Unconventional feed resources for livestock development and food security: paradigms for Nigerian livestock industry

Delivered on
Wednesday, 24th of June, 2009

By PROFESSOR BABINGTON
ONYEMAECHI ESONU,
B. Agric. Tech. (Hons.), M.Sc. Ph.D (FUTO)
Professor of Animal Nutrition,
Department of Animal Science & Technology
Federal University of Technology,
Owerri (FUTO), Imo State.

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Prof. B. O. Esonu

Prof. BABINTON ONYEMAECHI ESONU,
MASAN, MAITI, MASAN

INAUGURAL LECTURER
UNCONVENTIONAL FEED RESOURCES FOR LIVESTOCK DEVELOPMENT AND FOOD SECURITY: PARADIGMS FROM NIGERIAN LIVESTOCK INDUSTRY.

14th Inaugural Lecture of the Federal University of Technology, Owerri (FUTO), Imo State

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Prof. BABINGTONONYEMAECHI ESONU,
B.Agric. Tech (Hons.), M.Sc. Ph.D (FUTO) MNSAP,
MASAN, MASN, MASAS
Professor of Animal Nutrition
Department of Animal Science & Technology,
School of Agriculture and Agricultural Technology
Federal University of Technology, Owerri (FUTO), Imo State.
The Vice Chancellor,
Deputy Vice Chancellor, Academic
Deputy Vice Chancellor, Administration
Other Principal Officers of the University
Members of the University Governing Council,
Deans of Schools and Directors of Units
Heads of Departments
My Lord Spiritual and Temporal
Fellow Academic and Professional Colleagues
Distinguished Guests and friends of the University
The President, FUTO Alumni Association and Alumni Members
Great FUTOITES
Gentlemen of the Press
Ladies and Gentlemen.
INTRODUCTION

It is my great delight and privilege to present this day, 24th June, 2009, the 14th Inaugural lecture of the Federal University of Technology, Owerri, 22 years after obtaining my first degree from this citadel of learning in 1987, and also the 2nd FUTO Alumnus to be promoted to the rank of professor. It is the 4th inaugural lecture from the School of Agriculture and Agricultural Technology of this University and the 3rd from Department of Animal Science and Technology following Professors A. B. I. Udededie, a renowned nutritionist and former Deputy Vice Chancellor (Academic) of FUTO and Professor M.U. Iloje an erudite scholar and also former Deputy Vice Chancellor (Academic) of FUTO and the first staff to be promoted to the rank of Professor in the Department. I am happy today that I am giving a lecture on the history of my research spanning twenty-two (22) years as I look back to 15th October, 1984 with nostalgia. It was the day I arrived at FUTO, Lake Nwaebere campus, to register as an undergraduate student in the Department of Animal Production, School of Agriculture and Agricultural Technology (SAAT).


The aim of this lecture is to enlighten my audience on the uniqueness of the livestock industry, especially its economic viability, food security and to present my modest contributions to the academic and practical advancement of the industry to date. This lecture will be presented under the following headings:

- Animal Science as a profession
- Overview of principles of Animal Nutrition
- Problems Associated with Animal Agriculture
- Prospects of Animal Agriculture in Nigeria
- Food insecurity
- Livestock development and animal protein intake situation in
PREAMBLE

I wish to start this lecture with a prayer to the Almighty God, the Great I Am That I Am, Immortal, Invisible, the only wise God whose glory fills the heavens and the earth to receive all the honour, praises and thanksgiving for this day you have made for us to rejoice and glorify your name. Please see us through this lecture joyfully by your mercy and might in Jesus name, Amen.
Nigeria

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Conventional feed resources
Unconventional resources
My modest contribution to knowledge
Conclusion and Recommendation
Tributes and Acknowledgement
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ANIMAL SCIENCE AS A PROFESSION

Animal Science is what is also referred to as Animal agriculture. This is the application of many aspects of biological science, behavioural science, physical science, environmental science and Agricultural Engineering to produce food and companion animals that meet man’s nutritional, social, companionship and to some extent labour requirements. Animal science also plays a significant role in food security of a nation. Food security is defined as having enough food in quantity and quality and the poorest people having access to it. There is abundant scientific evidence that animal proteins have superior quality in terms of biological values when compared with vegetable proteins (or proteins of plant origin).

While carbohydrates act as important fuel for the body, proteins are the building blocks of the body and the actual life of living things. Animal science is therefore a high technology science comprised mainly of Animal Breeding and genetics. Animal Nutrition, Animal Products Technology, Animal Reproductive Physiology, Range and Pasture Management, Animal Behaviour and Bionemins and Animal Housing and Welfare (management).

Food animals produced through Animal Science include: poultry (chicken, turkey, duck, guinea fowl, Japanese quail, ostrich), swine, cattle, sheep, goat, fish, micro livestock such as grass cutter, snail, rabbit, giant rat, etc. Companion animals are: horse, donkey, dog and cat. Animal Science develops different breeds of these food and companion animals through scientific aggregation and manipulation of genes of economic trait or social merit and systemic feeding (nutrition regime). Continuous improvement in these have resulted in substantial cost savings for livestock farmer. For example, 50 years ago, 200 laying chickens were fed with 30kg of feed per day. Twenty-five (25) years later, the same number of chickens were fed 25kg of feed per day with improved performance in terms of number of eggs and egg quality. Today, with enzyme technology, 200 layers can be fed with 15kg of feed which will meet all the nutritional requirements with less adverse impact.
on the environment, as excreted phosphorous and nitrogen are minimal.

To qualify as an Animal Scientist, one must have a Bachelor of Agricultural Technology (B. Agric. Tech.) (Animal Science) or a B.Sc. Animal Science or B.Sc. Agric with specialization in Animal Science from a School or faculty of Agriculture of a recognized University.

Animal Science is taught in all Universities that offer Agriculture in Nigeria through a five (5)-year academic programme.

Here in Federal University of Technology, Owerri (FUTO), students generally offer University Courses in the first year of study irrespective of the Department or one's choice of course of study. These University courses are for Harmattan Semester: Elementary Mathematics I, General Physics I, General Chemistry I, Biology, Workshop Practice I, Engineering Drawing I, Use of English Language I and Humanities, and for Rain Semester, we have: Elementary Mathematics II, General Physics II, General Chemistry II, Workshop Practice II, Engineering Drawing II, Use of English Language II, Social Science and Science, Engineering and Technology in Society.


Third Year, First Semester: Farm Practice III, Agric Genetics, Introduction to Tropical Animal Health, Farm Management, Agric

The core courses in Animal Science are taken in the fourth and fifth years. In the 4th Year, we have: Farm Practice V, Animal Feed and Feeding II, Anatomy & Physiology of Farm Animals, Reprod. Physiol & Endocrinology of Livestock, Agricultural Planning & Development, Technical Report Writing.


OVERVIEW OF PRINCIPLES OF NUTRITION

What is Nutrition?

Nutrition is a subject that interests many casual readers simply because they must eat to live and because for most people eating and drinking are pleasurable social experiences. If one needs added incentives to become familiar with the subject, there is the profit motive if one is in the business of livestock production. Nutrition is defined as the nourishment of the body of plants and animals. It is also a function of living animals which consists of taking of food, tissues and other specific products which regulate the body by means of series of chemical reactions (Esonu, 2006). Nutrition in broad sense will include all those processes whereby food and oxygen are presented to and utilized by the living cells and unwanted products eliminated. The mechanisms of nutrition include: digestion, absorption, circulation, metabolism, respiration and excretion. Other nutrition related sciences include
physics, mathematics, genetics, cytology, microbiology, endocrinology, physiology, chemistry and biochemistry.

The feed eaten by an animal is broken down through digestion into six classes of nutrients, then absorbed into the body and used to build the tissues, organs and skeleton that make up the animal's body.

The term “feed nutrient” is applied to any feed constituent which may function in the nutritive support of animal life. Of the over 100 known chemical elements, at least 20 constitute the various essential feed nutrients. The elements are: carbon, hydrogen, oxygen, phosphorous, potassium, iodine, nitrogen, sulphur, calcium, iron, magnesium, sodium, chlorine, cobalt, copper, fluorine, manganese, zinc, molybdenum and selenium. It is probable that chromium, silicon, tin, vanadium and nickel are part of this group. These elements either alone or in various combinations make up what are known as the feed nutrients. Feed nutrients currently recognized are as follows:

**Carbohydrates:**

Carbohydrates contain carbon, hydrogen and oxygen with hydrogen and oxygen in the same proportion as in water. They consist largely of hexosans and pentosans, tetroses, trioses and dioses are also present sometimes but are not important. Carbohydrates supply mainly energy. Energy can be defined as the capacity to do work. It provides the driving force for all the biochemical reactions in the body. Energy is measured in kilocalories (kcal) or Megajoule (Mj).

The bulk of energy in monogastric animal ration is supplied by carbohydrates from grains such as maize, sorghum, millet and root crops such as yam, cassava, rice, potato, etc.

**Fats**

Fats contain carbon, hydrogen and oxygen with more carbon and hydrogen in proportion to oxygen than in carbohydrates. Fats contains 2.25 times as much energy per kilogramme than carbohydrates. Fats
commonly used in monogastric animal feeding include: palm oil, groundnut oil, soybean oil and tallow.

Protein
Proteins contain carbon, hydrogen, oxygen and nitrogen and sometimes iron, phosphorus and/or sulphur. Protein is the only macro-nutrient which contains nitrogen except for small amounts of lignin. Feed proteins on the average contain 16% nitrogen. Proteins are formed from 25 or more amino-acids. Protein is the basic structural materials from which all body tissues are formed, muscles, skins, nerves, blood cells, liver, hooves, horn, bone, etc. It is required for foetal development, egg and milk production. Body enzymes and hormones are basically proteins. It is important to note that no other nutrient can replace protein in the ration. Because of the animal’s numerous needs for protein and irreplaceable nature of protein, there is a certain minimum level of dietary recommendation for each class of animals depending on physiological, age and type of production. The most commonly used protein containing feedstuffs in Nigeria are: groundnut cake, soybean meal, cotton seed cake, palm kernel cake, blood meal, jackbean, mucuna bean meal, pigeon pea meal, etc.

Minerals
Among the twenty elements that function in animal nutrition, carbon, hydrogen, oxygen and nitrogen are regarded as the non-mineral elements. The other sixteen are referred to as the mineral elements. Of these, seven are macro, that is, they are required in relatively large amount and nine are micro, that is, they are required in very small or trace amount. The latter are referred to as the trace minerals. The macro minerals are: calcium, potassium, phosphorus, sodium, chlorine, magnesium and sulphur. The micro or trace minerals are: iron, iodine, copper, cobalt, fluorine, manganese, zinc, molybdenium and selenium. Bone meal, oyster shell and limestone are the most common sources of calcium and phosphorus in monogastric animal ration.
Vitamins
Vitamins are organic substances required by animals in very small amount for regulating various body processes towards normal health, growth, production and reproduction. They all contain carbon, hydrogen and oxygen. In addition, several vitamins contain nitrogen, some contain one or more of the mineral elements. There are sixteen or more vitamins that function in animal nutrition. Vitamins A, D, E, and K are fat soluble while the B vitamins are water soluble. Natural sources of vitamins for monogastric animals include green leaves, vegetables and fruits. The bulk of the vitamin supply in animal feeds are derived from adding a vitamin/mineral premix that is formulated to meet animal requirements.

Water
Water contains hydrogen and oxygen. Farm animals will consume from 3 to 8 times as much water as dry matter and will die from lack of it more quickly than from lack of any other nutrient. Water is found in all feeds, ranging from about 10% in dry feeds to over 80% in fresh forage. Water should be supplied daily, cold and clean.

PROBLEMS ASSOCIATED WITH ANIMAL AGRICULTURE
Some of the major problems facing animal agriculture in Nigeria include:

(a) The limited biological ability of the animals to grow and reproduce economically.
(b) The limited availability of productive resources like feed, water and suitable pasture.
(c) Ineffective veterinary services and limited availability of vaccines and drugs.
(d) Limited availability of capital or finance to support expansion programmes.
(e) Lack of skill and willingness of producers to utilize improved technology.
(f) The low profitability of the production enterprises.
The inability of our local breeds to produce economically has been a problem that has seriously affected animal agriculture in Nigeria. The indigenous cattle rarely yields over 120 kilogrammes of meat while the average for developing countries is 170 kilogrammes and an average of about 800 kilogrammes for developed countries. The situation is worse for milk production. Our indigenous breeds produce about 600 litres/lactation/animal as against the world average of 2,000 litres, while breeds in developed countries produce about 4,000 litres/lactation/animal. The situation is similar for the other livestock types.

Secondly, the issue of availability of suitable pasture all year round for cattle, sheep and goat and quality feed for poultry and pigs has remained a critical problem. This has exacerbated the yearly routine trekking of animals to the southern rain forest. The poultry and pig industry that improved considerably in the seventies and early eighties has also suffered great setbacks due to high cost and poor quality of available finished feeds.

The problem of effective veterinary drugs and vaccine has seriously affected animal agriculture. Veterinary drugs and vaccines are now scarce and when available the prices are exorbitant. The problems are more complex in the poultry sector with subsequent decline in productivity. There have been cases of disease outbreaks in flocks despite the fact that the birds were fully inoculated against the major diseases.

Finally, the limited availability of capital or finance for expansion programmes and the lack of skill to profitably produce and manage these animals are the other set of problems that affect animal agriculture in Nigeria. The provision of funds or loans through the various commercial banks and Government lending institutions needs to be increased to alleviate the problems associated with supply of capital or finance.
PROSPECTS OF ANIMAL AGRICULTURE IN NIGERIA

Animal agriculture in Nigeria will continue to face serious challenges which our policies and programmes will have to address in order to ensure that the national policy goal will remain undeterred. These include:

(a) the increasing instability in output, prices and income associated with animal agriculture due to vagaries of weather and disease outbreaks;
(b) the increasing competition between man, industry and livestock for grains emphasizing the need for development of non-conventional animal feeds, effective utilization of farm resources and agro by-products;
(c) the need for a technology breakthrough in animal nutrition and dairy processing to meet substantial deficits in dairy products in the country; and
(d) the increasing demands for granting of land use rights to the pastoralists as the various education and extension programmes are increasing their awareness and outlook.

Animal agriculture as is presently organized is not well developed to be left on its own. Physical infrastructure to support private producers such as markets, abattoirs, processing plants, ranches and dairy plants are either lacking, dilapidated or are at rudimentary stages. Extension and transfer of knowledge to traditional producers and many other key support services are still entirely provided by Government. Government should as a matter of urgency assist private entrepreneurs to develop domestic animals, feeds, drugs, vaccines and water. In this wise, government will champion the commercialization and/or the privatization of some aspects of animal agriculture especially vaccine production to ensure that the domestic demands for vaccines are met and possibly channeling surpluses to the export market.

2.0 FOOD INSECURITY

God in His infinite wisdom and power knew that the first challenge man will face on earth before his creation will be food insecurity and He
provided enough for man. “And God said let us make man in our image, after our likeness and let them have dominion over fish of the sea and over the fowl of the air and over the cattle and over all the earth and over every creeping thing that creepeth upon the earth”. And God said, “behold I have given you every herb bearing seed which is upon the face of all the earth and every tree in which is the fruit of a tree yielding seed to you, it shall be for meat. And to every beast of the earth and to every fowl of the air and to every thing that creepeth upon the earth wherein there is life, I have given every green herb for meat and it was so” Gen. 1:26-31; Gen. 2:29-30. However, because of the fall of man, in Genesis chapter three, these provisions eluded him and man now faced the grim realities of food insecurity”. And unto Adam God said “because thou hast hearkened unto the voice of thy wife and hast eaten of the tree of which I commended thee saying, Thou shall not eat of it, cursed is the ground for thy sake, in sorrow shalt thou eat of it all the days of thy life …. so God drove out the man and He placed at the east of the garden of Eden cherubims and a flaming sword which turned every way to keep the way of the tree of life”. Gen. 3:1-24. However, God in His love and amazing grace restored abundant spiritual food for man in His son Jesus Christ”. And Jesus said unto them “I am the bread of life, he that cometh to me shall never hunger and he that believeth on me shall never thirst”. John 6:35.

Hunger today remains the most devastating problem facing humanity. This is despite general improvement, not only in food availability, but in health and social services as well. One out of every five persons in Nigeria is chronically undernourished; millions of children suffer from protein energy malnutrition while many people experience micronutrients deficiencies. In addition, diet-related non-communicable diseases such as obesity, cardiovascular diseases, diabetes and some forms of cancer are fast emerging as public health problems in Nigeria and in many African countries.

In Nigeria and indeed Africa, the single most important problem today is the food crises, which precipitates hunger and malnutrition. This problem, no doubt is closely linked to economic and socio-political
factors, among others. Nigeria appears unable to tackle effectively the food problem without external assistance. Often emergency situation presents itself that calls for external intervention.

Poverty is the root cause of malnutrition in Nigeria and Africa. Acute and chronic malnutrition is rampant among the rural poor. Many households do not have access to enough food because of low purchasing power and they live in unsanitary environments without access to clean water and basic services. These people also lack access to appropriate education and information. On the other hand, over-nutrition and dietary imbalances, which can lead to diet-related non-communicable diseases cut across socio-economic boundaries, although historically increased prevalence of such conditions is related to rising affluence, stable food availability at the national, regional, community and household levels is the cornerstone of nutritional well being. At the household level, food security implies having physical and economic access to food that are adequate in terms of quality, quantity and safety. Often, this stability in food availability is not guaranteed. Seasonal fluctuations in food availability, post-harvest losses and unstable market prices are serious problems in Nigeria and Africa.

3.0 LIVESTOCK DEVELOPMENT AND ANIMAL PROTEIN INTAKE SITUATION IN NIGERIA

If one is to ask an American what he would have for lunch or dinner, the answer will be steak or chicken or fish. In contrast, if you ask a Nigerian the same question, the answer will be pounded yam or “eba or akpu” or tuwo or amala”. This shows that while the consumption of animal products is a regular part of the meal of an American, the Nigerian is much more worried about satisfying hunger. It is common knowledge that meals without any piece of meat are a regular diet for a large proportion of Nigerians.

It is therefore not surprising that available statistics shows that most Nigerians are malnourished particularly because animal protein intake is required for optimum physical and mental development.
The principal problem of the third millennium in the world particularly developing countries like Nigeria is the grim race between human population and human food supplies especially animal products. Sources of proteins of high biological value especially those of animal origin are limited and in recent years, the rate of population growth has aggravated this problem. From the practical point of view, there is no such thing as a world supply of food that can be distributed to different people of the world according to need. The solution has to come from the local population. For as long as man's protein needs have to be covered to the extent of 30–50% by food of animal origin, we must produce more animal products (meat, egg and milk) every year for the market, under the most favourable economic condition possible. As we are all aware, there is acute shortage of animal protein supply and intake in Nigeria. The recommended minimum daily animal protein intake of the average adult is 56gm (FAO, 1981). The daily per capita animal protein intake of Nigerians was estimated at 8.5gm in 1968 when most Nigerians were considered comparatively well fed. It declined to 6.5gm in 1980 and just about 6.0gm in 1988. It could be anything below 5.0gm now. These values which definitely represent less than 20% of the recommended minimum intake appropriately reflects the critical livestock products situation in the country.

The cultural and traditional systems of domestication and rearing of farm animals in Nigeria are as old as time but animal science as an economic potentiality to be depended upon to solve the farmer's need to significantly boost the national economy requires a little more critical survey. In Nigeria, certain factors militate against effective development of the livestock industry. The devastating drought in the Northern States limits the availability of herbage and forage crops. The southern states, on the other hand, are faced with the problems of rapid decline in nutritive value of forage crops, high cost of establishment, poor soil conservation and the farmer's inclination to grow more food crops than forage crops. The expense of supplementing forage grazing with concentrates is also a setback. The livestock business is an expensive proposition and requires a high initial capital, building, equipment,
purchase of initial stock, pasture establishment, feeding and management. There seems to be difficulty in translating research findings and improved technology into meaningful follow-up due to illiteracy.

There is the problem of poor marketing, which falls short of the required standards of an organized market for most livestock products like milk and meat due to their rapid deteriorating quality. Researchers have also recognized the following factors among the ones already mentioned as barriers to increased animal productivity in Nigeria. Accurate figures are not available but it is generally known that per capita livestock numbers are low. The genetic potentials are unexpected and as a result very few attempts have been made to seriously select and breed for economic traits. The problems of low productive rate of stock, slow growth rate and late maturity as well as small size at maturity are quite glaring. Livestock diseases which include foot and mouth disease, trypanosomiasis, rinderpest, etc also pose a serious problem to livestock production in Nigeria. The farming system in Nigeria is not yet integrated and this has resulted in unimproved systems of husbandry. There is the problem of inadequate numbers of suitably trained personnel at all levels in the fields of the livestock industry.

In addition, there is the serious problem of poor processing, preservation and distribution as well as seasonal scarcity of feed ingredients and water. The land tenure system in Nigeria and inadequate transportation facilities also add to the list of problems facing the livestock industry in Nigeria.

**WAY OUT**
Nigeria has about ............... hectares of arable land which have hardly been cultivated with our ever increasing population of more than 140 million. It should have at least 25 million crop and livestock farmers. If every farmer produces 5 broiler birds and 10 eggs/day, each citizen of Nigeria will have an egg and one chicken to eat a day, all things being equal.
As we know, there is underemployment as well as unemployment in Nigeria. The average Nigerian farmer does not work eight hours a day or 300 days a year. Therefore, he can easily devote up to 88 days a year required for cultivating an acre of land and raise his/her livestock farm without giving up whatever he/she is doing for a living at the moment. However, we cannot discuss animal protein sufficiency in Nigeria without looking at the plight of the poorest segment of our society which lacks virtually everything. Abundant animal products could be produced yet, a segment of the society remains malnourished and hungry. It has been rightly observed that the lack of ability to pay for needed animal products represents one of the fundamental stumbling blocks to the achievement of proper nutrition, that is animal protein sufficiency in Nigeria.

1. One of the ways of solving this problem is small scale animal production which will require improving land holding systems to ensure that every individual desirous to engage in animal production has a piece of land to farm on.
2. Increased real incentives which should be extended to the poor farmer to help him produce more thereby increasing his stock.
3. Adequate health programmes and facilities which should be provided to them to eradicate common diseases that prevent them from putting in their best in animal production.
4. Production and availability of high quality livestock feed at a relatively cheap cost.
5. Effective market system
6. Education and enlightenment.

4.0 FEEDSTUFFS OR FEED RESOURCES

Feedstuffs are plant and animal tissues which contain the food elements of livestock. Since they are nutrient carriers, it is necessary to know the composition, nature and form of each feedstuff used in formulating and compounding feeds, so as to know the yield and type of nutrients available from each quantity or source of feedstuffs. Classification of feedstuffs is based largely on the feed element which is preponderant in the feedstuff. For example, starchy concentrates contain a large
proportion of starch and may belong to a cereal (grain) or root-tuber sub
group. Oil seed cakes contain a large proportion of vegetable oil which
when extracted leaves a cake which is very high in vegetable protein.
Animal protein concentrates contain high amount of animal proteins
with a rich amino acid profile. In classifying feedstuffs, however,
attention is focused on those sources that yield a large quantity of the
desired nutrient with a minimum investment in resources.

In other words, those feedstuffs which provide the best and cheapest
sources of nutrients rank higher than those which have alternatives and
more expensive uses. Such considerations that determine the choice of
conventional feedstuffs can be summarized as follows:
(a) **Potency:** The highest yield of calories, proteins, vitamins or
minerals per unit area of land, capital, labour or time.
(b) **Competition:** A good feedstuff must not suffer from a severe
competition as a human food. Where this is not possible, the feed
channel must present at least an advantage in the quality or price of the
out-put to justify its preference for feed over food.
(c) **Nutrient Quality:** In addition to the quantity of nutrient yield,
feedstuffs are also evaluated on the basis of quality.
(d) **Physical Availability:** The availability of a feedstuff is an
important consideration in relation to livestock feeding. A feedstuff
which has seasonal occurrence may be disadvantageous in compound
feed manufacture, either due to fluctuations in availability or by
introducing variations in feed formulation.
(e) **Constant Composition:** A good feedstuff should have a
reasonably constant composition particularly of the prime nutrient.
(f) **Nutrient Availability:** Apart from physical availability, some
feedstuffs may contain nutrients which are not available. This may arise
from inherent solubility such as in blood meal, or the nutrient may be
destroyed by processing or storage such as in certain vitamins or the
nutrient may be bound chemically in an indigestible form such as phytin
phosphate.
(G) **Cost:** Cost is an important consideration in the choice of a
feedstuff. The ultimate objective of a feed manufacturer or a livestock
farmer is to maximize profit. Therefore, the cheaper his source of feedstuffs the lower his cost of producing feeds or feeding his livestock.

5.0 CONVENTIONAL FEED RESOURCES
Feed constitutes the dominant input in animal production, ranging from 65% - 75% of total cost of production (Esonu, 2000). Similarly, feed ingredients account for over 90% of the compound feed industry. Therefore, the relationship between feed ingredients and animal product output is both direct and obvious. Conventional feedstuffs are very expensive and scarce, the high cost and scarcity derived from crippling realities that are characteristic of third world developing economies. They vary in nature from technological to economic, sociological, political and environmental limitations of our system. Primary ingredients are expensive because they suffer from stiff competition with channels in the food chain which command higher priority and can pay higher prices than the compound feed industry. These are:
(a) Human food channels which may be direct (e.g. maize, groundnuts, fish, soybean) or indirect such as processed foods like semovita, soymilk, baby foods and confectionaries.
(b) Industrial channels which include breweries, industrial starch, food starch.
(c) Export channels both official and smuggled.

Feed formulation is the mixing of feed ingredients in such economic amount and proportion that will provide nutrients in optimum amounts and proportion for specific requirements of animals. Thus feed formulation is built around four main principles:
(a) Economics: The choice of ingredients and levels that will combine to produce the highest quality feed at the least price.
(b) Chemistry: Good knowledge of the chemistry and composition of feed ingredients is essential.
(C) Biology: Proper knowledge of nutrient requirements of animal in question, considering the animal's physiological condition, e.g. class, age, sex or size, breeding, pregnant, lactating etc.
(D) **Mathematics:** Computations that will produce answers as to quantities and proportions that will meet the above objectives.

In considering these four principles, any combination of ingredients which provides all the nutrients that meet the minimum requirements of the animal for its specified condition at least cost is the appropriate feed for that condition. The cost consideration is paramount because it is this factor that creates the necessity for formulation in the first place. It is this consideration that pushes ingredient and nutrient levels above the minimum requirements. In the case of fibre the reverse is the case where the upper tolerance limit of the animal can be approached but must never be exceeded.

Feed formulation for non-ruminant (monogastric) animals is more sensitive than for ruminants with additional consideration for amino acid composition and supplementation, mineral and vitamin levels and ratios. In the case of ruminant, the quality of feed offered is not very important because of the supplemental effect of microbial proteins provided the feed is high in energy or readily fermentable carbohydrate and non-protein nitrogen. Practical feed formulation with conventional feed ingredients is relatively easy. All it involves is using appropriate techniques to compute the outcome of choices based on nutrient yield and cost.

6.0 **UNCONVENTIONAL FEED RESOURCES**
An array of unconventional feed resources abound in Nigeria. Classification of these by states have also been documented (Tewe, 2002). Alternatives to maize include cassava, sweet potato, cocoyam, sorghum, millet, aerial yam etc. Substitutes to groundnut cake and soybean cake include full soybean and cotton seed cake etc. These alternative feedstuffs as well as oil palm sludge, palm kernel cake, rubber seed meal, pigeon pea, jackbean and swordbean hold some promise if the cultivation of the crops from which they are derived are substantially increased.
Studies on these alternatives as reported by the presidential task force suggest the viability of using them as indicated by the following deductions:

(a) Formulation containing as low as 20% or less maize were effective and economically efficient. Thus, the demand for maize could be reduced if the use of sorghum and millet in the savannah belt; cassava and sweet potato in the derived savannah and rain forest belt; biscuit waste and rice polishing waste in industrialized urban areas of Lagos, Ibadan, Enugu, Kaduna, Jos, Aba and Port Harcourt instead of maize is encouraged.

(b) Maize offal and dried brewers grain can be included in formulation at 10% 40% and 10% 20% in poultry and swine diets respectively with satisfactory economic returns.

(c) With soybean meal or full soybean (with or without methionine supplementation) as sole source of protein or constituting more than 80% of the dietary protein concentration in poultry diets giving economic returns.

(d) It is suggestive that the profitability of livestock production does not depend on the inclusion of fishmeal in commercial feeds.

(e) Most of the alternative formulations tested indicated cotton seed, delinted or undelinted as well as sunflower seed cake could be used to replace soyabean meal.

(F) The totality of the findings support the view that animal production activities can proceed meaningfully and economically based on existing internal raw material resources, provided there is recovery and adequate processing of available by-products and wastes to a form in which they can be readily incorporated into compound livestock feeding systems.

STRATEGIES FOR ECONOMIC USAGE OF UNCONVENTIONAL INGREDIENTS

(i) Inclusion Levels:
The shortage and rising cost of feed ingredients has forced livestock farmers to incorporate a number of alternatives without taking cognizance of their level of inclusion to
guarantee economic performance. Limitations exist for different species and classes of livestock and this also depends on the product mix and form of presentation. Generally, for commercial feed milling, the level of alternative energy sources used is lower than that of maize. For example, a low level of 10 20% usages of cassava for poultry feeds is largely due to its dustiness which can be overcome by pelleting as practiced in European Union countries or particularly by the use of full fat oil seeds to dowse the dustiness of the cassava (Tewe, 1997, 2002). Udedibie et al (2008) have been able to process cassava tuber into HCN-free and non-dusty cassava fufu meal which can completely replace maize in poultry diets.

(ii) Commercial Enzyme Usage:
The use of other cereals as substitute for maize has become prominent in recent times due to their slightly lower prices and nutritional improvement obtained by the addition of non-starch polysaccharide enzymes. Carbohydrates of cereals contain digestible nutrients like starch and sugars, but they also contain indigestible components that can exert major antinutritional effects in monogastrics. To counteract the antinutritional effects, polysaccharides are added to these cereals and their by-products notably wheat and corn offal. Studies conducted in Nigeria indicate significant cost reduction in such formulation with levels of cereal by-products up to 20% of the diet (Esonu et al, 1997, 1998). This has led many poultry farmers to adopt this practice. However, the specific levels of inclusion of these cereal by-products that will give consistent economic gains are very much in doubt as this is not the usual observation on many commercial farms.

The effects of other feed components on enzyme activity still need to be established as the results from manufacturers are usually in soybean meal mixtures rather than with other sources of protein. This uncertainty of level of inclusion is further
complicated by losses of enzyme potency in transportation and feed milling process (Esonu et al, 2004, 2005). This calls for urgent need for rapid test to assess the potency of these enzymes in this country coupled with need for establishment of interactive factors that limit their use in Nigeria feed industry with a robust array of alternatives. It should be noted that proteases and other enzymes that enhance availability of proteins and minerals are also available in the market.

Appropriate Processing Technologies:
The need to develop appropriate techniques and logistics for harnessing alternative crops and recovery of by-products need to be urgently addressed. The scattered location of alternative resources and lack of simple processing technologies to ensure their availability in storable forms seriously hamper their inclusion in economically justifiable rations. Cassava is a prominent alternative with Nigeria being the world's largest producer at 33 million tons per annum. Its agronomic potentials indicate its suitability for reducing maize requirements in livestock feeding. However, due to variability in its price and case of perishability, the prices have become prohibitive in recent times and inability to store the product over time limits its use as a back up during scarcity of maize.

The skyrocketing price of the protein concentrates, groundnut cake and soybean meal, has further discouraged its complementary role with cassava that needs to be augmented with protein concentrates to meet such needs in compound rations. It is therefore necessary to devise technologies that will guarantee consistently lower prices for cassava products to enable its economic usage in feeds. Analysis of the livestock feed data shows that cassava can enter into economic formulation when its price ranges from 38.9% to 76.2% as a proportion of price of maize.

Studies in Nigeria, Thailand, Ivory Coast and Zimbabwe also confirm
that price of cassava chips should range from 60 to 75% that of maize for its economic usage in livestock feeds (Tewe, 2002).

The need to adopt cost effective farm gate processing techniques to reduce the cost of unconventional feed ingredients will go a long way to reduce processing cost and availability. In this regard, it is important to note that providing mobile, drying, grinding, pelleting and briquetting equipment will enhance the quantity of crop residue-based complete feed for ruminants as pellets and cubes. As estimated in studies by the presidential Task Force (Tewe, 2003) all of Nigeria's cattle, sheep and goat will not require more than 66% of total crop residue available in the country for their total annual feed requirement if they are properly harnessed.

For animal by-products, suitably designed and well-integrated slaughter slabs or houses need to be constructed in different locations, country wide. The system should allow for easy collection of the blood and rumen content for further processing. The combined blood and rumen contents dry better and serves as a good alternative feedstuff for non-ruminant animals (Esonu et al., 2006, 2007).

**MY MODEST CONTRIBUTION TO KNOWLEDGE**
The research projects for my three degrees obtained from this premier University of Technology were on Monogastric Animal Nutrition.

I realized that there is an array of research areas of interest to researchers and graduate students alike. However, my major research area of interest is in the area of monogastric animal nutrition with a bias in poultry and rabbit nutrition. In this major area, are studies on nutrient metabolism, alternative source of feed nutrients, digestibility of feed ingredients and utilization of nutrients, interrelationships, and determination of optimum nutrient levels for various classes of poultry feeds. A little portion of each of these areas of research can use up a researchers life time and with no complete answers given to the unanswered questions.
My area of interest is primarily on seeking alternative energy and protein sources for poultry feed formulation. In Nigeria and most other developing countries, it is more and more becoming very expensive and uneconomical to produce poultry feeds with the conventional or orthodox feed ingredients, such as maize and fishmeal. The competition between humans and animals for maize is very high in Nigeria resulting in high costs of maize. Fishmeal is imported and this accounts for its expensiveness. If the profit margin of poultry farmers in Nigeria must be reasonable, the cost of producing good quality poultry feeds must be markedly reduced since feed is second most expensive item in poultry production.

It is my desire to look into some of the by-products of the brewery industry and ways of eliminating or reducing the trypsin inhibitors in most of our local seeds as good quality protein and energy sources respectively, for poultry feed formulation. This zeal led me to conduct series of research work on the following potential unconventional feed resources:

**Jackbean (Canavalia ensiformis)**

*Canavalia ensiformis* commonly known as jackbean has been identified as a high forage and seed yielding tropical legume, currently used in Nigeria as ornamental plant, grown near houses and allowed to trial on walls and trees. In some places, it is regarded as a snake expellant (Udedibie et al, 1994). The seed is large about 5 times the size of soyabean. Jackbean meal contains 28% - 32% crude protein, but also contains toxic substances which limit its use as feed ingredient for livestock, particularly monogastric animals. Some of these toxic factors (Concanavalin A, canatoxin, hemaglutinin and canavanine) are thermostable. (Udedibie et al, 1994).

Ten (10) trials were conducted at this station to determine the effects of:

1. Dry urea treatment prior to dry heat treatment (toasting)
2. Two-stage cooking
3. Sprouting alone
4. Sprouting prior to boiling
5. Two-stage cooking prior to microbial fermentation
6. Cooking or toasting with sun dried paw-paw leaf
7. Trona treatment
8. Ferrous sulphate treatment
9. Efficacy of synthetic papain and
10. Crack and cook method on the nutritive value of jackbean meal.


Poultry Offal Meal (POM)
Poultry Offal Meal (POM) is the processed edible and inedible parts (heads, viscera, feathers, beaks, blood, discarded eggs and dead birds) from poultry processing plants. Until recently, very little is heard about this by-products, particularly in the tropics, since less than 5% of the total slaughtering of broilers or table birds is done-through organized dressing systems. With the emergence of large scale poultry industries in Nigeria in late 80s and the declining availability of protein concentrates, there was need to recycle poultry waste into valuable products for livestock industry. Imo Modern Poultry Ltd., Avutu, Imo State Nigeria initiated the production of POM by a process called “wet-rendering”. Although the use of POM in poultry ration has been studied, information on its value for swine was quite limited.

We therefore decided to conduct experiments to determine chemical composition of POM from the plant at Avutu and to evaluate its nutritive value as a protein supplement for grower pigs. The results of this study
suggest that POM could be incorporated in grower pig rations up to 20% dietary level with improved performance (Udedibie et al, 1988).

**Cassava Peel Meal**
Cassava contains two major toxic factors, cyanogenic glucosides, linamarin and lotaustralin. Linamarin yields free HCN, acetone and D-glucose on enzymatic or acid hydrolysis, while lotaustralin yields free HCN, 2-butanone and D-glucose in the same process. Sugars in cassava may react with E-amino groups of lysine in a millard reaction thus making lysine less available and deficient in the diet. The process of drying cassava may result in infection by *Aspergillus niger* with the production of phytotoxin notably aflatoxin by the organism. Cassava root is equally deficient in methionine, cystine and tryptophan. Cassava root meal should not be fed in powdery form to swine to avoid ulcerogenic effects in the animal (Udedibie, 1997). Cassava peel is low in protein and energy level but high in crude fibre. It contain 4 to 16 times the concentration of hydrogen cyanide (HCN) than the amount in the tuber. A 12-week feeding trial was conducted to determine the optimal replacement level of dried cassava peel meal (DCPM) for maize in diets for weaner rabbits. It was observed that the optimal replacement level of maize with dried cassava peel meal from this trial is 50% (Esonu and Udedibie, 1993).

**Palm Oil Sludge**
Palm Oil Sludge (POS) is a major by-product from the extraction of palm oil and currently constitutes a major environmental pollutant in producing areas. It contain 9.6 10.2% crude protein, 11.4 11.5% crude fibre; 11% ash and 1840 3100 kcal/kg metabolizable energy on dry matter basis.

In Nigeria, especially the southern zone where there are large scale palm oil mills, the production of large quantity (millions of metric tonnes) of under utilized POS are available.

Therefore designed experiments to evaluate the effect of partial
replacement of maize with sun dried palm oil sludge (SDPOS) to serve as a major source of energy in the diet of broilers and turkey poults.

Results from these trials showed that SDPOS could be incorporated in broiler starter diets up to 20%, in broiler finisher diets up to 30% and in turkey starter diets up to 60% replacing maize on weight for weight basis (Esonu, 1995a; Esonu, 1995b).

**RICE MILL BY-PRODUCTS**
Mixture of rice milling by-products comprised a ratio of 1 : 1 : 1 : 2 of rice straw, hull, husk and bran mixed together. Until recently, these materials were regarded as waste (Esonu et al, 1996). Most researchers have dealt extensively on the bran (Gillespie, 1981; Aduku et al, 1986) while the husk and straw have been used mainly in providing litter materials for livestock (Reddish, et al, 1986). A mixture of rice milling by-products is locally available in large quantities, cheap and utilizable without much processing (Oyenuga, 1968; Aduku et al, 1986). The objectives of this study was to evaluate the substitution value of a mixture of rice milling by-products for maize in weaner rabbit diets.

The result of this trial showed that the mixture of rice mill by-products at a ratio of 1 : 1 : 1 : 2 of rice straw husk and bran could be substituted for maize at 50% level in weaner rabbit diets with improved performance (Esonu, 1997).

**Poultry Droppings**
Poultry waste is a proven valuable feed component and a rich source of nitrogen and minerals (Bhattachrya and Taylor, 1975; Esonu and Udediebie, 1991). It is safe and available at relatively low cost. Hen waste contains 19 31% crude protein, 14 24% crude fibre and about 2100 kcal/kg metabolizable energy on dry matter basis (Adu and Lakpini, 1983; Bhattacharya and Taylor, 1975). Two-thirds of the nitrogen in dried poultry dropping is uric acid which is unavailable and toxic to the chicks when included in purified diets. Uric acid also acts as gut irritant, depressing nutrient absorption or inhibiting the microbiological
synthesis of essential nutrients (Esonu, 2000).

The purpose for this investigation was to evaluate the performance of weaner rabbits to graded levels of sun dried poultry waste in the diet.

Two hundred (200) 2-month old New Zealand white weaner rabbits were used in this trial that lasted for 12 weeks. The result showed that inclusion of sun dried poultry waste up to 40% dietary level in weaner rabbit diet had no adverse effect on the animal (Esonu, et al, 1997).

**Soybean Hulls**
Soybean hulls also referred to as soyhulls, soybean millrun or soybran flakes are by-products of the soybean milling industry. Soybean hulls have estimated feeding value of 74 - 80% of that of maize when included in moderate to high quantity in maize-based finishing diets (Palmquist, 1988). It contains high levels of potentially digestible fibre and can replace some or all grains in the diets of ruminants. Soybean hull contains 22.75% crude protein, 18.15% crude fibre, 14.60% ether extract, 8.0% ash and 30.90% NFE (Esonu, et al, 1997).

My interest was to determine the optimal dietary level of soybean hulls for broiler birds. Two experiments were conducted. In the first experiment, five (5) broiler starter diets were formulated such that the diets contained soybean hulls at 0%, 5%, 10%, 15% and 20% inclusion levels, respectively. One hundred and fifty, 7-day old broiler chicks were divided into five groups of thirty (30) birds each and randomly assigned to the five treatment diets.

In the second experiment, four (4) broiler finisher diets were formulated such that the diets contained soybean hulls at 0%, 10%, 20% and 30% inclusion levels respectively. Two hundred and forty (240) 5-week old broiler chicks of Anak breed were used for this research. The birds were divided into four groups of sixty (60) birds each and randomly assigned to the four treatment diets.
The results from these trials suggest that the optimal dietary level of soybean hulls for broiler starter is 15% and 20% for finisher broiler. This allows the effective utilization of 15 - 20% soybean hulls by broilers thereby reducing the quantity of maize needed in the diet. This is of practical importance and offers a way of increasing broiler production at reasonable cost (Esonu et al, 1997) and for weaned rabbit 20% (Esonu, 1998).

**Velvet bean (Mucuna pruriens).**
*Mucuna pruriens* is a tropical legume. It is not directly consumed by human in Nigeria and its seed contains moderate percentage of crude protein and high in fatty acids (Moghis et al, 1978) with small amount of metabolisable energy (Emenalum, 1996). However, like other tropical legumes, velvet bean contains anti-nutritional factors which limits its use in the feeding of monogastric animals. Raw velvet bean seed contains high levels of anti-trypsin activity, phytate, cyanide and tannin (Olaboro et al, 1991).

The objective of this study therefore was to evaluate the effect of raw velvet bean on the performance of weaner rabbits. The result of this study suggest that weaner rabbits could not tolerate raw mucuna bean meal beyond 5% dietary level (Esonu and Okonkwo, 1998).

**Combination of maize/sorghum-based brewers' grains, cocoyam corms and cassava root meal**
A 28-day feeding trial was conducted to determine the effects of completely replacing dietary maize with combination of maize/sorghum based brewers' dried grains (MSBDG), cocoyam corms (CCM) and cassava root (CRM) meals on the performance of broiler finisher and cost of production.

The three (3) test materials (MSBDG, CCM and CRM) were combined at the ratio of 30 : 15 : 15; 15 : 30 : 15 and 15 : 15 : 30 respectively, in the diets BD2, BD3 and BD4. Diet 1 (BD1) contained 60% maize which was completely replaced in BD2, BD3 and BD4. Other ingredients in
the broiler finisher diets remained the same. One hundred and twenty (120), 4-week-old Anak broiler chicks were randomly assigned to the 4 experimental diets, giving 30 birds/treatment group in a completely randomized design (CRD).

The results of this study suggest that any of the combinations of the 3 test materials can completely replace maize in broiler finisher diets and subsequently reduce cost of broiler production by 50% (Esonu et al, 1999; Esonu, 1999).

**Snail Offal**
Snails are one of the main sources of animal protein in Nigeria, particularly in southern Nigeria, where the ecosystem favours their continued existence. They are usually collected from the wild, mostly by villagers, who either consume or sell them for consumption in urban centers.

Snail offal meal (SOM) is produced from the inedible parts of processed snail, excluding the shell. It is about 40% of the total weight of the snail and constitutes a nuisance if not properly disposed of. The purpose of this study was to evaluate the effects of replacing fish meal with sun-dried snail offal meal (on weight for weight basis) on performance of broiler finishers. It was deduced from the results of this trial that sun-dried snail offal meal could completely replace fish meal on an equal weight basis in broiler finisher diets (Esonu and Nwoko, 1999).

**Wild variegated Cocoyam Corm Meal (Caladium hortulanum)**
Wild variegated cocoyam (Caladium hortulanum) is a high forage and corm yielding tropical crop, currently used in Nigeria as an ornamental plant. It is weeded off from the farm because of its high rate of regeneration or regrowth. It has high potential as energy supplement in livestock feeds. The NFE content ranges from 75 - 85% and it attracts no competition between humans and livestock. However, it contains some anti-nutritional factors such as calcium oxalate which could be eliminated by boiling.
The objective of this trial was to evaluate the effect of partial replacement of maize with cooked wild cocoyam corm meal in broiler starter diet. The result of this trial suggest that cooked wild variegated cocoyam corm meal can replace 50% of dietary maize in broiler starter diet (Esonu et al, 2000).

**Wild Aerial Yam Bulbils (Discorea bulbifera)**
The bulbils of wild aerial yam (Discorea bulbifera) stores starch like yam tubers which can serve as an alternative energy source in poultry feeding. Wild aerial yam has a wide range of adaptability, high production capacity, resistance to diseases and pest, tolerant to poor soils and grows wild. (Purseglove, 1972).

Chemical analysis of raw wild aerial yam bulbil at our station showed that it contains 73.75% NFE, 4.89% crude protein and 2.15% ash on dry matter basis. However, the bulbils contain some chemical components such as alkaloids or saponins in such quantities that may be toxic when eaten (Irvine, 1969). The toxic principle was identified to be dioscorine which is sometimes used as heart stimulant (Osagie, 1992). Further, another principle, a furanoid diterpense was isolated by Kawasaki et al (1968) and is probably responsible for the bitterness of the bulbils. The plant if properly harnessed offers an unlimited production potential.

Twenty-one day feeding trial was conducted to evaluate the nutritive value of peeled, sliced, sun dried and ground raw wild aerial yam bulbils in broiler chicks diets. The results of this trial showed that broiler starter chicks could not tolerate sun dried, raw wild aerial yam bulbil meal beyond 10% dietary level (Esonu et al, 2000).

**Microdesmis puberula leaf meal**
One possible source of cheap protein is the leaf meal of some tropical legume and browse plants. Leaf meals do not only serve as protein source but also provide some necessary vitamins, minerals and also oxycarotenoids, which cause yellow colour of broiler skin, shank and egg yolk (D'Mello et al, 1987; Opara, 1996). *Microdesmis puberula* is a
very popular tropical browse plant predominant in southern Nigeria. It is known in Igbo language as “Mkpiri or Mgbugho” and in Yoruba language as “Idiapata” (Esonu et al, 2001). Dietary inclusion level of Microdesmis puberula leaf meal should be limited at 5% for broiler chicks, 10% for broiler finisher, 15% for laying hen and 12.5% in enzyme supplementation broiler finisher diet (Esonu et al, 2003; Esonu et al, 2002; Esonu et al, 2004a; Esonu et al, 2004b).

Pigeon Pea Seed Meal
Pigeon pea seeds have very low human food preference and especially at present no industrial use. Information on available literature on the feeding of pigeon pea seeds to poultry suggests that it is a satisfactory protein ingredient in the ration (Amaefule and Obioha, 1998).

The objective of this study therefore was to investigate the effect of feeding raw pigeon pea seed meal on the performance and blood chemistry of weaner rabbits. The results of this study suggest that weaner rabbits cannot tolerate raw pigeon pea meal up to 10% dietary level (Iheukwumere et al, 2001).

Toad Meal
What is referred to as toad meal is produced by harvesting and smoke-drying the toad. The dried toad was crushed in a hammer mill to produce a fine textured meal. Toad meal is not only a source of extremely valuable protein but also supplied phosphorus and calcium as well as vitamin B₁₂, essential for growth. Three broiler starter diets were formulated to contain toad meal at 0, 5 and 10 percent respectively. Three hundred (300), 14-day old Hubbard broiler chicks were divided into three groups of 100 birds each and randomly assigned to the three treatment diets in a completely randomized design (CRD) to determine the effect of toad meal on broiler chicks.

The results of this study suggest that toad meal (TM) could be incorporated in young broiler chicks diets up to 10% level with improved results (Esonu, 2002).
Bambara Groundnut Offal
Bambara groundnut (*Voandzea subteranea*) is a tropical legume abundant in the middle belt and most parts of Igboland and used for making a very popular delicacy called “Okpa” and the offal is a by-product of domestic processing of the bambara groundnut.

The offal still has a considerable amount of nutrients and has been used locally to feed poultry and other livestock with little or no documentation. Bambara groundnut contains trypsin inhibitors which can be inactivated by heat treatment. We designed experiments to evaluate bambara groundnut offal (BGO) as energy source in replacement for maize in broiler diets. The results of the trials suggest that BGO could replace maize in broiler starter diet at 60% level and broiler finisher diet at 80% levels with improved performance and reduction in production cost. (Anyanwu et al., 2003).

**Napoleona Imperialis**
Napoleona imperialis is an evergreen non-timber plant that grows abundantly in bush fallows, secondary bushes and marginal lands in most of the tropical humid zone of West Africa. Different parts of the plant are used for different purposes in the region including mulching and fodder (leaves and twigs) and firewood, chewing stick and ethnomedicine (stem and root). Humans consume the juice from the fruits and pods but the seeds are discarded. The objective of this study was to ascertain the effect of raw *Napoleona imperialis* seed meal as a feed ingredient on the performance, carcass and organ characteristics of finisher broilers.

The result suggest that 5% inclusion level of *Napoleona imperialis* seed meal could be included in finisher broiler diet without any deleterious effects (Uchegbu et al., 2004).

**Neem (Azadirachta indica) leaf meal**
Neem (*Azadirachta indica*) is one of the indigenous tropical plants predominant in Nigeria. It is commonly known as Neem and popularly called “Akum shut-up” in Igboland and Dogonyaro” by the Hausas.
Azadirachta indica has medicinal properties and can be used as insecticide and pesticide. Azadirachta tree and its derivatives have great relevance in organic farming practices. The leaf meal has 92.24% DM, 20.68% crude protein, 16.60% crude fibre, 4.13% ether extract, 7.10% ash and 43.91% NFE. We designed this study to examine the effects of neem (Azadirachta indica) leaf meal on the performance, egg quality and carcass characteristics of laying hens fed graded levels of the leaf meal. Results from this experiment suggest that 15% inclusion level of neem (Azadirachta indica) leaf meal in laying hen diet has no deleterious effect on the birds. (Esonu et al, 2005).

Rumen Digesta and Bovine Blood
Bovine blood and rumen digesta are by-products of cattle industry. Beef is the highest source of animal protein in Nigeria. It is estimated that about 1.873 million heads of cattle are slaughtered annually in Nigeria (Adeniji, 2001). The high demand for beef in Nigeria makes bovine by-products readily available. Bovine blood and rumen digesta singly or mixture has great potential as an alternative feed ingredient in livestock production if properly processed. Recycling these by-products will also reduce disposal and environmental pollution problems.

Five trials were conducted to evaluate the effect of dried rumen digesta and a mixture of rumen digesta and bovine blood on the performance of broiler birds and laying hens respectively.

Results from these trials suggests that dried rumen digesta alone or mixture with bovine blood could be incorporated in broiler starter diet at 7.5%, and 15% dietary level for broiler finisher. (Esonu et al, 2006; Esonu et al, 2007a; Esonu et al 2007b).

Oil palm (Elaeis guineensis) leaf meal
Oil Palm leaf meal is a by-product of Elaeis guineensis. With the increase in basket and broom making in the rural communities of Nigeria, resulting in the disposal of large quantities of the oil palm leaflets, it
became necessary to reduce the wastage by using it as alternative feed source for livestock. Oil palm leaf meal contains 12.79\% 14.2\% crude protein but also high in crude fibre. The trial herein reported was therefore designed to evaluate the nutritional value of oil palm leaf meal in broiler diets.

The leaves were harvested, the stalks removed and the leaves chopped to facilitate sun drying for 4 days until they became crispy while still retaining the greenish colouration. The material was milled using a hammer mill with a sieve size of 3.36mm to produce leaf meal.

In the first experiment, the leaf meal so produced was used to formulate broiler starter diets at 0\%, 2.5\% and 5.0\% dietary levels respectively, using 135, 14-day-old young broiler chicks with three replicates of 15 chicks per treatment. The trial lasted for 28 days. In the second experiment, the leaf meal was used to formulate broiler finisher diets at 5 dietary levels of 0\%, 2.5\%, 5.0\%, 7.5\% and 10\% inclusion levels respectively using 225, 6-week-old broiler chicks, with three replicates of 15 birds per treatment.

The feeding trial lasted for 28 days. At the end of the 28\textsuperscript{th} day, four birds were randomly selected from each treatment for carcass and organ weight evaluation. In both experiments, feed intake of the birds on diets containing the leaf meal were significantly (P<0.05) higher than the control (0\%) group. Body weight gain and feed conversion ratio of the birds were comparable, the relative organ weights of the birds in the second experiment were comparable. Dietary inclusion of oil palm leaf meal reduced cost of producing one kilogram of feed and this reflected in the feed cost savings (\%) but the N/kg meat produced values increased with increasing levels of the leaf meal (Esonu et al, 2008).
CONCLUSION AND RECOMMENDATIONS

The cost of conventional protein and energy sources such as groundnut cake, soybean meal, fish meal, and maize for non-ruminant animals in many tropical countries has been on the increase since the last two decades. This is because animals compete with humans over the few available cereal-grains and legumes with a resultant scarcity and increase in price. It is now becoming uneconomical to use these conventional feedstuffs in poultry feeds. Feed accounts for 65-75% of the cost of production of monogastric animals. Farm wastes, agro-industrial by-products and novel legumes particularly those that are indigenous to our tropical environment offer unique opportunities as alternative feed resources for sustainable animal production.

The necessity to improve the current animal production systems in Nigeria cannot be disputed. About two decades ago, it was projected that early in this millennium there would be more people, greater urbanization, with increasing income and a shift towards more adults and less children. Therefore, there is great need for more food in this country particularly more animal products. Obviously, the current livestock and poultry production systems cannot bring about the desired result and it is unrealistic to rely on importation of animal products from developed countries into this country because our foreign reserve is limited and cost of animal products in developed countries is prohibitive. It is difficult to assume that biotechnology research will flourish in this country if conventional research is not functioning well. Moreover, effective biotechnology research and development programmes in most developing countries will require a strong collaborative linkage among institutions at national, regional or international levels. However, biotechnology in developing countries like Nigeria should not first be established at the most advanced level because it has to be started with basic and simple procedures, and as we gain experience we may advance to more complex and sophisticated techniques. The future of animal production in Nigeria is bright and should be pursued vigorously until a time when the “common man” will have on his dinning table a piece of bread, an egg to eat and a glass of
milk to drink on a daily basis.

**RECOMMENDATIONS**

(1) The nation's poultry farmers who have been making tremendous efforts to save the industry from total collapse should be encouraged by the government of Nigeria. Government should subsidize various aspects of the industry (feed production, drug and vaccine, equipment and cost of birds/animals). This issue should be treated as very urgent.

(2) Improving animal production systems: There is the need for establishment of more Animal Production Research Institutes in Nigeria, if our country is to benefit from animal production research, it is first necessary to evaluate the present state of agricultural research, visualize the future trend and finally formulate the appropriate measure to remedy the situation. If animal production research in this country is given the serious attention it deserves, it can become the nucleus of Nigerian Industrial Development. Whereas ten crop production research institutes were established in Nigeria many years ago, only two animal production and veterinary research institutes were established and these two are situated in the North. More Animal Production Research Institutes should be established as a matter of urgency by the Federal government of Nigeria such as:

- Poultry Research Institute in Eastern Nigeria.
- Small Ruminant Animal Research Institute in the Middle Belt of Nigeria.
- Swine Research Institute in the south/southern Nigeria
- Mini-livestock Research Institute in the mid-western Nigeria.

Animal production research has been marginalized in Nigeria for many years even though animal production is vital to the economic recovery, long term progress and future prosperity of Nigeria.

**Mode of Approach/Government Policy**

The mode of approach to livestock production in Nigeria is faulty as
There is change in policy on agricultural production day by day once new government in place.

There must be consistent government policy on agriculture, a situation whereby in-coming government will inherit and continue with the past government's policy instead of finding faults in order to discredit the former government. Government agricultural policy should be improved, given sharper focus and reviewed periodically. Institutional stability and consistency in research policy and policy objectives are essential for productive animal production research. Instability of agricultural research is a major problem for research effectiveness. Instability in this country has been caused by frequent changes in government and political leadership. These bring with them different ideas and directions for scientific and agricultural research.

Passage of NIAS Bill
The passage and registration of the Nigerian Institute of Animal Science (NIAS) bill is a bold step in the right direction. This has professionalize the practice of Animal Science in Nigeria. The Institute/Council has among other responsibilities, to regulate the practice of Animal Science in Nigeria, monitor the training of Animal Science graduates and maintenance of minimum academic qualification for members. However, the Institute/Council has to work hard for the expected positive change in animal production in Nigeria. The Institute/Council has to move aggressively to industries with "tempting research projects" because we have to bridge the communication gap between research and industry. We have to broaden the base for funding research. Already, multinationals, which dominate the commercial life of this country, carry out their needed research in their home countries showing little or no interest in funding research in Nigerian institutions. This attitude must be changed either by persuasion or legislation.
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"O give thanks unto the Lord, for He is good, for His mercy endures forever" (Psalms 107 : 1). My first gratitude is to God the Father Almighty for His infinite grace upon my life. He opened my eyes to accept Jesus Christ as my Lord and Saviour and has kept me, through the Holy Spirit in spite of many physical and spiritual weaknesses.

It has been my heart desire from childhood to earn a University degree, this brought me to FUTO even after obtaining OND and HND from College of Science and Technology, Port Harcourt in 1978 and 1980 respectively. I completed my primary education in my village Umuabali, Umuopara, Umuahia in Abia State immediately after the Nigeria-Biafra civil war in 1970, not knowing what the future held.

I remembered meeting a University don for the first time after completing my secondary education. I took time that day to look at him critically, wondering what a University lecturer looked like. I could not imagine that one day I would be addressing an august audience at a formal occasion like this as a University Professor. What a privilege. I give all the glory to the Lord for sparing my life and providing the opportunity for me to reach this height.

After paying glowing tribute to the King of kings, the Almighty God, I must appropriately appreciate my parents. I would not have been physically existing today had God not arranged a man and woman to conjugally bring me forth. I gave them the most trouble in struggling to keep me alive. That struggle has been rewarded, a lesson for all parents. These are my parents. Dad and Mum, both of blessed memory, Deacon John Onwusonye Esonu and Deaconess Rose Onyecherelem Esonu. Please sleep on at the bosom of the Almighty God. How I wish they were here today. I thank them posthumously for all their care and love on me.

God deemed it fit that I should be born into a Royal family of ESONU ATULOMAH EKPE. The challenges of growing up as a boy in a disciplined family like ours contributed significantly to my determination
to succeed in life and never to be afraid of challenges. I appreciate all the members of Umuekpe family present here today. I thank the good people of Umuabali (my village), Ezeleke, Umuopara and the entire Umuahia people (Ndri nwe-madu) for both positive and negative support which helped me in my physical and moral development from primary to secondary education levels. I appreciate the respect and love of my immediate junior brother, blunt and honest, Chief Onumisnachi Abbey Esonu and his lovely wife Nkeiru. Our sisters highly industrious and courageous Mrs. Eberechi Onuoha and Mrs. Gift Chinazakpere Nkaogu. My father and mother-in-law, thank you. It is indeed a great blessing to have married from your family. The brothers and sisters of my wife are equally very important to me.

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The most prominent personality in my academic life here in FUTO during my first, second and tertiary degrees, to whom I am very grateful is Prof. A. B. I. Udedibie, an erudite Professor of Animal Nutrition. God used him to train my hands to “war” (skill in designing, conducting and publishing research results in journals). Words are inadequate to express my depth of gratitude to you. God will continue to bless you and your family. I wish to acknowledge with thanks Professors M. U. Illoeje, J. Obiefuna, M.I. Nwuf, E.T. Eshett, C.C. Asiabaka (Dean, SAAT), G. Osuji, and all the staff and students of School of Agric and Agricultural Technology (SAAT) for the various roles they have individually or collectively played in lifting me to this position. Special thanks go to my other colleagues in the Department of Animal Science and Technology, Federal University of Technology, Owerri, for the unity and love we share and for the immense support they have been giving me. I heartily acknowledge all my students, both graduate and undergraduate who participated in various aspects of my research. I want to acknowledge the various institutions, organizations and bodies that found me worthy for scholarship, fellowship and research grants, which enabled me to be what I am today.

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Lastly, I appreciate the Vice Chancellor, Prof. C.O.E. Onwuliri for his humility and hard-work, a man with a mind for God and honest intention to know him. Your wishes shall be accomplished in Jesus name.

Our lovely five children (Two girls and three boys) Victor Enyinnaya Chigozirim (Civil Engineering, final year, FUTO) Ihechukwu Daberechi (Statistics student, 2nd year MOUAU; Marvellous Ugwuumsinachi (Adanne) (Chemical Engineering student, 3rd year FUTO), Chimdi Ezichi (Biochemistry student, 1st year FUTO) and Precious Amarachi SS1 Student, Light House High School) are highly appreciated for their love, understanding, patience, disturbance and assistance in numerous ways.

Mr. Vice Chancellor, distinguished ladies and gentlemen, many persons are important to me but two personalities are most crucial, my God and my wife. I decided to start with God, the invisible and conclude with my wife.
Twenty-five years ago, I suddenly caught the glimpse of a pretty girl. The snapshot from my eyes kept my heart panting and my eyes almost losing sleep; the negative of that shot could not be destroyed. No other girl I had ever seen struck such chord. I followed up. Today, she is my wife, an Assuster. Are there words enough to thank this paragon? A woman who is able to study her husband, accept him for better for worse as hers and thereby complement him is worthy to be appreciated. My wife is the woman described in the book of Prov. 31, and indeed the most beautiful woman in the world by my perception, very understanding, loving, caring, enduring, industrious, rugged yet feminine, brilliant, faithful and above all prayerful. My dear, thank you so much for being a wife and a mother. God bless you richly.

It is not of him that willeth, nor of him that runneth but of God that showeth mercy” (Rom 9 : 16). For you God lift the poor and homeless out of the garbage dump and give them places of honour in royal palaces. You set the world on foundations and they belong to you (1 Sam 2 : 8).

Finally, .....” of making many books, there is no end, and much study is a weariness of the flesh. Let us hear the conclusion of the whole matter; fear God and keep His commandments; for this is the whole duty of man” (Eccl. 12 : 12 13).

Now unto the king eternal, immortal, invisible, the only wise God, be honour and glory forever and ever, Amen. Thank you for listening and God bless us all.
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