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REVOLUTIONISING THE FEED INDUSTRY FOR INCREASED POULTRY PRODUCTION

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Revolutionising the Feed Industry for Increased Poultry Production

The Vice-Chancellor,
Deputy Vice-Chancellor (Academic),
Deputy Vice-Chancellor (Development),
Principal Officers of the University,
Deans and Directors,
Heads of Departments,
My Academic and Professional Colleagues,
Members of My Immediate and Extended Family,
Gentlemen of the Print and Electronic Media,
Distinguished Ladies and Gentlemen,
Great UNAABITES.

1.0 INTRODUCTION

Dream lofty dreams, and as you dream, so shall you become. Your vision is the promise of what you shall one day be; your ideal is the prophecy of what you shall at last unveil. ***James Allen***

Food For Man: Historical Perspective

The essence of today's lecture is based on food an - important and basic necessity for the survival of the human populace. The form, nature and quality of food may vary, but all living creatures have to eat to live.

Food is material of plant or animal origin that consists of essential body nutrients such as carbohydrates, fats, proteins, vitamins and minerals, and is ingested and assimilated by an organism to produce energy, stimulate growth and maintain life. Feed from an Animal Scientist's point of view is food that is given to Animals. While the Animals ultimately become food for man. Looking at it in biological terms, it would appear that food is merely a source of energy and nutrients essential for life.

It is evident that food has played a central role in human history. While the everyday quest for food has shaped the life of pre-historic man and also the life of animals, the onset of the production of a reliable and sufficient supply of food is likely to have led to an expansion of human and animal populations. The food eaten by the pre-historic man is evidenced by the study of the majority of clues left behind like animal bones, sea food, plant food remnants and faecal remains at sites of human habitation. Until 10-12,000 years before the present times, humans just like animals relied on hunting and gathering of food including animals, such as, gazelles, antelope and deer as well as fish, crabs, migratory birds and shell fish, root vegetables, pulses, nuts and fruits. Man at that time developed his ingenuity to overcome the brute strength of animals and competed effectively for survival. Animals living in the wild too, apart from their own hunting exploits, fed off the remnants of man's hunting and feeding habits. The period between 11,000 and 6,000 years ago (Neolithic period), a time of crucial growth, a widespread food revolution was in place with the rudiments of agricultural production. Wild crops like wheat and barley, began to be cultivated and wild animals such as sheep and goats were tamed and domesticated. Domestication of animals led to the first informal feeding programs in animals with a view to benefiting from the usefulness of animals to man. Food acquisition by hunting and gathering was time consuming and unpredictable. The shift from hunting and gathering to domestication was gradual and by no means universal (even today there are pockets of human population that survive on hunting). With the advent of farming, the Neolithic man was for the first time in human history able to provide himself with a reliable and sufficient source of food. Humans were, thus, not devoting their entire time to sourcing for food.

However, farming contributed to a change in the nature of the diet. While the pre-neolithic man depended heavily on a diet of animal products, the Neolithic man through plant cultivation developed grains and tuber crops as staple constituents of human diets.

Food for Modern Man

Over the past 2000 years, there have been substantial increases not only in quantity of food but quality of food available to man. Furthermore, the ability of man to colonize almost every part of the world is at least in part due to his adaptability to food. Not only are humans omnivorous, they have also shown remarkable ingenuity in identifying and preparing nutritious foods out of unpromising materials. For example, bitter cassava (*Manihot esculenta*) is a root crop that contains toxic levels of cyanide producing compounds and which, after thorough processing, constitutes, the major food item in the diet of millions of people worldwide. Improved production techniques resulting in increased yields necessitated innovations in storage and/or preservation not only for use at times of scarcity but also for transportation to locations of need.

In order to ascertain quality food distribution, many agencies are available in different countries to monitor food safety, eg. FDA in the US, NAFDAQ, NIST, SON, etc, in Nigeria. These agencies are established to protect the consumer and improve the health of the public in relation to food by providing advice and information on food for consumption. Furthermore, such agencies develop policies relating to food safety and by carrying out their own research, monitor relevant developments in science, technology and other fields of knowledge that are related to food.

As a result of the slow but continued development of production, preservation and safety technologies, contemporary humans in developed countries have access to an astonishing quantity and diversity of foods. Modern technology has made it possible to supply consumers with foods produced in countries from around the world .However, the quest for food today has reached a new dimension. We talk about food security, food sovereignty and food vulnerability today. These conditions are very pertinent especially on the African continent. The changing world and the consequences of urbanization and technological developments may sometimes have devastating effects on our planet. Deforestation and land clearing and global warming due to increased carbon emission as a result of fossil fuel burning have contributed greatly to changing weather patterns leaving behind eroded lands and soils with low fertility which affect production yields of our crops. This is specially pronounced in Africa as most farmers in this continent still continue with the conventional or traditional mode of farming contributing to the prevailing reduced yields of the major staple crops that are so vital to the survival of the masses. Beyond production, other factors such as the processing, storage, quality control, availability and distribution of the final products are also key components of the entire food cycle chain. It is vital, therefore, that necessary changes must be introduced in the food production chain right from the production of our crops to the finished products for the continued survival of the human race.

Protein and Its Importance in Human Diets

The role of protein as an essential nutrient for the body is well recognized. Protein has nitrogen as an irreplaceable constituent of amino acids that are required for the assembly of proteins - the building blocks of all metabolizing tissues and enzymes that control the chemistry of organisms. Nitrogen is also an essential constituent of nucleotides and nucleic acids (RNA and DNA). Adults cannot synthesize all the amino acids that occur in proteins and, hence, these essential amino acids must be ingested in food. Children need one more essential amino acid in addition to those needed by adults for growth. Hence, a source of protein is an essential element of a healthy diet allowing both growth and maintenance of the 25,000 proteins encoded in a human genome as well as other nitrogenous compounds which together form the body's dynamic system of structural and functional elements that exchange nitrogen with the environment. The nitrogen balance index (NBI) is used to evaluate the amount of protein used by the body in comparison with the amount supplied from the daily food intake. The body is in a state of nitrogen (or protein) equilibrium when the intake and usage of protein are equal. The body has a positive nitrogen balance when the intake is greater than that expected by the body. In this case the body can build and develop new tissue. Since the body cannot store protein, over consumption of protein can result, in the excess amount to be converted into fat and stored as adipose tissue. A negative nitrogen balance represents a state of protein deficiency in which the body is breaking down tissues faster than they are being replaced. The ingestion of insufficient amounts of protein in food with poor quality protein can result in serious medical conditions in which an individual's overall health is compromised. The immune system is severely affected, amount of blood plasma decreases leading to medical conditions such as anemia or edema and leaving body systems vulnerable to infectious disease and other serious conditions such as Kwashiorkor. The treatment or prevention of this lies in consumption of protein-rich foods. The importance of protein in life is exemplified by the survival of a human offspring on milk (rich in animal protein) and the development of a chicken embryo solely on the contents of an egg. These two products of animal origin are classified as the best quality protein and till today regarded as vital to the development of body tissues. Plant proteins on the other hand are deficient in at least one essential amino acid. Cereal grains are deficient in lysine and legume grains are deficient in methionine and cysteine. Plant proteins are less digestible than animal protein and may warrant an Net Protein Utilization (NPU) score of 50 percent against 80 percent for all animal proteins.

In Nigeria, intake of animal protein is at present 4.82g/caput/day as against 35g recommended by FAO. A World Bank assisted National Strategy Plan (1996 – 2010) projected an animal protein intake of 5.32g/caput/day for the estimated 159 million population in 2010. How are we going to achieve this? Poultry production is a means of providing a good source of the necessary animal protein for the Nigerian populace. This can only be achieved if the cost of production of the products are drastically reduced. Feed being the major input in the production cycle has to be provided adequately and at affordable prices for an effective impact. This is possible only if there is a revolution in the existing feed production/distribution channels together with effective and efficient utilization capacities.

Compounded Feeds and History of Commercial Feeds

Since feed is the major input in a poultry enterprise, any major change effected in either the composition, enhancement, quality or availability will have a direct effect on the productive performance of the birds. Since the advent of balanced feeds, feeds have been prepared scientifically and economically to meet the specific requirements of the particular class of birds being produced.

Compounded feeds are feedstuffs that are blended from various raw materials and additives. These blends are formulated according to the specific requirements of the target animal. They are manufactured by feed compounders as meal, pellets or crumb types.

The beginning of industrial scale production of animal feeds can be traced back to the late 1800's. This was around the time that advances in human and animal nutrition were able to identify the benefit of a balanced diet and the importance of the role that the processing of certain raw materials played in the composition of feed. Corn gluten feed was first manufactured in 1882 while leading world feed producer, Purina was established in 1894 by William Danforth.

Cargill, mainly dealing with grains in 1865 started making feeds in 1884. By the 1900's the feed industry expanded rapidly and in 1927 the first feedmill was opened in Canada by Purina. Today there are about 3800 feedmillers world-wide manufacturing more than 80% of the World's industrial feed requirement.

In Nigeria, commercial feedmilling commenced in 1963 by Pfizer, today's Livestock feed Plc. In 1970 Ladokun Feeds was a franchise of Pfizer and later in 1976 was autonomous until they wound up activities in the 90"s. Between 1980-1983 with the implementation of the "Operation Feed the Nation" originated by the Obasanjo administration (1977-1979) it was obvious that the country needed to expand feed production. The number of feed millers grew to 303 as at 1983 with a combined installed capacity of 1039mt/hr. Feed production rose from 640,000 mtons in 1980 to 2.4 mmt in 1985. Within 3 years, poultry population was at its peak from 12 million to 40 million commercial chickens (Table1).There was strong collaboration in the early days with the establishment of – Commercial Feedmillers Association (COFAN), Industrial Feed Millers Association (IFAN) and the Poultry Association of Nigeria (PAN). Since then there has been a constant decline in the poultry population and consequently feed production.

Table 1: Feed production in Nigeria over the years

Year	QTY mmt
1980	0.640
1985	2.40
2000	1.60
2008	1.00
2010*	2.00

*Projection

Currently in the country there are only six (6) well established reputable feedmilling companies (Table 2).

The total output of commercial feed millers is only about 50%. The remaining 50% is produced without any quality control procedures or regulatory mechanism in place.

The monitoring body for regulating feed production, i.e., the Standards Organization of Nigeria (SON), in 2006 started an active program to monitor and standardize all feed operations in the country. This is important especially in view of the rising concerns about avian flu and now the

Table 2: Commercial/self mix feed market production (mtons)

Company	AVG/Month	Per annum	Share %
Top Feeds	11,000	130,000	13
Vital Feeds	8,500	102,000	10.2
Livestock Feeds	4,000	48,000	4.8
Boar Feeds	4,000	48,000	4.8
Animal Care	4,000	48,000	4.8
Amo Byng	2,500	30,000	3.0
Regional Com-pounders	8,000	96,000	9.6
Toll Millers	25,000	300,000	30
On-Farm/Self	16,470	198,000	19.8
TOTAL	83,000	1,000,000	100

Source: Bello (2008)

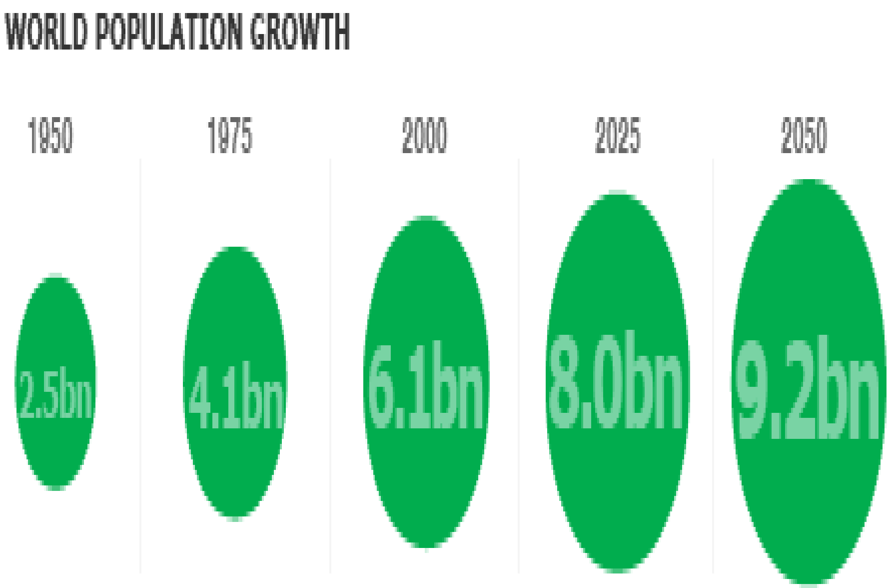
controversial "swine flu" which could have implications for public health issues. No significant impacts of the actions of SON have yet been felt in the industry. There is a need for the re-activation of COFAN and IFAN which used to be in existence to enable the industry co-ordinate, regulate and also influence policy decisions as they relate to feed, not only within the country, but also in meeting international standards. Presently it is the Poultry Association of Nigeria (PAN) that plays an active role in such matters and they may not be the appropriate body to handle such issues. Government involvement and policies in relation to feed and feed manufacturing are paramount to the success of the industry. Feed milling should be recognized as an agricultural enterprise and not entirely a manufacturing business. Streamlining and redefining all these factors which undermine the industry will go a long way in giving the industry the impetus it needs for growth.

2.0 CONTRIBUTIONS OF ANIMAL PRODUCTS TO HUMAN DIETS

Population growth and increased affluence have resulted in dietary changes and a large increase in animal and food products over the past two decades. There is a continuing rise in the demand for animal products especially from poultry and pigs.

World population was 2.5bn in 1950 and is expected to increase by 73% to 9.2bn in the 100 year period up to 2050. Currently there is a total population of 6.1 billion people in the world (Fig. 1).

Fig 1: World Population Growth



Source: UN (2008)

By the year 2030 it is expected that the population would have increased by at least 2 billion people (Fig.2). There is an expansion of growth by almost 98% in the developing world while the increase in the developed world is marginal.

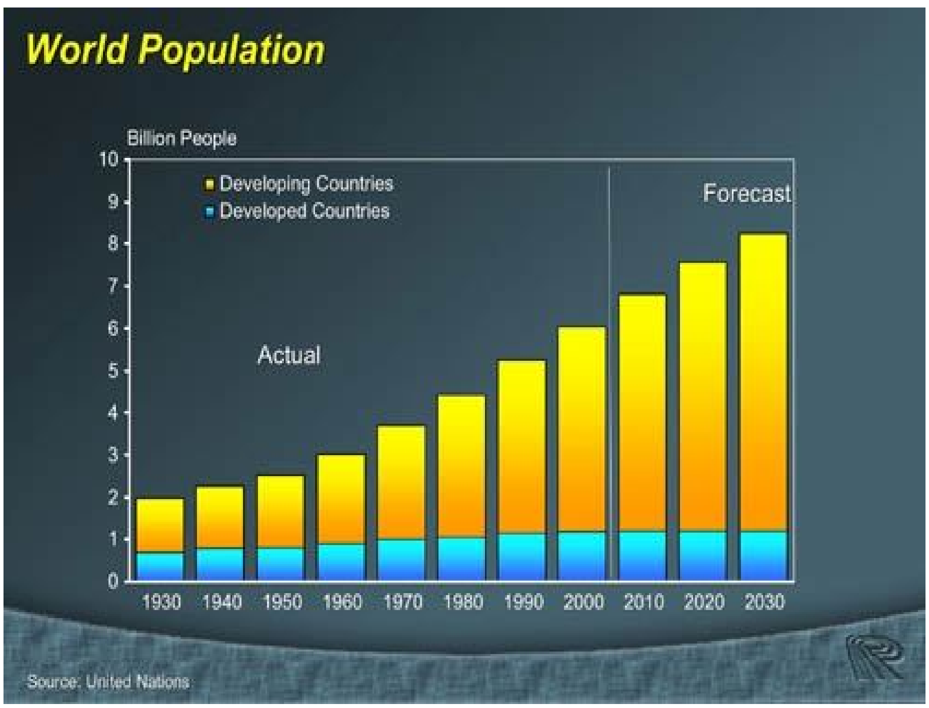


Fig 2: Population Growth in Developed and Developing Countries

Currently Animal products are a vital and important source for the world's existing 6 billion people. On a global basis, animal products provide 17% of food energy and more than 35% dietary protein (Fig.3). Thus, with the rising population over the years, the need for animal products are also increasing so that every human being can meet his/her basic requirement for animal protein.

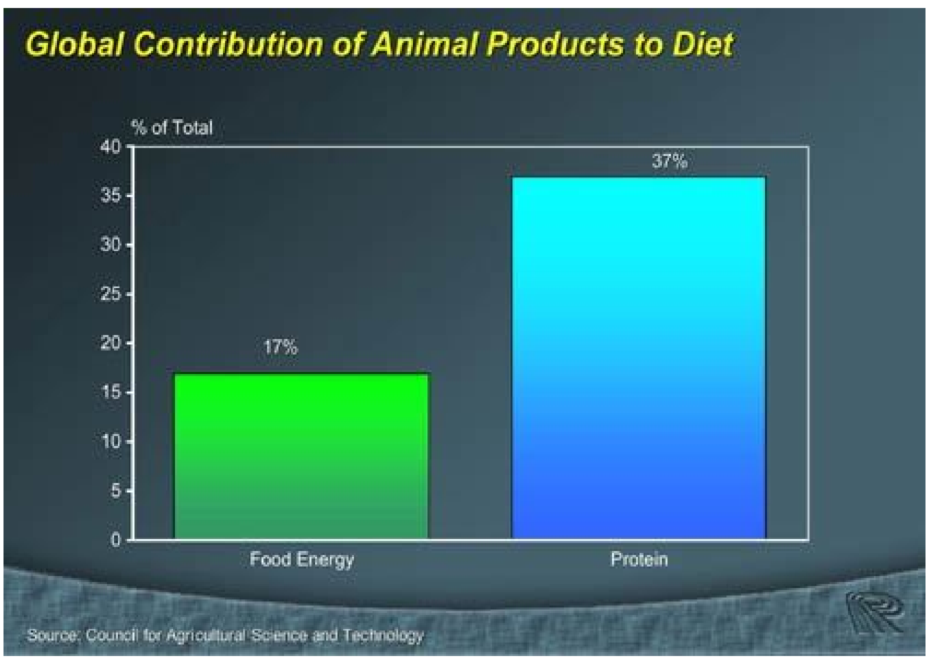


Fig 3: Global Contributions of Animal Products to Diet

The world per capita meat consumption is 35kg/person per year as against 75kg/person in developed countries (Fig. 4). Africa has the lowest meat consumption with 18kg/person, while in the developing countries the average is 24kg/person.

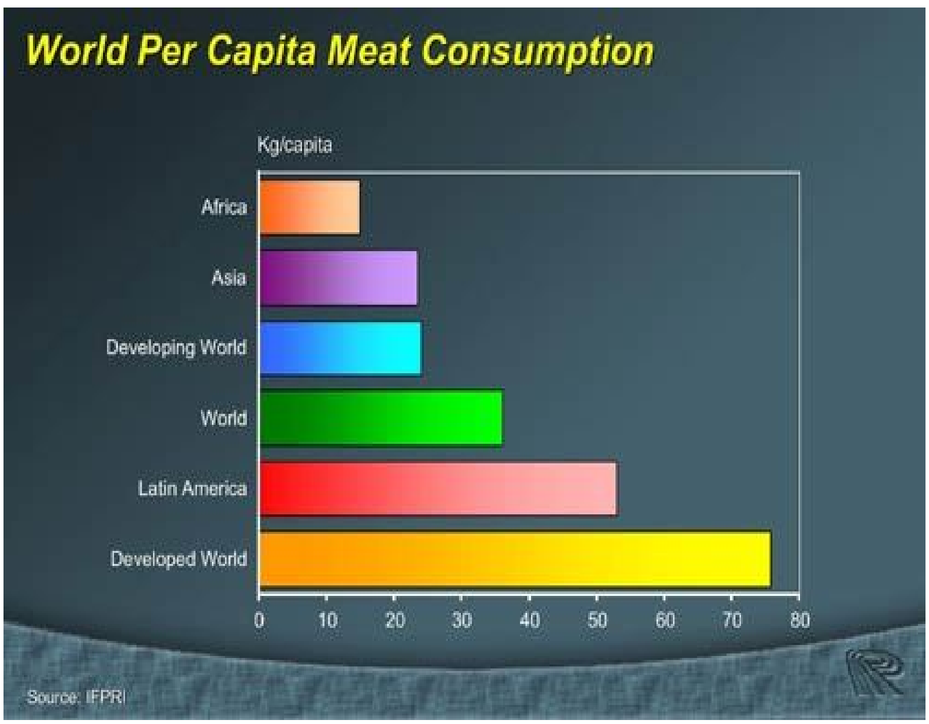


Fig 4: World Per Capita Meat Consumption

As mentioned previously, in Nigeria, the intake of Animal protein is at present 4.82g/caput/day as against 35g/caput/day recommended by FAO. A World Bank assisted National Strategy plan (1996-2010) projected an animal protein intake of 5.32g/caput/day for the estimated 159 million population in 2010 (Fig. 5). This value, however, falls short of the FAO recommended value.

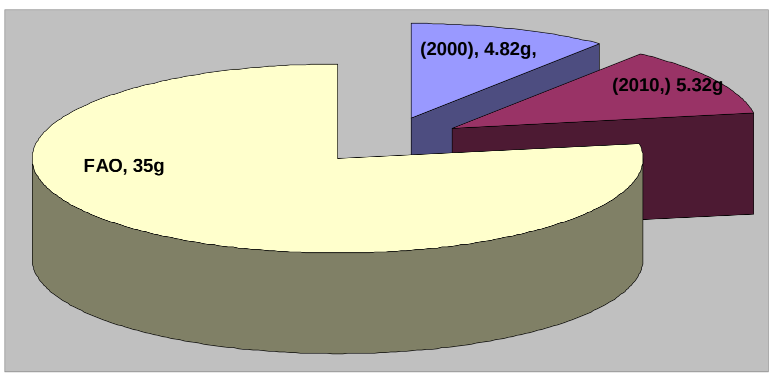


Fig 5: Animal Protein Intake in Nigeria

As countries develop, they will naturally demand for more and better quality food and, the per capita meat consumption will, therefore, rise. The world meat consumption (1995-

2030) shows that meat consumption will increase in the developed world by about 15 million tonnes during the period 1995 and 2015. Whereas, it will increase by 75 million tonnes for the same period in developing countries and 50 million tonnes for the period 2015-2030 also in the developing countries (Fig 6).

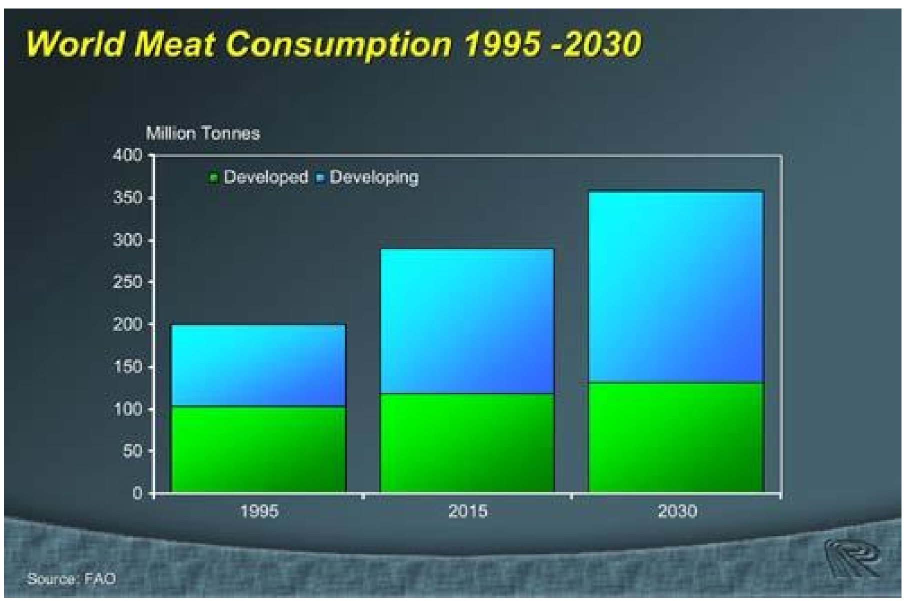


Fig 6: World Meat Consumption (1995–2030)

It has also been predicted that the increase in meat consumption over the years would be mainly poultry meat. International Food Policy Research Institute (IFPRI) estimates that poultry consumption would be double that of pork and beef. This is because in developed countries health conscious consumers are consuming poultry products (Fig. 7).

Fig 7: World Meat Consumption Growth

Among the poultry products, meat and eggs are most commonly consumed. For the 10-year period between 2006 and 2016, the projected production of both meat and eggs increased by 40 and 34%, respectively, in the developing countries as compared to 24.6 and 9.2% increase for the same period in developed countries. This shows that both poultry meat and egg production are on the increase in the developing world (Table 3).

Table 3: Production of poultry meat and eggs (MT)

Production (m MT) of poultry meat and eggs

Product	Country	2006	2016	% increase
Poultry meat	Developing	46.9	65.7	40.0
	Developed	35.8	44.6	24.6
Eggs	Developing	42.6	57.1	34.0
	Developed	18.5	20.2	9.2

Source: Pym (2009).

However, consumption of chicken meat and eggs in Nigeria over the 10-year period from 1995-2005 did not seem to have been on the increase while in countries like USA and China, there was significant increase in the consumption of both chicken and eggs over the same 10 year period. In Nigeria, although there was only a slight increase in meat consumption per capita over the last 5 years, egg consumption per capita over the same period was lower (Table 4). This is because even though more eggs may have been produced they were less available to each individual due to the increase in population.

Table 4: **Consumption of chicken meat and eggs (kg/Capita/year)**

Product	Country	1995	2000	2005
Chicken meat	USA	35.5	39.0	44.3
	China	5.1	6.8	8.0
	Nigeria	1.5	1.4	1.6
Eggs	USA	13.4	14.5	14.8
	China	11.0	13.6	17.5
	Nigeria	3.1	3.2	3.1

Source**:** Pym **(**2009**).**

3.0 SUPPLY AND DEMAND FOR FEED INGREDIENTS

The Animal feed industry is an integral and growing segment of the food supply chain. It supplies the feed ingredients needed to produce healthy animals. Animals consume one third of global cereal grain supply (Fig. 8).

Fig 8: Grain and Feed Inputs

The world feed requirement over the years has risen tremendously. According to Feed International, the feed produced over a period of 5 years rose from 580million tonnes in 1998 to a high of 610 million tonnes by 2003 (Fig 9). The rising population of animals and concomitant increase in meat production would no doubt entail a rising production of feed.

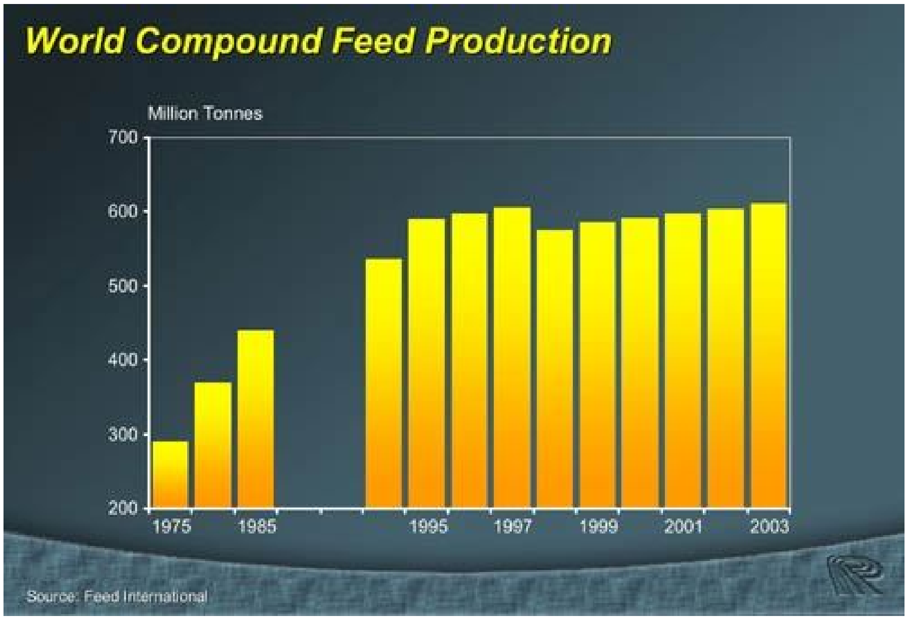


Fig 9: World Compound Feed Production

The top 15 countries in the world account for 73% of the total production of 625 mmt in 2003 (Fig 10). The leaders were the US 150.2 mmt, China 72.7 mmt, Brazil 42.7 mmt, Japan 24.3 mmt and Mexico 23.0 mmt.

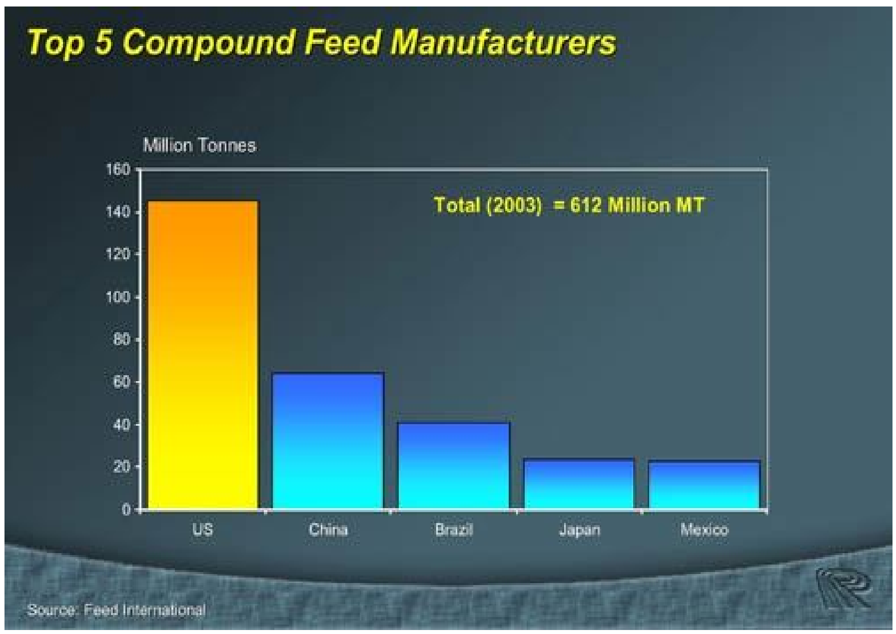


Fig 10: Leading World Feed Manufacturers

In order to feed the animals that will supply the meat for a growing world population, feed grain production will have to increase by 45% between 1996 and 2030, while cereal consumption for animals need to rise by 60% if the precipitous growth on meat demand is to be met (Fig. 11).

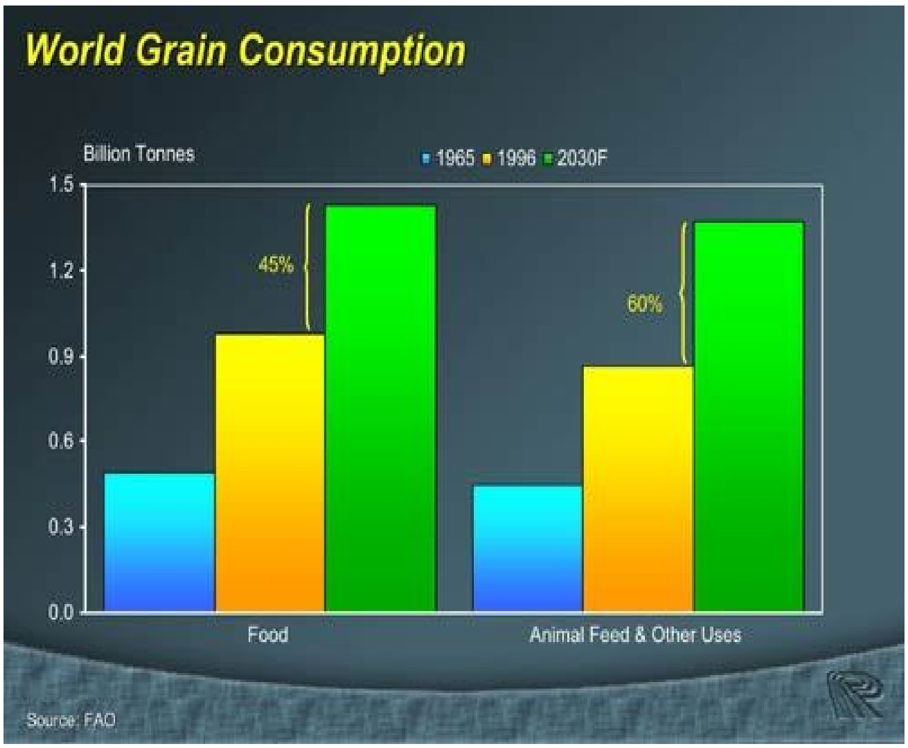


Fig 11: World Grain Consumption for Food and Feed

According to Swick 2008 a total of 766.2 mmt of corn is produced with the US being the largest producer followed by China (Fig 12)

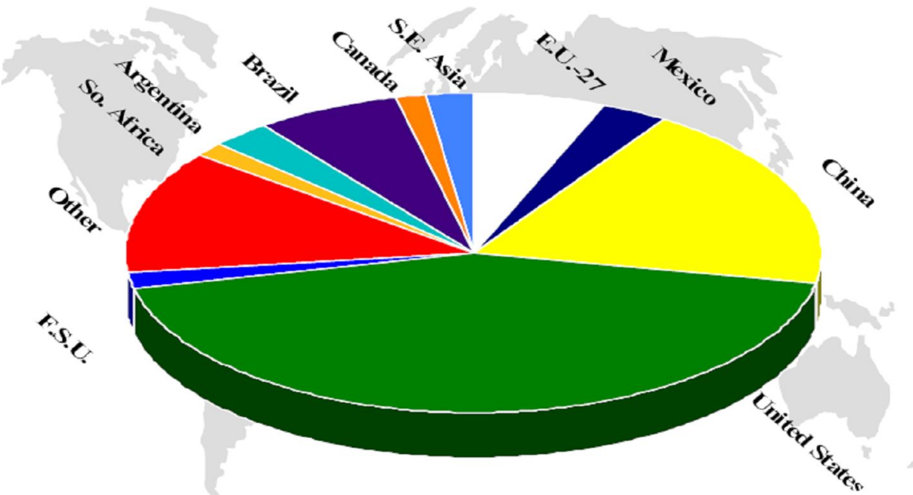


Fig 12: World Grain Production

Next to cereal grains, the other major ingredient requirement is that of oilseeds. Soybean meal, a residual product of the oil extraction process from soybeans is the most preferred protein source in animal feed worldwide. Soybean production has increased more rapidly than corn, wheat or rice over the past 14 years. The production increase has been driven by demand for soya-oil and meal. Other oilseeds such as canola, groundnut, sunflower and sesame seed have also been used, depending on their availability and location. If global production of feed goes up at its current rate of 2%, the world will be producing 750 mmt of feed by

2015. This will require additional 20% of grain and oilseed yearly, thus, translating to 1168 mmt of grain and 255 mmt oilseed meal by 2015.

4.0 NIGERIAN POULTRY INDUSTRY AND FEED REQUIREMENTS

Currently the poultry industry consumes about 90% of the total commercially produced feeds in Nigeria which can be put at 763,000 tonnes per year (FLD 2005). Poultry population estimates as given by FLD (cited by Oyediji, 2005) gives a population estimate of poultry over the years from 1990 to 2003. Since the year 2000, there has been a steady increase in the population (Fig. 13).

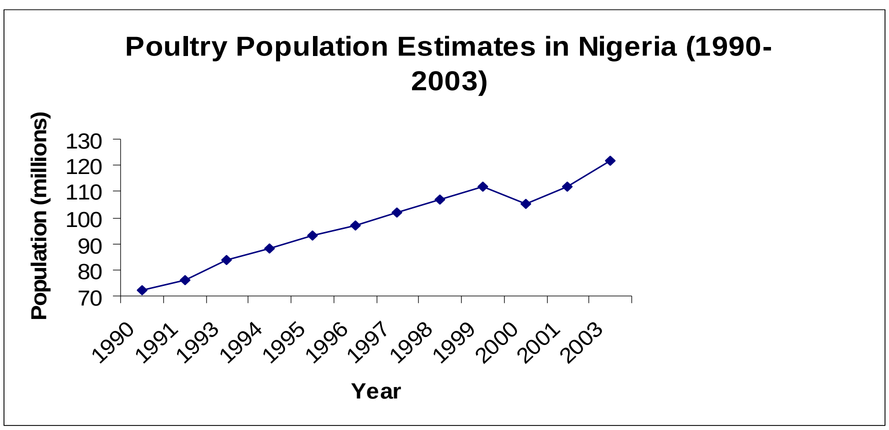
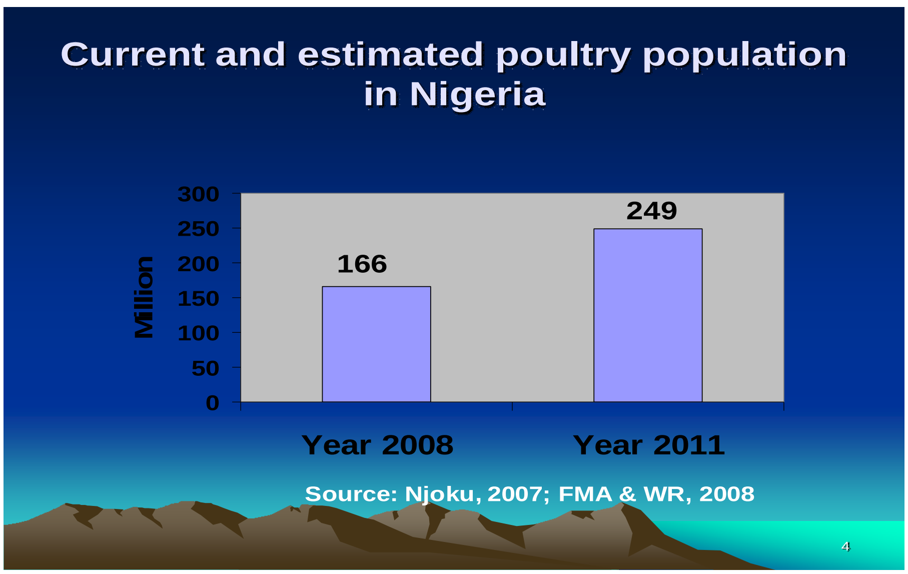


Fig 13: Poultry Population Estimates

Current and estimated poultry population (Fig.14) are about 166 million for 2008 and 249 million for 2011 (Njoku 2007; FMA and WR 2008).



14:Current and Estimated Poultry Population in Nigeria

A typical ration for poultry in Nigeria, meeting all the nutrient requirements of the bird while achieving its maximum potential contains about 50% maize, 25 % vegetable protein source, 5% animal protein source and the balance made up of minerals, vitamins and filler ingredients (Fig. 15).

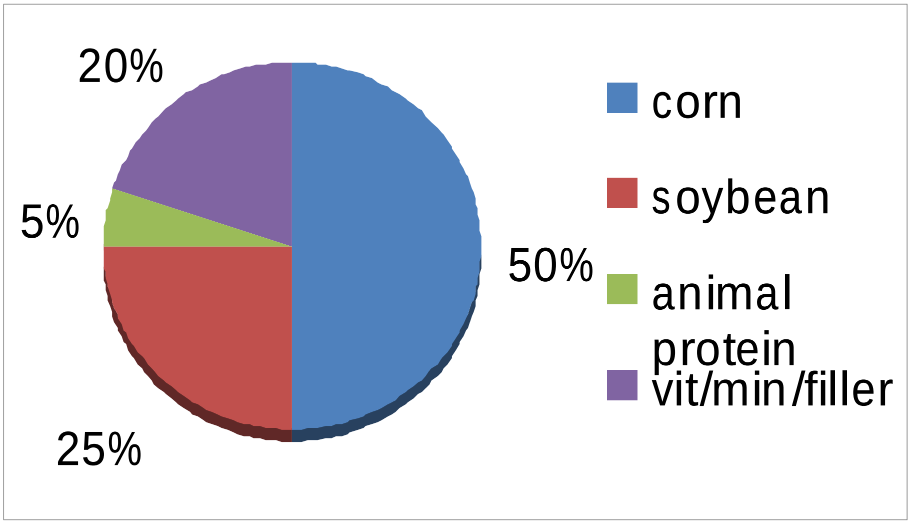


Fig 15: Typical Ration for Poultry in Nigeria

For the projected population for poultry, a total of 6.25 mmt of feed is required in Nigeria. If it is assumed that 50% of this is corn, then, approximately 3.125 mmt of corn is required while approximately 1.56 mmt of soybeans is also required to produce the projected 249 million poultry in 2011. How do we cope with this high demand? Land area for maize production has increased from 653,000ha in 1984 to 5m ha in 2003 while the production of maize increased from 1mmt to 7 mmt. Thus, the average yield of 1.4 to 1.5t per ha is still very low. An IITA research group is currently working to increase such yield and double production to 14 mmt by the end of 2009. The ban on the importation of corn has been the bane on the industry since the early 80's. However, the rising pressure on government to remove this ban had finally paid off when in February this year the ban was lifted and importation of corn has been liberalized. Most farmers are now awaiting the consequences of this action and it is hoped that ready supplies of corn through adoption of organized and fair marketing strategies will meet the rapidly growing demand presently.

Soybean production in the country has always been below the required demand level and most big time feed millers prefer to import soybean from other countries. We can, therefore, conclude that Nigeria is not self sufficient in its major raw materials for meeting its demand for the existing poultry population and, therefore, need to think ahead on the ways of solving this problem especially in the face of the global trends, where demand outstrips supplies.

A personal survey of prices of corn and soybean meal in Nigeria over the last two years (Tables 5 and 6) revealed that there was more than a 50% increase in price for corn for the period July to December 2008 when compared to the prices for the same period in the previous year. However, in the last 6 months there appears to be some stability in the prices. This could be due to the impact of importation of corn which might have had a positive effect or the improved production yields this year as against last year. Nevertheless, the price of a tonne of corn in Nigeria ($400) is much higher than the price of corn globally ($220).

With regards to soybean meal prices from July-June 2008/2009, these have been consistently higher than those in the corresponding period of the previous year. This might also have contributed immensely to the hardships faced by the poultry farmer in obtaining feed at reasonable prices.

Table 5: Price (N) of corn/kg in Nigeria (2007-2009)

Months	2007/2008	2008/2009	% Increase
July- September	35	55	57
October-December	45	69	53
January-March	60	60	0
April-June	58	62	7

Table 6: Price (N) of soybean/kg in Nigeria (2007-2009)

Months	2007/2008	2008/2009	% Increase
July-September	64	100	43
October- December	68	110	62
January- March	68	89	33
April – June	69	95	39

The price of finished feeds over the years also increased consequent to the rising cost of ingredients (Table 7).

Table 7: Price (N) of finished feed/bag

Year	Grower	Chick	Layer	Broil/Start	Broil/Finish
2007	900	1330	1240	1420	1230
2008	1200	1600	1600	1700	1400
2009	1300	1700	1800	1900	1600

Taking egg production costs as an example, the difference in price between cost of production and sale of eggs has declined due to the corresponding rise in the price of a bag of feed (Table 8).The implication is that the farmer continues to have a decline in revenue and finds it difficult to effect any significant change in the price of eggs due to fear of other market forces.

Table 8: Price (N) and cost of production of eggs

Year	Price/Crate	Feed Cost/Crate	Difference
2007	450	225	225
2008	500	290	210
2009	550	350	200

5.0 CONTRIBUTION TO KNOWLEDGE

Use of Cassava in Poultry Production

My major thrust in research over the years has been on the use of cassava in poultry diets. Research on cassava in the world commenced in 1935 in the Philippines. By the 1960's several Scientists in Nigeria had worked extensively on its use as an energy source for poultry diets. However, the availability of adequate amounts of cereals at that time did not pose any threat to the poultry industry which was growing rapidly with the establishment of several feed mills. Moreover, ready availability of imported chicken at very reasonable rates in a country which is blessed with oil wealth did not necessitate the developing of locally sourced ingredients for feeding poultry. However, in the late 1980's, the reality of the relegation of Agriculture to the background in the country had its toll especially on the livestock industry. The importation of cereals was then banned in 198l. The Presidential Task Force on Alternative Feeds for Livestock was set up in 1988. It was at this time that I joined the University and my attention was focused towards the use of cassava in poultry diets. In Nigeria, several eminent Scientists had already established the use of cassava in poultry diets. The question was why was it not being used? Feed millers were not happy using it and even when it was used, they refused to admit that it was in the diet.

Role of Cassava in Nutrition and its Importance

Cassava is mainly used for

(i) Human nutrition
(ii) Animal Nutrition
(iii) Industrial uses

We are all primarily concerned with its use in human nutrition. However, we are also aware that cassava being a major source of carbohydrates provides only energy and thus, cannot be the exclusive food item in the diet of human beings. The importance of protein as earlier mentioned cannot be over-emphasised. Thus, feeding of cassava in its ‘crude form’ as energy can bring about its transformation into high quality proteins meant for human consumption. Thus, when we refer to cassava for Animal Nutrition, it is viewed as an integral part of Human Nutrition. A quantitative comparison of cassava consumption for human beings and poultry as given in Table 9 shows that a producer could get more value for his cassava from producing either meat or eggs than gari. The quantity of cassava used for 1 meal with gari is enough to produce 7 eggs or 100g of broiler meat and at the same time giving him more returns in terms of money.

Table 9: Comparative Cost of Cassava in Human and Animal Diets

Specie	Product	Quantity /Meal	Quantity/ Processed Cassava (G)	Cost of Processed Cassava (N)	Cost of Finished Product (N)
Humans	Gari	1 meal	250	5.00	10.00
Layer	Egg	1	37.5	1.55	20.00
Broiler	Meat	100g	125	3.12	50.00

Advantages in the use of Cassava:

- Cultivation is easier with minimal use of chemicals and irrigation
- Low susceptibility to pests and diseases
- More favourable in developing countries

In terms of labour, even though cassava requires a higher number of mandays/ha production than maize, the yield per tonne involves only 21 days in relation to 121 days for maize. This is because of the high production yield of cassava in relation to maize. In Africa, average yield is set at 6 tonnes/ha while in Hawaii, new imported varieties produced up to 50 tons/ha. Production costs of cassava are also considerably lower than that of maize. Mandays in terms of energy yield is also lowest with cassava (Table 10).

Table 10: Comparative Labour Costs of Production of Major Crops

Crop	Mandays/HA	Mandays/MT	Mandays/MCAL
Cassava	183	21	21
Yam	325	45	69
Maize	90	121	36
Rice	215	145	60

Source: Nweke and Ezumah (1989).

Several studies were conducted over the years in the department together with colleagues from the Department of Animal Nutrition and other departments, and with several students at the undergraduate and postgraduate levels in the department. Some of these are highlighted as follows:

(a) OPTIMUM LEVELS OF INCLUSION OF CASSAVA IN DIFFERENT TYPES OF POULTRY FEED AS REPLACEMENT FOR MAIZE

i) Cassava Flour in Broiler Diets (Eruvbetine and Afolami, 1992)

Cassava flour was prepared by peeling, chipping, drying and grinding of cassava tubers. Body weight at 40% inclusion of cassava flour was similar to the control diet (Fig. 16).

Feed conversion ratio was best with 40% inclusion of cassava flour (Fig. 17).

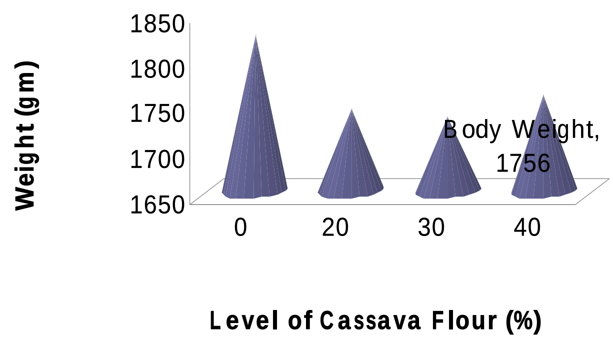


Fig 16: Cassava Flour on Body Weight of Broilers

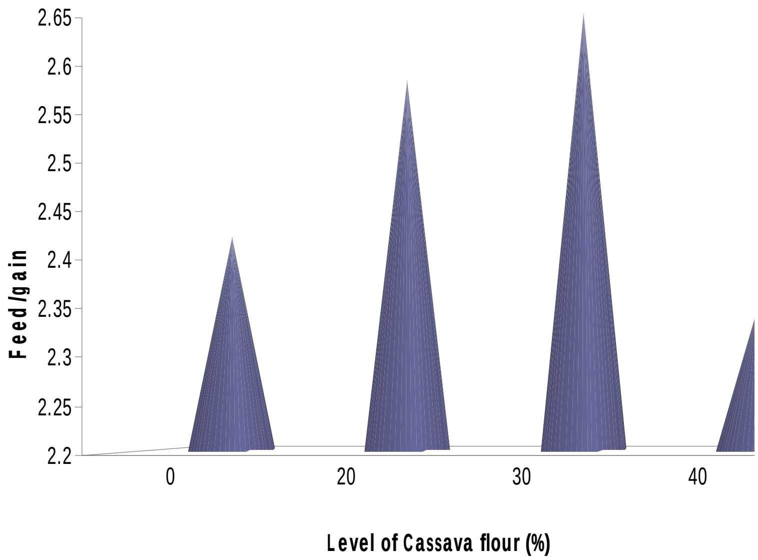


Fig. 17: Cassava Flour on FCR of Broilers

Cassava flour inclusion resulted in a linear decrease in abdominal fat content of the carcass with the lowest percentage of fat at 40 % (Fig. 18).

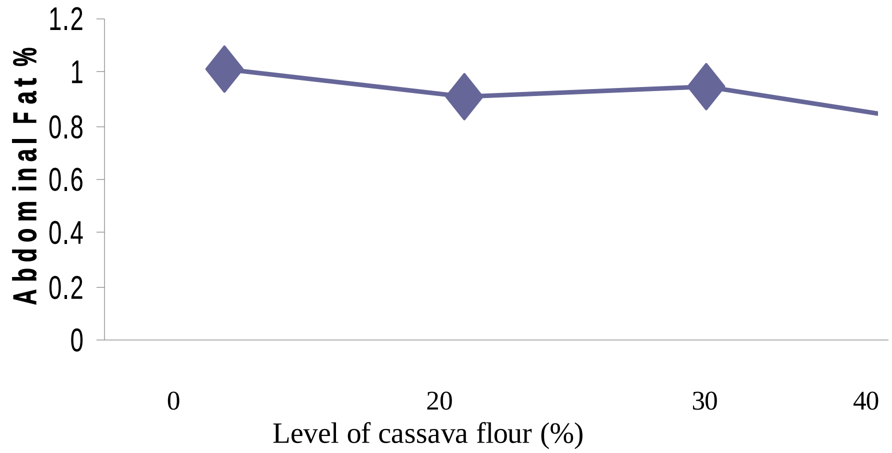


Fig 18: Percentage of Cassava flour on abdominal fat

Cost evaluation of diets (Table 11) revealed that total cost of feed and cost per kg body weight decreased as the level of cassava flour in the diets increased.

Table 11: Cost Evaluation of Cassava Flour Diets in Broilers (0-7 weeks)

Treatment	Quantity of Feed (kg)	Total Cost (N) (1992)	Total Cost (N) (2008)	Cost kg Body Wt(N) (2008)
0%	4.14	90.49	293.90	161.22
20%	4.30	76.07	271.99	156.14
30%	4.28	70.01	257.36	148.14
40%	4.16	61.86	238.78	135.98

ii) Peeled Grated Cassava in Broiler Diet (Eruvbetine, 1996)

Cassava tubers were peeled and grated before drying prior to inclusion in broiler diets.

Body weight of broilers at 30% inclusion level was similar to that of the control (Fig 19).

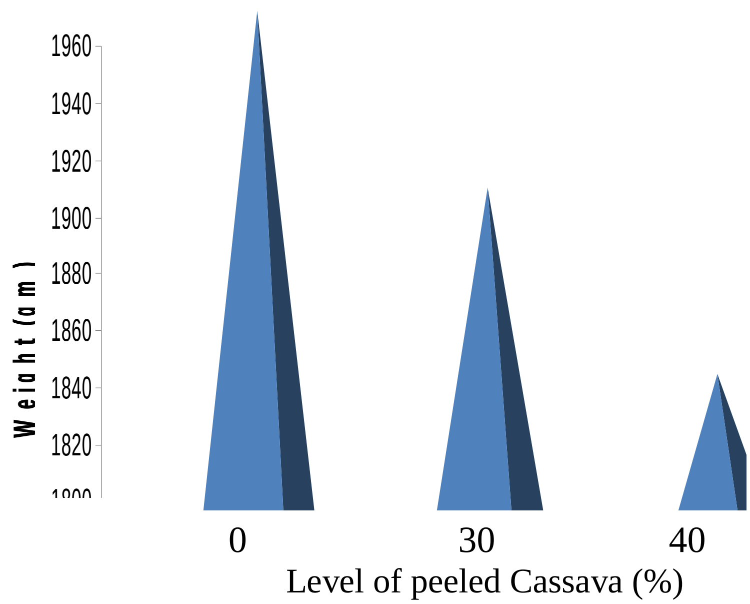


Fig 19: Peeled Grated Cassava on Body Weight of Broilers

The feed conversion ratio at 30% inclusion was also similar to that of the control (Fig. 20).

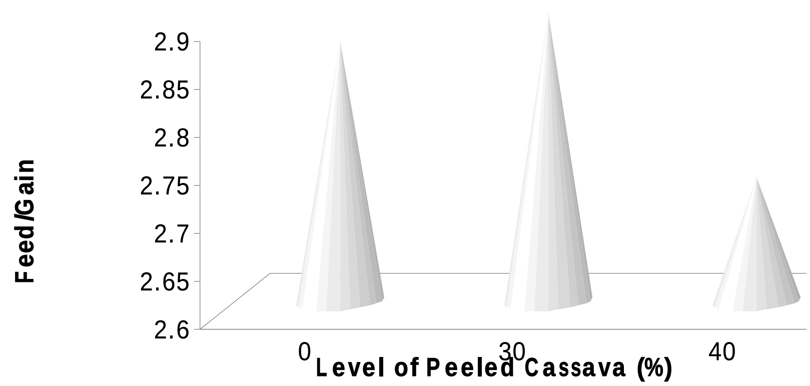


Fig. 20: Peeled Grated Cassava on FCR of Broilers

Abdominal fat % decreased progressively as the level of peeled grated cassava increased with significantly lower levels at 30 and 40% levels in relation to the control diet (Fig 21).

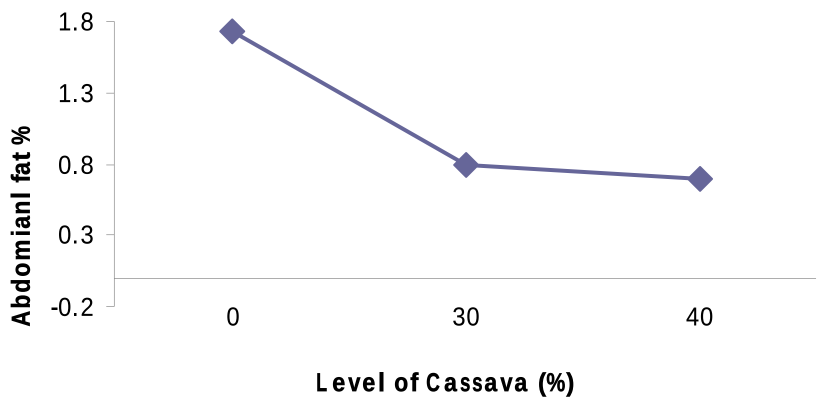


Fig. 21: Peeled Grated Cassava on Abdominal Fat of Broilers

Cost evaluation of these diets also shows that both total cost of diets and cost per kg diets reduced in the cassava based diets (Table 12).

Table 12: Cost Evaluation of Peeled Grated Cassava Diets for Broilers

Treat-ment	Quantity of Feed (kg)	Total Cost (N) (1994)	Total Cost (N) (2008)	Cost kg Body wt.(N) (2008)
0 %	5.62	121.42	390.53	199.66
30%	5.57	90.60	325.10	181.22
40%	5.11	76.56	276.76	151.40

iii**) Unpeeled grated cassava in Broiler diets (**Eruvbetine and Pius (1996).

Cassava tubers were greated with peels and included in diets for broilers. Body weight at 10% level of inclusion was similar to the control diet. This was because broilers cannot tolerate high levels of fibre and the presence of the peels in the diet resulted in higher fibre content in the diets (Fig 22).

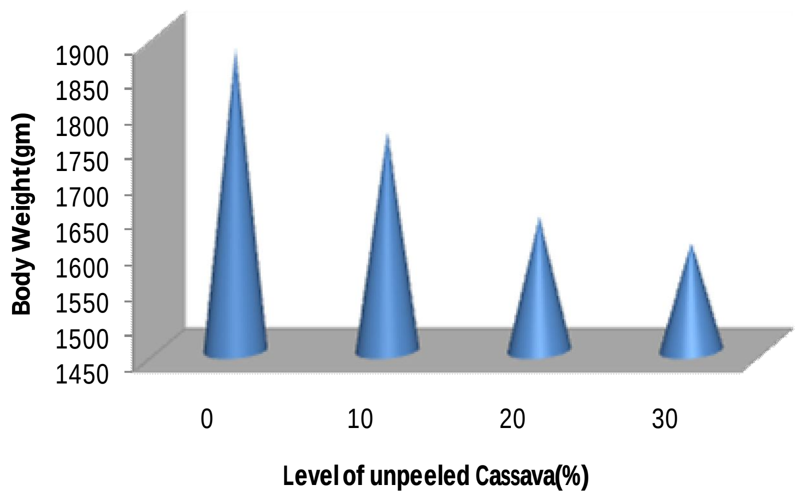


Fig. 22 Unpeeled Grated Cassava on Body Weight of Broilers

Feed conversion ratio was not affected by the inclusion of unpeeled grated cassava meal in the diets (Fig. 23).

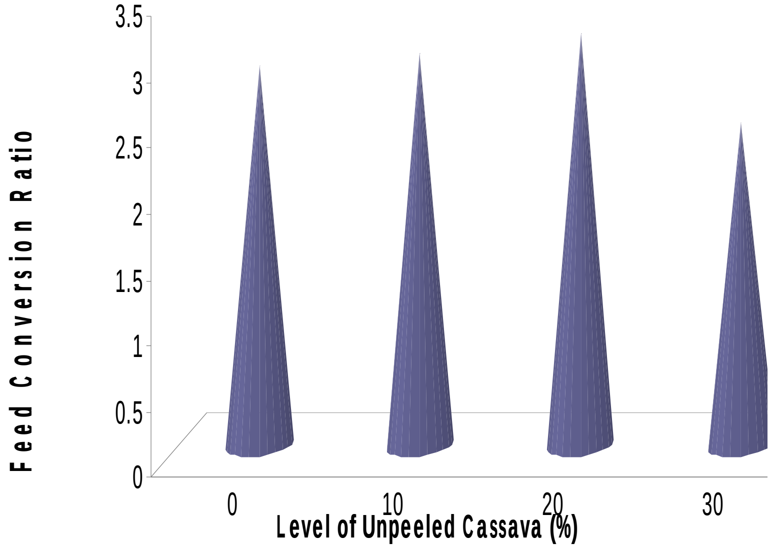


Fig. 23: Unpeeled Grated cassava on FCR in Broilers

Marked decrease in abdominal fat content was recorded when unpeeled grated cassava was included in the diets. (Fig. 24).

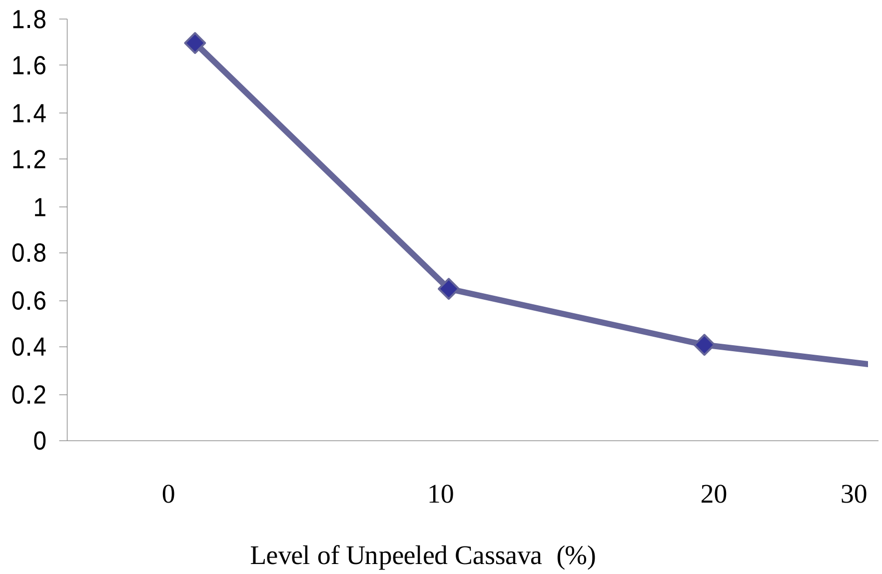


Fig. 24: Unpeeled Grated Cassava on Abdominal Fat

Cost evaluation also show that unpeeled grated cassava reduced cost of feed and cost per kg body weight (Table 13).

Table 13: Cost Evaluation of Unpeeled Grated Cassava in Broilers (0-8 weeks)

Treat-ment	Quantity of Feed	Total Cost (N) (1992)	Total Cost (N) (2008)	Cost/kg Body Wt. (N)
0 %	5.11	117.60	360.64	191.54
10%	4.82	105.11	320.48	181.99
20%	4.59	91.52	287.10	175.06
30%	4.23	77.60	247.62	154.76

iv**) Unpeeled Cassava meal in Cockerel Diets (0-18 weeks) (**Eruvbetine *et al* 1996).

Cassava was chipped with peels and included in diets for cockerels.

Inclusion of 10% unpeeled cassava in cockerel diets resulted in body weights similar to the control as reported by Eruvbetine *et al*. (1996) and shown in Fig. 25.

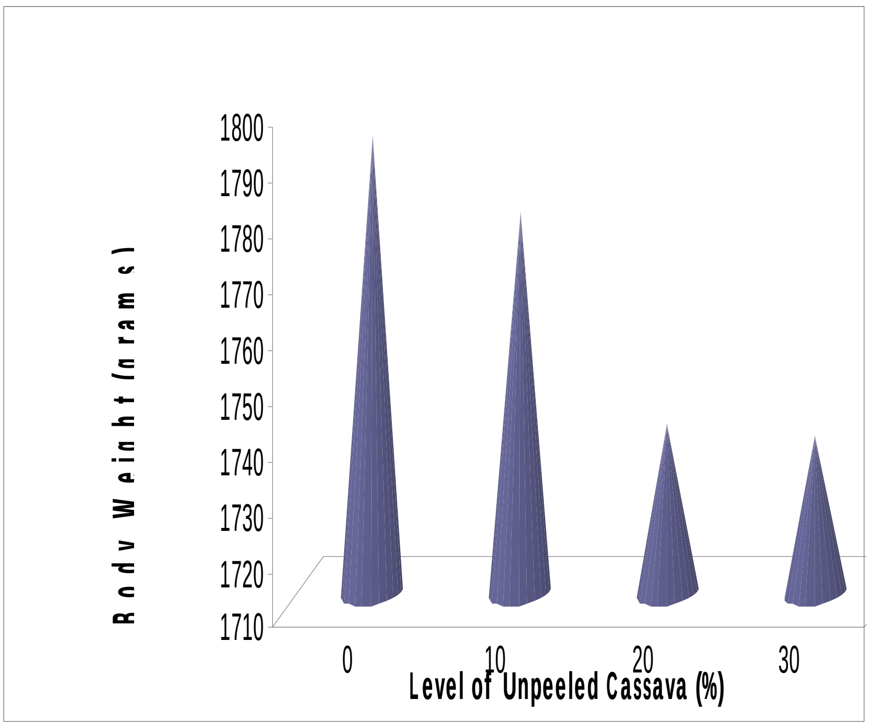


Fig. 25: Unpeeled Cassava on Body Weight of Cockerels

Feed conversion was best with inclusion of 10% unpeeled cassava in cockerels diets (Fig. 26).

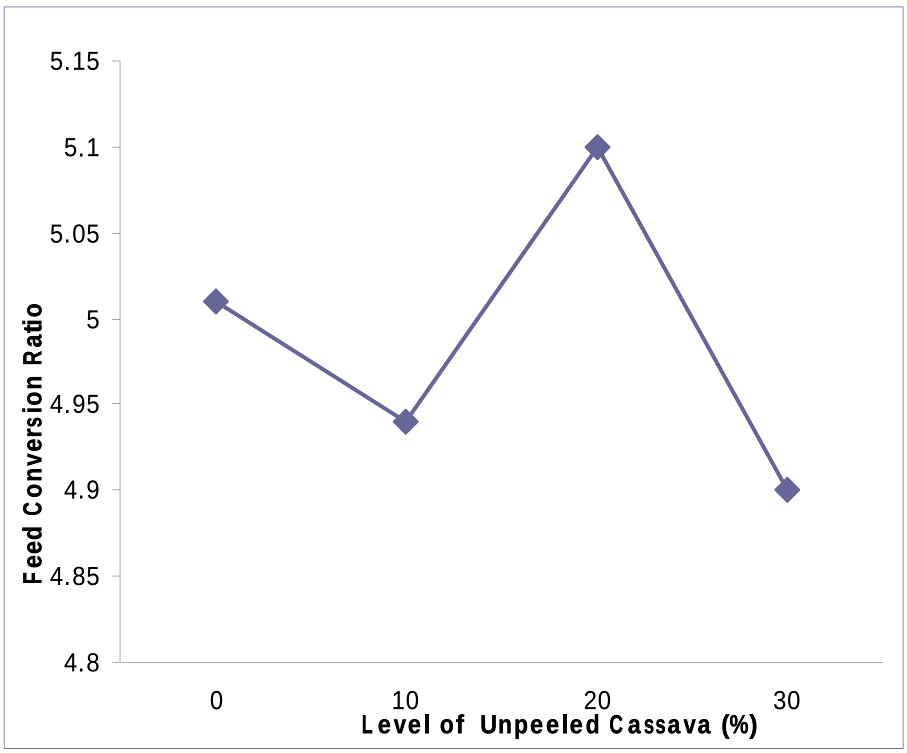


Fig 26: Unpeeled Cassava on FCR of Cockerels

Total cost of feed and cost per kg diet reduced with increasing levels of cassava in the diets (Table 14).

Table 14: Cost Evaluation of Unpeeled Cassava Diets for Cockerels (0-18 weeks)

Treatment	Quantity of Feed (kg)	Total Cost (N) (1996)	Total Cost (N) (2008)	Cost/kg body wt (N) (2008)
0	8.97	152.27	497.03	277.36
10	8.78	143.86	452.96	254.76
20	8.89	136.18	427.70	245.80
30	8.52	122.11	383.14	220.45

v**) Unpeeled Cassava Meal in Diets for Layers (Eruvbetine and Oguntona,1998)**

Cassava was chipped with peels and included in diets for layers.

Hen-day production was similar to the control with the 20% inclusion level of unpeeled cassava in the diets according to Eruvbetine and Oguntona (1998) as shown in Fig. 27.

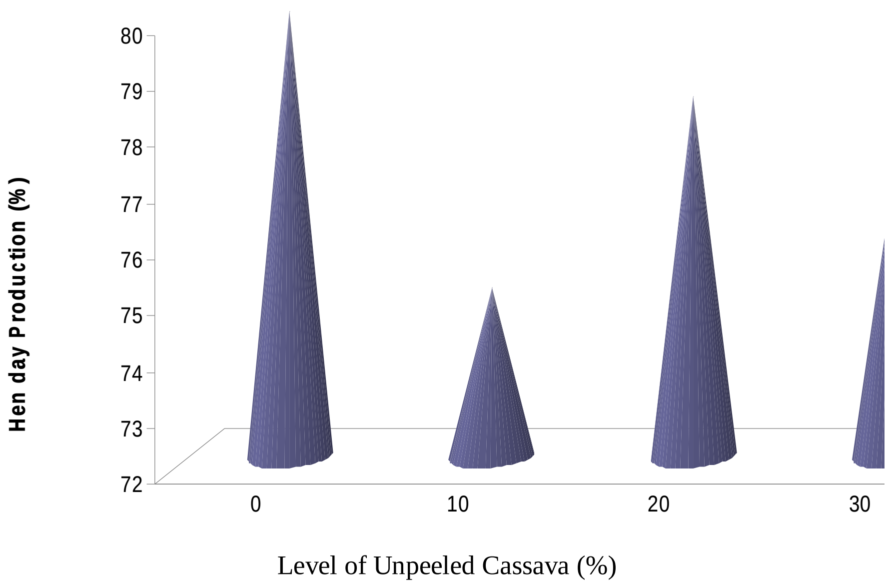


Fig. 27: Unpeeled Cassava on Henday production

Daily Feed consumption was low at the 20 and 30% levels of inclusion of unpeeled cassava (Fig. 28).

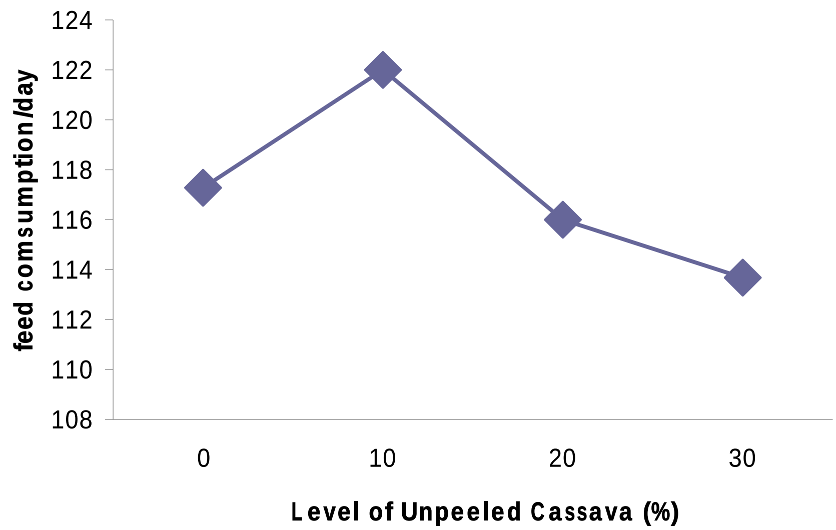


Fig. 28: Unpeeled Cassava on Feed consumption in Layers

Abdominal fat % was significantly reduced at the 20 and 30 levels of inclusion of unpeeled cassava (Fig. 29) .

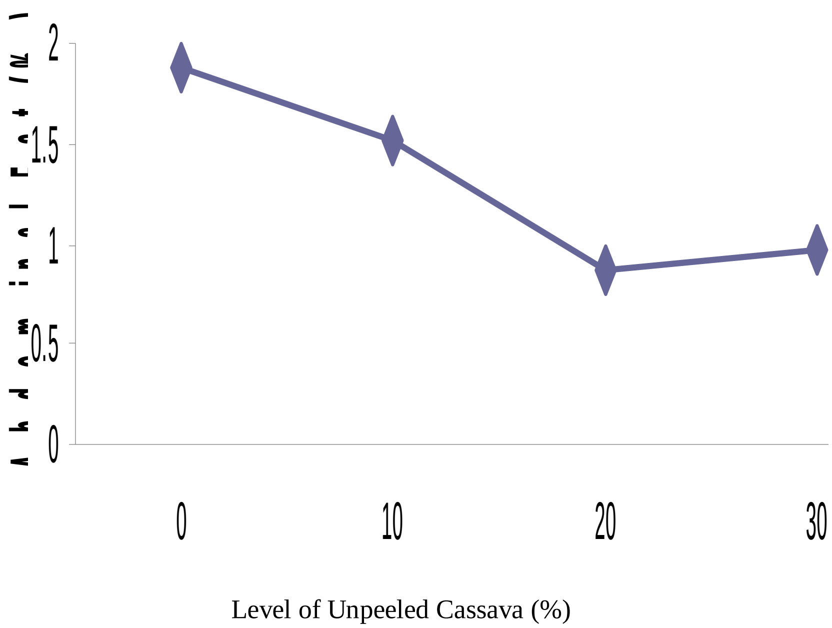


Fig. 29: Unpeeled Cassava on Abdominal fat of Layers

No significant differences were observed in all the egg quality parameters as a result of the inclusion of unpeeled cassava meal in the diets (Table 15).

Table 15: Effect of Unpeeled cassava meal diets on Egg quality of Layers

Parameter	0% Cassava	10% Cassava	20% Cassava	30% Cassava	SEM
Egg Weight (g)	58.73	57.07	57.32	57.75	0.37
Haugh Units	71.35	72.90	69.92	72.22	1.41
Shape index	0.82	0.82	0.81	0.81	0.01
Shell thickness (mm)	0.355	0.344	0.349	0.346	0.01
Yolk colour	2.27	2.37	2.30	2.47	0.05

(b) REDUCING CHOLESTEROL CONTENT OF EGGS AND MEAT THROUGH CASSAVA-BASED DIETS

From the previously reported studies, one key observation was that both in broilers and layers, the abdominal fat content in the carcass was low when cassava was included in the diet. Thus, it was speculated that cassava has some influence on fat metabolism. Since the last two decades, much interest has been raised on the role of cholesterol in human health. Eggs contain about 200-300mg cholesterol as reported by USDA (1989). The cholesterol content of eggs is a potential disadvantage for the use of eggs in human diets bearing in mind the consumer's fear for cholesterol and heart disease. This has given rise to continued interest by consumers to reduce dietary fat and cholesterol with attendant decline in egg consumption in the last few years. Thus, any reduction in the cholesterol content of market/table eggs, therefore, understandably becomes a subject of interest to both egg producers and health conscious consumers. At the Nigerian level of egg consumption (0.2 eggs per head per day), no evidence of too much egg consumption has been established to warrant any nutritional alarm. However, health conscious individuals who can afford the luxury of eating an egg a day are now concerned about regulating their intake of eggs.

Several reports have been made available about the myths surrounding the cholesterol content of eggs; cholesterol has long been an evil foe in the eyes of popular science. Consequently, eggs have received a bad rap because of the amount of cholesterol found in the yolk. But before you start throwing out those yolks, here are a few things to keep in mind about the cholesterol found in eggs:

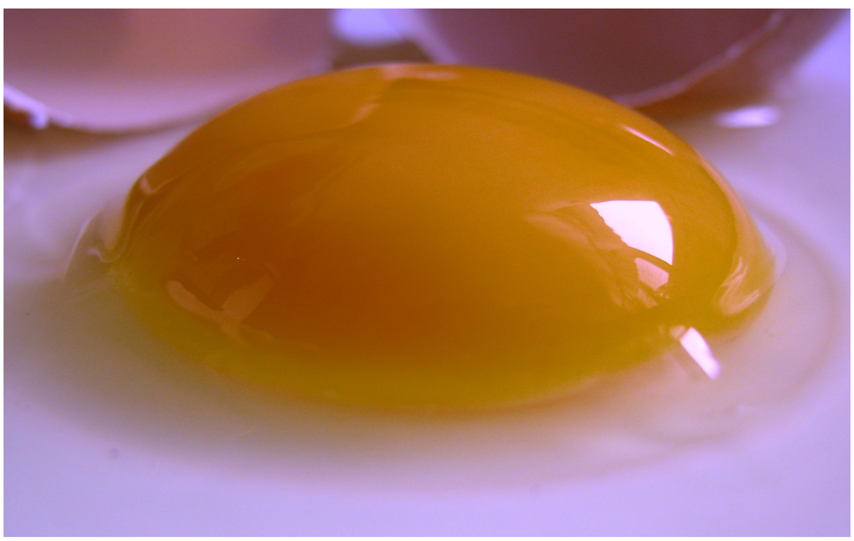


Plate 1: A Freshly laid egg

Reasons Not To Worry About Cholesterol In Egg Yolks.

Cholesterol is vital to body functions and required for construction, maintenance, and normal function of the cell membranes. Your cells could not function without cholesterol. Cholesterol also helps to create bile which aids in the process of digestion of fats. Bile helps to metabolize fat soluble vitamins A, D, E and K. Guess what? All of these fat soluble vitamins are found in the egg yolk along with the cholesterol.

(i) Your body produces more cholesterol than you eat

Cholesterol in the blood comes mainly from your liver and from your diet. The amount of cholesterol your body produces is directly related to how much cholesterol you ingest. When you eat a low cholesterol diet, your body produces more cholesterol. This is why a low cholesterol diet does not decrease a person's overall blood cholesterol level.

(ii) High Cholesterol Alone Does Not Cause Heart Disease

High cholesterol helps fight against infection. People with low blood cholesterol have the same rate of heart disease as people with high cholesterol. It is the ratio between high density lipoprotein (HDL) "good cholesterol" and low density lipoprotein (LDL) "bad cholesterol" that matters much more.

(iii) Cholesterol Found in Eggs Raises Your HDL levels and Lowers LDL levels

The fat in eggs (when you buy from healthy chickens) contains a large amount of omega 3 fatty acids. These fatty acids have been shown to raise HDL and lower LDL. However, vast majority of the fat contained in eggs is found in the yolk.

(iv) Eggs Help lower the triglyceride level in the blood

Triglyceride levels are usually much better indicators of coronary risk than cholesterol. High triglyceride levels in the bloodstream cause atherosclerosis, increasing the risk of heart disease and stroke.

(v) High Cholesterol intake raises testosterone levels

Testosterone is imperative for overall health. Testosterone increases natural energy levels, produces red blood cells, and protects against aging and osteoporosis.

In conclusion, there is absolutely no reason why egg yolks cannot be consumed by everybody. Cholesterol is vital and important for normal cell functioning.

However, efforts have been made by Researchers to reduce the cholesterol content of eggs by dietary manipulation. Due to the role of cassava in fat metabolism as observed from our own research, a series of studies conducted in the department were focused on the use of cassava in the diets of layers and broilers and their effects on cholesterol content of eggs and tissues.

(i) Cholesterol content of eggs from diets with Unpeeled Cassava meal in layer diets (Eruvbetine et al.2000).

Yolk cholesterol content reduced significantly at the 10 and 20% levels of inclusion of unpeeled cassava meal (Table 16)

Table 16: Effects of Unpeeled Cassava in layer diets on egg and yolk cholesterol contents

Level of Unpeeled Cassava meal	Egg cholesterol (mg/egg)	Yolk cholesterol (mg/g yolk)
0%	160.52	11.70a
10 %	156.00	10.85b
20 %	148.20	10.69b
SEM	1.11	0.36

As the level of unpeeled cassava meal increased with increasing duration of feeding, the egg and yolk cholesterol contents decreased (Table 17).

Table 17: Duration and Level of Unpeeled cassava meal inclusion on egg and yolk cholesterol content of eggs

WEEKS	EGG mg/egg			YOLK mg/g		
	0%	10%	20%	0%	10%	20%
0	163.59	167.69	178.62	11.71	11.58	11.69
2	156.73	151.75	149.35	11.69	10.47	10.94
4	152.42	133.97	144.23	11.71	9.74	10.24
6	165.13	172.23	147.47	11.69	11.55	11.29
8	167.81	166.26	151.70	11.71	11.65	10.25

(ii) Cholesterol content of eggs from unpeeled Cassava meal in layer diets(0-40 weeks)

As the level of unpeeled cassava root meal in the diets increased, irrespective of the period of lay, there was a decrease in yolk cholesterol content (Idowu and Eruvbetine, 2004). However, in all levels of inclusion, as the period of lay increased, the yolk cholesterol content increased as show in Fig 30.

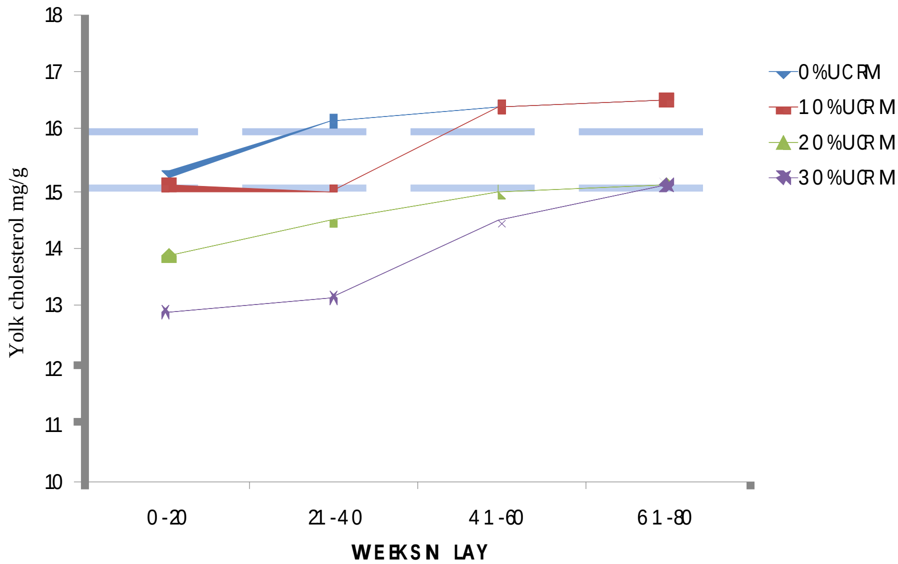


Fig 30: Effect of UCRM Diet on Yolk Chdesterol

(iii) **Cholesterol content of eggs with cassava sievate in layer diets (Idowu et al.** 2005).

Cassava sievate, a by product from fufu production was included in layer diets.

There was a decrease in both yolk cholesterol and egg cholesterol content in eggs as the level of cassava root sievate increased as shown in (Fig. 31)

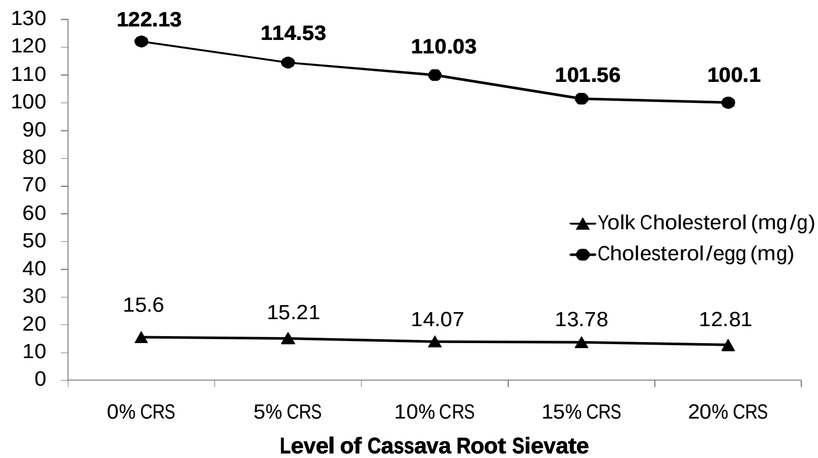


Fig 31: Effect of level of Cassava Root Sievate on Cholesterol contents of Egg and Yolk

The exact mechanism by which cassava reduces cholesterol levels is still not very clear. It is, however, known that high fibre diets bind bile salts and other organic materials, such as, cholesterol, thus, forming a complex at the absorption site, thereby, reducing its absorption. It is also possible that fibre shortens the intestinal transit time and increases fecal steroid excretion. Cassava, especially the unpeeled cassava and cassava sievate, which is a by-product from fufu production, has high levels of fibre which may be responsible for this.

(c) ENHANCING PROTEIN CONTENT OF CASSAVA

One of the major limitations of cassava utilization in poultry diets as a replacement for maize is the low protein content of cassava.

(i) Increasing Protein content through aerobic fermentation

One of the methods of increasing protein content is by fermentation. In this study, cassava chips were heaped separately for periods of 0, 3, 5 and 7 days both in the wet and dry seasons. Protein values for the two varieties used in the two seasons were as shown in Tables 18 and 19. There was a slight increase in protein content by day 3 irrespective of the season in both varieties used as reported by Eruvbetine and Adegboyega (1997).

Table 18: Dry season protein values of cassava after aerobic fermentation (%)

Variety	0 Day	3 Days	5 Days	7 Days
OTA	2.27	2.63	1.90	2.00
TMS	1.28	1.35	1.22	1.23

Table 19: Wet season protein values of cassava after aerobic fermentation (%)

Variety	0 Days	3 Days	5 Days	7 Days
OTA	2.48	2.77	2.40	2.27
TMS	3.76	4.01	3.71	3.39

(ii) Enhancing Protein Content through Anaerobic fermentation

From the earlier experiment, it was ascertained that the presence of a suitable microbe under anaerobic conditions may facilitate the conversion of the carbon skeleton to protein in the presence of a nitrogen source. Thus, a study was conducted (Eruvbetine and Adegbenro 1999a) to determine the protein content of cassava substrates inoculated with *Aspergillus niger* and anaerobically fermented with two different nitrogen sources (Table 20).

Table 20: Protein content of cassava inoculated with Aspergillus SPS after anaerobic fermentation(%)

Nitrogen Source	O Days	2 Days	4 Days	6 Days
Control	2.30	2.10	2.62	2.36
Poultry waste	2.80	4.73	3.78	2.45
Urea	14.36	20.50	33.13	27.53

This study showed that anaerobic fermentation of cassava inoculated with *Aspergillus niger* organisms in the presence of urea did result in an increase in the protein content of the cassava by Day 4.

(iii). Enhancing Protein content of cassava through inclusion of cassava leaves

Another study conducted to increase protein content of cassava was the mixing of cassava leaves and tubers together in different proportions and processing conditions and under different drying conditions (Tables 21, 22 and 23). Protein content was best with 50:50 proportion under sun drying, while the best processing technique was mixing the two and grinding before sun-drying (Eruvbetine *et al*., 2003).

Table 21: **Mixing proportion on proximate composition of leaf tuber concentrate**

Proportion	DM %	CP %	EE %	CF %	ASH %	NFE %
50:50	88.19	12.41	9.99	11.09	4.56	50.11
60:40	89.00	9.48	8.69	8.60	4.00	58.23
80:20	89.19	7.00	9.26	6.24	3.25	63.44

Table 22: Method of drying on proximate composition of leaf tuber concentrate

Drying Method	DM %	CP %	EE %	CF %	ASH %	NFE %
Sun Dry	87.67a	10.88b	9.96b	9.39b	4.08b	53.35d
Oven-Dry	89.92b	8.38a	8.66a	7.91a	3.79a	61.18b

Values with different letters in a particular column are significantly different (p≤0.05).

Table 23: Mixing process on proximate composition of leaf tuber concentrate

Mixing Process	DM %	CP %	EE %	CF %	ASH %	NFE %
Drying Before Mixing	89.49	8.68	9.96	8.80	3.11	58.94
Mixing Before Drying	88.13	10.58	9.50	8.50	3.96	55.59

The HCN content was lower in sun-dried samples, while mixing and drying the sample also had lower HCN content (Table 24).

Table 24: HCN content of samples (mg/g)

Drying Method	Level HCN	Mixing Process	Level HCN	Proportion	Level HCN
Sundry	0.162	Dry & Mix	0.279	50:50	0.235
Oven Dry	0.318	Mix & Dry	0.201	60:40	0.278
				80:20	0.208

An in vivo study was also conducted using samples of processed cassava. Tubers and leaves were mixed in a 50:50 proportion before sundrying and fed to broilers at different levels of inclusion (Table 25).

Table 25: Performance of broilers fed different levels of cassava leaf tuber concentrate

Parameters	Concentrate 0%	Concentrate 10%	Concentrate 20%	Concentrate 30%
Body weight 4 weeks gm.	855.50	744.11	651.90	54.70
Body weight 9 weeks gm.	2345	1935	1750	1441
Total Feed intake kg.	6.17	4.36	4.31	3.82
FCR	2.63	2.25	2.46	2.65
Mortality %	3.33	6.66	-	3.33

It was observed that inclusion of 10% concentrate in the diet showed some promise in terms of body weight gain, total feed intake and feed conversion ratio.

(d) IMPROVING PROCESSING TECHNIQUES OF CASSAVA

One of the drawbacks of cassava is its powdery nature making milling very difficult and resulting in wastage. A study was conducted to look at the means of improving the texture of cassava flour while still retaining its nutrient quality. In this study (Eruvbetine and Adejobi 1999), peeled cassava and raw soybeans were processed together in different proportions and heating methods. The best processing technique obtained was boiling 2 parts of soya beans for 20 minutes and, thereafter, adding 3 parts of raw cassava chips and further boiling for 20 minutes. The mixture was then sun-dried on flat concrete floors before grinding.

Raw Soybeans (2 parts)
↓
Boiling for 20 minutes
↓
Addition of Peeled Cassava chips (3 parts)
↓
Boiling for 20 minutes
↓
Sun drying for 5 days
↓
Grinding

Fig 32: Flow diagram for cassava-soya concentrate preparation

In vivo trials conducted (Eruvbetine et al., 1999b) with inclusion of 20 and 30% levels, of the concentrate showed that at 30% inclusion levels, final body weights and feed conversion ratios were comparable to that of the control diets (Table 26).

Table 26: Performance of Broilers fed Cassava- Soy Concentrate Diets

Parameters	0 % CONC.	20 % CONC	30% CONC
Final Body wt (gm)	1950	1930	1850
Avg. feed Intake (kg)	6.45	5.86	6.17
Feed Conversion	3.31	3.04	3.34
Mortality (%)	5.50	0.00	0.00

Realising the potentials of cassava as an animal feed ingredient, the Federal Government, as part of its cassava initiative program in 2003 made efforts to increase its utilisation in poultry feed. However, presently there are lots of contradictions in this program. The program does not seem to have made any positive impact, but rather was destroying the viability of small scale farmers. Between 1.2 and 1.5m tonnes of cassava is required for animal and poultry feeds while the requirement for ethanol production is about 1.2m tonnes. Additionally the policy requirement for flour containing 10% cassava could involve an additional 380,000 tonnes annually. Being the largest producer of cassava in the world today (40-50mtonnes annually), there is no doubt that the country can meet these needs even at its present production level. So why has the program failed? Recently the President of the country set up a Presidential Technical Committee to look into the problems in all its ramifications and make recommendations. The major problem identified was the cost of production. In spite of the large production capacity, the country cannot make cassava products competitive both locally and internationally. The committee also has the mandate to set up cassava revolution committees at the state and local government levels for participation and involvement of farmers from the grass roots. Therefore, the country would need to exploit this useful crop and use it to maximum advantage. The 1.5bn US dollar revenue and the "White Revolution" goals of the Cassava Initiative Program is not a dream but a challenge which all stake holders must overcome. This would also bring about a radical change or revolution in the feed industry.

5.0 NEED AND MEANS FOR EFFECTING A FEED REVOLUTION

Over the years, the carrying capacity of planet earth has long been exceeded. Land has been degraded through over-stocking by both livestock and humans. We continue to crop land which is marginal, has inadequate rainfall, unsuitable soil-type and insufficient organic matter leading to erosion.

Currently there is a population of over 6.5 billion people on planet earth as indicated earlier and increasing every year and more rapidly in the developing world. Is there sufficient arable land to grow the food and feed required? Apart from food and feed, there is a driving force in the US especially for biofuel production which has serious impact on the entire world. Presently estimated arable land for crop production is 500 million hectares. According to Farrel (2009), a total of 680mmt of feed was produced in 2007. If there is an annual 1.4% increase in rate of feed produced, by 2015 we will need 780mmt of animal feed.

Presently land requirement is as follows:

For food: Land requirement for grain cultivation of	260 mmt
For feed: Land requirement for grain cultivation of	35 mmt
For feed:Land for protein oilseed cultivation of	95 mmt
For Biofuel:Land requirement for grain cultivation **of**	100mmt
TOTAL	490mmt

This means that the world needs to double its existing land hectarage for cultivation of grain and protein sources by 2015. How do we as Feed Users solve the problem of increased requirement? Is increasing production the answer to our question? The problems associated with increased production which in variably contribute to climate changes, global warming, green-house gas emission necessitate seeking other solutions to this problem. These solutions are already gradually in place but the slow pace of change may not be sufficient to bridge the widening gap in terms of requirement. Thus, there is need for radical changes or a revolution in the feed industry to bring about a lasting effect. The changes that are currently ongoing and new changes proposed are categorized as follows:

- Utilization of available feed ingredients effectively
- Sourcing for non-conventional feed ingredients
- Looking for ingredients not competing with man but are environmentally friendly
- Embracing Genetic improvement of feed resources
- Adopting innovative technologies
- Proper monitoring and availability of raw materials

Utilization of Available Feed Resources Effectively

One of the most promising technologies in increasing utilization of feed ingredients is the inclusion of exogenous enzymes as feed additives. Efficient digestion and uptake of nutrients is the key to ensuring that the bird gets the most out of each ration irrespective of formulation. Some of the fibrous components in feed ingredients cannot be digested by the natural enzymes present in the gut and are, hence, excreted out undigested. In this respect, the inclusion of specific enzymes for the particular component within the ingredients could be utilized for effective digestion and release of nutrients. The use of enzymes can be categorized into four areas:

(i) Removal of anti-nutritional factors

(ii) Increasing digestibility of existing nutrients

(iii) Increasing the digestibility of non-starch polysaccharides (NSP).

(iv) Supplementing host endogenous enzymes.

Fortunately, major advances in enzyme and fermentation technology means that there are good commercial products available that increase digestibility and nutrient availability. This is particularly important wherever poorer quality raw materials or reduced specification diets containing byproducts are used.

Recent advances in the use of in-feed enzymes and fermentation technology not only improve production levels, but also reduce variability in the performance of all types of poultry and allow the use of raw materials with lower nutritional value. Due to the economic climate and raw material availability, cereals typically used as the main ingredients in diets are replaced with byproducts of lower grade raw materials.

Of recent much importance has been given to the use of probiotics in poultry feeding. Probiotics are microbes that protect the host and prevent diseases. It has fastly replaced antibiotics as a growth promoter. Other feed additives such as prebiotics – feed for enhancing growth of favourable microorganisms in the gut and mycotoxin binders to counteract effects of mycotoxin have also been used to promote effective feed utilization.

Unconventional feed ingredients

A lot of interest has been developed over the years in Nigeria over unconventional feed ingredients. What are unconventional feed ingredients? These are feed items which are not normally the first choice material to supply required nutrients. They can be whole products, part of a product or byproducts of industries. They may be of either plant or animal origin. Usually they are of lower prices and inferior nutritional qualities than the conventional ones. There is also need to have their nutritional content and value improved upon.

Unconventional energy sources

Plant Products: wheat bran, wheat offal, rice bran, rice husk, biscuit waste, cassava chips, cassava waste, cassava sievate, cassava grits, cassava peels and cocoa pod husks.

Recently at the University of Ibadan, a new product called cassava grits has been produced, tested and patented. It is comparable to maize and being used in large scale commercial farms (Iyayi, 2009). (plates 2 and 3)

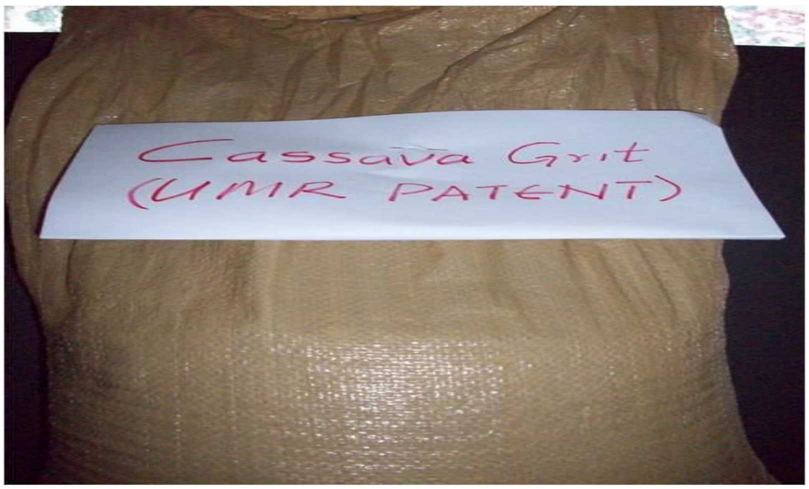


Plate 2: Cassava Grit in bag

Plate 3: Raw cassava grits

Unconventional protein sources:
Plant proteins: Sesame seed meal, Rapeseed meal, Safflower meal, Sunflower meal, Rubber seed meal, etc.
Animal protein: Shrimp waste meal, Hydrolyzed feather meal, maggot meal, etc.

New alternatives with potential, and available worldwide
(i) Distillers dry grain solubles (DDGS): By product of the distillery industry such as distillers dried grain have long been used. However, modern DDGS from ethanol fuel is equal or superior to the "old" DDGS. It is apparent that there is a variation in many of the essential nutrients especially as corn itself is of variable nutrient content (Table 27).

Table 27: Nutrient Composition of DDGS

Dry Matter	89.36%
Crude Protein	26.45%
Fat	10.08%
Fibre	6.99%
Calcium	0.07%
Phosphorus	0.77%
Lysine	0.73%
Methionine	0.50%

As ethanol production from corn increases, there is growing interest in modifying its production technology. This will result in different types of by-products that may have superior or inferior nutritional content. It will be necessary for Nutritionists to be sure that they have accurate values to be used in the diet. Ethanol producers should work with the feed industries to provide characteristic nutrient values for such new products as they develop. DDGS does not only replace corn, in addition it replaces soybean, bone meal, phosphorus , methionine, etc.

In Nigeria we have Brewers Dry grain which is obtained from the brewing industry. This is a popular product and is used widely for poultry feed. However, its availability is also irregular. Any attempts made in Nigeria to produce ethanol should focus on the byproducts that can be used effectively for animal feeding.

(ii) **Glycerin:** Of recent, a sugar company in the Middle East (Dubai) is supplying sugar syrup at an affordable price to poultry feed producers. The high levels of sugar provides higher ME value than corn (John, 2008) (Tables 28 and 29)

Table 28: Composition of corn and sugar syrup

Component	Corn	Sugar Syrup
Dry Matter %	89	80
Crude Protein %	9.6	4.6
Fibre %	2.5	0
Fat %	4.1	0
Ash %	1.5	6
NDF %	14.5	0
ADF %	2.0	0
Starch %	75	0
Sugar %	0	70
ME (MJ/kg)	13	14
Calcium %	0.1	0.92
Phosphorus %	0.3	0.2
Magnesium %	0.1	0.17
Potassium %	0.4	0.85
Sodium %	0.1	0.1
Lysine %	0.80	0.02

Source: John (2008).

Table 29: Energy Availability of Starch and Sugar

Component	GE kcals/kg	ME kcals/kg	Meatbolisability %
Starch	3760	2918-3396	78-90
Sucrose	3960	3900	98

Source: John (2008).

Other Advantages of sugar syrup in feed

- Increases palatability
- Improves DM digestibility
- Reduces Dustiness
- Inhibits Mould
- Stops insect infestation during storage
- Acts as a binder
- Increases energy density of the ration
- Masks less palatable ingredients
- Substitute for grain
- Free of afaltoxin
- Decreases gut viscosity

Although the high price of sugar may not necessarily warrant its use, glycerin which has a high sugar content can serve as a ready substitute.

Increased government pressures for biofuel had led to a significant increase in biodiesel production, resulting in increased availability of glycerin as a byproduct. Glycerin has been used successfully in broiler diets at a level of 10% for up to 42 days in the US (Waldroup et al., 2007). However, there are still problems associated with it related to mixing and flow of ingredients and the high levels of potassium in residual glycerin. Glycerin has a lot of potential as a feed ingredient if issues such as product consistency, methanol, sodium and potassium levels and mixture flow are better understood.

From 2006 to 2007 biodiesel production doubled from 250million to 450 million gallons making an additional 18 million gallons of glycerin available. Dozier et al. (2008) observed that the AME of Glycerin inclusion in broilers was 92-95% of GE. This shows that it can be utilised effectively as an energy source.

Of recent, a crop referred to as "Petrocrop" has gained much importance worldwide. *Jatropha curcas* is a plant belonging to the family euphorbiaceae. This crop is of particular value as it cannot be consumed by humans and, hence, is not in competition for human utilisation. In Malaysia, in order to protect their oil palm plantation from being exploited, acres of oil plantation crops have been intercropped with jatropha seedlings. The plant grows on loose sandy soils and can tolerate temperatures ranging from 16-40°C.The plant on maturity produces fruits whose seeds have an oil content of 32-36%. Seeds from 1ha of Jatropha plantation could produce 7-10 litres of biodiesel. Several countries worldwide including Malaysia and India have embarked on massive plantations of Jatropha and have harvested the potentials of this crop effectively, not only for biodiesel but also for several other products and byproducts.

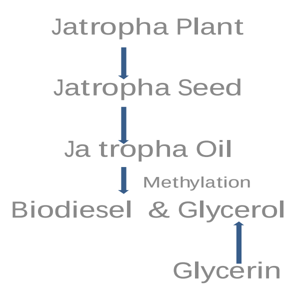


Fig 33: Flow diagram for Glycerol production from Jatropha

Plate 4: Jatropha Plots (www.svlele.com)

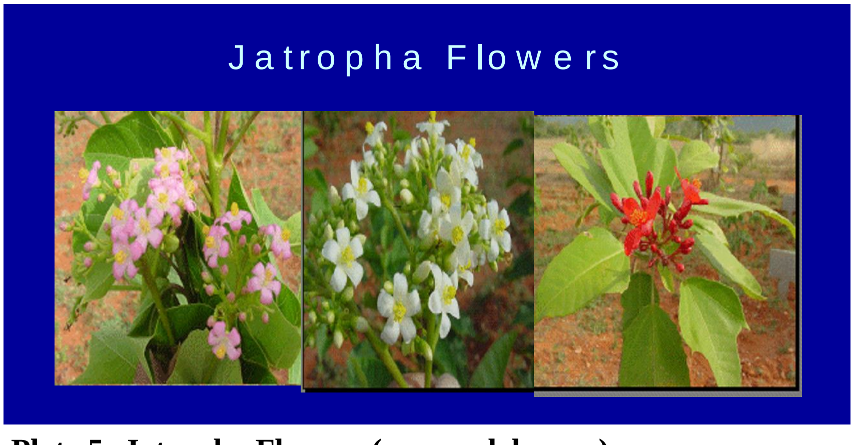


Plate 5: Jatropha Flowers (www.svlele.com)

Plate 6: Jatropha Fruits (www.svlele.com)

Plate 7: Jatropha Seeds (www.svele.com)

Genetic improvement of feed resources

Biotechnology is a modern tool by which crops and animal improvements are possible by applying cell and gene technology. Agricultural biotechnology brings together advanced disciplines of biology, genetics, molecular biology, biophysics, biochemical engineering and computer science. The potential contribution of biotechnology as it relates to feed is the Genetically Modified (GM) feedstuff and feed additives. There is improvement in feed through improving nutrient content as well as the digestibility of low quality feeds. With the help of modern science, the increase in food production in recent decades has kept pace to meet the needs of the ever growing population in most parts of the world. According to Swaminathan (1999), the term “Green Revolution” has now been replaced by “Gene Revolution”, where science and technology are addressing most issues pertaining to crop production at a cellular level.

Some of the limitations facing feed nutrition are the antinutritive factors like trypsin inhibitors, saponins, tannins, phytates, oxalates and high fibre. Developing genetically modified grains having improved nutritional values could solve these problems. Low phytate corn will bring about less excretion of phosphorus in the litter and also prevent pollution of the environment. High oil corn will not only improve oil content but also protein content resulting in better performance of birds. Low oligosaccharide soybeans improve digestibility in the birds, while high lysine soybeans increase the lysine content by 3-5%, thereby, reducing additional supplementation of lysine in the diets. However, all such newly introduced products need to be tested and certified before being introduced into the market. There is a lot of controversy today with respect to the use of GM foods. But it is a technology that is necessary to meet the demands of the ever increasing population.

According to MaxPlank:
A new scientific truth does not triumph by convincing its opponents but rather because its opponents die and the new generation grows up that is familiar with it.

Innovative Technologies

Nano Technology

Poultry farmers have given much emphasis on issues such as biosecurity, feed prices and environmental restrictions. While the world has focused on affecting the birds from outside in, one novel approach looks at affecting the bird from the inside out. This is a unique approach in providing critical cellular nutritional components at a nano level thereby directly affecting the health of the bird and allowing nature to exploit the intrinsic ability of the bird to resist disease, maximise growth potential, improve feed conversion ratios and reduce environmental impacts. How is it done? The nutrition particle (one billionth of a meter) is delivered in water as small clusters? Each cluster has the nutrition particle in the centre. Due to its small size, assimilation is in the gullet and no digestion is required. Since the shell of the cluster is the water, it is readily absorbed.

A commercial product Nano Nutrient Formula produced by Nano Nutrient Aviagen has been proven to be effective in reducing the cost of feed and increase in body weight of broilers. A 20% reduction in cost was recorded in broiler production (Table 30) according to Diaz (2007).

Table 30: Comparative cost of using Nano Feed and Standard Feed

Parameter	Standard Feed	Feed + Nano Nutrient Formula
Cost/broiler	$ 1.6	$1.28
Reduction %		20%

Cost of Formula is 0.08c/bird

A similar nano product called ‘Atovi’, commonly referred to as “wonder powder” was developed in the Philippines by an Industrial Engineer. Remarkable improvement in growth of broilers achieving market weight in 35 days, a sharp drop in vaccination and medication expenses and a 30% drop in chicken manure were recorded. The cost of production of a broiler was reduced by 20%.

Raw material availability and monitoring

This is a role where Government should make a heavy impact and investment. The following plan of action are suggested:

(a) **Availability of Source of Ingredients**

- Heavy subsidies for increased production of raw materials on a large scale wherever necessary. Proper storage mechanisms and even distribution of grain reserves and other vital inputs.
- Encourage the production of new crops suitable to the particular geopolitical zone. In Nigeria, we are totally dependent on corn as an energy source and soybeans as the protein source in diets for poultry. Scarcity of any of these two ingredients can result in a crisis in the industry. In most countries alternative protein sources such as sunflower seeds, rapeseed, safflower, etc, have proved use-

ful. These are crops that can be cultivated in Nigeria and efforts should be made to go into large scale production of these crops.

- Mandatory 5-10% investment of profits from multinational companies to go directly into farming investments (Bello, 2008)
- Adjustments of land laws to accommodate large scale farming (Bello, 2008)
- Increased budgetary allocation to the crops department of the Ministry of Agriculture for massive production.

(b) **Standardization of the Feed Industry**

- Standards Organisation of Nigeria (SON) should be involved fully in the monitoring of materials used in and products derived from the feed industry
- NAFDAC should ensure strict adherence to the quality of all feed additives, chemicals and premixes produced
- Special supervisory bodies for the monitoring of commercial feed millers, toll mixers and on-farm producers and ensure that such feed has nutritional labeling and certificates of analysis. Laboratories used should also be certified and accredited. Feed millers should also conform to standard practices of data and record keeping in approved formats.

6.0 REFLECTIONS AND THOUGHTS ON THE UNIVERSITY SYSTEM AND ACADEMICS

Mr. Vice-Chancellor Sir, at this point kindly grant me permission to ponder and express some of my thoughts on the University and Academics in general. A student who enters the University is a "raw material" who undergoes "value addition" and on graduation becomes a product that is marketable. The quality of the product determines its marketability. We as Academics have an important role to play in this "value addition". It means equipping our students with technical skills and knowledge and the embodiment of character together with adequate entrepreneurial abilities to enable them make meaningful contributions to society. Each and every academic by his/her own devoted and committed service can make this possible and the collective roles played by all will contribute to the quality and unique products we want to market. Our products will be known for its quality and that is what we have to strive for. I am happy that the current administration is also committed to this goal.

One of the objectives of the University is to produce graduates of Agriculture who are job creators and not job seekers. Have we achieved this objective.? Mr Vice Chancellor Sir, UNAAB in the 21 years of its existence has produced approximately 2000 graduates in Agriculture. Less than 5% of these graduates have embarked on active agricultural enterprises. I am happy the Vice Chancellor recently initiated a program to assist our graduates and, today this program is to take off with the first batch of 60 graduates. My lecture today has highlighted several ideas for very viable and growing enterprise as it relates to feed that our graduates could embark on. Universities should either by partnerships or provision of facilities foster a thriving relationship with our graduates to enable them embark on such meaningful agricultural enterprises, not only within the University but also across our mandate areas. Such liaisons would have a multiplier effect that brings about agricultural growth and also ensure that our mandate is met.

The changing world has brought about many changes within the University system and Academia in general. Universities are now corporate entities, which have to a great extent, changed the face of academics. The thirst for knowledge and information is now focused more towards monetary gains. Students seek admission to programs that bring them maximum monetary gains rather than those which they may have a natural aptitude for. Basic research has been overcome by applied or problem-oriented research. An average academic would opt for positions and placements that have maximum monetary gains. In seeking this, the personal values of genuinely imparting knowledge and making sacrifices for any extra efforts to ensure that our products are not ”half baked’ is usually lost. In line with the current trends in the system the academia should also seek for avenues for sourcing of funds to enhance available resources for conducting research. Unfortunately in Nigeria, the challenges facing an average academic are numerous but the ability to overcome these challenges is the key to success.

The time has now definitely come when every intelligent individual must learn to think globally, beyond the horizon of a narrow nationalist point of view.”
***Robert Maxwell** (1923 – 91)*

Finally Sir, we Animal Scientists in Nigeria have now cause to rejoice in having achieved a rightful status for our profession. The establishment of the Nigerian Institute of Animal Science is a step in the right direction. It also gives a lot of hope for our graduates not only in terms of the training they receive but also in their future job prospects. I, however, wish to observe that our profession cannot work in isolation; there are other related professions which are relevant to our own needs, as such, we must strive to work cordially with our sister professions in achieving our final goals for a virile and solid livestock sector.

7.0 CONCLUSION

Mr. Vice-Chancellor Sir, I have tried in my presentation to give an overview of the feed industry and the necessity for a change in our traditional and current mode of operations as it relates to feeding our birds. The survival of the poultry industry rests solidly on the availability of feed. The feed resources available to us are limited and in order to keep up with the needs of our people for adequate protein supplies, through poultry meat and egg consumption, drastic measures must be taken. New ideas and technologies must be embraced to meet up with world's growing demands for food. The slow pace of embracing innovations and technologies must be changed so that radical and immediate changes can be enforced. Countries which have larger populations than our own in the developing world are doing something right and are making giant strides in agricultural developments and are fast competing with the developed world even in poultry production. They have achieved self sufficiency in food production and are earning valuable foreign exchange through exportation of their surpluses. That the same raw materials, i.e., our valuable food crops are today competing for production of Food, Fuel and Feed is a cause for concern. The first choice of use is for Fuel followed by its use for food while production of feed is relegated to the last position. It is time for us to take these warning signals seriously. As suggested in my presentation, by-products of biofuel and biodiesel production are the answers to solving the ever increasing need for feed in the poultry industry. The effective utilization of products and byproducts which do not compete as food for man is central to the achievement of the feed revolution. We in Africa, especially in Nigeria, must wake up to this realization and embrace these new ideas in order to bring about the much needed development for the continued survival of the feed industry and poultry production in particular.

8.0 RECOMMENDATIONS

There is an urgent need for a revolution in the feed industry to make sure that the industry does not go into a crisis.

- The recent lift in the ban on maize importation is a step in the right direction. However, to have any positive impacts, Government should ensure that the importation of maize is monitored and the tax of 80% is reduced so that it is economical for the feed millers to benefit from it. Distribution of the maize should also be effectively managed.
- While the cassava initiative program is laudable, the high cost of production of cassava has defeated the purpose of this program. More efficient and cost saving devices must be put in place to encourage farmers to go into

massive cultivation of cassava with a view to encouraging farmers to use cassava in feed for poultry.

- Planting of new crops like sunflower, rapeseed, etc, should be encouraged so that additional protein sources are available for feed production. These crops can be grown in the various geopolitical zones across the country and are not only useful for animals but also for human consumption.
- The new trends in biodiesel utilization must be encouraged not only to help relieve our dependence on fossil fuels but also to save our limited crop resources from being converted to fuel. Establishment of Jatropha sps which is a plant not in competition for use by man and at the same time environmentally friendly is a valuable option not only for production of biodiesel but also the numerous byproducts among which is glycerin which can be fed to animals..
- Active Research in Feed Biotechnology should be encouraged to provide suitable and adequate quantities of feed ingredients that can enhance quality feed production.
- Research studies on technologies, such as, Nano technology in relation to feed should be conducted in the country to bring about accelerated growth and maximization of profits.

- Government and private sector standardisation and monitoring mechanisms should be put in place to ensure that all feeds produced conform to proper quality control measures that would guarantee the safety of the products meant for human consumption.

9.0 ACKNOWLEDGEMENTS

"Count your blessings name them one by one
Count your blessings see what God has done
Count your blessings, name them one by one
And it will surprise you what the Lord has done"

I wish to firstly thank God for his numerous blessings in my life. He has been my guide and strength at all times, his protection, grace and favour has enabled me to get to where I am today. The blessed Virgin Mary and her glorious love has been a source of inspiration to me always.

As I go down memory lane, I cannot forget my teachers in my schools far away in Sri Lanka. The solid memorable foundation they gave me early in my life has been a good beginning for the pursuit of my academic career. To my colleagues and Teachers in India during my undergraduate days, I say a big Thank you for giving me all the challenges which helped me in my quest for attaining greater

heights. The days I spent while pursuing my graduate studies in Canada can never be forgotten. Special thanks to my late supervisors, Professors Clandinin and Robblee from the University of Alberta, Canada for believing in me and giving me the opportunity to pursue my dreams. My colleague Prof. John Kennelly is specially acknowledged for the special friendship we share, which time and distance has not marred. To my other colleagues in Canada, Evelyn, Anna, Goh, Rohini, Laki, Margaret and a host of others, I am grateful for the wonderful time we spent together. Special mention is also made of Profs. Bob Hudson and Bob Hardin.

To the University of Agriculture, Abeokuta I am eternally indebted for making me what I am today. I wish to thank the pioneer Vice Chancellor, Prof. N.O. Adedipe, for opening the door for me to enter this great institution and begin my career. My deep gratitude is also extended to Prof. J.A. Okojie for touching my life in many ways. Prof I.F. Adu and Prof. I. Adamson are also gratefully acknowledged. UNAAB deserves the best and we have got the best since the appointment of the current VC Prof. O.O. Balogun, *"Outstanding people have one thing in common, an absolute sense of mission"* (Zig Zigler). His exemplary leadership has been an inspiration not only to me but many others in helping us fulfill our goals. I am honoured to be a part of his team and associated with the giant strides of progress in this University. Thank you sir for taking UNAAB to greater heights. Professor G.M. Babatunde, who was everybody's teacher was also my own teacher by proxy and I thank him for his objective advice always. I make special mention of Professor E.B. Oguntona, whose guidance in the early stages of my career assisted me greatly. To my HOD's in the college, fellow professors and other colleagues I thank you all for your co-operation at all times. At this point, I wish to reminisce about my dear colleague and friend, late Professor W.O. Biobaku. We had a very special friendship that we shared. His vibrant personality is always alive in my memory. May his soul rest in peace wherever he may be. Special mention of Professors, Bamgbose, Osinowo, Ozoje and Onagbesan for their wonderful support at all times. To my other colleagues Doctors Arigbede, Jegede, Sobayo, Oso, Fafiolu, Sogunle, Peters, Ladokun, Isah, James , Bemji and every one else, I cannot but say thank you for your confidence and belief in me. The loyalty of all staff in the Dean's office cannot but be mentioned. The warm and endearing atmosphere in the office has always been comforting to me. All farm staffs are also duly acknowledged . Other colleagues in the University, Professors Afolami and Afolami, Professor Clara Oguntona, Professor Olasatan, Professors

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To my family in Nigeria, I am specially grateful to all my in-laws, my late father-in law, Mr. Peter Odeh, late uncle-in-law, Chief David Eferakeya , Mama Celina, Charity, Wilfred, Ofejiro, Demuvi, Tejiri, Uncle Noah, Harriet and every body else in the family, I can only say "*Migwuo*" (I am on my knees) for the wonderful manner in which I was embraced into the family and for never giving me the feeling that I was not one of them. Their love and support has helped me adapt to my adopted country.

Last but not least, I come to my immediate nuclear family. My children Ome, Obor and Prem have always been my pride and joy. Of my daughter Ome, I am specially proud for fulfilling my father's dream for me which I could not fulfill, i.e, becoming a medical doctor. When I see my sons Obor and Prem who have also excelled in their chosen professions, I think I have been more than blessed by God. I thank my children for living up to my expectations for them and for letting me experience all the wonderful joys of motherhood and for never bringing tears to my eyes during their childhood and adolescent years. To my husband, Professor Agwonorobo Eruvbetine, I can only say that it was "Karma" that bought us together from two distant continents to meet in a third continent and come back to Nigeria to start our life together. I am here on this podium because of him and I am grateful to him for bringing me to Nigeria. Nigeria has become a part of me and I have become a part of Nigeria. I am also specially grateful to him for his undying love over the years and all the efforts he has made to make me comfortable and happy, and above all, allowing me the liberty to pursue my dreams and my career. His constant encouragement has motivated me to pursue greater heights. Indeed, I thank him for being both father and mother to our children whenever I was away from home in Abeokuta. I pray that God continues to bless our union.

Finally Mr. Vice Chancellor, Sir, let me thank the entire University community for the wonderful and cordial atmosphere we share together in this Institution under your able leadership. I am very proud to be part of this great UNAAB family.

Thank you all for listening and God Bless.

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