FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

TOWARDS ADEQUATE ANIMAL PROTEIN INTAKE BY THE YEAR 2020

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INAUGURAL LECTURE SERIES 11

24TH APRIL, 2008

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1.0 INTRODUCTION

Today, I am highly privileged to present to this distinguished audience my inaugural lecture in my chosen profession of Animal Science. I have chosen the theme "***Towards Adequate Animal Protein Intake by the Year 2020***" because of the present low level of animal protein intake in most developing countries, including Nigeria. For any nation to develop, the citizens must be well fed with a balance diet. In this direction, the contribution of livestock to the diet is very crucial. Developing countries are presently consuming far less than the recommended daily animal protein. This development apart from impacting negatively on the health of the citizenry, is also retarding the much desired economic growth. In order to catch up with the developed countries, many developing countries are setting up development targets. Here in Niger State of Nigeria, the Chief Servant, Dr. Muazu Babangida Aliyu has vowed to transform the state into one of the top three economies in the country by the year 2020. This transformation I believe should include the livestock sub-sector.

Livestock can make a major contribution to the efficient use of available natural resources. Livestock production constitutes a very important component of the agricultural economy of both developed and developing countries. First and foremost, animals are important source of high quality protein, minerals, vitamins and micronutrients. The value of dietary animal protein is in excess of its proportion in diets because it contains essential amino acids that are deficient in cereals. Increased consumption of even small additional amounts of meat and milk can provide the same level of nutrients, protein, and calories to the poor that a large and diverse amount of vegetables and cereals could provide. Eating even a small amount of animal products corrects amino acid deficiencies in cereal-based human diets, permitting more of the total protein to be utilised because animal proteins are more digestible and metabolised more efficiently than plant proteins. Foods derived from animal sources have major importance for optimizing human performance in chronically mild to moderately malnourished populations. This is especially important for young children.

The contribution of livestock sector goes beyond being a direct source of food even though official statistics tend to underestimate the overall contribution of animals since they generally underestimate or ignore the multipurpose role livestock play in agricultural production, as well as in the social life of small-scale farmers in developing countries. Livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability. In mixed-farming systems, not only can farmers mitigate risks by producing a multitude of commodities, but they can also increase the productivity of both crops and animals in a more profitable and sustainable way. Animals are important sources of products such as skin, fibre,

fertilizer and fuel, as well as capital accumulation.

In view of the rapid increase in the level of animal protein intake in many parts of the developing countries, it has become evident that a ***Livestock Revolution*** is currently taking place (Delgado, Courbois, and Rosegrant, 1998; Delgado, Rosegrant, Steinfeld, Ehui and Courbois 1999; Delgado, Rosegrant and Meyer, 2001). Such a rapid increase is creating new opportunities for livestock producers in developing countries, where some of the world's poorest people live. The increase in livestock food products also holds promise for relieving widespread micronutrient and protein malnutrition, while making positive contributions to the sustainable intensification of smallholder agriculture.

Unlike the supply-led Green Revolution, the ***Livestock Revolution*** is driven by demand. From the early 1970s to the mid-1990s, the volume of meat consumed in developing countries grew almost three times as much as it did in the developed countries. The demand-driven ***Livestock Revolution*** is one of the largest structural shifts to ever affect food markets in developing countries and how it is handled is crucial for future growth prospects in developing countries' agriculture for food security, the livelihoods of the rural poor, and for environmental sustainability.

This lecture will give a profile of the livestock industry, its important contribution to man, the present poor state of animal protein intake in the developing countries, particularly in Nigeria and strategies for ensuring adequate animal protein intake by the year 2020. It will also highlight some of my research focus and contributions in the field of animal production and profer some suggestions that will move the livestock industry forward, particularly in Nigeria.

2.0 ANIMAL SCIENCE AS A PROFESSION

The process of domestication brought animals under the control of man. Domesticated animals are constantly supposed to be under the care of man who domesticated them to serve his needs. For domestic animals to produce effectively and meet the needs of their human masters, man ought to meet the needs of the animals. These include provision of feed, health care, security and protection against adverse climatic conditions and thieves and predators. It amounts to cruelty, exploitation and neglect for owners of animals to abandon their animals and allow these animals to fend for themselves. A typical herdsman will do everything possible to meet the needs of his animals.

Animal Science is concerned with the science and business of producing domestic livestock species, including but not limited to beef cattle, dairy cattle, horses, poultry, sheep, and swine. An animal scientist applies the principles of biological, physical, and social sciences to the problems associated with livestock production and

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management. Animal Science is also concerned with foods of animal origin: meat, dairy foods, and eggs. In addition, animal science is concerned with efficient production of food animals, processing and consumption of high-quality meats and dairy products as well as the general well-being of animals.

Professional education and training in Animal Sciences provide challenging career opportunities in such areas as breeding, health maintenance and disease control, marketing, processing, distribution, and numerous allied service industries. Animal scientists must have formal training and appropriate experience to learn and apply the complex principles involved in animal science, care, and use. Knowledge of such basic subjects as animal behaviour and management, genetics, microbiology, nutrition, physiology, reproduction, and meat science is essential to persons entering most animal science professions.

Students enrolled in animal sciences curricula receive a firm background in the biological and natural sciences. This foundation is essential for understanding the principles of animal breeding, reproductive physiology, nutrition, meats and muscle biology, growth and mammary physiology, genetic engineering, molecular biology, and management of livestock and companion animals. Students can also gain expertise in the processing, quality control, product development, and marketing of meat, dairy, and poultry products.

Programmes of study in animal science are designed to give students a broad knowledge of animal and poultry production as well as the application of modern technology within agricultural systems. Programmes may emphasise: sustainable production systems and management, animal behaviour and welfare, physiology, biotechnology (e.g. growth, meat quality, immune system modulation), genetics, molecular genetics, computer modeling, nutrition (biochemistry, feeds and feeding evaluation), pasture management and forage production.

A career in Animal Science can make one to be part of the biggest industry in the world! The international trade of livestock products is valued at US$200 billion. (Slingenbergh, Hendrickx and Wint, 2002). According to McCalla and de Haan (1998), about 150 million tonnes, or about one third of internationally traded agricultural commodities are livestock products or livestock feed. U.S. agriculture alone is a $135 billion business, and animal agriculture is the biggest component of U.S. agriculture, employing large numbers of Animal Science graduates. Animal Scientists with a background in molecular biology, microbiology or genetics are in demand for laboratory work in universities and the pharmaceutical/biotechnology industry. Furthermore, with additional education and graduate degrees, more opportunities in research, teaching, extension and veterinary medicine become available.

Today's Animal Science graduates go on to challenging careers in different fields. These opportunities require technical, personnel, and management training and can lead to jobs in livestock, poultry, egg and dairy units as well as horse farms, zoos, pet animal breeders and other related industries. A graduate of Animal Science can prepare himself for one or more of the many careers related to animal agriculture. These include:

i. Livestock Production Managers in:
   a. Beef
   b. Dairy
   c. Poultry
   d. Sheep
   e. Goat
   f. Swine
ii. Feed Production/Sales/Management
iii. Livestock Equipment Sales/ Management
iv. Livestock Consultant
v. Breeding Expert
vi. Livestock Feedlot Operator
vii. Technical Representative
viii. Lecturer/Teacher
ix. Researcher
x. Extension Specialist
xi. Livestock Marketing Specialist
xii. Housing & Environmental Quality Specialist
xiii. Livestock Insurance Representative
xiv. Animal Scientist Consultant
xv. Food/Meat Product Development
xvi. Quality Assurance
xvii. Food Service Management
xviii. Farm Management
xix. Dairy Equipment Specialist
xx. Market Reporter
xxi. Meat Grade Specialist
xxii. Employment with Commercial banks
xxiii. Employment with Federal and State Governments

Disease and parasitism, which are also prime production considerations, are not a part of the traditional Animal Science but fall within Veterinary Medicine. Unfortunately, there has been limited communication between Animal Husbandry and Veterinary

Medicine, and this has slowed the progress in developing complete livestock production packages embracing all management components.

In some parts of the world, such as Latin America, Animal Scientists are trained not only in animal husbandry schools, but also in Veterinary Medicine faculties At the end of the training they grant the undergraduate degree of "***Medico Veterinario y Zootecnista***," meaning Doctor of Veterinary Medicine and Animal Husbandry, and those who hold it are the professional animal scientists in their setting. The degree granted implies equal emphasis on both Animal Husbandry and Veterinary Medicine

Pritchard and Turk (1961), however, pointed out that it is not possible for the student to gain competency in both veterinary medicine and animal husbandry in the 5-year course of study. On graduation, therefore, the student has a most impressive and inclusive title, but his training has actually been so broad as to be superficial, qualifying him as neither a proficient veterinarian nor as an animal husbandryman. This situation does not allow us to address the issue of inadequate intake of food of animal origin.

3.0 DOMESTICATION OF ANIMALS

The association between humankind and animals dates back to prehistoric times. The close relationship between domesticated animals and humans is evident throughout history and many societies have strong socio-cultural values attached to their animals. In most cases, these values reflect specific economic attributes and have important implications for livestock development.

The first animals known to have been domesticated as a source of food are goats in the Middle East (Table 1). Sheep followed soon after. Cattle and pigs were domesticated slightly later in Western Asia and in China respectively. The main reason for domestication was to secure a regular supply of fresh meat. However, these animals also provided for almost every other need of neolithic man. These include: manure, leather and wool for garments, horn and bone for sharp points of needles or arrows, fat for candles and hooves for glue. Cattle were harnessed and put to work. The horse was important in transport and warfare.

Animal species must meet certain criteria to be considered for domestication. These include:

- **Flexible diet** - Creatures that are willing to consume a wide variety of food sources and can live off less cumulative food from the food pyramid (such as corn or wheat) are less expensive to keep in captivity. Most carnivores can only be fed meat, which requires the expenditure of many herbivores.
- **Reasonably fast growth rate** - Fast maturity rate compared to the human life span allows breeding intervention and makes the animal useful within an

acceptable duration of caretaking. Large animals such as elephants require many years before they reach a useful size.

- **Ability to be bred in captivity** - Creatures that are reluctant to breed when kept in captivity do not produce useful offspring, and instead are limited to capture in their wild state. Creatures such as the panda and cheetah are difficult to breed in captivity.
- **Pleasant disposition** - Large creatures that are aggressive toward humans are dangerous to keep in captivity. The African buffalo has an unpredictable nature and is highly dangerous to humans. Although similar to domesticated pigs in many ways, American peccaries and Africa's warthogs and bushpigs are also dangerous in captivity.
- **Temperament which makes it unlikely to panic** - A creature with a nervous disposition is difficult to keep in captivity as they will attempt to flee whenever they are startled. The gazelle is very flighty and it has a powerful leap that allows it to escape an enclosed pen.
- **Modifiable social hierarchy** - Social creatures that recognise a hierarchy of dominance can be raised to recognise a human as its pack leader. Bighorn sheep cannot be herded because they lack a dominance hierarchy, whilst antelopes and giant forest hogs are territorial when breeding and cannot be maintained in crowded enclosures in captivity.

The association between man and livestock has undergone many changes over time and will keep changing. For example, the empire of largest geographical expansion ever, was based on transport and communication by horses (the Tartars in the 14th century). Today, non-food functions are generally in decline especially in the developed countries and are replaced by cheaper and more convenient substitutes. The following trends may be depicted:

- **Asset**: Petty cash and insurance functions that livestock provide is being replaced by financial institutions as even remote rural areas enter the monetary economy;
- **Draught**: With the notable exception of parts of sub-Saharan Africa and some areas in Asia animal draught is on the decline as more farmers mechanize;
- **Manure**: Manure continues to be important for nutrient management in mixed farming but its role in overall nutrient supply is declining because of the competitive price and ease of management of inorganic fertilizer;

- **Fibre**: Although the demand for natural fibres is still high, and in some places even increasing, there are increasingly more synthetic substitutes for wool and leather.

Table 1. Approximate dates and locations of original domestication

Species	Date	Location
Dog (*Canis lupus familiaris*)	15000 BC	East Asia
Goat (*Capra aegagrus hircus*).	10000 BC	Iran
Cat (*Felis silvestris catus*)	9500 BC	Near East
Sheep (*Ovis aries*)	9000 BC	Iraq
Pig (*Sus scrofa domestica*)	9000 BC	China
Cow (*Bos taurus*)	8000 BC	India, Middle East, and Sub-Saharan Africa
Chicken (Gallus gallus)	6000 BC	India and Southeast Asia
Guinea pig (*Cavia porcellus*)	5000 BC	Peru
Donkey (*Equus Asinus*)	5000 BC	Egypt
Water buffalo (*Bubalus bubalis*)	4000 BC	India, China
Horse (*Equus caballus*)	4000 BC	Central Asia
Dromedary (*Camelus dromedarius*)	4000 BC	Arabia
Llama (*Lama glama*)	3500 BC	Peru
Silkworm (*Bombyx mori*)	3000 BC	China
Rock pigeon (*Columba livia*)	3000 BC	Mediterranean Basin
Goose	3000 BC	Egypt
Bactrian camel	2500 BC	Central Asia
Yak	2500 BC	Tibet
Banteng	Unknown	Southeast Asia, Java Island
Gayal	Unknown	Southeast Asia
Alpaca	1500 BC	Peru
Ferret	1500 BC-	Europe
Domesticated duck	1000 BC	China
Muscovy Duck	Unknown	South America

Guineafowl	Unknown	Africa
Common carp	Unknown	East Asia
Domesticated turkey	500 BC	Mexico
Goldfish	Unknown	China
European Rabbit	1600	Europe
Second circle		
Zebu	8000 BC	India
Honey bee	4000 BC	Multiple places
Asian Elephant	2000 BC	Indus Valley civilization
Fallow Deer	1000 BC	Mediterranean Basin
Indian Peafowl	500 BC	India
Barbary Dove	500 BC	North Africa
Japanese Quail	11001900	Japan
Canary	1600	Canary Islands, Europe
Mandarin Duck	Unknown	China
Mute Swan	10001500	Europe
Third circle		
Rat	1800s	England
Fox	1800s	Europe
Mink	1800s	Europe
Budgerigar	1850s	Europe
Zebra Finch	1900s	Australia
Hamster	1930s	United States
Muskox	1960s	United States
Deer	1970s	New Zealand
Hedgehog	1980s	United States

Source: History of Domestication. Http:/en.wikipedia.org/wiki/

4.0 IMPORTANCE OF LIVESTOCK

4.1. Global Importance

Although economically not a major global player, the livestock sector is socially and politically significant. It accounts for 40 percent of agricultural Gross Domestic Product (GDP). It employs 1.3 billion people and creates livelihoods for one billion of the world's poor. Livestock products provide one-third of humanity's protein intake and a potential remedy for undernourishment. Growing population and incomes, along with changing food preferences, are rapidly increasing demand for livestock products, while globalization is boosting trade in livestock inputs and products. Global production of meat is projected to more than double from 229 million tonnes in 1999/2001 to 465 million tonnes in 2050, and that milk will grow from 580 million tonnes to 1043 tonnes.

The importance of livestock in the agricultural sector has been emphasised in a number of publications, notably, *Livestock production: a world perspective* (FAO, 1982a), *The role of ruminant livestock in food security in developing countries* (FAO, 1992a), *Livestock and improvement of pasture, feed and forage* (FAO, 1993a) and *Strategies for sustainable animal agriculture in developing countries* (FAO, 1993b). Below are some highlights of the contribution of livestock to man.

4.2 Food

Animal source foods can provide a variety of micronutrients that are difficult to obtain in adequate quantities from plant source foods alone. Reports indicate that 38.3% of children under the age of five in Nigeria suffer from malnutrition (FAO, 2003). Murphy and Allen (2003) identified six micronutrients that were particularly low in the primarily vegetarian diets. (Tables 2 and 3). These include vitamin A, vitamin B-12, riboflavin, calcium, iron and zinc. Negative health outcomes associated with inadequate intake of these nutrients include anemia, poor growth, rickets, impaired cognitive performance, blindness, neuromuscular deficits and eventually, death. Animal source foods are particularly rich sources of all six of these nutrients, and relatively small amounts of these foods, added to a vegetarian diet, can substantially increase nutrient adequacy. Plate 1 shows children with symptoms of protein deficiency.

Animal Sources of Food (ASF) tend to be richer sources of the vital nutrients. Not only are these foods high in many micronutrients, but the nutrients often are more available. Both iron and zinc are more bio-available in animal foods. In addition, the bioavailability of carotenoids as vitamin A precursors is now believed to be lower than indicated in traditional food composition tables (Institute of Medicine, 2001). Thus, for diets that depend on plant sources of vitamin A, more fruits and vegetables are needed to meet requirements than was thought previously. In the case of vitamin B-12, all requirements must be met from ASF, as there is virtually no vitamin B-12 in plant source foods.

Plate 1. Many of the children in this photograph show symptoms of protein malnutrition
Source: http://en.wikipedia.org/wiki/Image:Kwashiorko

Table 2. Composition of selected foods (per 100 g)

Nutrient	Plant sources			Animal sources	
	Maize, cooked	Beans, cooked	Carrots, raw	Milk, Whole, unfortified	Beef, cooked
Energy (*kcal*)	119	127	45	51	269
Protein (*g*)	2.7	8.7	1.1	3.3	24.9
Vitamin A (μg RAE)[3]	0	0	971	55	0
Vitamin B-12 (μg)	0	0	0	0.39	1.87
Riboflavin (*mg*)	0.07	0.06	0.06	0.16	0.15
Calcium (*mg*)	2	28	31	119	4
Available iron (*mg*)	0.12	0.15	0.06	0.01	0.32
Available zinc (*mg*)	0.12	0.11	0.14	0.18	2.05
Fat (*g*)	1.2	0.5	0.2	3.9	18
Saturated fat (*g*)	0.2	0.1	0.0	2.4	8.4
Cholesterol (*mg*)	0	0	0	14	75

Source: Murphy and Allen, 2003

Table 3. Percentage of nutrient intake supplied by three snacks

Nutrient	Recommended Intake	Cereal only (%)	Cereal + milk (%)	Cereal + beef (%)
Energy	1600 kcal	20	20	20
Protein	17.3 g	62	73	124
Vitamin A	400 RAE	53	70	17
Vitamin B-12	1.2 μg	0	83	106
Riboflavin	0.6 mg	25	82	27
Calcium	800 mg	4	38	2
Available iron	1.86 mg	11	5	26
Available zinc	1.44 mg	12	12	86

Source: Murphy and Allen, 2003

Murphy and Allen (2003) remarked that animal sources of food can fill multiple micronutrient gaps at a lower volume of intake than can plant source foods. They found that just 100 g of cooked beef provided an entire day's recommended intake of protein, vitamin B-12 and zinc and contributes substantially to meeting the riboflavin and iron recommendations. Likewise, 100 g of milk also provided substantial amounts of calcium, vitamin B-12, vitamin A and riboflavin. Thus, small amounts of ASF added to a vegetarian diet can compensate for many of the vitamin and mineral inadequacies. Furthermore, ASF provided multiple micronutrients simultaneously, which may be important in diets that are marginally lacking in more than one nutrient. For example, vitamin A and riboflavin are needed for iron mobilization and haemoglobin synthesis, and iron supplements may not reduce the prevalence of anaemia if intakes of these other nutrients are low (Allen, 2002). Thus, foods such as liver that contain substantial levels of both iron and pre-formed vitamin A may be more effective than single-nutrient supplements in alleviating poor micronutrient status.

4.3 Livestock as a source of income

Animal products not only represent a source of high-quality food, but, equally important, they are a source of income for many small farmers in developing countries, for purchasing food as well as agricultural inputs, such as seed, fertilizers and pesticides. In many poor regions, the rural poor depend heavily on income from livestock production. Paradoxically, the poor can seldom afford to eat animal products and usually trade them for staples with lower costs per calorie.

The agricultural sector remains one of the largest contributors to world economy. In Nigeria, agriculture accounts for over 38% of the non-oil foreign exchange earnings, and employing about 31% of the total labour force (FAO, 2003). As a component of agriculture, the livestock sector has considerable potential of contributing towards national economy

Over 3 million Nigerians depend primarily on livestock for their survival. Additional employment is generated by the livestock sector through specialised services and inputs required such as feed production, transportation, processing, and marketing of livestock products. Livestock can employ labour during periods of slack in other agricultural activities. Furthermore, livestock diversify production and income, provide year-round employment, and spread risk.

As in most developing countries, the share of agriculture in GDP is important in Africa, rising from 7.6 and 9.5% for Gabon and Congo, which are oil exporters, to 57 and 60% in Niger and Burundi (Jahnke, 1988). The average for all countries in tropical Africa is 29%. Traditionally, the share of livestock in agricultural GDP has been important to many African countries, rising from 2.2 and 2.3% for Gabon and Cote d'Ivoire, to 35.7% for Zimbabwe, 38.7% for Chad and even 81.6 and 86.3% for Somalia and Mauritania, with an average value of 17.4%. The average contribution of the livestock sector to the total GDP is 5.0% in tropical Africa. The gross value of meat represents 47% of the total value of all edible livestock products of tropical Africa, while milk represents 15% and draught power is an intermediate product at 31% (ILCA, 1987).

FAO (1992b), in a study in Nigeria found that an estimated 183,000 rural households derived some income from the dairy industry in 1986. The industry, through commercial dairy processing plants and marketing segments, provides employment and value. In this wise the livestock sector is important in providing employment for these groups even if its contribution to output and economic development is relatively low. For a country such as Nigeria, with both urban and rural unemployment and a declining foreign exchange base, the contributions of livestock to employment should be seen to be important.

An important feature of dairy income is its regularity. India's dairy development programme "Operation Flood" has created cooperatives that pay daily for the milk delivered, thereby providing regular income to thousands of poor farmers. An FAO/United Nations Development Programme (UNDP) dairy project in Burkina Faso assisted 100 families in increasing their monthly income by about US$80, which is

equivalent to an extra labour unit per family. In many countries, the provision of animal draught power services for cultivation, transportation and the pumping of irrigation water is an important source of income that is particularly beneficial to landless owners of cattle or buffalo.

Livestock also provide increased economic stability to the farm or household, acting as a cash buffer (small livestock) and as capital reserve (large animals), as well as a deterrent against inflation. In mixed-farming systems, livestock reduce the risks associated with crop production. They also represent liquid assets that can be realised at any time, adding further stability to the production system.

The importance of livestock as a source of income for poor farmers is illustrated by the example of the Grameen Bank in Bangladesh, which assists only the poorest segment of the population and provides about 50 percent of its loans for the purchase of livestock, mainly large ruminants for milk production and draught power (Hossain, 1988).

A broad variety of evidence from case studies in Africa, Asia, and parts of Latin America shows that the poor and landless derive a higher share of their house hold income from livestock sources than do the relatively better- off in the same rural communities. In Pakistan in the late 1980s, for example, Adams and He (1995) found that about 25 percent of the income of the poorest 20 percent of rural households in their sample came from livestock. The richest 20 percent received only 9 percent of their income from livestock. In Egypt in the mid- 1970s, Fitch and Soliman (1983) found that an average of 63 percent of the income of landless or near landless house holds came from livestock. Only 14 percent of the income of large land owners came from livestock. Von Braun and Pandya-Lorch (1991) identified four countries where the malnourished get more of their incomes from livestock than those who are not malnourished.

At farm level, the importance of livestock as an income source and the actual sources of income vary across ecological zones and production systems, which in turn determines the species raised and the products and services generated. Cash can be generated from sales of livestock products regularly (milk, eggs) or sporadically (live animals, wool, meat, hides) or from services (draught, transport). Dairy produce is the most regular income generator particularly for women (Plate 2). Dairy development has been shown to increase income, consumption and repayment capacity in India (Kulkarni, Bhatta and Kumar, 1989; Saini, Singh and Patel, 1989) and in Nigeria (Nwoko, 1988; Yahuza, 2002).

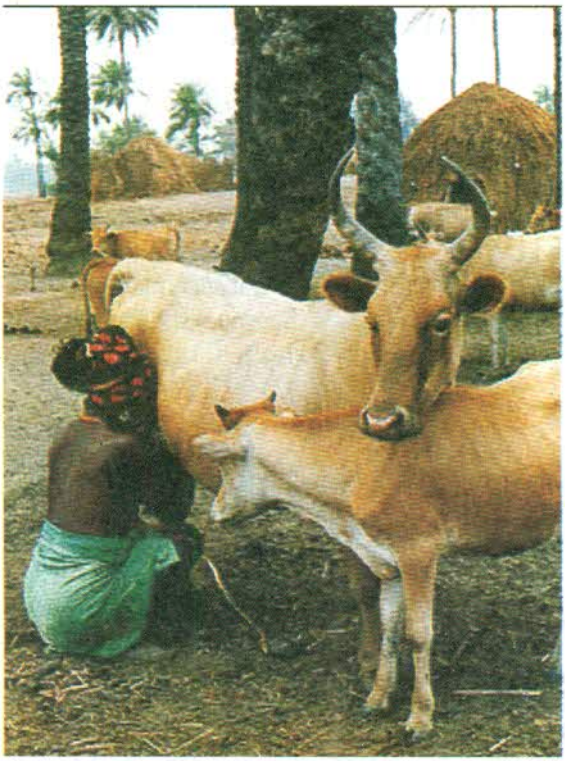


Plate 2. A Fulani woman milking cows

In small holder crop-livestock systems in the Ethiopian highlands livestock accounted for 34-87 percent of total cash income from crops and livestock. Crops are more often a subsistence enterprise. The livestock share in cash income was higher in those villages where total cash income was higher indicating that increased cash income came primarily from livestock (Gryseels, 1988; Asamenew, 1991; Omiti, 1995). In semi-arid Mali, livestock contributed 78 percent of cash income from crops and livestock on small holder mixed farms (Debrah and Sissoko, 1990).

In many societies, women have specific family responsibilities and ownership of livestock and access to livestock products for sale helps them in these functions (Adama and Kolo, 2003). In southern Nigeria 41 percent of 5460 sales of small ruminants in four village markets over a period of 14 months were by women. Although both male and female sellers sold primarily for cash needs (55 percent of sales), cash needs for buying food and clothing were a more prominent reason for sale by women (Jabbar, 1995).

4.4 Livestock as a Generator of Employment

At farm level, dairying is a labour-intensive activity, involving women in both production and marketing. Labour typically accounts for over 40 percent of total costs in smallholder systems. It has been estimated that for each 6 to 10 kg of additional milk processed per day in India, one working day is added for feeding and care. Data from Kenya show that smallholder production there is in the order of 25 kg per working day.

Similar levels were experienced on parastatal dairy farms in Zimbabwe. Goat, sheep, poultry and rabbit husbandry, especially in backyard production systems, provides an important source of part-time job opportunities, particularly for landless women and children.

The livestock-product processing sector has also been identified as a contributor to employment generation and in the reduction of rural depopulation. Small-scale milk processing/marketing is labour-intensive (50 to 100 kg per working day) and generates employment and income from the local manufacture of at least part of the equipment required. The meat sector also provides significant employment opportunities. Based on UN published data and experience from FAO projects (Sansoucy, 1997), estimates have been made of labour requirements in small to medium-sized slaughter and meat processing operations (Table 4).

Table 4. Staff requirements for meat processing/marketing operations -

Animal type	Staff requirements for 30 animals (persons/day)		
	Slaughtering	Meat marketing	Further processing
Cattle	20	4	>80
Pigs	10	2	>30
Small ruminants	3	1	-

Source: Sansoucy, R. (1997)

4.5 Livestock as a Source of Energy

4.5.1 *Draught Animal Power*

Bovines, equines, camelids and elephants are all used as sources of draught power for a variety of purposes, such as pulling agricultural implements, pumping irrigation water and skidding in forests. The current number of animals used for draught purposes is estimated at 400 million. Fifty-two percent of the cultivated area in developing countries (excluding China) is farmed using only draught animals and 26 percent using only hand tools (Gifford 1992). During the past ten years, there has been a 23-percent increase in the number of cattle and buffaloes used for draught purposes as well as for meat and milk production. During the same period, the number of equines (horses, mules and asses) used primarily for draught and transport has not changed significantly.

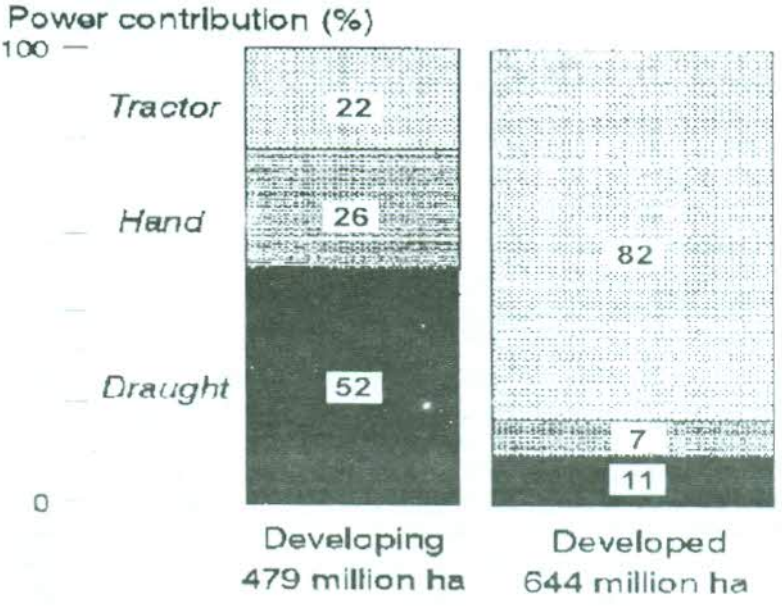


Figure 1. Livestock use in draught animal power, in developing and developed countries in 1992
Source: Wilson R T, Ehui S and Mack S (eds). 1995. *Livestock Development Strategies for Low Income Countries.*

The relative importance of draught animal power in developing and developed countries in 1992 is presented in Figure 1. Compared with the use of tractors, animal power is a renewable energy source in many developing countries and is produced on the farm, with almost all the implements required made locally. On the other hand, 90 percent of the world's tractors and their implements are produced in industrialised countries and most of those used in developing countries (approximately 19 percent) have to be imported. Animal traction, therefore, avoids the drain of foreign exchange involved in the importation of tractors, spare parts and fuel.

Draught animals remain the most cost-effective power source for small and medium-scale farmers. Draught animal power can be even more economic when one bullock is used instead of a pair or when a cross-bred cow is used instead of a male, since it reduces the cost of maintaining the larger herd necessary to satisfy both replacement and milk production requirements. It is expected that draught animal power will gradually decline in importance (FAO, 1987).

4.5.2 Dung for Fuel

In many countries, cow dung is highly valued as fuel for cooking and heating, reducing

expenditures for fuelwood or fossil fuels. It represents the major fuel supply for household use by millions of farmers in Asia, Africa and in parts of the Near East and Latin America. In India alone, 300 million tonnes of dung are used for fuel every year. The collection and drying of dung for cooking generates income for women. It is also used directly as plaster and other building materials, while its ash can be used as fertilizer.

4.5.3 *Biogas Production*

Biogas production from manure is an excellent substitute for fossil fuel or fuelwood for farmers in tropical countries. The best manure for these purposes comes from (in descending order) pigs, cattle, horses, camels and poultry (Kumar and Biswas, 1982). Twenty-five kilograms of fresh cow dung produces about 1 m^3 of biogas. Simple low-cost plastic bio-digesters have recently been developed in Cambodia, the United Republic of Tanzania and Vietnam through a number of FAO/Technical Cooperation Programme (TCP) projects. On-farm biogas production reduces the workload of women by eliminating wood collection or fuel purchasing. It is person-friendly because of its convenience and increased hygiene, and it also provides a number of services, such as lighting, warm water and heating. Biogas can also be used to drive machinery such as water pumps. Effluent from bio-digesters can be recycled as fertilizer - with even better results than the original manure (Talukder, Ali and Latif, 1988) - or as a fish feed, or it may be used to grow azolla and duckweed. Biogas technology has been successfully adopted by millions of farmers in developing countries; about 25 million people use it in China alone (Marchaim, 1992). New simple technology should be promoted to extend biogas development. Biodigestion has positive public-health aspects, particularly where toilets are coupled with the biodigester, and the anaerobic conditions kill pathogenic organisms as well as digest toxins, for example, botulinum toxin. In China, biogas (CO_2+CH_4) from dung has also been used to control insects in stored grains using the anaerobic reaction, without adverse effects on grain germination (Zhin and Pan, 1983).

Zero-grazing livestock production systems can be environment-friendly when feeds are grown on-farm and slurry is collected in biodigesters, the effluent of which may be used either as crop fertilizer or for fish production in ponds. For the former there is the added advantage that weed seeds have been inactivated during the digestion process.

The Grameen Bank in Bangladesh - which is very famous for its successful credit schemes for the rural poor, especially the "cattle lease" programme for many women - is now linking this activity to a biogas programme since the biodigester is considered to be the centrepiece of an integrated farming system, where the effluent entering the ponds increases fish yields by accelerating algae production.

4.6 Livestock as a Source of Fertilizer and Soil Conditioner

Chemical fertilizers are expensive. Approximately 20 million tonnes or 22 percent of total nitrogen fertilization of 94 million tonnes (FAO, 1997) and 11 million tonnes or 38 percent of phosphate is of animal origin, representing about US$ 1.5 billion worth of commercial fertilizer. One study conducted in the northern part of Nigeria showed that manure outputs of 1368 kg DM/head/year and 248 kg DM/head/year have been estimated for cattle and sheep respectively (Hendy, 1977). These outputs are a major contribution to soil fertility.

Livestock can help maintain soil fertility in soils lacking adequate organic content or nutrients (Ehui, Li- Pun and Shapiro 1998). Adding manure to the soil increases the nutrient retention capacity (or *cation exchange capacity*), improves the soil's physical condition by increasing its water- holding capacity, and improves soil structure. Animal manure also helps maintain or create a better climate for microflora and fauna in soils.

Nutrient recycling is an essential component of any sustainable farming system. The integration of livestock and crops allows for efficient nutrient recycling. Animals use the crop residues, such as cereal straws, as well as maize and sorghum stovers and groundnut haulms as feed. The manure produced can be recycled directly as fertilizer. One tonne of cow dung contains about 8 kg N. 4 kg P_2O_5 and 16 kg K_2O (Angé, 1994). The chemical composition of manure varies, however, according to the animal species (poultry manure appears to be a more efficient fertilizer than cow manure) and also to the nature of their diet. For example, farmers in Cambodia and the Niger have observed that they obtain more rice grain when they use manure from animals fed on urea-treated straw (because of its higher nitrogen content) than when they use that derived from animals fed on untreated straw. It has been estimated that, in the semi-arid tropics, less than 6 percent of the cropped area receives an average application of 10 tonnes of manure per hectare every year. In the humid tropics, up to 12 percent of the cropped area may be manured at this level. In addition to the direct contribution of plant nutrients, manure provides important organic matter to the soil, maintaining its structure, water retention and drainage capacity. The value of manure is so well-recognised that some farmers keep livestock primarily for this purpose.

The cultivation of legume fodders and trees, for example, in alley farming systems, also contributes to the enrichment of soils through nitrogen fixation. Soybeans in the humid tropics can supply 40 kg of nitrogen per hectare, although this contribution varies considerably with the species. In systems using sugar cane as livestock feed, for example, in Colombia and Vietnam, it has been demonstrated that the recycling of dead leaves into the soil (instead of burning them) favours the fixation of nitrogen by bacteria and reduces weed growth and water evaporation, thus increasing the yield of the subsequent harvest.

4.7 Livestock and Weed Control

Livestock can be successfully used for weed control and therefore contribute to the decrease of water pollution by herbicides. The fossil energy that would otherwise be used for making and spreading herbicides is also saved. Livestock are currently used in sugar-cane, oil-palm, coconut, rubber, citrus, kola and mango plantations. While grazing in these plantations, the livestock, most commonly sheep, also provide organic fertilizer. Other species also useful for weed control are geese, which are used in India, and horses, which, because of a herbicide shortage, have been used successfully in Cuba in citrus plantations to control such weeds as *Panicum maximum* and *Hyparrhenia rufa* that have a very negative effect on orange yields.

Sheep are also used in many countries in the Mediterranean basin to reduce forest undergrowth so that the risk of fire during summer is diminished. In rubber and oil-palm plantations in Malaysia, the integration of livestock to utilise the vegetative ground cover under the tree canopy has been shown to increase overall production and save up to 40 percent of the cost of weed control (Chen, Ahmad, Wam, Tajuddin and Salleh, 1988). Similarly, sheep have been used to control weeds in sugar-cane fields in Colombia (Carta Asolucerna, 1994), suppressing the cost of herbicides, reducing by half the total cost of weed control and providing an additional income from meat production. Such systems also safeguard the environment and avoid chemical pollution while supplying additional organic material to the soil.

4.8 Livestock-recycled secondary products, household and industrial wastes

Not only can manure be recycled for biogas and fertilizer, but it can also be a valuable source of feed for other animal species. For example, poultry manure is commonly used for ruminant feeding and poultry and pig manures can be used to generate algae as a feed for fish. By-products such as slaughterhouse wastes, when adequately processed, make a good source of protein (offal and viscera) and mineral (bones) supplements in animal feeds. In developing countries, household wastes are commonly fed to pigs and small animals in backyard farming systems. In urban and peri-urban areas, restaurant and catering wastes can be readily processed for pigs, as is done in Cuba. Industrial fish waste creates pollution around canning plants. The common practice is to dry it, at a very high cost, in order to produce fish-meal, which is then usually exported to developed countries. Preservation of fish waste in molasses has proved to be an option that is technically and economically feasible for poor farmers. Such recycling makes animal agriculture systems more sustainable and environmentally sound.

4.9 Utilization of Marginal Lands and Crop Residues by Livestock

In the vast semi-arid or arid areas where crop production is extremely risky, livestock

can use vegetation that would otherwise be wasted and convert it to valuable, high-quality products. However, these are environmentally fragile areas. Over the centuries, pastoralists established complex management systems that were sustainable until the relatively recent dramatic increases in population and subsequent livestock density. Overgrazing is the main threat to these areas, and a holistic approach to resource management is necessary to avoid their permanent and irreversible degradation.

Crop residues, such as straw, are more efficiently utilized through ruminant feeding, including the production and use of manure and possibly biogas, rather than by burning them, creating pollution and contributing to global warming, or ploughing them back into the soil to improve its structure and water retention. Several hundred million head of cattle and buffaloes are fed throughout the year on rice and cereal straws.

4.10 Increasing Animal Production Saves Foreign Exchange

At present, developing countries are major importers of animal feeds (mainly coarse grains) as well as meat and dairy products. The cost of importing animal feeds into developing countries is estimated at between US$10 billion and $15 billion per year. Although exports of animal feeds are not negligible, a large proportion of them are oilseed cakes. Being an important source of bypass protein, the cakes could be put to better use locally to improve production from the national herd, which, in turn, would reduce imports of animal products. Globally, however, these data mask the fact that exports are made by relatively few, high-producing countries only. There is still substantial potential for increasing local production to save foreign exchange from import substitution and to increase rural incomes.

The situation regarding the importation of dairy products into developing countries is critical. Imports have dramatically increased during the last three decades, while exports have remained negligible (Nwoko, 1986). The prospects for local dairy production have recently become more favourable, however, following the reduction of milk production subsidies in western developed countries and the introduction of more realistic exchange rates under structural adjustment programmes. These recent changes have provided many developing countries with the opportunity to develop their own milk industries, primarily through small-scale production, which will have a major impact on different levels of cash income.

4.11 Livestock for Investment and Savings

In the rural areas of many developing countries financial services such as credit, banking and insurance are virtually non-existent. In these areas, livestock play an important role as a means of saving and capital investment, and they often provide a

substantially higher return than alternative investments. A combination of small and large livestock that can be sold to meet petty-cash requirements to cover seasonal consumption deficits or to finance larger expenditures represents a valuable asset for the farmer.

4.12 Food Security

Livestock may contribute to food security through increased output of livestock and non-livestock products and by employment and income generation that may assure access to food. According to Speltz (1997) "***Development will bring food security only if it is people-centred, if it is environmentally sound, if it is participatory, and if it builds local and national capacity for self-reliance. These are the basic characteristics of sustainable human development***."

The meaning of food security has evolved since the first World Food Conference of 1974. Although food availability has increased along with the growing human population over the last 30 years, there are still 800 million people suffering from malnutrition. This problem is not only the result of insufficient food production and inadequate distribution, but also of the financial inability of the poor to purchase food of reasonable quality in adequate quantities to satisfy their needs (FAO, 1993c). It is now accepted that food security relates to access by all people at all times to enough food for an active healthy life (Reutlinger, 1985; World Bank, 1986; FAO, 1989) Food security issues encompass the ability of people to secure enough food on a regular basis for healthy and productive lives.

Food security embraces food production, stability of supply and access to food. A remarkable characteristic, important for global food security, is the capacity of the livestock sector to draw on many different types of feed resources, and to contract and expand with resources availability and market demand (Fresco and Steinfeld, 1998). Livestock play a role in three aspects: they make a significant contribution to food production through the provision of high value protein-rich animal products; they indirectly support crop production through draught power and manure; they stabilize supply; and finally, they are the most significant source of income and store of wealth for smallholders, thereby providing access to food (Fresco and Steinfeld, 1998). Increased livestock production in developing countries may add to food security in several ways:

- First, many poor small holders will have direct access to more food of livestock origin.
- Second, increased production will keep livestock product prices down and allow low income groups access to such food. Producers should gain in the face of lower prices because livestock products are both price and income

elastic, so lower prices should increase demand, total production and farm revenue. In many countries, low income people suffer more from energy than they do from protein deficiency. Increased production and low prices may allow consumers on low incomes to increase consumption of livestock products and help overcome the energy-protein deficiency simultaneously (Lipton, 1988).

- Third, increased domestic production will reduce imports and save foreign exchange which can then be diverted to productive investment and indirectly contribute to food security. Some countries generate revenue by taxing imported goods including animal products. Taxing increased income from domestic production may serve the same purpose.

4.13 Poverty Alleviation

Nearly one billion livestock are kept by more than 600 million small farmers and herders in rural areas around the world. Most of these livestock keepers about 95 percent live in extreme poverty. Livestock produce several benefits for the poor: They provide food directly; the poor consume some of this but sell more for cash, which is then used to buy staples. For many people, animals represent savings. The sale of livestock and manure can mean quick cash in hard times. Income from livestock and their many products milk, eggs, meat, wool, leather, honey can allow poor families to put food on the table, improve their nutrition, send their children to school and purchase medicine for themselves and their animals. Selling livestock in hard times acts as a buffer against loss of other assets. Ghirotti (1999) found in a study in Ethiopia that livestock ownership is a good indicator of wealth and a predictor of the child nutritional status. The study revealed that ownership of more that three cattle is associated with high income levels and good nutritional status of the child. A major conclusion of the study was that livestock played a protective role against land degradation and poverty.

In northern Nigeria, people without livestock at the beginning of a survey had 12% less land four years later; those with livestock retained the same acreage (IFAD, 2001). Livestock also act as a kind of social glue. Loans and gifts of livestock connect people to other family members, as well as to communities and institutions. In many societies, bride dowries are paid in livestock. Livestock are used to resolve conflicts, pay debts and settle scores. A family's place in society is often measured by the amount and kind of livestock it owns. When women own livestock, their social status can be improved, empowering them to participate in decision-making.

In spite of our huge natural resources, poverty level has remained high in Nigeria. According to UNDP (2008), 92.4% of Nigerians earn less than $2 per day and 70.8% earn less than $1 per day. The Federal Government has put in place various strategies

through various agencies such as The National Economic Empowerment and Development Strategy (NEEDS). Specifically, the National Poverty Eradication Programme (NAPEP) was to tackle the poverty issue in the country. Both programmes emphasise food security and poverty reduction.

4.14 Animal Production and Wildlife Conservation

Mainly in Southern and Eastern African countries, animal production systems, both those of cattle and wildlife, have proved to be sustainable and also to preserve biological diversity. A survey taken of a group of Masai in the Serengeti National Park in the United Republic of Tanzania has demonstrated the possibility of a successful coexistence between wildlife and Masai herds within the conservation area (Homewood, Rodgers and Arnhem, 1987). In the Kenya rangelands, McDowell, Sisler, Schermerhorn, Reed and Bauer (1983) found that the conversion of an existing cattle ranch into one comprising a mixture of game and cattle was the best form of range utilization.

4.15 Other Products and Functions

4.15.1 *Hides and skin*.

The yield of hides and skin in relation to the overall weight of the slaughtered animal is approximately 6.5 percent for cattle and 10 percent for small ruminants. Pig skins are not considered a by-product since they are usually used as food. Nigeria has a strong export industry for skin. The skin of the Nigeria's Savanna Brown goat called "Moroccan leather", commands a premium in the international market, especially from

Plate 3. Traditional Nigerian leatherwork on display

Italy. The leather products industry, from raw materials (animals, hides and skin) through to the manufacturing of various leather products such as shoes, handbags, upholstery (Plate 3) has tremendous potential to generate foreign exchange and create employment, especially for women, throughout Nigeria. Local leather industry is threatened by the local consumption of hides Nigeria also has a prosperous local food market for raw hides and skin, call "*Ponmo*", which is considered a delicacy. Nigeria faces several challenges to improving its leather production and processing, in addition to the challenge of competing with "*Ponmo*" for input supply.

The global market for animal hides and skin is worth $72 billion. World production of hides and skin increased significantly between the 1960s and the 1980s, with bovine hides reaching 1.8 million tonnes (55-percent increase) and sheep and goat skin up to 220 000 tonnes (5-percent increase). Over the same period, however, production in developing countries fell; bovine hides dropped by 50 percent (down to 47 000 tonnes) and sheep and goat skin were reduced by 25 percent (down to 68 000 tonnes). Since the number of cattle and small ruminants slaughtered has not declined in developing countries, it must be concluded that hides and skin are not being fully utilised.

4.15.2 Religious, Social and Cultural Functions

Often livestock keeping has considerable religious, social and cultural significance, which may be the main reason for keeping animals in many societies. For example, distributing meat among people is considered an essential part of the Eid ul-Adha festival or "the Feast of Sacrifice", when Muslims all over the world present an animal sacrifice as an act of gratitude to God for saving the Prophet Ismail's life. The slaughtered animal meat is distributed. In Nigeria, several thousands of rams and other animals are slaughtered each yea: to commemorate the festival.

It is not always possible to attach monetary value to many of these roles. Nevertheless, they cannot be ignored, since animals for cultural or religious events may command very high prices.

Plate 4. Distribution of meat of a traditionally sacrificed animal in Pakistan
Source: http://en.wikipedia.org/wiki/Eid_ul-Adha

4.15.3 Animal by- Products

Many by-products from livestock can be used to produce many valuable items such as buttons, surgical sutures, antifreeze, chinaware, soaps, upholstery, photographic film, cosmetics, leather, brushes, sports equipment, musical instrument and several others. Among the nomadic cattle keepers, various products are obtained from their cattle, milk and blood of cattle are drunk; their meat is eaten; their fat used as food and cosmetics; their urine as cleanser; their hides make sleeping-skin, shoulder capes, anklets; their horn and hooves provide snuff holders, feather boxes and food containers; bags are made from scrota; their intestines are used for prophecy, and their chime for anointing; their droppings provide fertilizer (Iro, 2001).

5.0 ANIMAL PROTEIN CONSUMPTION AND HEALTH

5.1 The Great Debate

The exact role of diet in health and disease continues to be debated. Over the years trends in consumption of foods and nutrients have developed. Historically, animal products have played a key role in the overall health of many nations. Animal products are indicted for their role in the major "killer diseases" of developed countries such as coronary heart disease, cancer, stroke and hypertension, diabetes, and cirrhosis of the liver (Marston and Page, 1978; Lofgreen and Speckman, 1979).

The controversy over the negative effect of animal protein intake continues to dominate the scientific and medical world. ***Health Day News*** of February 11, 2008 citing a recent publication in *American Journal of Obstetrics & Gynecology* (February 2008 edition) reported that women who consume large amounts of animal rather than vegetable protein are at higher risk of ovulatory infertility. The study was conducted among 18,555 married female nurses who were monitored over an eight-year period as they attempted pregnancy or became pregnant. The researchers found that 438 women reported ovulatory infertility. High intake of animal protein increased the risk of infertility, while high intake of vegetable proteins lowered the risk of infertility. The risk of ovulatory infertility was 50 percent lower in women who consumed 5 percent of total energy intake as vegetable rather than animal protein.

Some experts have argued that policies should prevent similar over- consumption in developing countries (Brown and Kane 1994; Goodland 1997; Pimentel 1997). However, even critics of animal foods have to acknowledge that most of the nutrients consumed in the diet is less than recommended amounts that are provided by animal products. For example, calcium generally is not consumed in recommended amounts by the adult population, but 81% of the calcium in our diets is provided by animal products (75% from dairy products alone) (Marston and Page, 1978). To date, members of the scientific and medical communities do not agree completely on the dietary goals, the way they were developed, or the expected benefits which might be

derived from their adoption (Harper, 1978).

The following diseases have often been attributed to animal protein consumption:

5.2 Animal Protein and Coronary Heart Disease (CHD)

The main discussion in CHD centres around the amount and kind of dietary fat and the relationship of this diet component to serum cholesterol (a risk factor for CHD). The effectiveness of dietary change alone to control CHD is not agreed upon by all scientists (Select Committee on Nutrition and Human Needs, U. S. Senate, 1977). Several epidemiological studies within homogenous populations have failed to demonstrate significant associations between individual nutrient intakes and either blood lipids or CHD risk within that population (Glueck and Connor, 1978). While some drug treatments may lower cholesterol in serum modestly and reduce the incidence of nonfatal heart attacks in subjects with initially high serum cholesterol, the effectiveness of this lowering on mortality from CHD was not demonstrated (Oliver, 1978). Likewise, the use of dietary manipulations to decrease cholesterol in blood and in turn delay or prevent the incidence of CHD, remains an area of active research. As an example, the National Heart, Lung, and Blood Institute of United States currently is supporting large clinical trials aimed at evaluating the effect of diet and other variables on the primary risk factors in CHD. One of the questions as yet unanswered is whether specific lowering of blood cholesterol through changes in diet of the average American will prevent CHD

5.3 Animal Protein and Cancer

In recent years the relationship of diet to various forms of cancer has been examined (Alcantara and Speckmann, 1976). Almost no food has been exempted from examination since diet represents an environmental factor which can be modified in studies of cancer. Generally, diet is believed to influence organ susceptibility and response to other causative cancer factors (Alcantara and Speckmann, 1976). At this point, various foods or nutrients are not believed to be carcinogens themselves. Epidemological studies show incidence of certain forms of cancer correlates with diets high in animal foods such as meat. However, these same diets tend to be low in fiber. It is conceivable that what the diet does not contain could be just as critical as what it does contain. To date, most studies on diet and cancer have been with animals, and results often have been conflicting

5.4 Animal Protein and Obesity

The trend to overconsumption and decreased physical activity has made obesity the most widespread nutritional problem in the developed countries. This condition also represents the common denominator of many nutrition-related public health problems (Lofgreen and Speckman, 1979). It is a risk factor in CHD, cancer, hypertension, atherosclerosis, diabetes, arthritis, and other diseases. To control body weight one

must control excessive calorie intake and/or increase caloric expenditure (i.e. exercise). In controlling calorie intake the question is often where to cut back on calories in the diet. The wisest choice is to consider sources of nutrients in relation to calories. Animal products provide many essential nutrients in relatively large amounts in relation to total calories provided. Thus, animal products have high nutrient density. On the other hand, fats, oils, sugars, and sweeteners provide a large proportion of total calories but few additional nutrients. These foods would have low nutrient density. Thus, to control obesity, intake of low nutrient-dense foods should be decreased.

5.5 Animal Protein and Iron-Deficiency Anemia

Surveys have indicated an inadequate iron intake by some segments of the population, particularly young children and young women (Lofgreen and Speckman, 1979). Animal products such as meat are excellent sources of dietary iron in a form which has high bioavailability.

5.6 Animal Protein and Bone Disease

Decreased density of skeletal bone (osteoporosis) and alveolar bone (periodontal disease) in advancing age resulting in bone fractures indicate that calcium intake and/or dietary factors affecting bone development may be lacking (Albanese, Edelson, Lorenze, Woodhull and Wein 1975). Or, there may be an excessive intake or altered ratio of factors adversely affecting bone integrity (Lofgreen and Speckman, 1979). Of all foods, dairy foods are the major dietary source of calcium ((Marston and Page, 1978).

Relative to these latter two health concerns, recommendations to increase dairy food consumption for its bioavailable calcium and to increase meat consumption for its bioavailable iron would go far in improving our inadequate or marginal nutritional status of these nutrients.

5.7 Inconclusive Evidence

Scientific conclusions about the effects animal products can have on nutrition in developing countries not only depend on the demographic and income levels of target groups and the commodities under study (CAST, 1997), but they vary also because of the methodologies employed (Hu and Willett 1998). One often cited approach to studying the link between meat consumption and health relies on correlations between disease rates and patterns of livestock product consumption across locations. A prominent example is a study that looked at such correlations across 65 counties of rural China (Chen, Campbell and Peto, 1990). Hu and Willet (1998) conducted a thorough review of the relationship between consumption of animal products and the risk of chronic disease for the World Bank. The goal was to sort through conflicting evidence in order to provide guidance to the World Bank's investment policies in

developing countries. They drew in evidence from all over the world, assuming that while diets and nutritional needs change across environments and work regimes, human biology probably does not. Yet while this approach raises issues quickly and exploits large amounts of data, its reliability is open to question as Chen, Campbell and Peto (1990) themselves pointed out.

The China study could not fully control for other variables that might also explain the results. Hu and Willett (1998) found that red meat consumption beyond a low threshold level probably increases the risks of coronary heart disease (CHD); dairy products may also do so but to a lesser extent; eggs are probably unrelated to CHD up to one egg a day; and poultry and fish probably decrease CHD. Moderate red meat intake, however, may reduce the risk of hemorrhagic stroke in cases where initial intake levels are very low. High levels of red meat intake may increase the risk of various forms of cancer, but substitution of poultry and fish for red meat probably reduces the risk. Dairy products may be a risk factor in prostate cancer. Hu and Willett (1998) concluded that health policy in developing countries should distinguish poultry and fish from beef and pork because the former probably provide greater nutritional benefit than the latter. They also saw benefits from expansion of egg and dairy consumption where consumption levels are as slow as they are in developing countries.

Perhaps the best way to conclude the matter is to compare countries with high animal protein intake in terms of prevalence of nutritional deficiency diseases, infant and child mortality, life expectancy and the general wellbeing of the majority of the population (Table 5 and Figures 2-5). Taking the United States of America as an example, during the past half century, nutritional deficiency diseases have been reduced greatly, most infectious diseases are controlled effectively, infant and child mortality have decreased steadily, and life expectancy has increased by 20 years (Leveille, 1977; Leveille, 1978). The American diet has had an impact on these trends, and animal products have been and will continue to be a prominent part of the American diet. In any case, one will have to die one day, with or without animal protein intake!

Table 5. **Vegetable and animal sources of energy in the diet (kcal per capita per day)**

Region	1967 - 1969			1977 - 1979			1987 - 1989			1997 - 1999		
	Total	Veg.	Anim.	Total	Veg.	Anim.	Total	Veg.	Anim.	Total	Veg.	Anim.
Developing countries	2059	1898	161	2254	2070	184	2490	2248	242	2681	2344	337
Transition countries	3287	2507	780	3400	2507	893	3396	2455	941	2906	2235	671
Industrialised countries	3003	2132	871	3112	2206	906	3283	2333	950	3380	2437	943

Veg, kcal of vegetable origin; Anim, kcal of animal origin (including fish products).

Source: FAOSTAT, 2003.

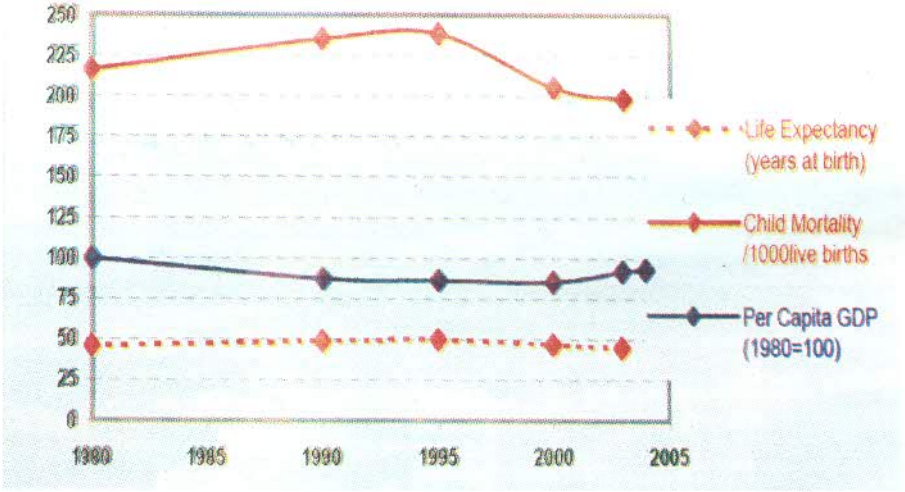


Figure 2. Life Expectancy, Child Mortality and Per Capita Product - Nigeria
Source: FAO, 2007

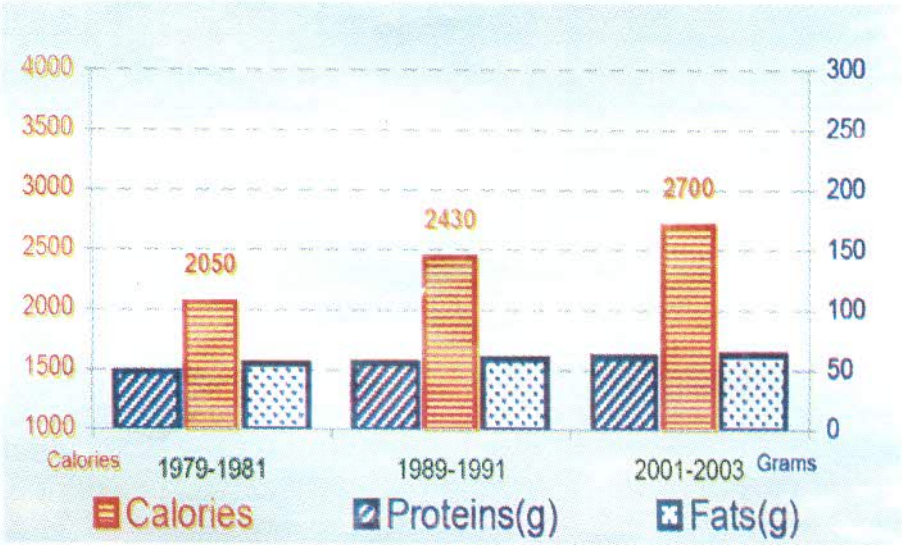


Figure 3. Per Capita Daily Consumption - Nigeria
Source: FAO, 2007

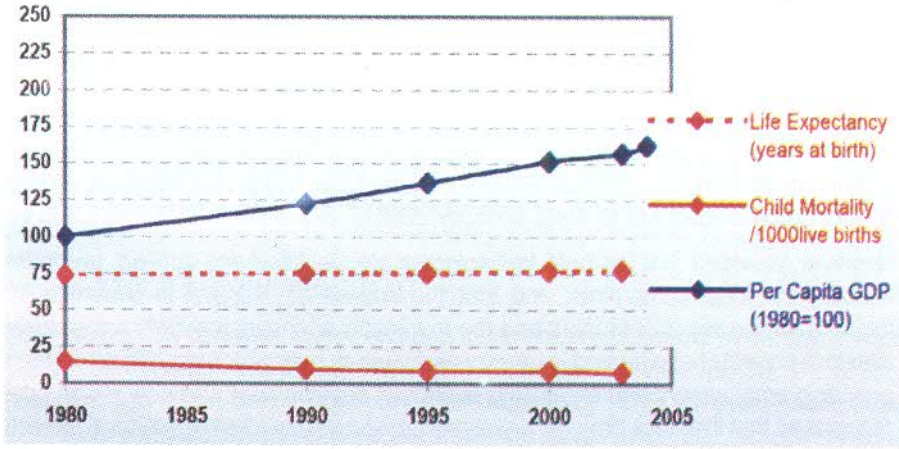


Figure 4. Life Expectancy, Child Mortality and Per Capital Product - USA
Source: FAO, 2007

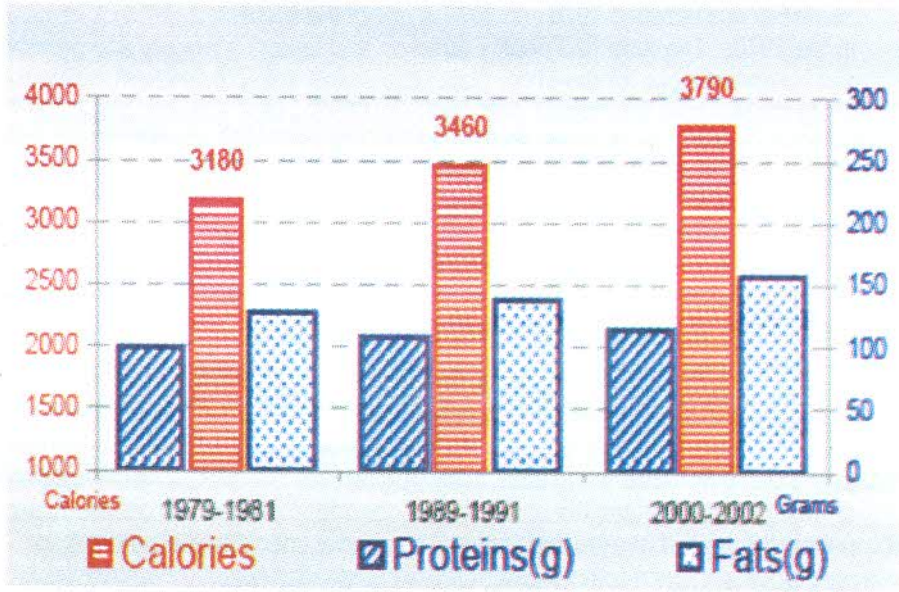


Figure 5. Per Capita Daily Consumption - USA
Source: FAO, 2007

6.0 APATHY ABOUT LIVESTOCK PROJECTS

In spite of the contribution of animals to both agricultural and overall economic development, the sector has suffered much neglect even among funding agencies. Livestock projects have a bad reputation among development banks and institutions, which have become reluctant to fund livestock projects. It is believed that livestock eat cereals that would be better used for feeding people; livestock cause environmental deterioration; livestock products are not indispensable in the diet; livestock projects are not viable in economic terms (Sansoucy, 2001).

However, provided that the right technologies are identified and applied, taking into account the local constraints, and that the appropriate support in expertise, the logistics for the supply of inputs and the marketing of animal products are ensured, livestock projects have proved to be very profitable, in both economic and social terms providing employment and enhancing economic development. It is now more widely recognised that livestock projects are as successful as any other agricultural projects, if not more so.

The following are some examples of successful projects.

- **Temu Integrated Livestock Complex**, Epe, Lagos State where I did my National Youth Service between 1976 and 1977 is one of the successful livestock ventures in the 1970s. The farm had poultry (chicken and turkey) a piggery and provided both meat and eggs for the whole state. The project also provided employment to many people in the locality and yielded revenue for the state government.
- **Dabban Sheep Breeding and Improvement Centre**, Niger State is another example of a livestock project which made impact on the immediate community and the society at large. Between 1978 and 1979 when I was the Livestock Officer in-charge, the centre stocked an impressive number of both local and exotic breeds of sheep. It became a centre of attraction to many research stations such as National Animal Production Research Institute, Shika.
- **Operation Flood in India**, which promotes dairy development among small or landless farmers, has established a modern and efficient dairy industry in that country.
- **Uganda Dairy Scheme**. In Uganda, a dairy project has successfully developed milk production around Kampala under difficult conditions, while small cheese-making units in the region have provided several hundred women with jobs and income.
- **China Beef Project**. Located in the Hebei and Henan provinces, this project has become the most important beef producers of China. Producers use local resources, such as cereal straw treated with urea, adequately supplemented with

cottonseed cake. Strategies for on-farm testing and field support activities were similar (but applied on a much larger scale!) to those implemented in another successful beef-fattening project in northern Tunisia in the 1970s.

- **The New World Screw Worm (NWS) project in North Africa** which, using environmentally safe biotechnology, successfully eradicated this threatening pest from the region in less than four years, has been a remarkable example of efficient organization and cooperation between donors and United Nations executing agencies.

7.0 LIVESTOCK AND ENVIRONMENT

Over the last few decades, there has been much emphasis placed on the detrimental effects of livestock on the environment especially in view of the increasing desertification in the Sahel region of Africa (Adefolalu, 1986). Livestock have been blamed for water pollution in Europe, deforestation in South America, desertification in Africa and, at the global level, for increasing the greenhouse effect and for reducing biological diversity as well as for feeding on grain (produced in a non-sustainable way) that could be better utilised directly by humans. These detrimental effects, however, are essentially generated by the way livestock have been managed recently, mostly on a short-term profit basis with no concern for sustainability.

Livestock are often accused of contributing to environmental degradation in different ways. Livestock have also been charged with wholesale devastation of African rangelands and irreversible destruction of soils - desertification" (Winrock International Institute, 1992). One classic example is the deforestation in the Amazon to produce grazing land, which has attracted much attention from ecologists and the mass media. Yet clearly it is not the animals that cut down the trees! Another example is that of the long-term overgrazing of semi-arid rangelands, which has led increasingly to desertification. It is well known, however, that sound resource management could avoid this deterioration of the environment while maintaining a productive system.

It would appear as if livestock themselves go out and decide to destroy or not to destroy our environment. Two centuries after the age of enlightenment we are still in need of a scapegoat, literally. The responsibility lies with the business people who cause irreversible damage by destroying the forests to plant pastures for short-term financial gain. Livestock do not move, produce or reproduce without human beings wanting it. They are completely dependent upon us and inseparable. Livestock do not degrade the environment; humans do. As a result of these misconceptions about livestock development, institutions and governments *continue to miss opportunities* which would permit the livestock sector to make its full contribution to environmental protection.

Rather than blaming livestock it should be noted that historically, livestock have played a critical role in the process of agricultural intensification. Livestock recycle nutrients on the farm, produce valuable output from land that is not suitable for sustained crop production, and provide energy and capital for successful farm operations. The integration of livestock and crop operations is still the main avenue for sustainable intensification of agriculture in many regions of the developing world. This is especially true in semi-arid and sub humid savanna areas receiving 600 to 1,200 millimetres of annual rain fall. Much of the interior of West, East, and Southern Africa, Northeast Brazil, and much of South Asia belong to this agro-climatic category (Sawadogo, Lewis and McCalla, 2006)

Livestock typically contribute to environmental sustainability in mixed farming systems that strike a proper balance between crop and livestock intensification. In these systems, livestock provide the manure and draft power to sustain intensive crop production. Grazing animals can improve soil cover by dispersing seeds with their hoofs and through manure, while controlling shrub growth, breaking up soil crusts and removing biomass which otherwise might provide fuel for bush fires. All these impacts stimulate grass tillering, improve seed germination and thus improve land and vegetation.

Animals are a crucial link in nutrient cycles, returning nutrients to the soil in forms that plants can readily use. They can bring nutrients from pasture and rangeland and concentrate them on crop land through their manure and urine. The animal manure and urine that people in the developed world see as pollutants are vital fertilizers in the developing world. Few smallholders can afford enough mineral fertilizers. Animals give farmers a reason to plant legumes as pastures and cover crops that protect the soil and restore its structure and fertility. According to a Winrock International Institute, (1992), the greatest threat to rangelands comes from human populations and expansion of cultivation.

Increasing the productivity of livestock systems and mixed crop-livestock systems motivates farmers to protect their rangelands and use them sustainably for raising livestock rather than putting them to the plough. Productive livestock can add value to 'idle' land. If livestock are managed in an appropriate way, they can even contribute to the reduction of soil erosion. The use of perennial fodder trees and high biomass fodders (sugar cane) and the establishment of fodder hedgerows on the contour provide excellent protection against erosion and should be established practices. Agro-sylvo-pastoral systems in semi-arid areas are a viable proposition for the protection of the fragile soils of these regions. Multipurpose trees contribute to the protection of the soil, as well as to animal and energy production, and store carbon that would otherwise contribute to atmospheric carbon dioxide (Steifeld, Gerber,

Wassesnaar, Castel, Rosales and de Haan, van Veen, Brandenburg, Gauthier, le Gall, Mearns and Simeon, 2006).

It is also a criticism of ruminant production that the animals contribute to the greenhouse effect, since they produce methane as an end-product of rumen digestion. It should be recognised, however, that ruminant populations have increased only moderately compared with those of other species, and that their contribution is estimated at just 2.5 percent of the total greenhouse gases (Leng, 1993). Gas emissions from cars and industry are far greater and have increased at a much higher rate. There are two ways to reduce methane emission from livestock: by introducing an appropriate diet supplementation that could reduce ruminant methane production per unit of milk or meat by a factor of 4 to 6, and by favouring the production of meat from monogastric animals.

The third complaint about livestock is pollution resulting from accumulated excreta and nitrite-contaminated groundwater. This is primarily a problem with intensive, industrialised production systems. It can be reduced by implementing manure processing technologies as well as nutrition and feeding strategies that reduce the amount of nitrogen and phosphorus in the diet of animals. It could also be controlled by limiting the size of such enterprises to that which allows excreta to be easily accommodated on neighbouring lands or used for fertilizer products. Small holders usually cause less pollution than large intensive units.

8.0 GLOBAL TRENDS IN ANIMAL PROTEIN INTAKE

The 23 percent of the world's population living in developed countries presently consume three to four times the meat and fish and five to six times the milk per capita as those in developing countries (Delgado, Courbois and Rosegrant 1998). But this pattern is changing. People in developing countries have increased their consumption of animal food products over the past 20 years. From the early 1970s to the mid 1990s, consumption of meat in developing countries grew by 70 million metric tonnes, whereas consumption in developed countries grew by only 26 million metric tonnes (Table 6). In value and caloric terms, meat consumption in developing countries increased by more than three times the increases in developed countries. Milk consumption in the developing countries increased by more than twice when compared with milk consumption in the developed countries. Between 1983 and 1993, per capita annual meat consumption rose from 14 to 21 kilo grams and milk consumption grew from 35 to 40 kilograms. During the same period per capita consumption of meat in developed countries rose by only 2 kilograms while per capita milk consumption fell.

In developed countries people obtain an average of 27 percent of their calories and 56

percent of their protein from animal food products (Table 7). The relative share of calories and protein coming from meat is also much lower in developing countries than in developed ones. Consumers obtained a greater share of calories and protein from animal food products in 1993 than in 1983 (Table 8). During this period, people in the developing countries obtained an average of 11 percent of their protein and 26 percent, of their calories from animal food products. Table 9 shows that intake of major nutrients such as calories, protein and fat have continued to increase in the developing countries compared with the developed countries.

Table 6. Increase in food consumption of meat, milk, fish, and major cereals, 1971-95

Commodity	Consumption increase		Value of consumption increase		Caloric value of consumption increase	
	Developed	Developing	Developed	Developing	Developed	Developing
	(million metric tonnes)		*(billion 1990 US$)*		*(trillion kilocalories)*	
Meat	26	70	37	124	38	172
Milk	50	105	14	29	22	64
Fish	5	34	27	68	4	20
Major cereals	25	335	3	65	82	1,064

Source: FAO, 1998

Table 7. Percent of calories and protein from animal products, 1983 and 1993

Region	Calories from animal products		Calories from animal products	
	1983	1993	1983	1993
	(percent)			
China	8	15	14	28
Other East Asia	11	15	29	38
India	6	7	14	15
Other South Asia	7	9	19	22
South east Asia	6	8	23	25
Latin America	17	18	42	46
WANA	11	9	25	22
Sub- Saharan Africa	7	7	23	20
Developing world	9	11	21	26
Developed world	28	27	57	56
World	15	16	34	36

Source FAO. 1997

Table 8. Per capita meat and milk consumption by region, 1983 and 1993

Region	1983	1993	1983	1993
	Meat		Milk	
	(kilograms)			
China	16	33	3	7
Other East Asia	22	44	15	16
India	4	4	46	58
Other South Asia	6	7	47	58
Southeast Asia	11	15	10	11
Latin America	40	46	93	100
West Asia & North Africa (WANA)	20	20	86	62
Sub-Saharan Africa	10	9	32	23
Developing world	14	21	35	40
Developed world	74	76	195	192
United States	107	118	237	253
World	30	34	76	75

Source FAO. 1997

Asia witnessed the most dramatic increases in per capita consumption of animal food products. Through out Asia, the share of calories and protein coming from animal food products increased, almost doubling in China, indicating that many consumers are increasing capita consumption of meat and milk in developing countries. In China, per capita consumption of meat and milk doubled between 1983 and 1993 (Table 7). Per capita meat consumption also increased in Other East Asia, South east Asia, and Latin America. Per capita milk consumption increased in India, other South Asia, and Latin America. At the regional level, people in Sub- Saharan Africa, West Asia and North Africa (WANA), South east Asia, Other South Asia, and India get a third or less than a third as many calories and half as much protein from animal products as people in developed countries.

The rapid growth in consumption of food from animals has not been and is not likely to be evenly distributed across regions or even within countries. Since the early 1980s, most growth in consumption of meat and milk has occurred in the rapidly developing countries of East and South East Asia and to a lesser extent in Latin America. Africa has lagged behind, as has India in the case of red meat, although India has recently witnessed rapid growth in milk and poultry consumption. Most African countries have low animal protein intake. In Sub- Saharan Africa and West Asia and North Africa (WANA) per capita consumption of meat and milk stagnated or even declined. These

levels give an indication of how far animal food product consumption in developing countries could grow. The per capita milk consumption in some selected African countries is presented in Table 9. Figures are much lower when compared with those in developed countries.

Table 9. Annual average per capita consumption of milk in selected African countries

Country	Per capita milk consumption (kg)		
	1971	1977-9	1983-5
Côte d'Ivoire	11.0	16.6	14.6
Ethiopia	21.1	19.4	17.1
Mali	20.7	17.2	17.2
Nigeria	8.0	11.4	7.8
Sudan	48.6	60.2	85.8
Zimbabwe	26.2	21.6	25.8
West Asia & North Africa	18.9	20.7	20.2

Sources: FAO (1987 and 1989); ILCA (1987)

According to food balance sheets estimated for the period 1961-85, (Table 10) the share of animal protein in total protein intake has remained more or less unchanged over the 25-year period in Nigeria. Given the daily requirement norm of 75 g of protein (Wagner, 1986), of which about 35 g is supposed to be of animal origin (David-West, 1978), it is obvious that both aggregate and animal protein consumption levels have been markedly below the norm. This was confirmed by studies carried out in five local government areas of Niger state (Adama and Tsado, 2001; Adama and Tsado, 2003).

Table 10. Estimates of per capita daily protein consumption in Nigeria, 1961-1985

Period	Protein (grams)		
	Animal	Vegetable	Total
1961-63	6.5	44.3	50.8
1964-66	6.6	43.6	50.2
1969-71	7.0	40.8	47.8
1972-74	7.3	43.0	50.3
1975-77	8.0	44.7	52.7
1979-81	10.0	40.9	50.9
1981-83	9.7	39.6	49.3
1983-85	7.0	38.0	45.0

Source: FAO Production Yearbook (various issues).

9.0 LIVESTOCK REVOLUTION

9.1 Animal Protein Intake in Developing countries

The world's population is projected to increase to about 7.2 billion in 2010. This increase will occur mainly in the developing countries. For example, between 1960 and 1990 the population of developing countries increased from 2.097 billion to 4.138 billion, representing an increase of 97 percent (Delgado, Rosegrant and Ehui, 1999). This will have a serious effect on food consumption particularly animal protein intake. Protein deficiencies remain wide spread in developing countries because people subsist on diets that are often entirely made up of starchy staples. To cater for the animal protein needs of the growing population, the world's livestock sector is also witnessing an unprecedented growth rate. This growth is only taking place in developing countries. The rapid increase in demand for livestock products in developing countries presents crucially important policy dilemmas that must be resolved for the well- being of both rural and urban people in developing countries.

According to Delgado, Rosegrant and Meyer (2001) annual demand for meat in the developing world is expected to grow from 111 million tonne in 1997 to 213 million tonne in 2020. Over the same period, milk consumption would grow from 194 million tonne to 324 million tonne per year in the developing world. The combined per capita consumption of meat, eggs, and milk in developing countries grew by about 50 percent from the early 1970s to the early 1990s. This trend toward diversified eating habits is likely to continue for some time to come. The course of these events in the increasing consumption of livestock products in the developing world over the next 20 years has been termed "**Livestock Revolution**" (Delgado, Rosegrant and Ehui, 1999).

Rapid demand growth in developing countries propels the global **Livestock Revolution**. Expanding demand is the result of a combination of high real income growth, swelling population, rapid urbanization, and the on going diversification of developing countries' diets away from very high levels of starchy staples. Between 1982 and 1994, the rate of milk consumptions grew by more than 3 percent per year while the rate of meat consumption also grew by about 5 percent per year. (Table 11). The projected figures between 1994 and 2020 for both milk and milk are presented in Table 12.

These developing- countries' growth rates can be compared to the slow forecast for consumption growth in the developed world: 0.6 percent per year for meat and 0.2 percent per year for milk through 2020 (Table 12). This low growth in developed countries is largely explained by slow population growth, slowing urbanization, satiation of diets, and growing health concerns about high intakes of cholesterol and saturated fatty acids from some animal products. By 2020, the developing countries are expected to produce 188 million metric tonnes meat per year and the developed

Table 11. Consumption of meat and milk by region, 1982-94

Region	Annual growth rate of total meat consumption 1982-94 (percent)	Annual growth rate of total milk consumption 1982-94
China	8.6	5.5
Other East Asia	5.8	4.8
India	3.6	3.6
Other South Asia	4.8	3.6
South east Asia	5.6	3.1
Latin America	3.3	3.1
WANA	2.4	2.6
Sub-Saharan Africa	2.2	2.9
Developing world	5.4	3.4
Developed world	1.0	0.4
World	2.9	1.9

Source FAO. 1998

Table 12. Projected trends in meat and milk consumption, 1993-2020

Region	Projected annual Growth of total Consumption, 1993-2020 (percent)		Total production in 2020 (million metric tonnes)		Per capita consumption in 2020 (kilograms)	
	Meat	Milk	Meat	Milk	Meat	Milk
China	3.0	2.8	85	17	60	12
Other East Asia	2.4	1.7	8	2	67	20
India	2.9	4.3	8	160	6	125
Other South Asia	3.2	3.4	5	41	10	82
Southeast Asia	3.0	2.7	16	11	24	16
Latin America	2.3	1.9	39	77	59	117
West Asia & North Africa	2.8	3.0	15	51	24	80
Sub-Saharan Africa	3.5	3.8	12	31	11	30
Developing world	2.8	3.3	188	391	30	62
Developed world	0.6	0.2	115	263	83	189
World	1.8	1.7	303	54	39	85

Source: Rosegrant et. al., 1997

countries 115 million metric tonnes. This production level equals an additional 15 kilograms per capita of meat in the developing world, given expected population in 2020.

Truly, it is not inappropriate to use the term "***Livestock Revolution***" to describe events in world agriculture in the next 20 years. Like the well- known Green Revolution, the label is a simple and convenient expression that summarises a complex series of interrelated processes and out comes. As in the case of cereals, the stakes for the poor in developing countries are enormous (IFPRI, 2006). Unlike the Green Revolution, the "revolutionary" aspect comes from the participation of developing countries on a large scale transformation of what had previously occurred mostly in the temperate zones of developed countries. And like the gradually but steadily rising cereal yields in the 1970s and 1980s that typified the Green Revolution, the Livestock Revolution is expected to increase its rate of growth in order to meet the increasing demand of animal protein.

9.2 Pointers to Livestock Revolution

9.2.1 Income

There is a strong positive relationship between level of income and consumption of animal protein. As people become more affluent, consumption of meat, milk and eggs increases relative to the consumption of staple food. Diets become richer and more diverse, and the high-value protein that livestock products offer improves the nutrition for the vast majority of people in the world. Incomes have increased in most countries over the past five years, particularly in Asian countries. In the developed countries, however, increasing incomes are no longer associated with incremental consumption of animal protein as markets have become saturated.

Per capita consumption increased in the regions where incomes grew rapidly during the 1980-95 period. For developing countries as a whole, GNP per capita grew at 2.1 percent per year (Table 13). In China, which had the most dramatic increases in per capita meat and milk consumption, per capita grew at the extraordinary rate of 8.6 percent per year. India and South East Asia also had high income growth rates, fueling increases in per capita animal food product consumption. Latin American income growth was about zero (0.4 percent), but the region still managed a slight increase in per capita meat and milk consumption. Sub- Saharan Africa's per capita GNP fell significantly, explaining the region's drop in per capita consumption of meat and milk during the period (Table 13).

9.2.2 Urbanisation

The most important life style change occurring in recent years is urbanization. Consumers in urban areas are more likely to diversify their diets into meat and milk

(Huang and Bouis 1996; Anderson, Dimaranan, Hertel and Martin 1997). Urban consumers have greater food choices and more diverse dietary and cultural influences than those typically found in rural areas. Urban consumers also often prefer foods that offer variety and convenience rather than maximum caloric content.

Table 13. Past population, urban population, and GNP per capita growth rates

Region	Population 1970-95	Urban Population 1970-95	GNP per capita 1980-95
	(percent change per year)		
China	1.6	3.8	8.6
India	2.1	3.3	3.2
Other East Asia	1.6	3.0	n.a.
Southeast Asia	2.1	4.0	4.3
Latin America	2.1	3.0	- 0.4
Sub-Saharan Africa	2.9	5.0	-1.3
Developing world	2.1	3.8	2.1
Developed world	0.7	1.1	1.7
World	1.7	2.6	0.9

Source FAO. 1998

Urban populations differ from rural populations in having a higher consumption of animal products in their diets, further fueling demand (Adama and Tsado, 2002). Currently, over 80 percent of the world's population growth occurs in cities of developing countries. Worldwide, urbanization has risen from 30 percent of the population to 45 percent in 1995 and is projected to reach 60 percent by 2025 (UNFPA, 1995). In the developed countries, urbanization rates have levelled at 80 percent while in the developing world, urbanization still averages 37 percent with marked differences between the regions: 74 percent in Latin America but only 34 percent in Africa and Asia.

Urban populations in Sub-Saharan Africa are estimated to be increasing at 6-7% per annum. A recent study conducted by the France-based Institute for Research and Development has reported that half of the population of sub-Saharan Africa will be urban dwellers by 2030 (***Punch***, 2008). The study found that more than 40 African cities currently have a population of one million each. According to the study, the population of the region increased from 100 million in 1990 to 770 million in 2005. As this trend continues, increased urban demand for food will create new markets for produce and promote the commercialisation of agriculture in peri-urban environments (Winrock International Institute, 1992).

9.2.3 Population

The importance of even small increases in per capita consumption is compounded by rapidly increasing populations in many developing regions. On average, population in developing countries grew by 2.1 percent per year between 1970 and 1995. (Table 13). The Population in Sub- Saharan Africa grew the most by 2.9 percent per year during the period. Rapid population growth coupled with increased per capita consumption resulted in dramatic increases in the total consumption of animal food products through out the developing world. In Table 14, both human and livestock populations are compared. Population and livestock growth rates are higher in the developing countries. However, it is unlikely that livestock number is growing at the rate that will accommodate the rapid increase in the demand for animal protein.

Table 14. Human and livestock populations (millions) in developed and developing countries, 1960 and 1990

Item	1960	1990	% change
Developed countries			
People	977	1251	28
Large ruminant	343	404	18
Small ruminant	573	591	3
Pigs	235	341	45
Poultry	2274	4465	96
Developing countries			
People	2097	4138	97
Large ruminant	692	1029	49
Small ruminant	792	1217	54
Pigs	171	515	201
Poultry	1648	6305	283

Source: FAO, 1992b.

9.2.4 Globalisation

Other factors may further boost demand. Greater trade and communications, for example, will expose people even in remote areas to other cultures and foods. Whether the world has the capacity to meet this surging new demand with increased animal food production remains a major question.

9.2.5 Technology

In the developed countries, technological progress for both ruminants and monogastric animals involved reproductive and genetic technology, including advances in biotechnology; feed improvement through blending, processing, genetic means, and chemical treatment; use of growth hormones; and improvements in animal

health maintenance. Some of these industrial technologies, especially for pigs and poultry, have been fairly easily transferred to developing countries.

The desire for greater productivity from livestock is resulting in a change in the use of animal genetic resources. Traditional genotypes, which have developed through exploitation of harsh environments, cannot match the sector's demands for higher productivity. Now that the means exist to modify the bio-physical environment, even in the tropics, exotic genotypes are being introduced which provide a higher return on external inputs. Consequently, the use of indigenous breeds is diminishing.

9.2.6 Research

Indigenous livestock have the capacity to perform reasonably well with improved management practices such as feeding, breeding health care etc. Research in NAPRI Shika have shown that some of our indigenous cattle can gain an average of 0.9 to 1.2 kg per day on silage and concentrate rations. The potential of this finding can be assessed when it is realised that at present over 1 million cattle are slaughtered annually in Nigeria, but that 75% of them are fit for further fattening and could yield an extra 25 000 to 45 000 tonnes of meat per year if this technology was employed (Nuru, 1978).

Also research on dairy cattle has shown that a linear increase in milk yield from crossbred cows takes place as the exotic gene is increased up to the 7/8 level. The F_1 Friesian x Bunaji cow (50%) gives 1684 kg, the 3/4 (75%) gives 1850 kg and the 7/8 gives 2051 kg of milk in a lactation of about 260 days. However, the economic return did not justify increasing the exotic gene pool beyond 50% (Nuru and Buvanendran, 1984).

9.3 Implications of Livestock Revolution

There are fears that the **Livestock Revolution** might crowd out small livestock keepers, thus eliminating one of the most powerful approaches to rural poverty reduction for the more than 600 million rural poor who now have livestock as one of the few possibilities of getting out of the poverty trap. This is already occurring in many middle-income countries where there is a strong concentration of production and processing. In Thailand, for example, 80 percent of the poultry production now comes from only ten large, vertically integrated companies, which supply feed and day-old chicks to medium- and large-sized, producers under contract (Henry and Rothwell, 1996). Similarly, in Brazil, four integrators cover about 40 percent of the broiler market, and the number of farms with less than 1000 birds decreased by 25 percent, while the number of birds doubled (de Haan, van Veen Schillhorn, Brandenburg, Gauthier, le Gall, Mearns and Simeon, 2001).

At a more general level, there is a significant danger that the environmental and health problems will affect funding for livestock development, thus closing also the options for the poor. The increased concentration of animals in industrial operations will greatly increase the disease transmission risk. Moreover, "new diseases", such as the Nippah virus, the Bird Flu, and other diseases are emerging. Increased global trade will also increase the spread of diseases, as is shown by the recent outbreaks of Foot and Mouth disease, which over a period of less than 10 years spread to more than 40 countries.

Other public health issues raised by the **Livestock Revolution** are also of major importance. The intensification of livestock production is leading in many parts of the world to a build- up of pesticide sand antibiotics in the food chain. Furthermore, as the scale of output increases, especially in the tropics, food safety risks from microbial contamination are becoming more prevalent.

Over-consumption of animal food products raises another concern. A growing consciousness of the dangers of large amounts of saturated animal fats in diets exists in most developed countries. Some experts have concluded that policies should prevent a similar over-consumption in developing countries by discouraging public investment in livestock production (Brown and Kane 1994; Goodland 1997; Pimentel 1997).

Increasing livestock consumption may also affect cereal prices. Because ruminant livestock such as cattle, sheep, and goats consume grain, and monogastric livestock such as pigs and poultry depend on grain in the industrial production systems of developed countries, some analysts argue that the high demand for livestock products in developed countries and rapidly increasing demand and production in developing countries deplete the grain available for direct consumption by man.

10.0 MANAGEMENT: THE WHEEL OF PRODUCTION

Proverbs 27:23-27 (New American Standard Bible)

23 Know well the condition of your flocks, And pay attention to your herds;

24 For riches are not forever, Nor does a crown endure to all generations.

25 When the grass disappears, the new growth is seen, And the herbs of the mountains are gathered in,

26 The lambs will be for your clothing, And the goats will bring the price of a field,

27 And there will be goats' milk enough for your food, For the food of your household, And sustenance for your maidens.

10.1 Management

The key to a successful livestock production is management. The quotation above emphasises on "***knowing the condition of your flock and paying attention to your herds***". The importance of managing animal well from birth cannot be overemphasised (Adama, Arowolo, 2002; Adama, 2002b). Research into these factors has therefore been increasing in recent years, especially in situations in which higher productivity is expected from the animals.

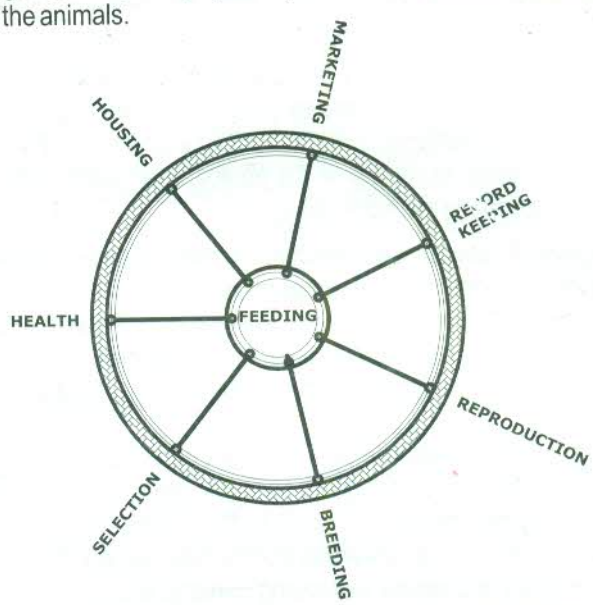


Figure 6. The Wheel illustrating the basic components of management of livestock

Management as it relates to agriculture can be defined as the science and art of looking after things on the farm with a view to obtaining better results. In animal production, several management tools are crucial for optimum productivity by the animals. These include selection, breeding, feeding, health care, housing, marketing, record keeping and reproduction (Adama, 1997; Adama, 2001). They constitute the basic components of the Wheel of Production in a livestock venture (Figure 6). Each of the components plays a vital role to the overall success of livestock production system. They can be referred to as the Eight Pillars of Animal Production. Management should provide for optimum production. As long as the needs of the animals are met, their production will remain high and profitable.

10.2 Feeding

If we consider the various components of management as a wheel, then, feeding

serves as **"the hub that turns the wheel".** The remaining seven components can be considered as spokes that connects the rim to the hub. Poor nutrition is the major constraint to animal performance. Once a farmer can guarantee optimum nutrition, animals will be able to perform optimally. Animals require energy, protein, minerals and vitamins not only to maintain body weight but for lactation, growth and reproduction.

Nuru, de Leeuw and Abalu (1978) among others, have identified insufficient feed, as the primary factors limiting livestock development in Nigeria.Chronic feed deficits represent a major constraint to animal production in many developing countries. The situation manifests itself in poor animal performance, low growth rates, reduced reproductive efficiency, high mortality rates, etc. The genetic potential of many farm animals is inadequately exploited and the outputs of animal production, such as meat, milk, eggs, fibre and skin, often fall far short of national requirements. Well-fed animals grow faster and bigger and produce better products (e.g. milk, meat); they can be sold at a higher price too. Feeding animals well helps to keep the animals healthy and more resistant to diseases and pest attack. They reproduce better, and the offspring are strong with a good chance of survival.

The basic livestock products derive the constituent materials from various feed items consumed by the animal. These nutrients must be supplied in the diet in correct proportion in order to meet the needs of the animal. Feed is vital for the physiological or biological functions performed by the animal e.g. respiration, excretion, reproduction etc. Both the quantity (level of production) and the quality of livestock products are directly influenced by the state of nutrition. Nutrition plays a vital role particularly in the reproduction of various livestock. Thus, oestrus cycle, ovulation, fertility, libido, quantity and quality of sperm, foetal development, birth weight, post natal development etc. are all directly affected by nutrition.

When animals are not properly fed, their productivity in terms of meat, milk and egg is adversely affected. Poor feeding may also result in disease condition and animals need feed for the maintenance of good health and to ensure resistance against diseases and parasites. Maximum production from a particular class of animal can only be achieved when adequate quantities of high quality diets are consumed daily. The greatest proportional cost in livestock production is expended on animal feeding-stuffs. The cost of feeding may vary from 55 to 65 percent for ruminants (cattle, sheep and goats) and 65 to 75 percent for the monogastrics (pigs and poultry).

10.3 Housing

Housing farm animals is an expensive item of management and is second in importance only to feeding. Modern housing protects the animals from adverse weather, predators, accidental injuries, insects and parasites, and many diseases. It

also allows farmers to monitor animal health and provide proper nutrition, clean water, sanitation, and regular care.

Improved management and breeding programmes to increase animal production have created a need for more appropriate animal housing. The main purpose of housing animals is to provide shade, and therefore the radiant heat from the sun should be reduced as much as possible. Poor housing contributes to retarding performance, increasing mortality, health and fertility problems and a high frequency of abnormal behaviour thus endangering the welfare of the animals. Animal houses should be as simple as possible particularly in the tropics. Regardless of the type or size of the housing system, the site for construction should be selected to provide adequate ventilation, but be protected from strong winds.

Animal housing design is mainly concerned with the physical environment, in particular climatic and mechanical factors, but all other factors should also be considered in order to create a good layout, where healthy, high yielding animals can be provided with correct feeding, can be easily handled and can produce without stress or suffering physical harm.

10.4 Health

As far as disease is concerned, prevention is better than cure The potential benefits of enhanced animal health and welfare are great; for animals, their owners, society, public health and the wider rural economy. The health and welfare of farm animals makes a major contribution to the sustainability of the livestock sector, to the wider farming and food industry, and more broadly to the countryside, rural communities and the rural economy. For a sustainable livestock sector, this strategy does not exist in isolation. It complements other management strategies such as feeding, housing, selection, breeding, reproduction, record keeping and marking to support a sustainable agricultural sector and is crucial to the protection of public health and food safety.

The cost of providing health care will be considerably reduced if other components of production are taken care of. The strategic outcome "prevention is better than cure" speaks for itself; animals that are cared for appropriately and in accordance with existing welfare standards are more likely to be healthy, and less likely to contract or spread disease. It is therefore essential for all livestock owners to have the necessary skills to care for their animals, exercising good practice and using veterinary services and drugs appropriately.

In the livestock industry, minimising disease and welfare impacts through good husbandry should maximise profitability and help maintain rural sustainability. Each

year, the industry culls large numbers of livestock animals due to poor health and loss of productivity. This should be unnecessary and unacceptable and is an unsustainable approach to rearing livestock.

Fit and healthy animals which are appropriately cared for are likely to be higher yielding or remain productive over a longer period of time. They can also be more profitable, particularly if they can be sold at higher profits. High standards of management will help reduce the need for drugs thereby production costs.

Livestock extension services in the developing world have traditionally focused on animal health services at the expense of production issues and there has been an almost complete neglect of the environmental aspects of livestock production. Improvement will not be easy.

10.5 Selection

The selection of farm animals are at the basis of the farm animal production chain. Changes in the choice of breeding animals will influence the performance of the animals and the products they deliver throughout the chain. The best start of good livestock management lies in the selection of good animals for the farm. The ability to choose selectively and to breed farm animals of superior quality would lead to great economic rewards for livestock farmers. Selection is definitely one of the most sustainable cultural techniques ever invented, since effects are cumulative and have long term effects without the need for follow-up investments. With the advent of the DNA era it was expected that it would become feasible to improve selection schemes through selection on genotypes.

10.6 Breeding

Breeding is the science of keeping and improving the genetic potential or capability of the animal. The objective of any livestock keeper is to produce good quality animals as a means of producing good quality products. Animal breeding also aims at the selection of a new generation of farm animals which will fit better under the expected production circumstances. Hence the science and art of breeding is the backbone of any livestock enterprise. The performance of an animal is influenced by the type of breed. Exotic animals are usually more productive than our local or indigenous breeds (Adama, 2003a; Adama, 2003c). Table 15 average performance of exotic and indigenous breeds of animals.

The face of animal breeding has changed significantly over the past decades. Major developments were caused by the introduction of biotechnology (Adama, 1991; Orth, A., Adama, Din, and Bonhomme, 1998; Adama, Orth and Bonhomme, 1999 and Adama, 2003d). Other tools such as molecular genetic, artificial insemination, multiple

ovulation, ovum pick up, in vitro fertilization, embryo transfer, cloning of individuals, cloning of genes, and selection with the use of DNA markers have greatly assisted animal breeding.

Table 15. Performance of exotic and local breeds of livestock and poultry*

Type of animal	Exotic breed	Indigenous breed
Dairy cattle Milk yield kg/day	20-30	1-3
Beef cattle Matured weight (kg)	750-1000	300-550
Layer chicken Matured Weight at 8 weeks(kg)	1.0-2.0	0.8-1.2
Layer chicken Number of egg/year (kg)	265-280	20-30
Broiler chicken Weight at 8 weeks (kg)	3.0-4.0	-
Rabbit Matured weight (kg)	5.0-7.0	1.5-2.5
Pigs Matured weight (kg)	400-500	70-100

**Compiled from various sources*

Breeders have developed several breeds of livestock and poultry which have allowed phenomenal increases in production. Some modern breeds of livestock and poultry are presented in Plates 5 13 below.

Plate 5. Guernseys Cows. The Cow of this breed can produce between 20-30 kg of milk per day.

Plate 6. Brangus is essentially a beef (meat) cattle. Mature male can weigh up to 1000 kg

Plate 7. Awassi Sheep ram. The hair of Awassi sheep is important for making high quality carpets

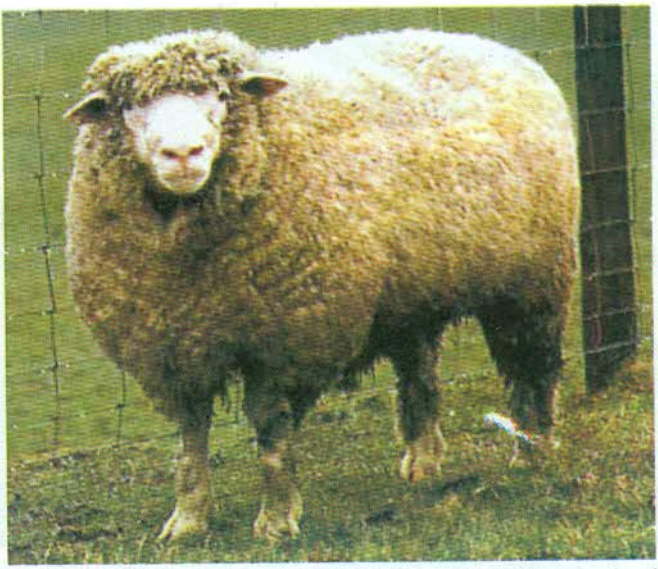


Plate 8. Ile-de-France sheep. The sheep is famous for both high quality meat and wool

Plate 9. The Angora goat. The breed is famous for its good quality wool

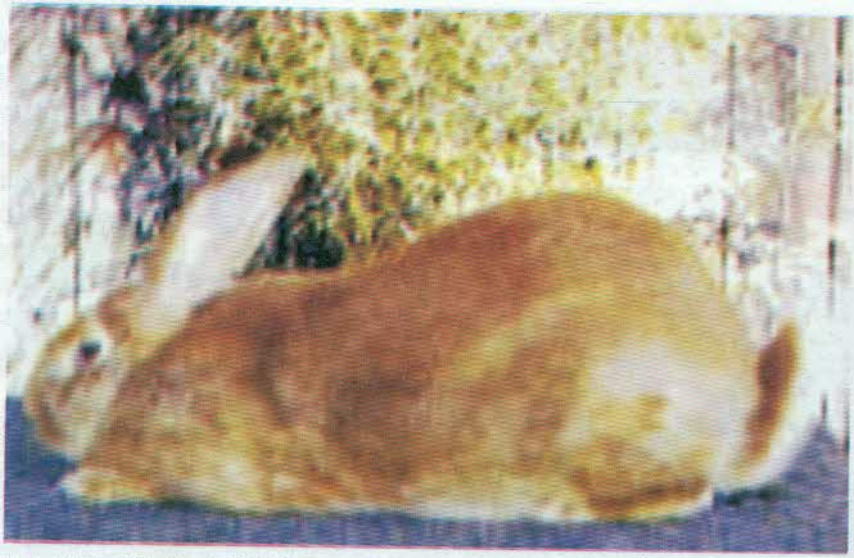


Plate 10. Flemish Giant rabbit. Mature animals can weigh more than five kg

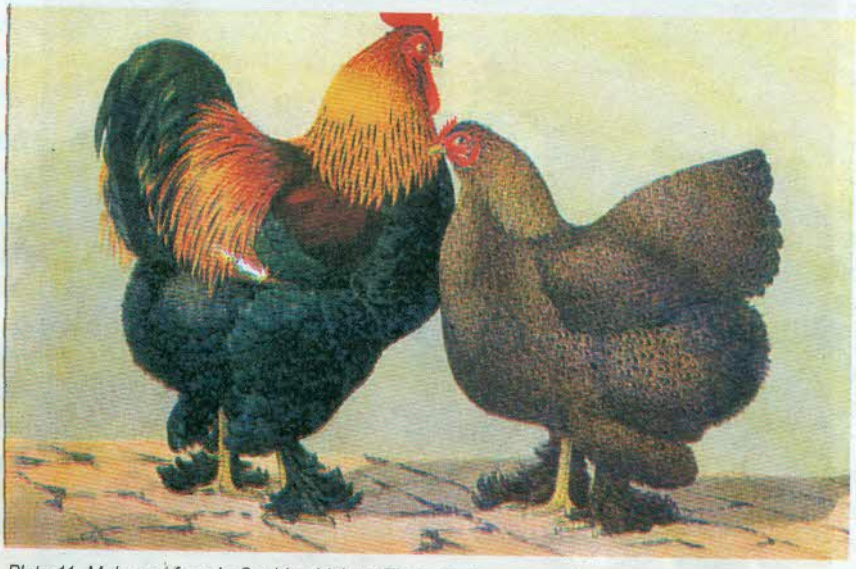


Plate 11. Male and female Cochin chicken. They are heavy breeds

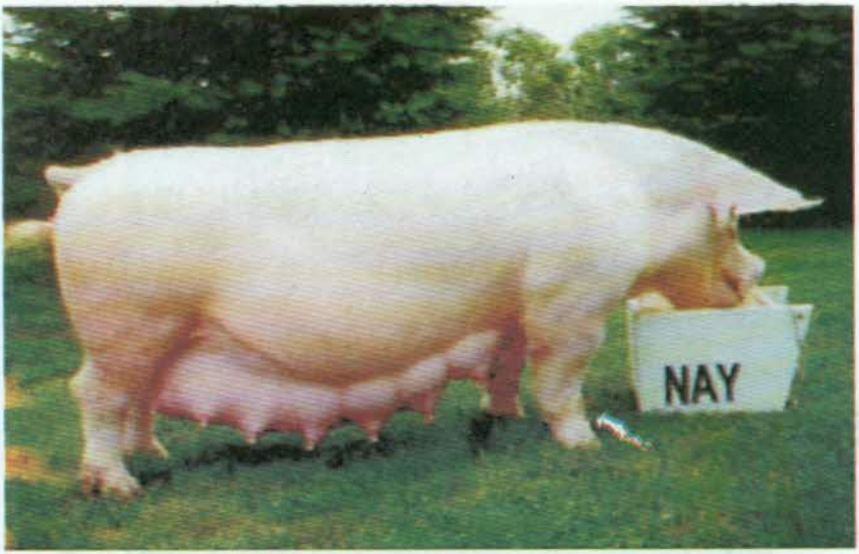


Plate 12. Yorkshire is a popular breed of pig

Plate 13. A sow with several piglets. Pigs are very prolific

10.7 Reproduction

One of the major functions of all living things is reproduction. Regular and efficient reproduction is an important factor affecting profit from a livestock enterprise. Under natural condition, the instinct for reproduction of the species will maintain an efficient reproductive activity. However, under restricted conditions of domestication, the efficiency of reproduction mainly depends on the understanding of the basic facts about reproduction and the application of sound management principle and techniques. Reproduction technologies such as artificial insemination, embryo transfer, cloning and others, can be used for sustainable dissemination of breeding material and consequently decrease the risk of disease spread.

10.8 Record keeping

This is an important aspect of management which should never be neglected. There are many reasons for keeping records as they are of great value as aids to management and necessary for financial analyses. Records are necessary for selecting breeding stock, for knowledge of ages required for vaccination, weaning, marketing, changes in feed and when breed. Records are needed to identify animals which produce well, those that have chronic health problems, the females which fail to produce, and those males with fertility problems. Financial records are necessary for evaluating the profitability of the operation. The trial should keep adequate and accurate data on all the animals (breeds, dates of birth/hatching, parents) and on all farm operations such as vaccination, feed consumption, sales, purchases, transfer etc.

10.9 Marketing

One of the objectives of keeping livestock is for income. A good understanding of marketing strategies is important for a profitable livestock enterprise. (Adama and Ndako-Gona, 2003; Adama and Zhymuada, 2003) Primary marketable products from ruminants include meat, milk, hides and skin, hair, wool etc. Other products include blood, bones, manure, fat etc. Livestock products are perishable and should be marketed fresh. All forms of contamination should be avoided. Adequate storage facilities should be available on the trial site. If the products are to be marketed within the farm, the marketing unit should be located far from the production units in order to avoid disease transmission from people coming to purchase the products. Marketing of livestock and livestock products is not managed well enough in Nigeria when compared to developed countries. In such countries, livestock and their products are based on certain criteria such as grades, dressing percentage, cuts, age, weight, colour etc.

11.0 LIVESTOCK POPULATION AND DISTRIBUTION

Human and livestock populations have both grown considerably over the last three decades, although at different rates (Seré and Steinfield, 1995; FAO, 1996; Wint and Robinson, 2007). Estimates of world livestock population is presented in Table 16. The major differences are found between developed and developing countries (Table 17 and Figure 7). Since 1960 the total human population has increased by 75 percent, but developing-country populations have grown by 97 percent, compared with 28 percent in the industrialised world (Slingenbergh and Wint, 2006). All categories of livestock have increased in number as well, with a much greater increase for monogastric animals (pigs and poultry) than for ruminants. Ruminant populations have grown at about half the rate of the human population, while small ruminant populations (sheep and goats) have only increased in developing countries. The pig and poultry populations, however, have grown about one-and-a-half to two times that of the human population, and are three to four times greater in developing countries than they are in developed countries.

Various efforts have been made to compile livestock distribution at global, continental and national levels. The distribution of different categories of livestock between continents shows Asia to be prominent in ruminants, poultry and pigs: it supports approximately 64 percent of the global livestock biomass. Generally, animals in the developed countries are more productive than those in the developing ones.

Generally, it can be observed that:

i. All categories of livestock have increased in number as well, with a much greater increase for monogastric animals (pigs and poultry) than for ruminants.

ii. Ruminant populations have grown at about half the rate of the human population, while small ruminant populations (sheep and goats) have only increased in developing countries.

iii. Nevertheless, ruminant species remain widespread in many of the less developed regions - and indeed are increasing in number rather than efficiency of production. They continue to be critically important to the rural poor.

iv. The pig and poultry populations have grown about one-and-a-half to two times that of the human population, and are three to four times greater in developing countries than they are in developed countries.

v. The greatest concentrations of livestock are in India, China and Europe - where there are most people.

vi. The main concentrations of cattle in Africa are in the highland regions of Ethiopia, East and southern Africa.

vii. China has half of the world's pigs and poultry, and their numbers are increasing fast.

viii. India is the world's biggest milk producer, but the industrialised countries are the most efficient.

ix. For the last fifteen or twenty years India and China have become increasingly efficient, and are fast approaching the productivity levels for milk and mutton and pork found in the industrialised countries.

x. Livestock numbers are generally increasing worldwide - particularly pigs and chickens.

xi. There are some places where livestock numbers are falling - pigs in parts of Europe; bovines in most of Europe; poultry in Scandinavia and eastern Europe; and sheep and goats in central Europe and the former USSR. This is usually being offset by increases in productivity, so overall production levels remain more or less stable.

xii. Sheep and goats are much more important than is often assumed - they outweigh cattle throughout a large part of the hotter drier regions north of the tropics - in a band stretching from Spain and Libya to China.

xiii. The developing countries are most efficient at producing meat and milk from sheep and goats.

xiv. Goats are usually more common than sheep near the equator.

xv. Most poultry in China are ducks.

xvi. Buffaloes outweigh cattle in Pakistan and Southeast Asia.

xvii. The biggest change that is happening to the world's livestock is a move away from traditionally farmed ruminant species (bovines, sheep and goats) towards more intensively reared monogastric species (chickens and pigs).

Table 16. Estimates of World Livestock Population for 2003

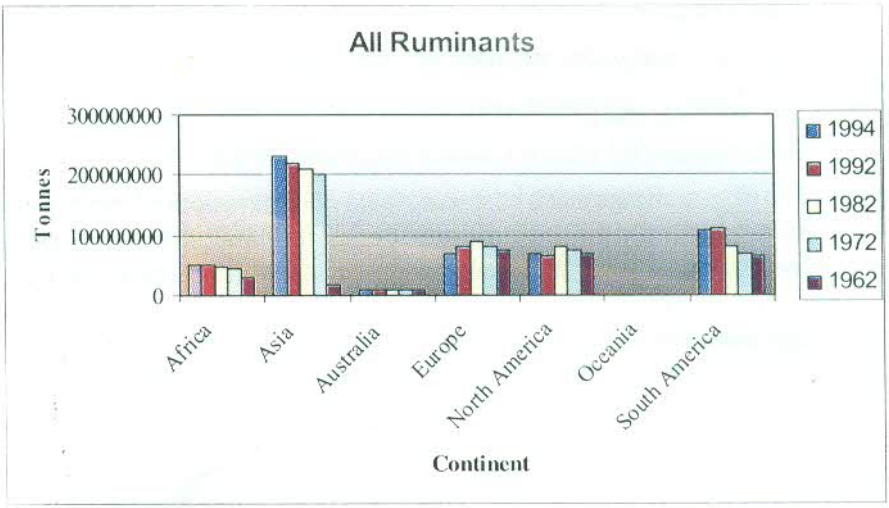
Species	Number
Cattle	1,371,100,000
Buffaloes	170,700,000
Sheep	1,024,000,000
Goats	767,900,000
Pigs	956,000,000
Horses	55,500,000
Mules	12,800,000
Asses	40,300,000
Camels	19,100,000
Chickens	16,600,000
Ducks	1,100,000

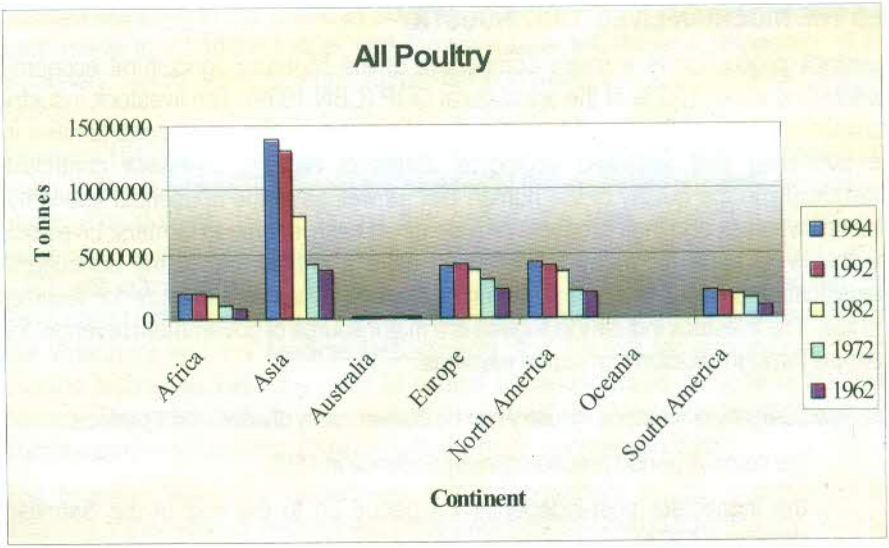
Source: FAOSTAT - Website

Table 17. Livestock numbers in Sub-Saharan Africa, West Africa, and the world, 1990

Number and percent	Cattle	Sheep	Goats	Pigs
World (million head)	1,279.3	1,190.5	557.0	856.7
Sub-Saharan Africa (million head)	178.6	162.4	157.8	13.5
% of world	14.0	13.6	28.3	1.6
West Africa (million head)	42.8	42.2	59.5	6.4
% of Sub Saharan Africa	24.0	26.0	37.7	47.4

Source: FAO (1991).





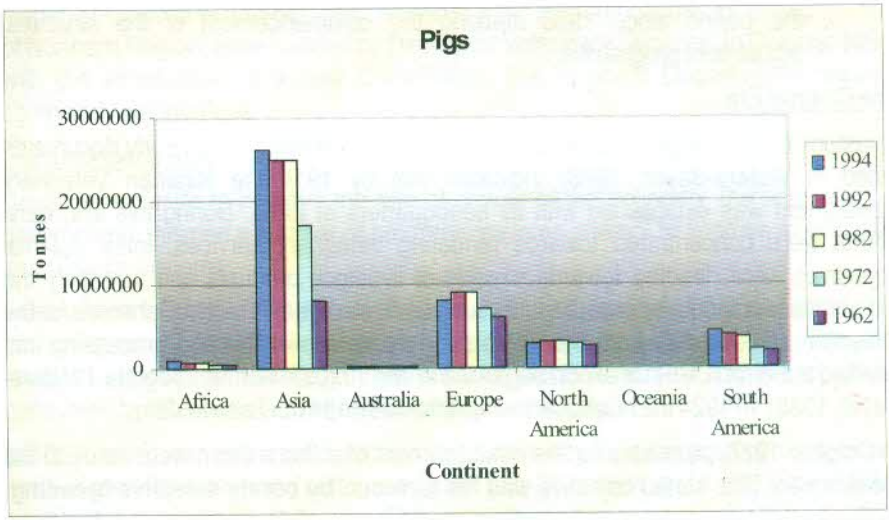


Figure 7: Livestock Biomass by Continent

Adapted from: Slingenbergh, J. and Wint, W. (2006). Livestock Geography and Land Use. FAO, Rome

12.0 THE NIGERIAN LIVESTOCK INDUSTRY

Livestock production is a major component of the Nigerian agricultural economy contributing about 12.7% of the agricultural GDP (CBN 1999). The livestock industry provides a means of livelihood for a significant proportion of rural pastoral families in the subhumid and semi-arid ecological zones of Nigeria. Livestock contribute substantially to the quality of the human diet as well as to the household economy. Sales of livestock and their products provide direct cash income to farmers. Livestock are the living bank for many farmers and have a critical role in the agricultural intensification process through provision of draught power and manure for fertilizer and fuel. The livestock industry in Nigeria is a major source of government revenue, for example through taxation and export earnings.

A review of Nigerian livestock industry can be conveniently divided into 4 periods:

- the colonial period preceding independence in 1960,

  the immediate post-independence period up to the end of the Sahelian drought in 1974,
- the oil-boom period from 1975-85, and
- the period since 1986 marking the commencement of the structural adjustment programme.

The Colonial Era

Livestock trade in Nigeria dates back to early 1900 (Okediji, 1976). Early documents (cited in Waters-Bayer, 1988) indicated that by 1914 the Nigerian Veterinary Department was established with its headquarters at Zaria. During this era, most efforts were concentrated towards rendering veterinary services. Initial colonial objectives were directed towards exports of livestock products and to satisfy the expatriate demand for animal products such as fresh milk and butter. Schemes for the collection of fresh milk from the Fulanis for cream separation and processing into clarified butterfat (CBF) for export began in the late 1920s in northern Nigeria. (Waters-Bayer, 1988). In 1924 the headquarters was transferred from Zaria to Vom.

In October 1927, proposals for the establishment of a Stock Farm were made to the Government. The stated objective was **"to turn out, by purely selective breeding, male stock for use as stud by native stock owners."** It was proposed that three breeds, namely, the White Fulani, Gudali and Shuwa represented by a dairy herd of about 20 heads each be stocked at Shika.

It was only by 1934 that the role of boosting livestock produced through improved feeding appeared to be considered important and by this time sweet potatoes and

cassava were fed to the cattle, as sources of energy. By 1938, numerous attempts were made to introduce fodder and browse plants into Nigeria (especially at the Veterinary Station, Vom, the Agricultural Station at Samaru, and at the Stock Centre at Shika).

The early 1940s also witnessed the establishment of dairy herds and milk processing plants in Vom and Agege to boost the demand of the expatriate population in Jos and Lagos (David-West, 1978). During this period, the Vom Veterinary School was established to train Nigerians for animal health work. A Livestock Investigation Centre (LIC) was also set up as auxiliary to the school and laboratory. Later, an Egg Production Unit was created to supply fertile eggs for virus research, vaccine for both the Veterinary and the Medical Departments and Poultry for research work and vaccine testing. In 1947 the need to control trypanosomiasis disease in the West African Territories led to the establishment of a West African Institute for Trypanosomiasis Research (WAITR) with the main laboratory in Vom.

The Nigerian Veterinary Department with headquarters in Jos, coordinated the activities of the livestock sector. Field offices were established in each Region. With the coming of regional governments, the Nigerian Veterinary Department was split into separate Regional Departments. The Director of Veterinary Services became the Inspector-General of Animal Health Services while the regional offices, except for that of Northern Region, were headed by Director of Veterinary Services. In October 1954, with the introduction of a new Constitution, the Regional Departments became completely autonomous.

From Independence to 1974

Driven by a desire to improve the rate of growth of the economy, the new regional governments initiated a number of programmes in an attempt to improve smallholder and pastoral systems.

Even after the independence, emphasis was placed on trade policies rather than promoting local consumption of animal products such as meat and milk. This was justified by government on the grounds that such products as meat and milk are goods consumed by **"the better-off sections of the community"**.

In 1962, in order to boost production, a supplementary feed programme using equal parts of groundnut cake and cottonseed cake plus 2% common salt and mineral licks, was introduced in northern Nigeria. This was aimed at increasing animal productivity and to reduce seasonal weight losses particularly during the dry season. Although the response was favourable, the scheme failed due to inadequate supply and untimely distribution of the supplements.

In recognition of the importance of other livestock management factors, the Technical

Committee established for the various aspects of primary production and the Veterinary Technical Committee were replaced by the enlarged National Livestock Development Committee which reported to the National Council for Agriculture and Natural Resources. The Livestock Meat Authority, established to serve the northern states, was empowered to act on a national scale, to collate data and conduct surveys as well as researching into various aspects of livestock production, slaughter and marketing in Nigeria.

By 1965, due to large deficits in domestic production, Nigeria had started importation of meat. During this period, the government attempted to boost local production, particularly meat, by starting grazing reserves in order to protect the traditional grazing lands from crop farming, to secure a year-round source of fodder for ruminants, and to encourage the settlement of pastoral nomads.

Also, in 1971, The Nigerian Livestock and Meat Authority (NLMA) was established to operate abattoirs and cattle farms, engage in wholesale meat marketing, manufacture animal feeds, trade in hides and skin, control and regulate the interstate activities of traders in livestock and livestock products, and to carry on any business connected with the livestock industry.

In 1972, intensive feedlot fattening for beef, based on high intakes of molasses with supplementary feeding of cottonseed and restricted grazing was started at the Mokwa, Niger State, cattle ranch owned by the NLMA. Bilateral assistance was initially provided by the Federal Republic of Germany. A significant development was the introduction of sugarcane molasses from the Bacita Sugar Factory. Under the scheme, local bulls and steers (mainly Sokoto Gudalis and Bunajis) were purchased as yearlings with average weights of 200-240 kg. Over a three-month fattening period, the animals averaged 300 kg liveweight. The dressed carcasses were sold through government-owned cold stores. Although the scheme was initially successful, it soon proved difficult to maintain the ranch due to management problems. Thus, only about 15,000 animals were fattened between 1972 and 1978 (National Livestock Production Company, 1980).

The Period 1975-1985

Between 1974 and 1977, quantitative import restrictions were removed and tariff rates were reduced such that, customs duties on most livestock products fell in the range of 10-30%.

In 1976 Nigerian Livestock Production Company (NLPC) was established to provide credit and technical services for the development of the Mokwa and Manchok fattening ranches. Following the dissolution of the Nigerian Livestock and Meat Authority in 1979, the NLPC was reorganised and enlarged to take over the former's functions. Various dairy processing plants were also set up as part of the government's strategy to encourage the domestic dairy industry. Among these were Mandara Limited in Vom,

Nigeria Dairy Company in Kaduna and Minna Dairy Plant in Minna. The success of these plants was short-lived as a result of poor management, poor maintenance of equipment and shortage of raw materials.

Due to the sudden downturn in the world oil market between 1978 and mid-1979, Customs tariffs were revised upwards and quantitative import restrictions were re-imposed covering fresh milk, eggs and live poultry, while frozen or chilled meat came under import licensing. These measures served to raise the domestic prices of imported livestock products well above world prices.

In 1978, the Agricultural Credit Guarantee Scheme (ACGS) was introduced. The scheme was established to guarantee loans granted by commercial and merchant banks for agricultural purposes. About 85% of the loan disbursed was for food crops. The livestock sector received only 7.5% while 1.6% went to cash crops. Even in the livestock sector, only 2.4% of the borrowers received the lion share of 60.1%, while small and medium scale borrowers who represented 97.6% of all borrowers in this sector got only 39.9% of total loans.

From 1986 to date

Although this period covers 28 years, little has been achieved in the livestock sector, and in the agricultural sector in general, due to increasing dependence on oil as the main foreign exchange earner for the country. The Structural Adjustment Programme (SAP) initiated in September 1986 brought about a reduction in the role of the state in production activities with a corresponding emphasis on using the private sector as an instrument for production and input supply. This led to the scrapping of the NLPC and its subsidiaries.

In summary, the history of livestock development in Nigeria revealed that policies which were instituted in the livestock sector were not favourable to boosting production. Such policies largely focused on trade and economic policies which appeared to have been driven by macro-economic concerns rather than by a desire for a comprehensive livestock development.

13.0 LIVESTOCK SPECIES IN NIGERIA

Livestock species tend to distribute themselves according to vegetation and agroclimatic zones. The semi-desert is the camel zone, the semi-arid is the cattle zone, and the sub-humid the goat zone. In Nigeria, the distribution of livestock species such as cattle, sheep and goats follow the more conventional divisions of the breeding areas in the north; the fattening areas in the middle; and the consumption areas in the south (Horowitz, 1980). These divisions coincide roughly with the Sudan, Guinea, and Forest zones, respectively. The estimated livestock population in Nigeria in 1992 is presented in Table 18. The summary data by RIM (1992) is indicated in Table 19.

Table 18. Estimates for livestock population in various states of Nigeria in 1992

State*	Cattle	Goats	Sheep	Camels
Abuja	7,000	816,000	480,000	....
Anambra	64,000	1,467,000	426,000	....
Bauchi	1,732,000	3,465,000	2,811,000	4,000
Bendel	47,000	1,748,000	737,000	....
Benue	146,000	2,432,000	864,000	....
Borno	2,727,000	3,188,000	2,424,000	27,000
Cross River	10,000	351,000	117,000	....
Gongola	1,503,000	1,970,000	1,324,000	....
Imo	13,000	1,281,000	495,000	....
Kaduna	998,000	866,000	441,000	....
Kano	999,000	2,490,000	2,059,000	6,000
Katsina	626,000	2,009,000	1,553,000	7,000
Kwara	563,000	1,132,000	843,000	....
Lagos	3,000	158,000	57,000	....
Niger	1,165,000	969,000	752,000	....
Ogun	27,000	905,000	340,000	....
Ondo	9,000	1,747,000	589,000	....
Oyo	296,000	1,889,000	863,000	....
Plateau	1,054,000	1,865,000	964,000	....
Rivers	3,000	670,000	509,000	....
Sokoto	1,769,000	2,449,000	2,546,000	43,000
Total	13,761,000	33,867,000	21,230,000	87,000

*Source NPDL record (1992); * Some states have been split*

Table 19. Summary of livestock population estimates in Nigeria, 1994

Species	Number
Chickens	82,400,000
Goats	34,500,000
Sheep	22,100000
Cattle	13,900,000
Donkeys	900,000
Horses	200,000
Camels	90,000
Other poultry*	31,900,000
Pigs	3,500,000
Dogs	4,500,000
Cats	3,300,000
Rabbits	1,700,000
Guinea pigs	500,000
Giant rats	60,000

*Source: RIM, 1992; * Includes pigeons, ducks, guinea fowl and turkeys*

13.1 Cattle

Cattle are found throughout Nigeria, but they are most common in the northern two-thirds of the country. Seasonal transhumance does take place, but generally to a limited extent. The composition of the National herd is presented in Table 20. There is usually seasonal migration in search of greener pastures and water, but almost half the total cattle population is permanently resident within the subhumid zone. The distribution of cattle in Nigeria during raining season is presented in Figure 8.

Table 20. Estimated percentages of different zebu breeds in the Nigerian National Cattle Herd

Breed	Proportion of Cattle Population (%)	Calculated Number of Each Breed
Bunaji	37.2	5,118,547
Sokoto Gudali	31.6	4,351,523
Rahaji	22.0	3,029,541
Wadara	6.6	904,731
Adamawa Gudali	1.9	263,019
Azawak	0.7	103,280
Total	100.0	13,770,641

Source: RIM, 1992

Major breeds of cattle are described below:

13.1.1 White Fulani (Akou, White Bororo, White Kano, Yakanaji, Bunaji)

The White Fulani commonly called Bunaji is well distributed in Nigeria mainly in the north western and north eastern states. The breed is the most common cattle breed found in Nigeria and owned by the nomadic Fulani people. It is a triple purpose animal (beef/dairy/work), used primarily for milk production by the Fulani as milk constitute their basic diet. The breed is typical of the West African lyre-horned Zebu. The White Fulani is fairly a large beast about 130 cm around the withers. The average bull weighs about 550 kg and the cow about 500 kg. It has a well developed hump, dewlaps are also well developed especially in the bulls. The horns are medium to very long, curving outwards and upwards. In some animals there is an outward turn again at the tip. The hump is well developed and often more or less cervico-thoracic in position. The dewlap is large and well developed, possessing many folds. The sheath and naval flap are not large. The udder of the female is well developed with medium-size teats. The coat is usually white with black points, but few animals possess coats that are black with blue flecking or red and white. The skin is loose and pigmented and the hair soft. The ears are erect.

13.1.2 Red Bororo (Red Fulani or Rahaji)

This is possibly a cross between the Hemitic long horned and the lateral horned simple

cattle called the Africander found mainly in East Africa. They are large framed; bulls weigh up to 410 kg at maturity and height at withers is about 145 cm. The head is carried high and bears long, lyre-shaped horns giving a general impression of a great size but the body is narrow. The colour of the animal varies from light reddish brown to dark red brown. The Red Bororo is mainly a beef animal and found in large numbers in the north of Nigeria.

13.1.3 Sokoto Gudali (Bokoloji)

It is distributed throughout the north eastern districts of Sokoto State. It is a medium to fairly large animal of about 127 cm high at the withers. Mature bulls weigh up to 450 kg at maturity.The hump is well developed, the dewlap and the sheath are large, the body is compact and fleshy. The usual colour is white or cream in the female and light grey or cream with dark shading over the poll, neck, shoulders and tail in the male. The hair is short and the skin is medium thick, loose and pigmented. They possess pendulous ears. The male has very short, lateral upturned horns while the female has smaller but slightly longer horns. The hump is almost cervico-thoracic and well developed in both sexes. A well-pronounced dewlap and umbilical fold is possessed by both sexes. The animal has the appearance of a dairy type and it is essentially a dairy breed, but the cattle are also used for beef production. The cattle are comparatively docile and are easily trained for farm work.

13.1.4 Adamawa **Gudali**

This is a medium-horned, zebu, with flacid cervicothoracic hump; similar to White Fulani, with variable coat colours. It is found in the mountainous areas of Adamawa state, particularly in relatively humid parts and is kept by sedentary owners (Fulani) who practice limited seasonal migration. Live weight ranges from 325-454 and 337-363 in males and females respectively. The body tends to be long and well balanced. The shoulders blend smoothly into the body. The back has a good width and carries a well developed muscular system; apparently trypanosomiasis-resistant.

13.1.5 Kuri (Lake Chad)

The breed is found around the shores of Lake Chad in Borno State. It is a humpless longhorned cattle and is the oldest and is even recognizable in the Saharan rock paintings. Its origin is presumed to be Asian, and its appearance in Africa is dated to about 4000 BC. They are the largest breed in West Africa, weighing between 500-600 kg. They are often white or light grey with coloured spots. They are used for meat and milk production. The sole occurrence of the Kuri, in the Chad region implies that it is no longer of significance for the cattle population as a whole. Since by Nigerian standards it is an efficient producer of milk and beef and excellently adapted to semi-sedentary

life in a swampy living area, it is very often crossed with the cattle of the Shuwa Arabs in the lake area. However, should the Kuri leave this amphibian living area, it will tire quickly and lose weight.

13.1.6 N'Dama

Plate 14 The N'Dama breed of cattle is representative of "Bos Taurus" breed in West Africa

The N'Dama is a well known breed in Nigeria. It is a small, humpless well-built animal with a straight top line and short, fine limbs (Plate 14). It has short horns but certain strains have no horns. It is a small well-built animal. The coat is usually yellow, fawn, light red or dun in colour, although there are black and pied animals with black or fawn on a white background. The Sierra Leone variety is usually coloured with various shades of red. The skin is pigmented and the colour vary from black to light brown, and the hair is soft and short. The head is short and broad. The ears small and horizontal. The horns are lyre-shaped and grow sideways and then forwards and upwards from the poll. In mature cattle, they are 45-50 cm long, circular in cross-section and white with dark tips. The dewlap and umbilical fold are not large. The udder of the female is very small and set between the legs. The N'Dama is a poor milker, but they can be, and sometimes are, used for draught purposes. They are essentially beef animals, producing reasonably good carcasses under poor grazing conditions. The meat is of good quality. Their most unusual attribute is that they are inherently tolerant to trypanosomiasis and streptothricosis. The breed has a reputation for longevity. Mature weight is between 275 and 300 kg and attains this in three and half to four years. Height at withers is about 109 cm.

13.1.7 **Muturu** (Dwarf Shorthorn or West African Dwarf horned)

The breed is found in the rain forest and to some extent in the derived savanna in small numbers. The Hausa refer to dwarf cattle as Muturu, said to mean 'without a hump'. They are small, thickset animals with short, fine boned limbs. The skin is tight and

pigmented and the coat usually black, dark brown or pied in colour. The head is short and broad, the animal possessing a broad poll and short horns that grow sideways and upwards and curve forwards at the extremities. Polled animals are common. There is little dewlap or sheath. The height at withers is between 120 cm and 125 cm for both sexes. Average mature weights under extensive management system are 205 and 159 for the males and females. Maturity is between 3 to 4 years on improved pasture and live weight could be up to 300 kg. The Muturu can be used for working purposes, but their capacity is small and their stamina limited. Like N'Dama, they also exhibit tolerance to trypanosomiasis, streptothricosis and ticks. In the south eastern states of Nigeria, Muturu is the major indigenous breed of cattle and is well adapted to the area.

13.1.8 Keteku

The breed is found mainly in derived Guinea Savanna zones. The origin is unknown but generally believed to be a crossbreed of White Fulani and Muturu. The colour varies from White with fawns, white, light red and white with black spots. The hump varies from very small to complete absence. Mature body weight is between 150-200 kg or more. The breed possesses some tolerance to thrips.

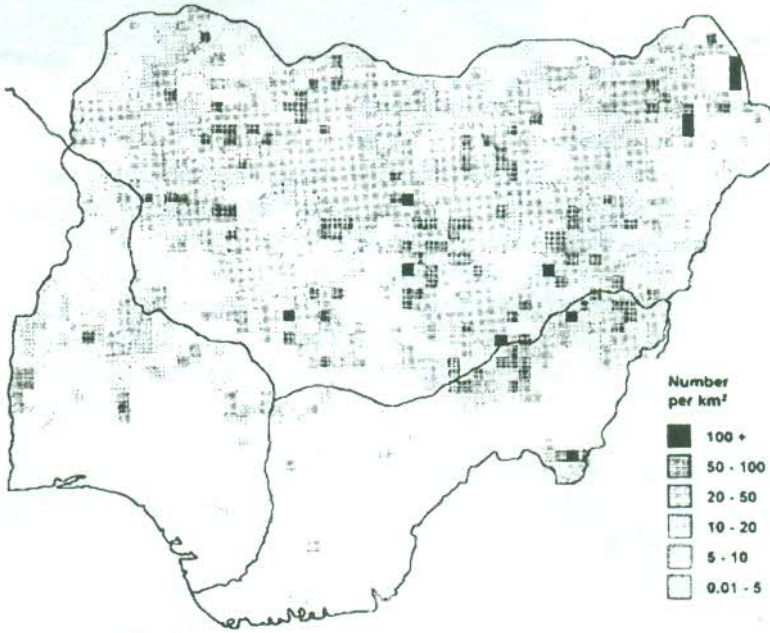


Figure 8. Distribution of cattle in Nigeria during raining season
Source: RIM, 1992

13.2 Goats

There are three main varieties of goat in Nigeria: the West African Dwarf, the Savanna Brown (Sokoto Red) and the Sahel. Some authors have classified Nigerian goats as Red Sokoto (Red Skin, Sokoto Red), Kano Brown (Kyasuwa), Katsina Light Brown, Mambilla, Bornu White (Buduma (Chad), Damagaran dapple-grey; Maradi, Dwarf Plateau Goat." (Fricke 1979). Goats are renowned for their hardiness and can survive in most environments: West African Dwarf goats are kept in the forest zones and in the Middle Belt; Savannah Brown are kept throughout the north; and Sahel goats are restricted to a strip along the frontier with the Niger. Most goats are kept in villages. The distribution of goats in Nigeria is presented in Figure 9.

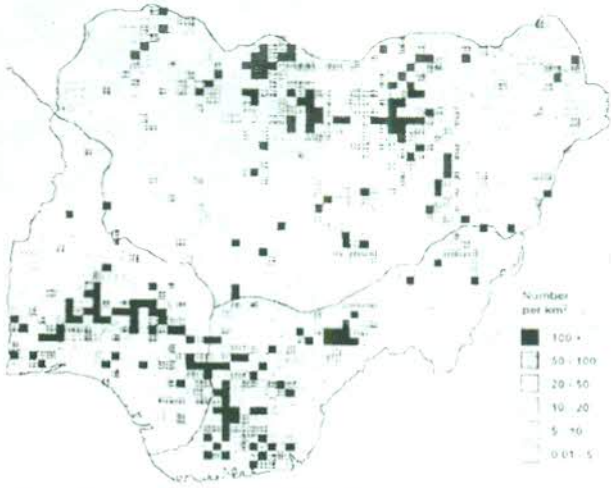


Figure 9. Distribution of Goats in Nigeria
Source: RIM, 1992

13.2.1 Savanna Brown

The Savanna Brown , Kano Brown or Maradi goat (Maradi is a *Département* of the Niger Republic) is probably the most widespread and well-known type in Nigeria. It is the usual village goat in the northern two-thirds of the country although it is less common with transhumant pastoralists. The populations of the Savanna Brown spread south and east from Sokoto through the savanna belts giving rise to the Kano Brown and, further east, to the Sahel types of Borno State.

This type of historical speculation is difficult to accept without more detailed evidence. The most complete overview of the breed is a comprehensive survey which integrates data from Nigeria and Niger (Roger, 1999) Savanna Brown is the only Nigerian breed for which there is a record of systematic attempts to stabilise a particular type. The Savanna Brown goat was the source of 'Morocco leather' known in Europe from the medieval period onwards. It acquired this name because it was transported across the Sahara by caravans controlled by Moroccan merchants. The Savanna Brown is still known for its suitability for fine leather.

13.2.3 West African Dwarf Goat

Plate 15. West African dwarf goat

The West African Dwarf (WAD) goat is found in mainly in the forest belt of the country. Although they are stereotypically said to be native to the forest belts, their presence in Borno State and in adjacent Republics of Cameroon and Chad suggests that they were far more widespread until recently. Like muturu cattle, they may once have been the main race of goat over most of Nigeria. Just as the zebu has replaced the muturu, so WAD goats have been driven to remoter areas in the savannahs. Goats are not native to West Africa, so the WAD goat must originally have evolved from a long-legged type, probably ancestral to today's Sahel goat. The WAD is usually black, although patched, pied, and occasionally all-white animals can be seen, even on the coast. Although the WAD is a proportionate dwarf. The small size is probably an adaptation to the goats' environment though the nature of the selective force is unknown. The WAD goats in the semi-arid zone resemble Savanna Brown Red goats in their body proportions. The WAD goat is believed to be trypanotolerant because it thrives in tsetse areas, but there have been no critical studies of this belief.

13.2.4 Sahel or Desert Goat

Occurring in the Sahel region, south of the Sahara, the breed is adapted to nomadism, grazing on the sparse vegetation of semi-desert areas. It has a high quality skin and the animal is used for meat and skin. Milk production is low. Most animals are whitish, with spots, although all different colours occur.

13.3 Sheep

There are four main types of sheep native to Nigeria: the Uda, Yankasa, Balami, 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. Sheep are the second most numerous pastoral species, and small flocks accompany many cattle herds in the north and in the Middle Belt. Major Nigerian breeds of Sheep. The distribution of sheep in Nigeria is presented in Figure 10.

13.3.1 Uda

The breed is found in the north western part of Nigeria. The mature rams measures 75-85 cm and weigh 60-70 kg. The classical hair colour is dark head and forequarters, with white hindquarters. The male profile is convex, the horns heavy and latterly spiralled. The ewes are normally polled. The ears are long and lopped. The tail is long and thin; the rump short and sloping. The Uda yields mutton of excellent quality and is of great economic importance especially during the Muslim festivals.

Plate 16. Uda sheep in Northern Nigeria

13.3.2 Yankasa

The sheep is primarily bred by the Fulani people of north central Nigeria. It is the most prevalent breed in Nigeria. It is well suited to the southern Sudan and northern Guinea Savanna zones with the average rainfall of 500-700 mm. The height at wither for the rams is 70-80 cm and weighs 55-60 kg. The tail is long and thin, the ears moderately long and somewhat dropping. The rams carry heavy out-spiraling horns; the ewes are polled. The coat cover is short hair usually white but with some black about the eyes and face. It is used to upgrade the West African Dwarf breed. They produce both meat and milk but emphasis is rather on meat.

13.3.3 Balami

The Balami is the largest bodied native sheep in Nigeria. As a pastoral animal it is confined to the semi-arid north, but it is favoured as a stall-fed breed by Muslims throughout the Nigerian Middle Belt. It is white and hairy with pendulous ears and a long thin tail; rams have a throat ruff and are horned but ewes are normally polled. Another feature that makes the Balami distinctly recognisable is its Roman nose, a large bulbous nose that distinguishes it from the Yankasa.

13.3.4 The West African Dwarf

The West African Dwarf is a small-bodied, compact breed which may be all white,

black, brown, or spotted black or brown on a white coat. Its variation in colour and patchy distribution make it difficult to distinguish clearly from the Yankasa.

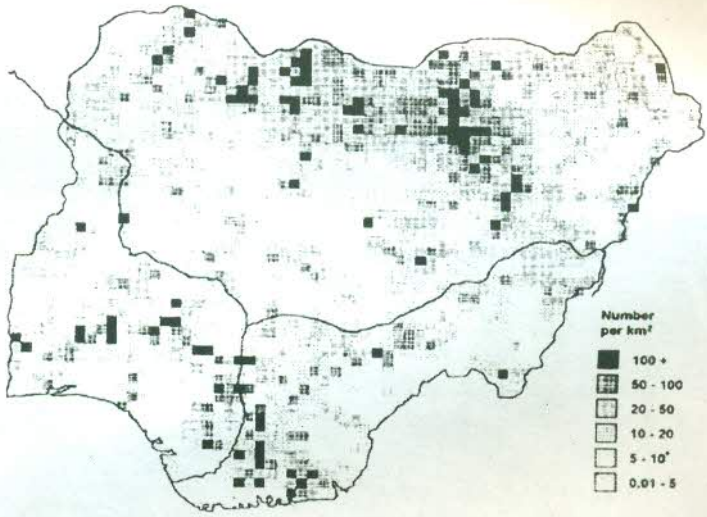


Figure 10. Distribution of Sheep in Nigeria
Source: RIM, 1992

13.4 Poultry

Poultry outnumbers all other forms of livestock in Nigeria, and, not surprisingly, is found throughout the country, wherever there is human settlement. Although pigeons, ducks, guinea fowl and some turkeys are also widely kept, chickens are by far the most common. Typically, they are maintained under traditional, low-input, free-range systems of management, but substantial numbers are also reared intensively on a commercial basis, particularly in the southern states. Current estimates put the country's poultry population at 140 million. Backyard farmers account for 60 percent of all poultry producers, commercial farmers for 25 percent and semi-commercial farmers for 15 percent. There was a boom in intensive chicken production in the early 1980s, when the government subsidised the prices of day-old chicks and feed ingredients. As the subsidies have now been withdrawn, however, both extensive and intensive commercialised production have tended to decline, especially in urban areas, despite the continued demand for chicken meat and eggs. The major constraint on traditional chicken production is Newcastle disease, which affects local breeds in particular, while for more intensive commercial producers it is the availability of feeds and drugs that is limiting. The distribution of poultry in Nigeria is presented in Figure 11.

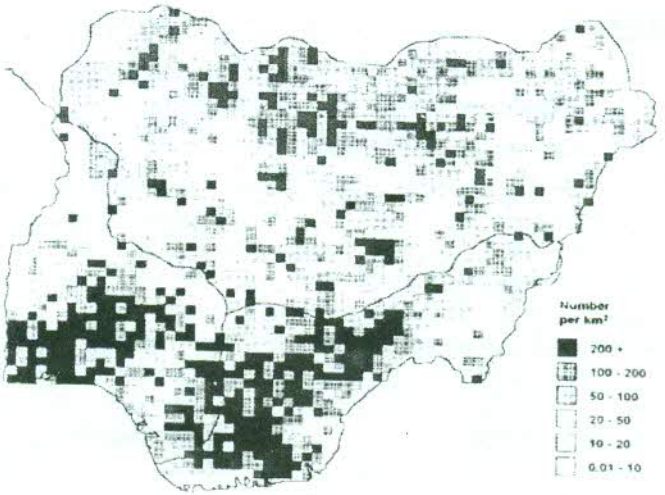


Figure 11. Distribution of Poultry in Nigeria
Source: RIM, 1992

13.5 Pigs

Pigs are generally kept in the South and Middle Belt. The traditional Nigerian black hairy pig is gradually being replaced by various exotic breeds, including the Large White, Landrace, Hampshire and Duroc. Pigs must be given supplementary feeds. Under the village system of production, pigs are usually seen roaming around scavenging for household scraps and other food items. Intensive pig rearing is economically viable on the periphery of large cities because of the availability of industrial by-products. Pigs are not commonly reared in the North due to religious factor. The distribution of pigs in Nigeria is presented in Figure 12.

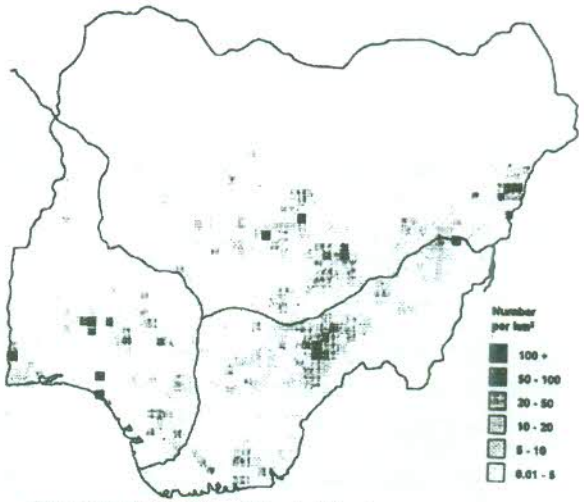


Figure 12. Distribution of Pigs in Nigeria
Source: RIM, 1992

14.0 RESEARCH FOCUS AND CONTRIBUTION TO KNOWLEDGE

Our research focus has been largely in the area of Animal Nutrition. Some of the areas that have formed our research focus are presented below:

14.1 Pasture Improvement and Evaluation

A large proportion of pastures are marginal lands. Traditional, low- intensity livestock production methods remain in many regions of the world. Production levels in these systems are determined by locally available resources. Over the years animals have lived in harmony, striking an ecological balance. With increasing livestock population and increasing demand for livestock products, these marginal lands are severely under pressure. Increased demand pressure can push these systems to produce beyond their capacity. This can bring them into conflict with the crop farmers and the environment. The United Nations Environment Programme (UNEP) estimates that since 1945 about 680 million hectares, or 20 percent of the world's grazing lands, have been significantly degraded (Oldeman, Hakkeling, and Sombroek 1991). The resulting overgrazing and land degradation have threatened the livelihood of pastoral communities.

A series of studies were conducted in the Crau region of Southern France (Figure 13) bordering the Mediterranean Sea (Adama, 1994; Adama, Lapeyronie, Hubert and Molélat, 1994; Hubert, Adama, Lapeyronie, and Molénat, 1995; Lapeyronie, Adama, Hubert, and Gouy, 1995; Molénat, Adama, Lapeyronie and Gouy 1995; Adama, Lapeyronie, Hubert, Guoy and Molénat, 2003; Adama, Thimonier, Lapeyronie, and Hubert, 2003). In the course of these studies, the capacity of cultivated pastures such as a legume namely subterranean clover (*Trifolium subterraneum* L. var 'Woogenellup') and a cultivated grass namely Italian rye grass (*Lolium multiflorum* Lam. var. 'Tiara') as well as the possibility of improving native rangeland by over-seeding with pasture species was assessed. The results of the studies showed that quantity and quality of spring forage production in the French Mediterranean region can be increased under rain-fed conditions by the introduction of plant material such as subterranean clover and rye grass (Figures 14, 15 and 16 and Plates 17 25). In these studies, the two forage crops have demonstrated considerable capacity towards solving the problem of spring forage deficit in the French Mediterranean region. Rye grass provided abundant pasture for an "early bite" at the beginning of the season although as the season progressed, its nutritive quality as reflected by the chemical composition declined. Subterranean clover was relatively less productive, but its cumulative spring production was comparable to that of the rye grass. The encouraging results obtained from the over-seeded rangeland is of particular interest for regions with unproductive native rangelands. It is expected that in such regions, pasture renovation when carefully planned and executed through the introduction of suitable plant species and fertilization application will go a long way towards increasing pasture productivity and consequently an increased livestock production.

Figure 13. Map of France showing the location of the Crau

Plate 17. A native rangeland "Crau" in Southern France

Plate 18. A native rangeland over-sown with Subterranean clover in Southern France

Plate 19. A native rangeland over-sown with Ray grass in Southern France

Plate 20. A well established pasture of Subterranean clover in Southern France

Plate 21. A flock of sheep grazing native pasture "Crau" in Southern France

Plate 22. A flock of sheep grazing improved pasture in Southern France

Plate 23. A sheep equipped with apparatus for collecting faeces in order to measure digestibility at pasture

Plate 24. Measuring pasture yield - biomass

Plate 25. Measuring pasture height

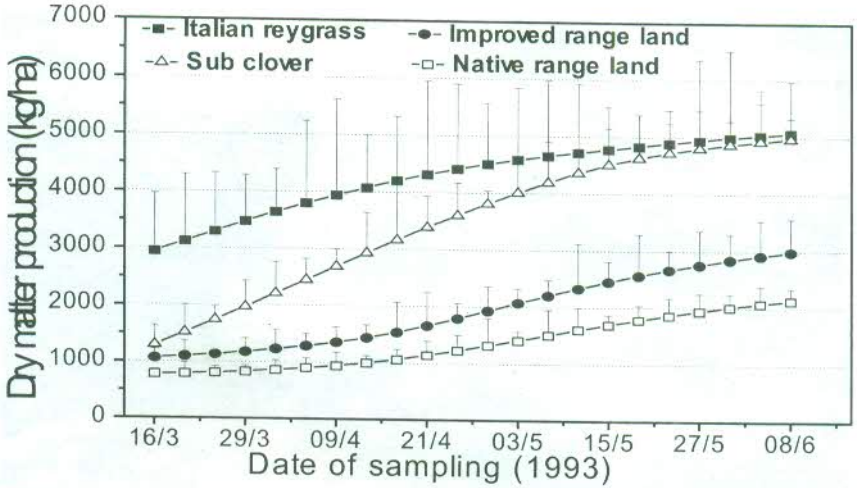


Figure 14. Cumulative above ground dry matter production on sub clover, rye grass, improved and native pasture types in 1993. Vertical bars represent standard errors of means.

Source: Adama, T.Z., Lapeyronie, P. Hubert, D., Guoy, J. and Molénat, G. (2003). The productivity and chemical composition of four rainfed Mediterranean pastures. Journal of Sustainable Tropical Agricultural Research. 5:14 - 19.

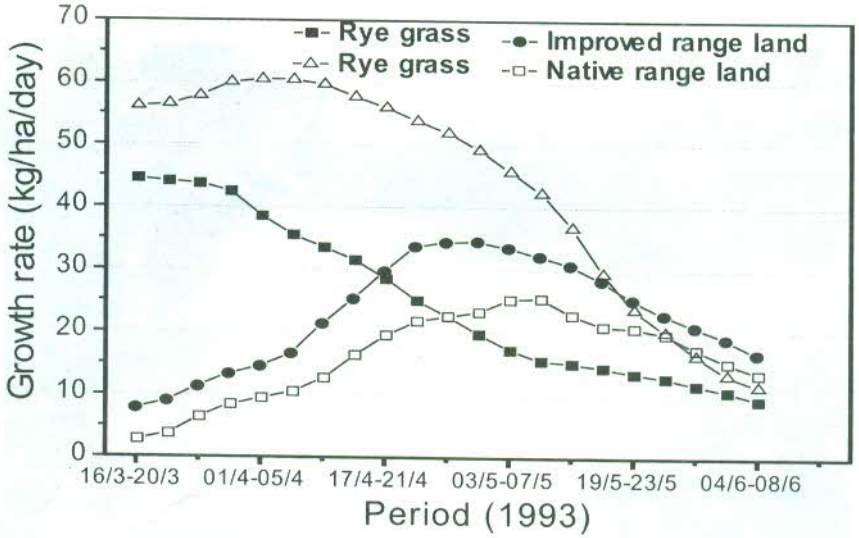


Figure 15. Herbage growth rates on sub clover, rye grass, improved and native pastures in 1993

Source: Adama, T.Z., Lapeyronie, P. Hubert, D., Guoy, J. and Molénat, G. (2003). The productivity and chemical composition of four rainfed Mediterranean pastures. Journal of Sustainable Tropical Agricultural Research. 5:14 - 19.

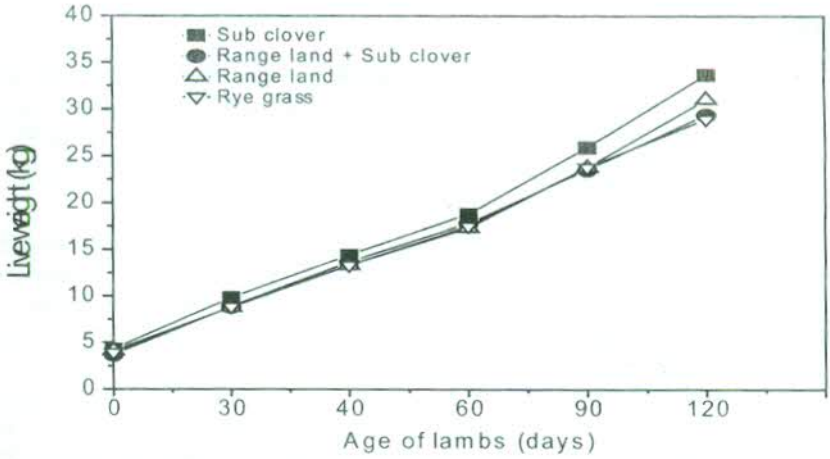


Figure 16. Growth performance of lambs produced by ewes on sub clover, sub clover with range land and rye grass pastures.

Source: Adama, T.Z., Thimonier, J., Lapeyronie, P., and Hubert, D. (2003). Effect of vegetation type on body weight, body condition and lambing performance of Merinos ewes. Journal of Sustainable Tropical Agricultural Research. 5:45 - 49.

Other studies consisted of determination of botanical composition of various vegetation types and the yield potential of cultivated and non-cultivated pasture species (Adama and Guoy, 1997; Adama and Lapeyronie, 1997; Molénat, Hubert, Lapeyronie, Gouy and Adama 1997; Adama, 1999a; Adama, 2000 and Adama, 2002a) as well as the behaviour of grazing animals at pasture (Adama, 1994, Adama, 1999). Results indicate the potential of various vegetation types and pasture species (Table 21). It was also observed that animals at pasture divide their time between various activities. These include grazing, walking, resting and rumination. Information on grazing behaviour is important in assessing the quality of pasture. More time is spent on pastures with fibrous plants which are relatively less nutritive.

Table 21. Dry matter production of the three legume species

Age of plant (days)	Centro	Lablab	Stylo
20	60.00	5628.57	1412.57
27	192.86	14157.14	3001.71
34	786.43	28085.71	5238.29
41	2044.29	43507.14	9240.57
48	3887.15	80550.00	16244.57
55	7482.87	98114.28	19952.57
Mean	2408.93	45007.14	9181.71

Source: Adama, T.Z. (2000). Preliminary agronomic evaluation of three forage legumes in the southern guinea savanna zone of Nigeria. ***Journal of Nigerian Association of Teachers of Technology. 3: 411 - 422***

14.2 Non-Conventional Feed Resources

Historically, the *raison d'être* for keeping livestock was its use of resources for which there was no alternative use. Presently, however, there is strong competition between human beings and animals, we cannot seriously think of meeting the nutritional requirement of improved livestock from the kind of feed resources that are conventionally available (Ben Salem, Makkar and Nefzaoul, 2001).

The subject finding alternative feed resources represents possibly the most compelling task facing animal scientists particularly in the sub-Saharan region where chronic annual feed deficits and increasing growths of the human populations are common (Devendra, 1988). Non-Conventional feed resources (NCFR) refer to all those feeds that have not been traditionally used in animal feeding and/or are not normally used in commercially produced rations for livestock. We have conducted several work on the use of Non-conventional feed resources in feeding mostly rabbits and poultry (Adama and Ayanwale, 1999; Adama, 1999b; Adama and Danwake, 1999; Adama and Ayanwale, 2000a; Adama and Ayanwale, 2000b; Adama, Ijaiya, Ayanwale and Onotu 2001; Ayanwale, Adama and Jiya, 2001; Ayanwale, Adama and Mustapha, 2001; Adama and Adekojo, 2002; Adama and Haruna, 2002; Adama and Nma, 2002 ; Adama and Alfa, 2002; Jiya, Ayanwale and Adama, 2002a; Jiya, Ayanwale and Adama, 2002b; Adama and Ribadu, 2003; Ayanwale Adama and Jiya, 2003a; Ayanwale, Adama, and Jiya, 2003b; Ayanwale, Adama and Jiya, 2003c ; Ayanwale, Adama and Musa, 2003; Adama, Ogunbajo and Mambo, M. 2007).

The results showed that replacement of conventional feeding stuffs such as maize with non-conventional ones such as rumen ingesta, rice bran, sorghum dried brewer's grain and cocoyam in the diet of livestock (Figures 17 & 18 and Tables 22 - 25) can bring about reduction in the cost of feed, thus increasing the profitability of rabbit production. Also, the practice will reduce the competition between man and animals for grains. Most of the non-conventional feeds studied showed no adverse effect of the feed substance on the animal. Some of the results are presented below:

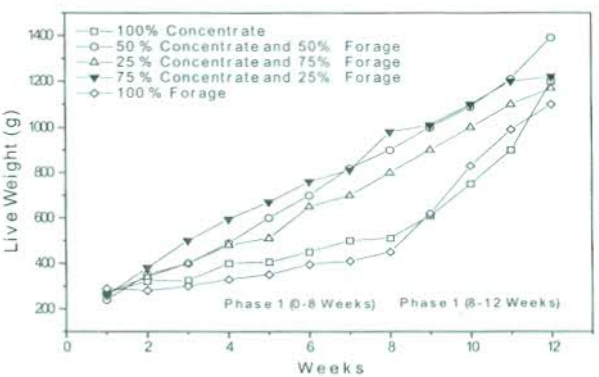


Figure 17. Growth pattern of rabbits fed diets containing various proportions of concentrate mixture and forage.

Source: Adama, T.Z. (1999b). Body weight changes and feed intake of weaner rabbits fed varying proportions of concentrate and forage diets. Journal of Nigerian Association of Teachers of Technology. 3: 251 - 261

Table 22. Performance of growing rabbits fed various proportions of Xanthosoma sagittifolium (cooked and uncooked) and Luffa aegyptiaca as non-conventional feeds.

	Diets				
	No Cocoyam	Cooked Cocoyam	Cooked Cocoyam		
Items	0%	17.50%	35.00%	17.50%	35.00%
Number of Rabbits	12	12	12	12	12
Number of Days	70	70	70	70	70
Initial Weight (g)	788.5 ±11.5	865.0 ±3.0	853.5 ±62.5	838.0 ±66.0	829.5 ±49.5
Final Weight (g)	1539.0 ±20.	1499.0 ±35.0	1490.5 ±93.5	1506.0 ±53.0	1406.0 ±56.0
Weight Gain (g)	750.5 ±8.5	634.0 ±38.0	637.0 ±31.0	668.0 ±13.0	576.5 ±6.5
Daily Weight Gain (g)	10.7 ±0.1a	9.1 ±0.5a	9.1 ±0.4a	9.5 ±0.2a	8.2 ±0.1b
Cumulative Forage Intake (g)	1291.5 ±11.2a	1608.1 ±100.7b	1616.7 ±142.7b	1506.4 ±19.4b	2050.8 ±244.1c
Daily Forage Intake (g)	18.5 ±0.2a	23.0 ±1.4b	23.1 ±2.0b	21.5 ±0.3b	29.3 ±3.5c
Cumulative Concentrate Intake (g)	3470.0 ±46.0	3418.8 ±116.5	3496.5 ±18.8	3317.9 ±154.4	3243.1 ±21.6
Daily Concentrate Intake (g)	49.6 ±0.7	48.8 ±1.7	50.0 ±0.3	47.4 ±2.2	46.3 ±0.3
Cumulative Feed Intake (g)	4761.5 ±34.8	5026.9 ±217.2	5113.21 ±61.5	4824.3 ±135.0	5293.9 ±265.7
Daily Feed Intake (g)	68.0 ±0.5	71.8 ±3.1	73.0 ±0.1	68.9 ±1.9	75.6 ±3.8
Feed to Gain Ratio	6.4 ±0.0a	7.9 ±0.1b	8.0 ±0.1b	7.3 ±0.1a	9.2 ±0.6c
% Forage of Total Intake	27.13 ±0.43	31.96 ±0.62	31.56 ±1.79	31.26 ±1.28	38.60 ±2.67
% Concentrate of Total Intake	72.87 ±0.43	68.04 ±0.62	68.44 ±1.79	68.74 ±1.28	61.40 ±2.67
Dry Matter Digestibility %	84.74 ±1.24a	74.98 ±0.81b	75.89 ±1.01b	81.34 ±2.00a	64.47 ±0.52c

[abc]Values in the same row denoted by different letters are significantly different (P < 0.05).

Source: Adama, T.Z. and Ayanwale, B.A. (2000). The effect of replacing maize with two types of cocoyam (Xantosoma sagitifolium and Colocasia esculentum) corms on the performance of weaned rabbits. Nigeria. ***Journal of Science, Technology and Mathematics Education. 3 (1): 170 178***

Table 23. Performance of rabbits fed cooked and uncooked cocoyam corms supplemented with mango leaves

Parameters	Diets					SEM*
	Control	Cooked corm		Uncooked corm		
	0%	17.50%	35%	17.50% CY	17.50%	
Initial body weight	754.5	784.0	762.5	756.0	735.0	±5.01 NS
Final body weight (g)	1538.0	1553.0	1653.0	1550.0	1437.0	±7.14 NS
Body weight gain (g)	783.5	769.0	890.5	794.0	702.0	±3.15 NS
Mean concentrate intake(g)	2419.55a	2442.2a	2414.2a	2421.86a	1319b	±5.08 *
Mean forage intake (g)	445.33ab	500.78a	410.55b	411.21b	461.7a	±2.61 *
Forage+Concentrate intake(g)	2860.90	2968.78	2822.82	2801.48	2780.60	±7.72 *
Feed/Gain ratio	4.39	4.99	4.50	4.36	4.33	±2.54 NS

abc Means in the same row with different letters are significantly different (P<0.05).

* Standard error of mean; NS Not significant; * Significant (P < 0.05)

Source: Ayanwale, B.A., Adama, T.Z. and Jiya, E.Z. (2001a). Growth and nutrient digestibility of rabbits fed Colocasia esculentum corm and Mangifera indica leaves. Journal of Science, Technology and Mathematics Education. 4 (1) : 179 - 186.

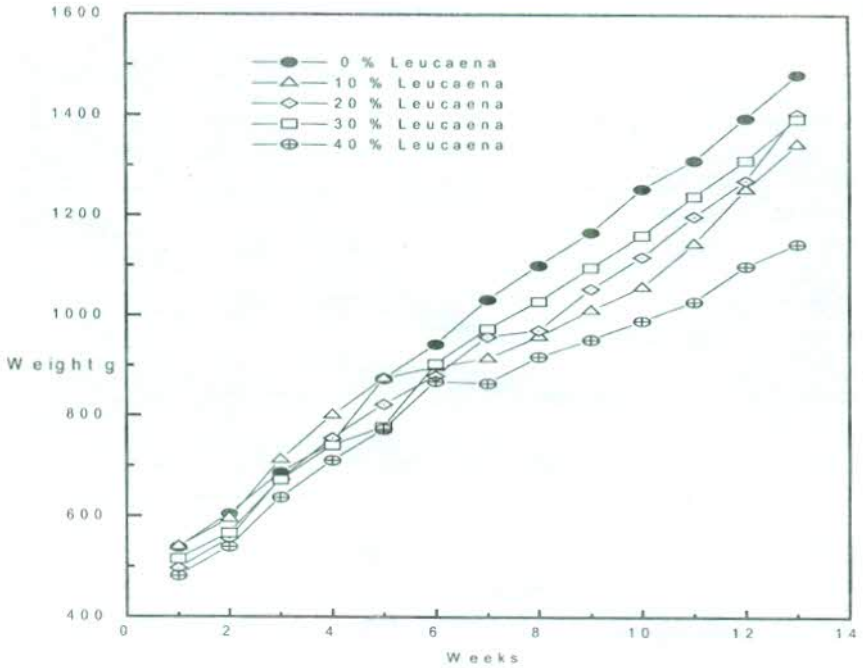


Figure 18. Growth pattern of rabbits fed varying proportions of Lucaena leucocephala

Source: Adama, T.Z. and Adekojo, S.A. (2002). Growth and carcass characteristics of rabbits fed diets containing varying proportions of Leucaena leucocephala. Journal of Science, Technology and Mathematics Education. 5(2): 5 - 11

Table 24. Analysis of returns based on the cost of feeding diets containing varying levels of Leucaena leucocephala on growing rabbits.

Parameters	Diets				
	1	2	3	4	5
	0% Leu.	10% Leu	20%Leu	30%Leu.	40%Leu.
Average total weight gained/rabbit (g)	942.8c	877.9b	905.4bc	877.0b	706.9a
**Value of weight gained (₦)	188.56bc	175.68b	181.08bc	175.40b	141.38a
Total feed consumed/rabbit (kg)	5.7	5.6	5.5	5.4	5.0NS
Unit cost of feed/kg (₦)	27.52c	27.71bc	22.27c	19.51b	16.95a
Total cost of feed consumed (₦)	156.89e	138.36d	122.47d	105.37b	84.74a
Return (₦) per rabbit	31.67a	37.32ab	58.61c	70.03d	56.65a

**At ₦200.00/kg live weight; abcMeans in the same row with different letters are significantly different ($P<0.05$); Leu = *Leucaena leucocephala*

Source: Growth and carcass characteristics of rabbits fed diets containing varying proportions of Leucaena leucocephala. Journal of Science, Technology and Mathematics Education. 5(2): 5 - 11

Table 25. Average feed intake and growth performance of rabbits

Parameter	Groundnut	Potato	Luffa	Tridax	Mango
Feed intake					
Average daily concentrate intake (g)	78.73	84.23	83.98	84.57	86.94
Average daily forage intake (g)*	19.68d	18.70d	18.39bc	17.44b	14.22a
Average total daily feed intake (g)	98.42	102.93	103.37	102.01	101.16
Growth performance					
Initial body weight (g)	1361	1380	1358	1370	1368
Final body weight (g)	2099d	1987c	1798b	1759b	1327a
Total weight gain (g)	738d	607c	440b	389b	259a
Average daily weight gain (g)	17.6d	14.5c	10.5c	9.3b	6.2a
Feed to Gain Ratio (g)	5.5cd	7.3c	9.6bc	11.4b	16.3a

Means in the same row with different letters are significantly different ($P<0.05$).
*Expressed on dry matter basis

Source: Adama, T.Z. and Jiya, E.N. 2002. Effect of different forage types on the performance of Rabbits. ***Journal of Sustainable Tropical Agricultural Research Vol. 4: 1-4***

14.3 Techniques on Management Practices

A number of studies were conducted in order to determine best management practices for sheep and goats production (Plate 26). This includes the effect of tethering (Adama and Mijidadi, 2002) or castration of male goats (Adama, 1976, Adama and Kolo, 2002, Adama, 2003b; Tsado and Adama, 2003). Results showed that tethering as usually practiced during the raining season can affect the performance of animals and that for tethered animals to perform well, their diet must be adequately supplemented (Figure 19). They should also be adequately protected from adverse weather conditions such as high temperature and rainfall. As for the practice of castrating of male goats it was found that castration of male kids could be of economic benefit to farmers since growth rate and body condition are enhanced without a significant adverse effect on dressing percentage (Table 26). Consumers of goat meat are likely to obtain more meat from the carcass of castrates because of the high meat to bone ratio. Meat from castrate, male and female tended to have similar chemical characteristics, as no significant differences were observed in their crude protein, crude fibre, ash and nitrogen free extract contents. It is recommended that excess male kids (goats) should be castrated as this will enhance their growth rate and meat to bone ratio (an advantage to the consumer) without adversely affecting the dressing percentage.

Some of the results are as follows:

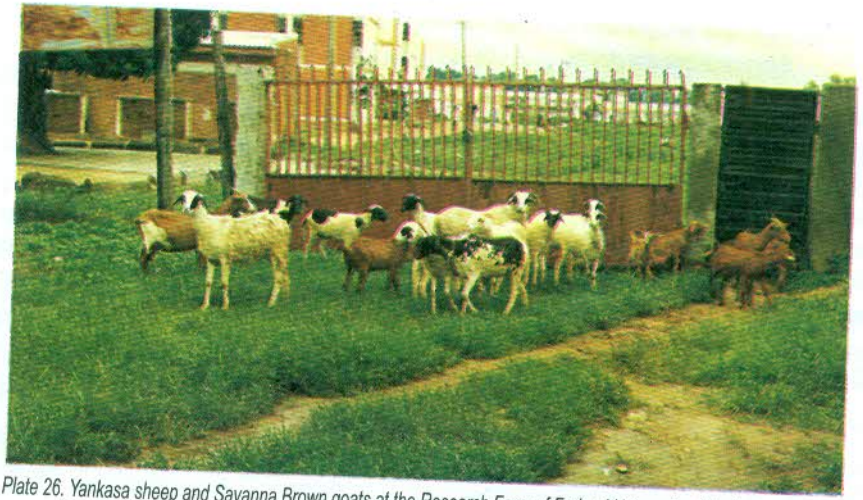


Plate 26. Yankasa sheep and Savanna Brown goats at the Research Farm of Federal University of Technology, Minna.

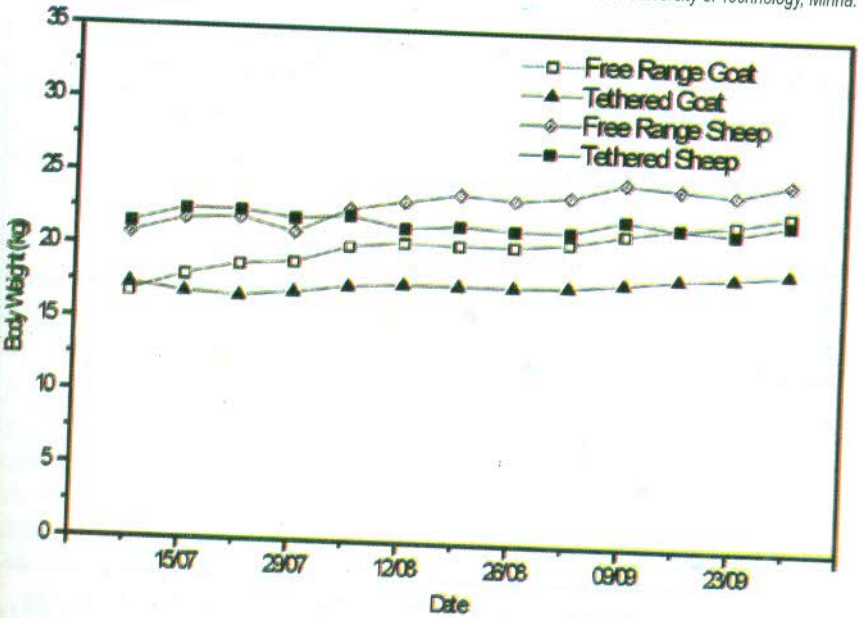


Figure 19. Weekly body weight of free range or tethered Savanna brown goats and free range or tethered Yankasa sheep

Source: Adama, T.Z. and Mijidadi, H.H. (2002). Performance of Yankasa sheep and Savanna Brown goats under free grazing and tethering systems of management. Tropical Journal of Animal Science. 5 (2) : 73 - 79

Table 26. Age, live weight and carcass values of castrate, male and female Savanna brown goats.

Parameters	Castrate	Male	Female	
Age (months)	12.0	12.0	12.0	NS
Body condition	3.34b	2.69a	2.78a	*
Live weight at slaughter (kg)	17.40b	15.24b	12.88a	*
Weight after slaughter (kg)	16.35b	14.25ab	11.90a	*
Weight of dressed carcass (kg)	8.45b	8.10b	6.73a	*
Dressing percent (%)	48.32	52.21	51.59	NS

abcMeans in the same row with different letters are significantly different (P<0.05).
NS Not significant (P > 0.05); *Significant (P < 0.05)

Source: Adama, T.Z. and Kolo, T.G. (2002). Body conformation and carcass characteristics of male, female and castrated male Savanna Brown goats. ***Journal of Applied Science and Education. 6:167 - 173***

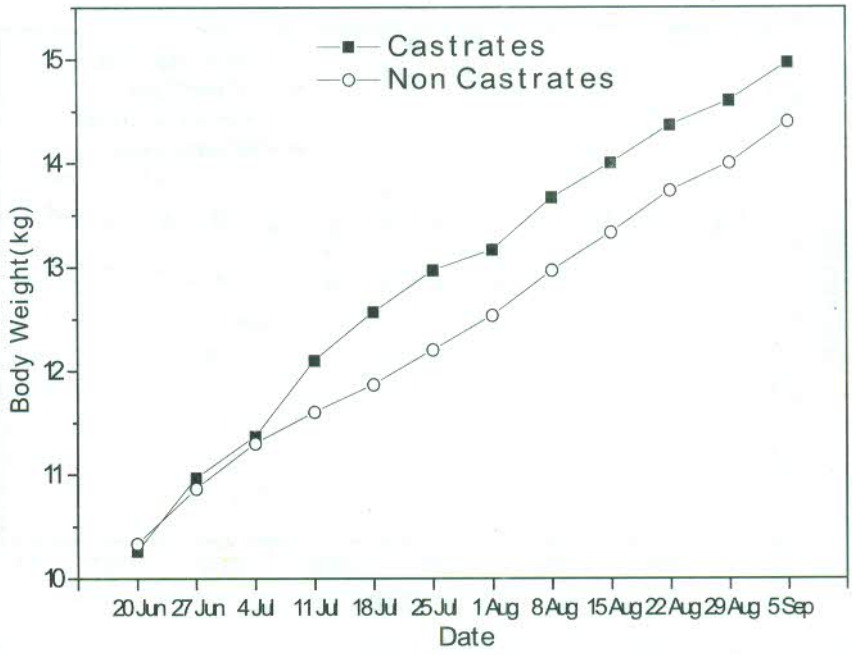


Figure 20, Weekly live weight (kg) of male (entire) and castrate goats over a period of twelve weeks.

Source: Adama, ***T. Z.*** *(2003b). Effect of castration on growth performance and feed utilisation of Savanna Brown Goats.* ***Journal of Sustainable Tropical Agricultural Research 7:17 - 21***

15.0 CONCLUDING REMARKS

The world's livestock sector is growing at an unprecedented rate and this growth is only taking place in developing countries. Livestock are not only important as producers of meat, milk and eggs, which are part of the modern food chain, and provide high value protein food, but other non-food functions, although of declining importance, still provide the rationale for keeping the majority of the world's livestock. For millions of smallholder farmers, animal draught power and nutrient recycling through manure compensate for lack of access to modern inputs such as tractors and fertilizer, and help to maintain the viability and environmental sustainability of production. Often, livestock constitute the main, if not the only, capital reserve of farming households, serving as a strategic reserve that reduces risk and adds stability to the overall farming system. As such, livestock can satisfy a large variety of human needs.

Livestock production is an important source of income for the rural poor in developing countries. It enables poor and landless farmers to earn income using public, common property resources such as open rangeland. Livestock consume many crop by-products that would otherwise become waste. They often can be raised on land that has no other sustainable agricultural use, and they can employ labour during periods of slack in other agricultural activities. Poor women in particular often rely on the cash income from a dairy cow or a few chickens kept in the household. As livestock consumption increases there is considerable interest in how the poor can retain their market share of livestock production.

Given sufficient economic resources, people *naturally* choose meat and dairy. Demand for meat and milk will rise by 87% and 65% by 2020 (2000 baseline) respectively. Also, 84% of the increase for meat and milk will occur in developing nations. The major reasons are increases in population, urbanization, and affluence.

Technological progress in the production, processing, and distribution of livestock products will be central to the positive outcome of the **Livestock Revolution**. Rapid advances in feed improvement, genetic and reproductive technologies offer scope for overcoming many of the technical problems posed by increased livestock production. Institutional and regulatory development will also be critical to securing desirable environmental and public health out-comes.

*The **Livestock Revolution** could well become a key means of alleviating poverty in the next 20 years. This is capable of creating new opportunities for livestock producers in developing countries, where some of the world's poorest people live. The increase in livestock food products also holds promise for relieving widespread micronutrient and protein malnutrition, while making positive contributions to the sustainable*

intensification of smallholder agriculture. Yet, significant new dangers are also arising. Some forms of livestock production encouraged by policy distortions are leading to serious environmental and health risks. Furthermore, increasing global livestock and feed markets are sharing economic pains faster and more directly, even as they share economic prosperity. Understanding the stakes involved helps motivate those who seek to meet the emerging challenges.

Taken together, the many opportunities and dangers of the **Livestock Revolution** suggest that it would be foolish for developing countries including Nigeria, to adopt a *laissez faire* policy for livestock development. It is in fact interesting to note that since 1981, Nigeria has been planning a **Livestock Revolution** (FMARD, 1981) which, since then has remained in the pipeline. We hope the pipe will not be vandalised. We must prepare for this revolution with long-run policies and investments that will satisfy consumer demand, improve nutrition, direct income growth opportunities to those who need them most, and alleviate environmental and public health stress.

The demand-driven **Livestock Revolution** is one of the largest structural shifts to ever affect food markets in developing countries. How it is handled is crucial for future growth prospects in developing countries' agriculture, for food security, livelihoods of the rural poor, and for environmental sustainability.

16.0 RECOMMENDATIONS

Some people want to halt the **Livestock Revolution**. But the ongoing nutritional transformation in developing countries driven by income, population, and urban growth leaves little room for policy to alter the widespread increase in demand for animal food products. Policy can, however, help make the form of the revolution as beneficial as possible to the overall well-being of the poor. To do this, policy makers will have to focus on some key issues:

I. Funding

Of primary importance is the issue of funding. Publicly funded research and extension should focus on agricultural resource management that comprehensively furthers policy goals that relate to human needs. Rather than emphasizing output maximization, research and extension should find ways to use a dynamic livestock sector to improve food security and alleviate poverty and at the same time minimise adverse effects on public health and the environment. The design of public investment must therefore go beyond a strict technical orientation and consider the social, economic, and ecological dimensions of the interaction of livestock with the betterment of livelihoods.

II. Integration of local and large-scale producers

Small-scale producers have to be linked vertically with processors and marketers of perishable products. The poor find it difficult to gain access to productive assets such as credit and refrigeration facilities and to information such as knowledge about microbial infection prevention. The integration of small-scale livestock producers and large-scale processors would combine the environmental and poverty-alleviation benefits of small-scale livestock production with the economies of scale and human health benefits that can be had from large-scale processing.

III. Strategy on Government Intervention

In Nigeria, there is a total lack of coordinated, field-oriented approach to the problems of livestock production. For a sustainable **Livestock Revolution**, what producers need most is not necessarily subsidies. Rather we must have in place a policy which can help facilitate the incorporation of smallholders into commercial production by remedying distortions that promote artificial economies of scale. Experience in Nigeria has shown that most incentives hardly get to the right people. Success in this effort will require political commitment as well as public and private partnership. An interdisciplinary approach embracing nutrition, genetics, physiology and veterinary medicine must be followed if we are to effectively and quickly resolve the myriad of problems confronting the livestock industry. Much greater attention should be given to livestock productivity and management, including post-harvest processing and marketing.

IV. Environmental Protection

Regulatory mechanisms for dealing with the health and environmental problems arising from intensification of livestock production need to be developed. Technologies that address environmental and public health dangers will not work unless regulatory enforcement backs them up. Such institutional developments will likely occur when the political demands for better regulation become strong.

V. Inter-disciplinary Cooperation

The constantly advancing technology requires increasing specialization. However, let us not be drawn too far into the maze of professional compartmentalization that, through lack of communication and coordination with our fellow scientists, we lose sight of our principal goal which is the optimal use of animal species in contributing to world food needs. No one

single profession should claim to be superior and our efforts should be directed principally towards the area of our specialization. We ought to be cognizant of our collective responsibility in animal agriculture on the world scene. Neither disease control nor injecting superior genes, for example, can alone bring about improvements in our livestock production. It should also be noted that animal agriculture will continue to have an integral role in the world's food economy. The challenge and the opportunity for all the professionals in the livestock sector are to contribute to the well-being of mankind throughout the world.

VI. Grass-root mobilization

Above all, small-scale producers need to be included in the response to this dynamic opportunity. Lack of policy action will not stop the **Livestock Revolution**, but it will ensure that the form it takes is less favourable for growth, poverty alleviation, and sustainability in developing countries.

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