HUMAN FOOD
AND HEALTHY LIVES:
CONFRONTING INSUFFICIENT PRODUCTION AND PRESERVATION OF GOOD QUALITY MEAT AND EGG

32nd Inaugural lecture

of the Federal University of Technology, Owerri (FUTO), Imo State, Nigeria.

Delivered on: Wednesday, April 26, 2017

BY

PROF. NDUKWE JAMES OKEUDO

B. AGRIC., FIRST CLASS (IFE), M. PHIL. (IFE), PH.D (QUEEN'S, BELFAST), MNSAP, MASAN, RAS

Professor of Animal Science (Animal Products & Processing)
Department of Animal Science and Technology,
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PROTOCOL

The 7th Substantive Vice Chancellor of FUTO

Deputy Vice Chancellors (Academic and Administration)

Registrar, Librarian and Bursar

Deans, Directors and Distinguished Professors

Heads of Departments and Units

My Lords Spiritual and Temporal

Staff and Students of the University

Gentlemen of the Press

Distinguished Ladies and Gentlemen

1.0 PREAMBLE

To God be all the glory for enabling me to stand here today to deliver this inaugural lecture. I believe that God planned it that I study animal science. Although I was doing quite well in the sciences in secondary school, I did not want to study medicine. Handling human waste or blood was not exactly to my liking, nor was I configured to endure the emotional trauma of being beside folk suffering from intense physical or emotional pain. Pharmacy was the next option. Later, I dropped the idea and as I was considering what to do, I was told that a man from my village studied agriculture and was doing well. That was what informed my decision to study agriculture.

In 1979, I applied to University of Ife for the direct entry admission to study agricultural economics. I was admitted, but in the 4th year I decided to switch over to the Department of Animal Science. Although I was making better grades in agricultural economics courses than in animal science courses, when I saw the day old chicks in the University Farm, I just loved them. As I held one of them, it looked so cute, innocent, harmless and in fact cherubic. Secondly, I was getting a bit fed up with some of the terminologies I kept hearing in agricultural economics courses. It appeared that no action ever had a definite and predictable outcome. Always, it may be this "on one hand" or even the exact opposite "on the other hand." I found that quite frustrating. So after seeing those birds, I decided to change. However, I do not imagine that anyone would infer that I am in any way suggesting that animal science is a better course than agricultural economics.

Howbeit, taking care of animals is a rewarding experience in more ways than one. It awakens in people the love and appreciation of life. In many countries, some people love their pets more than siblings. Your dog or cat can be such a nice and dependable friend that loves you the way you are and do not indulge in destructive criticisms or may abandon you and elope with your neighbour. Shepherds are the most patient people in the world, and God has a special love for them. When Christ, the Son of God was born, the only people God was moved to share the good news with were shepherds

in the field. Cain, the first child of Adam was a crop farmer, whilst Abel, the second son was a shepherd. God was pleased with Abel's service and detested that of Cain. Moses, the famous lawgiver of Israel and the only man who interacted with God face to face, and David who was given the everlasting throne over Israel were both called and commissioned by God while they were in the field taking care of livestock.

Mr. Chairman, from the foregoing I therefore consider it as a divine assignment as I deliver this inaugural lecture in animal science.

2.0 INTRODUCTION

2.1 Foods of Animal Origin in Human Nutrition

It is difficult to imagine the cultural, social, economic and nutritional configuration of human existence on earth without animal domestication and husbandry, and the consumption of animal products. In all probability and likelihood, human population would have been much smaller and civilization with development tremendously retarded. Doubtlessly, sustainability of human growth and development provided the *raison d'etre* for the divine injunction permitting the slaughter of animals and the consumption of animal products (Genesis 9:3). This being the case, it cannot be gainsaid that the consumption of meat, milk and egg emanated from the Divine Mind who understands human nutrition and health exceedingly better than the world's foremost philosophers and scientists.

The principal justification for the consumption of animal products is provision of nourishment with all essential nutrients in appropriate balance. Animal products are much richer in digestible proteins, essential amino acids, vitamins and minerals than crop products. Empirical evidence (table 1) shows that animal products are significantly higher in biological value (BV) than crop products. BV is a parameter used to indicate the proportion of a protein utilized in the body based on the amount consumed.

Mr. Chairman, Sir, it is interesting to note that the vast majority of people who eat meat do so because of its excellent organoleptic or gastronomic value, not out of any conceivable desire or conscious effort towards balancing the diet. Animal products are highly palatable. In fact, some people lose appetite and even reject any food that is without a chunk of meat visibly and strategically positioned on top of the dish. Moreover, animal agriculture provides employment to a significant proportion of the labour force, supplies raw materials to industries and produces animals used in many cultural / religious sacrifices and rituals.

Table 1: Biological value of common foods

Foodstuff	Biological value (%)
Whole egg	93.7
Milk	84.5
Fish	76.0
Beef	74.3
Soybeans	72.8
Polished rice	64.0
Whole wheat	64.0
Corn	60.0
Beans, dry	58.0

Source: Wageningen University, the Netherlands (www.food-info.net)

2.2 Malnutrition in Sub-Saharan Africa (SSA)

Malnutrition results from inadequate and /or imbalance in the intake of any nutrient such as carbohydrates, lipids, proteins, vitamins and minerals. In many regions of the developing or underdeveloped world, the nutritional challenge is that of inadequacy of protein and micronutrient (vitamins and minerals) supply. Except in times of conflict, war or natural disaster, deficit in dietary energy supply has

been less in occurrence than deficit in proteins / micronutrients. Average per capita consumptions of livestock products and energy are shown in table 2 and table 3, respectively.

Table 2: Per capita consumption of livestock products (kg/year)

Region	Meat			Milk		
	1964-1966	1997-19992030[b]		1964-1966	1997-19992030[b]	
World	24.2	36.4	45.37	3.9	78.1	89.5
Developing countries	10.2	25.5	36.7	28.0	44.6	65.8
Near East + North Africa	11.9	21.2	35.0	68.6	72.3	89.9
Sub-Saharan Africa[a]	9.9	9.4	13.4	28.5	29.1	33.8
Latin America + Caribbean	31.7	53.8	76.6	80.1	110.2	139.8
East Asia	8.7	37.7	58.5	3.6	10.0	17.8
South Asia	3.9	5.3	11.7	37.0	67.5	106.9
Industrialized Countries	61.5	88.2	100.1	185.5	212.2	221.0
Transition Countries	42.5	46.2	60.7	156.6	159.1	178.7

[a]Excludes South Africa; [b]estimated

Source: www.who.int/nutrition/topics/3_foodconsumption/en/index4.html

Table 3: Per capita energy consumption (Kcal/person/day)

Region	1964-1966	1997-1999	2015
World	2358	2803	2940
Developing Countries	2054	2681	2850
Near East + North Africa	2290	3006	3090
Sub-Saharan Africa[a]	2058	2195	2360
Latin America + Caribbean	2393	2824	2980
East Asia	1957	2921	3060
South Asia	2017	2403	2700
Industrialized Countries	2947	3380	3440
Transition Countries	3222	2906	3060

[a]Excludes South Africa

Source: www.who.int/nutrition/topics/3_foodconsumption/en/index4.html

The annual per capita consumptions of meat and milk in 1997 – 1999 in Sub-Saharan Africa (SSA) were 9.4 kg and 29.1 kg; whereas the corresponding levels in Industrialized Countries were 61.5 kg and 212.2 kg, respectively (table 2). Thus, on the average an individual in Industrialized Countries consumed 6.5 times more meat and 7.3 times more milk daily than his counterpart in SSA. However, comparison of energy consumption for 2015 (table 3) shows that daily per capita energy intake in Industrialized Countries was 0.69 times higher than the corresponding level in SSA (3440 kcal. versus 2360 kcal.). According to FAO (2004a), a 75 kg bodyweight middle age man needs 2500 kcal/day for light activity and 3050 kcal/day for moderate activity. This indicates that the current average energy intake (for the entire population) in SSA is 94.4% and 77.4% of the requirements of the middle age man for light and moderate activities,

respectively. This clearly shows that dietary protein deficit in Sub-Saharan Africa is a far greater problem than energy shortage.

A survey of the animal protein intake in SSA (table 4), showed that in 18 out of the 50 countries that make up the continent of Africa, the per capita animal protein intake was less than a half of the minimum requirement. This dismal and deplorable record is indicative of the deep shortage of animal products and the consequent level of malnutrition in this region.

Children constitute the most vulnerable class in times of food crisis. Internationally, three measures are used in reporting malnutrition in children:

- Stunting – extremely low height for age
- Wasting – extremely low weight for height
- Underweight – extremely low weight for age

In SSA, 28%, 38% and 9% of all children under 5 years of age are underweight, stunted and wasted, respectively (table 5). This is equivalent to more than 3 out of every 4 children being malnourished. It is therefore evident that countries in SSA suffer the most from this human tragedy. Malnutrition results to nutritional deficiency diseases, reduced immunity to infections and low life expectancy. Severe and prolonged malnutrition in children is associated with irreversible psycho-cognitive deficit and low aggregate potentials.

2.3 Limitations to Animal Protein Supply in Nigeria

The principal limitations to animal protein supply in Nigeria include:

i. Low income per capita
ii. Low inherent productivity of indigenous animals
iii. Management related problems, especially inadequate feeding and high disease challenge
iv. Poor product preservation
v. Religious / cultural prohibition

The latest Human Development Report (UNDP, 2015) placed Nigeria as the 152nd out of 188 countries in human development. The report indicated that 36.4% of children under 5 years of age are stunted and 62.0% of the people live below the poverty line

(<$1.25/day). WHO (2016) observed that economic development is strongly related to the level of food supply in any country, with a strong positive relationship between per capita income and average quantity of animal protein consumed. As aggregate income increases, demand for meat, milk and egg increases at the expense of staple foods. Depreciating household income levels have the opposite effect.

Low animal productivity in Nigeria is the consequence of two main factors. First, indigenous animals are of low genetic merit and relatively of low performance. As a result, non-ruminants (poultry and pigs) reared under commercial systems in Nigeria are sourced from exotic stock. Although exotic animals outperform the indigenous counterparts in daily weight gain, prolificacy and feed conversion efficiency; they are, however, comparatively less hardy.

Table 4: Sub-Saharan African countries with per capita animal protein intake less than a half of the minimum animal protein requirement in 2002

Country	Animal protein supply (g/d)	Country	Animal protein supply (g/d)
Burundi	2.4	Togo	7.3
Mozambique	3.5	Nigeria	7.5
Malawi	3.8	Burkina-Faso	7.7
Congo (DRC)	4.0	Niger	7.8
Rwanda	4.0	Lesotho	8.1
Liberia	5.0	Zambia	8.7
Eritrea	5.6	Sao Tome & Principe	9.0
Ethiopia	6.0	Zimbabwe	9.0
Guinea-Bissau	6.9	Sierra Leone	9.0

Note: average for SSA = 10.3 g; whereas daily requirement is at least 18.67 g (NRC, 1974).

Abstracted from FAO (2004b)

Table 5: Malnutrition in under five children (1996 – 2005)

Regions	Under-weight (%)	Stunted (%)	Wasted (%)	Total (%)
CEE /CIS	5	14	3	22
East Asia / Pacific	15	19	-	34
Sub-Saharan Africa	29	41	7	77
Eastern / Southern Africa	28	38	9	75
West / Central Africa	28	35	10	73
Latin America / Caribbean	7	16	2	25
Developing Countries	27	31	10	68
Industrialized Countries	-	-	-	-
World	26	30	10	66

Source UNICEF (2006)

Secondly, ruminant animal husbandry in Nigeria is strongly dominated by the traditional nomad, and this production system is characterized by moderate body weight gains of animals during the rainy season and significant weight losses during the dry season when forage is scarce. The concomitant effect of the combination of low genetic potential of stock and poor feeding is aggregate low body weight gain such that on the average beef cattle in Europe attain slaughter weight of about 650 kg in 18 – 24 months; whereas in Nigeria the slaughter weight of 400 – 600 kg may not be achieved before 48 months of age.

Exotic non-ruminants reared in Nigeria are not as productive as same animals reared in developed countries in temperate climes. The major reason is the persistent scarcity and high cost of balanced feed in Nigeria, which represents about 70% – 80% of the variable cost in poultry production. Although the current level of investment in

the poultry production subsector by private outfits is sufficient to supply enough meat and egg for the country, depressed demand occasioned by low average household income has led to the closure of many production facilities. The solution to this problem has been sought through numerous research investigations on the utilization of alternative feed resources, particularly agro-industrial by-products as livestock and poultry feedstuffs (Okeudo, 2007). Presently, in addition to maize, soybean cake, groundnut cake and fish meal, agro-industrial by-products like brewers' grains and palm kernel cake are fully integrated as valuable feedstuffs, thereby enlarging and diversifying the feed resource base. This has resulted in no small measure to significant reductions in the prize of poultry meat and egg. Exploitation of other agro-industrial by-products as animal feedstuffs is a research area of immense and critical importance to continual survival and advancement of animal agriculture in the near and distant future.

Research on improvements in animal productivity must proceed in tandem with product quality enhancement and feasible and locally implementable systems for post-harvest preservation. We can only neglect product quality issues to our peril since the Nigerian economy is intrinsically joined and cannot be isolated from developments in the global economy.

Mr. Chairman, Sir, the Honourable Vice Chancellor of this great university, standing before you today is a man who decided many years ago to make a difference through rigorous and painstaking teaching, mentoring, research and community service so that our people will have enough, affordable and good quality meat and eggs to eat and to spare for today and all our tomorrows.

3.0 STUDIES ON IMPROVEMENT IN PRODUCTION OF MEAT AND EGG

3.1 Exploitation of Agro-products and Agro-industrial By-products as Feedstuffs for Animal Production

Utilization of non-conventional feedstuffs such as agro-industrial by products for animal feeding was necessitated by scarcity of dry season feed for ruminants and the rapidly increasing cost of conventional feedstuffs for non-ruminants.

3.1.1 Utilization of Poultry Manure and Cassava Peels

Nigeria is the leading producer of cassava in the world. FAO (2015) records showed that in 2014, cassava production in Nigeria stood at 54.8 million tonnes (MT) followed by Thailand (30.0MT), Indonesia (23.4MT) and Brazil (23.2MT).According to Tewe (1996), cassava peel represents about 8% of the cassava root, and consequently about 4.67MT of cassava peels were generated in Nigeria in 2015.

Okeudo and Adegbola (1993) fed grower ewes five experimental concentrate diets containing 0, 13, 25, 35 and 45% sun dried and milled caged-hen manure which replaced 0, 25, 50, 75 and 100% of the groundnut cake (sole protein supplement) and wheat offal; and also replaced 0, 9, 18, 23 and 28% of the maize in the control diet, respectively. Each animal was fed 55.0g/kg$^{0.75}$/day of the concentrate feed and air dried cassava peels were provided *ad libitum* in a 104 days growth study. Average growth rates of the ewes fed 0%, 13%, 25%, 35% and 45% caged hen manure were 91.4, 90.6, 84.5, 100.6 and 91.1g/head/day, respectively. Neither growth rate nor efficiency of food conversion was significantly influenced by dietary differences. Results demonstrated that grower ewes can be profitably reared on caged-hen manure as the sole protein supplement (up to 45% inclusion level) in cassava peel based diets. Rumen degradability studies using rumen fistulated rams revealed that ruminants fed diets containing poultry manure should also be offered simultaneously readily available carbohydrate sources because of the high level of the rapidly degradable fraction in the manure (Okeudo and Adegbola, 2000).

3.1.2 Inclusion of Palm Kernel Cake in Animal Feeds

Nigeria is the 4th leading producer of palm oil. Production level in 2013 was reported as 0.96 MT (FAO, 2015). Countries with higher levels of production include Indonesia (26.9MT), Malaysia (19.2MT) and Thailand (2.0MT). Palm kernel cake (PKC), a medium grade protein feedstuff, is a by-product in palm oil and palm kernel oil extraction. Earlier reports (Onwudike, 1986a,b) demonstrated that starter pullets, grower pullets, starter broilers and finisher broilers can be fed diets containing 34, 38, 28 and 35% PKC inclusion levels, respectively, without incurring significant reductions in growth performance.

Jegede *et al.* (1994) reared pigs on compounded feed with PKC dietary levels at 20.55, 42.1 and 61.65% and observed that the animals suffered significant depreciation in body weight when fed diets containing more than 20.55% inclusion level. Chin (2002) reported that in Malaysia, PKC is the main ingredient in feeding dairy cows, and it is an adequate sole feed (with mineral and vitamin supplementation) in cattle fattening operations.

Okeudo *et al.* (2005) observed that although feeding finisher broilers 30% PKC diets had no significant influence on live weight gain, percentage head and shanks contents were significantly reduced compared to corresponding values for birds fed the control diet. However, dietary inclusion of PKC resulted in significant increases in gizzard size and flavour intensity of broiler meat. In a follow-up study, Okeudo *et al.* (2006) fed finisher broilers diets containing 0, 15, 30 and 45% PKC levels and observed that broilers fed the 45% PKC diet were significantly lower in body weight compared to the other counterparts. Nonetheless, feed costs per unit body weight were similar across the four dietary treatments, indicating that finisher broilers can be reared on diets containing up to 45% PKC levels without incurring financial losses. This would represent a tremendous gain to the economy since increased utilization of PKC in poultry diets would reduce the demand pressure on conventional feedstuffs such as maize and soybean which are important human staples. Further investigations (Okeudo *et al.*, 2008) revealed that dietary inclusion of PKC at the 40% level (plus 4% fish

meal level) did not result to a significant reduction in liveweight gain or efficiency of feed conversion. It was also observed that such diets did not require additional lysine and methionine supplementation. Other findings in the same report indicated that finisher broilers fed 30% PKC diet with the exclusion of any animal protein source or lysine and methionine supplementation did not suffer a significant depreciation in performance. This shows that during the finisher phase, rations devoid of the expensive fish meal which would translate to much cheaper diets may be profitably fed to broilers, resulting to enhanced aggregate profitability.

Results published by Egenuka *et al.* (2013) confirmed that feeding pullets diets containing 40% PKC level resulted to significant improvement in liveweight gain and significant reduction in feed cost per unit weight gain compared to the control diet.

3.1.3 Utilization of Other Agro-products in Animal Feeding

Mr. Chairman, Sir, quite a wide array of agro-products has been studied in the critical search for cheap and sustainable utilization of the abundant biomass as animal feed. In FUTO numerous studies on some of these products include jackbean (Udedibie and Carlini, 1998a; 1998b; Esonu *et al.*, 1999; Esonu, 1999), cocoyam (Esonu, 2000), velvet bean (Emenalom *et al.*, 2008a; 2008b), neem leaf meal (Obikaonu *et al.*, 2011; 2013), *Anthonotha macrophylla* seed meal (Durunna *et al.*, 2007), blood meal (Egenuka *et al.*, 2015), etc.

Commercial utilization of most of these novel or non-conventional feedstuffs is hindered by the exorbitant cost of collection and transportation due to current limited production capacity and non-existent centralized large scale processing enterprises. This is particularly the case with cassava / yam / cocoyam peels, leaf meals and wild legume seeds. Secondly, the presence of anti-nutritional factors necessitating elaborate and often expensive detoxification procedures may constitute enormous hindrances militating against the possibility of adoption (Okeudo and Adegbola, 1993; Udedibie and Carlini, 1998; Etuk *et al.*, 2012a; 2012b).

Consequently, apart from palm kernel cake and brewers'

grains, most novel feedstuffs that have been found through research to be suitable for commercial livestock and poultry feeding are yet to be integrated in feed formulation on industrial scale. Of course, this is in consonance with the economic logic which teaches that a new innovation can only be adopted if it has a more favourable cost – benefit profile in comparison with existing procedures. Simply stated, this means that the commercial farmer will only be persuaded to undertake the implementation of a novel feeding regimen if the inherent cost is lower than the prevailing cost of the conventional feedstuffs such as maize, soybeans, groundnut meal, wheat offal, etc.

3.1.4 Feeding Ruminants in Nigeria: The Incessant Herdsmen-Crop Farmers Clashes

Feeding forage to ruminants is the established, time tested and the most cost effective way of rearing ruminants all over the world. The norm is animals grazing extensively on cultivated pasture during the forage growing season and fed indoors on preserved fodder (hay and silage) during the off season. Significant investment in pasture development, establishment and conservation are basic requirements. High producing animals are stocked and the entire production system is operated as a commercial, profitable and self-sustaining industry.

In Nigeria, pastoralists with their animals continue to transverse the country in search of "free" pasture (Figure 1).Unfortunately, in many instances this resulted in road accidents and bloody clashes with crop farmers. This will in all likelihood exacerbate since the human population is expected to double within a few decades with the attendant necessity for more land for crop production. Thus, the "free" land for pastoral grazing will proportionately shrink.

The generally accepted solution is that the nomadic herdsmen should settle and rear their animals in ranches or grazing reserves (Okeudo, 2004; 2007). The technical knowhow to actualize this is available in the country and procurement of the financial input should not be too difficult. However, what is lacking presently is the political will for implementation, including educating or coercing the nomads

to accept the unavoidable cultural change this will doubtlessly impose on them. No one should be deluded as to consider this as an easy task, because nomadism is not just employment but a culture that has endured for millennia. Howbeit, we do not have another solution to this lingering national tragedy.

3.2 Contribution of Indigenous Breeds to National Meat Supply.

Although indigenous breeds lag behind exotic breeds in average daily live-weight gain, nevertheless, they represent a very important contributor to the aggregate animal protein supply in Nigeria. Moreover, their hardiness, resilience and ability to thrive under poor nutritional regimen and high disease challenge continue to underpin their relevance in the national animal production industry. Thus, whilst exotic and high producing pigs, poultry and rabbits are intensively housed under various categories of commercial ventures, the ruminant sub-sector (cattle, sheep and goats) consists predominantly of indigenous breeds.

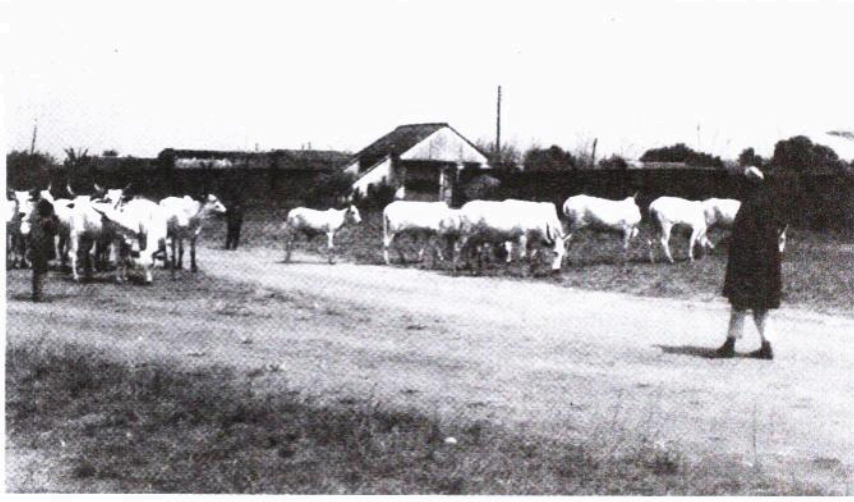

Figure1: Nomads With Their Cattle in Owerri Town

Evidence exists indicating that in Nigerian local chicken and pigs account for about 80% of the entire chicken population (Sonaiya, 1997) and more than 80% of the pig population (FMANR, 1978), respectively. This was the *raison d'etre* for empirical investigations into the nutritional, physiological and genetic characteristics of these breeds which are essential requirements in all animal production improvement programs.

Mr. Chairman, my first foray into research in indigenous livestock species was as an Assistant Lecturer in 1990 when I applied for a University Research Grant to study the indigenous duck (*Caraina moschata*). Ducks outperform chickens in egg production, survivability and livability under adverse conditions such as poor feeding, high temperature, excessive humidity and pathogenic affliction. Although the application was approved, I was reduced to the position of co-researcher because I was judged to be in need of tutelage in the art and science of scientific research. We established a flock of local ducks in the farm and the first study concentrated on the investigation of the haematological profile of ducks. At that time the basic diagnostic benchmark for the local duck was unavailable. The following year (1991) I travelled to United Kingdom as a Commonwealth Scholar and commenced research in animal products for the doctorate degree (Figure 2).Howbeit, results on the hematological study were published in *Tropicultura*, a highly reputable European journal (Okeudo *et al.*, 2003a). Etuk *et al.* (2012c; 2015) have also published results on the haematological characteristics of local turkeys at starter and grower phases.

After returning to Nigeria and through another University funded research I procured and commenced research on Nigerian Indigenous (NI) pigs (Figure 3). Dr. N.O. Aladi, who was then my M.Sc. student conducted various studies on the performance of these pigs in comparison with the exotic Large White (LW) pigs and NI x LW crossbreeds. As shown in table 6, the LW pigs were significantly higher in live-weight, better in efficiency of feed conversion and higher in dressing percentage than NI and NI x LW pigs. However, NI pigs were higher in percentage four lean cuts, lower in back-fat

thickness and higher in standardized fat free lean (SFFL) expressed as percentages of hot carcass weight or live-weight. The general implication is that pork from NI pigs are lower in fat content compared to pork from LW pigs. Thus, crossbreeding LI and LW pigs will result in improvement in live-weight and reduction in fat content. Haematological profile was similar between the NI breed and LW breed (Aladi *et al.*, 2008a) and the best predictor of the pig live-weight was the neck circumference (Aladi *et al.*, 2008b).

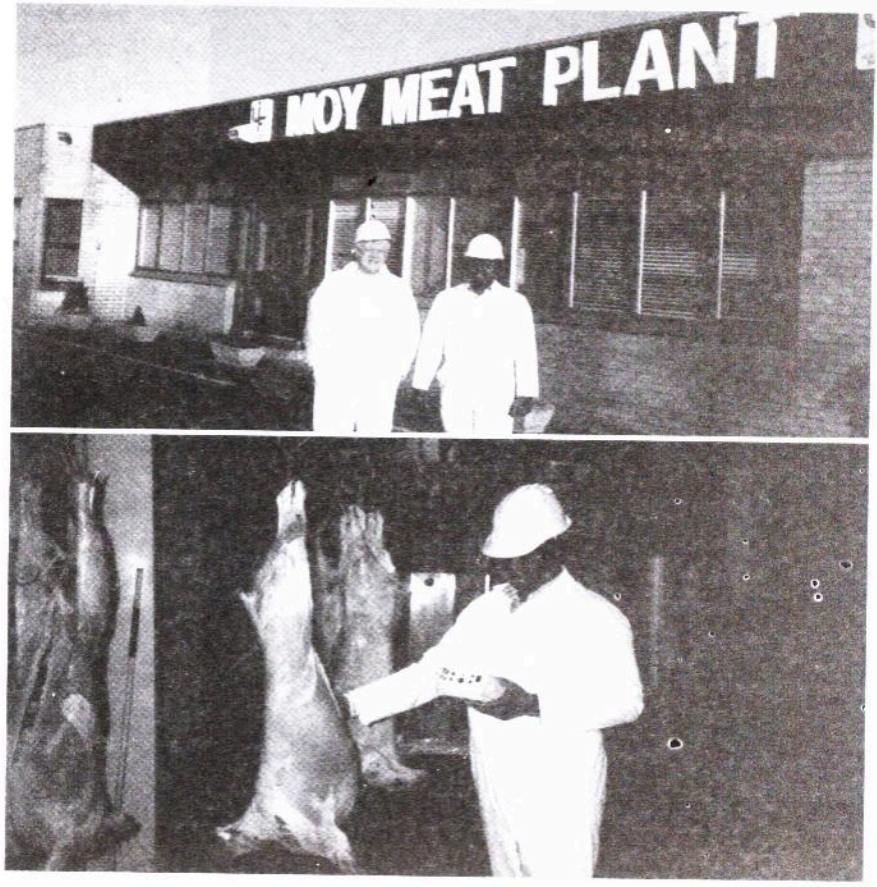

Figure2: The Inaugural Lecturer as a Ph.D Student in United Kingdom

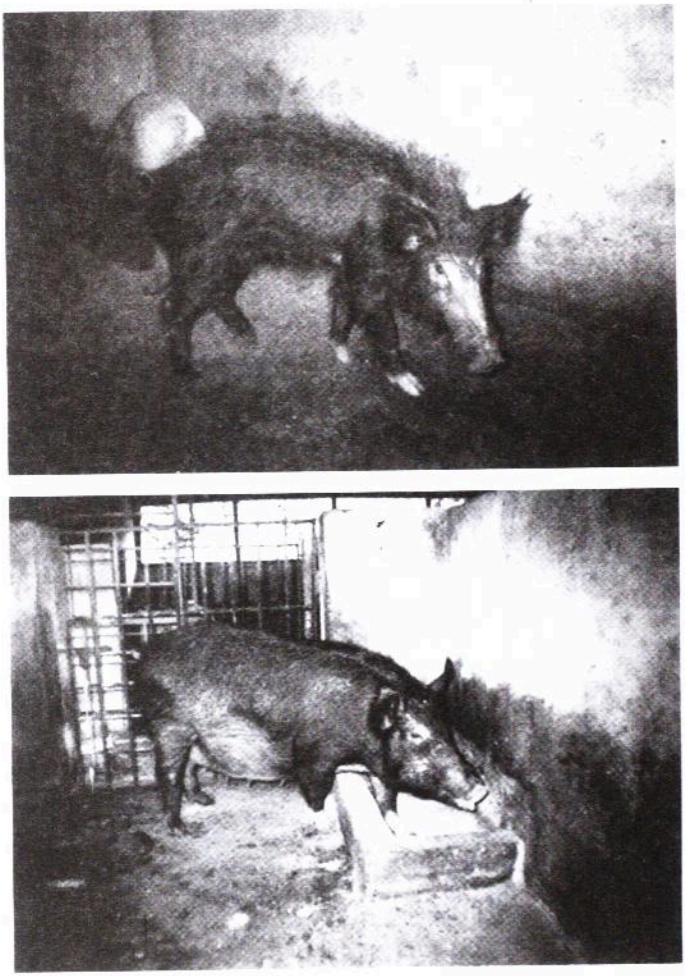

Figure3: Nigerian Indigenous Female and Male Pigs

Oestrous was silent in pubertal NI gilts, but was more detectable in subsequent post-pubertal periods. Generally, NI pigs were more restless, vibrant and aggressive than LW counterparts. When NI males were cross-mated with LW females, the NI males exhibited relatively short reaction and ejaculation times leading to frequent ineffective intromission and wastage of semen (Aladi *et al.*, 2008a).

Mr. Chairman, recently I supervised an M.Sc. student (Ubokudom, 2014) in University of Uyo, Uyo during my sabbatical leave. The thesis was on a comparative growth and physiological study using the local chicken and exotic boiler chicken. Results demonstrated the hormonal basis for the relatively low performance of the local chicken in comparison with exotic chicken (Table 7). This pioneering physiological assessment on the local chicken is expected to provide a critical mass of information that would underpin subsequent genetic improvement programs.I supervised the thesis of another Master of Science student (Ezetoha, 2013) in FUTO and the research was on milk production from Red Sokoto Goats fed tiger nut (Figure 4). Results showed that this animal can make an important contribution to the national dairy industry.

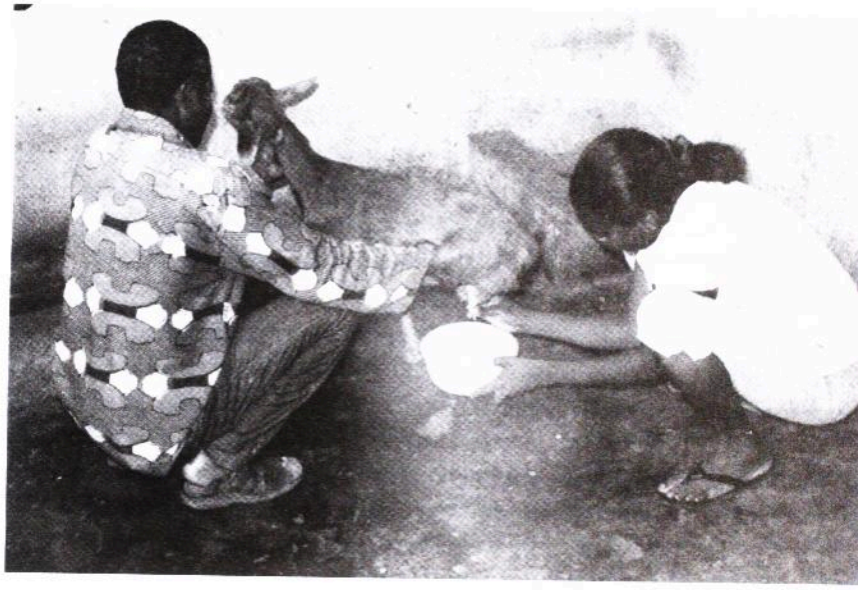

Figure 4: A Master of Science Student (Right) Milking a Red Sokoto Doe

3.3 Effects of Sex-Type on Animal Growth and Meat Production

In addition to intact males and females, castrated or emasculated males constitute an important sex-type in the livestock industry. Perinatal orchiectomy involving removal of both testicles results in full emasculation leading to the production of an animal intermediate in growth rate between the intact male and intact female. Fully emasculated males in the bovine are called steers; in sheep, weathers; and in swine, barrows.

Table 6: Live-weight, feed intake and carcass characteristics of Nigerian Indigenous (NI) pigs, Large White (LW) pigs and F_1 crosses.

Parameters	NI	LW	NI x LW (F_1 cross)
Live weight	10.4[a]	26.9[b]	11.9[a]
At 25 weeks of age (kg)			
Average daily feed intake (g/d)	303.9a	636.0b	441.1c
Feed conversion ratio	6.5[a]	3.3[b]	6.2[a]
Carcass traits at 34 weeks of age (%):			
Dressing percentage	64.6[a]	69.2[b]	-
Ham	18.1[a]	18.0[a]	-
Shoulder	17.6[a]	20.1[a]	-
Head	9.4[a]	12.5[b]	-
Four lean cuts+	57.7[a]	55.0[b]	-
Fat cuts++	7.0[a]	14.1[b]	-
SFFL/hot carcass weight +++	84.7[a]	57.7[b]	-
SFFL/liver weight	53.3[a]	40.0[b]	-
Back fat thickness at 10th rib (cm) 0.6[a]	1.5[b]		-

[a,b,c] Means in the same row bearing different superscripts are significantly different ($P<0.05$). + Four lean cuts = shoulder, ham, lion and spare ribs. ++ Fat cuts = jowl and belly. +++ SFFL = standardized fat free lean, an estimate of weight of lean based on hot carcass weight.

Source: Okeudo *et al.* (2007).

Table 7: Live-weight and serum growth hormone levels in local chicken compared to exotic chicken

Parameter		Exotic Male	Exotic female	Local male	Local female
Live-weight at14 weeks of age (kg/bird)		3.58[a]	3.48[a]	1.18[b]	1.07[b]
Weekly weight gain (g/bird)		298.61[a]	295.24[a]	100.20[b]	91.43[b]
Feed/gain		2.17[a]	2.25[a]	4.15[b]	4.48[b]
Growth hormone levels (ng/ml):					
Age (weeks)	6	29.93[a]	28.31[b]	19.08[c]	16.41[d]
	10	27.11[a]	26.53[b]	21.33[c]	20.51[d]
	14	20.06[a]	23.15[b]	24.39[c]	24.05[d]

[a,b,c,d] Means in the same row bearing different superscripts are significantly different ($P<0.05$).

Source: Ubokudom (2014).

According to Dransfield *et al.* (1990) and Thonney *et al.* (1987) males are emasculated for the following reasons:

i. Reduction in aggressive behaviour (e.g. fighting) and increase in docility, safety and handling ease
ii. Removal of offensive male odour, especially boar taint in pigs
iii. Increase in carcass quality through alteration of carcass conformation. Castration results in the production of carcasses with heavier hindquarters which is positively correlated with more valuable meat cuts.

A fourth sex-type exists in animal production, though of less numerical importance. These are epididymectomized or vasectomized males used as teasers in detecting females undergoing oestrus. The superiority of intact males over castrates and females in rate of gain is no longer in doubt or debatable. Crighton (1980) noted that regardless of species, daily liveweight gain in intact males exceeds that of females by 5-20%. Lirrette *et al.* (1984) reported that in the

Suffolk breed of sheep, the daily live-weight gain in rams and weathers were 278 and 245g/d, respectively. Okeudo and Moss (2008) reported that the average daily live-weight gain in intact rams, intact ewes, castrated rams and vasectomized rams of Greyface x Dutch Texel crossbreed lambs were 146.3, 134.8, 138.1 and 145.1g, respectively. No significant differences in growth performance were detected between the three male sex-types,or between ewes and castrated rams ($P>0.05$).Intact rams and vasectomized rams were significantly higher than ewes ($P<0.05$) but similar to castrates ($P>0.05$) in daily live-weight gain. Results from Okeudo *et al.* (2007) showed that sex-related differences in live-weight of 25 weeks old pigs were only significant in Large White (LW) pigs, but not in Nigerian Indigenous (NI) pigs or NI x LW cross breeds. It is probable that the inherently low performance of local pigs and the cross-breeds is the cause for lack of significant differences in daily gain bétween the two sexes. Serum baseline and amplitude growth hormone levels manifest in sexually dimorphic patterns, with males always maintaining higher levels than females (Keller *et al.*, 1979; Velle, 1982). Intersex and intrasex differences in growth rate are dependent on growth hormone levels (Davis *et al.*, *1984*).

Ewes are higher in dressing percentage compared to rams (Kremer *et al.*, 2004; Okeudo and Moss, 2008) which implies that on an equal live-weight basis, ewes will record higher carcass weights than ram carcasses. Furthermore, Okeudo and Moss (2008) observed that on an equal age basis, rams were higher in live-weight but after dressing out, ram carcasses were similar to ewe carcasses in weight. This showed that the differences in live-weight between rams and ewes at a specific age could be accounted for wholly by differences in the weight of non-carcass parts. Consequently, the faster growth rate of rams over the ewe counterparts may be of little economic significance, except in countries like Nigeria where offal like liver, heart, tongue, kidneys, cow leg and goat head are highly valued and demanded. Nonetheless, ewe carcasses have better conformation and more highly prized than ram carcasses.

3.4 Rearing Cockerels from Layer Strains for Meat Production

Genetic improvements in poultry and cattle have resulted in the development of two distinct animal types, namely broilers and layers in poultry; and in cattle beef and dairy breeds, respectively. Oluyemi and Roberts (1979) and Smith (1990) noted that broiler breeds / strains are higher in growth rate and should attain market weight of 1.5-2.0kg in 6-8 weeks of age. However, broiler strains are poor layers, while layer strains are slow growers and ultimately attain small - medium highest body weight. Layer strains are highly prolific and on the average produce about 240 eggs/hen/annum.

This dichotomized production system comprising of birds with superlative performance in comparison with their genetically undifferentiated ancestors has inadvertently resulted in the production and wastage of cockerels from layer strains. Being males they are incapable of egg production, and being of layer strains they are poor growers. Because of this unfortunate double incapacity, cockerels (representing about a half of total layer day old chicks) are destroyed immediately after hatching in developed countries. In Nigeria, layer cockerels are sold to poultry farmers, howbeit, at very low prizes compared to broiler day old chicks.

Okeudo *et al.* (1998) studied the growth rate and feed consumption of Anak broilers reared alongside with Harco cockerels and observed that on the average, the broilers weighed 0.46kg and 2.04kg at 4 and 10 weeks of age, whereas the cockerels weighed 0.18kg, 1.00kg and 1.60kg at 4, 10 and 18 weeks of age, respectively. Broilers were generally more efficient in feed conversion than cockerels. The total costs of feeding per broiler (3 - 10 week) and per cockerel (3 - 18 weeks) were N251.06 and N518.78, and the corresponding feed costs per kg live weight were N158.90 andN365.33, respectively. This study provided empirical evidence showing that it is unprofitable feeding layer cockerels with commercial rations. Rather, the village/neighborhood scavenging system was suggested as a more feasible management system for rearing layer type cockerels for meat production.

4.0 ANIMAL SLAUGHTER AND MEAT HANDLING

4.1 Animal Slaughter

Animal slaughter and carcass handling in Nigeria fall short of acceptable international standards. Modern, hygienic and humane systems installed by government for animal slaughter and meat handling have been abandoned due to lack of patronage from local butchers. Consequently, most often, slaughtering takes place on slaughter slabs or on the bare floor in violation of basic requirements and regulations for hygienic animal slaughter. The process of putting the animal to death is prolonged and involves a lot of struggling and undue pain to the animal (Okeudo, 2004).

Generally, very old animals are slaughtered and in consequence the meat is usually tough and of low quality. Best quality beef is produced when slaughter age of cattle is not more than 18 months. As was stated heretofore, it usually takes about 4 – 6 years for cattle to attain slaughter weight of 400 – 600 kg because of poor feeding and the limitations imposed by poor genetic potential of indigenous animals. Tukur and Umar (1998) reported that 20% of cattle slaughtered in Minna Abattoir were over 10 years of age. Results from Opara *et al.* (2006) showed that 47. 2% of cows slaughtered in Ibadan have calved 3 or more times and therefore may not be less than 4 years of age. In developed countries, typical slaughter ages of beef cattle, pigs, broilers and goats are 18 months, 5-6 months, 5-7 weeks and 3-5 months, respectively.

Coupled to this is the high level of pregnant cows being slaughtered, resulting to considerable foetal wastage. This was as high as 14.1% of total cattle slaughtered in Owerri (Okoli *et al.*, 2001) and 10.9% in Ibadan (Opara *et al.*, 2006). Records suggest that the vast majority of ruminants (cattle, sheep and goats) slaughtered are intact males (Okoli *et al.*, 2002). Castration of bulls (production of steers) which is done to improve beef quality is rarely practiced by cattle producers in Nigeria.

4.2 Carcass Handling and Meat Marketing

The common practice in Nigeria presently, is the conveyance of the carcass straight to the open market immediately after

slaughtering and dressing. This is often undertaken, not in purposefully designed and constructed vehicles suitable for transportation of fresh meat, but in wheelbarrows, car boots, motorcycles or even by head porterage. Meat is retailed on dirty tables and exposed to contamination by dust and fly infestation while prospective buyers are permitted to handle the meat to guage the weight as prize is negotiated (Okeudo, 2004; Okoli *et al.*, 2005). Of course, it goes without saying that considerable contamination with high microbial load on meat would occur in such unregulated and unhygienic practice. Nwafor *et al.* (2013) examined weight loss and cooking loss of retail beef kept on butcher's table, stored at room temperature, exposed to direct sunlight or kept in an ice-packed cooler, from 9.00 am-6.00 pm, in rainy season or dry season. Significant differences amongst the various treatment means were observed (table 8). Exposure of retail beef to sunlight, not uncommon in Nigerian markets, resulted to 35. 27% loss in weight during the dry season.

Meat marketing in Nigeria is dominated by trade in fresh, unaged and unprocessed meat. Animals are slaughtered and the meat marketed the same day. This is the consequence of poor and erratic power supply and unaffordability of facilities for cold storage by a significant segment of the populace particularly the rural and urban poor. As a result, fresh meat may be procured from the market and cooked even before rigour mortis is established resulting to heat shrinkage, meat toughening and general reduction in organoleptic quality.

Evidence exists indicating that about 40% of some agricultural produce are lost due to lack of effective and affordable storage systems. Typical examples include tomato, banana and vegetable. The high temperature and humidity characteristic of the tropical environment promote rapid deterioration of fresh produce. Although crops like grains and tubers can be stored under ambient conditions for days and months without significant depreciation in quality, this is far from the case with fresh meat, milk and eggs. Meat and milk cannot be stored in like manner for longer than 24 hours without spoilage.

There are various indigenous meat and milk processing methods that rely on simple processing techniques such as slicing, chopping, drying, spicing or fermentation. Notable products include milk products: *wara* (local cheese) and *fura de nono* (ground millet, *fura*, in fermented cow milk, *nono*); and meat products: *tsire suya, kilishi, balangu, dambu nama* and *banda*.

Table 8: Effect of season and handling method on weight loss and cooking loss of beef retailed in Owerri Market.

Season	Handling method	Weight loss(%)	Cooking loss(%)
Rainy season	A	6.27[a]	40.47[a]
	B	4.10[b]	42.47[a]
	C	9.60[a]	34.00[a]
	D	1.30[b]	42.80[a]
	Mean	5.32	39.99
Dry season	A	24.93[a]	29.97[b]
	B	28.13[a]	37.50[a]
	C	35.13[a]	27.00[b]
	D	21.23[a]	39.23[a]
	Mean	27.39	32.59

[a,b,c,d,e] Means in each column, excluding general means for each season bearing a similar superscript (s) are not significantly different ($p > 0.05$).Beef samples were kept: A = on butchers table; B = under room temperature, C= exposed to sunlight; D = in ice- packed cooler.

Source: Nwafor *et al.* (2013).

5.0 PRESERVATION OF EGGS

Although in comparison with other animal products, shell eggs maintain their freshness and have longer shelf life, preservation and storage of surplus eggs, especially during periods of glut, continue to constitute a major challenge to poultry farmers in Nigeria (Essien, 1990; Okoli and Udedibie, 2000). Egg producers are faced with two major problems. The first is unavailability of efficient and feasible cold storage facilities for shell eggs, and the second, the dearth of local industries capable of processing shell eggs into value added products. Therefore, egg handlers continue to seek for simple, cheap and feasible methods for prolongation of shell life of fresh eggs.

Studies conducted in Nigeria have demonstrated the benefits of application of vegetable oil on eggs as a preservative method (Joseph *et al.*, 1994; Joseph and Ogundele, 1996; Okoli and Udedibie, 2000). Okeudo *et al.* (2003) observed that oil coating of eggs was associated with the development of off-flavours. Nonetheless, it was concluded that groundnut oil coated eggs stored for 21 days, retained most of the interior quality and were microbiologically safe for human consumption. Furthermore, Okeudo *et al.* (2005) reported that such simple procedures as packaging shell eggs in polythene bags prior to storage under ambient temperature or refrigeration significantly reduced weight loss.

6.0 MEAT QUALITY

6.1 Major Aspects of Meat Quality

Meat quality is a composite trait and comprise various aspects:

i. Organoleptic /eating quality: Tenderness, flavor and juiciness
ii. Visual quality: Colour quality, texture
iii. Nutritional quality: Protein content, essential amino acids profile, mineral content, essential fatty acids distribution, vitamins content, cholesterol content, etc.
iv. Technological /manufacturing quality: This is the suitability of the meat as raw material for manufacturing of value added products. The major attribute is water holding capacity.
v. Wholesomeness: Freedom from taint, residues and pathogens
vi. Gross compositional quality: Proportions of lean, fat and bone

The most important attribute of meat that influences a prospective buyer is the colour quality. Visual colour of meat is due primarily to the total myoglobin (meat pigment) concentration, the proportions of the various types (native myoglobin, oxymyoglobin and metmyoglobin) and the pH level. Animals like rabbits and poultry characterized by relatively low myoglobin concentrations produce white meat in contrast with red meat animals like cattle, swine, sheep and goat (Lawry, 1991). Males contain higher levels of myoglobin than females, and in both sexes mean myoglobin concentration increases with increase in age.

Meat tenderness is another important quality attribute because it influences the consumer's sustained interest in any meat product. Although colour and tenderness are sensory characteristics, they can be determined objectively; the former through reflectance spectroscopy, and the latter using sheering devices (e.g. Warner-Bratzler equipment) mounted on an Instron Universal Testing Machine.

6.2 Studies on Fat Content and Fatty Acid Profile

Animal fat is generally high in saturated fatty acids. Because of this, health conscious consumers reject or reduce meat consumption since high levels of saturated fatty acid (SFA) in human diet is widely considered a predisposing factor to incidences of hypercholesterolemia, atherosclerosis and coronary heart disease (Woodward and Wheelock, 1990; Wood and Warriss, 1992; Azain, 2004). It is believed that polyunsaturated fatty acids (PUFA) with appropriate n-6/n-3 ratios are associated with the prevention or amelioration of these diseases, including rheumatoid arthritis and breast cancer (Simopoulos, 1991; Zamora, 2005). Based on current evidence, the lower the fat content, the lower the percentage SFA content; and the higher the PUFA content, the higher the quality of meat, health-wise. Ironically, organoleptic or eating quality increases with an increase in fat content (Lawry, 1991).

Female animals are fatter than male counterparts (Seideman *et al.*, 1986; Solomon *et al*, 1990; Okeudo and Moss, 2007) and in both sexes adiposity or fattiness increases with increase in live-weight and age (Okeudo and Moss, 2007). The local pig is less fatty than Large White pigs (Okeudo *et al.*, 2007b). Okeudo *et al.* (2004) reported that conventionally reared lambs (fed pellets plus hay) were significantly lower in carcass fat compared with lambs reared solely on milk. The former was also higher in PUFA and SFA, but lower in monounsaturated fatty acids (MUFA) than the latter. Significant negative linear correlations were observed between serum cortisol concentration and muscle myristic acid, oleic acid and linolenic acid levels (Okeudo and Moss, 2005b). This suggeststhat animals reared in stressful conditions are more likely to produce meat with low PUFA content. Okeudo and Moss (2007) reported that while sex-related differences in SFA and MUFA levels were not significant, the PUFA level in vasectomized rams was significantly higher that the level in intact ram, intact ewes and wethers. Explanation for this observation is difficult. However, Mohan Raj *et al.* (1991, 1992) reported that vasectomized bulls were more homosexually hyperactive and produced more dark cutting beef than intact bulls. This may be the consequence of a distinct physiological difference between the two

sex-types.

6.3 Research on Organoleptic Quality, Colour and Mineral Content

Considerable contradictory reports on the effect of sex on meat tenderness have been published. Some reports signify a sex-dependent effect (Butler-Hogg *et al.*, 1984; Lirrette *et al.*, 1984; Okeudo and Moss, 2000), while in other reports no such effect was reported (Vergara *et al.*, 1999; Arsenos *et al.*, 2002). On an equal live-weight basis, intact rams and vasectomized rams were higher than ewes in shear force (meat toughness) whereas values for wethers and ewes were similar in shear force (Okeudo and Moss, 2008). However, on an equal age basis all sex-related differences were not significant. Our report provided one likely explanation for the discrepancies in the literature on sex effects on meat tenderness. Thus, the sex-related difference may not be observed when all animals (males and females) in a flock or herd are slaughtered at the same age, but may become evident if animals are slaughtered as they attain a specific target weight. Furthermore, Okeudo and Moss (1999b) studied meat toughness in samples from *Longissimus dorsi, Supraspinatus, Quadriceps femoris, Triceps and Gluteobiceps* muscles. Results showed that ram meat was tougher than ewe meat only in *L. dorsi* samples. It is worthy of note that more research in meat science is carried out using *L. dorsi* muscle compared to other muscles because it is easily accessible and its removal does not affect the primal joints. Interestingly, our results demonstrated that conclusions on sex-related effects on meat tenderness based on the *L.dorsi* muscle alone would not apply to the whole carcass. Tenderness decreases with chronological age or live-weight in sheep (Okeudo and Moss, 2008), and increases with post-mortem aging or conditioning (Okeudo and Moss, 1999b).However, Okeudo and Ngoka (2000) showed that six days aging period did not result to any significant improvement in organoleptic quality of spent hens. In broilers, strain related differences in flavour intensity, but not in tenderness, juiciness or hedonic scores were observed between Anak and Hubbard strains (Okeudo *et al.*, 2005).

The *L.dorsi* muscles of rams were higher in CIELAB hue angle and lower in metmyoglobin proportion compared to corresponding values from ewes (Okeudo and Moss, 1999b). This suggests that meat from rams is darker and with greater colour stability than meat from ewes. Rapid chilling of carcasses in contrast with slow chilling improves a*, b* and c* values indicating general improvement in colour quality associated with the former (Okeudo and Moss, 1999a). Note that the a*, b* and c* in CIELAB colour space stand for redness, yellowness and colour saturation, respectively.

Okeudo (1999) reported that ewe meat was higher in iron content than ram meat sampled from Charolais, Suffolk and Texel breeds. It was also observed that phosphorus, potassium, magnesium and sulphur contents in mutton increased with increase in chronological age of the animal.

6.4 Interrelationships Between Meat Quality Parameters

Mr. Chairman, we analyzed a large pool of experimental data generated during my Ph.D research in Belfast to establish interrelationships amongst important meat quality traits (table 9). The result was published in Meat Science, one of Elsevier's highly reputable journals, and for a long time was classed as a hot article.

Intramuscular fat was positively correlated to carcass weight and oxymyoglobin proportion, but was negatively correlated to moisture content, shear force, cooking loss, hue angle and percentage *L. dorsi* content. Surprisingly, shear force was negatively correlated with carcass weight which contradicted numerous reports. However, intramuscular fat was positively correlated with carcass weight and negatively correlated with shear force. This implies that the expected increase in shear force (meat toughness) as the animal increases in live weight would be somewhat moderated or even reversed by the concomitant increase in fattening. Thus an older and fatter animal may produce more tender meat than a younger and leaner animal. It is important to note that in the USDA Beef Quality Classification Scheme, chronological age of animals is a negative factor whereas degree of marbling (intramuscular fat) is a positive factor in determining the quality grade.

7.0 THE PROBLEM OF HYPERCHOLESTEROLEMIA

Mr. Chairman, the way some people talk about cholesterol, the uninformed would conclude that this very important substance must be poisonous. This certainly is not the case. Cholesterol is a very important component of the cell membrane and myelin sheet, and plays critical roles in inter-plasmalemma transport. Moreover, it is the precursor of all steroid hormones (e.g. oestrogen, progesterone, testosterone, cortisol, etc.), bile acids and following ultra-violet irradiation, it is converted to cholecalciferol (vitamin D_3). In a nutshell, the animal body, including humankind, cannot survive without cholesterol.

Daily cholesterol intake should be less than 300 mg/day (American Heart Association, 2000). The cholesterol contents of various foods are shown in table 10. Since whole egg contains 450 mg/100g, a medium size egg (55g) would contain about 247.5 mg of cholesterol. Thus, it is perfectly safe to consumed one medium size egg every day if that is the only animal food consumed. In fact, current evidence suggests that incidences of hypercholesterolemia were due more to high endogenous cholesterol synthesis than to excessive dietary intake.

Cholesterol is not a dietary requirement since the body synthesizes adequate amounts. According to Wikipedia, a human male (68 kg body weight) synthesizes about 1 g cholesterol each day and the total cholesterol content in his body is 35 g. Cholesterol being a lipid is transported in the aqueous blood stream in combination with proteins, forming lipo proteins.

Table 9: Correlation between meat quality traits

Trait	Positive correlation	Negative correlation
Intra-muscular fat (IMF)	carcass weight, oxymyoglobin	moisture, shear force[+] myoglobin, cooking loss, hue angle,% *L. dorsi*
Shear force	cooking loss hue angle myoglobin moisture	carcass weight, IMF oxymyoglobin
Metmyoglobin	moisture shear force	IMF, myoglobin carcass weight
Oxymyoglobin	carcass weight IMF	moisture shear force, myoglobin
Cooking loss	moisture shear force metmyóglobin	carcass weight, IMF

[+]A measure of meat toughness

Source: Okeudo and Moss (2005a)

Table 10: Cholesterol contents of food ingredients

Ingredient	Cholesterol content (mg/100g)
Egg yolk	1260
Whole egg	450
Kidney (pig)	410
Liver (pig)	260
Butter	230
Cheese (Cheddar)	70
Chicken	69
Beef	65
Milk	14
Vegetable oil	0

Source: Fox and Cameron (1989)

According to Fox and Cameron (1989), the blood plasma cholesterol content is distributed amongst the following lipoproteins.

1. **Chylomicron:** Contains 4% of cholesterol and transports cholesterol from the intestines after digestion to the liver.

2. **Very low density lipoprotein (VLDL):** Contains 22% cholesterol. It is produced in the liver to transport triglycerides. When they lose triglycerides, they are converted in the blood to low density lipoprotein (LDL)

3. **Low density lipoprotein (LDL):** Contains 45% cholesterol. They are the major carriers of cholesterol in the blood.

4. **High density lipoproteins (HDL):** Contain 17% cholesterol. They export lipids from cells and artery walls.

Transportation of cholesterol to and fro the cell is chiefly in the form of HDL and LDL particles. Normal blood cholesterol level is regarded as less than or equal to 200mg. Plasma cholesterol levels higher than 240mg/dl constitutes hypercholesterolemia, a strong factor associated with atherosclerosis, thrombogenesis, embolism, hypertension, stroke and coronary heart disease. Cholesterol carried in LDL particles contributes to atherosclerosis and so it is regarded as bad cholesterol whereas HDL cholesterol removes LDL cholesterol from arteries and transports them to the liver for conversion to bile acids and other metabolites. From that point of view, HDL cholesterol is called good cholesterol. Optimal LDL cholesterol level in the blood should be less than 70mg/dl while HDL cholesterol level should be higher than 60mg/dl (Wikipedia). Blood HDL cholesterol level within the above stipulated range is considered protective against cardio-vascular diseases. Current evidence from Wikipedia showed that the majority of those suffering from stroke, heart attack and peripheral arterial diseases have normal total cholesterol level (< 200mg/dl). Normally, it is elevated levels of LDL and VLDL that are associated with atherosclerosis and not the total cholesterol level.

Measures for controlling VLDL and LDL levels and atherosclerosis include:

1. **Dietary modification**
   - Increase in consumption of fresh fruits, fresh vegetables and whole grains
   - Limited intake of red meat and salt
   - Reduction in fat and oil consumption, especially those high in saturated fats (see table 11)
   - Avoidance of trans-fat, by rejection of fried foods
   - Regulation of total energy intake. Eat at requirement level, not "belle full"

2. **Behavioural modification**
   - Quit smoking
   - Increase physical exercise. This converts bad cholesterol (LDL) to good cholesterol(HDL)
   - Avoid stress, e.g. physical, mental and emotional stress. Maintain cheerful and joyful attitude. A merry heart doeth good like a medicine, but a broken spirit makes one sick (Proverbs 17:22, Today's Living Bible)

3. **Maintain low body weight**

4. **Medication:** Drugs called statins reduce endogenous cholesterol synthesis

Table 11: Composition of saturated fat (SFA), monounsaturated fat (MUFA) and polyunsaturated fat (PUFA) in foods (%)

Food	SFA	MUFA	PUFA
Cooking Oil:			
Canola oil	8	64	28
Corn oil	13	24	59
Olive oil	14	73	11
Sunflower oil	11	20	69
Soya bean oil	15	24	58
Peanut	17	46	32
Coconut oil	87	13	1
Palm oil	50	37	9
Dairy Products:			
Cheese	64	29	3
Milk (whole)	62	28	4
Ice-cream	62	29	4
Meats:			
Beef	33	38	5
Ham	35	49	16
Chicken (breast)	29	34	21
Turkey (breast)	30	20	30
Turkey (drumstick)	32	22	30
Salmon	28	15	28
Nuts:			
Cashew (dry roasted)	20	59	17
Peanuts(dry roasted)	14	50	31
Soya bean	14	38	44
Walnuts (dry roasted)	9	23	

Source: Wikipedia

8.0 CONCLUSIONS AND RECOMMENDATIONS

Nigeria and indeed the entire Sub-Saharan Africa is still grappling with the problem of severe malnutrition, which is due mainly to insufficient animal protein consumption. The stark reality is that the majority cannot afford the procurement of adequate quantities of meat, milk and eggs required to balance the diet. In fact, the ugly face of penury, poverty and destitution is often shown with the face of black Africans. Nonetheless, there exists a significant segment of the population in the upper and middle classes who indulge in liberal consumption of meat and are overtly concerned with quality aspects and health implications.

The solution to these problems require multi-dimensional strategies. These entail development of productive systems that yield relatively cheap products, process optimization, deployment of efficient and feasible preservation technologies and transformation of the nomadic pastoral system. An important strategy is incorporation of agro-byproducts and farm wastes into animal feed. In the course of this lecture, it was shown that sheep can be profitably reared on sun-dried caged-hen manure as the sole protein supplement (up to 45% inclusion level) in cassava peel based diets. Diets containing poultry manure should also include readily available carbohydrate sources. Finisher broilers can be fed profitably diets containing PKC at 40% inclusion level (plus 4% fish meal level) without additional lysine and methionine supplementation. Finisher broilers fed 30% PKC diet with the exclusion of any animal protein source or lysine and methionine supplementation did not suffer a significant depreciation in performance.

Commercial utilization of most of these and other novel or non-conventional feedstuffs is hindered by the exorbitant cost of collection and transportation due to current limited production capacity and non-existent centralized large scale processing enterprises.

Indigenous animals represent a highly significant percentage of the entire animal population. Although, they are lower in live-weight gain, milk production and prolificacy than exotic breeds,

indigenous animals are generally lower in percentage fat content, higher in percentage lean content, more tolerant to stress and higher in resistance to infectious diseases. Crossbreeding indigenous animals with exotic counterparts imparts the desirable traits of the former in the progenies. This therefore brings to the fore the necessity to preserve them from extinction.

Important conclusions were drawn from basic research in meat science: On an equal age basis, rams are higher in live-weight but after dressing out, ram carcasses are similar to ewe carcasses in weight. On an equal live-weight basis, meat from intact rams and vasectomized rams are less tender than meat from ewes. However, on an equal age basis all sex-related differences are not significant. This finding provides one likely explanation for the discrepancies in the literature on sex effects on meat tenderness. The expected increase in meat toughness as the animal increases in live weight would be somewhat moderated or even reversed by the concomitant increase in fattening. Thus, an older and fatter animal may produce more tender meat than a younger and leaner animal. It was shown that ram meat is tougher than ewe meat only in *L. dorsi* muscle and that meat from rams is darker and with greater colour stability than meat from ewes. Furthermore, rapid chilling of carcasses in contrast with slow chilling improves colour quality. The average polyunsaturated fatty acid (PUFA) level in vasectomized rams is significantly higher than average levels in intact rams, intact ewes and wethers. Information provided herein should guide future strategies in optimizing all processes and procedures in animal husbandry and meat production in order to produce healthy meat with high organoleptic, visual, nutritional and manufacturing quality.

Animal slaughter and carcass handling in Nigeria fall short of acceptable international standards. Modern, hygienic and humane systems installed by government for animal slaughter and meat handling have been abandoned due to lack of patronage from local butchers. Meat marketing is dominated by trade in fresh, unaged and unprocessed meat, and most often it is displayed for sale on dirty and unwashed wooden tables in the open market. Often retail beef is

exposed to direct sunlight which results to considerable loss in weight and rapid deterioration.

The majority of those suffering from stroke, heart attack and peripheral arterial diseases have normal total cholesterol level (< 200 mg/dl). Normally, it is elevated levels of low density lipoproteins (LDL) and very low density lipoproteins (VLDL), and low high density lipoproteins (HDL)levels that are associated with atherosclerosis and not the total cholesterol level.

All over the world, there is growing concern and apprehension towards the increasing incidences of hypercholesterolemia, atherosclerosis, hypertension, stroke and cancers. Consumption of animal products does not cause any of these sicknesses, although some studies suggest that it may be a predisposing factor. Critical analyses of the entire body of empirical research report on food intake and health implications suggest that these problems may be controlled by increased consumption of fruits and vegetables, low consumption of refined and high calorie diets, adequate bodily exercise and avoiding conditions that result to acute and chronic stress. Every food, including animal products must be consumed with moderation.

Recommendations

Current efforts in developing alternative and cheaper animal feedstuffs should be sustained and intensified. Increased intervention from the government, especially the Raw Materials Research and Development Council (RMRDC) is key. Centralized and large scale processing of such agro-products as cassava, rice and palm fruits will yield large and commercial quantities of cheap by-products which will be channeled to animal feeding.

Crossbreeding of indigenous animal species with high performing exotic counterparts should be intensified. This had been done in chicken decades ago in the old Western Region of Nigeria which resulted to a significant increase in live-weight of the local birds.

Government and all stakeholders in the ruminant animal

production industry must come together and do the needful in persuading the nomadic herdsmen to settle. Without this, cattle, sheep and goat production in Nigeria will remain underdeveloped, and the increasing clashes between herdsmen and crop farmers will exacerbate. Existing facilities for animal slaughter in Nigeria must be upgraded and all operators must be compelled to use them. These measures are essential conditions for prevention of carcass contamination and preservation of products. Conformity to and implementation of international standards are essential requirements for global acceptance of livestock products.

Finally, corruption the cruel bane of all our developmental efforts must be eradicated, else we will continue to take one step forward and two steps back.

ACKNOWLEDGMENTS

It is the truth, the manifest and undeniable truth, and to which all who had known me from birth will concur that I am a special beneficiary of the unmerited favour and grace of God. It is therefore not a thing of wonder that my biggest gratitude goes to the Most High God and to my Saviour, the Lord Jesus Christ. During the Nigerian civil war, my survival from the pangs of malnutrition and escape from kwashiorkor which snuffed out the lives of many friends and loved ones were due to divine intervention alone. Even protection from instant death by gun fire when I was specifically targeted by a jet fighter plane was of the mercies of God. The Almighty made sure that despite my financially constrained upbringing, that I received excellent educational training.

In 1972 when I was in primary six, I sat for the common entrance examination and scored 35 out of the maximum score of 36.Thereafter, I was admitted into the then famous Methodist College, Uzuakoli. After the first year in secondary education, I had to change school to the nearest school from home, Item High School, because my parents could no longer afford the boarding fees. It was with financial difficulty that I completed secondary schooling which involved most of the time trekking about 16 kilometers to and from school every day. Divine assistance made it possible for me to pass the West African Schools Certificate Examination in Grade One.

Around July 1977 and at 19 years of age, I had no other option than to leave the village and travel to Umuahia in search of any available employment like clerical work in any public or private establishment. In Umuahia, I stayed with the late Mr. Agwu Ichie (my maternal uncle) and his wife, Mrs Miriam Ichiemwho promised to pay for my study for the Higher School Certificate (HSC, A' level) in Government College, Umuahia. Again, because of financial constraint I started the HSC program around February, 1978 just about midway into the academic year. Another maternal uncle, the late Mr. Chukwu Ichie also contributed in paying the fees. A few months in school, the staff went on strike and this coupled with other issues made me to spend about a year in the classroom out of the two years for the program. Despite these challenges and to the glory of God, I passed and got the best result in my class.

Because of my performance, I was recruited by a nearby school, Immaculate Concepfion Seminary, Ahiaeke, Umuahia, to teach biology and mathematics to the seminarians. My uncles promised to pay for my university education and advised that I save enough money to cover the first year. This I diligently did.

After teaching for a year, I secured a direct entry admission to study agriculture in University of Ife, Ile-Ife (now Obafemi Awolowo University). After a few months on campus, God drew me and I became a born-again Christian. Again, God helped me marvelously and I was awarded the Shell Petroleum Development Company Scholarship. Consequently, I had no financial lack. I graduated in 1984 in first class, being the best student in the whole faculty.

Next was national service, and during that time I was informed by the Department of Animal Science in Ife that they intend to employ me as a Graduate Assistant and I must apply for postgraduate admission. That was how God compelled me to apply which I would not have contemplated since no helper was available to shoulder the bills. However, the promise for employment was cancelled and replaced with another promise of being awarded the University Graduate Fellowship if I commence the Master of Philosophy program. Actually I did not like the idea because it seemed to me like a leap in the dark. God intervened again and sent Mr. Kola Oloke to persuade me to believe God and start the

program. Immediately I decided to start, financial assistance came from expected and unexpected persons which sustained me till a few months later when I was awarded the fellowship and paid immediately. Really I had more money than I needed.

After completing the program, I spent a long time seeking for employment. On 28th February, 1989 (my birthday) I told God to give me a birthday present. The same day I came across an employment advert placed by FUTO in Concorde Newspaper. I was excited when I read it and I knew that this was from God. I applied and was employed as an Assistant Lecturer with effect from 1st October 1989.The following year I applied for Commonwealth Scholarship. While I was in Ife, and for two consecutive years I had planned to apply for this same scholarship and on each occasion God said no. On Friday, 22nd March 1991, by late afternoon and less than 24 hours to my wedding I received a letter from the Association of Commonwealth Universities informing me that I have been awarded the prestigious Commonwealth Scholarship. What a wonderful wedding gift from God!

With my young and beautiful wife, we travelled to the United Kingdom later that year and studied in Queen's University, Belfast. I got the Ph.D degree and my wife got the Master of Social Science degree plus three kids added to us before we returned to Nigeria on 16th January, 1995.God has been extraordinarily kind to me. Even till today, His blessings have been flowing to me like a river to me. I cannot but agree with the song writers:

GOD IS SO GOOD! GOD YOU ARE KIND! GOD YOU ARE WONDERFUL! MY GOD, YOU ARE EXCELLENT!

GREAT IS THY FAITHFULNESS OH GOD MY FATHER; THERE IS NO SHADOW OF TURNING WITH THEE; THOU CHANGEST NOT, THY COMPASSIONS THEY FAIL NOT; AS THOU HAST BEEN THOU FOR EVER WILT BE. *Great is thy faithfulness (2ce); Morning by morning new mercies I see; All I have needed Thy hand hath provided; Great is thy faithfulness, Lord, unto me.*

I sincerely thank Prof. F. C. Eze (7th substantive Vice Chancellor, FUTO) for approving, funding and superintending over this outing. Sir, I wish you unparalleled divine support as you continue to drive the culture of excellence. I appreciate Prof. O. Ogbobe (Deputy Vice Chancellor, Academic), Prof. I. C. Ndukwe (Deputy Vice Chancellor, Administration), Mr. J. U. Nnabuihe (Registrar), Dr. (Mrs.) C. V. Anunobi (University Librarian) and Mr. D. O. Nwokeocha (Bursar).

I will like to express my deep appreciation to all my teachers during my sojourns in primary, secondary and tertiary education. Worthy of special mention include my first degree project supervisor (Prof. (Mrs.) O. Matanmi; and M. Phil. thesis supervisor (the late Prof. A. A. Adegbola). I will forever remain grateful to Dr. Bruce W. Moss (my Ph.D thesis supervisor) and his wife, Dr. (Mrs.) Joan Moss for the wonderful support and encouragement to me and to my young family during our stay in Belfast.I thank my lecturers in Ife including Prof. I. C. Onwueme, the late Prof. A. A. Ademosun, the late Prof. O. Chiboka, Prof. E. B. Sonaiya, Prof. O. C. Onwudike, Prof. O. B. Smith and Prof. A. A. Aderibigbe. Shell Petroleum Development Company, Lagos; Obafemi Awolowo University, Ile-Ife; and Association of Commonwealth Universities, London are greatly appreciated for sponsoring my first, second and third degrees, respectively.

I wish to thank in a special way all who played one role or the other in giving me a job in FUTO in 1989. Among these worthy personalities include Prof. A. Nduka (Vice Chancellor), Prof. M. U. Iloeje (Dean, SAAT) and the late Dr. N. O. Eshiette (Ag HOD, AST). All the academic and moral supports received from Prof. M. U. Iloeje and Prof. A. B. I. Udedibie are gratefully acknowledged. I also thank all other members of staff in AST Department: Prof. B. O. Esonu (Current Dean, SAAT), Prof. G. A. Anyanwu, Prof. I. C. Okoli, Prof. (Mrs.) U. E. Ogundu, Prof. M. C. Uchegbu, Prof. O. O. Emenalom, Dr. E. B. Etuk (Ag. HOD), Dr. C. T. Ezeokeke, Dr. (Mrs.) H. O. Obikaonu, Dr. I. F. Etuk, Dr. V. M. O. Okoro, Mr. N. J. Anyanwu, Dr. I. P. Ogbuewu, Dr. E. C. Akanno, Dr. O. N. Aladi, Dr. V. U. Odoemelam, Miss. F. C. Egenuka, Dr. C. C. Ugwu, Mr. T. C. Iwuji, Mrs. O. E. Kadurumba, Dr. I. C. Unamba-Oparah, Mrs. C. P. Okere and Mr. E. U. Ahiwe. I also acknowledge assistance received from the non-academic staff in AST Department, including Mrs. P. Ekeledo, Mr. M. D. Okafor and Mr. E. O. O. Onuoha.

Sincere appreciation is due to all my students, especially those I supervised their theses / projects. In this worthy group include Prof. O. O. Emenalom, Dr. E. B. Etuk and Dr. Victoria Meremikwu, all of whom I was Co-supervisor. I greatly appreciate Dr. N. O. Aladi (my star student), presently a Lecturer and Exam Officer in our Department. He was my student throughout his studies for the Bachelor's, Master's and Doctorate degrees in FUTO. I also appreciate Dr. J. S. Ekpo (Lecturer, Akwa Ibom State University) who was my doctorate degree student here in FUTO. It was indeed a thing of joy and highly rewarding being the major supervisor to the following 12 M. Sc. Students: Ekwuagana, I. C. (2009), Egenuka, F. (2009), Okwunna N. O. (2012), Maduawia, I. L. (2013), Ezetoha U. C. (2013), Ezeoke, F. C. (2015), Onwuka, K. C. (2015), Agu, E. N. (2015), Anyanwu, V. C. (2016), Chukwukaelo, A. (2016), Uneze, C.U. (2016) and Ikpamezie, I. C. (2017).

I appreciate the staff (Mr P. C. Isiwu and Mrs. H. Ndukoro), and all members of the current and previous Board of Anti-corruption and Transparency Monitoring Unit (ACTU), including Prof. A. E. Ibe, Mr. L. C. Ofolete, Dr. (Mrs.) J. C. Orji, Dr. F. O. Nwosu, Mr. J. Ewurum, Mr. C. Opara and Dr. C. C. Molokwu.

I acknowledge all the spiritual and material supports from the Deeper Life Bible Church, especially from the General Superintendent (Pastor William F. Kumuyi), Imo State Overseer (Pastor Emmanuel Okoro), Anambra State Overseer (Pastor Emmanuel Ogbodo), Enugu State Overseer (Pastor Godson Ezenwanjiofor), Abia State Overseer (Pastor Damian Umeh) and all my fellow Region Overseers in Imo State: Pastor Ebere McLawrence, Pastor Peter Achoja, Pastor James Ngoka (Ex Perm. Sec.), Pastor (Dr.) Charles Egeonu (Retired Chief Lecturer, Poly-Nek.), Pastor Raymond Okoigun, Pastor Godwin Nwangwa, Pastor Raymond Osuji, Pastor Johnson Nwaduvuand Pastor Fabian Ekwueme, Pastor Friday Lenu and Pastor Joseph Ogu. All my brethren in Imo State, especially the wonderful people of Ikeduru Region, I say thank you and remain blessed.

A huge debt of gratitude is owed to my late parents, Mr. Ogbonnaya Okeudo and Mrs. Esther Ukanwa Okeudo who brought me into this world and took special care of me with all they had. I also

thank my maternal uncles, the late Mr. Agwu Ichie and the late Mr. Chukwu Ichie for looking after me like their own sons. I thank their wives, Mrs. Miriam Ichie who has been a mother to me, and Mrs. Chukwu Ichie for all the care she showered on me and my family. I salute all my maternal cousins, including Chinyere Ichie, Hannah Ichie, Sunday Ichie, Miriam Ichie, Obinna Ichie and their siblings.I thank my step mothers – Mrs. Jenny Okeudo and Mrs. Mary Okeudo for being there for me. Sincere appreciation is due to all my siblings: Mrs. Comfort Godwin, Mrs. Mercy Okeosisi, Mr. Ndubuisi Okeudo, Mr. Daniel Okeudo, Mrs. Jane Ogbonnaya, Mr. Ejiofor Okeudo, Mrs. Patience Ibeabuchi, Mr. Onyekwere Okeudo, Mr. Ekeoma Okeudo, Mr. Okechukwu Okeudo, Dr. Chijioke Okeudo (Consultant Gynaecologist), Mrs. Okwuchi Maxwell, Mrs. Dibunma Oko Ndukwe, Mr. Okwe Okeudo, Mr. Anasu Okeudo, Mr Emenike Okeudo, Barrister Uche Okeudo, Mr Chukwunenye Okeudo and Mr Ogonnaya Okeudo. Assistance of other relatives like Prof. Onwukwe Alaezi, Mr. Okeudo Uzoubi Okeudo and Sir Onuoha Ogbonnaya in various occasions is gratefully acknowledged.

My late father in-law, Mr. Patrick A. Odoeme, and mother in-law, Mrs. Pauline A. Odoeme, deserve special gratitude. I thank my brothers and sisters in-law, including Mr Joseph Odoeme, Mrs. Adanma Osondu, Mrs. Mary Omokpariola, Miss Philomena Odoeme, Mrs. Chinwe Ude, Mr. Obinna Odoeme and Miss Chika Odoeme.

Finally and most importantly, I am highly indebted and will be forever grateful to my wife, Dr. (Mrs.) Geraldine Nkechinyere Okeudo. She has been to me all that an excellent wife and companion should be – physically, spiritually, emotionally, intellectually, financially, etc. I thank God and greatly appreciate all my children: Esther (B. Sc., (Hon.) Microbiology, resident in Leeds, Northern England), Paula (B. Tech., (Hon.) Mechanical Engineering), Mary (B. Sc. (First Class), Biochemistry), Israel (Undergraduate, Economics), David (Prospective Undergraduate) and Deborah (SS1 student). May God bless you all in Jesus Name, Amen.

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