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ANIMAL BREEDS: A NATION HERITAGE

By

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The Chairman and Vice-Chancellor, Prof. I.F. Adu
The Deputy Vice-Chancellor, Prof. T.O. Tayo(JP)
Principal Officers of the University,
Deans and Directors,
Distinguished Guests
Highly Esteemed Colleagues,
Great Unaabites,
Ladies and Gentlemen.

With all honour and due reference to the awesomeness of my God and Father, my personal Lord and Saviour Jesus Christ and His divine guiding Holy Spirit, it is with great pleasure and priviledge that I welcome you all to my Inaugural Lecture, the 16th in the series in this great University, titled "Animal Breeds – A Nations' Heritage"

In the past 30 years (1973 to date) I have been involved in the research, teaching and production of animal; principally in the area of Animal Breeding; Genetics and Biotechnology, a highly specialized and distinct field within the Animal Sciences.

Mr. Chairman Sir, distinguished ladies and gentlemen, it is not by mere coincidence but by the infinite mercy and the special grace of God that I found myself in this rare but highly esteemed field of agriculture and so it is in humility and total submission to the will of my God that I stand before you today to share my experience as a breeder in a nation that does not believe in her own naturally endowed resources, a nation so highly endowed, wonderfully blessed but finds it difficult to appreciate the worth of it's wonderful genetic resources.

A nation that continuously wastes her livestock genetic resources will continue to grope and be at the mercy of other nations who use her as the dumping ground for their prowess in the ability to create employment, alleviate poverty, eliminate protein malnutrition and provide for the social needs of their human heritage. **In essence Nigeria's animal breeds are a neglected heritage!!**

At the beginning of creation, in Genesis Chapter One, we were told that God created the light, the firmaments, the plants, the sun, the moon and the stars, the fishes – the heavenly creatures – birds and finally the mobile earthly creatures - livestock and man in that order and not until He created the sea creatures-fishes; the birds, the livestock and man did He give the commandment, "Be fruitful, multiply and fill the earth and subdue it and have dominion over" (Gen.1: 28). In other words, the livestock is so important to man that there is need for them to be fruitful and multiply. The totality of the importance could be seen in the following texts of the Bible:

- Now Abel was a keeper of sheep and Cain a tiller of the ground, in the course of time, Cain brought to the Lord an offering of the fruit of the ground and Abel brought of the firstlings of his flock and of their fat portions. And the Lord had regard for Abel and his offering" Gen. 4:2-4.

- Abraham was most blessed, "Now Abram was very rich in Livestock in Silver and in gold" (Genesis 13:2)

Being the Text of 16th Inaugural Lecture delivered on 8th October 2003.

- Job, the richest man in the East during his time was blessed with:
  7,000 sheep
  3,000 camels
  500 yoke of oxen
  500 female donkeys (Job 1:3).

- In sparing Nineveh that place that God sent Jonah to warn of impending destruction, the Lord said "Should I not pity Nineveh that great city in which are more than 120,000 person …….. and much livestock" (Jonah 4:11).

- In the commandment to the children of Israel, Moses said "The Lord will love you and bless you and multiply you, he will also bless the fruit of your body……., the increase of your flock……. there shall not be male or female barren among you or among your livestock" Deut. 7: 13-14.

Is it then surprising that when Jesus was to be born there was no place for Him in the hotel (Inn) but one was found in the manger among cattle and sheep and to crown it all it was the shepherds, who first saw His star in the East and they went down to worship Him with their gifts (Luke 2: 7-8).

At the end of this lecture, I hope to provoke your mind and particularly that of the youths of this great nation to know that livestock development is not supposed to be in the hand of the pitiable farmers all over the villages but that the commercial exploitation of our animal genetic resources lies in the hand of trained graduates of Universities like ours who will begin to create wealth for this nation. The livestock scientists as graduate farmers are to generate employment for their teeming colleagues who are waiting for their money in the banks, those who are waiting for their milk, eggs, pork, sausages, cheese, yoghurt, mutton, chicken cutlets, beef etc. for their daily food intake to create and generate wealth and alleviate poverty to minimize diseases and eliminate malnutrition. From the income from our semen bank, data bank and gene bank, we are to pay the salaries of those at the Union bank, First bank, Wema bank, etc. From our products, we are to strengthen the doctors, energize the petroleum, gas, theatre workers and the football players, the president, senators, ministers, commissioners and other civil and public servants.

A nation that wastes her livestock can never have enough to feed her children, her youth, the aged and so will continue to suffer in the midst of plenty. **A wasted livestock is a wasted heritage!**

INDIGENOUS ANIMALS

Indigenous animals are both functionally and genetically valuable because they may contain genetic materials which has been lost in the improved gene pool. They may possess relic characteristics or genetic variants that are either absent in modern improved stock or that exist in their rare ancestors. These traits may be of commercial, scientific, aesthetic or historical value. They may have novel and/or rare characteristics such as adaptation to extreme environmental conditions (temperature, stress, drought and high parasitic load) either as a result

of selection pressures that have led to an increase in the frequency of rare genetic types or mutations or both.

Indicators of important genetic traits.

Genetic indicators could be direct or indirect. Direct indicators are usually the best and they include (1) morphological features that may indicate ancestry or adaptation such as hair colour, coat length or presence and shape of horns. Quantitative characteristics including body size, degree of sexual dimorphism, litter size, duration of breeding season, may also indicate significant differences in ancestry or selection pressure.

Genetic markers

The presence of rare or unique alleles in indigenous population determined using the fast evolving techniques of molecular biology might indicate, that those animals have a different ancestry to that of improved domestic stock. Alternatively, the difference may be due to a particular mutation that has subsequently increased frequency of unique alleles as a result of selection and/or genetic drift. **Why then the total neglect !!**

THE NATION – NIGERIA.

In the contemporary world, livestock production is one of the most valued component of human diet. For this reason, the rational use of farm animal is of vital economic importance.

Nigeria has a wide diversity of climatic zones. From the humid forest zone of the South to the very dry Sahel region of the North and the mountainous cool belt of the Plateaus in the Middle Belt region. Vast areas of the forest region lie under the blood-sucking insect challenges, hence, the production of ruminant animal species is somehow limited. Nevertheless, poultry and pig breeds thrive better in this zone. Apart from the high population density in these zones, the religious taboo that limits the production of pigs also localized the production of these species to the Southern/Middle belt zone of the country. Thus, a very high percentage of indigenous and exotic pigs and poultry breeds are found in these areas.

The World Bank country report for rural poverty threshold showed 40, 304, 540 Nigerians to be below the poverty line of less than US $ 2 day^{-1} out of which 24,010,436 are livestock producers (i.e.60%)(Thornton et.al. 2002). It is a generally agreed phenomenon that human well-being has many dimensions and that poverty can be defined as a pronounced deprivation in well-being. It means lack of food, shelter and clothing; being sick and having very limited access to health services, being illiterate and having few or no educational opportunities; having little security and being very vulnerable to outside events such as natural disasters, and economic crises, being excluded from power and political access, and most of all, having no hope for the future. **What a waste !!**

Nigeria's Animal Agriculture

Nigeria is endowed with 13.8 million cattle, 97% of which are traditional Zebu breeds, 34.8 million goats, 22 million sheep, 72.4 million local chicken, 11.8 million ducks, 4.7m guinea fowls and 3.1 million pigs, yet the average Nigerian consumes less than 25% of the recommended 34

gm/head/day animal protein, i.e. less than 9 gm. 90% of the cattle are in the hand of Nomads, who move up and down the country in search of food and water, despite Nigeria's 923,738 sq. km. of land mass which are grossly underutilized with only 31% under cultivation. 100% of the sheep and goats are in small holder units whilst 70% of the poultry breeds are in the backyard.

International attention has never being on African sheep breeds because the exotic wool sheep can not thrive under hot humid condition and only the skin of the goat is needed for leather works and shoes. Exotic cattle and poultry have been developed beyond measure in the developed homelands, hence foreign markets are required for the disposal of the stock and their excess products. Nigeria has therefore been brainwashed, hypnotized or programmed to believe that she can never produce anything good from her indigenous animal genetic resources, she can always buy with her hard earned money at a cheaper rate and thereby discourage her citizens from going into production and competition in the international market, throwing her own children into the unemployment market and creating job opportunities for children of her supposedly friendly producer nations. **The neglect can thus continue!!**

Table 1: Nigeria's livestock population.

	Pastoral	Village	Urban	Total	% S.E.
Cattle	11,478,145	2,358,078	49,590	13,885,813	1.6
Goats	1,142,154	32,287,589	1,023,981	34,453,724	2.9
Sheep	2,678,152	18,356,718	1,057,732	22,092,602	3.2
Pigs	-	3,352,560	53,821	3,406,381	6.0
Rabbits	-	1,475,437	244,409	1,719,846	8.3
Poultry	-	97,860,320	6,397,640	104,257,960	3.3

Source: RIMS 1992.

Animal Protein supply: the Nigerian Situation.

Average daily Nigerian intake of protein food is currently estimated at 55g. This may be considered to be adequate in its totality, but the average Nigerian diet is seriously deficient in animal protein. Indications from food balance studies show the desirable targets as follows:

	Protein intake / caput / day	
	Total Protein	**Protein of Animal Origin**
Nutritionists target	50 – 65g	25 – 30g
Europe and USA	88.4g	51 – 52g
West and Central Africa	51.8g	5 – 6g

If we assume a population of 100m for Nigeria, then in order to meet the nutirtionist target, our estimated requirements per day would be:

Total protein required	3100	metric tons
Suggested % animal protein (50%)	1550	" "
Current Nigerian Consumption	400	" "
Animal Protein gap	1150	" "

The major sources of animal proteins available to Nigerians are – milk, chicken meat, eggs, beef, pork, lamb and goat meat as well as meat from wild life and other micro-livestock. The least cost sources of animal protein are milk, chicken meat, pork and eggs. Beef is presently a relatively expensive commodity because of world – wide scarcity. Given the present circumstances therefore there is need to embark on problem- solving crusade by setting targets to improve the animal protein intake by about 25 – 40% within the next 5 years. Converting this immediate target to product terms will require an annual output of approximately:

120,000,000 broilers
2,500,000,000 eggs
1,500,000,000 litres of milk

This in essence requires the harnessing of all genetic resources of Nigeria's animal breeds, as well as the plants to provide the essential nourishment for the animal and human population.

Today's Research and the Country's Development

Today's research is tomorrow's wealth. IITA has been in Nigeria for close to 30 years collecting, characterizing, improving plant breeds both local and exotic all over sub-Saharan Africa with many other commodity specific research stations dotted all over the continent such as WARDA for rice, ICRISAT for maize and sorghum etc. Nigeria has 18 crop based Research Institutes, both for mono and multi-commodity research and only two Research Institutes research into the development of her numerous livestock breeds, one for production and the other for health, despite the numerical strength of her livestock species.

Nigerian Universities continue to turn out hundreds of animal science graduates every year into barren fields, half-baked because the animal research even in these Universities are nothing to write home about with data collected on only handful of animals without any continuity in research and no correlation with production.

From the Central Bank report, the poultry industry alone contributes about N5.1 billion, i.e. 5-8% of total GDP in Nigeria, and despite the 36.5% contribution of livestock to protein intake of Nigerians, the sector is still deficient in playing the primary role of satisfying the protein requirement of Nigerians.

Average annual growth rate of livestock products in Nigeria stood at 3.5, 2.4, 5.1, 5.1, 2.4, 16.1 and 2.2% for poultry meat, egg, goat meat, lamb/mutton, beef, pork and milk between 1993 and 1996 (CBN, 1997).

Nigeria's animal breeds are adapted to the climatic, ecological, nutritional and disease state of the country. These are qualities that are inherent in the animals over the centuries which can not be quantified in monetary values. Dryden in 1917 started poultry breed development at the Oregon Agric. Experimental Station and in 10 years, he improved egg production in the Barred Rocks from 85 – 215, the Oregons from 155 – 231 and the White Leghorns, from 107 to 212. Presently, only 5 companies comprising basically 3 groups, the Lohman group; producers of Lohman, Hyline and H & N breeds, the Merial group, producers of ISA, Babcock, Shaver and Hubbard, Hendrix and others producing Delkab, Hisex, Bovans and Tetra, together are controlling the 700 billion eggs consumed in the world annually.

Nigeria can aim at controlling 1/700 share of the market within this decade if she encourages her own research group by establishing **Specie Specific Animal Breeding Stations**.

A collection of only:

- 10,000 great grand parent from the 70 million local chicken available in this country, with a selection of 20 grand parent per great grant parent, 60 parents per grand parent, 70 pullets per parent and 200 eggs per pullet, would generate the much needed 16.8 billion eggs from both crossbred and purebred production .

10,000	x	20 gp	⇐	200,000 gp
200,000	x	60	⇐	12,000,000 parents
12,000,000	x	70	⇐	840,000,000 commercial pullets
840,000,000	x	200	⇐	168,000,000,000 eggs.

If only there could be Regional Poultry Breeding Research and Progeny Testing Stations.

If only there could be Regional Species Specific Animal Breeding Stations, Progeny Testing Centres, Animal Feed Production and Nutrient Testing Stations; Animal Pasture, Forage and Rangeland Production and Management Stations, Animal Products Development and Processing Centres as well as Central Semen Production and Distribution Stations which form the basis for livestock development in other nations in addition to the recently introduced Animal Biotechnology Institutes and DNA Diagnostic Centres.

From this submission you will agree with me that livestock production is not an enterprise that could be handled by a single National Livestock Research Station, that livestock production is a multifacetted, interknitted enterprise requiring capital, human and animal resources to create wealth and generate employment for the nation's citizenry. **The time to think about this heritage and stop the national neglect is NOW!**

Livestock Productivity and Associated problems.

Sub-Saharan Africa owns 14% of the world's cattle population, yet produces only 5% of the beef/veal and 2% of the milk. The complex nature of livestock production, coupled with a low technical base and long generation time, have slowed down progress in livestock production. Productivity of the indigenous animals is hampered primarily by:

- genetic components
- shortage of feed
- diseases
- management factors in addition to technical policy and institutional problems.

Economic losses, due to disease alone is high. For example, annual losses due to brucellosis was estimated at 50 and 224 million dollars in East Africa and Nigeria respectively. Annual losses due to helminthiasis in Ethiopia alone was put at 380 million dollars whilst that due to ovine fasciollasis were in the region of 24 million dollars in Ethiopian high lands. Over 10.3 million km^2 area in sub-Saharan Africa is underutilized due to disease threat, and risk to tsetse flies and the trympanosomes they transmit. The economic losses due to disease as enormous as it looks, requires targets for solution, but definitely not in the importation of drugs alone but also through genetic intervention. It is on record that despite all palliative measures taken to eradicate these diseases, there are available on the continent, animals which without any intervention possess some degree of tolerance or resistance to those diseases hence could co-habit with the disease parasites without any adverse effect. It is easy for government to rush to import drugs and vaccines which is short-term and temporary but difficult to search for genes that confer resistance and tolerance in a population because that is a long term permanent solution to the problem. Now is the time to start using conventional and biotechnological approaches to solve our disease problems.

The contribution of West Africa to the genetic resource of livestock species, breeds and strains in the world is highly significant although data on their genetic characteristics are very limited. The different breeds and species have better survival, are hardy, have a high degree of heat tolerance and are partly resistant to many of the prevailing diseases, as well as the ability to survive long periods of feed and water shortage under hostile environments and poor management practice.

These properties are genetic, they have been acquired through natural selection over hundreds of generations, hence the indigenous African breeds of livestock represent unique source of genetic materials that could be used in other parts of the world and at the same time be improved in their own environment to increase food production, eradicate protein malnutrition and alleviate poverty.

Animal Breeding in Nigeria

Despite the multifaceted problems of livestock production in Nigeria and the numerical strength of her livestock genetic resources, Nigeria's first Department of Animal Breeding and Genetics was established at the University of Agriculture Abeokuta in 1988. To date, the Department had turned out 106 graduates in Agriculture with some bias into Animal Breeding 7 postgraduate students in Animal Breeding, into barren fields of agricultural development. The University of Ibadan's Department of Animal Science founded in 1966 has been the major research center for the production of Animal Breeders since 1973 and my humble self happened to be the first female Doctor of Philosophy graduate in Animal Breeding produced by that Department in 1976 after Dr(Mrs) O. Adebanjo the first female Ph.D. holder in Animal Nutrition in 1975. Several

nutritionists, biochemists, reproductive physiologists, mineralogists, dairy specialists, animal product specialists etc. had been turned out and are being turned out annually from this department and other similar departments in the 26 Nigerian Federal Universities, we may want to ask ourselves the major impact of these graduates in the livestock production system and in the nation in general.

The Nigerian livestock farmer would rather employ the graduate of Animal Health who is supposed to be knowledgeable in the disease of the animal as the general producer or Nutritionist who studies the management and/or feeding of the animals in the feed mill.
The function of the Animal Breeder, who is trained to study and understand the totality of the animal, its survival strategies, its genetic makeup and the way to manipulate the genetic system of the individual or population of animals for the benefit of the farmer, the consumer and the generality of man, through selection for improved performance, efficiency of production and reproduction, rapid genetic gain, faster turn-over, higher survival and quality of products, which are all intrinsic values deposited naturally in the individual livestock is relatively unknown to the generality of the people. These values are what the geneticist / breeder is trained to find out using both conventional and new biotechnological procedures. Improving the environment of the animal is short-term, faster, cheaper, palliative, unsustainable and temporary. Genetic improvement through breeding and selection on the contrary is longer term, capital intensive, sustainable, durable and permanent, requiring total commitment and dedication of both the government and the scientist. The developed countries would rather invest in this long term procedure in order to control the global market economically than undertake short term palliative measures although the two systems of controlling the breeds and the environment runs pari passu in these nations.

The consequence of importing highly efficient and productive domestic livestock breeds from these countries, is that more and more of the local breeds with their unknown genetic attributes get lost.

Breed evaluation studies are needed to find out the promising candidates from comparison within an environment and production systems in which the breeds have proved themselves valuable.

The value of indigenous breeds as biological materials relative to their performance, i.e. superiority, versatility, temperament, heterosis, complementary expectations in crosses, fertility and other special characteristics of adaptation to specific environmental circumstances of climate, feed, disease agents, water shortage, variable day length, management system, difficult terrains are of profound importance in tropical areas where about half of the world's livestock abound as conservatories of valuable and probably rare genetic variants. Yet little is known about the genetics of most of these animal population available in developing countries.

The science of population genetics developed in the 1830's and 1840's by scientists in Europe and North America has since been effectively applied to achieve substantial increases in animal production and productivity in developed countries. Progress has been greatest in dairy cattle, pigs and poultry compared especially within the last 30 years. Today's dairy cow in Europe and United States and other industrialized countries produces 5,000kg of milk per cow per year and sometimes twice as much milk. Back-fat thickness has declined by half in today's pigs, while the broiler chicken today matures in 6-8 weeks, instead of 3 months (NRC, 1993). By contrast, average annual milk production per cow is 509kg in Africa, 610kg in Asia and 900kg in South

America (Heap, et. al. 1992). Genetic improvement of local domestic stock is therefore not only a very important option but a condition sine-qua-non for the development of the livestock sector in developing countries.

Traits in Breed Selection

Many breeders usually want to improve every trait or at least several traits of economic importance at the same time. The more the traits that are included in the selection process, the lesser is the progress that can be achieved for individual traits and zero progress could result from inclusion of too many traits. This puts emphasis on the importance of getting the breeding objectives right and pursuing the objective to a logical conclusion.

Technical advances in ruminant livestock breeding which presently revolves around manipulation of embryos, has led to the development of Multiple Ovulation Embryo Schemes which can potentially provide as much genetic progress as large Progeny Testing Schemes but with a fraction of the resources in technical imputs and infrastructures.

Woolliams and Wilmut (1989) reviewed and assessed the likely impact of most of these new techniques of MOET, Embryo Splitting, Nuclear Transfer and Embryo Sexing. The reported potential benefits include, reduction in generation interval, increase in selection differential, improvement in accuracy of selection which will eventually offset some of the potential disadvantages of increase inbreeding or reduced genetic variability.

With a lot of economically important traits such as milk and egg production which are sex limited and/or expressed later in life, search for physiological or biochemical criteria which are thought to underline these productive traits as well as those expressed in both sexes early in life, such as growth, must be vigorously pursued. Such indirect criteria may also help in improving traits which can not be readily measured on life animals or in traits which when expressed could be intrinsically undesirable such as with disease or death.

Breeds with unique physiological and ecological characteristics are of great interest because they usually provide the missing link in the genetic history of livestock species through the study of blood groups, protein polymorphism and morphological characteristics. The developing science of molecular engineering, to identify DNA sequences that cause uniqueness of breed traits, the techniques of genome mapping and transfer of DNA within and between species and the production of viable transgenic animals for products used in pharmaceutical industries are still far from application in Nigeria. These are the current focus of intensive research that may have greater impact on animal production and animal health management in the current millenium.

Genetic improvement programmes

Genetic improvement programmes generally require population sizes that are larger than can be managed by single institution. The development of cooperative breeding programmes with sets of biological procedures and organisational structures where different species can be accomodated must be in place. Large volumes of animal life history and pedigree data are needed in these programmes, hence their development could not be possible without various computer databases and analytical programmes that are coordinated and distributed both nationally and internationally within Nigeria and the African continent.

Genetic Diversity

Genetic diversity within a livestock species is reflected in the range of types and breeds that exist and in the variation that is present within each genotype. It has been shown that differences among breeds substantially exceed those within breed, suggesting that genetic variation among breeds is a major component of the readily accessible livestock diversity. Losses of unique types and breeds compromise access to their unique genes and gene combinations.

The presence of a breed with desired characteristics in place, and with the controlling gene at high frequency, greatly enhances the efficiency of improvement process. The recombination of favourable genes within major commercial stocks under intensive selection has allowed development of animals with productive capacities that greatly exceed those of their ancestors. The store of genetic diversity within commercial breeds has similarly permitted prompt responses to changes in societal demands.

Historically, the preservation of genetic diversity within commercial stocks is not the issue, the accurate identification of superior individuals, their intensive propagation in order to increase production (i.e. more meat, milk and eggs) and that, at the earliest possible time is the problem at stake.

If genetic diversity is to decline, then selection of stock for commercially desired traits will be unproductive for developing improved breeds. Technological advances in animal breeding and reproductive control have the potential to change this situation. Embryo transfer, gene cloning, molecular aids to selection and greater control of reproductive processes can produce rapid and considerable increases both in accuracy of selection and in the ability to propagate selected individuals. Through these procedures, a pair of parents could produce hundreds or even thousands of progeny in their lifetime even long after they are dead. Given this prospect then, maintenance of genetic diversity must be given a major consideration in Nigeria's livestock improvement programmes in this millenium.

Genetic erosion

Trends in genetic erosion of indigenous livestock have been more pronounced among dairy cattle, pigs and poultry breeds than any other stock.

The history of crossbreeding and upgrading of the indigenous breeds of livestock could be traced to 1926 in Egypt where several Bos taurus – Friesian, Shorthorn, Jersey, Guernsey – were introduced (Fahmy, et. al. 1976). In Sudan, Butana females were crossed to dairy Shorthorn imported in 1925 and to Holstein Friesian Bulls imported in 1927, and their crossbreeding continued for 35 years (1935 – 1970) (Osman and Russell, 1974).

In Ethiopia, crossbreeding of Bos indicus and Bos taurus with the local Arsi cattle commenced in 1968 (Kiwuwa, et. al. 1983), Kenya happened to be the only African country with major resources of a recognized dairy breed of Bos indicus – the Kenyan Sahiwals. However crosses with Ayrshires was initiated as early as 1939 (Kimanye and Russell, 1975). Breeding work at the Livestock Production Research Institute at Mpwawa in Tanzania dated back to early 1930s with the development of mixed Indo-African Zebu breed with a small population of Bos taurus inheritance (Mc Farlane, 1970).

In Nigeria, upgrading of the locals towards European breed for milk production started in 1964 at three stations of Shika in Northern Nigeria, Agege dairy, near Lagos, in Southern Nigeria and at Vom, in Plateau State. Crosses were bred between the White Fulani (Bunaji breeds) and the Friesian. In Cote d'Ivoire, N'Dama cattle were crossed with the Jersey (Letenneur 1978).

Several crossbreeding programmes with African cattle breeds, poultry, pigs and rabbits were recorded in other African countries with unsustainable productive and reproductive performances. The imported exotic breeds could not survive because of inadequate provision of ideal environment of food, temperature or rearing systems. Most of the programmes were discontinued on most stations from the 1970s because of the inconsistency in policies of government of the different countries relative to sustainable animal production and genetic improvement.

It is now a well known fact that African countries will only achieve productive and adapted domestic breeds if they take cognisance of their indigenous breeds in selection programmes.

In contrast, Jamaica , a South American country decided to embark on the development of dairy cattle breed for the tropicsin 1910. Holness et.al. (2001) traced the origin and the introduction of cattle breeds to Jamaica from the time of Spanish occupation of 1494, when the animals were only reared to produce hides and skin, with beef production merely secondary and dairying was on a limited scale. The position then was the establishment of many farms with animals from a mixture of breeds as it is presently in Nigeria. Experimentation in breeding dairy cattle for the tropics began in Jamaica at the Government Hope farm in 1910 with local cattle, temperate dairy breeds and the infusion of the Sahiwal (Zebu) breed from India, when there was high demand for milk, hence there was need to develop a dairy breed, capable of coping with the heat, humidity, diseases and low quality forages of the tropics. A nucleus of local dairy cows purchased from local farmers and importations made up of dairy cattle from the Jersey, Guernsey, Ayrshire, Holstein, Brown Swiss and the Red Poll breeds as well as two bulls of the Sahiwal breed from India formed the basis for experimentation. The research results, which also influenced farmers' operations, indicated the superiority of the grade Jersey for production and fertility, which was considered to be the result of adaptation. Thereafter, breeding inter-se, a tropical dairy breed, the Jamaica Hope was established and was declared a breed in 1952. This was immediately followed by the formation of the Jamaica Hope Cattle Breeders' Society. This Government grade Jersey herd was given a pure-bred status. The genetic make up of the breed is estimated to be 80 percent Jersey, 15 percent Sahiwal and 5 percent Holstein. The breed has been used successfully over a wide spectrum of conditions ranging from subsistence farming to large commercial enterprises. On low-imput farming systems and with little supplementary feeding. The breed development is controlled by the Jamaica Hope Cattle Breeders' Society. The society operates an open HerdBook Policy whereby approved females are upgraded through three generations by the use of registered Jamaica Hope bulls. This is to prove to the world that tropical countries can take their destiny in their own hands.

Applications of Biotechnologies

With the adoption of the 3rd Framework Programme of Community Activities in the field of Research and Technological Developments (1990 – 1994) the European Community Council

decided to introduce conservation of animal genetic resources as one of the priority areas of the next community biotechnology research programmes. The European Workshop on Biotechnology for Livestock Improvement involves the assessment, conservation and utilization of Biological diversity in the different countries (Brussels, 1990). With experts from Science, Breeding and Industry, the recommendation for future community research orientation is the Rapid Molecular genetic screening of plants and animals for germplasm conservation strategy.

The objective is to develop efficient routine procedures to obtain genetic data on large numbers of animal samples in order to estimate genetic distances or to identify specimens which bear genetic traits that are associated with commercially interesting properties of growth, reproduction and carcass traits.

The global genetic conservation programmes require that indigenous animal species in various countries be conserved and utilized in their areas of diversity. Data bank information are therefore required for the different animal species found in different ecological zones.

Within the last 50 years, there had been instituted an International Committee on Animal Recording, formed to streamline all the guidelines on Milk production in different countries and to follow up the remarkable progress made in each participating country. From 1990 the beef recording group was set up to study the guidelines on beef production characters as well as that of other ruminants (ICAR 2001). It is on record that out of the questioneers sent to 48 countries, 26 responses were returned and only 2 from the African continent –Namibia and South Africa. How could Nigeria have participated when the Animal Scientists are not given proper recognition, the Animal Breeder has no relevance, there are no breed societies, how then can there be formal beef recording groups.

The Genetic Material

Nucleic acids were first discovered as long ago as the late 1860's by Friedrich Miescher, however, it was not until 1944 that it was proved that the Deoxyribonucleic Acid (DNA) is the substance that codes for the cells genetic information, when Avery, Macleod and McCarty expanded the previous experiments of Griffith in 1928.

In the period 1949-53, Chargaff and his colleagues made numerous important observations on the composition of the DNA, they discovered that:

- it is composed of four bases- adenine (A), guanine(G), thymine(T), and cytocine(C)-which vary in composition according to the organism

- DNA in different cells from the same organism has the same composition

- The amount of DNA in cells from any species or organism is remarkably constant and it is not altered by external influences such as environmental factors, diet or metabolism.

- DNA from closely related organisms have a similar base composition whereas distantly related organisms have widely different DNA composition.

- DNA, although coding for proteins, also has encrypted within it all the necessary control sequences and regulators required for the correct expression and production of proteins and ultimately, the maintenance of the organism.

- Diseases are usually caused by mutations in these control sequences as well as by changes in protein structure.

- DNA has also been implicated in the higher order organisation of the chromosome and that it affects more than just the protein it encodes.

The Deoxyribonucleic acid in the form of base composition and type, varies from organism to organism. The sequences can be divided into 3 types depending on the number of times a sequence appears in the genome.

- there are low or single copy DNA, these are sequences encoding most enzyme function. They constitute up to 50% of total DNA.

- There are middle repeat DNA. These are sequences encoding most of the structural components of a cell such as histones, ribosomal RNAs and transfer RNAs. This class also contain retrotransposons and the retrovirus-like sequences which are assumed to be inactive and redundant such as the Alu repeats in humans. 30-40% of the genome may comprise middle repeats.

- Highly repetitive DNAs which are the simple mostly non-coding sequences. These can constitute 20-50% of the genome in mammals and up to 80% in many plants.

In general, the DNA in the genome is arranged with the single copy sequences interpersed with either repetitive or middle repeat sequences. The understanding of the DNA is the basis of breed development, breed improvement, adaptation, survival and longevity.

My Research Thrust and Contributions

Mr. Chairman Sir, the lecturer of today as the first female graduate of Animal Breeding in Nigeria and subsequently, the first female Professor of Animal Breeding and Genetics in Nigeria, has over the years been involved in the utilization of conventional and biotechnological procedures in animal breed improvement and the development of new breeds from Nigeria's indigenous genetic resources.

My research thrust has been the breeding and genetic improvement of indigenous livestock species of Nigeria with emphasis on pig and poultry breeds.

Within the last 30 years, I have concentrated on the development of improved hybrid lines of pigs from Nigeria's indigenous, scavenging pigs from which several papers had been published in both national and international journals and presentations made at many local and international conferences.

Within the last nine years, I am involved in the characterization and genetic improvement of Nigeria's indigenous ruminants and poultry breeds using both conventional and biotechnological approaches.

My contributions

I started my research carrier in 1973 under the first animal breeder employed in the first Department of Animal Science in the first University in Nigeria, Dr. Almut Dettmers, who took me through the general characterization of Nigeria's indigenous pigs for their milk production potential, litter productivity as pure and crossed strains and growth potentials in comparison to some exotic stocks that were imported into the country.

Let me digress a bit into the pig industry in Nigeria. The first set of exotic pigs were imported into Moor Plantation (The Institute of Agricultural Research and Training) in 1944 from Britain. These were Mollington and Bradbury Strains presently called Large White or Yorkshire.
In 1963, the Landrace breed was imported from Sweden and in 1972 more of these pigs were imported from Republic of Togo. In addition, some Durocs and Hampshire breeds were imported into some states, such as Lagos and Oyo.

In 1956, Professor Hill initiated the evaluation of the indigenous pigs collected into the University of Ibadan Teaching and Research Farm on their status, relative to prevalent diseases and various nutritional standards and in 1973, Dr. Dettmers proposed the evaluation and general characterization of these indigenous pigs for their genetic values with the aim of improving them and for the development of hybrids.

With the major obstacle to pig production and development being religious taboo, we went down history lane to find out what other countries did or are doing with their own pig population. We discovered that the United Kingdom established pig breeding societies in 1925 and initiated pig progeny testing stations in 1954. These were upgraded to Performance Testing Stations in 1960.

In Denmark, there was open selection of different pure bred strains into established breeding stations. The programmes changed to utilization of crossbreds and the evaluation of breeding values and use of Artificial Insemination to increase genetic progress. Whilst Norway practices purebreeding of the different strains using 100% Artificial Insemination on their breeding farms, 50% of the slaughter pigs for consumption are crossbreds, Netherlands on the other hand practices 100% crossbreeding with the Yorkshire and Duroc used as male lines and the Dutch Landrace as female line. Also Artificial Insemination plays a prominent role.

Germany initially has no national breeding programme but rather there are Herdbook breeders organized on state and regional basis which in the 70's metamorphosed into a Federal Hybrid Programme initiated with 12 breeding companies which are currently operating internationally.

In France, the National Breeding Programme has 5 Central Testing Stations on which the Largewhite is used as sire line and the Landrace and Pietrain as dam lines. Canada operates along the same line as in France with 20% of slaughtered pigs from 2 breeding companies while extension agents monitor herd performance and production practices.

The United States practice Rotational Crossbreeding System with records kept across herds to assist in evaluating the across herd breeding value.

In summary both private Breeding Companies and National Breeding Stations utilized both pure and crossbreds for slaughter pigs utilizing in essence, hybrid vigor in lines brought into the cross. With this background into historical perspective, it became very necessary for me to get committed to utilization and upliftment of the potential of African Animal genetic resources since all these countries were using their own indigenous pigs in their production processes.

Traditionally, the indigenous pigs found in many villages in Nigeria are reared on an extensive system where they are allowed to roam, scavenge and graze at will. Ogunfowora, et. al. 1975, reported that about a third to half of the compounded feeds produced for the pigs in the period 1973 to 1975 found their way into feeding of these breeds of pigs in the rural areas, indicating an increasing awareness of the role of proper feeding and a tendency towards confinement rearing of the local pigs of Nigeria. Evidence from some earlier studies, Vohradsky (1968), Cameron and Ashton (1969) in Ghana and Hill (1956) in Nigeria indicated some improvement in the performance of these animals resulting from improved housing and management. However, such improvement are well below observed performance of the imported European pigs in the tropical environment. Some observations in Latin America (Bressani 1974) and Nigeria (Ilori, 1974) indicated that the native pigs out-produced their European counterparts when reared on diets of low protein concentration, thereby advocating lower requirements for nutrients coupled with lesser susceptibility to careless management. This therefore raises considerable hope for additional meat production from the large number of indigenous pigs kept by peasant farmers whose present level of management know-how cannot cope with the very exacting demands of the imported European pigs for nutrients, careful management and disease control.

INDIGENOUS PIGS CHARACTERIZATION

The Nigerian pigs are said to be of no specific identity. They are characterized by slow growth, small body size, small litter size, high mortality rate, low kill-out percentage with carcasses of high fat content (Fig. 1). Vohdrasky (1968) in Ghana studying the local breeds of pigs, observed that the reciprocal crossing of LargeWhite and Local Black sows by boars of both breeds did not bring expected effect of higher weights at birth, weaning or lower death rate. Similarly, Cameroon and Ashton (1969) also in Ghana working with the local pigs suggested that in any programme of intensive pig production, the Local Black pigs should not be given any consideration. However, in Nigeria, considerable body of information is available on the imported European pigs reared in Nigeria (Fetuga, et. al. 1975a & b, Sofoluke and Dettmers, 1979) and some limited report on the Nigerian indigenous pigs (Ilori, 1974; Hill 1956; Fetuga, et. al. 1976) (Tables 3& 4).

While Hill (1956) in his 4 years study of the Nigeria's indigenous pigs, like his counterpart, Cameron and Ashton (1969) in Ghana, condemned the utilization of the indigenous pigs in intensive rearing programmes, the report by Fetuga, et. al. (1976 a & b), concluded that the indigenous pigs would continue to contribute to the rural meat supply particularly in areas where

pig production based on improved breeds can not succeed because of lack of management skills such as improved rearing conditions of feeding and housing.

Most workers, comparing the performance of Nigeria's indigenous pigs with exotic under intensive management conditions, reported a relative reduction in performance with reduced dietary protein intake (Ilori, 1974), best gains on lower protein levels of 12% (Fetuga, et. al. 1977), declining ratio of lean to fat deposition with increasing liveweight (Fetuga, et. al. 1976b). Higher fat deposition at the shoulder region than at the rump area was similarly confirmed by Sonaiya (1986). From the results, it became obvious that the indigenous pigs and the imported European pigs have inherently different capacities for tissue growth. The indigenous pigs were producing fatter carcasses than the European pigs even at lower levels of feed intake because of lower potential for muscle growth. The pattern of growth however further indicate that the indigenous pigs are earlier maturing because a decline in the daily rate of lean tissue deposition was observed beyond 34 kg live weight (Tables 4).

Table 3: Some reproductive traits in indigenous pigs.

Number of litters studied	63
Mean litter size	6.7 (4-13)
Mean litter birth weight	6.10 (2.7 – 11.8)
Mean litter weaning weight	29.4 (15.0 – 60.0)
Preweaning Mortality %	15.80
Still birth %	4.79

Source: Fetuga et.al. 1976

Table 4: Comparative growth rate of indigenous and exotic Large-White x Landrace Pigs from weaning to different terminal weights.

Terminal wts. (kg)	Mean daily	Liveweight gain (kg)	Mean No. of weight	Days to attain
	Ind	LW x LD	Ind	LW x LD
22.7	0.25 ± 0.04	0.42 ± 0.04	78±11.86	39 ± 6.41
34.1	0.29±0.03	0.48±0.03	111.19.20	58±6.73
45.5	0.30±0.02	0.55±0.05	139±22.66	69±9.42
56.8	0.32±0.05	0.61±0.03	179±22.14	83±12.37
68.2	0.34±0.03	0.66±0.06	197±24.87	109±14.36
79.6	0.31±0.02	0.74±0.05	243±4.60	123±12.87
91.0	0.30±0.03	0.78±0.06	289±26.42	148±15.44

Source: Fetuga, et. al. 1976.

Sex influence on carcass characteristics was similarly observed. Boars were found to be significantly superior to gilts in carcass quality with barrows producing fatter carcass at 56 – 68kg slaughter weights. In all, the indigenous pigs were shown to be of inferior carcass in all respect although with better carcass colour. A need for slaughter at weights lower than

conventional for the Europeans pigs was advocated. Advantage of muscle development in the intact male was suggested despite the boar odour. Considering the fact that billy goats and rams with markedly distinct sex odours are not objectionable to Nigerian consumers, boar odour cannot be a hinderance to pork consumption.

Crossbreeding with imported breed was suggested to improve the carcass leanness of the indigenous pigs so as to increase the meat production in rural areas rather than part of large scale commercial enterprises.

Within the same University environment, Adebambo and Dettmers (1973- 1976) reported heterotic advantages in milk production and higher milk quality in indigenous pigs as pure breed and when crossed with Duroc sire (Adebambo and Dettmers, 1977, 1978, 1979 and 1982). At the Institute of Agricultural Research and Training (1977-1993) Adebambo (1981), Adebambo and Onakade (1983) evaluated the breed differences – litter productivity, milk production, efficiency of feed and milk utilization. It was found that the utilisation of selection indices to categorise pure indigenous and pure exotic LargeWhite, Landrace Hampshire and Duroc breeds and their crossbreds with the indigenous pigs resulted in selected individuals with better performance. The index gave a ranking of 31.8 to 56.1. With selection pressures of 20-25%, genuine genetic changes of 1.39 in Duroc sired Landraces to 3.60 in the Landrace x Lw cross resulted. Out of 110 sows used in the experiment based on the population mean, 3 indigenous pigs could be selected for an overall performance rating while on genotypic mean 10 indigenous pigs ranked above the herd average of 45.0 (Figs 2&3) (Table 5).

Table 5: Comparative performance of indigenous and exotic pigs, Milk production and sow productivity.

	Purebreds			Crossbreds				
	IND	LW	LR	DU.LW	DU.LR	LW.LR	LR.LW	SE ±
Feed consumption/ sow (kg)	54.3^{aefghi}	112.2^{e}	95.7^{bi}	105.4^{dg}	98.5^{eh}	121.3^{ABCD}	111.5^{F}	11.48^{**}
Milk production/ Sow (kg)	79.4^{adfgh}	140.8^{ch}	120.0^{bc}	176.4^{abc}	149.1^{g}	153.2^{f}	171.0^{de}	15.25^{**}
Feed consumed/ sow/kg milk	0.70	0.88	0.91	0.62	0.65	0.82	0.65	0.15
Feed consumed/ sow/kg litter gain	4.00^{abcde}	3.59^{e+}	3.83^{fghi}	2.22^{di}	2.10^{bg}	2.19^{af}	2.17^{bg}	0.42
Milk consumption/ kg litter gain	6.06^{abcde}	4.23^{e}	4.82^{fghi}	3.24^{di}	3.10^{bg}	2.74^{af}	3.17^{ch}	0.49^{**}
Creep feed consumed/kg litter gain	0.56^{abcd}	0.24^{b}	0.36^{af}	0.16^{aef}	0.29^{e}	0.33^{D}	0.44^{E}	0.09^{*}
Feed consumed by sow and litter/kg litter gain	4.56^{abcde}	3.83^{e}	4.19^{fgh}	2.37^{bg}	2.34^{af}	2.52^{ch}	2.61^{d}	0.59^{*}
Weight lost	22.2	34.3	23.2	40.6	44.2	37.4	33.2	7.00
No. of animals	4	4	4	4	4	4	4	

• = $p<0.05$
** = $p<0.01$
a-i = mean followed by similar constants differ significantly from each other

Source: Adebambo and Dettmers 1982.

The indigenous pigs form a greater part of the total pig population but it appears there is a declining contribution of these breeds and strains to the total meat production. Nevertheless, they are still available in greater number than the exotic pigs. RIMS (1992) put the total pig population at 3.41 million, 3.35 million of which are from village herds with 53,821 reared in urban centres (Table 6). The largest herd population are in the middle belts states of Benue and Plateau which are predominantly Christians. While it is obvious that large scale commercial pig production based on indigenous pigs may not be a profitable venture, it is quite clear that the indigenous breeds will continue to contribute to the rural meat supply. There are no authoritative studies on the possible economic viability of production based on indigenous pigs. However, recent reports at Ibadan and Obafemi Awolowo Universities have shown conclusively that under conditions of improved management and feeding, these pigs have a much more improved productive capacity and can grow fairly rapidly.

The present level of performance of these pigs could be improved so as to increase meat output through increased number of piglets per sow and increased meat output per animal. It is also observed that the stunted growth of these pigs in the rural areas is attributed to lack of provisions of shelter, heavy parasitic load, inadequate effort or complete failure to offer feeds in sufficient quantities.

Table 6: Estimated population of pigs in Nigeria by states

Benue	703,438	Kwara	80,791
Plateau	535,309	Borno	75,275
Gongola	476,143	Cross River	68,106
Ondo	291,304	Rivers	66,136
Kaduna	249,651	Bauchi	65,719
Bendel	180,150	Anambra	62,350
Oyo	177,406	Lagos	24,823
Ogun	149,442	Federal Capital	16,301
Akwa Ibom	91,596	Imo	8,211
Niger	81,019	Sokoto	3,199

Source: RIMS 1992

Crossbreeding with the indigenous pigs

The experiments initiated between 1952 – 1956 at the University College Ibadan (Hill, 1956) showed that crossbreeding of local pigs with LargeWhite is of little value where intensive production is intended. The study on feed conversion efficiency and carcass quality of local pigs under the same conditions of management as that of the exotics from weaning to 16 weeks

showed that the pigs consumed 4.41b feed per 1b of liveweight gained. The major defects in the carcass quality of the local pigs at different ages were the narrow ratio of length to depth measurements, thickness of back and loin fat and a high percentage of flare fat around the kidneys.
The head was proportionately lighter than that of the imported breeds. However, the flesh quality and flavour were good. It was thence suggested that the local pig is best suited to the village environment, where it can root, scavenge and graze at will, under which condition it produces a good lean carcass at minimum cost. This was the submission of a non-Nigerian, a non-breeder but an health specialist.

In a limited number of feeding trials carried out with pure, di and trihybrid cross (Table 7), feed conversion was satisfactory, ranging from 4.0 to 4.3 while most baconers averaged 2001b liveweight between 31 and 32 weeks of age. In essence they submitted that the rapid growth and maturity of the trihybrids indicate that with existing conditions, maintenance of vigor and the rapid growth depend more on the quality of the parent stock than on the quality of feeding-stuffs available in Nigeria.This was the submission of the nutrition experts whose concept on breed improvement is geered basically towards the animals environment.

Table 7: Percentage weight distribution of carcass and dressing percentage.

Breed	Average liveweight LBS	Weight of side %	Weight of head %	Kidney & Flare %	Stomach & Intenstine	Dressing Percentage
Large White (LW)	201.5	35.9	5.6	2.1	11.6	79.36
Tamworth (TAM)	190.67	36.0	5.6	3.6	11.0	78.63
Large Black (LB)	199.00	34.7	5.5	3.0	11.5	78.80
LB x TAM	201.08	34.83	5.73	2.5	11.1	77.60
LB x LW	199.3	34.00	5.73	2.6	11.3	76.90
Three breed cross LB x LW x TAM	198.00	35.10	5.5	2.4	12.7	77.60
Local breeds	91.90	33.60	5.4	6.0	10.5	76.95

Source: Hill 1956.

THE BREEDERS SUBMISSION ON THE INDIGENOUS PIGS OF NIGERIA.

Genetic and Environmental Effects on the Indigenous Pigs Performance.

Reproductive performance is of major economic importance to pig producers, with emphasis placed on genetic and environmental sources of variation on litter weights, i.e. numerical

distribution of the sexes within the litter, parity of dam and season of farrowing (Olivier, et. al. 1967; Bereskin and Frobisch, 1981). In examining these sources of variation in a herd of exotic and Nigeria's Indigenous pigs in a study spanning 6 years (1977 to 1982), significant breed of dam and parity effects were noted on number of pigs born alive ($P<0.001$), while breed of sire effect was noticed in almost all traits studied which included litter size, the sex ratio and gestation length (Adebambo 1981,Adebambo et.al.1986). There were more pigs born per litter with increased parity without significant alteration in the sex ratio (Table 8). Environmental influence seems greater at the third parity with more females produced and the gestation length about a day longer in the second and third parities. There was however no significant seasonal influence except that more pigs were born in January to April compared to other periods of the year (Table 9).

Genetic effects.

Least square estimates of the effects of breed of sire, type of dam and breed of dam, showed significant breed of sire variations (Tables 10 and 11). While the Hampshire- sired litters were about half a pig larger than the others, the indigenous crossbred sired litters had 1.33 days shorter gestation length and the crossbred dams had about 7.5% larger litter than the purebred dams with degree of heterosis of about 7 percent. The LargeWhite dams had approximately 13.1% pigs than the pure indigenous or Hampshire dams which was significant ($P<0.01$).

Reproductive traits are characters of low heritability and are highly affected by environmental variation. Parity, seasonal period (dry or wet) had been found to affect litter traits in pigs (Strang and King, 1970; Leigh, 1977). While higher birth weight was related to faster postnatal growth and early reproduction of cows and pigs (Young, et. al. 1978; Hughes and Varle 1980 and Hutchens, et. al. 1981), contrary observations were reported in indigenous pigs of Nigeria, where with a body size of 30 to 45kg at an age of 125 to 149 days, the pigs are found to be fully matured and able to carry their first litter. With the shorter gestation length reported in the purebred indigenous pigs a similar shorter length was also reported in the indigenous crossbred suggesting that the shorter gestation is a function of the genotype of the dam herself rather than that of the litter carried. Actual gestation length varied from 109 to 119 days, the low heritability and repeatability values of these traits suggest a strong genetic control of other complex physiological mechanism. With the high repeatability value of 0.54 obtained in this study, 30 and 49% of the variation in litter size and gestation length respectively were attributed to genetic influences suggesting that gestation length and litter size could be altered through genetic manipulations.

Table 8: Litter productivity traits.

	Large-white (LW)	Indigenous (IND)	Breeds Hampshire (Hamp)	LW x Ind	Crosses HAMP X IND	LW X HAMP
Litters born	70	45	55	90	65	85
Mortality % (birthweaning)	28.2	6.5	17.8	12.3	18.5	22.8
Litter size (liveborn)	8.1	6.9	7.3	7.2	7.2	7.9

Sex ratio (% males)	44.6	42.2	52.4	47.2	51.5	42.8
Gestation lengths (days)	114.6	113.6	114.6	114.2	114.1	114.4

Source: Adebambo, 1986

Table 9: Environmental effects on litter size, sex ratio and gestation length.

Parity	No. of litters	Litter size	No. of males	No. of females	Sex ratio	Gestation
1	180	0	0	0	0	0
2	125	1.26±0.04**	0.42±0.03	0.34±0.03**	-2.3±2.6	0.50±0.2**
3	85	2.33±0.2**	0.81±0.2**	1.52±4.2**	-2.8±1.4	-0.60±0.1
Season of parturition						
Jan – April	137	0	0	0	0	0
May – Aug	151	-0.44±0.3	-0.14±0.2	-0.29±0.2	0.50±1.8	0.05±1.2
Sept-Dec	122	-0.39±0.2	0.00±0.2	-0.39±0.2	-0.30±1.6	-0.17±1.1

Source: Adebambo, 1986.
(**P<0.01)

Selection response for higher body weight

In an attempt to infuse some of the genes of the indigenous into exotic blood lines, six generations of selection was carried out between 1984 and 1990 (Adebambo, 1986; Adebambo, et al. 1993; Adebambo 1994 a & b).

Table 10: Genetic effects on reproductive performance.

	No. of litters	Litter size	No. of males	No. of females	Sex ratio	Gestigation
Breed of sire						
LW	220	0	0	0	0	0
IND	55	-0.05±0.2	0.19±0.2	-0.24±0.2	2.8±1.4*	-1.33±0.1*
Hamp	135	0.59±0.3*	-0.15±0.2	-0.53±0.2	2.6±1.8	-0.13±0.1
Type of Dam						
Purebred	170	0	0	0	0	0
Crossbred	240	0.62±0.1**	0.41±0.01**	0.22±0.1*	1.1±0.1*	-1.34±0.1

Breed of dam						
LW	70	0	0	0	0	0
IND	45	-1.27±0.3**	-0.65±0.2**	-0.62±0.3*	-1.1±2.0	-1.34±0.1**
Hamp	55	-0.89±0.5**	-1.1±0.4*	-0.48±0.4	-2.8_3.2	-0.19±0.2
LW x IND	90	-0.06±0.3	0.08±0.2	0.02±0.2	0.7±1.9	-0.l21±0.1
Hamp x IND	65	-0.55±0.9	-0.07±0.7	-1.47±0.7*	3.3±5.6	-0.20±0.4
LW x Hamp	85	-0.15±0.5	-0.06±0.4	-1.0±1.1	-1.0±2.3	-0.37±0.2

Source: Adebambo 1986
*P,0.05; **P<0.01
Table 11: Repeatability and percentage variation of litter productivity.

	Litter size	No. of males	No. of females	Sex ratio	Gestation length
Repeatability	0.15±0.5	0.10±0.05	0.07±0.05	0.06±0.05	0.54±0.05
Variation (%)	30.8	19.1	11.8	10.6	49.5
Error variance(σ^2e)	8.2	4.7	5.0	214.4	2.6

Source: Adebambo, 1986

Most efforts in pig improvement in Nigeria had been made through the use of breeds of Europe and North America, with the previous investigations (Adebambo, 1986; Fetuga, et. al. 1976; Hill 1956), there seem to be opportunities to utilize traits such as prolificacy and adaptation to climatic and nutritional stress in indigenous breeds peculiar to other parts of the world (Nigeria inclusive). The considerable variability among Nigeria's indigenous pigs showed that their potentials are highly subjective to selection procedures to attain higher level of performance.

Data analyses on 1681 pigs raised from 125 litters of Largewhite x Indigenous crossbred litters and 120 litters of Hampshire x Indigenous lines in a 7 year research, were based on sire, dam and within fullsib family components of variance for each line. Selection within the lines was also based on the mean gain of the group selected to be parents over the generation mean for that line, while response to selection was obtained by regression of the generation mean for all progeny on the generation number. Realized heritability was estimated by regression of the generation means on the realized cummulative selection differentials. Four times the sire component of variance was used for evaluating heritability values whilst the regression analyses were based on within line-year basis.

Weight were measured at 56, 150 days and 12 months. Results obtained showed that improvements in body size over time was apparent particularly in the 150 days and yearling weights. The 56 day weight increased from 6.5kg in 1984 to 8.1 in 1989 with a slight insignificant decline to 8.0 in 1990 in the LW line. Corresponding increases were 7.5 to 9.5kg from 1984 to 1990 in the Hampshire line.

The 150 day weight similarly increased from 19.2 ± 4.9kg in 1984 to 28.2 in 1989 in the LW line also from 22.8 to 29.95 in the Hampshire line whilst the yearling weights were 65.3 to 82.7 and 70.1 to 85.7 in the two lines respectively. The sire components were significant at all ages while the dam component was only significant at 12 months of age. Notice that in all the lines, the dams originated from the indigenous and subsequent indigenous infused lines (Tables 12 and 13).

Table 12: Pig performance data for LW crossbred line over 7 years (LINE A).

Year	No. of litters	Litters born	No. weaned	Mean 56d weight (kg)	Mean 150d weight (kg)	Mean yearling weight (kg)
1984	16	7.5	7.1	6.5±0.95	19.8±6.1	65.3±9.4
1985	14	8.1	7.5	6.8±1.21	21.5±5.6	68.9±8.1
1986	16	8.5	7.6	7.1±1.56	23.6±3.5	72.0±7.7
1987	17	8.4	7.6	7.6±1.80	25.4±4.8	76.2±7.9
1988	18	8.6	7.9	7.5±1.71	26.6±4.2	76.4±8.2
1989	20	9.2	8.1	8.1±1.56	28.5±5.1	80.5±5.4
1990	24	8.2	7.6	8.0±2.12	28.2±4.9	82.7±5.6
Overall-Mean		8.36	7.63	7.37±1.56	24.8±4.89	74.6±7.5

Source: Adebambo 1995.

Heritability Estimates

Heritability estimates for 56 days weight from regression and paternal half-sibs was negative and insignificantly different from zero in the LW line (Table 14). -0.01), while it was 0.16 and 0.35 from regression and paternal half-sibs respectively for the Hampshire line. The h^2 for 150 day weight was from mid-parent offspring regression with values of 0.69±0.17 and 0.65±0.09 for lines A and B respectively. These were higher than 0.36 ± 0.16 and 0.40±0.18 using paternal half-sib correlations.

The average effective selection differential weighted by the number of offsprings produced by each parent resulted in 6.7kg weight improvements for males and 2.7kg for females in the A line and 7.3kg for males and 2.5kg for females in the B line. Using the average h^2 of 0.38±0.11 obtained by pooling the paternal half-sib correlations in both lines and weighting the estimate inversely by its variance, the expected progress was 16.1kg for line A and 20.8 for line B, in 6 generations of selection.

Table 13: Pig performance data for Hampshire crossbred line over 7 years (LINE B).

Year	No. of	Litters	No.	Mean 56d	Mean 150d	Mean yearling

	litters	born	weaned	weight (kg)	weight (kg)	weight (kg)
1984	15	7.4	6.5	7.5±1.8	22.8_5.4	70.5±14.2
1985	17	71	6.8	7.4±1.4	25.5±4.6	77.2±16.8
1986	15	7.6	6.9	8.6±1.7	26.6±5.1	78.1±9.9
1987	14	7.3	6.9	8.8±1.1	28.2±6.2	81.4±7.6
1988	20	7.8	6.5	8.2±0.8	28.8±4.8	84.7±5.8
1989	23	7.8	7.1	91.±1.5	29.8±5.1	85.0±7.6
1990	16	8.2	7.3	9.5±1.2	29.95±3.9	85.7±6.5
Overall Mean		7.6	6.9	8.44±1.36	27.38±5.01	80.37±9.8

Source: Adebambo 1995

Table 14: Heritability estimates for weights at 56d, 150d and 12 months weight.

Method	Line A			Line B		
	56d	150d	20 mons	56d	150d	12 mons
Sire component	-0.01±14	0.36±16	0.58±22	0.35±18	0.40±18	0.61±36
Offspring on parent	-0.01±10	0.69±12	0.71±19	0.16±10	0.65±09	0.76±21

Source: Adebambo 1995.

Regression analyses

Average increases obtained per year from regression analyses were 0.73±0.32 kg and 1.01 ± 0.20 for lines A and B at 150 days, whilst it was 2.25 and 6.18kg at 12 months of age. Observed increases over the 6 years were 4.8kg in Line A and 7.9kg in Line B at 150 days followed by corresponding increases of 31.5kg and 37.08kg at 12 months of age respectively, representing 26 and 41% at 150 days and 76 to 84 percent at 12 months from the average weight of the indigenous foundation herd (Fig. 3).

Response to selection

The response to selection expressed as the regression of generation means on generation number and the realized heritability of growth traits in these 6 generations was almost linear averaging 4.7 ± 1.21 and 4.9 ± 1.48 per generation in lines A and B respectively. Realized heritabilities ranged from 0.51±0.28 to 0.71±0.36 in line A and 0.62 ± 0.32 to 0.75 ± 0.33 in line B. High selection pressures reported were as a result of high growth rate and mass recurrent selection practiced in these line of pigs. Average selection differentials were consistently higher in line B than in line A, except in generations 3 and 6 which resulted in lower responses in this line during the period (Table 15).

Since growth and carcass traits are the dominant breeding objectives in pigs within the last 4 to 5 decades, in most scientific selection experiments and in practical pig breeding programmes, in countries with intensive pig production, the results of these genetic improvement on the growth of Nigeria's indigenous pigs are of general agreement with reports of Johnson, et. al. (1993), Young, et. al. (1976) and Mikami, et. al. (1977), where weights of crossbred pigs were found to

be intermediate to those of the parental breeds. Significant direct response in selection were achieved from most traits in early generation. In line with reports of Glodek (1982), plateaux were not reached in these lines, though selection response seemed to diminish in later generations particularly in the Hampshire crossbred line. Surprisingly, small breed differences in response among such breeds as Duroc, Larcombe, Landrace and Yorkshire were reported (Glodek, 1982).

The crossbreeding effect resulted in very rapid genetic change due to selection for growth and increased vigor, characteristics of crossbreds, associated with complementary effects of favourable dominant genes brought into the cross from each parent.

Table 15: Response to selection for growth traits in improved indigenous pigs (Lines A & B)

Generation	Lines	Response[a]	Realized Heritability[b]	Realized selection differential
1	A	4.29±1.61	0.56±0.21	1.63
	B	7.29±0.95	0.65±0.44	2.27
	Average	5.79±1.28	0.61±0.33	1.95
2	A	4.03±0.95	0.51±0.28	1.68
	B	5.98±1.21	0.71±0.26	1.72
	Average	5.01±1.08	0.61±0.27	1.70
3	A	5.82±1.85	0.65±0.33	1.91
	B	5.89±1.62	0.72±0.41	1.67
	Average	5.86±1.74	0.69±0.37	1.79
4	A	4.60±1.18	0.59±0.38	1.66
	B	6.63±1.25	0.68±0.25	1.99
	Average	5.62±1.22	0.64±0.32	1.83
5	A	5.50±1.48	0.71±0.26	1.65
	B	7.39±1.01	0.75±0.35	2.01
	Average	6.54 ± 1.25	0.73 ± 0.31	1.83
6	A	4.82±0.99	0.58 ±0.41	1.77
	B	5.01±0.76	0.62±0.32	1.65
	Average	4.92±0.88	0.60±0.37	1.71

Source: Adebambo 1995a.
a = regression of generation mean on generation number b ± se
b = regression of generation mean on cumulative realized selection differential.

Correlated responses in weights

From the data on breed formation in the improved indigenous pigs of Nigeria (Adebambo, et. al. 1993), their carcass quality analyses (Adebambo 1992) and growth selection responses (Adebambo 1995 a & b), the study of selection response for single traits was conducted. This was basically aimed at deriving information on expected direct and correlated responses from single trait selection.
Differential age response with relatively small response in preweaning weights (birth to 56 days) were reported in these pigs, larger responses to maturity (150 days) and even greater response among adult yearlings were discovered. The direct and correlated responses from single trait selection are as presented (Table 16).

Expected response from direct selection was greater than expected correlated response in all cases. Selection for weaning weight appears to be a good criterion for selection for growth.

Table 16: Average correlated response from single trait selection with the ratio of correlated to direct responses.

Selected trait		BW	BWG	WW	WG	IPW	IYW	YW
BW	a	0.63	1.47	2.11	2.45	3.65	6.79	7.74
$\sigma\rho$ = 0.19	b	1.00	0.45	0.39	0.16	0.57	0.45	0.56
BWG	a	0.98	1.60	2.05	-2.11	4.51	5.29	6.18
$\sigma\rho$ = 1.20	b	0.47	1.00	0.26	-0.22	0.52	0.65	0.46
WW	a	0.89	1.69	2.58	2.65	1.95	6.25	6.19
$\sigma\rho$ = 1.42	b	0.65	1.03	1.00	0.63	0.79	0.76	0.92
WG	a	0.22	1.49	1.95	3.85	4.78	8.19	10.25
$\sigma\rho$ = 3.31	b	0.08	0.24	0.28	1.00	0.36	0.61	0.76
IPW	a	1.71	2.79	0.95	6.95	9.25	7.81	9.38
$\sigma\rho$ = 4.91	b	0.38	0.68	0.79	0.34	1.00	0.77	0.94
IYW	a	1.21	2.65	1.21	5.11	6.05	4.11	8.56
$\sigma\rho$ = 5.01	b	0.41	0.46	0.42	0.45	0.58	1.00	0.81
YW	a	2.03	2.85	2.92	6.21	7.18	6.58	8.21
$\sigma\rho$ = 8.27	b	0.69	0.66	0.92	0.76	0.94	0.68	1.00

Source: Adebambo 1995b
a = Correlated response $\Delta Gu = hshu / rGsGu\sigma\rho u$
b = Response shown as ratio $\Delta gu / \Delta Gs$
BW = Birth weight;
WW = Weaning weight,
BWG = Weight gain (birth to weaning);
IPW = 150 day weight;
WG = Weaning to 150 days;
IYW = 150 days to yearling day weight;
YW = Yearling weight.

Table 17: Line superiority for correlated responses for weaning weight versus 150 days (IPW) and Yearling Weights (YW).

		IPW (kg)	YW (kg)
LW X	Male	17.075±2.35	25.118±2.19
	Female	8.823±1.62	12.979±2.01
	Mean	12.949±2.12	19.085±2.63
HAMP X	Male	20.589±1.79	38.663±2.77
	Female	10.593±1.11	19.892±2.16
	Mean	15.516±1.63	29.138±3.01

Source: Adebambo 1995b
* LW X = Large White crosses; HAMP X = Hampshire Crosses.

The expected correlated response in weaning weight was 79% as effective as the direct selection while that for 150 days and yearling weights were equally as effective, with 94% and 92% represented respectively.

From the correlated response, it follows that for every kilogram increase in weaning weight above the population mean, there could be expected a 12.95kg and 19.09kg weight increases at 150 days and one year of age in the LargeWhite line and 15.52 and 29.14kg increases in the Hampshire line (Table17). The overall increase in the weight of males was 17.05kg and 25.12kg in the LW line and 20.59 and 38.67kg in the Hampshire line at 150 days and yearling weights. This was much lower in the females. The two lines are not only sexually dimorphic, the Hampshire line is much superior to the LW line.

Contrary to expectations, the improved indigenous pigs were found to have a higher lean deposition beyond the 60kg weight (Adebambo, 1992). Coupled with the fast rate of gains hereby reported, selection for increased weight at maturity, would result in little change in size at birth and growth rate till weaning as reflected by the degree of correlation but with moderately correlated changes in post weaning weight. Hence for more direct genetic effects, it would be more efficient to base selection on post weaning weight gains because of the high heritabilities, coheritabilities and genetic correlations observed with weights, post-weaning, in these sets of pigs (Tables 18 and 19).

Table 18: Heritability estimate4 (h^2), Genetic (r_g), Environmental (r_e), and Phenotypic (r_p), correlations among Parternal Halfsibs.

Trait	BWG	WW	WG	IPW	IYW	YW	h^2
BW_r g	0.12	0.25	0.45	0.38	0.33	0.44	
r^e	0.48	0.58	0.49	0.36	0.42	0.31	0.09±0.08
r^p	0.25	0.41	0.35	0.46	0.27	0.45	
BWG_r g		0.38	0.33	0.47	0.49	0.41	
r^e		0.54	0.46	0.71	0.42	0.54	0.14±0.11
r^p		0.58	0.39	0.79	0.24	0.64	
WW $_r$ g			0.25	0.81	0.54	0.78	
r^e			0.48	0.86	-0.58	0.64	0.25±0.16
r^p			0.45	0.92	0.29	0.66	

WG_{r^g}	0.65	-0.21	0.41	
r^e	0.68	-0.31	0.38	0.49±0.28
r^p	0.64	-0.19	0.46	
IPW_{r^g}		0.18	0.76	
r^e		-0.11	0.58	0.49±0.28
r^p		-0.10	0.68	
IYW_{r^g}			0.36	
r^e			0.40	0.41±0.26
r^p			0.34	

Source: Adebambo, 1995b.
BW = Birth weight;
BWG = Weight gain (birth to weaning);
WG = Weaning to 150 days
YW = Yearling weight
WW = Weaning weight
IPW = 150 day weight;
IYW = 150 days to yearling day weight.

Table 19: Components of covariances

Traits	PBW Vs PWW	PBW vs IPW	PBW vs PYW	PWW Vs IPW	PWW vs PYW	IPW vs PYW
Covariances						
$\sigma g_u g_s$	0.066	0.080	0.681	0.330	0.764	0.468
$\sigma e_u e_s$	-0.013	0.153	0.270	0.166	0.372	1.137
$\sigma p_u p_s$	0.19	0.233	0.951	0.493	-0.892	-0.669*
Coheritability	0.316	0.343	0.716*	0.669	0.856*	0.699*

Source: Adebambo 1995b
*p> 0.05
σgugs = genetic covariance between trait s and trait u
σeues = environmental covariance between trait s and trait u
σpups = phenotypic covariance between trait s and trait u
PBW = Pig birth weight;
PWW = Pig Weaning Weight;
IPW = 150 days pig weight;
PYW = Pig yearling weight.

Mortalities and Morbidities

We did not just stop at the genetic improvement of the pigs, we also looked at the contributory factors to mortalities and morbidities in the indigenous pigs.

Preweaning mortality is a significant cause of loss in the pig industry, with rates of 10 to 26 percent reported in different countries (Sharpe 1966; Nielson, et. al. 1974; Svendson and Bille 1982). Apart from religious and sociological factors, diseases and management problems had constituted major constraints to the early take off and expansion of the pig industry in Nigeria (Olufemi, et. al. 1981). The incidence and aetiology of preweaning mortality at two intensive

piggeries, the University of Ibadan Teaching and Research farm and my research outfit at the Institute of Agricultural Research and Training, were reported (Ayoade, Ladosu and Adebambo1991). Both exotic (comprising LargeWhite, Landrace, Duroc and Hampshire) and the indigenous pigs and their crosses were involved. Weight records, preweaning, till eight weeks, were recorded in the two herds routinely. Some identification, parity, clinical diseases and treatment were also recorded. All dead piglets were necropsied within eight hours of death. Rectal swabs were also collected for most scouring piglets. 658 piglets (26.97%) out of 2429 piglets born between 1984 and 1987 were lost before 8 weeks of age (Table 22). Highest mortality were recorded during the month of June (16.1%). Most mortalities occurred during the raining season of March to September (Table 23). Lower birth weights below 0.6kg resulted in high mortality, as small piglets hardly survived. Mortalities increased with litter size. Identified infecting bacteria were E.coli 64.96%, Klebsiella sp. 15.9%, Staphylococcus aureaus 9.6%, Salmonella sp. 5.7%, Clostridium perfringens 2.5% and Pseudomonas sp. 1.27%. Staphylococcus aureus, Pastuerella multocida and E. coli were the most common bacteria isolated from Pneumonic lungs. In this study, pseudomonas aeruginosa was also reported as an enteric pathogen.

From these observed cases, it was suggested that improved housing to prevent this mortalities is worth the investment. Controlled farrowing with presence of personnels to assist during the first 3 days of farrowing would also be profitable. Use of E. Coli. vaccine was advocated for the prevention of diarrhoea. The quick response of diarrhoea to antibiotics therapy, suggested very little viral involvement. Apart from prenatal mortality due to stillbirth, post-natal dam-overlay and enteric diarrhoea are major disease outbreaks that had been reported in Nigeria pig industry until very recently 1998 – 1999 when with the introduction of pigs across the border within Benin Republic that African swine fever outbreak was reported resulting in massive slaughter/destruction of many pigs, similar to the foot and mouth disease outbreak of the 1970s.

Pigs like other animals suffer from a variety of diseases – bacterial, viral, mycotic, parasitic and even non-aetiological ones like metabolic disorders and poisoning. While there are some scattered reports on bacterial and parasitic diseases of swine in Nigeria, only a handful of report on viral diseases are recorded. A survey of ectoparasites of the indigenous pigs shows that the sucking louse Haematopinus suis are most predominant. Other ectoparasites found were ambyloma varigaetum, Rhipicephalus sanguineus, Demodex and Sarcoptes specie and Tunga penetrans (Dipeolu, 1975). The young pigs have much heavier load than older ones and the ectoparasites were more numerous during the rains than the dry season.

Table 20: Ectoparasities of local pigs at Ibadan and Eruwa in Oyo State.

Species of Ectoparasites	No. of pig infested	% of total pigs examined	Predilection site	6-12 months	12 & 18 months	Above 18 months
Hematopinus suis	281	78	All over the body	147	85	49
Ambylomma variegatum	49	13.6	Flanks, perineal region	38	8	3
Rhipicephalus sanguineus	18	5	Below origin of tail	13	4	1
Demodex sp.	220	61	Neck &	107	79	34

			Shoulders			
Sarcoptes sp.	79	33	Back & Flank	55	18	6
Tunga penetrans	7	2	Belly & Flank	-	4	3

Source: Dipeolu, 1975.

The helminths parasites of pigs were classified in Northern Nigeria (Fabiyi, 1972; Ikeme, 1970) and in Western Nigeria (Akinboade 1974; Olufarati 1975) whilst blood and ectoparasites were similarly classified by Dipeolu (1975) in Oyo State. There is no doubt that the free range system which necessitated the scavenging of the local pigs on refuse dumps, sand and dirty environments was responsible for the acquisition by the pigs of so large number of parasites. The exotic pigs on the other hand kept under intensive system are regularly sprayed with ixodicides and dewormed, hence, are always free for ectoparasites and helminths. The younger pigs are usually more active in search of food on the refuse dumps this is probably responsible for their carrying greater burden of ectoparasites. As is also expected, a greater number of pigs would be infested with Haematopinus suis during the raining season since the parasite is principally transmitted by contact of infested with uninfested animals. During rainfall, closer contact between pigs is effected when they hoard themselves together while seeking shelter in their dirty and overcrowded mud huts.

As long as most of the local pigs are scanvengers, it is sure that they will acquire these ectoparasites which are vectors of several diseases.

Rhipicephalus sanguineus had been incriminated in the transmission of Babesia trautmanni to pigs in Africa (Riek, 1968) while H. suis could transmit Eperythrozoon paryum to pigs (Saemer, 1960), Tunga penetrans similarly is of public health importance. This flea commonly known as 'Jigger' has the pigs as the reservoir host (Gordeon and Lavoipierre 1969). This was corroborated by the farmers, that human infection arises from association with pig keeping in the houses. Survey of viral diseases (Majiyagbe, et. al. 1986) showed that the diseases exert their influence on limiting production principally in:

(i) direct losses of the young ones
(ii) losses from arrested growth and waste in feed consumed.

Devastation from swine viral infections reviewed by Majiyagbe (1981) ranged from highly contagious and usually fatal African Swine Fever (ASF), various diarhoeic disease of the young to the relatively mild Swine Pox Virus (SPV) infection. The result of earlier findings by Scott and Hill (1966) and Taylor, et. al. (1977) showed that Nigeria is ASF free. However because of the insidious nature of the disease and recent outbreaks in Cameroon in 1982 and 1984 which shares a common boarder with Nigeria especially with Cross River and Gongola States with large pig population and also a recent outbreak in Benin Republic in 1998 which shared border with Nigeria along Ogun Lagos and Oyo States, the prevalence of this disease in Nigeria can no longer be ruled out.

High antibody titre for swine influenza which was not reported for African swine fever were recorded in an antibody survey by Majiyagbe, et. al. (1986) in the Northern parts of the country where pigs are found. The negative titre value reported for ASFV does not imply that the disease is not prevalent, considering the very recent outbreak. However, records have shown

that the ASF virus is a weak antigen which does not provoke high antibody production it similarly initiates poor or very low secondary response from contact with the antigen hence it is very difficult to develop vaccine against the virus during reported outbreaks. In essence only animals that are resistant to the virus are able to survive.

Table 22: Antibody survey of swine influenza virus (SIV) and African swine fever virus (ASFV) in Northern Nigeria.

	Number tested	Number positive (%)
Kaduna	68	19 (27.9%)
Kano	41	2 (50.0%)
Jos	841	632 (75.1%)
SIV Total	5*	5* (100%)
	913	635
ASV 773	0	

Source: Majiyagbe, et. al. 1986.

- Local black pigs

Lessons from the study

Successful pig production implies that there must be improved production practices and properly organised community programmes for interested pig farmers. There is need to educate farmers in the need to improve their managerial skills and the level of technology adopted with respect to feeding methods, quality of feed, proper breeding and selection methods, general management, housing, manure disposal as well as disease and parasite control. The solution to these require the combined effort of the pig producers acting as cooperatives, backed up by research and management ideas provided by well organised extension service and definitive action by all arms of the government.

Let me humbly report here that the UNAAB pig farm was established with some of these improved pigs in 1998 and from a lowly beginning with only 17 pigs and regular sales to pig farmers and pork consummers UNAAB presently has over 200 pigs in her herd. A small booklet to assist pig farmers from a collection of my 16 years of continous genetic improvement of the indigenous pigs and 29 years of genetic research and production of pigs has been put together and is available for sale. The infusion of the indigenous blood into our breeding programme has assisted us in keeping out unforseen circumstances such as disease outbreaks witnessed in other farms and other parts of the country. I believe that this University is well set to populate Nigeria with improved indigenous pigs for the cormmecial producers if fund is made available for progeny testing of these pigs in Zonal trials and to expand the present genetic base.

Nigeria's Poultry Genetic Resources

It is well known that with the exception of South Africa where poultry production is largely an integrated concern, 90% of poultry birds in Africa are still managed under the traditional system and much of the production depends on subsistence poultry farmers in rural households (Table 23).

Table 23 : Nigeria's Poultry population.

Species	Pastoral	Village	Urban	Total	% S.E.
Poultry	-	97,860,320	6,397,640	104,257,960	3.3
Chickens	-	68,244,195	4,156,661	72,400,856	3.5
Ducks	-	11,220,461	.573,507	11,793,968	3.7
Guinea fowl	-	4,621,670	58,237	4,679,907	4.1
Turkey	-	207,219	16,144	223,363	11.8

Source: RIMS 1992

Poultry Structure

Generally, rural poultry production is characterized by minimum inputs from producers. The birds scavenge around farms, compounds or households with no major investment other than occasional grains, fed along with other household wastes. The birds are kept overnight in portable cages made of palm fronds or mud huts and released in the morning to a diet of broken/crushed grain-maize, rice, sorghum grains or fermented grain wastes (Duza). The birds are allowed to go on free range with resultant low productivity of eggs and meat. Free range birds are usually infected with one type of parasite or the other, as they similarly fall into the hands of predators.

One of the major problems of the poultry industry in Africa is the lack of breeds of poultry that are adapted to the traditional small scale system of production prevalent in the area.

Taran (1974) pointed out the need for national or regional breeding programmes based on gene pools from local strains. Similarly, Akinokun (1990) recognised the limitation of exotic breeds as being due to temperature and moisture stress under tropical environment. It was therefore suggested that a breeding policy in which the introduction of gene of the local stock onto the exotic stocks be initiated.

The creation of a multiple stock of eggs or meat strains of exotic and local breeds therefore, which will provide a base population that can be subjected to long term selection, appear to be a feasible proposition. The suggestion was the use of multiple cross as a base for sampling a wide variety of genes to increase over all production rate of chicken in tropical environment and the introduction into the exotics, genes of adaptation to the environment and resistance to local diseases. With the evidence that there is adequate amount of genetic variance in growth rate and egg production in native fowl populations, there is need to be sufficiently consistent with selection procedures for sexual maturity and egg production for a longer duration for the effort to be effective.

Several short term programmes of introducing exotic cocks to improve free range stock had proven largely unsuccessful due to low survival rate of distributed stock, as well as shortage of effective organization to effect plans for removal or purchase of local cockerels that are not needed for breeding purposes in the rural areas. The technology for the production of replacement stock is often not available at the village level. The dearth of scientists in the field of animal breeding is now stearing us in the face, hence the need to focus our attention and that of international organizations on assistance with national manpower development along this area. There is need to look at the genetic resource that are available in our local ecotypes. The role that such genes as frizzling and naked neck can play in the development of adapted layer

and meat type birds should be examined. We need to search for hardy birds that do not require massive imputs of vitamins and antibiotics that are now frequently used as additives in commercial poultry strains.

More than before, is the need to generate teaching aids for manpower development and audio visuals for the rural producers to enable him compare and contrast his production processes and improve on his efficiency when the needs arise.

Nigeria's indigenous poultry breeds distribution

In reality, the rural poultry stocks in the villages and sub-urban localities exists in small groups of mixed ages which roam freely, scavenging for food in nooks and corners, among shrubs and bushes where they often come in contact with groups of chicken from other sources during the day time, while they more often return to base towards the night time to perch on trees or in dilapidated huts and sheds.

The survey of rural poultry in South Western Nigeria in 506 villages households, showed that 88% kept chicken and had 17.6 chicken per village household compared with 14.73 chicken per town household. (Adegbite 1990). In the Northern States, the 22 villages sampled (Abdu, et. al. 1999) showed preponderance of chicken in the rural households. 98.3% of the farmers are found to be keepers of chicken, 32.7% kept ducks, 13.5% kept turkeys, 11.5% kept guineafowls whilst 14.2% kept pigeons. Number of birds per household range from 28.9 chicken, 5.8 chicks, 3.2 turkeys, 10.5 guinea fowls to 31.7 pigeons. Every chicken flock comprised of 3.7 cocks, 8.4 hens and 15.3 chicks or growers, mostly managed under free range (87.5%), restricted range (14.2%) and intensively (2.3%). In the East, 91.7% of the household keep indigenous fowls, 47% of whom kept 20 birds per household. 60% of these were under free range management while 30% kept the birds semi-intensively. The birds so managed are of much more importance to the household because they are marketed to generate cash. They are traded as insurance policy, when cash is hard to come by to offset bills and pay childrens' school fees (Table 24).

There is definitely no commercial source for foundation stock of indigenous poultry. Foundation and replacement stocks are obtained from open market, neighbours or both. It is however discovered that it is customary for parents especially mothers to buy a hen and a cock for their children to start a flock.

Table 24: Poultry distribution.

	South West	South East	North West	North East	Middle belt
	506 household	220 household	33 villages	22 villages	11 villages
No. of household	88%	91.7%	98%	98.3	93.9%
Birds/household					
Chicken	17.6	20.0	18.0	28.9	19.6
Ducks			8.0	5.8	1.1
Turkey			5.0	3.2	-
Guineafowls			18	10.8	-

Pigeons			-	31.7	-
Management					
Free range		60%	91.0	87.5%	53.7%
Semi intensive		30%	9.0	14.2	44.4
Intensive		10%	-	2.3	-
Feeding					
Grains		80.3%	72.0	45.9%	Yes
Bran/by products		13.4	24.0	36.7	
Commercial feed		4.6	-	-	
*Kitchen wastes		75.0	-	-	Yes
Crop residue		-	Yes	-	Yes

The Poultry Characteristics.

In Nigeria, poultry breeds especially the local chicken had been characterized along genetic lines of feather and plumage colour (such as normal or frizzle feathered),body structure,(such as naked neck, dwarf types), colour variants (such as black, white, brown, mottled) and production lines (such as extensive, semi intensive and intensive systems of production). Comparisons had similarly been made in different areas with available exotic genotypes (Table 25).

Table 25: Productivity characteristics

Parameter	Mean	Production system	Author(s) location
Liveweight	1.285kg	Intensive	Nwosu, et.al. 1979 Nsukka East Nigeria
Live wt.	1.123	Intensive	"
Carcass wt.	0.634	"	"
Bone wt.	0.212	"	"
Liveweight	1.5	Extensive	Ikani & Louis 1999 Adamawa State, Nigeria
"	0.77-1.13	"	Ikeobi, et. al. 1996 S.W. Nigeria
"	0.90-1.80	Extensive	Adedokun & Sonaiya, 1999
Age at point of lay	35 weeks	Extensive	Eshiett, et. al. 1989, Owerri

Length of lay	11.5 day	"	"
No. of egg/period	8.89	"	"
Eggs laid per year	27-37	Extensive	Ikeobi, et. al.1996 S.W
Incubation period	21 days	"	"
No. of cluthes/year	2.13	"	"
Rearing period	2.75m	"	"
Productive life	2.3 years	"	"
Egg laid per year	40-60	Intensive	Oluyemi, 1979, Akinokun 1981, Sonaiya & Olori, 1990, S.W.

Productivity.

Studies of the Nigerian chicken breeds showed, average number of eggs laid per clutch as 8-9 within a laying period of 12-14 days. Rearing period is 64-70 days and the age at point of lay between 32-36 weeks with the age at first-egg within 155-165 days. The number of pauses similarly vary.

Poultry Ecotypes

In the South West Zone of Nigeria, 4 ecotype or strains were identified according to their genetic variants. This is based on the expression of adaptive major genes for frizzling (F) naked neck (Na) and the dwarf (dw) genes. These are generally genes found to be affecting the body metabolic processes. Hutt (1949), reported that while naked neck condition is caused by a single dominant gene, frizzling is caused by an incompletely dominant autosomal gene leading to higher rates of metabolism and heat loss in the frizzled bird than in fully covered ones. Observations on earlier maturity of birds with either the F or the Na gene relative to those with normal feathering had been made (Ibe, 1992). Deeb and Cahaner (1994) also reported that the Na gene increased breast meat yield whilst Ibe (1993) also postulated that the advantages of the F and Na genes over normal feathering conditions would probably be exhibited during egg production (Fig. 4-6).

The observed genetic parameters relative to body conformation and plumage colour gathered in these indigenous poultry breeds were as reported by Ikeobi, Ozoje, Adebambo and Adenowo(1996 -1999) for breeds in South-Western Nigeria in our cooperative effort at characterising these indigenous poultry breeds of South Western Nigeria towards breed formation for commercial production in the humid zone of the country.

Table 26: Frequency of some genes in the local chicken of SW Nigeria.

Genetic group	N	% Incidence	Gene frequency	Carriers in the

				population
Normal	1594	78.44		
Frizzled	223	10.97	F = 0.06 F = 0.94	11.64%
Naked neck	175	8.61	Na = 0.05 Na = 0.95	9.75%
Frizzled / naked neck	29	1.43	-	
Dwarf birds	11	0.54	Dw = 0.07 Dw = 0.93	13.51%

Source: Ikeobi, et. al. 1996.

In all, the liveweight of the birds in the South Western states were comparable with those of the South Eastern states (1.13± 0.07kg).(Ikeobi, et. al. 1996), 1.14± 0.03kg (Nwosu, et. al. 1985) but smaller than those of the Northern breeds which varied from 1.7 – 1.9kg.This might however, not be unconnected with the effect of the introduced cocks(the Rhode Island Reds, RIR) of the 1950s in the Northern States.

Comparative analyses of the growth characteristics with other poultry breeds under extensive conditions (Mustapha, 1995) are also as listed in Table 27.

Table 27: Growth parameters of local poultry breeds under extensive condition in SW Nigeria.).

	Chicken		Duck		Guinea fowl		Pigeon	
	M	F	M	F	M	F	M	F
Liveweight	1.9	1.6	3.4	3.3	1.6	1.5	0.8	0.8
Shank length	7.3	6.9	5.7	5.0	7.6	7.5	3.6	3.1
Body girth	24.9	24.1	42.8	42.5	28.3	25.4	24.3	22.7
Breast length	11.9	11.7	19.9	19.7	14.9	14.4	6.7	5.8
Wing length	17.5	17.3	39.5	38.3	29.7	28.6	18.6	13.7
Birds height	19.4	17.6	15.6	15.4	24.4	21.4	9.5	9.3

Source: Mustapha, 1995

Smith (1990) reported that white birds are more productive than brown ones at high ambient temperatures. White plumage controlled by the dominant autosomed gene I and inherited in accordance with Mendel's laws (Hutt, 1949) could be seen as an adaptive feature, enabling the birds to withstand the adverse effect of the high environmental temperatures through radiant heat loss while still producing and performing optimally. White shank colour has also been reported to be genetically superior to yellow shank owing to the presence of an autosomal

dominant gene which prevents yellow from developing in the skin and this has much effect on black pigmentation (Oluyemi and Roberts, 1979).

While white superiority in performance of ducks was observed, black was the superior colour in turkeys and mottling in local chicken (Tables 28 and 29). Ear lobe colours have been reported to be hereditary but with no relationship to plumage or comb type (Hutt, 1949). Apart from this, results obtained in the indigenous poultry types indicate that white ear lobes are important in influencing desirable meat traits such as adult live weight, and breast girth, while red earlobes affect length of the body extremities such as shanks, beaks and wings. The results highlighted the possibility of utilizing the pigmentation of the various body parts and the genes controlling them in future improvement efforts involving the indigenous poultry types.

Table 28: Factors affecting performance of local turkeys.

Variables	Shank length (cm)	Beak length (cm)	Backbone length(cm)	Wing length (cm)	Live Weight (kg)	Breast girth (cm)	Eggs laid/ year	Eggs hatched/year
Overall mean	13.62	4.36	46.28	35.66	3.99	62.97	15.37	12.79
Sex: Male	14.00a	4.24	50.57a	38.76a	4.60a	61.86	-	-
Female	13.25b	4.84	41.74b	32.58b	3.39b	58.00	-	-
Plumage colour								
Black	13.19	3.83c	44.38	35.19b	3.40b	44.91c	15.43	13.71
Brown	13.31	3.76c	43.82	33.11b	3.42b	42.68c	14.67	14.00
Grey	14.24	4.80b	43.19	48.53a	3.53b	73.45ab	16.00	10.00
Mottling	13.74	5.77a	53.23	25.85c	5.64a	78.68a	-	-
Shank colour								
Black	-	4.38	41.95	33.21b	4.21a	74.51a	-	-
Brown	-	3.74	39.44	44.35a	2.61c	47.52c	-	-
Slate	-	4.24	44.59	44.14a	3.24b	53.81b	-	-
Ear Lobe Colour								
White	11.24b	3.71b	43.26	32.60b	4.44a	64.27	-	-
Red	16.00a	5.37a	49.05	38.74a	3.54b	55.59	-	-

Source: Adebambo, et. al. 1996.

a-c: Least-square means in the same column, within variable bearing different letters, differ significantly (P<0.05)

Table 29: Influence of sex and colour of plumage, shank, and beak on the performance of local ducks.

Variable	Shank length (cm)	Beak length (cm)	Backbone length (cm)	Wing length (cm)	Live Weight (kg)	Breast girth (cm)	Bird height (cm)	Eggs laid per year (cm)	Eggs hatched per year
Overall mean	6.03	4.80	29.17	27.09	2.78	40.18	18.90	46.72	41.85
Sex:									
Male	6.54a	5.01a	30.70a	27.66	2.95a	41.63a	20.20a	-	-
Female	5.52b	4.59b	27.65b	26.51	2.62b	38.73b	17.60b	-	-
Plumage									
Black	5.96b	4.75	29.81	26.62	2.61b	40.12ab	19.70a	49.26	43.73
White	6.32a	4.83	28.90	26.81	2.89a	39.08b	17.94	45.01	40.05
Black & white Mixed	5.80b	4.82	28.81	27.82	2.85a	41.33a	19.06	45.88	41.76
Shank Colour									
Black	6.44a	4.79	28.94	26.76	2.74	38.78b	17.58b	41.53c	36.68b
Yellow	6.39a	4.79	28.82	26.15	2.62	38.73b	20.62a	43.80 b	38.34b

White	5.25b	4.82	29.76	28.35	2.99	43.02a	18.50b	54.82 a	50.52a
Beak colours									
Black	6.01	4.84	29.49	27.89a	2.91a	40.49	18.27	47.21	42.52
Mixed	6.05	4.75	28.85	26.28b	2.66b	39.87	19.52	46.23	41.17

Source: Adebambo, et. al. 1996.
A,b: Within variable set, means in the same column bearing different superscripts, differ significantly (P<0.05)

Reproductive performance

In the extensive system practised by the rural poultry producers, egg production is in clutches. The number of eggs reported for each clutch ranged from 4 to 14 with an average of 9 eggs (Sonaiya and Olori, 1990, Eshiett, et. al. 1989, 1990, Dafwang 1990, Ikani and Louis, 1999) with 2-3 clutches per year. Hatchability was estimated from the number of chicks reportedly hatched from the number of eggs laid in a clutch. Average hatchability was 77% with a range of 52-100%. The brooding period varied from 10-13 days and usually only 60% of total chicks hatched survive to weaning at approximately 2 months (Table 30). The age of the birds at point of lay was reported to be 20-36 weeks with more eggs laid during the dry season than the rainy season. Egg production varied from 40-60 egg under the extensive system, but could be as high as 170 under intensive system (Nwosu, 1987, Sonaiya, 1989).

Table 30 : Estimates of some reproductive traits.

	Domestic fowl	Ducks	Guinea fowl	Turkey
Clutch period (days)	8.0 ± 1.8	11.5 ± 2	12.5 ± 2	7.0 ± 2
Pause (days)	2.6 ± 0.7	3.5 ± .09	3.8 ± 10	3.0 ± 0.9
Eggs/Clutch	12.0 ± 2.1	15.8 ± 2.3	16.2 ± 3.3	9.4 ± 1.9
Egg hatched	9.4 ± 1.7	12.9 ± 2.8	9.4 ± 1.6	6.5 ± 1.6
Chicks weaned	7.2 ± 1.4	8.3 ± 2.4	6.2 ± 1.7	3.9 ± 1.3
Age at weaning days	59 ± 0.9	55 ± 0.9	46 ± 0.9	66 ± 1.3
Preweaning mortality %	23.4	35.7	34.0	40.0

Source: Hassan et.al. 1990

Egg quality traits

The different poultry species contribute significantly to the annual protein supply of the populace especially the rural dwellers, since there are virtually no taboos against the consumption of poultry meat and eggs. The egg quality parameters of the local chicken, ducks, guinea fowl and local pigeon were compared for both external and internal chacteristics. The external characteristics included shell colour, shell texture, shell bloom, presence or absence of protuberances or cracks. The egg weight, length and breadth were also measured. The internal characteristics included the yolk and albumen height, used to calculate the Haugh Unit (HU), yolk, albumen and shell weights. The characteristics are as reported below (Tables 31 and 32):

Table 31 : Shell colour variation.

Species	White eggs	Light brown	Brown	Mottled	Tinted
Local chicken	60%	40%	-	-	-
Local duck	92.5%	-	-	-	7.50%
Guinea fowl	40.0	24.0	26.0	6.0	4.0
Local pigeon	87.5	-	-	-	12.50

Source: Ikeobi, et. al. 1999

From these comparisons, the egg shapes are similar, the guinea fowl eggs are thicker shelled than the others, whilst the deep orange colour of the guinea fowl eggs could be attributed to the birds consumption of mostly grasses and crop residues. In all, the egg of the local poultry species, except for the duck has Haught Unit in the range of United States standard for quality of industrial eggs, with values above 60 as categorised by Nalbandov and Card (1944) in the grade A while the duck egg with value of 41 fall under category B.

Table 32: Species differences in egg quality traits.

Traits	Local chick	Duck	Guinea fowl	Pigeon
Egg weight (g)	36.26 ± .58	74.22 ± .66	41.60 ± .04	4.20 ± .09

Egg length (cm)	4.70 ± .03	4.51 ± .44	4.80 ± .04	4.20 ± .09
Egg width (cm)	3.61 ± .02	4.51 ± .02	3.80 ± .02	2.58 ± .04
Shape index	0.83 ± .04	0.73 ± .04	0.80 ± .04	0.62 ± .08
Shell thickness (mm)	0.36 ± .05	0.52 ± .06	0.59 ± .05	0.20 ± .13
Shell weight (g)	3.42 ± .24	7.45 ± .24	8.50 ± .27	2.09 ± .61
Yolk weight (g)	12.00 ± .46	38.36 ± .52	13.79 ± .45	6.86 ± 1.15
Albumen weight (g)	22.41 ± .42	27.76 ± .48	20.78 ± .42	8.60 ± 1.06
Yolk colour score	4.0 ± .21	8.00 ± .34	13.00 ± .21	4.00 ± .57
Yolk height (mm)	13.73 ± .39	17.99 ± .44	14.96 ± .39	8.38 ± .98
Albumen height (mm)	3.01 ± .05	3.41 ± .06	3.66 ± .05	1.94 ± .13
Haugh Unit	61.85 ± .70	41.35 ± .79	64.65 ± .70	66.34 ± 1.76

Source: Ikeobi, et. al., 1999.

Housing

In some cases, there are household provisions such as raffia boxes and baskets to shelter the birds at night. In the majority of cases, they are exposed to the vagaries of weather, onslaught of predators, diseases, life long under-feeding and poor nutrition. The birds are in essence, subjected to chronically sub-optimal live-ability and productivity. The rural poultry management system though in efficient, has its own merits. These includes simplicity, convenience and cheapness. This also allows individual household, to exercise some level of autonomy which they hate to abandon for cooperative or commercial system.

Prevalence of major diseases.

Studies on aspects of disease and liveability of the indigenous poultry in Nigeria dates back into the early 1950's. Although there was a nucleus of opinion suggesting that the indigenous chicken under rural or improved management conditions are relatively hardier than their exotic counterparts (Modebe and Hill, 1960, Oluyemi, et. al. 1979), this hypothetical view has often been misinterpreted as a claim of disease resistance in the chickens. On the contrary, existing reports have actually been equivocal on the susceptibility of the indigenous chickens to diseases such as NewCastle, (Hill, et. al. 1953), Salmonellosis (Sen and Collard 1967) Visceral lymphomatosis (Hill and Davis, 1962) and parasitisms. The presence of disease specific antibody is a simple and reliable way of verifying the presence of an infection. The detection of the specific antibodies to a given pathogen when unaccompanied by clinical disease can give rise to speculation on the resistance or tolerance of the host animals.

The prevalence of antibodies or similar criteria of infection for major diseases of poultry in the local chicken are as listed in Table 33.

Table 33 : Prevalence of major disease in rural poultry.

Diseases	Bird Type	% Prevalence	% Mort	Authors
Newcastle disease	Local chicken	-	0	Hill & Davis, 1962
-do-	Exotic	-	5.7	-do-
-do-	Local chicken	100	50	Fatumbi & Adene, 1979
-do-	-do-	-	2.2 – 7.2	Oluyemi, et. al. 1979
-do-	Exotic	-	3.4 – 11.2	-do-
-do-	Guinea fowl	65.2	-	Durojaiye & Adene, 1988
-do-	-do-	40.3	-	Adewuyi, 1986
Fowl pox	Local chicken	R++	R+++	Hill & Davis, 1962
-do-	Exotic	R+	R+	-do-
Infectious Bursal disease	Guinea fowl & Turkey	0	-	Nawathe et al. 1978
-do-	Local chicken	25	-	-do-
-do-	-do-	30 – 100	-	Adene, et. al. 1958
-do-	-do-	43 – 70	-	Durojaiye, et. al. 1985
-do-	Exotic	33 – 70	-	Adewuyi, 1986
Fowl Typhoid	Exotic	-	5.2	Hill & Davis, 1962
-do-	Local chicken	-	0	Hill & Davis, 1962
Egg drop syndrome EDS-76	Guinea fowl	100	-	Durojaiye & Adene 1988
-do-	Ducks	73.9	-	Ahmed 1986
-do-	Pigeon	86.6	-	Ahmed, 1986

Mareks	Chicken	8.3	-	Adene, 1975
Mareks	Exotic	16.4	-	Adene, 1983
Sarcoma	Local chicken	12.1	-	Adene, 1984
V. Lymph	Exotic	-	3.2	Hill & Davis, 1962
-do-	Local chicken	-	4.4	-do-
-do-	Local & Exotic	-	5.2	-do-

Source: Adene, 1990.

This survey revealed

(1) that in many cases, there were presence of disease antibodies, suggesting continous exposure to infection but without the clinical diseases subsequently.

(2) the antibody prevalence varied from 40-100% for Newcastle disease, 25-100% IBD, 51-100% for EDS etc. suggesting an effective spread of infection within and across flock populations.

(3) there was a similar prevalence in guinea fowls and ducks indicating lack of selective or species related spread of infection.

(4) data on mortality from the various sources are conflicting or equivocal.

For example:

Hill & Davis, 1962 - No Mareks Disease Mortality in locals

Oluyemi, et. al. 1979 - Record mortalities in locals and exotic chickens

Fatunbi and Adene, 1979 - Recorded high NewCastle Disease mortality in locals

Aire and Ojo, 1974 - Observed greater resistance to experimental salmonellosis in locals

With the disease prevalence ranging from 8.7% in MD, 12.1% in Sarcoma, 4.4% in Lymphomatosis, 40-100% in ND and 25-100% in IBD, this actually demonstrates that infected local chickens can shed or transmit infection to other species.

Differences in disease susceptibility with animal populations have generally been associated with breed, strain or genetic factors. Although such genetic factors are poorly defined in some cases, studies on Mareks disease in poultry have identified some MHC genes in the susceptibility of chickens to MD (Cole, 1968, Hansen, et. al. 1969, Longenecker, et. al. 1976). Thus certain MHC related allotypes have been identified on both side of the susceptibility spectrum of chicken to MD (Table 34).

Table 34 : Reactivity of local chicken with typing sera – in Ibadan, Nigeria.

Flock samples	Haplotypes			
	B^{21}	B^{19}	B^{17}	B^{Q}
(A) Abadina				
Positive	8	11	-	13
Negative	42	39	51	35
Doubtful	5	5	4	7
(B) Samonda				
Positive	3	1	8	3
Negative	13	14	10	11
Doubtful	4	5	2	6

Source: Adene, 1990.

Immunogenetic studies concluded to explore possible existence of allotypic segregation in Nigeria local chicken (Adene, 1990) revealed some degree of genotypic segregation from the pattern of selective reactivity in the tests.

Comparative performance with exotic chicken.

In several studies the indigenous poultry types had been compared with commercial exotic stock as purebreds or crossbreds in the same environment. Although the exotics outperform in all cases, their performance was relatively lower than what obtains in their zones of origin. Evaluation of indigenous and exotic strains of chicken in Nigeria (Akinokun 1974, 1975, Akinokun and Dettmers 1976) showed that exotic chickens are generally inferior in tropical location than in the temperate areas, although expected higher performances than the indigenous were reported.

A comparison of the indigenous genotypes with exotics at the University of Agriculture, Abeokuta (Peters, 2000) showed significant breed effect on egg parameters and carcass quality in the exotics than the indigenous.

Table 35: Mean egg values % as affected by breed type

Type	No. of eggs	Mean egg wt (g)	Mean egg length (cm)	Mean egg width (cm)
Indigenous	602	39.99 $\pm$ .18	4.97 $\pm$ 0.01	3.91 $\pm$ .01
Exotic layer	108	54.28 $\pm$ .34	6.32 $\pm$ 0.02	5.39 $\pm$ .01

Source: Peters, 2000.

Highly significant correlations were reported between mean egg weight and mean chick weight in all the genotypes studied (Peters, 2000).

Table 36: Hatchability of eggs as affected by major genes.

Major genes	No. of eggs Set	Hatched		Infertility		Dead in shell	
		No.	%	No.	%	No.	%
Naked neck	165	65	39.4	31	18.8	69	41.9
Frizzled	128	69	53.9	39	30.5	20	15.6
Normal feathered	309	178	57.6	97	31.4	34	11.6
Exotic	106	58	54.7	34	32.1	14	13.2

Source: Peters, 2000.

Liner body dimension were also regressed against body weight using both simple linear and exponential procedure.

Genetic correlation

Genetic correlation coefficients among the live body measurements were generally medium to high and significant ($P<0.05$) with values ranging from r_G = 0.993 between body length and head length to r_G 0.181 between thigh length and shank length. The most important parameters of body weight to body length, shank length and chest girth were similarly very high r_G=0.747, r_G0.888 and r_G0.731 respectively and highly significant ($P<0001$). These values are of greater relevance in selection criteria for improvement in the growth rate and meat production attributes of the chicken (Table 37).

Phenotypic correlation

The coefficient of phenotypic relationships between body weight and live-body measurements did not follow the same pattern as the genetic relationships. The coefficients were generally low to medium. The value ranged from r_p=0.466 between the body weight and shank length to r_p=0.438 body weight and body length to r_p=0.146 body weight and chest girth (Table 37).

Environmental correlation

The coefficient of environmental correlation between the body parameters did not follow any particular trend while it was positive and significant between some parameters like body weight and chest girth (r_G=0.736), it was negative and highly significant in others such as between body weight and shank length (r_c=-0.999) and body length (r_e=-0.998).

Heritability estimates.

The heritability estimates were in essence found to vary from medium to high using basically the sire components of variance. The values ranged from h^2 = 0.420 of the wing span to h^2 = 0.998 for body weight. (Table 38).

Table 37: Genetic and Phenotypic correlation and Heritability estimates of body parameters.

	BW	SL	TL	WL	WS	BL	BDL	HL	CG
BW	0.998	0.466*	0.205	0.270	0.296	0.453*	0.438	0.198	0.146
SL	0.888**	0.978	0.265	0.415	0.399	0.410*	0.387	0.225	0.344
TL	0.597*	0.181	0.489	0.298	0.278	0.262	0.422	0.301	0.195
WL	0.772**	0.743**	0.620*	0.533	0.077	0.279	0.358	0.309	0.467
WS	0.841**	0.869**	0.718**	0.922**	0.420	0.279	0.386	0.298	0.479
BL	0.747**	0.779**	0.522*	0.402*	0.546*	0.972	0.420	0.590*	0.471*
BDL	0.687*+	0.861**	0.739**	0.899**	0.933**	0.592*	0.971	0.107	0.267
HL	0.728*	0.826*	0.443*	0.333	0.462*	0.993*	0.448*	0.900	0.501*

	**	*	+			**			
CG	0.731**	0.866**	0.482**	0.670*	0.706**	0.883**	0.843**	0.821**	0.473

*** P<0.001, ** p<0.01, *P<0.05

Lower part are the genetic correlations; Upper part are the phenotypic correlations ; Heritability along the diagonal.

Key: BW - Body weight; WS - Wing span CG - Chest girth
WL - Wing length HL - Head length BDL - Body length
TL - Thigh length SL - Shank length BL - Beak length

Source: Peter, 2000.

Lessons from the studies

The fact that at least 60% of the total poultry population in Africa is made up of indigenous stock located in the rural areas as one of the sources of sustainance to the rural populace, should encourage us to spare some efforts at the development of these birds beyond the existing subsistence level. It is on record (Modebe, et. al. 1963) that battery caged housed chicken produce an average of 135 eggs per annum and up to a maximum of 198 eggs, compared to 60-80 associated with these birds under rural setting and that the response of these birds or their crosses with exotics under intensive management was good in terms of egg productivity and liveability (Modebe and Hill, 1960). David West (1979) also ascerted that despite the low productivity traits of the indigenous birds they have contributed immensely to the internal supply of poultry meat and eggs. Poultry scientists similarly tend to agree that the indigenous birds have great potentials for a meaningful genetic improvement (Oluyemi, 1979, Akinokun and Dettmers, 1979, Nwosu, et. al. 1985, Omeje and Nwosu 1983, Ikeobi et. al.1996, Adebambo, et. al. 1996, Peters, 2000). These and other earlier studies had indeed opened up debates in the past on policy options aimed at producing locally adaptable stock. Although attempt were made through selection of the birds or crossbreeding with exotics or both, suffice it to say that some progress was made on these proposals though the original goal was never attained.

To get the best out of the indigenous stock, the Bangladesh experience was suggested. These scheme was adjudged successful though it was sponsored by the government in collaboration with the UNICEF and the World Bank. Participants were educated and organized into cooperatives. The use of improved strains of cocks on the local chicken was also practised in

Nigeria in the early 1960s (FAO, 1966, Oluyemi, 1978) but was not as organized as with the Bangladesh's experience. The impact of such unorganized improvement of the local chicken would rather be imagined than discussed here.

POULTRY BREED CHARACTERIZATION IN THE UNIVERSITY

In 1994, the Department of Animal Breeding and Genetics of the University of Agriculture, Abeokuta under my leadership was challenged on the indigenous poultry breed development with the aim of developing lines of improved indigenous poultry for egg and meat production.

Between 1998 and year 2000 Indigenous chicken types from different parts of South Western Nigeria and some Fulani types from Fulani settlements in Ogun State were collected and screened for their productive performance along with two exotic strains for crossbreeding and performance testing.

The Department of Animal Breeding and Genetics, being the custodian of the project has within the period evaluated the growth parameters of the crosses between indigenous and exotic birds with the aim of increasing the average bird size through crossing and selection which has a highly significant implication for reproductive performance, egg size, egg numbers, fertility hatchability and survivability of the birds as indicated above in the reports of Peter (2000). Within the last 2 years, the improvement on the growth of the first and second filial generation of the crosses has been in the neighbourhood of 19.9 to 49.1 percent compared to the pure indigenous breeds with heterotic advantage of 4.5 – 19.2% of the F_1 (Table 38) and 16-69% at the F_2 (Table 39).

Heterotic advantages for the body parameters ranged from 0.01 – 0.09% for shank length, 6.02 to 0.07% for wing length, 1.1 – 5.15% for backbone length and 5.1 – 8.2% for breast girth. These all have implication for the higher body size of the crossbred chicken (Table 40).

Table 38: Growth parameters of indigenous F_1 and F_2 crossbreds.

Breed/Weight (g)	Age – weeks			
	1	4	8	12
Ind.	33.13 ± 0.9	85.18 ± 6.1	286.93±19.4	545.08±36.9
Ex x Ind	42.98 ± 1.1	132.0 ± 7.1	456 .2 ± 22.7	804.0 ± 43.4
Ind x Ex	37.72 ± 0.9	119.8±6.0	409.0±19.1	742.5±36.4
Exotic	42.82 ± 1.5	128.25± 12.3	430.73±39.1	834.45±86.4
Genotype				
Local	33.15 ± 0.9	85.18±6.1	286.9±19.4	545.8±32.0
Exotic	42.82±1.6	128.25±12.4	430.7±39.8	834.18±86.7
Crossbred	39.70±0.8	124.7±4.9	427.9±15.7	767.16±29.6
Heterosis %	4.54	16.8	19.2	11.2
Crossbred (g)	6.6g	39.5g	141g	222g

Improvement (%)	19.9%	46.3%	49.1%	40.7%

Source: Adenowo, Adebambo and Adebambo 2001

Table 39: Improvement in body dimensions.

	% Heterosis			
	1	4	8	12
Shank length cm	0.01	0.08	0.09	0.06
Wing length cm	0.05	0.06	0.07	0.02
Backbone length cm	1.10	4.50	5.15	4.20
Breast girth cm	5.24	5.14	8.18	5.44
Breast length cm	3.85	5.14	3.90	3.53
Birds height cm	4.02	8.73	7.42	4.39

Source: Whetto,Iposu and Adebambo (2001)

Table 40: Effect of Gene substitution.

	Age weeks			
	1	4	8	10
50% Exotic = F_1	42.54 ± 2.4	109.11 ± 6.7	321.3 ± 22.8	451.11 ± 32.3
50% Exotic = F_2 (i) i.e. F_1 x F_1	51.14 ± 3.5	126.31 ± 9.8	416.5 ± 35.6	609.29±50.3
75% Exotic = F_2 (ii) (upgrade)	63.97 ± 3.3	181.46±9.2	453.38±31.4	587.33±44.3
Heterotic advantage				
% of				
F_1	12.3	16.8	19.2	11.2
F_2(i)	36.7	18.3	16.1	18.8
F_2(ii)	68.5	69.9	26.3	14.5

Source: Whetto, Iposu and Adebambo 2001.

By the year 2001, two crossbred strains with identifiable features were selected based on the plumage colour combinations of White with black tail feather and brown with black tail feather Tagged α Strains (α's 1 & 11) for egg production.

In October 2001 Two additional exotic breeds were imported from India for genetic evaluation under UNAAB condition and crossbreeding with the Indigenous and the improved indigenous. These are the White Leghorn egg breed and the dual purpose Giriraja developed in India for rural poultry egg and broiler meat production. The inclusion of these lines in the breeding programme is the basis for the production of Sharon strains I & II for meat production.

UTILIZATION OF DNA TECHNOLOGIES

The increased use of Molecular Biology and the initiation of the Human Genome Project (HGP) in 1984 shifted the attention in animal breeding research on the need to isolate specific genes, localise them to a chromosomal region and determine their immediate Molecular environment. Presently there are two types of biological maps in animal improvement research, these are Genetic and Cytological maps. While genetic maps, often called linkage maps identify the linear arrangement of genes on a chromosome, which are assembled from meiotic recombination data (that is the order of genes on a chromosome), they can not pinpoint the physical whereabout of the genes or determine how far they are apart. They are measured in Centimorgans (cM).

Cytological maps on the other hand are known as physical maps which identify the actual physical position of genes on a chromosome. The distances are measured in basepairs, kilobase pairs (1000 bps) or megabasepairs (1m bps)

Let me demonstrate this with the example of the Human Genome project.
The aim of the HGP is to sequence the entire human genome that is all the genes in the human body by the year 2005. The idea for such a project originated in year 1984 but the level of financing required was not achieved until 1988. There was need for international pooling of resources, collaboration and free exchange of data. By 1990, the HUGO organisation was formed with goal and time scales set. The aim was:

- To produce high resolution map of the human genome with an average spacing of 2cM
- production of sequence tagged sites every 300kb
- identification and localisation of genes to produce transcription map
- physical spacing in gene regulation
- organisation of repetitive elements and nontranscibed spacers

- distribution of transposons

- pathologies of DNAs including mutations and rearrangements.

The potentials of this type of project are to obtain detailed knowledge of individuals genetic make-up, including genetic disposition to diseases and life expectancies. By 1997 several genetic diseases have been typed and allocated to their different genetic locations on the human 22 autosomes and the sex chromosomes (Fig 7). This therefore summarises the result of scientific collaborations between Europe, USA, Canada and Australia, signifying the importance of applying biological techniques in the study of disease predisposition of all living organisms in their various environments.

APPLICABLE BIOTECHNOLOGIES

Biotechnology in Disease diagnosis

In genetic studies, genes influencing cellular metabolism cause normal or abnormal development, conditions that are viable or lethal, low or high productivity and all other variations in the living organism. In the study of pharmacogenetics, genetic differences in sensitivity to certain drugs have been very important in man. For example the defficiency of the enzyme glucose-6-phosphate dehydrogenase have been implicated in such people who develop haemolytic anaemia when given primaquine one of the drugs used to combat malaria. Genetic variation in biochemical processes have been used in identification of parentage in doubtful cases, while differences in blood antigens have similarly been used in genotyping cattle breeds for genetic identity, disease resistance and genetic tolerance to harsh and stressful ecological conditions.

In this wise between 1986 and 1987 under the CommonWealth Fellowship programme I was involved in the evaluation of responses of cattle breeds to antigenic challenges on the basis of their allotypic inheritance from their sire breed. In our report (Adebambo, Simpson, Glass, Williams, Spooner, Oliver and Morgan 1992), genetic and allelic variation to the antigenic challenges were discovered (thus confirming the importance of genome analyses in genotyping genetic predisposition to various diseases (Fig 8).

Utilisation of Molecular Markers

The utilisation of Molecular markers which are generally phenotype neutral in effect as their detection is at molecular level and the markers behave in a codominant fashion i.e. all alleles can be detected in the population unlike morphological markers which are subject to dominant, recessive and epistatic interactions, is now a widely accepted norm in animal breeding propositions. It's utilization allows the detection of heterozygotes in the population. This is of great significance in the study of genetic disposition to various diseases where homozygotes are difficult to differentiate from heterozygotes. Selection is more accurate and it's use at earlier

age of the animal affords the breeder the opportunity to reduce waiting time and hence reduce the generation interval. Animals could be selected for lifetime performance on the basis of electrophoretic banding patterns at 6 weeks of age. In most instances enzymes, proteins and randomly amplified polymorphic DNA have been effectively utilised.

In the utilisation of this methodology, we genotyped cattle and pig breeds for their blood protein segregation patterns (Adebambo, Ross and Spooner 2000), the polymorphic banding patterns of serum and plasma proteins are found to be genetic in the 550 Hereford cattle and 8 pig litters typed using the one and two dimensional agarose/acrylamide electrophoretic systems While the plasma polymorphic proteins -Transferrin and Albumin found to be linked with tolerance to climatic and nutritional stress conditions in cattle, the Transferrins and Post Albumins were found to be associated with meatiness and growth in pigs (Table 41 and 42).

Table 41: Frequency of plasma protein types in British Hereford cattle breeds.

Transferrins (TF)		Post Transferrins (PTf2)		Albumin(Alb)		Post albumin (PAlb)	
Types	Frequency	Types	Frequency	Types	Frequency	Types	Frequency
A	0.170	F	.714	A	.961	A	.0429
D_1	0.045	S	.0554	B	.00018	B	.0637
D_2	0.140	FS	.313	AB	.0376	AB	.204
E	-	No band	.0250			No Band	.170
AD_1	0.198						
AD_2	0.215						
AE	.045						
D_1D_2	.132						
D_1E	.028						
D_2E	.028						

Source: Adebambo et. al. 2000

Table 42: Inheritance of protein types in pigs.

	PGD	PHI	TF	PO_2
Boar type	AB	BB	AB	FS
Sow type	AB	BB	AB	F
Piglet type	AB	BB	A	S
Frequency	0.05	1.00	0.166	0.33
Piglet type	A	-	AB	F
Frequency	0.33	-	0.116	0.33
Piglet type	B	-	B	FS

Frequency	0.166	-	0.67	0.33

Source: Adebambo et. al. 2000
PDG:phosphogluconate dehydrogenase; GPI: Glucose-6-phosphate isomerase or phosphohexose isomerase; TF: Transferrin; PO_2: post-albumin 2

Species differences in number of postulated genes were also reported in animal breeds, each specie exhibiting different protein bands with varying staining intensities in agarose or acylamide gels. The most extensively studied and which is of significant relevance to tropical countries are the Beta-globulin or transferrin locus and the blood group loci which are now being routinely used for parentage testing, pedigree registration and breed characterization. Using this system it is possible to detect wrong parentage and correlate traits in 95-98% of cases tested, animals could be typed as early as 4 weeks of age, the system is very cheap and highly reproducible and it is of current use in several countries for animal selection and breeding purposes.

ANIMAL DIVERSITY STUDIES

Until 1988, analysis of DNA polymorphism was limited to the characterization of Restriction Fragment Length Polymorphisms (RFLPs) (Georges, et. al. 1990). With the introduction of the Polymerase Chain Reaction (PCR) (Saiki, et. al. 1985), the analyses of polymorphisms based on length variations in tandemly repeated sequences became popular. These are termed Variable Number of Tandem Repeats (VNTRs) and Simple Tamdem Repeats (STRs). Nearly 23% of the genome in higher animals consist of repetitive sequence of DNA identified as Micro, Mini, Midi and Macro Satellites (Perret, et. al. 1990).

RFLPs have been used extensively to reveal polymorphism in DNA and to characterize populations of a variety of microbial, plant and animal species (Anderson and Fairbanks, 1990; Karl, et. al. 1992; Megnegnean, et. al. 1993). RFLPs occur frequently, follow Mendelian inheritance and are detected in co-dominant fashion. As coding sequences, they are conserved between species, i.e. probes derived from one species can usually be used to detect polymorphism in another species, nevertheless, RFLPs have not been used extensively for livestock genome mapping. They are expensive to develop, have limited number of alleles with low heterozygosity and polymorphic information content (PIC) which is the measure of the usefulness of a marker for linkage studies. VNTRs on the other hand are repeated throughout the genome, are highly polymorphic, the PIC is generally higher than for RFLPs, however, VNTRs, generally termed minisatellites, are longer than micro-satellites (15-60 bps) and differ in their genome distribution. In cattle, VNTRs are clustered in the telomeric region of the chromosomes (Royle, et. al. 1988; Nakamura, et. al. 1988), whereas, microsatellites appear to be distributed throughout the genome (Weber and May, 1989). While Minisatellites, i.e. VNTRs are analysed by Southern blot as is the case with RFLPs, microsatellites are characterized by PCR amplification and polyacrylamide gel electrophoresis.

Use of Microsatellites.

Microsatellites are dinucleotide repeat sequences representing one of the most abundant families of interspersed repetitive DNA in the eukaryotic genome (Miesfield, et. al. 1981). The variation of a dinucleotide repeat unit in a malarial parasite antigen (Kemp, et. al. 1987; Weber, 1988) prompted the study of other (dA-dC)n (dG-dT)n, sequences, and it was found that the repeats are polymorphic and informative (Smeets, et. al. 1989). Based on the variability in length and shortness of repeat sequences they could be used as genetic markers. In 1989, three groups of workers simultaneously discovered that microsatellites are highly polymophic in eukaryotic genomes (Litt and Luty 1989; Tautz 1989; Weber and May 1989), that they show site-specific length variation and have on the average PIC of 0.61 which makes them versatile markers for genome mapping. PIC calculated from the alleles frequencies in the population is found to be positively correlated with the length of repeat. For longer repeats more alleles are expected (Weber 1990a; Hazan, et. al. 1992).

Even though no specific function has been assigned to micro-satellite sequences, they have proved to be efficient markers for the mapping of economic trait loci (Georges, et. al. 1994) and disease genes in animals (Holmes, 1994). The use of these markers for parentage determination (Glowatzki-Mullis, et. al. 1995; Usha, et. al. 1995) and evolutionary studies (McHugh, et. al. 1994) has also been suggested. These markers have proved to be of great use for population, ecological genetic studies, gene mapping and medical genetics and are therefore currently the favoured markers in human and animal genetic research.

Comparative genome analysis

The map of the human genome is more extensive than those of other species and contains considerable number of genes whose products and functions are known. Comparison of genomic maps between species reveals large regions that are conserved in term of the genes present and their order, i.e. conservation of syntheny (Womack and Moll 1986; Womack 1987). This suggests that the knowledge obtained through the study of one species can be used to predict the location of loci in another and thus speed up the mapping procedure (Pepin, et. al. 1995). Alignment of the regions conserved between man and cattle enables information from human maps to be used in cattle studies. For example, homologies of genes found on the short arm of human chromosome 11 (11p) and on mouse chromosomes 2 and 7 are found on chromosome 15 in cattle (Fries, et. al. 1993). Others are the high degree of conservation of genes on human chromosomes 9 and 12 which are highly conserved in cattle chromosomes 8 and 5 (O'Brien 1991; Barendse, et. al. 1994) and the same genes are also found on 3 mouse chromosomes (Threadgill and Womack, 1990a, & b). A special aspect of comparative mapping is the high degree of karyotype conservation in the bovidae (Gallagher and Womack, 1992). Mapping several genes in cattle, sheep and goats revealed that homologous genes usually map to karyotypically homologous chromosome regions (Hediger, et. al. 1991). Because of the conservation of synteny between bovine and ovine sequences, primers used to detect microsatellite polymorphisms in cattle are often directly used to reveal polymorphisms in sheep and vice versa (Moore, et. al. 1991).

Hence this study has its main objective in using microsatellites applicable to cattle recommended by the International Cattle Genome Mapping Group to study genetic diversity in Nigeria's cattle, sheep and goat breeds.

The structure and variation of the bovine genome

The bovine diploid genome consists of approximately 6,000 million base pairs of DNA, distributed over 29 pairs of acrocentric autosomal and a pair of sex chromosomes (Gallagher and Womack, 1992). In addition, the mitochondrial genome is approximately 16,500 bp (Anderson, et. al. 1982). It is estimated that between 50,000 and 100,000 pairs of genes are encoded by the bovine genome of which about 300 have been mapped to chromosomes (O'Brien, et. al. 1993a). The average bovine chromosome is approximately 100 million base pairs long containing 2,000 to 5,000 genes which consist of coding sequences known as exons, interrupted by intervening sequences referred to as introns (Watson, et. al. 1992). Only about 5% of the genome is thought to actually code for proteins, rRNA, and tRNA (Caskey, et. al. 1989; Cunningham, 1990). The remaining 95% of the DNA consist of various non-coding sequences (Jellinek and Schmidt, 1982). The complement of genes in the genome is the blue print that determines the genetic make up of the animal. The molecular structure of the genome offers a powerful insight into the characteristics of the organism as the blue print of its structure and function. At the nucleotide level, there are variants practically at every locus. These variations constitute the so-called genetic polymorphism. To date, over 1,000 polymorphic loci have been identified in the bovine genome (Bishop, et. al. 1994; Georges, et. al. 1995). The nucleotide sequences of coding genes are fairly conserved and therefore show less polymorphism than the non-coding introns and the intergenic regions (O'Brien, 1991). The non-coding regions are often repetitive sequences and are generally very polymorphic. It has been estimated that the genomes of two individuals vary by at least one nucleotide in every 300-1000 bp on average (Cooper, et. al. 1985). A large proportion of these sequence variants (30-40%) have been shown to occur as single base changes (Barker, et. al. 1984) or as variations in the number and type of repeat sequences. It is these polymorphisms that form the molecular basis of DNA genotyping.

Diversity Studies

The strong emphasis placed on production and specialization of breeds in developed countries has favoured the prevalence of some breeds. This process has markedly accelerated the introduction of Artificial Insemination and increased exchange of breeding stocks between regions. Consequently, concern about the reduction of genetic diversity in terms of breeds and strains has been expressed leading to FAO's concerted efforts in the 1980's to preserve the genetic diversity of cattle breeds (FAO, 1981).

Genetic Diversity of Nigeria's ruminant breeds.

It is on record that Nigeria's livestock breeds in general and the ruminants in particular are essentially localized and hence are difficult to rear in areas outside their ecological niche. Genotyping the various breeds is expected to reveal the genetic diversity and degree of differentiation of the breeds as pure or cross breeds.
In our genetic diversity studies,blood samples were collected from 249 unrelated cattle, 61 sheep and 78 goats from Oyo, Ogun, Lagos, Osun, Kwara, Plateau and Kaduna States of Nigeria (Table 43).

Table 43: Animals used on diversity studies.

Cattle	Sheep	Goats

Breed	*No*	*Breed*	*No*	*Breed*	*No*
N'Dama	76	**Yankassa**	39	Maradi	61
Bunaji	63	Balami	4	WAD	13
N'Dama X Bunaji	6	Uda	6	Maradi X WAD Cross	4
Gudali	6	WAD	6		
Wadara	16	Merino	2		
Holstein	20	UdaxYankassa Crosses	4		
Holstein x Bunaji (F_1)	39				
Holstein x Bunaji (F_2)	20				
Hostein x Wadara	3				
Total	**249**		**61**		**78**

Source: Adebambo et.al. 1998,1999,2000.

Table 44: Primers used, their sequences and marker alleles found in Nigeria's cattle, sheep and goat breeds.

S/N	Marker	CHR /DYE	PRIMER SEQUENCES	SPECIES	ALL SIZE	ALL NO
1	ETH 225 (D9S1)	9 FAM	GATCACCTTGCCACTATTTCCT ACATGACAGCCAGCTGCTACT	CAT (SH	139-161 132-154	20 17
2	INRA 35 (D16S11)	16 TET	ATCCTTTGCAGCCTCCACATTG TTGTGCTTTATGACACTATCCG	CAT (SH)	104-127 106-122	17 10
3	ILSTS 5 (D10S25)	10 TET	GGAAGCAATGAAATCTATAGCC TGTTCTGTGAGTTTGTAAAGC	CAT (SH)	181-196 189-204	12 16
4	ETH 152 (D5S3)	5 FAM	TACTGGTAGGGCAGGCTGCCTG GAGACCTCAGGGTTGGTGATCAG	CAT (SH)	179-205 190-205	16 11
5	ETH 10-2 (D5S3)	5 FAM	GTTCAGGACTGGCCCTGCTAACA CCTCCAGCCCACTTTCTCTTCTC	CAT (SH)	199-226 206-214	19 9
6	INRA 63 (D18S5)	18 HEX	ATTTGCACAAGCTAAATCTAACC AAACCACAGAAATGCTTGGAAG	CAT (SH)	176-197 162-182	17 12
7	INRA 5-2 (D12S4)	12 HEX	CAATCTGCATGAAGTATAAATAT CTTCAGGCATACCCTACACC	CAT (SH)	110-179	31
8	HEL 9 (D8S4)	8 FAM	CCCATTCAGTCTTCAGAGGT CACATCCATGTTCTCACCAC	CAT (SH)	149-171 94-108	21 4
9	HEL 1 (D15S10)	15 TET	CAACAGCTATTTAACAAGGA AGGCTACAGTCCATGGGATT	CAT (SH)	101-125 107-157	22 24
10	CSSM 66 (D14S31)	14 TET	ACACAAATCCTTTCTGCCAGCTGA AATTTAATGCACTGAGGAGCTTGG	CAT (SH)	179-200 173-213	20 22
11	MM 12 (D9S20)	9 HEX	CAAGACAGGTGTTTCAATCT ATCGACTCTGGGGATGATGT	CAT (SH)	105-164 83-102	26 11
12	ETH 3 (D19S2)	19 FAM	GAACCTGCCTCTCCTGCATTGG ACTCTGCCTGTGGCCAAGTAGG	CAT (SH)	103-131 96-119	21 17
13	BM 2113 (D2S26)	2 FAM	GCTGCCTTCTACCAAATACCC CTTCCTGAGAGAAGCAACACC	CAT (SH)	124-147 124-160	16 16
14	BM 1824	1 TET	GAGCAAGGTGTTTTTCCAATC	CAT	180-199	12

	(D1S34)		CATTCTCCAACTTCTTCCTTG	(SH)	162-183	12
15	CSRM 60 (D10S5)	10 HEX	AAGATGTGATCCAAGAGAGAGGCA AGGACCAGATCGTGAAAGGCATAG	CAT (SH)	91-108 77-95	15 10
16	ILSTS 6 (D7S8)	7 FAM	TGTCTGTATTTCTGCTGTGG ACACGGAAGCGATCTAAACG	CAT (SH)	285-306	17
17	TGLA 122 (D21S6)	21 HEX	CCCTCCTCCAGGTAAATCAGC AATCACATGGCAAATAAGTACATAC	CAT (SH)	134-167 135-158	20 15
18	HEL 13 (D11S15)	11 TET	TAAGGACTTGAGATAAGGAG CCATCTACCTCCATCTTAAC	CAT (SH)	184-196	10
19	SPS 115 (D15)	15 FAM	AAAGTGACACAACAGCTTCTCCAG AACGAGTGTCCTAGTTTGGCTGTG	CAT (SH)	244-260 234-268	14 9
20	TGLA 126 (D20S1)	20 HEX	CTAATTTAGAATGAGAGAGGCTTCT TTGGTCTCTATTCTCTGAATATTCC	CAT (SH)	112-128 113-134	15 14
21	TGLA 226 (D2S6)	2 TET	AGTGGAATCCAGATAAGATGTATCA ACATGAAAAGAAGCAATATCGTAAC	CAT (SH)	126-158	18
22	HAUT 24 (D22S26)	22 TET	CTCTCTGCCTTTGTCCCTGT AATACACTTTAGGAGAAAAATA	CAT (SH)	100-134	34
23	BM 1818 (D23S21)	23 TET	AGCTGGGAATATAACCAAAGG AGTGCTTTCAAGGTCCATGC	CAT (SH)	209-275 261-279	24 11
24	TGLA 53 (D16S3)	16 TET	GCTTTCAGAAATAGTTTGCATTCA ATCTTCACATGATATTACAGCAGA	CAT (SH)	143-186 147-167	34 20
25	INRA 37 (D10S 12)	10 FAM	GATCCTGCTTATATTTAACCAC AAAATTCCATGGAGAGAGAAAC	CAT (SH)	100-140 109-141	29 18
26	HAUT 27 (D26S21)	26 FAM	TTTTATGTTCATTTTTTGACTGG AACTGCTGAAATCTCCATCTTA	CAT (SH)	143-164	20

All loci amplified were found to be polymorphic in the breeds generating a total of 520 alleles in cattle from 249 animals, 286 alleles in the sheep breeds from 61 animals and 280 alleles in the goat breeds from 78 animals. Out of the 30 markers used, 26 amplified the cattle genome, 20 the sheep and 21 the goats genome respectively.

The total number of alleles detected ranged from 12 in ILSTS 5 to 34 in TGLA 53 among the cattle breeds; 2 in INRA 35 to 22 in CSSM 66 in the sheep breeds whilst 4 were found in INRA 35 to 16 in CSSM 66 among the goat breeds. The mean number of alleles varied from 3.77 in the NDBU cross to 14.77 in the BU among the cattle breeds, 2.85 in the Me to 11.55 in the Yank sheep and 3.54 in the MAWA crosses to 10.57 in the MAR goats. Average heterozygosity varied from 0.50 to 0.70 in cattle, 0.57 to 0.77 in the sheep and 0.46 to 0.58 in the goats.

Table 45: Mean No. of Marker alleles discovered among Nigeria's cattle, sheep and goat breeds.

	Breeds	N	BU	NDBU	GUD	WAR	HF	$HBUF_1$	$HBUF_2$	HWAR
Cattle	No	76	63	6	6	16	20	39	20	3
	Allele No	14.77	10.73	3.77	4.06	8.23	7.73	10.92	8.42	3.69
	Heterozyg	0.53	0.62	0.50	0.62	0.59	0.61	0.66	0.64	0.70

	Breeds	Yank	Bal.	Uda	WAD	ME	U/Yxes
	No	39	4	6	6	2	4

Sheep	Allele No	11.5	3.9	5.85	5.05	2.85	4.6
	Heterozyg	0.57	0.61	0.68	0.58	0.72	0.65

	Breeds	MAR	WAD	MAWA
Goat	No	61	13	4
	Allele No	10.57	6.52	3.57
	Heterozygosity	0.46	0.55	0.49

.Source: Adebambo et.al. 1998.

The genetic distance ranged from 0.43 between Ndama and Bunaji cattle to 1.25 between the Holstein and the Gudali. The Ndama and the Ndama x Bunaji crosses were found to be closer to HF_1 with DS of 0.38 and 0.56 respectively while the Gudali was similarly closer to the Wadara and the F_1 with DS of 0.59 and 0.58 whilst the DS between the Wadara and F_1 was 0.34 that between HF and the F_2 is 0.28 and the F_1 to F_2 was 0.293. Although the DS between the Bunaji to Gudali was 0.42 and to Wadara was 0.18 the DS to Holstein was 0.83 dropping closer when crossed to the Holstein as F_1 (DS-0.25) the distance was further widened at the F_2 (DS 0.45). In other words, the Northern breeds BU, GUD and WAD appeared genetically close together and very far from the exotic Holstein by the values of 0.83, 1.25 and 0.90 respectively. Among the sheep breeds the Genetic distances were 0.43 and 0.47 respectively between Balami and Uda and the Balami and the Yankassa. This Northern breed is genetically distant from the Merino and the WAD with values of DS 0.80 and 0.67 respectively whilst the Uda was 0.53 from the WAD it was 0.74 from the Merino just as the WAD was similarly 0.71 from the Merino.

Table 46: Genetic distances between Nigeria's cattle breeds and crosses.

N'Dama							
Bunaji	0.4255						
N'Dama x Bunaji	0.4175	0.4338					
Gudali	1.0484	0.4200	1.0423				
Wadara	0.5169	0.1826	0.5970	0.5912			
Holstein	0.7990	0.0825	0.9263	1.2537	0.9080		
Holstein x Bunaji (F1)	0.3759	0.2526	0.5617	0.5825	0.3390	0.5041	
Holstein x Bunaji (F2)	0.5084	0.4521	0.6224	0.8182	0.5417	0.2859	0.2931
Wadara x Hoeltein	0.5910	0.4430	0.7956	0.7796	0.5176	0.9965	0.5093	0.5693

Source: Adebambo et.al. 1998.

Table 47: Genetic distances between Nigeria's sheep breeds and crosses.

Yankassa				
Balami	0.4761			
UDA	0.3561	0.4335		
West African Dwarf	0.4318	0.6652	0.5343	
Merino	0.5597	0.8047	0.7425	0.7136

UDA x Yankassa Crosses	0.3874	0.6126	0.3491	0.661	0.5321

Source: Adebambo et.al. 1999.

On the other hand the Maradi showed proximity to the WAD goat with DS value of 0.39 while keeping its distance genetically from the crossbreds (MAR and AngloNubian) with values of 0.725 and the WAD to crosses with value 0.718.

Table 48: Genetic distances between Nigeria's goat breeds.

Maradi		
West African Dwarf	0.3886	
Crossbreds	0.7254	0.7179

The high bootstrap values and the cluster arrangement of the breeds showed their ecological distribution and the degree of diversity and adaptability of the breeds to their different zones of origin (Fig 9 – 11). The Uda and Balami which are basically Northern sheep breeds formed a cluster with 65% bootstrap value, just like the Bunaji, Wadara and Gudali cattle breeds clustered with 87% value, genetically further away from the exotic Holstein breeds, it's croses with Nigerian breeds and the Southern cattle breeds.

The high degree of polymorphism, allelic differences, percent heterozygosity and cluster arrangement of the breeds demonstrate the importance of genomic characterisation in breed development. Whilst large number of polymorphic loci were found both in the purebred locals and the exotics, many alleles were lost during crossbred formation. These lost alleles might eventually be found to confer some degree of major significance in ruminant breed development. The average allele number was higher in the Ndama (14.77) than all the other Northern breeds of cattle although the degree of heterozygosity (DOH) was lower (0.53). The average allele number was similarly higher in the Yankassa sheep (11.5) though with a corresponding lower DOH value of 0.57. Similar result emanated from the Maradi goat with 10.57 average allele number, yet with a lower DOH value of 0.46. Whilst monomorphic genes tend to increase homozygosity, thereby inducing no genetic variation among breeds, polymorphic genes are expected to induce genetic variation in animal breeds, particularly in a cross and so it is expected that the utilization of polymorphic genes will be valuable in genotyping quantitative traits for improved performance in these animal species.

This study has thus revealed the diverse nature of Nigeria's ruminant species, strongly emphasizing their genetic differences and hence the extent to which the breeds can adapt in areas outside their zone of descent. The polymorphic nature of the genes also go to confirm that the genes could be manipulated for selection and improvement of the breeds.

The comparative result with the allele sizes on the Cattle Diversity Database (Cattle Diversity Index Roslin Institute 1996) showed wide variation between allele sizes of Bos Indicus of India and the Bos taurus of European origin compared to those of the animals in this study. Many alleles were found outside the range of alleles reported for the different loci typed. For example, the locus ILSTS 5 (D10 S25) on chromosome 10, the Bos taurus had allele range of 184 – 186, the Indian Bos indicus (i.e. the ruminant species. Butana, Hariana and the Tharparka) ranged from 182 – 190 whilst in this study the range was 181 – 195 for the cattle breeds, 189 – 204 for

the sheep breeds and 179 – 194 for the goat breeds. Thus confirming further the diverse nature of Nigeria's ruminant species (Table 49).

The DNA based technologies are now of practical significance in livestock breed development and human genetic screening both in parentage testing, forensic analysis and assessment of genetic relationships.

Parentage control

Microsatellite markers have been suggested as an alternative to blood typing for parentage determination in cattle, goat, pigs and dogs (Glowatzki-Mullis et.al. 1995, Amigues et.al. 1994, Hohenhorst et.al.1994, Usha et.al.1995). DNA typing in cattle was considered first in 1993 in the international comparison test when panel of markers and techniques involved in bovine parternity tests were compared between laboratories but with poor results. Considerable progress has since been achieved in the automation of bovine parternity testing with microsatellites using fluorescent technology(Valkan et.al.1994;Glowatzki-Mullis et.al. 1995).

In addition to our diversity studies, I was opportuned to utilize some genetic markers in parternity testing among some cattle breeds (Adebambo and Williams 1997), 5 genetic marlers were selected from panel of microsatellite markers on the basis of their polymorphism and ease of genotyping. These are the markers coding for the gene for steroid 21-hydroxylase (CYP21), a microsatellite with repeat sequence stretch of $(CA)_{20}$ dinucleotides on chromosome 23 (Fries et.al. 1986) have been used in pedigree verification, also the beta subunit of the follicle stimulating hormone FSHβ which has a stretch of $(AT)_{20}$ repeat is also found to be polymorphic. These are found to be microsatellites within the gene coding for the Bovine Major Histocompatibility Complex (MHC) gene Class II antigen DRβ3. The DRβ3 microsatellite is composed of three repeat motifs, a stretch of at least 10 uninterrupted (TG)n dinuclotides, a long but interrupted stretch of (GA)n dinucleotides and a few (CAGA)n tetranucleotides (Ellegren et.al. 1993). These two, together with the anonymous sequences D21S4 (ETH131) with (CA) 23 dinucleotide repeats and IDVGA 37 were chosen as markers of choice for parternity testing (Table 51).

Efficiency of parentage testing usually increases with the number of loci tested and the number and frequency of alleles at each locus. Regions containing microsatellite repeats were amplified by Polymerase Chain Reactions carried out with an end-labelled primer γ^{33}PATP

Using this procedure it was possible to exclude one of the calves as not being of the same allele with his parents at the IDVGA37, FSHβ and the CYP21 loci.

DNA based technologies have been introduced in forensic medicine (Jeffreys et.al. 1991, Wenk et.al. 1992) because of large numbers of DNA polymorphisms present in the genome which allows large number of loci to be used with higher precision of parentage determination. DNA typing methods theoretically have been found to achieve a better than 99.9% probability of exclusion of incorrect parentage and offer a high level of precision in individual identification (Vakan et.al. 1994; Usha et.al. 1995). Where blood can not be used, for example, in disease outbreaks such as in foot and mouth (FMD), sources of DNA other than the blood such as

semen, meat or carcass can be used. Genotyping of dead individuals is also possible because DNA can be extracted from all formally living nucleated cells. The technology is not affected by age of animals, the DNA can be stored for unlimited period of time, thus allowing the establishment of DNA banks for animal genetic resources.

The Marks of a Veteran

The writer, David C. MacCalard in the2001 edition our Daily Bread a publication of the Radio Bible Class said and I quote "if your faithfulness to Christ has caused you to suffer you bear the marks of a true Veteran in His service".

In the Kingdom of God, it's not ribbons and stars but redemption and scars that set you apart as the real thing.

Apostle Paul listed the authenticity of his own Apostleship. He boasted not of his successes but of his sufferings. In like manner, I would boast of my mental anguish and spiritual exhaustion that seems so overwhelming when I considered what I had to endure to be what I am today. Having to sell kerosene, puff-puff, moin-moin, guineafowl eggs during the season and having to learn to sew at a tender age to be able to pay my school fees before Federal Government came to my rescue. Having to endure mental torture and hardship to see my pigs through before The Federal Ministry of Science and Technology through the intervention of Prof Emovon and the then Director of Agric Sciences late Mr Iyamabo stepped in and subsequently by the then Director of DFRRI Dr Larry Koinyan and the officer in charge of the Agric. Division, Alhaji Magaji. Having to sustain my present experimental poultry birds with more than ½ of my monthly salary is not so funny to remember. When I had to be told to sell off my animals because my projects are always too expensive and even when I was adviced to tell a lie on what I was doing so that developed nations would not ban Nigeria on international market, I continue to wonder whether those who are carrying out these fits outside Nigeria are double-headed monsters and not human beings like ourselves. For every opportunity I have had to acquire knowledge outside Nigeria, I have always tried to put in my best only to come back and be frustrated because Animal Breeding is not on the priority list of our national policy. Even when the World Bank assisted research grant of $75,000 was approved for my project , over $50,000 was never released by the national body.Yet through it all, I learnt to:

Trust in Jesus
Trust in God
Depend upon His love.

True followers of Jesus Christ, who suffer in His name will proudly bear the marks that come when His words are proclaimed.

We can never sacrifice too much for the one who gave His All for us. I have given my time, money and my all for the research I have presented here, for my students who are to be future breeders of tomorrow. I pray that they are able to step in and continue, whenever and wherever I happen to leave off. Our Lord Jesus in His respoinse to His disciples in John4: 31-32 when they urged Him saying "Rabbi, eat." He said to them "I have food to eat of which you do not know" My food is to do the will of Him who sent Me and to finish His work." Thus my food which I enjoyed most is to develop animal breeds for Nigeria all discouragement notwithstanding, I have been trained, I have been challenged as a breeder both withn and outside Nigeria, my God has given me the grace and at every opportunity has been proving Himself to back me up all the way. In Isaiah 26;12 it is written "Lord, You will established peace

for us, for You have also done all our works for us." If this is true as I believe that He is able to make me what He wants me to be, lie or no lie, frustration or no frustration, discouragement or no discouragement all I know is that Nigerians need food, our children need jobs, I will get their in Jesus Name.
Thank you and God bless you all.

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The new adage says "In front of every successful man, there is a woman – in essence it is logical to say behind every successful woman there is a man". I want to state here proudly and categorically that I have not seen a man behind me, BUT many men right from my youth, primary school days up till the moment. Men of good will, men of honour, kings and queens, foreigners and natives, for it is written "Kings shall be your foster fathers and their Queen your nursing mothers, foreigners shall built your walls, you shall call on nations that you do not know, nations that do not know you will run to you because of the Lord your God and of the Holy One of Israel for He has glorified you.

I see my aunties and uncles, late Mr. And Mrs. Soleye and of dearest memory, Mrs. Julianah Olabisi Soleye, a.k.a. Sisi Aba. Late Pa and Mrs. Arinola Aweni Solanke, late Mr. Ososanwo and Mrs Yetunde Ososanwo, Chief and Chief Mrs. Kehinde, Late Pa. Sojinrin, my first Headmaster who registered me and took me to school in infant one in january 1954 when my hand could hardly reach my ear not to talk of touching it and Mr Ayodele Okusaga, who led me in bible recitals at the St. Pauls Primary School, Makun Sagamu, where I had my primary education, Late Messrs Dada and "Onaeko". my principals at Remo Secondary School, Sagamu, where I was nurtured. Mr. And Mrs. John, Mr. and Mrs. Charcko, Mrs. Jones, who was the teacher and Boarding House Mistress, when I entered RSS and who first noticed from my dressing to the interview that I was a Joseph and more importantly, Mr. And Mrs. Koya. Mrs. Ososanwo and Mrs. Koya are my mothers who clothed me in the University, thank God, they are alive to witness this occasion in my life.

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All my lecturers at the University of Ibadan, from brother (Dr) Giwa (now Prof. Giwa) (PHY 001), Prof. Oguntoyinbo (Bioclimatology) from whom I learnt of the cumulus and the nimbus clouds,I remember you always when the clouds gather and for terribly long moments refuse to disperse and when on several occassions, they burst in mercy on my head. Prof. Adedipe, Prof. Adeniji, Professors Ngere, Oluyemi, Babatunde, Fetuga, all of you too numerous to mension. Late Prof. Taylor, who took me into IAR & T as Research Fellow 11, Late Prof. Olaloku, all my Directors and Colleagues during my sorjourn 1977 to 1993 at IAR & T, OAU. I say God bless you all.

Once again to Prof. Nimbe Adedipe and Prof. G.M. Babatunde, I pray that the Lord will reward you and your children abundantly for the part you both played in my life to bring me thus far.

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Profs. Okojie, Adu, Tayo as VC and DVCs I want to express my profoundl gratitude for bearing with me and my troubles. My friends and colleagues in Scotland right from 1982, the Jones, Stays, Reemi, my supervisors, Dr. Roger Spooner and his wife Nikky at the Institute of Animal Physiology and Genetic Research, Dr. John Williams at the Roslin Institute, the Urquharts, Liz Glass, Sarah Blott and other colleagues at the Roslin Institute, Scotland, ILRI, Ethiopia and the University of Vet Med. Hungary.

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O, you men of goodwill of the University of Agriculture, Abeokuta, my colleagues at the College of Animal Science, staff and students of the Department of Animal Breeding and Genetics, my wonderful students, collaborators and achievers on the poultry breeding project, you are all great and wonderful for we have planted and have waited patiently to harvest a hundred fold,whatever is the thought of anybody concerning this project, this will be our portion in Jesus Name.

May the Lord bless you all out of Zion. May you see and eat the good of Nigeria all the days of your life in Jesus Name (Amen).

Mr. Chairman, sir, members of University Management, members of University Council, my stately colleagues, my glorious students, Great Unaabites, my spiritual leaders, Pastor and Pastor (Mrs) Ola-Obaju, Rev. & Rev. (Mrs) Amosun, you are all worthy of my special thanks. Members of Adebambo family, thank you all. My in-laws, Chief and Chief (Mrs) Pearse, Mr and Mrs Adepoju my wonderful daughters, Ife-Olorunbode and Olufunwamilayo, and all my prospective in-laws, sons and daughter, I am sincerely grateful to you all. The only surviving fullsib of my mother, Mrs Adeleke, all my cousins, Mrs Aremus, the Adelekes, Solankes, Kehindes and my sisters, Mrs Akande and Kosoko, May the good Lord bless you all.

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"THANKS BE TO GOD 2ce
FOR HE HAS DONE ALL THINGS WELL,
HE MADE ALL THINGS BEAUTIFUL IN HIS OWN TIME,
HE HAS DONE ALL THINGS WELL."

"ARA EDIDE E BA MI JO,
ENIA MI E BA MI YO,
OLUWA MI LOGBE MI GA."

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