FEDERAL UNIVERSITY OF AGRICULTURE
ABEOKUTA NIGERIA

65TH INAUGURAL LECTURE

FEEDS AND FEEDSTUFFS: PANACEA FOR DECLINING COMMERCIAL ANIMAL AGRICULTURE AND FOOD INSECURITY IN NIGERIA

by

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@ Adeyemi Mustafa Bamgbose

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The Vice-Chancellor

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FUNAAB INAUGURAL LECTURE SERIES

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FEEDS AND FEEDSTUFFS: PANACEA FOR DECLINING COMMERCIAL ANIMAL AGRICULTURE AND FOOD INSECURITY IN NIGERIA.

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Heads of other Departments;
Presidents and Members of Professional Associations;
Distinguished and Eminent Scholars and Academics from FUNAAB and other Institutions;
All Non-Teaching Staff;
My Spiritual Fathers and Mothers here present;
Members of my Immediate and Extended Family;
Special Guests and Friends;
Gentlemen of the Print and Electronic Media;
Distinguished Ladies and Gentlemen; and
Greatest FUNAABITES!!!

1.0 PREAMBLE:

I give all the glory to Allah, for the privilege to stand before this audience to present the 65th Inaugural Lecture of our great University – Federal University of Agriculture, Abeokuta (FUNAAB), the fourth from the Department of Animal Nutrition, (the Department of the first Inaugural Lecturer of the University – Prof. E.B. Oguntona, from the College with the highest number of Emeritus Professors (Late Emeritus Prof. I.F. Adu and Emeritus Professor (Mrs) A.O Adebambo) and highest number of Professors (serving and retired) and still counting!!! It is also the fourth after the case of the lockdown due to the coronavirus pandemic that is ravaging the world!!! This is also the twelfth Inaugural Lecture from the College of Animal Science and Livestock Production (COLANIM), coming after presentations by Professors E.B. Oguntona, I.F. Adu, O.A. Osinowo, O.A. Adebambo (Mrs), C.F.I. Onwuka, S.S. Abiola, D. Eruvbetine, A.B.J. Aina, O.S. Onifade, M.O. Ozoje and C.O.N. Ikeobi.

It has been a moment of sober reflection and most importantly appreciating my creator for His abundant grace and mercy on me. I return all honour and glory to Almighty God for his protection and for the journey so far. It has been really wonderful!. I found myself in the field of Agriculture and specifically Animal Science by sheer influence and interaction with my room-mate at the University of Ibadan, Ibadan – Prof. Bayo Aliu (currently working at University of Benin, Benin City) here seated today. I must confess, it has been very interesting, challenging and very rewarding too. I thank God for the grace bestowed on me to remain focused.

Inaugural lectures mark the peak of events as one attains the highest level of achievements in the academia (Professor). I would like to specially thank our amiable Vice-Chancellor, Prof. Felix Kolawole Salako for keeping faith with this important academic culture. Furthermore, the essence of an inaugural lecture is for the presenter to showcase what he professes in his field of study and specialization over the years, show the direction of his future research work and to give a message to the world.

Today's lecture titled **“Feeds and Feedstuffs: Panacea for Declining Commercial Animal Agriculture and Food Insecurity in Nigeria”** focuses on feeds and feedstuffs resources management, processing and utilization for improved productive performance of farm animals towards increased animal protein consumption by the populace.

2.0 INTRODUCTION

Nigerian's Agricultural production is operated by a large number of small producers with little capital and more than 90% of the total food produced is from these small scale farmers (CBN, 1995). Priority issues in many African countries include how to improve food security, conserve bio-diversity, reduce pest management costs, reduce feed costs, increase productivity, processing and marketing. Poor performance of Agriculture in sub-Saharan Africa, Nigeria and other African countries inclusive is gradually leading to food/feed crisis and poverty. Agriculture is Nigeria's most assured engine of development, a reliable key to its industrialization, in spite of the huge but ephemeral revenue derived from the oil (Igboeli, 2000). Agriculture accounts for more than 32% of Africa's Gross Domestic Product (GDP). In Ghana, agriculture contributed 25% of the GDP in 2017 and employed about 50% of the working population. However, agriculture in Nigeria which happened to be the major driver of the economy during the 1960s (contributing about 64% of the GDP and employing about 90% of the working population) now contributes only about 21% of the GDP in 2016 and employs about 28% of the working population.

This is the current situation across many African countries. Africa today is not meeting up with the growing demand for food from urban centres and depends solely on food importation from other continents. For a continent with such a vast land area, a booming young population and tropical climate, it is surprising that Africa is not a net exporter of Agricultural products. In the 1970s, Africa provided about 8% of the world's total agricultural exports. Today, this number has dropped to a negligible 2%.
The types of agriculture commonly practiced in Nigeria include:

(i) **Animal Husbandry:** a branch of agriculture concerned with animals that are raised for meat, fibre, milk, eggs or other products. This comprises poultry farming, fish farming, pig farming, small and large ruminant farming, mini-livestock and a few others.

(ii) **Crop Farming:** a branch of agriculture that deals with the commercial production of crops for food, fuel or raw materials. It includes cassava, rice, vegetables etc.

(iii) **Mixed Farming:** agriculture which combines both animal husbandry and crop farming. It offers several advantages, for example, the crop farming gives feed materials to the animals and in turn, the animals can supply organic fertilizers to the crops. It also enhances the profitability of the farm land and reduces wastage.

Agriculture is one section of the economy that will never go extinct, because no matter the economic situation at anytime present or future, people must eat. Many notable persons and top government functionaries all over the world have invested heavily in agriculture. Ex-President of America Jimmy Carter was a wealthy peanut farmer before going into politics. One of the richest men in China, Liu Yongxing made his wealth from poultry farming. He has an estimated net worth of over $6 billion dollars. Obasanjo Farms Nigeria Limited, in Nigeria, is a well-known farm owned by the former President, Chief Olusegun Obasanjo. The farm is reported to bring in over ₦360 million annually (BBC, 2004).

3.0 THE FIELD OF ANIMAL NUTRITION

Mr. Vice-Chancellor Sir, permit me to shed a little light on the field of Animal Nutrition for the benefit of those who may not be well-acquainted with it.

Animal nutrition refers to the art of feeding the animals as well as the scientific investigations into the feed supplied or fed. It is the science of dietary feeds to formulate a complete and balanced feed intake in accordance with the animal's needs.

- What is nutrition? A dictionary defines nutrition as the interrelated steps by which a living organism assimilates food and uses it for growth, reproduction, tissue repair and replacement or elaboration of products. This definition encompasses all forms of life, including plants and animals. On a global scale, the balance of nutrients and all energy transformations must be in equilibrium. Janick *et al*. (1976) described the nutritional aspect of this phenomenon succinctly:

  > The diversion of the flow of nutrients through the food cycle is the aim of all agricultural

> technologies. The distinction of modern agriculture is that it has augmented the food supply by increasing the rate at which nutrients flow through the cycle. This has been accomplished by several methods but by far the most common and one of the most important consists of spending the return of nutrients to the soil, where they can be reabsorbed. Hence, in order to feed the human population we must ensure the nutrition of an assortment of plants, animals and microorganisms.

Most plants require inorganic elements, nitrogen in the form of nitrate or ammonia, water, carbon dioxide and solar energy captured by the chlorophyll in the plant through photosynthesis. In this way, plants provide the essential link between the soil and animal life. The organic molecules (proteins, carbohydrates, lipids, minerals, vitamins) produced by plants provide the nutrients for animals, certain plants and for micro-organisms.

The science of nutrition requires the application of Chemistry, Physics and Mathematics, as well as the integration of advances in soil science, plant science, animal science, biochemistry, engineering production systems and other disciplines. The competent practicing nutritionist must not only be knowledgeable

in the nutrients and their chemistry, functions, occurrence, metabolism and metabolic interrelationships but must also be familiar with animal behaviour, physiology, genetics and husbandry and other disciplines.
The productivity of tropical livestock can be enhanced through improvement in feeding regimes and good management practices, among others. The improved feeding programmes imply the provision of feed rations which are complete and balanced nutritionally. Each specie and category of animals within a specie has different nutritional requirements which must be calculated with care to ensure maximum performance and productivity.

Animal nutrition, therefore, becomes a very vital management practice that must not be compromised if the ultimate aim of livestock production is maximum output. The quantity and quality of WHAT is fed to an animal at any given time and stage thereby represent a critical factor for urgent consideration and attention which must be managed with care.

Keeping farm animals is no simple or easy task. It requires both knowledge of the animal and what to feed them as well as the devotion to manage them by the rules of the game. The knowledge of both the stock and the rules must be properly channeled into the very ART and SCIENCE of feeding them. It must be noted that inputs are always directly proportional to outputs '*ceteris paribus*' and the farmer cannot (or should not) expect his stock to make any

wonderful production (performance) unless he feeds them properly, adequately and regularly.
However, care must be taken so that over-feeding is prevented, under-feeding is avoided and mal-nutrition is controlled always. The practice of livestock feeding requires that the stock-man must bear in mind that, apart from high productivity, well-fed animals are more resistant to pests, parasites and diseases than their under-nourished counterparts.

The aim of every livestock farmer is to bring out maximum products and by-products (eggs, milk, meat, hides/skin, wools etc) from his stock; therefore, the realisation, acquisition and utilization of the basic techniques involved in the real **art and science** of livestock nutrition, forms a good starting point for any future achievement of his aims.

According to Komolafe *et al.* (1979), animal nutrition is an area of animal science that deals with the nature and properties of substances that can serve as feed for animals, the various proportions in which these substances could be made available to the animals at all times to suit their body needs, and the mechanisms that would convert these substances into animal products and tissues. The farmer must therefore, identify what to use in feeding his stock or else, they become useless. The impact of feed on various components of livestock operation is summarized in Figure 1.

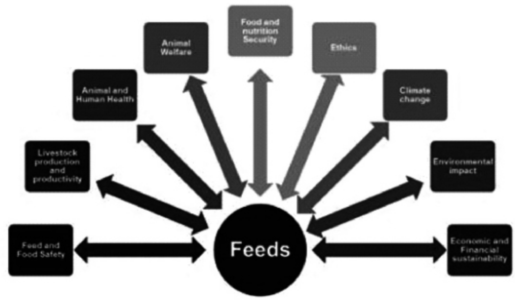


Figure 1: Ir ponents of livestock operation.

In summary, animal nutrition can be viewed in a simplified form as a practice which attempts to answer five basic questions:

(a) **WHAT** do you feed to the animal that you want to feed or are feeding?

(b) **WHICH** animal do you feed **what** you want to feed?

(c) **WHEN** do you feed **what** you want to feed to the animal?

(d) **WHY** do you feed **what** you are feeding to the animal?

(e) **HOW** do you go about the **art/science** of feeding the animal that you want to feed?

By the time the farmer properly provides answers to all these questions, the whole field of livestock feeding is understood and better appreciated. It is by attempting these questions that one come to realise the physiological and anatomical differences existing between the various farm animals as shown in Figure 2.

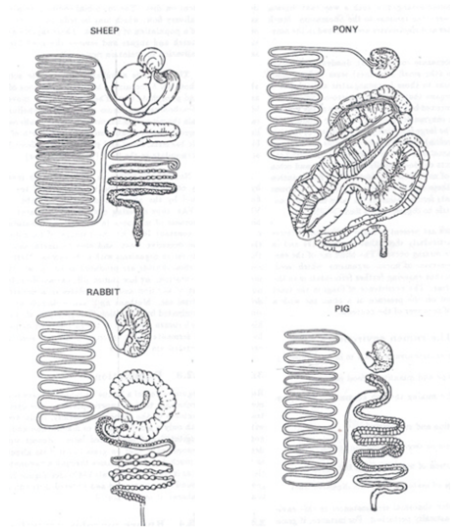


Figure 2: Diagrammatic representation of the digestive tracts of the sheep, horse, pig and rabbit

Some farm animals have very complex gastrointestinal tract (GIT) with rumen, reticulum, omasum and abomasum while others are purely monogastrics (non-ruminants) with simple GIT. Ruminants (cattle, goats, sheep, etc) for instance are animals with 4-stomach compartments (Fig. 2) and they can consume and digest a lot of roughage feeds without any problem whereas, non-ruminants (poultry, pigs, rabbits, etc) have simple stomach and are referred to as monogastrics which can not digest large quantities of roughage feeds. Therefore, knowing **which** animal to feed **what, why, when** and **how** becomes imperative in the overall **art** and **science** of feeding called animal nutrition.

4.0 DEFINITION OF SOME TERMS IN THE TITLE

a) **Feeds** are naturally occurring ingredients or materials fed to animals for the purpose of sustaining them. They are materials which after ingestion by the animal are capable of being digested, absorbed, utilised and transformed into body elements of the animal.

b) **Feedstuffs** is any product of natural or artificial origin, that possess nutritional value in the diet when properly prepared. In general, feedstuffs may be classified into one of the following categories – forages, concentrates, supplements, and additives.

c) **Panacea** means a solution or remedy for all difficulties. Something that will solve all problems (Cambridge Dictionary).

d) **Declining** means smaller or fewer or less relating to the period during which something is deteriorating or decreasing.

e) **Commercial** means concerned with or engaged in commerce. It also means making or intended to make a profit. A commercial product is one that is produced and sold in large quantities.

f) **Animal Agriculture** is the branch of agriculture concerned with animals that are raised for meat, fibre, milk, eggs or other products (organic fertilizers, hides, bones etc). It includes day-to-day care, management, selective breeding and raising of livestock.

g) **Food Insecurity** is the state of being without reliable access to sufficient quantities of affordable and nutritious food that meets dietary needs for an active and healthy life.

5.0 NUTRIENTS IN FEEDS AND FEEDSTUFFS

Nutrients are components of feeds that are essential for the preservation of life. They are otherwise referred to as food substances and identified as follows: water, carbohydrate, proteins, fats/oil, minerals and vitamins.

5.1 **Water**

Water, the simplest of feed nutrients, plays an important role in all life processes. It is an essential part of a diet, which is readily available and is the cheapest, its importance is sometimes ignored. Animals require water for the formation of their bodies and it exists in the body as part of the protoplasm or as a major component of every animal, accounting for 50-80% of body mass. A constant supply of clean and fresh water is essential for the survival of livestock. Water is the constituent of the blood, lymph, cells, and the quality of fresh water that an animal requires varies with a number of variable factors namely: water content of feed, prevailing enviro-climatic conditions, the metabolic water available, age, breed/type of the animal, its size, activity/productive ability, physiological state, type of products, etc.

Generally, animals obtain water by drinking directly, as a constituent of feeds and through metabolic process. Research has shown that a starving animal can lose nearly all its carbohydrates, fats, as well as 50% of its protein without dying, however, if it loses 10% of its water, serious disorders will start and if 20% is lost, the animal dies.

5.2 Proteins

These are complex nitrogenous compounds composed of chains of simpler units called amino acids. Proteins are vital components of all animal cells. The soft tissues and internal organs of animal body have protein as their main constituent. The transformation of food protein consumed into the body is vital nutritional process which sustains growth and repair. The body of animals build up their protein primarily from the amino acids absorbed from the digested dietary protein. Proteins are classified or divided into two groups depending on the complexity of its chains:

(i) Simple Proteins produce only amino acids on hydrolysis. They include all high quality, commonest and true protein type found in meat, milk, eggs, fish etc. They are sub-divided into two groups – fibrous and globular proteins according to shape, solubility and chemical composition.

a. Fibrous proteins have structural roles in animal cells and tissues. They are insoluble and very resistant to animal digestive enzymes. They are composed of elongated, filamentous chains joined together by cross-linkages. Examples are:

- Collagens – proteins of the connective tissues
- Elastin – proteins found in the elastic tissues such as tendons and arteries.
- Keratin - -keratin (proteins of wool and hair); -keratin (proteins of feathers, skin, beaks and scales).

b. **Globular Proteins** include all the enzymes, antigens and hormones which are proteins. Examples are:

- Albumins are water soluble and heat-coagulable and occurs in milk, blood, eggs and many plants.
- Histones are basic proteins which occur in cell nuclei where they are associated with DNA, they are soluble in salt solution and are not heat-coagulable.
- Protamines are basic proteins of relatively low molecular weight, which are associated with nucleic-acids and are found in large quantities in mature male germ cells of vertebrates.
- Globulins occur in milk, eggs and blood and the main reserve protein in many seeds.

(ii) Coagulated Proteins contain, in addition to amino acids, a non-protein moiety termed prosthetic group. Examples are glycoproteins, lipoproteins, phosphoproteins and chromoproteins.

a. Glycoproteins are components of mucous secretions acting as lubricants in many parts of the body and also as storage of protein in egg-white and ovalbumin.
b. Lipoproteins are proteins conjugated with lipids such as triacylglycerides and cholesterol which are the main components of cell membranes and are also the form in which lipids are transported in the bloodstream to tissues, either for oxidation or for energy storage. They can be classified into three main categories in increasing order of density; chylomicrons, low density lipoproteins (LDL), high density lipoproteins (HDL).
c. Phospoproteins contain phosphoric acid and include the caseins of milk and phosvitin in egg yolk.
d. Chromoproteins contain a pigment as the prosthetic group in which the iron-containing compound haem as found in haemoglobin and cytochromes and also flavin in flavoproteins are examples.

5.3 Carbohydrates

These are substances containing the elements C,H,O in certain proportions. Carbohydrates are mainly energy producers and form a greater bulk of livestock feeds providing the main source of energy and without energy, all metabolic processes which keep animals alive will automatically stop and the animal will die. Carbohydrates include sugars, starches, celluloses, hemicelluloses etc and differented into mono-, di-, tri- and poly-saccharides depending on the number of sugar molecules present in them. Animals obtain their carbohydrates from the external environment (compared with plants which synthesize carbohydrates by photosynthesis). Sugars and starches, as found in green plants, are used as food by animals:

i. **Sugars** are the first substances manufactured during photosynthesis in the green leaf. There are two types of sugars known as simple and complex sugars. Forms of simple sugars are glucose or grape sugars and fructose or fruit-sugars and galactose. All simple sugars have the same chemical formula – CnH_2n+On where 'n' represents the number of atoms present. All simple sugars occur in nature in dried raisins, sweet fruits, honey, roots and leaves of some plants. They have a sweet taste and dissolve slowly in water and are otherwise called reducing sugars. They are generally called monosaccharides. Complex sugars compose of sucrose or cane-sugar, maltose or malt-sugar, lactose or milk-sugar. Complex sugar are found in large quantities in sugar cane, breast milk, and malt-extracts. They are far more soluble in water and are easily converted by hydrolysis into simple sugars by enzymes or by acids. They are generally called disaccharides obtained by condensation of two simple sugar molecules: sucrose (glucose + fructose), maltose (glucose + glucose) and lactose (glucose + galactose).

ii. **Starch** is formed through the condensation of a large number of simple sugars in the chloroplasts of green plants. Starch is insoluble in water and is stored in granules in various parts of plants and available in foodstuffs such as rice, cocoyam, yam, potatoes, maize, cassava, millet, oats, etc.

iii. **Cellulose** is starch converted through a process called polymerization (many molecules of starch). Cellulose is only found in plants where it forms the supporting structure of plant stems. This form of carbohydrate does not play any vital role in livestock nutrition, although often taken in when animals consume herbage with high fibre content at advanced stage. It plays a little role in ruminal digestion.

5.4 **Fats/Oils** are energy producing groups of food nutrients containing carbon, hydrogen and oxygen, but unlike carbohydrate, the hydrogen:oxygen ratio is not as in water (H_2O). Fats are oils at room temperature and generally found in solid form in animals while oils are purely liquids or melted fats found in plants. Fats are insoluble in water except in ether, benzene and chloroform.

Animal fats are found in the body as part of the structural components of the cells called essential fats; as found in the brain, liver, milk, egg and heart; they may be stored around the intestines and under the skin. Fats are used up during oxidation yielding high energy more than what the same unit of starch will yield. Fats/Oils are found in abundance in fruits and seeds e.g. groundnuts, coconut, melon, cashewnuts, soybean, oil-palm fruits, cottonseeds, castor seeds etc.

5.5 **Minerals** are elements needed for their importance in the vital activities of the body. They are needed in fairly small quantities and they exist in the body of the animal as ions or as compounds of organic compounds of the body. The sources of these elements are bones, seashells, oyster shells, limestone, meat, common salt, zinc oxide, manganese sulphate or oxide. Among the minerals required by animals are calcium, phosphorus, sulphur, potassium, sodium, chlorine, iron, magnesium, manganese, zinc etc. Animals usually obtain these minerals when they consume plants, also minerals are often added to the diet as supplements. All these minerals are not required in the same proportions; while some are needed in large quantities (macro-minerals), others are required in trace quantities (trace minerals). Generally, the demand for minerals by an animal depends on the activities and species of the animal.

5.6 **Vitamins** are active substances, essential for life of man and animals. They belong to the micronutrient group and are required for normal metabolism in animals. They are required in adequate levels to enable the animal efficiently utilise all other nutrients in the feed. Vitamins are essential for optimum health, as well as normal physiological functions such as growth development, maintenance and reproduction. As vitamins cannot be synthesized, they must be obtained from the diet.

Vitamins are present in many feedstuffs in minute amount and can be absorbed from the diet during digestive process. Vitamins are grouped into two broad classes on the basis of their solvents – water or fat, hence, we have water-soluble vitamins – B complex and C, fat-soluble vitamins – A, D, E, K while water-soluble vitamins (B and C) are composed of only C, H, O. All vitamins B and C groups appear to be responsible for energy transfers in the body while ADEK see to the regulation of the metabolism of the structural units of the body.

5.7 **Feed Additives**

Feed additive is an ingredient or a combination of ingredients added to the basic feed mix or parts thereof to fulfil a specific need. Feed additive can also be referred to as any chemical incorporated in an animal feed for nutritional purpose of improving rate of gain, feed efficiency, feed utilization or preventing and controlling diseases or acting as protection against unwanted environmental influences. Varieties of feed additives are used in animal feed and are usually used in small quantities of about 1% or less and requires careful handling and mixing. Feed additives are broadly classified into two (2):

i. Nutritive feed additives include Amino acids, minerals and vitamins.
ii. Non-nutritive feed additives are Antibiotics, hormones, coccidiostat, enzymes, probiotics, prebiotics, antioxidants, mycotoxin binders, flavouring agents, colouring agents.

The advantages of feed additives in feed include:

- Increased feed quality and palatability
- Improved animal performance
- Improved feed efficiency and nutrient utilization
- Improved final products from farm animals
- Reduced cost of animal protein for human consumption.

Feed additives are beneficial in animal nutrition to a very great extent, but certain side-effects associated with their use make them disadvantageous, For instance residues of these substances e.g. antibiotics are likely to remain in meat/milk and pose possible danger to public health.

6.0 MY RESEARCH ACTIVITIES AND CONTRIBUTIONS TO KNOWLEDGE

Mr. Vice-Chancellor, Sir, having highlighted the significance of feeds and feedstuffs in the efficient nutrition of farm animals. I wish to discuss my humble contributions in specific aspects of feeds and feedstuffs in nutrition of farm animals.

In the course of my career in research, my philosophy and focus has been on exploring alternatives to some feed ingredients in monogastric animal nutrition with the aim of reducing cost and ultimately making animal protein more available for Nigerians. As we know, the rising cost of animal products for human consumption has direct correlation with the cost of animal feeds, and, indirectly, the general well-being of man.

I wish to state that my research activities over the past 36 years can be concisely summarized at a glance as summary of feeds, feedstuffs and experimental animals for my research activities.

SUMMARY OF FEEDS, FEEDSTUFFS AND EXPERIMENTAL ANIMALS USED FOR MY RESEARCH ACTIVITIES

❖ **Energy Feedstuffs**

a. Tigernut (*Cyperus rotundus)* meal
b. Ripe and unripe plantain (*Musa paradisiaca)* peels
c. Cowpea (*Vigna unguiculata)*
d. Maize (*Zea mays)* cobs
e. Wild variegated cocoyam (*Caladium hortulanum)* corm meal
f. Peeled and unpeeled Cassava (*Manihot esculenta*) root meal
g. Cassava peels
h. Kolanut (*Cola acuminata)* husk
i. Yam (*Discorea rotundata)* peels
j. Indomie noddles wastes
k. Macaroni wastes
l. Corn flakes rejects
m. Acha rice (*Oriza sativa)*
n. Breadfruit (*Artocarpus altilis)*
o. Wheat (*Triticum aestivum)*
p. Sorghum (*Sorghum bicolor)*
q. Cassava sievates
r. Millet (*Pennisetum glaucum*) residues

❖ **Protein Feedstuffs**

a. Animal Protein Feedstuffs

i. Local blood meal
ii. Local and imported fish meals
iii. Chicken offal meal
iv. Maggot meal

b. Plant Protein Feedstuffs

i. Raw soyabean *(Glycine max)*
ii. Full fat soyabean
iii. Roasted full-fat soyabean
iv. Extruded full-fat soyabean
v. Defatted soyabean cake
vi. Glanded cottonseed cake
vii. Pigeon pea (*Cajanus cajan)* seed meal
viii. Groundnut (*Arachis hypogea*) cake
ix. Cashewnut (*Anacardium occidentale*) rejects
x. Castor oil seed (*Ricinus communis)* meal
xi. Sunflower (*Helianthus spp)* meal
xii. Sesame *(Sesamum indicum)* meal
xiii. Bambara groundnut (*Vigna substerranea)* seeds meal
xiv. Baobab (*Adansonia digitata)* seed meal
xv. Rapeseed (*Brassica napus)* meal

❖ **Combinations of Energy-Protein Feedstuffs (Blends)**

a. Extruded Corn-Soyabeen (ECS)
b. Cashewnut rejects – Maize milling wastes (CMW)
c. Cassava-Soyabeen meal (CASSOY)

❖ **Fibrous and Forage Feedstuffs**

a. Rice milling wastes
b. Sorghum milling wastes
c. *Syndrella nodiflora*
d. Soyabean siftings
e. Sawdust
f. Maize milling wastes
g. Cassava offals
h. Brewer's dried grain

❖ **Mineral Sources**

a. Discarded egg shells
b. Discarded snail shells

❖ **Feed Additives**

a. Amino acids, Lysine - L-Arginine, DL-Methionine, Herbal Methionine
b. Xylanase Enzyme
c. Prebiotics – Mannan oligosaccharids (MOS), Arabinoxylan oligosaccharide (AX)
d. Probiotics – *Prediococcus acidilactis, Bacillus cereus*
e. Charcoal
f. *Zymomonas mobilis*
g. Baobab (*Adansonia digitata*) leaves ("Luru")

❖ **Vitamin Source**

a. Ascorbic acid (Vitamin C)

❖ **Value-Added Rabbit Meat**

a. Rabbit meat processing and packaging

❖ **Experimental Animals**

a. Albino rat (*Rattus rattus*)
b. Broiler chickens
c. Turkeys
d. Cockerel chickens
e. Laying hens
f. Rabbits
g. Pigs

6.0.1 Nutritional evaluation of some feedstuffs

Basically, I evaluated the nutritional value of some plant protein concentrates in Nigeria with emphasis on protein quality (Table 1) and metabolisable energy (Table 2) for their usage as potential feedstuffs in monogastric animal nutrition (Bamgbose *et al.* 1989a; Bamgbose *et al.* 1989b).

Table 1: Protein quality of some oilseed cakes using rats

	CSC I	CSC II	FFSBM I	FFSBM II	FFSBM III	SBM I	SBM II	SBM III	GNC I	GNC II	RSBM	ECS	S.EX
Average Initial Weight (g)	47.94	44.00	45.11	43.55	49.21	45.39	41.99	45.09	43.77	46.02	46.30	45.26	0.41
Average final weight (g)	58.68	56.66	68.48	66.12	63.34	62.77	59.73	64.37	48.92	63.13	63.65	63.45	0.15
Feed intake (g)	118.21^{abc}	128.79^{a}	120.11^{ab}	17.75^{bc}	114.31^{bcd}	118.79^{abc}	105.74^{d}	108.33^{cd}	109.80^{bcd}	111.75^{bcd}	90.27^{e}	107.76^{cd}	3.44
Crude Protein of diet (%)	9.98^{b}	10.03	10.08^{b}	10.14^{b}	10.19^{b}	10.09^{b}	10.11^{b}	10.32^{b}	10.00^{b}	10.45^{a}	10.77^{a}	10.31^{b}	0.001
Protein Intake (g)	11.80^{bc}	12.92^{a}	12.11^{ab}	11.94^{abc}	11.64^{bcd}	10.69^{d}	11.99^{abc}	1067^{d}	10.98^{cd}	11.68^{bcd}	9.71^{e}	11.11^{bcd}	0.32
Weight gained (g)	10.74^{e}	12.66^{de}	23.37^{a}	22.57^{a}	15.13^{cd}	17.38	17.74^{bc}	19.28^{b}	17.35^{bc}	18.19^{b}	5.15	17.11^{bc}	0.94
Protein efficiency ratio (PER)	0.91^{f}	0.98^{f}	1.93^{a}	1.89^{a}	1.30^{e}	1.45^{de}	1.66^{bc}	1.72^{b}	1.58^{bcd}	1.56^{bcd}	0.53^{g}	1.54^{cd}	0.06
Net Protein retention (NPR)	2.19^{d}	2.14^{d}	3.18^{a}	3.15^{a}	2.59^{c}	2.70^{c}	3.07^{ab}	3.07^{ab}	3.08^{ab}	3.00^{ab}	2.08^{d}	2.81^{bc}	0.09
Protein retention efficiency (PRE)	37.45^{d}	36.51^{d}	54.38^{a}	53.90^{a}	43.14^{c}	46.17^{c}	51.98^{ab}	52.50^{ab}	52.14^{ab}	51.26^{ab}	35.57^{d}	48.03^{bc}	1.65
Net Protein retention (NPR)	2.19^{d}	2.14^{d}	3.18^{a}	3.15^{a}	2.59^{c}	2.70^{c}	3.07^{ab}	3.07^{ab}	3.05^{ab}	3.00^{ab}	2.08^{d}	2.81	0.09
Protein retention efficiency (PRE)	37.45^{d}	36.51^{d}	54.38^{a}	53.90^{a}	43.14^{c}	46.17^{c}	51.98^{ab}	52.50^{ab}	52.14^{ab}	51.26^{ab}	35.57^{d}	48.03^{bc}	1.65
Biological value (BV)	50.95^{e}	53.88^{de}	73.01^{a}	71.06^{ab}	59.00^{cd}	61.00^{c}	63.00^{c}	65.00^{bc}	62.99^{c}	59.95^{cd}	44.00^{i}	58.04^{cd}	2.16
Apparent Protein digestibility (APD)	54.41^{c}	58.33^{bc}	76.31^{a}	75.26^{a}	70.42^{a}	71.25^{a}	71.53^{a}	72.37^{a}	71.99^{a}	70.95	46.26^{d}	81.15^{b}	2.00
True protein digestibility (TPD)	61.12^{b}	66.93^{b}	80.73^{a}	79.09^{a}	74.91^{a}	75.19^{a}	75.00	76.13^{a}	76.27^{a}	76.40^{a}	50.64^{c}	65.29^{b}	2.62

^{a,b,c} *means without common superscripts on the same rows are significantly different (P<0.05)*

	CSC I	CSC II	FFSBM I	FFSBM II	FFSBM III	SBM I	SBM II	SBM III	GNC I	GNC II	RSBM	ECS	S.EX
Average Initial Weight (g)	41.48	43.20	42.14	43.85	41.51	44.54	42.83	40.17	42.24	42.69	40.17	41.44	0.31
Average final weight (g)	72.26	80.11	101.73	101.56	83.69	84.48	80.13	72.60	83.08	97.79	55.60	72.03	0.25
Weight gained (g)	30.78^{e}	36.91^{d}	59.59^{a}	57.71^{ab}	42.18^{c}	39.94^{cd}	37.30^{d}	32.60^{e}	40.84^{cd}	55.10^{b}	15.43^{f}	32.59^{e}	1.31
Feed intake (g)	80.94^{d}	95.22^{a}	85.21^{c}	90.60^{b}	81.40^{d}	79.48^{d}	82.05^{d}	75.15^{e}	80.45^{d}	88.71^{b}	48.09^{f}	79.22^{d}	1.06
Feed/gain ratio	2.63^{b}	2.59^{b}	1.43^{f}	1.57^{ef}	1.93^{d}	1.99^{d}	2.20^{c}	2.31^{c}	1.98^{d}	1.62^{e}	3.12^{a}	2.59	0.05
Gross Energy (GE) (Kcal/g)	3.52	3.67	4.48	4.36	3.93	3.39	3.09	3.56	3.70	3.67	5.12	4.25	0.01
Digestible energy (DE) (Kcal/g)	2.87^{b}	3.00^{b}	3.68^{a}	3.67^{a}	2.76^{b}	2.70^{b}	2.74^{b}	2.71^{b}	3.01^{b}	2.93^{b}	2.62^{b}	3.54^{a}	0.99
Metabolisable energy (ME) (Kcal/g)	2.16^{h}	2.31^{fg}	3.55^{a}	3.32^{b}	2.62^{d}	2.41^{ef}	2.26^{ef}	2.35^{fg}	2.43^{ef}	2.51^{de}	1.18^{i}	3.00^{c}	0.04
DE/GE (%)	81.53^{bc}	81.74^{bc}	82.14^{b}	84.18^{ab}	70.49^{d}	79.65^{bc}	88.67^{a}	76.45^{c}	81.35^{bc}	79.84^{bc}	51.14^{e}	83.35^{b}	1.68
ME/DE (%)	75.32^{g}	77.95^{fg}	96.51^{a}	90.48^{bc}	94.61^{ab}	88.74^{bcd}	82.53^{def}	86.87^{cde}	80.75^{efg}	85.68^{cde}	44.86^{h}	84.99^{cde}	2.00
ME/GE (%)	61.08^{g}	62.94^{fg}	78.63^{a}	78.96^{a}	66.67^{def}	71.75^{bc}	73.14^{b}	66.30^{ef}	65.68^{ef}	68.67^{cde}	22.95^{h}	70.95^{bcd}	1.38
Nitrogen corrected ME (Men) (Kcal/g)	2.12^{g}	2.28^{efg}	3.49^{a}	3.29^{b}	2.57^{d}	2.38^{def}	2.21^{fg}	2.32^{efg}	2.41^{def}	2.49^{de}	1.15^{h}	2.98^{c}	0.07

^{a,b,c} *means without common superscripts on the same rows are significantly different (P<0.05)*

Furthermore, the nutritional value of some oilseed cakes- groundnut cake (GC), cottonseed cake (CSC), full fat soyabeans meal (FFSM), defatted soyabean meal (DSM), raw soyabeans (RS) sesames meal (SESM) and sunflower meal (SUFM) were assessed by chemical analyses (Table 3, 4 and 5). Crude protein content in the range of 44.25 to 50.54% were recorded with FFSM, GC, DS, SESEM, while CSC gave highest crude fibre of about 20% and the highest either extract content between 18.55 to 19.94 were obtained with FFS products.

Phosphorus was abundant while magnesium was the least occurred mineral among the oilseed feedstuffs. Calcium occurred abundantly in soyabean. Feedstuffs and sesame meal, percent phytic, phytin phosphorus and tannin were higher in raw soyabean, CSC, GC, RASM, SUFM and SMSM. Trypsin inhibition activity (TIA) was highest in RS and CSC gave significantly higher free and total gossypol. SUFM, SESM, RASM and soyabean products gave the highest values for available methionine while highest nitrogen solubility and available lysine occurred in FFS 1 and 2. Based on their nutrient profile, oilseed cakes could serve as important plant protein sources in livestock production in Nigeria (Bamgbose, 1995).

Table 3: Proximate and mineral composition of some oilseed cakes (DM basis)

Samples (processing, texture)	DM[1] (%)	CP (%)	CF (%)	EE (%)	Ash (%)	P (%)	Ca (%)	K (%)	Na (ppm)	Mg (%)	Fe (ppm)	Ca (ppm)	Zn (ppm)	Mn (ppm)
CSC 1 (undecorticated hydraulic press, flake)	92.27	36.16	19.96	13.42	5.04	1.05^{c}	0.16^{gh}	0.60^{g}	181^{a}	0.28^{a}	33.05^{f}	11.00^{cde}	57.00^{a}	150.00^{a}
CSC 2 (decorticated screw- press, flake)	93.01	37.59	20.22	10.94	4.25	0.92^{c}	$0.20f^{g}$	0.68^{g}	172^{b}	0.24^{b}	48.75^{e}	25.00^{a}	46.00^{b}	123.50^{f}
FFS 1 (extrusion-cooking, granules)	93.36	44.25	5.76	19.94	5.11	0.65^{g}	0.30^{d}	1.76^{bc}	125^{gh}	1.19^{cd}	112.00^{a}	13.00^{a}	35.00^{cde}	129.00^{de}
FFS 2 (extrusion-cooking, granules)	91.21	42.31	4.29	18.67	4.50	0.60^{hi}	0.31^{d}	1.81^{ab}	131^{f}	0.16^{d}	49.90^{de}	11.50^{ed}	40.50^{bc}	134.75^{bc}
FFS 3 (toasting, broken flakes)	91.54	42.50	5.82	18.35	7.61	0.77^{f}	0.29^{d}	1.47^{d}	143^{d}	0.17^{cd}	59.75^{cd}	$10.50c^{de}$	36.50^{cde}	138.50^{b}
DS 1 (hydraulic press, flake)	92.43	42.41	5.32	5.97	6.97	0.60^{hi}	0.26^{e}	1.91^{a}	117^{hi}	0.10^{e}	73.00^{b}	10.50^{cde}	$37.00c^{d}$	124.50^{f}
DS 2 (hydraulic press, flake)	92.60	47.25	5.23	5.61	5.60	0.56^{h}	0.32^{d}	1.67^{c}	120^{hi}	0.18^{c}	24.30^{f}	7.50^{c}	27.50^{f}	131.00^{cd}
DS 3 (toasting-expeller, flake)	88.69	45.49	6.08	5.53	6.49	0.59^{hi}	0.30^{d}	1.69^{c}	127^{fg}	0.17^{cd}	62.50^{c}	21.00^{b}	30.50^{ef}	117.00^{g}
GC 1 (screw-press, flake)	99.10	44.43	4.96	9.88	4.03	1.30^{x}	0.14^{h}	0.70^{g}	111^{j}	0.17^{cd}	46.45^{c}	$9.00d^{ee}$	34.00^{de}	113.00^{h}
GC 2 (screw-press, flake)	94.83	50.54	3.81	7.88	4.24	0.98^{d}	0.12^{h}	0.60^{g}	124^{g}	0.10^{e}	25.00^{f}	$9.50cd^{e}$	45.00^{b}	126.50^{ef}
ECS (extrusion-cooking, pellets)	92.80	37.81	5.93	11.77	4.76	0.58^{hi}	0.21^{f}	1.50^{d}	$128f^{g}$	0.27^{a}	70.00^{bc}	$9.00d^{e}$	32.50^{def}	126.00^{ef}
RS (ground, mash form)	93.66	39.57	6.05	19.00	6.35	0.62^{g} h	0.28^{d}	1.74^{bc}	161^{c}	0.11^{e}	74.00^{b}	7.50^{e}	31.00^{ef}	138.00^{b}
RASM (expeller, flake)	91.48	36.42	13.75	1.75	7.40	0.25^{k}	0.70^{b}	1.04^{f}	115^{l}	0.13^{e}	28.21^{f}	7.88^{e}	30.00^{ef}	132.00^{cd}
SESM (expeller, flake)	94.00	46.22	6.90	7.30	11.60	1.17^{b}	1.87^{z}	1.20^{e}	137^{e}	0.12^{e}	24.55^{f}	7.11^{e}	33.41^{de}	112.00^{h}
SUFM (expeller, flake)	92.67	37.55	17.66	0.97	6.80	0.32^{j}	0.47^{c}	1.23^{e}	122^{hi}	0.15^{d}	30.14^{f}	$9.13d^{e}$	26.00^{f}	127.12^{ef}
S. EX	–	–	–	–	–	0.01	0.01	0.02	0.03	0.02	3.20	1.00	1.79	1.27

[a,b,c] means without common superscripts on the same column are significantly different (P<0.05)

DM', Dry matter; CP, crude protein; EE, ether extract; P, phosphorus; Ca, calcium; K, potassium; Na, sodium; Mg, magnesium; Fe, iron; Cu, copper; Zn, zine; Mn, manganese. (a-j) means without common superscripts in vertical rows are significantly different (P<0.05).

Table 4: Antinutritional factors of some oilseed-cakes

	Phytin (%)	Phytin phosphorus (%)	Tannin (mg/100g)	Urease activity (DPH)	Dye binding capacity (cresol-red absorbed mg/g)	Trypsin inhibitor activity (mg/g)	Free grossypol (%)	Total gossypol (%)
CSC 1	1.74^{b}	0.49^{b}	4.11^{a}				0.099^{a}	1.13^{a}
CSC2	1.95^{a}	0.55^{a}	3.59^{b}				0.061^{b}	1.01
FFS 1	0.71^{g}	0.20^{e}	2.00^{b}	0.08^{d}	4.23^{a}	3.88^{b}		
FFS 2	0.60^{g}	0.17^{ef}	2.19^{b}	0.10^{d}	4.10^{b}	4.25^{a}		
FFS 3	0.50^{gb}	0.14^{fg}	2.45^{a}	0.17^{b}	3.52^{a}	5.53^{b}		
DS 1	0.36^{b}	0.10^{b}	2.80^{f}	0.13^{bc}	3.75^{cd}	4.78^{e}		
DS 2	0.32^{b}	0.09^{b}	2.92^{e}	0.15^{bc}	3.68^{d}	5.13^{d}		
DS 3	0.57^{g}	0.16^{f}	2.75^{f}	0.16^{bc}	3.55^{e}	5.41^{c}		
*GC 1	1.46^{e}	0.41^{c}	3.08^{d}					
*GC 2	1.7^{gb}	0.50^{b}	2.88^{ef}					
RS	1.17^{b}	0.33^{d}	3.41^{c}	0.25^{a}	2.93^{f}	8.51^{a}		
ECS	0.39^{h}	0.11^{gb}	2.35^{g}	0.11^{cd}	3.80^{c}	4.44^{f}		
RASM	1.10^{f}	0.45^{c}	3.22^{c}					
SESM	1.55^{d}	0.41^{c}	3.00^{d}					
SUFM	1.61^{c}	0.42^{c}	2.79^{f}					
S.EX	0.02	0.01	0.07	0.05	0.26	0.32		

[a-h] means without common superscripts in columns are significantly different (P<0.05);
*did not fluorescence under ultraviolent light.

Table 5: Chemical evaluation of some oilseed cakes

	CSC 1	CSC 2	FFS 1	FFS 2	FFS 3	DS 1	DS 2	DS 3	GC 1	GC 2	RS	ECS	RASM	SESM	SUFM	S.EX
Available lysine (g/16$_g$N)	2.85^{bcd}	2.69^{cd}	4.25^{a}	0.06^{a}	3.60^{abc}	3.76^{ab}	3.70^{abc}	3.62^{abc}	3.47^{abc}	3.50^{abc}	2.34^{abc}	3.38^{abc}	1.78^{e}	1.31^{f}	1.23^{f}	0.29
Available methionine (g/16$_g$N)	0.67^{f}	0.63^{fg}	0.97^{c}	0.83^{cd}	0.77^{de}	0.81^{d}	0.70^{ef}	0.74^{e}	0.51^{g}	0.59^{g}	0.41^{b}	0.75^{c}	0.89^{c}	1.23^{b}	1.35^{a}	0.03
Nitrogen solubility index (%)	31.02^{bc}	32.38^{b}	24.00^{g}	24.60^{dc}	27.06^{de}	25.00^{fg}	27.14^{de}	26.25^{def}	27.80^{d}	30.00^{c}	36.03^{a}	25.25^{efg}	34.22^{ab}	34.78^{ab}	35.31^{a}	0.11
Protein dispersibility index (%)53	54.56^{b}	53.86^{b}	40.61^{h}	41.24^{h}	50.97^{de}	46.11^{g}	50.00^{f}	52.04^{c}	50.13^{cd}	51.32^{cd}	66.71^{a}	45.26^{g}	55.10^{ab}	58.44^{ab}	60.77^{a}	0.29
Nitrogen solubility (% in 6N-HCl)	50.01^{i}	53.42^{g}	80.09^{a}	78.58^{b}	63.36^{e}	67.67^{c}	61.66^{f}	64.00^{e}	62.26^{f}	59.75^{g}	45.89^{j}	66.17^{d}	48.37^{ij}	45.44^{j}	46.23^{j}	0.58

$^{a-j}$ means without common superscripts in rows are significantly different ($P<0.05$)

The effect of cooking, autoclaving and roasting on the nutrient and anti-nutrient components of bambara groundnut seeds (BGS) were determined in a joint research by Omoikhoje *et al.* (2006a). It was concluded that processing enhanced the proximate and mineral components of BGS with roasting being the best while the processing techniques adopted significantly reduced the anti-nutrients suggesting that these processing techniques can minimize the concern posed by metal chelation and protein binding actions brought by the phytate naturally present in food materials of plant origin. Related collaborative study by Omoikhoje *et al.* (2006b) documented the proximate and mineral compositions, gross energy, sugars, oligasacharides and some anti-nutrient substances of raw, soaked, dehulled and germinated bambara groundnut seeds. It was observed that germinated BGS is superior to soaking and dehulling with respect to nutrient retention and inactivation of inherent anti-nutrient substances, confirming that germinated bambara groundnut seeds can be used as source of plant protein for man or livestock.

6.1 Rat studies

One of the most serious problems facing the feed industry is inadequate supply of feed ingredients for animal production. Hence, it is imperative that more studies be carried out with lesser known feedstuffs which hopefully will supply the same or nearly the same kind and amount of nutrients supplied by the commonly used feedstuffs like maize and imported fish meal and at an affordable cost.

i. A six weeks trial was conducted to investigate the effect of replacing maize at 50 and 100% levels with sorghum residue (SR), millet residue (MR), maize offal (MO) and tigernut meal (TGN) while replacing imported fish meal at 50 and 100% levels with local fish meal (LFM) and local blood meal (LBM) on performance, relative organ weights and nutrient digestibility of albino rats (Bamgbose *et al.,*1999). Results indicated that maize could be replaced with SR and MO at 50% level without any significant reduction in growth performance and nutrient utilization while LBM at 50% replacement level compared favourably with imported fish meal.

ii. In another study, feeding trial was conducted with albino rats to determine the nutritive value of processed baobab seed meal as replacement for soyabean meal at 33.33%, 66.67% and 100%. It was recommended that baobab seed meal as a protein source at 33.33% level supported improved growth performance and can replace soyabean meal without any deleterious effect on the growth rate of rats. (Yusuf *et al.,* 2008).

6.2 Energy Feedstuffs

It is a known fact, that energy feedstuffs represent the highest percentage in a typical monogastric animal diet and they supply energy to the farm animals. My scientific contributions over the years covered some alternative energy feedstuffs and I will enumerate a few here-under.

6.2.1 Tigernut meal (*Cyperus rotundus)*

A pilot survey showed that tigernut is available all year round in the semi arid and arid zones of Northern Nigeria (Bamgbose, 1993) and because of the emphasis on the utilization of alternative feedstuffs in developing the livestock industry in the developing countries, this study was undertaken to assess the effect of feeding tiggernut meal (TGN) as replacement for maize in diets of weaner rabbits. TGN replaced maize at 0, 20, 40, 60, 80 and 100% levels to give six diets.

On dry matter basis (g/kg) the TGN contained 942.4 ± 0.94 dry matter, 78.8 ± 0.20 protein, 173.3 ± 0.36 fat, 83.5 ± 0.09 fibre, 44.4 ± 0.29 ash, 1.6 ± 0.09 calcium, 6.0 ± 0.07 phosphorus, 2.8 ± 0.22

lysine and 3.3 ± 0.23 methionine while maize contained 8900 ± 0.78 dry matter, 97.5 ± 0.45 protein, 39.8 ± 0.46 fat, 20.5 ± 0.11 fibre, 13.0 ± 0.34 ash, 0.2 ± 0.05 calcium, 2.9 ± 0.21 phosphorus, 2.4 ± 0.19 lysine and 1.9 ± 0.11 methionine. The optimal replacement level of maize with TGN for weaner rabbits was 60% (300g/kg). No mortality was recorded suggesting that the weaner rabbits were able to tolerate the TGN based diets (Bamgbose *et al.,* 1997).

Furthermore, the utilization of tigernut meal in poultry feeding was explored with a feeding trial and the effect of feeding graded levels of tigernut meal (TGN) as replacement for maize in the diets of cockerel starters with emphasis on carcass yield and economics of feed conversion (Bamgbose *et al.,* 2003).

Inclusion of TGN at 33.33% in cockerel diets supported better carcass yield in terms of weights of eviscerated carcass, drumstick, thigh, wings, lungs and heart without significant differences in values obtained. The recommended replacement level of maize with TGN was 33.33% with feed cost savings between 4.88% and 8.9%. It required a feed cost of N42.90 ($ 0.31) to produce one kilogram weight gain on diet 2 (33.33%).

6.2.2 Cocoyam Corm Meal *(Caladium hortulanum)*

The wild variegated cocoyam *(C. hortulanum)* is a neglected variety of cocoyam because it is not edible to humans. It is a high forage and corm yielding tuber crop having high potential as energy supplement in livestock feeds. Chemical analysis indicated that variegated cocoyam corm meal (VCM) has 7.21% crude protein, 1.48% crude fibre, 3.60% ether extract, 5.60% ash, 0.76% calcium, 0.51% phosphorus and 5.01 kcal/g gross energy (Esonu *et al.*, 2000a; Esonu *et al.,* 2000b).

Two trials were conducted with broiler chickens, in the first trial, raw wild cocoyam corm meal replaced maize at 0, 5, 10, 15 and 20% for broiler starters while in the second trial, raw wild cocoyam corm meal was included at 0, 10 and 20% for broiler finishers. Data obtained on performance, organ measurements and apparent nutrient digestibility suggested that RWCCM could be incorporated in broiler starter diet at 15% and broiler finisher diet at 20% for comparable performance and economic benefits (reduced feed cost).

6.2.3 Instant Noodle Wastes.

I have tried to harness and improve the utilization of agro-industrial by-products and wastes that are not directly used by man and are usually less expensive for the feeding of farm animals. Instant Noodle Wastes (INW) which is derived from the processing of noodles is a wheat product with lots of residues and is one of such agro-industrial by –products that needs to be tested for its potential usage as poultry feed ingredient.

In a collaborative research, Lala *et al.* (2009) assessed the utilization of instant noodle wastes as replacement at 0, 15 ,30 and 45% for maize in diets of cockerel chickens. Results revealed that inclusion of up to 45% instant noodle wastes in starting and finishing cockerels supported optimum growth without adverse effect on nutrient digestibility, haematological indices, serum chemistry, carcass yield and taste of the meat.

Other industrial by-products are macaroni wastes, golden morn wastes, spaghetti wastes which can be used as energy feedstuffs in place of maize in diets for monogastric animals.

6.2.4 Other Unconventional Energy Feedstuffs

Maize constitutes the bulk of energy source used in compounding feed for various classes of livestock in the different regions in Nigeria. The current prohibitive prices of maize and the great diversity of uses for which they are put, stemming directly from their demand as stable human foods in many areas of developing world and as industrial raw materials threaten, more than ever before, the potentials for increasing animal protein production.

The future for efficient and profitable production of meat and eggs from poultry, pigs and rabbits would, therefore, depend on finding cheaper alternative sources of energy not directly required as components of human diets. I wish to briefly explain my collaborative research activities on the following additional unconventional energy feedstuffs.

6.2.4.1 Plantain peels

The peels from plantain (*Musa paradisaca)* is a by-product not directly utilizable by human. Of the 28.3 million tonnes of plantain produced worldwide, 69.4% is destined for human consumption, 11.1% processed and 8% fed to livestock. More than 6% of this world volume is produced and consumed in Central and West Africa (Spore, 1998).

It was reported that dried plantain peels can serve as a direct replacement for maize in diet of rabbit without any impediment in their growth efficiency (Ketiku, 1973) while there was optimum production with 5% replacement value of plantain peels for maize on layer performance (Dairo *et al.,* 1987).

An experiment was conducted (Fanimo *et al.,* 1999) to determine the effects of ripe and unripe plantain peels as replacement for maize on the performance and carcass characteristics of broiler chickens. The dried plantain peel (DPP) was included in the diets to replace maize at 0, 7.5, 15.0, 22.5 and 30% levels in iso-nitrogenous and iso-caloric diets with 22% crude protein (CP) and 14.3MJ metabolisable energy (ME) per kg diet in the starting phase and 18% CP and 14.0MJ/kg diet in the finishing phase. Results showed that the 22.5 and 30% (higher) inclusion levels of DPP in the diets depressed weight gain and feed consumption at the starting phase and weight gain at the finishing phase. In conclusion, DPP could be included in broiler diet up to 15% while ripeness improved the performance of the broiler chickens.

6.2.4.2 Kolanut husk

The fact that the availability of the world's raw materials is dwindling as population grows exponentially, together with the real threat of global food shortages, contributes to a growing awareness of the need for conservation and the re-use of things which otherwise, would have been thrown away without a second thought.

Agro-industrial by-products and crop residue such as maize offals, cassava peels, rice husk, cassava shiftings, cocoa pod husk, kolanut husk etc have proved to be valuable in replacing (partially or wholly) maize in monogastric nutrition (Ogbonna and Adebowale, 1993).

Oluokun and Olalokun (1999) reported that Nigeria produced 2 million metric tonnes of kolanut annually which represented 70% of world Kolanut production and majority of this kola were produced in the forest zone of South western Nigeria. Kolanut husk is a by-product from processing the seeds *Cola acuminata* and *C. nitida* and its nutritive quality has been reported (Babatunde and Hamzat, 2005). Kolanut husk meal (KHM) shared similarity with cocoa pod husk (CPH) but had higher crude protein and lower crude fibre contents than CPH. It was reported that KHM contained (g/kg): 139 crude protein, 173 crude fibre, 12.5 crude fat, 58.5 ash and 5,562 kcal/kg gross energy (Oluokun and Olalokun, 1999).

In a project I supervised, Abioye *et al.* (2006) assessed the effect of feeding kolanut husk meal (KHM) at five levels 0, 50, 100, 150 and 200 g/kg on growth performance and apparent digestibility of Anak 2000 broiler chicks. We concluded that the feeding value of KHM is low and if used to replace maize, it will have detrimental effects on broiler performance with increased cost of feed per kg weight gain.

6.2.4.3 Cowpea shell and Maize cobs

Rabbit production is being promoted as solution meat supply in Nigeria because of their sustainability to both large and small-scale production. Rabbits require a level of crude fibre in excess of 9% for normal growth and to reduce the incidence of enteritis (Champe and Maurice, 1983). The need to identify cheap and suitable feedstuff has led to more research in the area of unconventional feed materials such as farm wastes and agro-industrial by-products. A collaborative research study (Doma *et al.,* 1999) was conducted to determine the effects of two fibre types – cowpea shell and maize cobs, at two levels (20% and 40%) on growth, nutrient intake and digestibility in grower rabbits. We discovered that the dry matter intake (DM), acid detergent fibre (ADF), daily weight gained (DWG) and feed conversion ratio (FCR) were significantly affected by type and level in the diets of rabbits. Evidently, cowpea shell and maize cobs which are agro by-products can be incorporated into rabbit feeding up to 40% and 20% respectively without compromising productive performance of rabbits.

6.2.4.4 Yam Peel Meal

The tremendous agronomic potentials of root and tuber crops and their wastes make it imperative for detailed investigation to be carried out on their utilization both as food and feed. To achieve efficient utilization of these agro-industrial by-products, it is very essential to have a knowledge of their nutritive values and response of animals to their usages (Oluokun and Olalokun, 1999).

Yam peels are usually regarded as waste products and white yam and its peels are free from cyanogenic glycosides. There is a high concentration of the non-starchy nutrients in the peels, particularly of proteins and minerals (Oyenuga, 1968).

The Presidential Task Force (1992) projected 1000 tonnes of yam peels in 1993 and 1700 tonnes in 2000 which confirmed the availability of this crop by-products in Nigeria with some scholars, a research work was carried out to evaluate the haematological parameters, serum metabolites and carcass characteristics of weaner rabbits fed yam peel meal (YPM) based diets. (Alade *et al.,* 2005). YPM was incorporated at the rate of 0%, 15%, 30% and 45% as replacement for maize in rabbits diets. Results indicated that yam peel meal can be included in weaner rabbit diet at 30% level without any deleterious effects on blood parameters and performance characteristics.

6.2.5 Cassava and By-products (*Manihot spp*)

The escalating cost of maize and its attendant high demand and seasonal scarcity has led to the high cost of raising monogastrics. Animal nutritionists are currently focusing on cheap but suitable alternative feedstuffs especially crop residues and industrial by-products to sustain livestock industry globally. The evaluation of these unconventional feed resources besides other strategies would reduce pressure on the demand for conventional feed resources thereby ensuring attainment of feed security for poultry (Fajimi *et al.,* 1993).

One of the alternatives to conventional feed resources is Cassava. Cassava (*Manihot esculenta* Crantz) can be described as a perennial woody shrub with edible roots, which grows in tropical and sub-tropical parts of the world. Cassava is an essential crop in developing countries, especially in sub-Saharan Africa, because it thrives well in poor soils with low rainfall and being a perennial crop, it can be harvested as required by the farmers. More than 248million tones of Cassava was produced worldwide in 2012 of which Africa accounted for 58% (IITA, 2012). Nigeria produced about 54 million metric tonnes per annum of Cassava tubers (FAO, 2013), she became the highest cassava producer in the world, producing a third more than Brazil and almost double the production capacity of Thailand and Indonesia (Onyenwoke and Simonyan, 2014). Cassava has been used as an alternative energy source and its inclusion in diets for monogastrics has been extensively studied (Tewe and Egbunoke, 1992; Eruvbetine, 1995; Adegbola, 1977).

It is cheaper, easier to cultivate and manage compared to maize and can survive many harsh environmental conditions. Cassava root has been used to a large extent as energy feedstuff in poultry nutrition, the major limitations to its utilization in poultry nutrition consists of its constituent low quality and poor quality protein, presence of cyanogenic glucosides, linamarin and high fibrous content (of its peel). A collaborative studies focused on improved utilization of cassava root meal (peeled or unpeeled) and cassava by-products (peels, sievates and offals) in animal nutrition (Eruvbetine, 1995). The chemical composition of sun-dried unpeeled cassaa (Oso *et al.,* 2013) is shown in Table 6.

Table 6:Chemical composition of dried unpeeled cassava root meal (UCRM)

Composition	Values
Moisture (g/kg)	95.5
Crude protein (g/kg)	15.5
Ether extract (g/kg)	9.4
Crude fibre (g/kg)	162.0
Ash (g/kg)	61.2
NDF (g/kg)	245.0
ADF (g/kg)	133.7
ADL (g/kg)	32.6
Hemicellulose (g/kg)	111.3
Cellulose (g/kg)	101.2
Gross energy (MJ/kg)	16.4
Metabolisable energy (MJ/kg)	14.6
Hydrocyanide (mg/kg)	4.0
Tannin (mg/kg)	0.001

ADF – Acid detergent fibre, ADL – acid detergent lignin, NDF – neutral detergent fibre Values obtained were average of five determinations,

Utilization of unpeeled cassava root-meal (UCRM) in diets of weaner rabbits, (Oso *et al.*, 2010) concluded that inclusion of up to 200g/kg as replacement for maize supported better response in terms of carcass yield, cut parts, blood constituents and nutrient digestibility. Similarly, Omoikhoje *et al*. (2008) opined that UCRM as replacement for maize up to 30% level is profitable and feasible in rabbit diets.

Apart from cassava peels, the two major products of cassava processing in Nigeria are cassava sievates (a product from 'garri' production) and cassava offals (waste from “fufu” production). A study was undertaken, with other scholars to document their processing methods in Figures 3 and 4 and nutrient composition of these cassava waste products collected from different locations in Edo State (Nwokoro *et al.,* 2005).

Freshly harvested cassava with peels removed and washed

↓

Grating of peeled cassava tuber

↓

Dewatering by specially constructed screw press jack

↓

Fermented in sacks for 24 hours (overnight)

↓

Sieving of the cassava

↙ ↘

Cassava for frying (roasting) | Cassava sievate (waste)

Figure 3. Procedure for production of cassava sievates

Freshly harvested cassava is peeled, washing and cutting into sizeable chips

↓

Fermentation in water for about 5 – 7 days

↓

Special sieving process in water

↙ ↘

Starch in water | Cassava offals (wastes)

Figure 4. Derivation procedure for cassava offals.

6.2 Protein Feedstuffs

These are feed materials which have low moisture and fibre contents with relatively high digestible protein contents. They can either be of plant or animal origin.

6.3.1 Animal protein feedstuffs

6.3.1.1 Chicken offal meal

The effect of replacing 0, 25, 75 and 100% of soyabean meal (SBM) with chicken offal meal (COM) was investigated using weaner rabbits for ten weeks feeding trial (Bamgbose and Kudi,1996). Chicken offal me al was analyzed to contain 57% crude protein, 12% ether extract 2% lysine, 0.70 methionine, 5.5% calcium and 2.9% phosphorus. It was concluded that COM could replace 50% of SBM without compromising performance and nutrient digestibility in weaner rabbits .Feed cost savings (%) of 6.34, 12.45, 18.66 and 25.34 for the replacement levels confirmed that replacement of SBM with corn is economical.

Mr Vice- Chancellor, I seek your permission to share my personal experience during my Ph.D training at University of Ibadan, Ibadan under my supervisor- Late Professor Olumide Odeleye TEWE on the practical usage of chicken offal meal for feeding pigs at McTee Farms, Apete-Ibadan. This information will be useful for pig farmers. Collect chicken offal meal from broiler chicken/layers processing unit, remove dirts and sand, put in open drum, add little salt and boil for 30-45minutes. Allow to cool and mix with brewer's waste grains then serve to pigs. It is a special delicacy for them and growth rate was enhanced immensely.

6.3.1.2 Maggot meals

Maggot meal, (MAM) was analyzed to contain 48.61% crude protein, 20.12% ether extract and 4.15% ash (Bamgbose, 1999). Maggot meal (MAM) harvested from under laying cages and processed were used, to replace meat meal (MM) at 0, 50 and 100% levels in practical diets for cockerels. Results showed that MAM can completely replace MM at 8% in diets for cockerel chicks and supplementation with 0.20% methionine enhanced performance and nutrient utilization significantly.

6.3.1.3 Comparative protein supplement studies

The effects of groundnut cake (GNC) and local fish meal (LFM) on the growth and protein utilization of rabbits were studied by Biobaku *et al.* (2003). The control diet had the combination of GNC and LFM while the experimental diets had either GNC or LFM as the protein source.

The control diets gave significantly better weight gains than the GNC and LFM diets. There was no incidence of enteritis or mortality among the treatment groups.

In a related further study, Egbo *et al.* (2005), examined the effect of dietary protein sources on growth performance and nutrient digestibility in cross-breed weaner rabbits. Full-fat soya-bean (FFSB), groundnut cake(GNC), cottonseed cake(CSC) and blood meal(BM) were the protein sources in the formulated diets. From the findings, FFSB-based diet was found to be superior to GNC, CSC and BM as a source of dietary protein in rabbit diet.

6.3.2 Plant protein feedstuffs

6.3.2.1 Cottonseed cake (*Gossypium spp)*

One locally available plant protein feedstuffs is cottonseed cake (CSC) which is a by-product of the cottonseed oil production. Cottonseed cake has not been used extensively in the diets for laying hens because of its potential deleterious effect on egg production and egg quality parameters (Reid, 1984).

Preliminary studies carried out showed that locally processed CSC obtained from Livestock Feeds Nigeria Limited, Lagos contained 36% protein, 13% fat and 20% fibre with biological value (BV) of 51.0 (Bamgbose *et al.,* 1989a). A study used feeding trial to assess the potentials of replacing groundnut cake with cottonseed cake in diets of layers (Bamgbose and Oyawoye, 1997).

It was observed that dietary inclusion of CSC at higher levels (75 and 100%) significantly depressed feed consumption, egg production, kg feed per unit egg and Haugh unit. However, layers fed diets supplemented with meat meal had improved performance and egg quality parameters. It was deduced from the results of this trial that cottonseed cake should not be included more than 15g/kg in layers diet and supplementation with meat meal (animal protein) improved performance and egg qualities.

In another study, Bamgbose and Nwokoro (1997) investigated the effect of graded levels of cottonseed cake as a replacement for groundnut cake in broiler chicken diets. Parameters assessed included serum matabolites, nutrient utilization and economy of feed conversion. From the study, it was evident that quality of dietary protein, high crude fibre and to a lesser extent the free gossypol content of the diets limited the efficient utilization of CSC by broiler chickens. Based on the estimated gross profit, higher level of CSC delayed attachment of good market live weight which might not be economically beneficial to the poultry farmer.

6.3.2.2 Pigeon pea seed meal (*Cajanus cajan*)

Pigeon pea seed has very low human food preference and especially, at present, no industrial use. It is a widely cultivated legume in Nigeria and in other tropical countries. However, pigeon pea is under-utilised because of lack of knowledge of its nutritional potentials.

In a study with growing rabbits, Alokan and Bamgbose (1997) examined the effect of various dietary levels (0, 20, 30 and 40%) of pigeon pea (*Cajanus cajan*) seed meal as a replacement for groundnut cake (GNC). On growth performance, there was no significant difference amongst the treatments in all the parameters assessed. The results underscored the importance of pigeon pea seed meal as a protein feedstuff and also showed that 40% of groundnut cake could be replaced by pigeon pea seed meal in the diet of growing rabbits without deleterious effect on performance characteristics with considerable decrease in cost.

In a second study with broilers chickens, four experimental diets were formulated with the inclusion of pigeon pea seed meal (PPSM) at 0, 33, 67 and 100% levels as replacement for soyabean meal (SBM) at both starter and finisher phases (Nwachukwu *et al*., 2004). Results showed that feed conversion ratio, daily weight pain, cost of feeding and feed cost/kg weight gain of broiler chickens fed 33% PPSM were comparable with the control diet. Therefore, the use of PPSM will have a sparing effect on SBM and increase profit margin to the farmers by reducing feed cost which is a major item in broiler production.

Furthermore, the effect of dietary inclusion of fermented pigeon peal meal on growth response, apparent nutrient digestibility, haematological indices and serum biochemistry of cockerel indices and serum biochemistry of cockerel chicks was studied using 240-day old cockerel chicks. It was concluded that dietary inclusion of up to 50g/kg FPPM could be used in the diet of cockerel chickens without imposing any threat on the growth response, nutrient digestibility and blood constituents, (Ogunsola *et al.,* 2012).

6.3.2.3 Cashew nut (*Anacardium occidentale Linn*) Residues (CNR)

Cashew is among the tree nuts, an oilseed with excellent consumer acceptance and therefore has a great potential for increased utilization as food. Cashew nuts are obviously mainly consumed as edible nuts and there is potential for their use to some extent for animal feeding based on the fact that only 60 to 65% cashew nut, which are produced, are suitable for edible purposes while about 35 to 40% are discarded as broken kernels or rejects or residues due to scorching in the roasting process (Fetuga *et al.,* 1974). CNR have been used in diets for broiler chickens (Sogunle *et al.,* 2005) and pullet chicks (Sogunle *et al.,* 2007). Akinnusi *et al*. (2007) conducted a 42-day feed trial to evaluate the performance characteristics and cost benefits of feeding weaner rabbits (CNR) based diets. The average daily weight gain, average daily feed intake and feed conversion ratio were not significantly influenced by the dietary treatments. There was reduction in feed cost/kg and cost of feed/kg liveweight, hence lower cost of production. It was affirmed that it is cheaper to reduce the cereal content of weaner rabbit diets by partial replacement with cashew nut residues at 10% inclusion level.

6.3.2.4 Castor oil seed (*Ricinus communis*) meal

Castor oil seed is popularly grown in the tropical countries for its oil which is used for industrial purposes. The seed is commonly used as food condiments in local dishes in West African countries.

In Nigeria, it serves as a flavouring agent used to add value to local soups and dishes (Okorie *et al.,* 1983). Castor oil seed is rich in protein, making it a potential protein supplement for use in poultry; however, castor seed contains a group of toxic glycol proteins (ricin group), ricinoleic acid and alkaloid ricinin which limit its utilization in poultry diets (Okorie *et al.,* 1985).

Oso and Bamgbose (2013) investigated the amelioration of anti-nutritive effects of castor oil seed meal in broilers diet using natural fermentation and DL-methrimie supplementation. Dietary inclusion of fermented castor seed meal without supplementation with 5g/kg DL-methoinine showed poor growth response, serum biochemistry and reduced carcass yield of broilers. However, supplementation of diets containing 50g/kg fermented castor seed meal with 5g/kg DL-methionine showed prospects in ameliorating the anti-nutritive effect of castor toxicity resulting in improved growth performance and nutrient digestibility comparable to broilers fed control diet.

6.3.2.5 The Soyabean Studies

Soyabeans like most legumes contain some biologically active substances in their raw state. Some of these compounds are toxic while others inhibit the availability of desired elements and substances that are otherwise useful to various animals. Soyabeans contain trypsin inhibitors, haemagglutinin, saponins

and compounds which couple minerals. These anti-nutritional factors can also inhibit growth, reduce fat absorption, cause enlargement of the pancreas and cause agglutination of the red blood cells. Therefore, soyabean must be processed to obtain its optimum nutritive value for human and livestock feeding.
Soyabean grown in the country is rich in protein (44.08%), good in its content of oil (19.10%) and has an average amount of fibre (5.71%) and ash (5%) (Tewe, 1984; Njike, 1988).

Soyabean has a favourable amino acid profile (Weingartner, 1988) and in addition the oil content represent a potential increase in caloric density (Waldroup, 1989) compared to other plant protein sources such as groundnut cake, therefore, the interest in this crop stands out permanently as a source of energy and proteins for the development of a stable livestock feed milling industry in Nigeria.
With the establishment of the National Coordinated Research on soyabeans, organized local production of soyabean meal commenced. Production has been further accelerated with the establishment of Taraku Oil Mill in Markurdi, Benue State in 1988. This mill has a total installed capacity for processing 72,000 metric tones of soyabeans annually.
A relatively new development in poultry feeding in the country is the use of extruded full fat soyabeans in practical diets.
SEEPC Nigeria Limited, Benin; Morrisons Food Nigeria Limited, Makurdi; Oja Farms Limited, Ilorin and International Institute of

Tropical Agriculture (I.I.T.A), Ibadan to mention a few, were involved in the process of locally produced soyabeans into full-fat extruded meal.

This involves extrusion-cooking of raw soyabeans with or without steam at a temperature of about 150 – 160^{0}C within a very short processing time (usually less than a minute). This ensures minimum protein damage. The resulting product is a fully cooked, texturized, granular material that does not require additional drying or grinding, there is usually considerable amount of cell rupture, the nutrients are highly digestible, coupled with high oil availability.

The extrusion of full-fat soyabean with conventional energy sources such as maize, sweet potato and cassava e.g. extruded corn-soy (50:50) was accomplished IITA and tested in practical poultry diets at Animal Science Department, University of Ibadan, Ibadan; as replacement for maize and groundnut cake while research activities into blends of Cassava tuber and full-fat soyabean to give Cassoy is ongoing at Department of Animal Nutrition, FUNAAB.

The nutrient compositions of full-fat soyabean (toasted/extruded), defatted soyabean, extruded corn-soy (50:50), raw soyabean have been reported by Bamgbose *et al.* (1989a).

Factors that influence the characteristics of extruded products are raw materials characteristics (type of material, moisture content, physical state, chemical composition, pH of the materials) and operational conditions of the extruder (temperature, pressure, die diameter and shear force; screw geometry and rotational speed).
Extruders are composed of five main parts – the pre-conditioning system, the feeding system, the screw, the barrel; the die and the cutting mechanism using High Temperature, Short Time (HTST) technique.

In summary, when cooking full-fat soyabeans via extrusion process, one must consider control of growth inhibitors, control of enzymes responsible for rancidity, rupturing of the oil sacs and minimization of protein damage during cooking. When compared to other cooking methods, extrusion cooking method has proven to be effective from a cost and energy stand point.
The transverse section of a typical extruder cooker is shown in Figure 5 for Instant-Pro Extruder Model – 500.

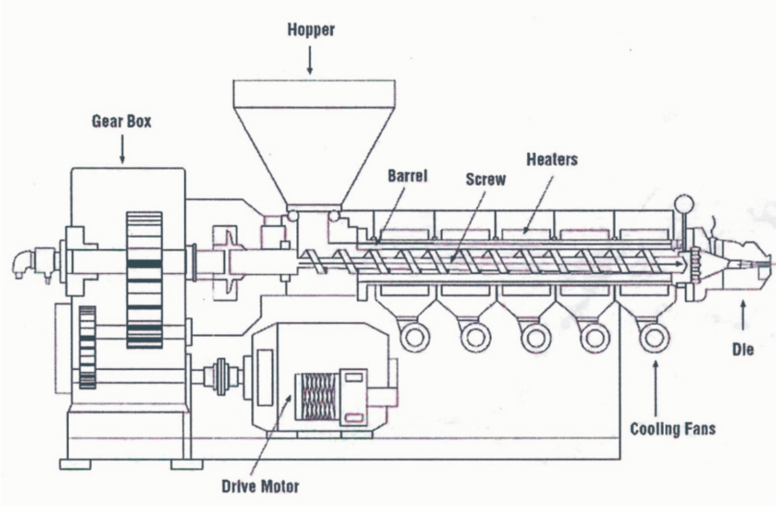


Figure 5. Transverse Section of an Extruder

The general overview for the processing of raw soyabeans the defatted soyabean cake/flakes and full-fat soyabean meal is as shown below in Figure 6.

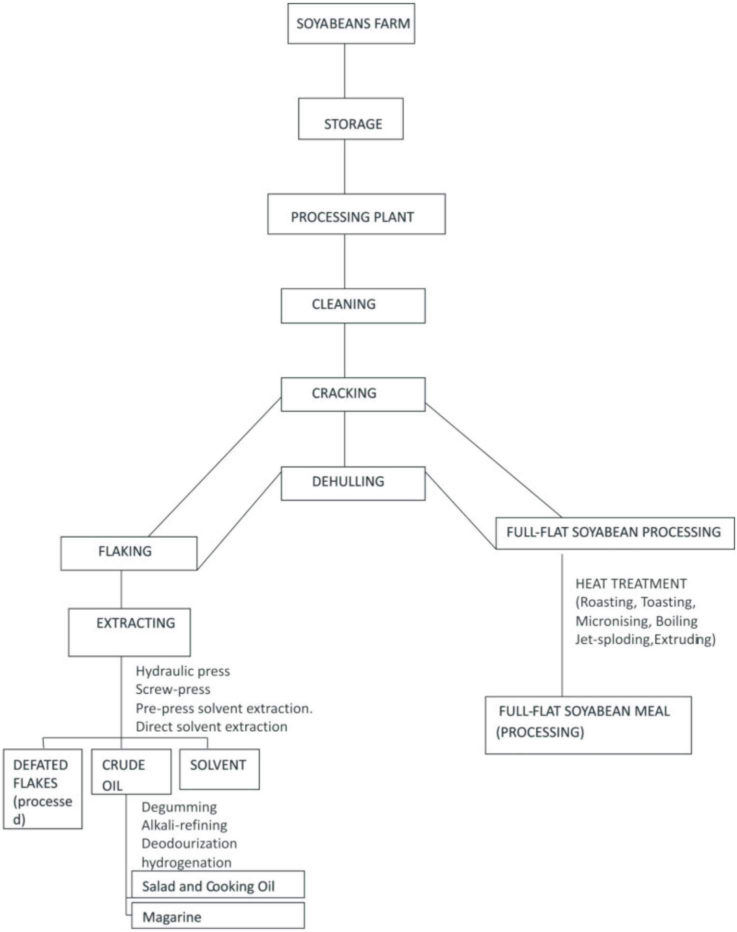


Figure 6. Scheme for processing soyabeans into oils, cakes and meals (Cowan, 1973).

Mr. Vice Chancellor, Sir, I consider myself lucky to be, involved in the onset of soyabean revolution (production, processing and utilization) in Nigeria in the 1980s. The Federal Government of

Nigeria installed an Extruder machine at International Institute for Tropical Agriculture (IITA), Ibadan in 1980 for research activities and awareness into soyabean processing and utilization . I was fortunate to be involved through my Late supervisor – Professer O. O Tewe who ensured that I carried out my Ph.D research work titled “Biochemical evaluation of some oilseed cakes and their utilization in poultry ration” which was fully sponsored by Livestock Feeds Ikeja, Lagos and I.I.T.A, Ibadan and I defended in 1988.

I have been part of considerable studies on the utilization of whole soyabean meal (cooked, full-fat) and defatted soyabean cake over the past 36years at the National Animal Production Research Institute (NAPRI), Zaria; University of Ibadan, Ibadan in collaboration with International Institute of Tropical Agriculture (I.I.T.A), Ibadan and Institute of Agricultural Research and Training, Obafemi Awolowo University, Ile-Ife.
Summary of the results presented in Tables 7, 8, 9 and 10 (Bamgbose, 1988) showed that feed efficiency in terms of feed/grain ratio and protein efficiency ratio (PER) were improved with increasing level of extruded full-fat extruded meal (FFSB) and extruded corn-soy (ECS) meal.

Table 7: Performance characteristics of broilers fed varying full-fat extruded soybean levels in practical type diets

Levels of FFSB Inclusion Parameters	**% (0)**	**6% (25%)**	**12% (50%)**	**18% (75%)**	**24% (100%)**
Daily weight gained (g/bird)	25.01^{b}	20.88^{d}	23.90^{e}	27.71^{a}	20.68^{d}
Feed/gain ratio	4.03^{b}	4.38^{a}	4.49^{a}	3.71^{e}	4.56^{a}
PER	1.20^{b}	1.19^{b}	1.17^{be}	1.42^{a}	1.13^{e}
Serum Albumin (g/100ml)	3.67	3.91	3.97	4.56	4.91
Serum Globulin (g/100ml)	3.22^{b}	4.01^{a}	4.4^{a}	3.01^{b}	4.20^{a}
Nitrogen Retention (%)	63.13^{b}	64.94^{b}	63.28^{b}	68.74^{a}	52.38^{e}
Dressing Percentage (%)	74.96^{b}	72.14^{be}	70.96^{e}	76.48^{a}	69.80^{b}
Flesh/Bone Ratio	3.80^{b}	3.82^{b}	3.96^{b}	4.10^{a}	3.56^{e}
Abdominal fat	1.50^{d}	2.73^{e}	3.65^{b}	3.10^{b}	5.66^{a}
Feed Cost/kg liveweight	3.31^{e}	3.44^{b}	3.54^{be}	3.10^{d}	3.86^{a}

$^{a, b, c}$ means without common superscripts in horizontal rows are not significantly different ($P < 0.05$)

Table 8. Performance characteristics of broilers fed varying ECS levels in practical type diets

Levels of Inclusion Parameters	**% *(0)**	**6% (25%)**	**12% (50%)**	**18% (75%)**	**24% (100%)**
Daily weight gained (g/bird)	25.01^{b}	24.41^{b}	24.79^{e}	26.29^{b}	28.38^{a}
Feed/gain ratio	4.03^{a}	3.98	3.75	3.69	3.60
PER	1.29^{e}	1.31^{e}	1.40^{b}	1.41^{b}	1.46^{a}
Serum Albumin (g/100ml)	3.67^{b}	3.80^{b}	4.52^{a}	4.30^{a}	4.66^{a}
Serum Globulin (g/100ml)	3.22^{b}	2.75^{e}	3.15^{b}	4.01^{a}	4.12^{a}
Nitrogen Retention (%)	63.13^{e}	64.02^{e}	67.89^{e}	65.14^{e}	70.38^{a}
Dressing Percentage (%)	74.96^{b}	73.29^{b}	71.58^{b}	77.15^{a}	78.39^{a}
Flesh/Bone Ratio	3.80^{b}	3.87^{b}	3.90^{a}	3.98^{a}	4.22^{a}
Abdominal fat	1.50^{b}	1.94^{e}	2.91^{a}	2.69^{b}	2.81^{a}
Feed Cost/kg liveweight	3.31^{a}	3.20^{b}	3.02^{e}	2.99^{d}	2.89^{e}

$^{a, b, c}$ means without common superscripts in horizontal rows are not significantly different ($P < 0.05$)

Table 9. Performance characteristics of layers fed varying full-fat extruded soyabeans levels in practical type diets.

Parameters	**Level of inclusion**				
	0 *(0)	**3.75 (25%)**	**8.03 (50%)**	**11.56 (75%)**	**16.0 (100%)**
Egg Production (% Hen Day)	60.71^{e}	60.54^{e}	62.38^{e}	65.89^{b}	69.88^{a}
Egg Weight (g)	59.01	57.40	58.55	58.17	60.45
Egg mass (g)	35.82	34.75	36.52	38.33	42.25^{a}
g feed/egg	2.38^{b}	2.44^{a}	2.45^{a}	2.30^{b}	2.12^{e}
Haugh unit (%)	61.96^{e}	62.48^{a}	65.00^{b}	69.59^{a}	70.23^{a}
Yolk index	0.40	0.41	0.40	0.41	0.41
Nitrogen retention (%)	50.42	51.70	54.35	53.17	56.49

a, b, c means without common superscripts in horizontal rows are not significantly different (P < 0.05)

Table 10. Performance characteristics of layers fed varying ECS levels in practical type diets

Parameters	**Level of inclusion of extruded corn soy**		
	19%	**23%**	**27%**
Egg Production (% Hen Day)	48.90^{e}	65.39^{g}	60.80^{b}
Egg Weight (g)	62.50	62.30	63.00
g feed/egg	2.74^{a}	2.06^{b}	2.01^{b}
Haugh unit (%)	58.17^{b}	73.10^{a}	70.00^{a}
Yolk index	0.42	0.42	0.40
Nitrogen retention (%)	42.62^{b}	56.06^{a}	54.31^{a}

a, b, c means without common superscripts in horizontal rows are not significantly different (P < 0.05)

It was observed that the inclusion level of more than 18% of FFSB resulted in depressed performance of broilers. Horani (1987) observed that growth was depressed significantly at level of 22% and 23% inclusion of full fat soyabean in broiler diet (Bamgbose *et al.,* 2000; Bamgbose *et al.,* 2003; Bamgbose and Olakulehin, 2003).

Performance characteristics of laying hens fed full-fat extruded soyabean meal and extruded corn-soy are shown in Tables 9 and 10 (Bamgbose, 1988; Bamgbose, 1995; Bamgbose and Tewe, 1996). The percentage hen-day egg production of 69.88% and 65.39% obtained for FFSB (100% inclusion level) and ECS (23% inclusion level) respectively were higher than 53.90% reported by Babatunde and Fetuga (1976) for layers fed groundnut value based on cake.

6.4 Fibrous Feedstuffs and Forages

The use of agro-wastes and other renewable resources are one of the means of reducing cost of animal feeds. Agro-industrial by-products and milling wastes have been identified as potential feed ingredients in livestock feeds. Milling wastes (rice milling waste, maize milling waste, sorghum milling waste) from cereal grains constitute major alternative source of fibrous feed ingredients in Nigera (Oso *et al.,* 2006).

i. In two separate studies on rice milling (RMW) we investigated the replacement of maize with RMW at 0, 25 and 75% levels on performance characteristics and nutrient digestibility of weaner rabbits. Although, the cost of production reduced as RMW inclusion increased, it shows that RMW can conveniently be included in weaner rabbit diet at 25% level of inclusion (replacing maize) without any adverse effect (Oso *et al.,* 2006). In the second trial, the performance and nutrient utilization of cockerel finishers fed graded rice milling waste was assessed (Awesu *et al.,* 2002). Evidently, inclusion of RMW at 50% level supported comparable performance in cockerel finishers with significant feed cost reduction and savings.

ii. The growth performance, carcass characteristics, sensory evaluation and cost benefit analysis of feeding maize milling waste (MMW) included at 0, 10 and 20% to partially replace maize in rabbit nutrition was assessed. The results obtained showed that feed cost, cost of feed/kg live weight gain and savings on feed cost were significantly influenced by the dietary treatment. It was concluded that the inclusion of MWW in weaner rabbit at 20% level as replacement for maize would have no adverse effect (Akinnusi *et al.,* 2009).

iii. Another study was undertaken to test the effect of supplementary concentrate diet with *Syndrella nodiflora* (forage) on the performance, haematology and serum chemistry of weaner rabbits (Omoikhoje *et al.,* 2006). Four treatment diets were formulated such that *S. nodiflora* supplemented concentrate diet at 0, 25, 50 and 75% for weaner rabbits. Performance data of weaner rabbits showed that average final live weight, weight gain, feed intake and feed conversion ratio were significantly higher in rabbits fed 25 and 50% supplemented diets. The results point to the fact that the growth performance of weaner rabbits could be improved by supplement concentrate diet with up to 50% *Syndrella nodiflora* forage without any alteration to their blood profiles

.6.5 Mineral studies

Minerals may be in the natural form or as pure elements. Some studies were carried out to assess the inclusion of some mineral sources in diets of farm animals.

6.5.1 Discarded egg shell

The increasing need for bioavailable mineral source in poultry nutrition have stimulated investigations into the exploration of varying unconventional calcium sources in broiler diet (Oso *et al.,* 2010). The rapid proliferation of egg industries and increased growth of fast food centers and hostels have resulted in the generation of large quantities of discarded egg shells as biological wastes. Discarded egg shell (DES) is readily available at no cost but currently constitutes an environmental waste in Nigeria and other egg producing developing countries. A study was conducted to determine the utilization of discarded egg shell as mineral source in diets for broiler chickens. Two experimental diets were formulated; control diet (oyster shell used as sole non-phytate calcium source) and a non-phytate calcium source.

Broilers fed diets containing discarded egg shell had longer tibia bone (9.77cm), stronger tibia bone breaking strength (214.67N) and reduced tibia ash: length ratio (4.27). discarded egg shell constituted a potential source of easily bio-available calcium mineral in broiler diet with no adverse effect on tibia ash, bone mineralization and serum minerals.

6.6 Vitamin Source

i Ascorbic acids (Vitamin C)

Ascorbic acid is a simple six carbon compound found in considerable amounts in citrus fruits and green vegetables. There is increasing evidence that a dietary requirement may exist under certain environmental and physiological stressful conditions.

Under these conditions, ascorbic acid (AA) is involved in the synthesis of the central stress hormones (epinephrine and corticosterone) responsible for the mobilization of energy for the so called essential functions such as blood flow, heat dissipation maintenance of body temperature, respiration etc. (Sobayo *et al.,* 2008a). We therefore decided to conduct experiments to evaluate the nutritional effect of supplementing ascorbic acid at levels of 0,100, 200 and 3000mg/kg in the diets of starter pullet (Sobayo *et al.,* 2009), growing pullets (Sobayo *et al.,* 2008a) and laying birds (Sobayo *et al.,* 2008b) reared under different seasons (dry and rainy).

Results from these trials showed that optimum responses occurred with supplementation of 200mg/kg in pullet chick's diet. It was evident that dietary supplementation with 300mg/kg AA supported least feed cost/kg weight gain, feed conversion ratio, improved hen-day production and higher livability in growing pullets and laying birds.

6.7 Studies on Feed Additives:

Feed additives are micro-ingredients added/incorporated in minute quantities to feed mix for a particular nutritional goal/target.

In series of collaborative research activities, we explored the effect of some feed additives in the diets of monogastric animals.

I. My experience with Baobab (*Adansonia digitata*) leaf meal as yolk pigmenter in laying birds was an off-shoot of the vibrancy and the interest to take-on new challenges by my Ph.D Supervisor-Late Professor Olumide Odeleye Tewe. He directed me to supply about 20/30 crates of eggs to leading eateries and confectionaries in Ibadan metropolis. We received feedback that the yolks were not deep-coloured enough. As an experienced Animal Scientist my Supervisor sent me to Ilorin town to purchase bags of dried, milled Baobab leaf meal ("luru"), which I got in large quantities around the Central Mosque in Ilorin town.

He instructed us to supplement the Layer's feed with 0.15-0.20% Baobab leaf meal. Consequently, the yolk colouration improved immensely and we became prime supplier of quality eggs to these outlets in Ibadan metropolis.

ii. The effect of graded levels of dietary lysine on carcass characteristics and offal measurements of finisher cockerels. The study was carried out in order to obtain information on dietary lysine requirement of cockerels especially at the finisher phase.

The results suggest that optimal dietary lysine requirement for cockerel finisher is 0.62 – 0.72%, and flesh to bone ratios of 3: 1 were met. This means for every cockerel reared to finished or live cockerel purchased, you are sure of 75% of meat and 25% for the bone and others (i.e. 3:1) (Nwokoro and Bamgbose, 1994).

iii. Meanwhile, Animal Nutritionists in Nigeria are presently paying attention to the use of by-products and waste products of crops and animal origin for compounding animal feed.

a. Maize as a staple food in humid tropics guarantees the availability of maize milling waste (MMW), which is a by-product in the processing of corn flour.
   It consists of the testa or seed coat and bran depending on the efficiency of milling machine. It has been used in feeding goats (Olayemi *et al.*, 2006).
   The response of weaner rabbits to xylanase® enzyme supplement maize milling wasted based diets was assessed. The result suggests that xylanase® supplementation at 1:00pm improved productive performance of rabbits and no mortality occurred (Olayemi *et al.*, 2006). The inclusion level of MMW should not be above 12%.

b. In another study (Oso *et al.*, 2013), a total of 90 male mixed breed rabbits were used in a 70-day feeding trial to evaluate the performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing *Prediococcus acidilactis* (1 x 10^{10} cfu/g 0.5g/kg), *Bacillus Cereus* (1 x 109 cfu/g 0.5g/kg), mannan oligosaccharides (MOS, 1g/kg), arabinoxylans oligosaccharides (AX 1g/kg), oxytetracycline (1g/kg) or synbiotics (TGI, 1g/Kg). A basal diet containing no feed additive was formulated. It was concluded the prebiotics (MOS and AX) in diets for growing rabbits showed improved growth performance and better gut morphology than rabbits fed diets contains probiotics (*Prediococcus acidilactis*, *Bacillus cereus*).

iv. A 42-day feeding trial was conducted by (Oso *et al*., 2014) using 480 day-old, male Marshall broiler chickens to study the utilization unpeeled cassava root meal (UCRM) supplemented with or without 6g/kg charcoal. Dietary supplementation with charcoal resulted in increased concentration of serum glucose, cholesterol and reduced serum glutamate oxalate transaminase (SGOT) concentration. Conclusively, supplementation of diet containing up to 100g/kg UCRM with 6g/kg charcoal significantly improved weight gain without any deleterious effect on serum metabolites.

v. The evaluation of some unconventional feed resources which are by-products of farm and industries; such as lignocellulosic materials – rice milling waste, sawdust, corn husk, cassava sifting, corn cob, wood-chips, barks, rice straw e.t.c. The lignocellulosic materials are abundant and poorly utilized as livestock feeds because they are high in tannin and oxalate compounds with indigestible fibre however, they contain high levels of potential digestible carbohydrates for livestock. This is because the structural characteristics of the wastes are composed of lignin, hemicellulose and cellulose which form a close physical and chemical complex known as lignocellulose (Anigbogu, 2011).

Mr. Vice-Chancellor, Sir, in order to crystallize the above statements, permit me to mention completed and on-going Ph.D research works in this area, they include:

- Alade, A.A (2019): Response of broiler chickens fed diets containing various fibrous feedstuffs treated with *Zymomonas mobilis* (completed and co-sponsored by World Bank African Centre of Excellence in Agricultural Development and sustainable Environment (CEADESE), FUNAAB and in fact he was the first Ph.D Graduate in Livestock Agriculture and Sustainable Environment (Liv. AgSE).
- Ogbonna, C.C. Utilization of multi-enzyme supplemented soyabean hull meal as replacement for wheat offal in diets for broiler chickens and laying hens. (on-going).
- Martins, E. Response of egg-type chickens to various fibre sources supplemented with and without phytase enzyme.

A Ph.D thesis by Alade (2019) which I supervised evaluated the response of broiler chickens fed diets containing various fibrous feedstuffs treated with *Zymomonas mobilis*. One of the alternative fibrous feedstuff is cassava sifting which was collected from Thai Farm International Limited, Ososa near Ijebu-Ode, Ogun State, Nigeria.
The cassava sifting is a waste and even constitute nuisance in waste disposal of these industries (Odunsi, 2017). One of the trials investigated the effect of undegraded and degraded cassava sifting on growth performance, apparent nutrient digestibility, ileal digesta viscosity and economy of feed conversion of broiler chickens (Alade *et al.*, 2019). The result confirmed that replacement of wheat offal with 50% Zymomonas degraded cassava sifting in diet of broiler chickens improved feed conversion ratio, crude fibre digestibility, rate of return on investment and economic efficiency.

The utilization of wheat offal as a major dietary fibre source in most parts of poultry producing areas in many countries has escalated its price, thereby necessitating a search for a cheaper and locally available alternative (Lamidi *et al.,* 2008). Sawdust is a lignocellulosic material that is burnt away annually in industrial sites resulting in environmental pollution which can be harzadous.
Efforts to improve the bioconversion of cellulosic materials as feed have been made during the last decades. Microbial technology using efficient microorganisms and solid-state fermentation

technology (Anigbogu *et al.*, 2019) may be appropriate for the biological conversion of sawdust (lignocellulosic waste) to valuable feed, making enzymatic hydrolysis more accessible in the rumen.

Zymomonas mobilis is a bacterium belonging to the Zymomonas genus that is known for its bio-ethanol production efficiency, with activities that surpass yeast. In some aspects, it is generally found in African palm wine; it's ability to efficiently, ferment carbohydrates using the Entner-Dondoroff pathway makes it an attractive option for life-enzyme for animal feed (Onyejekwe, 2010). This study was carried out to determine the effects of untreated or treated sawdust on haematology, serum metabolites, carcass characteristics and sensory evaluation of the meat of broiler chickens (Alade *et al.*, 2020). Results show that dietary inclusion of 50% *Zymomonas mobilis* – treated sawdust (ZTS) significantly improved carcass yield in terms of breast, thigh, drumstick and back weights. Generally, ZTSD posed no negative effects on the health status of finishing broilers at finisher phase.

7.0 VALUE ADDED RABBIT MEAT FOR HUMAN CONSUMPTION

Mr. Vice Chancellor, Sir, historically, about twenty years ago, I asked students in my Postgraduate class, if they had ever eaten rabbit meat and about 87% of them answered in the negative but had eaten "smoked bush meat". This reply prompted me to pioneer research activities in the intensive commercial rabbit production within FUNAAB community and beyond using least cost feeding programme. Additionally, I veered into increasing the consumption of processed/dressed rabbit meat termed 'Value added rabbit (VAR) meat'.

Rabbit (*Oryctolagus cuniculus)* is an animal whose potential can be tapped because of its obvious advantages over other farm animals. The domestic rabbit is characterized by early sexual maturity, high prolificacy, relatively short gestation length, short generation interval, high reproductive potential (number of progeny produced per doe per annum), rapid growth, good ability to utilize forages and fibrous plant materials and agricultural by-products, efficient feed conversion, low cost per breeding female and profitable business for small scale system of production and in backyards. Rabbit have potential as meat-producing animals in the tropics, particularly on subsistence-type small farms (Bamgbose, 2019).

Rabbit production in Nigeria could be described at its best as rudimentary, developing or emergent. This is evident from the small rabbit keeping population which is characterized by a low sociological status of rabbit keepers, weak inventory of rabbit keeping infrastructure, low consumption rate of rabbit meat, absence of organized or thriving market for rabbit meat production and lack of governmental and institutional support.

Interest in rabbit production has been on the increase in Nigeria. The understanding of the usefulness of the meat for diabetics, hypertensive and middle-aged people has further raised awareness on the production of rabbits, thus increasing the demand and consumption of rabbit meat; as appropriate meat for enhancing protein intake of many Nigerians which is in line with the vision 2050 Sustainable Development Goals (SDGs) of the Federal Government of Nigeria.

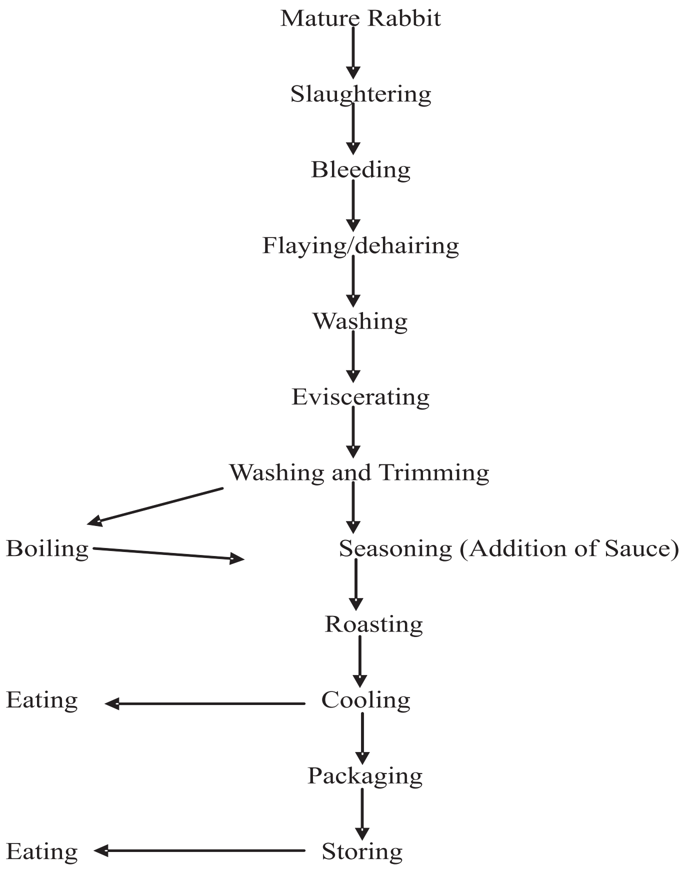
The meat of domestic rabbit is outstanding both for its dietetic effect and nutritive value (chemical composition). When rabbit meat is compared to other sources, it is found that rabbit incorporates more protein in its body than others (Aduku and Olukosi, 1990). The chemical composition of rabbit meat compared to other livestock species is shown in Table 11:

Table 11. Composition of rabbit meat compared to other livestock species

Meat Type	Protein (%)	Fat (%)	Water (%)	Energy (Kcal/kg)
Beef	16.3	28.0	55.0	3,175
Chicken	20.0	1.0	67.6	1,786
Lamb	15.7	27.7	55.8	3,131
Pork	11.9	45.0	42.0	4,519
Rabbit	20.8	10.2	67.9	1,753

Beijmen (1984)

A typical processing method for slaughtering, processing and storage of rabbit meat is depicted in Figure 7:



(Kitchen Temperature 37-38^{0}C; Freezer Temperature -20^{0}C)

Figure 7. Flow chart of rabbit processing and storage

I wish to share with everyone present the combination of sauces that I have used to enhance and encourage the consumption of rabbit meat, they are:

- ❖ Sauce 1: Water, Salt, Knorr cubes, Soyabeans oil
- ❖ Sauce 2: Water, Salt, Knorr cubes, Groundnut oil
- ❖ Sauce 3: Water, Salt, Knorr cubes, Groundnut oil, Curry, Nut meg
- ❖ Sauce 4: Water, Salt, Knorr cubes, Ginger powder

Examples of processed Rabbit meat are:

(i)	Rabbit meat	$\xrightarrow[\text{roasting}]{\text{suya sauce}}$	Suya Rabbit Meat
(ii)	Rabbit meat	$\xrightarrow[\text{grilling}]{\text{oven drying}}$	Oven-dried Rabbit Meat
(iii)	Rabbit meat	$\xrightarrow[\text{frying}]{\text{soyabean oil}}$	Fried Rabbit Meat
(iv)	Rabbit meat	$\xrightarrow[\text{frying}]{\text{groundnut oil}}$	Fried Rabbit Meat
(v)	Rabbit meat	$\xrightarrow{\substack{\text{pepper sauce} \\ \text{roasting}}}$	Peppered Rabbit Meat
(vi)	Rabbit meat	$\xrightarrow[\text{roasting}]{\text{curry sauce}}$	Cured Rabbit Meat

In the humid and sub-humid tropical environment, lots of values have been added to rabbit meat through series of systems such as production, processing, packaging and marketing as a panacea for sustainable rabbit production for national development.

Obviously in the South-western Nigeria, there is high demand for live rabbits and processed rabbits at supermarkets, hostels, restaurant, eateries, bars, secondary and tertiary institutions. This can be viewed below:

Plate 1: Showing preparation, processing and final products of Value Added Rabbit (VAR)

Rabbits have enlarged caecum which confers on them the ability to feed on concentrate feed forages (*Tridax procumbens, Aspilla africana*), leaves (pawpaw, sweet potato), fruits (carrot, pawpaw), kitchen wastes (cooked beans, yam), crop residues (groundnut havlms, cowpea husks), agro-industrial by products (rice bran, indomie noodles wastes).

The composition of a typical practical concentrate diet for rabbit is maize 38%, soyabean cake 17%, wheat offal 40% fish meal (72% CP) 0.50%, bone meal 2.50% oyster shell/limestone 1.50%, premix (growers) 0.25%, salt 0.25% and total is 100%. (to supply 18% crude protein and 2.55 kcal/g metabolisable energy).

8.0 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Mr. Vice Chancellor, Sir, I have been able to bring to the knowledge of this noble audience, the significance of improved animal agriculture as a step towards ensuring adequate food security for Nigeria populace. Evidently, there is the need to harness the available unconventional/alternative feed resources localised in different eco-systems and regions in Nigeria; for utilization in the efficient and sufficient nutrition of farm animals (monogastrics) for improved productive and economic performance. The necessity to improve the current animal production systems in Nigeria cannot be disputed. There is great need for more food in this country particularly more animal products. I have in the course of this lecture emphasized the chemical composition, nutritive value and utilization of some unconventional feedstuffs for incorporation in the feeding of monogastric animals. Unconventional feed resources are edible wastes either directly or indirectly from the industry or from the farm. Disposal of many of these by-products, if not properly handled will sooner or later become environmental nuisance. This is a result of increasing urbanization and population growth. If well-designed and executed like Indian story we read about, Nigeria may even begin to attain self sufficiency in these processed wastes as feeds and even export to sister African countries thereby generating more foreign exchange.

I highlighted my research efforts and have shown how processing and utilization of some important unconventional feedstuffs through improved feeding regimes and management practices could be used to improve the productivity of monogastric animals which would stimulate human productivity, engender development and increase Gross Domestic Products (GDP) thus accentuating economic recovery and food security. By so doing, Nigeria will join the league of advanced countries in the world in no distant future. The effective utilization of products and by-products which do not compete as food for man is central to the availability of feeds/feedstuffs to reduce cost of feeding monogastric animals to bring about the much needed development and availability of animal protein at affordable prices for the Nigerian populace.

I have tried in my presentation to give an overview of the important role of quality feeds and feedstuffs for enhanced nutritional status of farm animals. However, in an attempt to reduce feed cost in livestock production, care should be taken not to compromise quality.

8.2 Recommendations

- Critical evaluation, assessment, impact and output of different agricultural policies aimed at overall improvement and sustainability of agriculture in Nigeria. This will ensure food security for the Nigerian populace.
- The task ahead of Nigeria livestock sub-section (Agriculture) is multifarious and challenging and success will only be achieved through re-orientation, commitment, dedication, sacrifice, honesty, accountability, adequate funding, motivation and cooperation of all Nigerians in particular and the International community in general.
- Re-introduction and commercialization of branded FUNAAB feeds to guarantee availability of quality feeds to livestock farmers.
- Commercialization of poultry and rabbit production as an avenue to increase the internally generated revenue (IGR)

of the University and ensure farm-fresh animal products-meat, eggs etc for the University community and beyond (Just like it is done for FUNAAB bread and FUNAAB water). We can have FUNAAB poultry and rabbit products with retail cuts available to our esteemed students and general public at affordable prices.

- Establishment of Agricultural village on the University Farm under the management of DUFARMS to be involved in Agribusiness ventures and enterprises. Also it can be involved in training, workshop, certificate courses, about-to-retire entrepreneurship, production, processing, preservation, packaging, youth/women empowerment and marketing.
  - ➢ “when Federal Government announced lockdown during Covid-19, none of us rushed to buy gold, car, phone, T.V, fridge etc. All of us rushed to buy groceries, wheat, vegetables, meat, eggs, milk etc confirming that farmers are the soul of our nation. Respect Farmers (Crops and Livestock)”
  - ➢ “I don't think you need much motivation to consider agriculture (crops and animals) as businesses and as investment.... Please decide positively today!!!”

8.3 Suggestion

- The listing of past, present and future Inaugural Lecturers, their title and date of presentation at the inner back cover and Bibliography/ Biodata of the Inaugural Lecturer.

9.0 ACKNOWLEDGEMENTS

Mr. Vice Chancellor, Sir somebody says "to be thankful for the benefit received is the nature of a well-groomed person but the most detestable crime is ingratitude…"
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I wish to thank the Vice-Chancellors, Professor N.O. Adedipe (who was the VC when I was interviewed as Lecturer II in 1989), Professor J.A. Okojie (who employed me and my wife into UNAAB), Professor I.F. Adu (under whom I served as Acting Dean, Acting HOD, Member of Governing Council), Professor O.O. Balogun who approved my Sabbatical Leave to MOUA, Umudike, Professor O.B. Oyewole who appointed me as Director – FUCONS Ltd, Professor A.O. Enikuomehin gave excellent financial support for the improvement and increased operations of all production activities at FUCONS Limited especially FUNAAB bottled water), Professor Felix Kolawole Salako (as DVC he believed, supported and encouraged staff of FUCONS Ltd to embark on production of FUNAAB water, and as VC, he approved my Sabbatical leave to ESUT, Enugu in 2018 and excursion trip by Students of Faculty of Agriculture, Enugu State University of Science and Technology, Enugu.

I am grateful to all Deans, Directors, Head of Department/Units of the University, Members of Senate, Publications Committee, staff and students of the University for their love and affection as FUNAAB family which I cherish a lot.

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At the University of Ibadan, Ibadan I am eternally indebted to my mentor – Late Professor Olumide Odeleye TEWE (Prof. OOT) for making me what I am today. He supervised my M.Sc and Ph.D and groomed me as an Animal Scientist, Researcher and an Author with lots of practical exposures to Animal Production, Nutrition and Management, Processing and Marketing. In fact working with Late Prof. OOT means all round and holistic training in Animal Agriculture and he made me climb the ladder of my educational career with ease. In the same vein, I crave the permission of the Vice Chancellor and honourable audience, to specially and respectfully recognize the presence of Madam Abimbola Tewe (wife of my Mentor – Prof OOT) and mother of all postgraduate students supervised by Late Professor Tewe. Her lovely children

Pastor Jimi Tewe, Engr. Kayode Tewe, Dr. Tosin Olabisi, Mr. Rotimi Tewe and their families are also appreciated for being ever-accommodating and understanding.

Mr. Vice Chancellor, Sir, please at this juncture, I register my profound gratitude to members of Staff of College of Animal Science and Livestock Production (COLANIM), FUNAAB under the able leadership of my Dean – Professor Olusiji Sowande. I remember those that have retired – Prof. E.B. Oguntona instrumental to my appointed at FUNAAB, Prof. O.A. Osinowo accommodation me on assuption of duty at FUNAAB, Emeritus Prof. O.A. Adebambo, Prof (Mrs.) D. Eruvbetine, Prof. S.S. Abiola, Prof. O.M. Onagbesan, Prof. A.B.J. Aina and those who have passed on to glory – Emeritus Prof. I.F. Adu, Prof. O.O. Oluwatosin, Prof. W.O. Biobaku, Dr. Olatunji, Dr (Mrs.) Adenowo, may their souls rest in peace and those who have left the services of FUNAAB Prof. O.A. Fanimo, Dr. S.O. Iposu, Dr. S.O. Peters, Dr. Y. Anele.

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(Dr) AbdulWaheed Badrudeen (a.k.a. Temitope), National Executive Council, Zonal Missionaries led by Alhaji Agba Tajudeen Odegbola, National Working Committee members led by Alhaji Tajudeen Oyeniyi, Branch Missioners, All Organs and Members of SUDAI Worldwide. Allah will continue to give you grace, mercy and strength to serve him in spirit and truth.

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'O ti se o o o ...... Baba ti se o (2ce),
Ohun t'obawa leru Baba ti se o…..…'

This is the day that the Lord has made, we will rejoice…..…

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REFERENCES

Abioye, J., Fanimo, A.O. and **Bamgbose, A.M.** (2006). Nutrient Utilization, Growth and Carcass Performance of Broiler Chicken Fed Graded Levels of Kolanut Husk. *Journal Poultry Science*. 43:365-370.

Adegbola, A.A. (1997). Methionine as an additive to cassava-based diets. In Mestel, B,; Graham, M Editors. Cassava as animal feed. *Proceedings of a workshop held at the University of Guelph.* 18-20th Apriil, Ottawa. International Development Research Centre, Canada. P 9-17.

Aduku, A.O. and Olukosi, J.O. (1990). *Rabbit management in the tropics: Production, Processing, Utilisation, Marketing, Economics, Practical Training, Research and Future Prospects*. Living Book Series, GU Publications, Abuja, Nigeria. 111pg.

Agboola, A.A. (1977). Methionine as an additive to cassava-based diets. In:Mestel, B., Graham, M. Editors. Cassava as animal feed. *Proceedings of a workshop held at the University of Guelph, Ottawa, Canada.* Ottawa International Development Centre. 18-20th April, 1977. pp 9-17.

Ajetumobi, A.W and Ola, O.O (2002). *Animal Agriculture: Monogastrics and Minilivestock Farming*. Alografiks Kommunikation Kompany, Lagos, Nigeria. 138pg.

Akinnusi, F.A.O, **Bamgbose, A.M**., Okpaku, M.O, Uche, E.K and Alade, A.A (2009). Growth performance, carcass characteristics sensory evaluation and cost benefit analysis of feeding wearier rabbits maize milling waste based diets. *Ghana Journal Science Agriculture Education*. 1(1):122-128.

Akinnusi, F.A.O., **Bamgbose, A.M**., Ogunola, A.B. and Alade, A.A. (2007). Performance characteristics and cost benefit of feeding weaner rabbits cashewnut residence based diets. *Nigerian Journal Animal Production*. 34(2):203-207.

Alade, A.A, **Bamgbose, A.M**., Oso, A.O., Adewumi, B.A., Anigbogu, N.M. and Agwunobi, L.N. (2020). Effects of dietary inclusion of *Zynomonas mobilis* treated sawdust on haematology, serum biochemistry, carcass characteristics and sensory evaluation of meat of broiler chickens. *Slovak Journal Animal Science*. 53:168-183.

Alade, A.A, **Bamgbose, A.M**., Oso, A.O., Adewumi, B.A., Jegede, A.V., Anigbogu, N.M., Agwunobi, L.N. and Ogunsola, I.A., (2019). Effects of dietary inclusion of *Zymomonas mobilis* degraded cassava sifting on growth performance, apparent nutrient digestibility, ileal digesta viscosity and economy of feed conversion of broiler chickens. *Tropical Animal Health Production*. 112:19—30.

Alade, A.A., **Bamgbose, A.M**., Oguntona, E.B., Fanimo, A.O., Olayemi, W.A., Odelola, B.O. and Ogunsola, M.A. (2005). Haematological parameters, serum metabolites and carcass characteristics of weaner rabbits fed yam peel meal based diets. *Proceedings of Annual Conference, Animal Science Association Nigeria*. 12-15th September, 2005. UNAAD, Ado Ekiti.

Alokan, J.A. and **Bamgbose, A.M**. (1997). Utilization of pigeon pea (*Cajanus cajan)* seed meal by growing rabbits. *West African Journal Biological and Applied Chemistry*. 41(1-4):16-18.

Awesu, J.R, **Bamgbose, A.M.**, Oduguwa O.O, Fanimo A.O and Oguntora, E.B (2002). Performance and nutrient utilization of cockerel finisher fed graded levels of rice milling waste. *Nigerian Journal Animal Production*. 29(2):181-188.

Babatunde, B.B and Hamzat, R.A. (2005). Effects of feeding graded levels of Kolanut husk meal on the performance of cockerels. *Nigerian Journal Animal Production*. 32:61-66.

Bamgbose, A. M. (1999). Utilization of maggot meal in cockerel diets. *Indian Journal Animal Sciences*. 69 (12) : 1056-1058.

Bamgbose, A.M, Nwokoro, S.O, Kudi, A.C, Bogoro, S, Egbo, M.L and Kushwaha, S. (1997). Effect of feeding tigernut (*Cyperus rotundus*) meal on the performance of rabbits. *Tropical Animal Health Production* 29:60-62.

Bamgbose, A.M. (1988). *Biochemical evaluation of some oilseed cakes and their utilization in poultry rations*. Ph.D. Thesis. Department of Animal Science, University of Ibadan, Ibadan. 502pg.

Bamgbose, A.M. (1995). Chemical analysis of some oilseed cakes. *Indian Journal Animal Science*. 65 (12): 1341-1345.

Bamgbose, A.M. (2019). *A scientific presentation on value added rabbit for human consumption*. Paper presented at Harmony Farmers Forum, Abeokuta, Nigeria. 14pg.

Bamgbose, A.M. and Kudi, A.C (1996). Utilization of chicken offal as replacement of soyabean meal diets for rabbits. *Journal Agricultural Technology*. 4(10) : 60-64.

Bamgbose, A.M. and Nwokoro, S.O. (1997). The effect of partial replacement of groundnut cake with cottonseed cake on serum metabolites and nutrient utilization of broiler chickens. *West African Journal Biological Science* 6(2): 122-131.

Bamgbose, A.M. and Oyawoye, E.O. (1997). Effect of glanded cottonseed cake in diets of laying hens. *West African Journal Biological Science*. 6(1): 64-70.

Bamgbose, A.M., Eruvbetine, Daisy and Dada, W (2003). Utilization of tigernut (*Cyperus rotundus L*) meal in diets for cockerel starters. *Bioresource Technology*. 89:2435-248.

Bamgbose, A.M., Ndiangang, C.S, Oyawoye, E.O, Egbo, M.L Ogunkunle, M.M and Adeogun, I.O (1999). Performance of weanling albino rats (*Rattus rattus*) fed some local energy and protein feedstuffs. *Tropical Journal Animal Science* 1 (1): 67-74.

Bamgbose, A.M., Tewe, O.O and Weingartner, K.E (1989a). Nutritional value of some plant protein concentrates in Nigeria. 1. Protein Quality. *Tropical Grain Legume Bulletin*. 36:15-16.

Bamgbose, A.M., Tewe. O.O and Weingartner, K.E (1989b). Nutritional value of some plant concentrates in Nigeria. 2. Metabolisable Energy. *Tropical Grain Legume Bulletin*. 36:17-18

BBC (2004). British Broadcasting Corporation. news. bbc.co.uk/2/in africa/4037633.stm

Beijmen, A.C (1984). The composition of different types of meat. *Journal Applied Rabbit Research*. 7(4):134.

Biobaku, W.O, **Bamgbose, A.M.** and Achike, C.U (2003). Utilization of different protein sources of growing rabbits. *Pertanika Journal Tropical Agricultural Science*. 26(2): 73-77.

CBN (1995). Real Grows Domestic Products. *Annual Report*.
Champe, K.A and Maurice, D.V. (1983). Research review on response of early weaned rabbits to source and level of dietary fibre. *Journal Applied Rabbit Research*. 6(2):64-67.

Dairo, F.A.S, Ojikutu, L.B and Otaiku, L.O. (1987). Effects of partial replacement of plantain peels for maize on layers performance. *Proceedings of the 12th Annual Conference of the Nigerian Society for Animal Production.* 131-132.

Doma, U.D., Adegbola, T.A., **Bamgbose, A.M.** and Umeh, P.A. (1999). Utilization of cowpea shell and maize cobs in diets of rabbits. *Tropical Journal Animal Science* 2(1): 27-32.

Egbo, M.L, Adegbola, T.A, Oyawoye, E.O, Abubakar, M.M and **Bamgbose, A.M.** (2005). Effect of dietary protein sources on growth performance and nutrient digestibility in rabbits. *Tropical Journal Animal Science*. 8 (1) : 103-108.

Eruvbertine, D. (1993). Processing and utilization of cassava as animal feed for non-ruminant animals. *In: paper presented at the workshop on alternative feedstuffs for livestock.* Organized by the Lagos State Ministry of Agriculture, Cooperative and Rural Development, Lagos, Nigeria.

Esonu, B.O and **Bamgbose, A.M.** (2000b). Evaluation of the nutritive value of wild raw variegated cocoyam corm meal (*Caladium hortulanum)* for broiler chickens. *Nigerian Poultry Science*. 1:42-51.

Esonu, B.O., Iwu, P.E., Opara, C.C. and **Bamgbose, A.M.** (2020a). Evaluation of partial replacement of maize with cooked wild variegated cocoyam corm meal (*Caladium hortulanum)* in broiler starter diet. *Tropical Journal Animal Science*. 3(1):85-89.

Fajimi, A.O, Babatunde, G.M. Ogunlana, F.F. and Oyejide, A (1993). Comparative utilization of rubber seed oil and palm oil by broilers in a humid tropical environment. *Animal Feed Science and Technology*. 43: 177-188.

Fanimo, A.O., Oduguwa O.O., Idowu, O.K. and **Bamgbose, A.M.** (1999). Nutritive value of ripe and unripe (green) plantain peels (*Musa paradisiaca)* for broiler chickens. *Tropical Journal Animal Science*. 1(2):85-93.

FAO (2013). 35:36-39.

Fetuga, B.L, Babatunde, G.M. and Oyenuga, V.A (1974) Protein quality of some Nigerian feedstuffs II. Biological evaluation of protein quality. *Journal Science Food Agriculture* 24: 1515-1523.

GDP (2016). *Gross Domestic Product*. 4th Quarter and Annual Report (2016). 60 pp.

GDP (2017). *Gross Domestic Product*. 4th Quarter and Annual Report. (2017). Third Estimate Corporate Profit, 4th Quarter and Annual (2017). 80pp.

Igboeli, G (2006). The growing importance of Neem (*Azadiracht Indica*. A). In Agriculture, Industry, Medicine and Environment. *Research Journal Medicinal Plants*. 5:230-245.

IITA (2012). *An annual report on cassava production*. 4-6pp.

Isaac, S (2013). *Basic Principles of Animal Nutrition and Health*. Joyce Graphic Printers & Publishers. Kaduna Nigeria 141 pg.

Janick, J, Carl, H.N and Charles, L.R. (1976) Cycles of plants and animal nutrition. *Scientific American Journal*. 235 (3):74-87.

Kehinde, A.S. (2019). *Utilization of graded levels of herbal methionine (Methiorep^{TM}) as replacement for DL-methionine on performance and blood parameters of egg-type chickens*. M.Agric Dissertation. Department of Animal Nutrition, Federal University of Agriculture, Abeokuta. 74pg.

Ketiku, A.D. (1973). Chemical composition of unripe (green) and ripe plantain (*Musa paradisiaca)*. *Journal Science Food Agriculture*. 24:703-707.

Komolafe, O.O., (1979). Effects of storage on the integrity of purified feline calcivirus particles. *Microbios*. 26 (105-106): 137-146.

Lala, O.A; Oso, A.O; **Bamgbose, A.M;** Eruvbetine, D and Martha Bemji (2009). Utilization of instant noodle wastes in diets of cockerel chicken. *Nigeria Poultry Science Journal.* 6:36-43.

Michigan State University (2014). *Energy Issues in Animal Agriculture*. MSU Extension. Manual. 6pg.

Njike, M.C. (1988). Unconventional oilseeds and legumes in poultry nutrition. *In. Proceedings on National Workshop on Alternative Formulation of Livestock Feeds in Nigeria.* 21st – 25th November, 1988: pp 248-297.

Nwachukwu, C.B., Oyawoye, E.O., Adegbola, T.A. and **Bamgbose, A.M.** (2004). Performance and economy of utilization of pigeon pea seed meal as a replacement for soyabean meal in broiler diets. *Nigerian Poultry Science Journal.* (2&3):88-92.

Nwokoro S.O, Vaikosen, S.E and **Bamgbose, A.M.** (2005)

Nutrient composition of cassava offals and cassava sievates collected from different locations in Edo State. Nigeria. *Pakistan Journal Nutrition* 4(4): 262-264.

Nworgu, F.C (2006). *Prospects and Pitfalls of Agricultural Production in Nigeria*. Blessed Publications Consultants, Ibadan, Nigeria. 181pg.

Ogbonna, J.U. and Adebowale, E.A. (1993). Effects of sundried cassava peel meal as replacement for maize and wheat offals on performance and nutrient utilization of cockerels. *Nigerian Journal Animal Production* 20:61-70.

Ogunsola O.M., **Bamgbose, A.M.**, Oso, A.O and Sogunle O.M (2012). Utilization of discarded egg shell. *Nigeria Poultry Science Journal*. 9:179-185.

Okorie, A.U, Anugwa, F.O.I, Anamelechi, G.C and Nwaiwu, J. (1985). Castor bean: A potential livestock protein supplement in the tropics. *Nutrition Report International* 32: 659-666.

Oluokun, J.A. and Olalokun, E.A. (1999). The effects of graded levels of brewers spent grains and kolanut pod meal on the performance characteristics and carcass quality of rabbits. *Nigerian Journal Animal Production*. 26:71-77.

Omoikhoje, S.O, **Bamgbose A.M**. and Aruna, M.B (2006a). Effect of processing of some nutrient and anti-nutrient components of Bambara groundnut (*Vigna subterrarea*) seeds. *Nigerian Poultry Science Journal* 4:7-11.

Omoikhoje, S.O, **Bamgbose, A.M**. and Aruna, M.B (2006b) Determination of the nutrient and anti-nutrient components of raw, soaked, dehulled and germinated Bambara groundnut seeds.

Journal Animal and Veterinary Advances. 5.(11): 1022-1025.

Omoikhoje, S.O, **Bamgbose, A.M.,** Aruna, M.B and Animashaun, R.A. (2006). Response of weaner rabbits of concentrate supplemented with varying levels of *Syndrella nodiflora* forage. *Pakistan Journal Nutrition* 5(6): 577-579.

Omoikhoje, S.O; **Bamgbose, A.M.** and Aruna M.B. (2008). Replacement value of unpeeled cassava root meal for maize in weaner rabbit diets. *Nigerian Journal Animal Production.* 35(1):63-68.

Onyenwoke, C.A. and Simonyan, K.J. (2014). Cassava post-harvest processing and storage in Nigeria. *A Review Africa Journal Agricultural Research*. 9(53):3853-3863.

Oso, A.O and **Bamgbose, A.M.** (2013). The amelioration of anti-nutritive effects of castor oil seed (*Ricinus communis*) meal in broilers ration using natural fermentation and DL-Methonine supplementation. *Bulletin Animal Health and Production in Africa*. 61(3):293-306.

Oso, A.O, **Bamgbose A.M.,** Isah, O.A, Olatunji J.E.N, Mabadeje, A.T, Alade, A.A and Oni, A.O (2006). Performance of weaner rabbits fed rice milling wastes-based diet. *Journal Animal Veterinary Advances*. 5:836-838

Oso, A.O, Idowu, A.A and Niameh, O.T (2010). Growth response nutrient and mineral retention, bone mineralization and walking ability of broiler chickens fed with dictionary inclusion of various unconventional mineral sources. *Journal Animal Nutrition and Animal Physiology*. 95 (4) 461 – 467.

Oso, A.O., Akapo, O., Sanwo, K.A. and **Bamgbose, A.M.** (2014). Utilization of unpeeled cassava (*Manihot esculenta crantz)* root meal supplemented with or without charcoal by broiler chickens. *Journal Animal Nutrition and Animal Physiology*. 98:431-438.

Oso, A.O., Idowu, O.M.O, Hasstrup, A.S., Ajibade, A.J., Olowonefa, K.O., Aluko, A.O., Ogunade, I.M., Osho, S.O. and **Bamgbose, A.M.** (2013). Growth performance, apparent nutrient digestibility, ceacal microflora of growing rabbits. *Livestock Science*. 157(1): 184-190.

Oso, A.O., Idowu, O.M.O., Jegede, A.V., Olayemi, W.A, Lala, O.A and **Bamgbose, A.M.** (2012).Effect of dietary inclusion of fermented pigeon pea (*Cajanus Cajan*) meal an growth apparent nutrient digestibility and blood parameters of cockerel chicks. *Tropical Animal Health and Production* 44: 1581-1586.

Oso, A.O., Sobayo, R.A., Sanwo, K.A., Lala, O.A., Olayemi, W.A., Peter, O.O. and **Bamgbose, A.M.** (2014). Breast meat yield muscle linear measurements and meat composition of turkeys feed diet containing wheat or sorghum as sole cereal source. *Nigerian Journal Animal Production*. 40:30-38.

Oyenuga, V.A. (1968). *Nigeria's Foods and Feeding Stuff*. Their chemistry value. Ibadan University Press, Ibadan. Pg 90-93.

Pond, W.G, Church, D.C and Pond K.R (1995). *Basic Animal Nutrition and Feeding*. John Wiley & Sons Inc. Publishers, New York. 615pg.

Reid, B.L, Galaviz-Moreno, S and Maiorino, P.M. (1984). A comparison of glandless and regular cottonseed cake for laying hens. *Poultry Science*. 63:1803-1809.

Sobayo, R.A, Adeyemi, O.A, Oso, A.O, Iyasere, O.S, Oguntona, E.B, Eruvbetine, D, Osonowo, O.A and **Bamgbose, A.M.** (2009). Effect of ascorbic acid supplementation on the performance indices of starter pullets in a hot – humid environment. *Journal Agricultural Science and Environment*. 9 (1): 11-19

Sobayo, R.A, Oguntona, E.B, Adeyemi, O.A, Fafiolu, A.O, Oso, A.O, Osinowo, O.A, Eruvbetine, D and **Bamgbose, A.M**. (2008b). Effect of ascorbic acid supplementation on the performance, cost benefit, egg quality and haematological profile of laying birds in a humid environment. *Nigeria Poultry Science Journal.* 5(2): 45 – 52.

Sobayo, R.A, Oguntona, E.B, Osunowo, O.A, Eruvbetine, D, **Bamgbose, A.M.,** Adeyemi, O.A, Olomola, A, Oso, A.O and Usman, J.M (2008a). Effect of ascorbic acid supplementation on the performance of growing pullets. *Nigeria Journal of Animal Production* 35(2): 186 – 194

Sogunle, O.M, Fanimo, A.O., Abiola, S.S. and **Bamgbose, A.M.** (2007) Growth response, body temperature and blood constituents of pullet chicks fed cassava peel meal supplemented with cashew nut rejects. *Nigerian Journal Animal Production* 34(1): 32-44.

Sogunle, O.M, Fanimo, A.O., Biobaku, W.O. and **Bamgbose, A.M.** (2005). The feeding value of full fat cashew nut (*Anacardium occidentale* Linn) rejects and low cereals for boiler chickens. *Nigeria Journal Animal Production* 32(1): 46-53.

Spore (1998). *A world of bananas*. CTA information for agricultural development in ACP countries. SPORE 74:3.

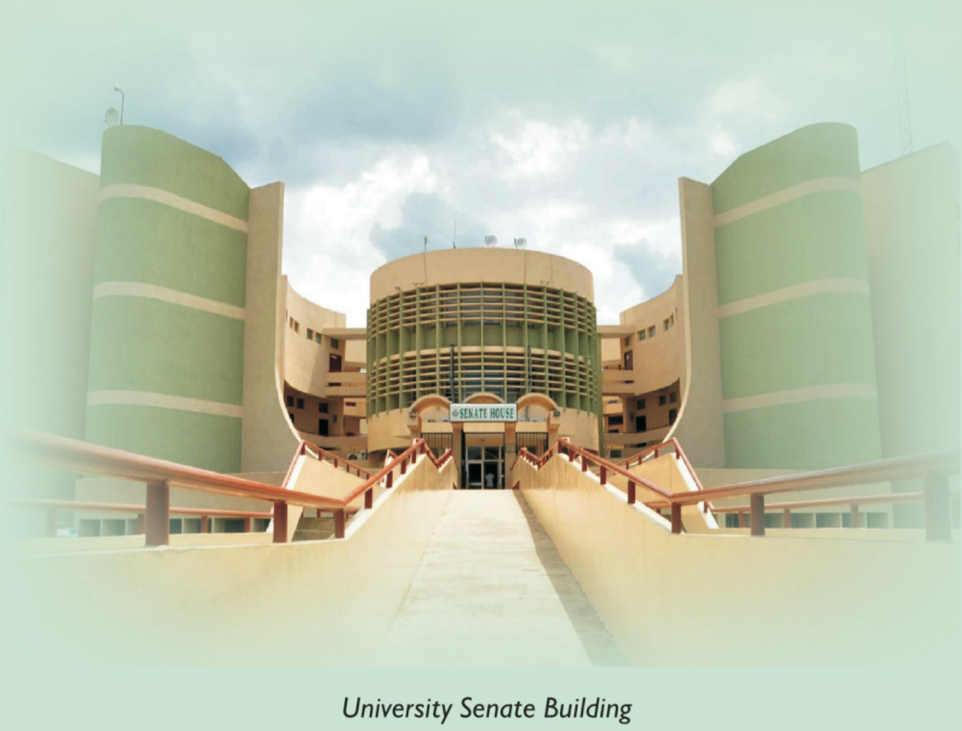
Tewe, O.O. (1984). *Energy and protein sources in poultry feeds*.

Paper presented at the seminar organized by Poultry Association of Nigeria, University of Ibadan: 21st July, 1984. Pp 52-96.

Tewe, O.O. and Egbunike, G.N. (1992). Utilization of cassava in non-ruminant livestock feeds. In:Hahn; S.K. Reynolds, L, Egbunike, G.N. Editors. Cassava as livestock feed in Africa. *Proceedings of IITA/ILCA/University of Ibadan Workshop of the potential utilization of cassava as livestock feed in Africa*. 28-38pg.

Ukpongson, M. Nodu, M and Okejim, J.A (1999). *Essentials of Animal Nutrition.* Cape Publishers International Limited. Onitsha/Owerri, Nigeria 54pg.

Yusuf, K.O; **Bamgbose, A.M**., Oso, A.O, Fafiolu, A.O and Oni. A.O (2008). Nutritional evaluation of Baoba (*Adansonia digitata*) seed meal with rats. *ASSET*. 8 (2) 226-231.



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