. The beneficial effects of feeding these forages to ruminant animals are many such as increased metabolisable energy and nitrogen intake, improved palatability, increased available minerals and vitamins, better rumen function and a laxative influence on the alimentary system.

Table 16. Daily milk yield of White Fulani cows fed urea-treated or untreated maize husk with or without *Gliricidia sepium* foliage supplementation

	Untreated		Urea-treated	
	Without *Gliricidia* foliage	With *Gliricidia* foliage	Without *Gliricidia* foliage	With *Gliricidia* foliage
Milk yield (kg)	3.1d	3.8c	4.0bc	4.4a

All cows received 1.5-kg concentrate ration per day and Gliricidia septum *foliage formed approximately 15% (untreated maize husk) or 10% (treated maize husk) of dietary dry matter intake.*
a, b, c, d Means in the same row not having common letters differ significantly (P<0.05).

Adebowale (1992) reported the results of a trial in which 20 White Fulani steers were fed ad libitum on treated and untreated maize cobs (chopped) with fresh Siam weed (2 kg/head/day). Live-weight improved from a daily loss of 320 g, when animals were fed untreated maize cobs, to a daily gain of about 480 g, when cobs were treated and supplemented with Siam weed. When Gliricidia foliage was supplemented to about 15% of the DMI of White Fulani cows on a diet of maize husk, the milk yield increased by about 22.5%. However, when maize husk was ensiled with 6% urea for ten days, the milk yield increased by 42% with Gliricidia foliage and 29% without it (Table 16). When maize husk and bran supplemented with Leucaena foliage were fed to West African Djallonke goats for 12 weeks, animals reacted better to maize bran than to maize husks. This confirms that maize bran is better degraded in the rumen than maize husks. However, these two maize residues are either expensive or cumbersome to procure, especially for feeding large animals (Adebowale, 1992).

Alhassan (1985a & b) in a comparative study of maize residues with other crop residues fed Red Sokoto goats with various cereal or legume residues and found that dry matter intake (DMI) ranged from 0.7% of body weight for maize stover to 2% for sorghum leaves, while legume crop residues intake ranged from 0.8% for cowpea vines to 3.4% for groundnut haulms. When feeding maize residues was compared with other cereal or legume crops, it was found that liveweight gain compared favourably. Highest feed consumption was recorded for the maize residue, although this was not significantly higher than the sugar-cane tops. However, this high consumption did not produce better liveweight gain, except with sorghum stalks.

ILCA (1979) tested supplementary feeding with the most easily obtainable agro-industrial by-product, cottonseed cake. The yield responses recorded by Synge (1981) in Table 15 were obtained by supplementing cows with feed containing 41 percent crude protein fed at the rate of 1 kg/head/day for five months (December to April) during the dry season. The mean calving rate in supplemented herds rose from 33% to 77% while that in control herds was never more than 40 percent. Feeding all the animals 1 kg/head/day gave a return of 132 kg milk/1 000 kg cottonseed cake; if only the breeding females were fed the return was 455 kg milk/1000 kg cottonseed cake. The ILCA's preliminary figures correspond closely with Synge's (1981) results with the additional observation that the break-even curve for cottonseed cake to milk off take is very steep. Thus a small increase in feed prices requires a large increase in milk prices to retain profitability, but this does not take into account the value of the extra calves (FAO, 1983).

Recommendation

Research has been carried out over the years in Nigeria to improve pastures in the savannahs which contain about 80% of the population of grazing ruminant livestock. The development of grazing reserves for livestock was highlighted in the third National Development Plan and a number of areas were designated as cattle settlement areas in the 19 northern states (Agwuna, 1983). However, there are flaws in grazing reserves and group ranches. Despite the inclusion of grazing reserves and group ranches in official plans, demarcating large pieces of land for the exclusive use of pastoralists is fraught

by competing land claims. The case for the establishment of grazing reserves has not been helped by the failure to plan them in the context of total land use systems. Grazing reserve and group ranch plans typically envisage self-contained, year-round grazing systems and result in the allocation of large areas of land to a few people (FAO, 1983).

Future research to improve pasture in Nigeria should focus on soil conservation and management through the use of legumes instead of mulching with straw. Survey of indigenous legumes (browse/ multipurpose trees) – to identify those that are more suitable for particular agro-ecological zones, methods of establishment, fertilizer use, seed production – that involves field establishment and weed control (manual, mechanical and chemical methods;); management practices; harvesting methods, storage quality determination should be undertaken. The present poor system of livestock production of the majority of herd/flock owners however, should not be a deterrent to exploring future possibilities. In this context, therefore, one could stress the need to increase farmers' awareness of the benefits of legume-based technology through increased farmer participatory activities, adequate training of extension officers/agents as an integrated part of the forage-legume production system.

Government policies and programmes to assist livestock farmers and the millions of people engaged in livestock enterprise need to take cognisance of the following (Nuru, 1996):

(i) The land tenure system must be revised in some countries to make it easier for those who really need land to obtain it. The need to instil pride of ownership and willingness to invest in development is crucial because communal grazing is free and therefore unattractive for commercial livestock enterprise.

(ii) The supply of sufficient manpower/experts, e.g. animal scientists, range managers, and technical staff, is essential to foster rapid improvement in ruminant livestock production.

(iii) Regulatory control of herd size and distribution to achieve ecological balance and avoid overgrazing needs policy attention. The encouragement of herd owners to move to the sub-humid zone in Nigeria, which is rich in feed resources, is a very slowly developing programme.

(iv) More incentives to producers - marketing, credit facilities, technical supervision, subsidized inputs, etc. - are essential.

(v) Active participation by the private sector - Private sector participation in the primary production of livestock is highly desirable if the necessary output of livestock products is to be achieved in the future. Through this sector, environmental degradation can be minimized and increased productivity of livestock products ensured. The need to invest in the industry as a high-potential economic enterprise cannot be overemphasized if the future is to be safeguarded.

In conclusion, government assistance through research and the development of specialist skills in range management, pasture agronomy and management, and animal science, would be of significant importance to ensure future economic growth and development in the livestock sector to enable Nigeria to meet the challenges of the future.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Universities

Animal Science Department, University of Ibadan, Ibadan, Nigeria
Agronomy Department, University of Ibadan, Ibadan, NigeAnimal Science Department, Obafemi Awolowo University, Ile Ife, Nigeria.
Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.
Department of Animal Science, University of Nigeria, Nsukka, Nigeria.
Department of Pasture and Range Management, University of Agriculture, Abeokuta, Nigeria.
Department of Animal Production, University of Agriculture, Abeokuta, Nigeria**.**
Department of Animal Science, Federal University of Agriculture, Umudike, Umahia, Nigeria.
Department of Animal of Animal Science, University of Agriculture, Makurdi, Nigeria.

Ministry

Federal Ministry of Agriculture, Director, Livestock Division, Abuja, Nigeria**.**

Institutes

National Animal Production Research Institute (NAPRI), Ahmadu Bello University Shika, Zaria, Nigeria.
Institute for Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria.

Contacts for information on pasture and fodder production and management

Name	Main field of interest	Institution	E-mail address
Omokaye, A.T.	Pastures Agronomy/ Ruminant Nutrition	National Animal Production Research Institute (NAPRI), Ahmadu Bello University Shika, Zaria, Nigeria.	
Onifade, O.S	Pastures Agronomy/ Ruminant Nutrition	Dept. of Pasture and Range Management, University of Agriculture, Abeokuta, Nigeria	
Akinola, J.O	Pasture Agronomy	National Animal Production Research Institute (NAPRI), Ahmadu Bello University Shika, Zaria, Nigeria.	
Shehu, Y.	Pasture Agronomy	School of Agriculture, Abubakar Tafawa Balewa University, P.M.B 0248, Bauchi, Nigeria	
Bamikole, M.A.	Ruminant Nutrition	Department of Animal Science, University of Benin, Benin City, Nigeria	bankymao@uniben.edu
Balogun, R.O.	Ruminant Nutrition	National Animal Production Research Institute (NAPRI), Ahmadu Bello University Shika, Zaria, Nigeria.	
Arigbede, O.M	Ruminant nutrition/ Pastures Agronomy	Dept. of Pasture and Range Management, University of Agriculture, Abeokuta, Nigeria	
Babyemi, O.M.	Ruminant Nutrition	Animal Science Department, University of Ibadan, Ibadan, Nigeria	

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the international Symposium on Animal production in the tropics, held at the University of Ibadan, Ibadan, Nigeria 26-29 March 1973. pp. 167-176.

9. CONTACTS

Profile prepared by:

Eroarome Martin Aregheore while he was at:
The University of the South Pacific,
School of Agriculture,
Animal Science Department
Alafua Campus, Apia
SAMOA.

Present address/contact:
Eroarome Martin Aregheore, PhD
Marfel Consulting (Agricultural and Educational Services)
118-7341, 19th Avenue
Burnaby, BC, Canada, V3N1E3
Tel: 604 395 5428
778 991 2295 (Cell)
Email: aregheore_m@yahoo.com
[
This profile was completed by the author in May/June 2005 and was edited by J.M. Suttie and S.G. Reynolds in June/July and September 2005, livestock data were slightly adjusted in August 2006 and the profile was slightly edited in January 2009 by S.G. Reynolds.]