UNIVERSITY OF PORT HARCOURT

FEED MY FLOCK!

An Inaugural Lecture

By

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ORDER OF PROCEEDINGS

2.45 pm Guests are seated

3.00 pm Academic Procession begins

The Procession shall enter the Ebitimi Banigo Auditorium, University Park, and the Congregation shall stand as the Procession enters the hall in the following order:

Academic Officer
Professors
Deans of Faculties / School
Dean, School of Graduate Studies
Provost, College of Health Sciences
Lecturer
Ag. Registrar
Deputy Vice Chancellor, Research and Development
Deputy Vice Chancellor, Academic
Deputy Vice Chancellor, Administration
Vice Chancellor

After the Vice Chancellor has ascended the dais, the Congregation shall remain standing for the University of Port Harcourt Anthem.

The Congregation shall thereafter resume their seats.

THE VICE CHANCELLOR'S OPENING REMARKS.

The Ag. Registrar shall rise, cap, invite the Vice Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction.

THE INAUGURAL LECTURE

The Lecturer shall step on the rostrum, cap and deliver the Inaugural Lecture. After the Lecture, he shall step towards the Vice Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice Chancellor and resume his seat. The Vice Chancellor shall present the document to the Ag. Registrar.

CLOSING

The Ag. Registrar shall rise, cap and invite the Vice Chancellor to make his Closing Remarks.

THE VICE CHANCELLOR'S CLOSING REMARKS.

The Vice Chancellor shall then rise, cap and make his Closing Remarks. The Congregation shall rise for the University of Port Harcourt Anthem and remain standing as the Academic [Honour] Procession retreats in the following order:

Vice Chancellor
Deputy Vice Chancellor, Administration
Deputy Vice Chancellor, Academic
Deputy Vice Chancellor, Research and Development
Ag. Registrar
Lecturer
Provost, College of Health Sciences
Dean, School of Graduate Studies
Deans of Faculties / School
Professors
Academic Officer

PROTOCOL

- The Vice Chancellor
- Past Vice Chancellors
- Deputy Vice Chancellor, Administration
- Deputy Vice Chancellor, Academic
- Deputy Vice Chancellor, Research and Development
- Past Deputy Vice Chancellors
- Members of the Governing Council
- Principal Officers of the University
- Provost, College of Health Sciences
- Dean, School of Graduate Studies
- Deans of Faculties / School
- Heads of Departments
- Distinguished Professors
- Directors of Institutes, Centres and Units
- Visiting Academics and Colleagues
- Esteemed Administrative Staff
- Captains of Industries
- Cherished Friends and Guests
- Unique Students of UniPort
- Members of the Press
- Distinguished Ladies and Gentlemen

DEDICATION

I dedicate this lecture, first and foremost, to Jehovah Raah (The Lord My Shepherd), who has never left me without a revelation per time. He makes all things beautiful for me in due season.

Next, I dedicate this lecture to my late parents (Late Chief Josephus Etela Jackson - Jackson XI, Paramount Ruler of the Da Jackson Group of Houses and communities in Ifoko and Late Madam Makinyeba Gwendoline Georgewill; Gogo Bereyin)

And to my late parents-in-law (Late Elder Garwell Marian Ikiriko and Late Madam India Smart Robert).

Lastly, I dedicate this lecture to all those innocent Nigerian men, women, youths and children who have lost their lives and the millions displaced by reason of man's mismanagement of Animal Agriculture in Nigeria.

May their souls rest in peace.

ACKNOWLEDGEMENTS

I return all the glory to the good Lord who had been at the centre of it all. He is the Doer! For this I am, eternally, grateful and truly appreciate God's leading and ever-abiding presence.

The 9th Vice Chancellor, Professor Owunari Abraham Georgewill, Sir, I sincerely, appreciate you for approving this date for me to present the Inaugural Lecture Series No. 174.

I want to pay tribute to Late Mrs. Olufunmilayo Manua, founder, Aunty Ayo Preparatory School established 1962 (now Aunty Ayo International School), Eti Osa Local Government Area, Ikoyi, Lagos. Your gift of a full scholarship commenced this academic journey.

Acknowledged is Chief Fubara Thomas Akoko, Chairman Ifoko Council of Chiefs, who as assistant Head Teacher when I was admitted to St. James Primary School, Ifoko in 1978. Although my dad wanted me in primary two, he insisted I be placed in primary four, based on my interview performance. Thank you, for revealing the spiritual understanding that, *"I am different"* very early in my life. It has remained my motivation till date.

I pay tribute to Late Mr. Asiedu, my Mathematics teacher at Government Sea School, GSSI (now Sports Institute), Isaka for kindling my interest in Mathematics. Rest in peace!

Also, acknowledged is Mr. Mensah, my Biology and Chemistry teacher also at GSSI. Your excellent handling of both subjects were next to none. God bless you, Sir!

To my Bachelor's degree project supervisor, Professor A. Monsi, you taught me scientific writing. Thank you, Sir! My sincere appreciation to Professor Boma Oruwari, who connected me with the International Livestock Research Institute (ILRI), Onne sub-Station in 1996.

Let me pay tribute to my Masters programme thesis supervisor at the Rivers State University of Science and Technology (RSUST), Late Professor Uche I. Oji. You taught me how to be thorough; going through every single line. Rest in peace!

And to my Doctorate programme dissertation supervisorat the University of Benin, Benin City, Professor U.J. Ikhatua, thank you daddy, for believing in me. I, specially, acknowledge my friend and brother, Professor M.A. Bamikole, for the bond has grown stronger in our personal and professional lives.

Let me, sincerely, acknowledge my professional father, Dr. Asamoah Larbi, who was my supervisor at ILRI-Ibadan. This international research exposure meant so much to me as a Ruminant Nutritionist. Also acknowledged is Professor Alex Ariho, CEO, African Agribusiness Incubators Network (AAIN), Accra, Ghana, for your professional support.

Let me pay tribute to a destiny helper Late Professor J.A. Ayoade, who was my PhD External Examiner in 2005.Fate again made himthe one who interviewed me for Readership and Professorship positions at UniPort. Rest in peace!

Please, permit me to, sincerely, acknowledge, in no particular order, other great men and women God had positioned here in UniPort prior to my arrival that, have continued to enable me maintain the right path. First, Professor O. Akaranta for his tutelage and friendship, Professor B.W. Abbey for being a

mother to me, and Professor L. Akonye for always being supportive.

Also, acknowledged are the 5th Vice Chancellor, Emeritus Professor N.D. Briggs for always leading the way as a role model, the 6th Vice Chancellor, Professor Don Baridam who approved my employment in 2005, the 7th Vice Chancellor, Professor J.A. Ajienka for your ever-ready mentorship - you are a fountain of multidisciplinary knowledge and I have benefited there-of, and the 8th Vice Chancellor, Professor N.E.S. Lale, who as Dean, recommended me for employment in 2005, and as Vice Chancellor, approved my promotion to the rank of Professor in 2016.

I do appreciate Professor O.F. Joel, my Dean and Centre Leader, World Bank Africa Centre of Excellence in Oilfield Chemicals Research (ACE-CEFOR) for always inspiring me to move ahead.

Permit me to also acknowledge the support of Professor Jitendra Paliwal, University of Manitoba, Winnipeg, Canada for our work on near infrared reflectance spectroscopy (NIRS) and Dr. S.O. Afuape for follow up works on sweet potato.

Also, appreciated are all the Professors as well as the Academic, Administrative and Technical staff in the Faculty of Agriculture, Department of Animal Science and the Institute of Agricultural Research and Development (IARD) for all your support and prayers.

Let me appreciate the following for, painstakingly reviewing the draft of this lecture: Professors O. Akaranta, Alice R. Nte, Nenibarini Zabbey, M.A. Bamikole (UNIBEN), and D.J.U. Kalla (ATBU), and Dr. Asamoah Larbi (USA).

I appreciate my pastors at Winners Chapel: Pst. Chukwunda Tamunotonye; Pst. John A. Dominion; Pst. Celestine Obuosonand Bishop Dabibi Otonyemieba of St. Matthias African Church, Anozie Street, Mile 1, Diobu, for all your prayers.

Permit me to express appreciation to my Committee of Friends (for all the arrangements), ARIBA Family - UniPort, Kengema Kobiri - UniPort, Hospitality Service Group - LFC-Rumuigbo, the Da Jackson Group of Houses-Ifoko, and the Ifoko Community for all your love and support. I want to acknowledge my first cousin, Ms. Ngo Smart Robert, who typed my BSc Project free of charge. Thank you, for that show of love.

I like to, deeply, acknowledge my Late father, Chief Josephus Etela Jackson, Jackson XI, who always admonished me to ensure that, in everything, I should have trust in God and seek to do good always. These words have kept me going.

Also appreciated are all my present and past postgraduate and undergraduate students at the Faculty of Agriculture, Centre for Oilfield Chemicals Research (CEFOR), Institute of Natural Resources, Environment and Sustainable Development (INRES), Centre for Occupational Health, Safety and Environment (COHSE), and International Institute for Trade and Development (IITD), all in UniPort.

Finally, I want to appreciate my lovely wedded wife, Mrs. Warigbani Ibisime Etela, for all the prayers, emotional, moral and financial support. You filled the gap when I embarked on those trips. And to my children Hadriel Tamunoebube, and Janice Tamunoorinate, thank you, for making me your hero and friend. God bless you all!

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INAUGURAL LECTURE

FEED MY FLOCK!

The Question!

Do we still need livestock since they are accused of contributing to greenhouse gas emission, global warming and climate change?

The Global Goals

"From ending poverty and hunger to responding to climate change and sustaining our natural resources, ***food and agriculture lies at the heart of the 2030 Agenda*** *towards attaining the 17 Sustainable Development Goals" http://www.fao.org/faostat/en/#data/FS*

The title of this Inaugural Lecture is, directly, connected to SDG 2: Zero Hunger and SDG 13: Climate Action

Preamble

The title for this 174th Inaugural Lecture is relevant because, it was inspired after I attended a two-week Word of Faith Bible Institute programme organised by the Living Faith Church (aka Winners' Chapel) in April 2006. On the last day of thatprogramme I sought the face of God to hear from Him and got a revelation of the Scripture "Feed my lambs." 'John 21: 15: *So when they had dined, Jesus saith to Simon Peter, Simon, son of Jonas, lovest thou me more than these? He saith unto him, Yea, Lord; thou knowest that I love thee. He saith unto him,* ***Feed my lambs.'***

However, over the years as I practised my professionthrough different leadership positions and interacted with diverse officers, I daily reconsidered the command. Although the definition of ruminants has a wide scope, I shall attempt to speak only on cattle, sheep and goats being the commonly reared ones in Nigeria. While cattle is referred to as a large ruminant, sheep and goats are referred to as small ruminants.

Permit me Vice Chancellor, Sir, to refer to the Holy Bible, showing these three farm animals have always been together for the good of humanity as we see in the Book of Genesis Chapter 30 and verse 32: *"I will pass through all thy* ***flock*** *to day, removing from thence all the speckled and spotted* ***cattle****, and all the brown cattle among the* ***sheep****, and the spotted and speckled among the* ***goats****: and of such shall be my hire."*

As I pondered over what title to speak on, I considered a major challenge observed among many livestock farmers, the difficulty of feeding their animals. Thus, I felt the title should be in the form of advice or instruction (Feed My Flock) or a question (Feed My Flock?) or a directive or command (Feed My Flock!).

I further analysed it and observed that, if presented as advice or instruction, the reader can choose to ignore it. If it is a question, the reader also has the liberty to question it saying, why should I feed animals when they can simply scavenge for food? And if given as a directive or command, my intentions could be misread or misconstrued.

But, I had succour, when I came across this truth in the Book of Ezekiel, Chapter 34 and verse 3 in the Holy Bible, which reads: *"Ye eat the fat, and ye clothe you with the wool, ye kill them that are fed: but ye feed not the flock."* As independent as they might appear, ruminants (here simply defined as cattle, sheep and goats) need attention to be paid to their welfare and feeding.

Mr. Vice Chancellor, Sir, ladies and gentlemen, it is common knowledge that, people appreciate eating good meat, wearing nice leather shoes and belts, and sitting on well-made leather chairs at home, office and cars. Unfortunately, many do not seem to understand that, the raw material for these quality natural products come from these wonders of nature called ruminants. Most persons would be glad to have their domestic pets feed well, at all costs than, these living factories.

Therefore, I came to a conclusion that, the title of my Inaugural Lecture today being the Inaugural Lecture Series No. 174 of the University of Port Harcourt, should be **Feed My Flock!** Mr. Vice Chancellor, Sir, distinguished ladies and gentlemen, in preparing this lecture, I was cognisant of the facts that, I am: (1) the 6th Dean, Faculty of Agriculture, (2) presenting the 4th Inaugural Lecture from the Faculty of Agriculture, and (3) presenting the 1st Inaugural Lecture from the Department of Animal Science in UniPort.

Becoming an Animal Scientist

Although there are several accounts about the origin of Animal Science, permit me to dwell on the account of the Holy Bible, which showed that, ruminants like the cattle predate man's existence on the earth. In Genesis Chapter 1 and verse 25, which reads, "*And God made the beasts of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind: and God saw that it was good."* Verse 26 of the same Chapter reads, "*And God said, let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.*"

"Animal Science", also referred to as "Animal Agriculture" or "Animal Husbandry", shall be used interchangeably in this lecture. Animal Science is an Applied Science for problem solving, which applies the knowledge and principles behind many aspects of Biological Science, Behavioural Science, Physical Science, Social Science, Environmental Science and Biosystems (Agricultural) Engineering.

The purpose of Animal Science is to rear farm animals through scientific understanding to produce quality animal-source protein as food, serve as source of raw materials, draught power to support crop farming, animals for companion and recreation, economic needs as sources of employment and maintaining ecosystem integrity when, properly, managed.

The core subjects to qualify one to pursue Animal Science degree are Biology/Agricultural Science, Chemistry, Mathematics/Physics and English Language, then a five-year programme in a Higher Education Institution. This is followed by a one year internship at an accredited farm after which the

person is inducted as a Graduate Animal Scientist (GAS) into the Nigerian Institute of Animal Science (NIAS) after passing the GAS Examination.

And after five years mentorship under a Registered Animal Scientist (RAS) the person shall be inducted as a Registered Animal Scientist after passing the prescribed RAS Examination. The first batch of 265 RAS was inducted on 27th July 2009 at the University of Calabar; fortunately, I was No. 145. To date, the Institute has 12 zonal offices with two offices per geopolitical zone.

Animal Science Profession

By training, the typical Animal Scientist is a professional expected to consider issues holistically or conceive, develop and implement projects using the Systems Approach. The rearing of animals by various ethnic groups in Nigeria using indigenous knowledge pre-dates the practices in the colonial era. And throughout the ages, humans have always found a way to relate with the animals not just for food but, also for companionship and other social and religious benefits and obligations.

The Holy Bible account indicates that, the Almighty God showed preference for the Animal Scientists at the time represented by Abel, Abraham, Isaac, Jacob and David, the shepherd boy who became preferred King of Israel.

The journey for professionalisation of Animal Science in Nigeria commenced through nation-wide consultations with Animal Scientists from the Industry, Public Service and the Academia, which led to the establishment of the Animal Science Association of Nigeria (ASAN) in 1990. Through continuous multi-stakeholder engagements, ASAN was

formally registered with the Corporate Affairs Commission (CAC), Abuja-FCT in 1997 (Oyediji, 2010).

The ASAN is the umbrella body for all Animal Scientists in Nigeria with the Mandate of coordinating Animal Husbandry Systems in the country. Prior to the establishment of ASAN, the only professional association for livestock production and management was the Nigerian Society for Animal Production (NSAP).

With that initial success, the road to full professionalism of Animal Science Practice in Nigeria became clearer culminating in the establishment of the Nigerian Institute of Animal Science (NIAS; *https://nias.gov.ng*). The NIAS was established by the National Assembly Act No. 26 on 28th May 2007 under President Olusegun Obasanjo. The NIAS is the regulatory body established by Act No. 26 of 2007 as Amended 2015, whose Mandates are professional, social and industry regulation of Animal Science Practice in Nigeria (Table 1).

The Mission of the Institute is regulation of Animal Husbandry Practices for increased profitability to all stakeholders and guarantee improved Animal Husbandry and Production Systems that will embrace environmental sustainability and ensure high quality and quantity of animal proteins to Nigerians.

The areas of discipline of NIAS are: Animal Biotechnology; Livestock Economics and Marketing; Range and Pasture Management; Animal Genetics and Breeding; Dairy Science; Poultry Science; Beef Production Science; Swine Production Science; Small Ruminant Production Science; Animal Physiology and Bioclimatology; Livestock Production and Environment; The Feed Milling Industry; Livestock Processing

and Preservation Technology and Agro-Allied Industries as well as Civil Society Organisations Liaison.

The NIAS is similar to the American Registry of Professional Animal Scientists (ARPAS; *https://www.arpas.org*), which was established in 1984. The ARPAS provides certification of

Table 1: Core professional, industry and social mandates of the Nigerian Institute of Animal Science (NIAS)

Professional Mandate	Industry Mandate	Social Mandate
• Registration and Certification of Animal Scientists • Internship • Accreditation • Resource Verification • Mandatory Continuing Professional Education • Research • Affiliations • Policy	• Regulation / Guidelines for Value Chains • Processing • Distribution • Inspection and Monitoring of Livestock Farms and Feed Mills • Marketing • Training of Operators	• Advocacy • Partnerships for Entrepreneurship • Job Creation / Self Employment • Training • Enlightenment

animal scientists through examination, continuing education, and commitment to a code of ethics in the United States. A RAS from Nigeria can practice in the USA and vice versa without any qualifying examination.

The ARPAS is affiliated with five professional societies, namely: American Dairy Science Association, American Meat Science Association, American Society of Animal Science, Equine Science Society and Poultry Science Association. The ARPAS has twelve species discipline areas namely: Dairy; Beef; Meat Science; Sheep and Goats; Dairy Food Processing;

Companion Animals; Poultry; Poultry Processing; Horses; Aquaculture, and Laboratory Animals.

Context Analysis

Mr. Vice Chancellor, Sir, ladies and gentlemen, permit me to place this Inaugural Lecture titled ***"Feed My Flock!"*** in perspective just to be sure that, everyone is on the same page although, we might be at different parts of the same page. The title, "Feed my Flock!" means different things to different persons since, it could simply mean providing food, directly, for humans or it could mean feeding livestock like cattle, sheep and goats to make their meat healthy, safe and affordable for human consumption and, thereby, feeding humans, indirectly.

Thus, whichever way it is defined, the meaning still revolves around providing healthy, safe and affordable food in the right quantities, quality and prices for human consumption; this is what food and nutrition security entails. But, why should we bother about feeding animals and livestock, for that matter? There are several reasons why we should bother about what we feed to our livestock, how we feed them and the kinds of residues we leave behind or emit into the environment (land, air, water).

This is because, when attention is not paid to this vital aspect, we end up compromising the delicate balance of the ecosystem, which ends up endangering the livestock that, in turn, poses as a source of hazard to humans who might consume such unhealthy animal-source proteins. At a time such as this, when the global slogan for implementing the 17 Sustainable Development Goals (SDGs) is *"leave no one behind"*, everyone should be concerned about how our actions affect the ecosystem (SDGC-A and SDSN, 2020).

FAO (2021) report on the state of food security in the world showed that, about 760 million people faced hunger in 2020. Out of this number, an estimated 418 million live in Asia, 282 million live in Africa, and the rest 60 million persons live in Latin America and the Caribbeans. The 2020 Africa SDG Index and Dashboards Report also showed that, no African country scored green for 13 of the 17 goals, with SDG 3 (Good Health and Wellbeing), SDG 9 (Infrastructure) and SDG 16 (Peace, Justice and Strong Institutions) recording the greatest challenges.

Mr. Vice Chancellor, Sir, ladies and gentlemen, the report indicates a 23.5% score in terms of performance attributable to good performance in SDG 13 (Climate Action) and SDG 12 (Responsible Consumption and Production). A critical analysis of the, likely, reasons behind this abysmal performance showed they were either poor knowledge about the SDGs, lack of adequate commitment towards achieving them, and not knowing what to do, at all or their combination.

Ruminants as Living Factories

About 155 species of ruminants exist and the best known herbivores like cattle, sheep and goats are the most commonly known ruminant species. Other ruminant species are Camelidae (camel, Llama, Alpaca, Guanaco, Vicuna), Hippotamuses, Tree Sloths (Cholopus, Bradypus), and leaf-eating monkeys. Ruminants are capable of utilising fibrous feedstuffs because, of their forestomach (rumen; reticulum; omasum) with its rich diversity of microorganisms (bacteria, protozoa and anaerobic fungi like yeast) that, colonise the gastrointestinal tracts (G.I.T.).

Ruminants utilise grasses, browse plants and crop residues due to the metabolic activities of the anaerobic (in the absence of oxygen) microbes in the rumen and the large intestine. Table 2

indicates a typical example of the population of each type of microbe in the G.I.T. of ruminants. The smaller the cell size, the more the population per millilitre (mL).

Generally, ruminants have two digestive processes:

(1) the **microbial digestion** process, which takes place in the rumen, reticulum [reticulorumen or fermentation chamber or vat in which bacteria and protozoa can convert plant materials to volatile fatty acids (VFAs), methane (CH_4), carbondioxide (CO_2), ammonia (NH_3), and microbial cells] and the omasum, and

(2) the **enzymatic digestion** process, which takes place in the abomasum; described as the true stomach similar to that of non-ruminants like poultry and pigs. To function, effectively, the pH in the forestomach of ruminants must always be neutral (pH 6.2-7.0) and may be lower when a high grain: roughage is fed.

Table 2: Average volumes and numbers of microbial groups in the rumen of sheep

Organism	**Average cell volume**	**Number/mL**	**% of total***
Ciliate protozoa:			
Isotricha; Epidinium; Diplodinium sp.	1,000,000	1.1×10^4	33.55
*Dasytricha, Diplodinium*sp.	100,000	2.9×10^4	8.78
Entodinium sp.	10,000	2.9×10^5	8.79
Polyflagellated fungal zoospores	500	9.4×10^3	0.01
Oscillospiras and fungal zoospores	250	3.8×10^5	0.26
Selenomonads	30	1.0×10^8	0.09
Small bacteria	1	1.6×10^{10}	48.52

Total microbial volume was about 0.036 mi per millilitre of rumen fluid [Source**:* Chiba (2007)*]*

Some Important Attributes of Ruminants

1) Possess three to four stomach compartments, hoofs, chewing-the-cud, may have horn / hump.
2) Break carbohydrates to volatile fatty acids (VFAs) like propionate, acetate and butyrate not monosaccharides.
3) Synthesise B vitamins or Vitamin B Complex.
4) Convert poor quality proteins and non-protein nitrogen (NPN) like urea to "good quality" microbial protein.
5) The microbes detoxifyharmful substances in their diets to beneficial nutrients like nitrite reduced to methane (CH_4).

Table 3 shows a summary of the five stages that the cattle G.I.T undergoes to make them the living factories as they mature. The five phases are: newborn; predominant; transition, and preweaning and postweaning. The type of diets at each of those five phases of G.I.T development are summarised in Table 3.

Table 3: Percent proportion of the gastrointestinal tract as cattle develop from birth to maturity

Development Phase	Age	Diet	RR*	Om	Ab
1. Newborn	0-24 hrs (birth)	Colostrum	31%	8%	61%
2. Preruminant	1d-3wks (2 wks)	Mainly milk Lactobacilli	36%	5%	59%
3. Transitional	3-8wks (7 wks)	More milk Small roughage	72%	4%	24%
4. Preweaning	about 4 mths	Less milk More roughage	73%	6%	21%
5. Postweaning	Adult	Less/zero milk 100% roughage	69%	8%	23%

*RR: Reticulorumen; Om: Omasum; Ab: Abomasum
Source: Chiba (2007)

Table 3 illustrates that, as the cattle grows from birth to maturity, the proportion of the G.I.T occupied by the reticulorumen increases, while the proportion of the abomasum decreases.These changes get to their peaks at the transitional phase, which is when the animal is about seven weeks old. Usually, once the young animal consumes any roughage, the rumen begins to function as a fermentation vat and increases that function, gradually.

The Role of Livestock

Generally, livestock supports sustainable livelihoods of smallholder farmers and humans. Animals have been raised by different ethnic groups in Nigeria for food, as a source of raw materials and for other uses. Abbey (2006) while presenting the 48th Inaugural Lecture of UniPort observed that, plant proteins were inferior to animal proteins due to deficiencies in some essential amino acids like methionine and lysine.

Table 4 shows the average dietary protein consumption and percent contribution of protein to total daily dietary consumption in grams per person in different regions of the world. Livestock accounts for 25 percent of agriculture value added in Africa compared to 55 percent in North America and 67 percent in Western Europe (FAOSTAT, 2018).

Andreoli *et al*. (2021) reported increase in milk and meat consumption with improvement in income levels. This is because, with advancing economic development, most consumers become increasingly well-off and have the tendency to move away from cereal-based diets to high value proteins offered by meat, milk and other livestock products, fruits and vegetables (Delgado *et al*., 1999).

Table 4: Dietary protein consumption per person in grams per day

Area	Protein Intake (g/person/day)	Protein Percent in Daily Diets (%)
World	77	11
Developed World	103	12
Developing World	70	11
Sub-Saharan Africa (SSA)	55	10
Range in SSA	25 - 133	6 - 14
Nigeria	62	9

Source: ChartsBin statistics collector team (2011) <http://chartsbin.com/view/1155>

This projection makes livestock important as they provide a channel for quality animal-source protein required to supplement the plant-source proteins that are often deficient in the sulphur-containing amino acids (Table 5). The annual growth rate in production of 3.2% for meat, 3.7% for beef, 3.3% for meat from small ruminants (mutton plus chevon), and 3.8% for poultry shows clear deficits in supply levels for milk, beef and mutton plus chevon.

This is because, the increase in supply levels may not meet these demands. For sustainability and ecosystems integrity, it is expected that, such increase in meat and milk supply should be driven by improved productivity rather than just increase in animal population (Wisser *et al.*, 2019). Increase in human and animal populations and shrinking land area will lead to overgrazing and other environmental concerns.

Table 5: Projected consumption and supply of milk, beef and meat from small ruminants in Nigeria for 2012, 2030 and 2050 in '000 tons

Livestock Product	Milk	Beef	Mutton & Chevon	Poultry
2012:				
Consumption	1,384	392	467	296
Supply	579	392	468	297
Difference	-58.2%	nil	+0.2%	+0.3%
2030:				
Consumption	2,804	800	878	602
Supply	1,372	846	851	671
Difference	-51.1%	+5.8%	-2.4%	+11.5%
2050:				
Consumption	4,226	1,393	1,473	602
Supply	2,242	1,306	1,215	671
Difference	-46.9%	-6.2%	-17.5%	+11.5%

Source: Wisser*et al*. (2019)

Livestock and the Environment

Mr. Vice Chancellor, Sir, ladies and gentlemen, permit me to assume the position of a livestock advocate at this time because, they are voiceless. As an Animal Scientist, I have been trained to listen and communicate with them. This is essential at this point because, livestock is said to be guilty of causing environmental degradation leading to several schools of thoughts and Animal Rights groups questioning whether Animal Agriculture should still be allowed?

However, such advocates against livestock have failed to say that, even livestock, as living things are, equally, victims of the changes like poor yield and quality of pasture and forage, and

have rights to existence, protection and food. Amakiri (2018), highlighted the fact that, like humans, animals are also at risk from environmental pollution hazards.

While presenting the 481st Inaugural Lecture of the University of Ibadan on 23rd January 2020 titled: ***"The Wonders of Ruminants"***, the presenter, Professor O.J. Babayemi stated that, *"If livestock have their way, they shall all migrate out of Nigeria to better places where their welfare shall be assured."* Figure 1 depicts the population density of ruminants in Africa with indication of how they could affect the ecosystem. The higher the density of ruminants in an area, the more likely the chances of overgrazing that, can result to vegetation loss, nutrients imbalance and environmental degradation.

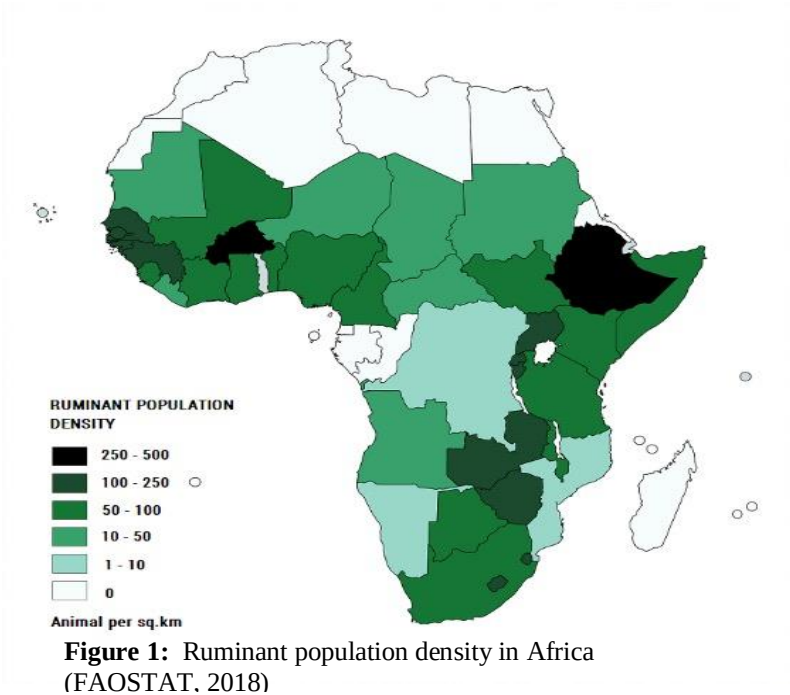

Figure 1: Ruminant population density in Africa (FAOSTAT, 2018)

Table 6: Protein supply and protein of animal origin for different countries from years 2016 to 2018

Area	Daily Protein Supply (g/capita/day)	Daily Protein of Animal Origin(g/capita/day)
Africa:		
Kenya	60.7	14.3
Morocco	99.7	27.0
Nigeria	58.0	7.0
South Africa	83.7	36.0
Asia:		
China	100.6	40.3
Israel	125.0	73.3
Antarctica:		
Australia	106.6	71.6
New Zealand	93.7	51.7
Europe:		
Germany	104.3	63.0
Netherlands	105.0	68.3
North America:		
Canada	103.3	55.0
United States	112.7	72.7
South America:		
Brazil	94.0	52.7
Mexico	22	22

Source: FAOSTAT (2021)

Table 6 shows the average daily protein supply in grams per capita (person) and the average daily protein of animal origin per capita (person) for different countries. The values for Nigeria were the least meaning there is a large room of opportunities for improvement.

Livestock is said to contribute to climate change through greenhouse gas emissions (GHGs) yet, at other quarters, we

await the use of animal dung as feedstock for biogas as source of renewable energy (EPA, 2019). That is the dilemma of the Animal Scientist, especially the Ruminant Nutritionist, and the farm animals raised for the survival and comfort of man.

Poor feed resources offered to livestock just because, they are animals result to improper metabolic processes by the rumen microbes (microbiomes). This leads to high production of methane gas (CH_4) emission through enteric fermentation, which is considered as a waste of energy. Use of quality feed resources capable of supplying the right proportions of prebiotics like feed fibre can help ameliorate this challenge.

A critical appraisal of the situation reveals that, the real culprits of environmental degradation blamed on livestock are:
a) Man's insatiable taste for exploiting the ecosystem.
b) Improper feeding resulting to unwanted residues.
c) Poor management systems for raising the animals.
d) Adverse weather and climatic conditions.

But, knowledge and understanding in doing this is what Animal Science seeks to achieve as a profession. God Almighty speaking to the creature in Jeremiah Chapter 3 and verse 15 of the Holy Bible said: *"Then I will give you shepherds after My own heart, who will feed you on knowledge and understanding."* Mr. Vice Chancellor, Sir, ladies and gentlemen, this is what makes Animal Science a Profession because, the Animal Scientist works with knowledge and understanding in raising farm animals. Animal welfare, like housing, is as important as feeding the animals good quality feed (Babayemi, 2020).

Ruminant Animal Production Systems in Nigeria

Generally, in Nigeria, as in most parts of the globe, ruminant animal farming relies on pasture and other roughages for survival. The livestock production systems are, mostly, extensive, semi-intensive and intensive farming systems. Briefly, this section shall look at the available feed resources and the animal production systems in Nigeria.

a) Ruminant Production Systems in Nigeria

The production systems are extensive, semi-intensive and intensive systems. Their characteristics are as outlines in Table 7 below. As the system intensifies, we tend towards more sedentary lifestyle that, will see the mixed farming model or crop and livestock farming system emerge.

Table 7: Livestock production systems and forage improvement strategies

Production System	Feed and Feeding Method	Improvement Strategy
Extensive	Range grazing alone	Over-sowing
Semi-intensive	Grazing + Supplements	•Interplanting
		•Fodder bank
		•Intensive feed garden
		•Boundary cropping
Intensive	Cut Fodder + Supplements	•Intensive feed garden
		•Fodder bank/fodder

b) Available Feed Resources

Feed here means resources used for feeding the animals to provide the required nutrients for the expected level of production. The feed resources are used as sources of the common feed components namely: water, energy, protein, minerals and vitamins.

Grasslands

- natural pasture
- artificial pasture

Forage grass

- Guinea grass (*Panicum maximum*)
- Elephant grass (*Pennisetum purpureum*)
- Gamba (*Andropogon gayanus*)
- Stargrass (*Cynodon nlemfuensis*)

Forage legume

- Centro (C*entrosema molle*)
- Puero (*Pueraria phaseoloides*)
- Stylo (*Stylosanthes guianensis*)

Browse Plants (Fodder trees and shrubs)

- *Alchornea cordefolia*
- *Ficus exasperata*
- *Costos afar*
- *Aspillia africana*
- *Spondees mombin*

Crop residues

- Cowpea fodder
- Groundnut haulms
- Sweet potato vines
- Maize husk
- Cassava leaves

Agro-industrial by-products

- Palm kernel meal
- Groundnut cake
- Cassava peels
- Plantain peels
- Yam peels

Household wastes

- vegetable remains and other kitchen residues

Characteristics of Poor Production Systems

Poor animal welfare - leading to low milk yield such as 1.5-3.0 L/day/cow in Nigeria compared to 25-30 L/day/cow in Israel. An earlier study indicated the importance of the management system for improving production range from 330-880 litres per cow per day for extensive management system to a range of 2,000-4,000 litres per cow per day for the intensive management system with zero grazing or cut-and-carry system (Etela *et al*., 2009a).

Inadequate animal nutrition- expecting much from the animals without willing to provide them quality life results to sub-optimal performance due to malnutrition.

Run as a way of life - instead of being managed as a profitable business. Etela (2015) demonstrated the business potentials of goat farming and the goat value chain as a profitable agribusiness enterprise.

Undeveloped livestock value chain - the reason for the poor progress from subsistence animal farming to viable business ventures then, commercial farming businesses.

Lack of relevant environmental and social standards - lack of proper enforcement of stocking density, reducing environmental footprints to protect the ecosystem, preserving cultural heritage and social life pattern.

Unattractive labour source for youths - level of drudgery discourages the youth from engaging in Animal Agriculture.

Low know-how by farmers and untapped skills- poor extension support services contributing to poor outputs.

Unstructured procurement systems- unpredictable market volumes and undue influence by middlemen.

Available topography not utilised for ranches - about 32.42 million hectares of grazing lands (Plate 1) and 39.41 million hectares of croplands capable of providing feed resources for ruminants still untapped (Shiawoya and Tsado, 2011).

Plate 1: Animals reared under poor production system

Looking at the various livestock production systems highlighted above coupled with incessant farmers-herders crises, it could be argued that, the adoption of an integrated crop and livestock farming system can help to prevent the disagreements. Figure 2 below illustrates the various pathways of crop and livestock integration to show how increasing population pressure and the drive for economic growth will lead to increasing intensification, specialisation and organisation (Steinfeld, 1998). As farmers and herders begin to tend towards mixed farming systems, they shall move from a nutrient deficit to a nutrient surplus ecosystem.

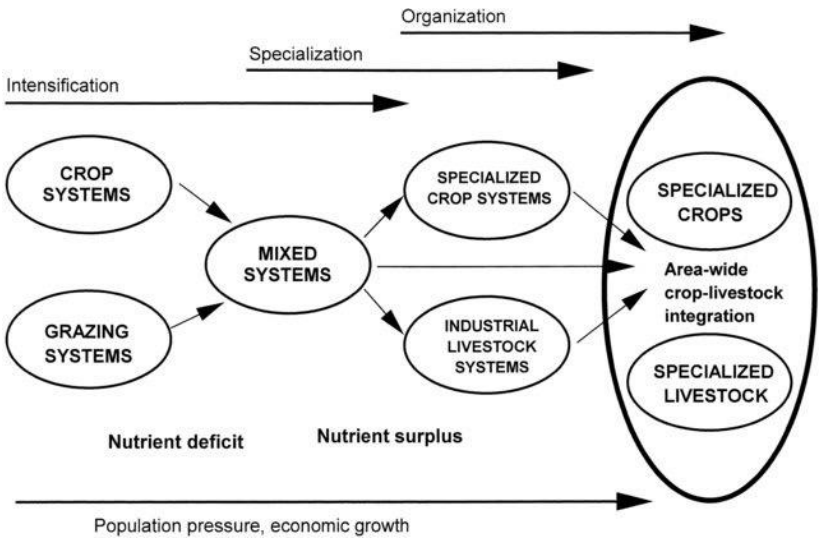

Figure 2: The pathways of crop and livestock integration (Steinfeld, 1998)

Government Policy for Livestock Development

Policy briefs to support livestock value chain development should be fashioned as results-based projects for tangible impacts. Currently, the livestock value chain is still, poorly,

developed compared to most crop production value chains (Ari *et al.*, 2016). This is worrisome because, the marginal profit per livestock enterprise is often higher than that of crop enterprise. Filling such identified gaps requires Systems (Holistic) Approach that, should be:

- Economically viable - *profit driven.*
- Environment friendly - *ecosystem services conscious.*
- Socially inclusive - *sensitive to cultural, traditional and religious diversity*.

Thus, two key gaps identified in the Nigerian Agriculture sector by the Federal Ministry of Agriculture and Rural Development (FMARD) in 2016were:

- **Gap 1** - Inability to meet domestic food requirements due to inefficient farming model
- **Gap 2** - Inability to export at quality levels required for market success due to poor enforcement of food quality standards and poor knowledge of target markets

Table 8 below illustrates the priority crop and livestock value chains both for domestic markets and for export markets in Nigeria as published by the Federal Ministry of Agriculture and Rural Development (FMARD) in 2016. There are, basically, two categories of farm animals, namely: non-ruminant or monogastric animals like poultry (chicken; turkey; quail; ostrich) and ruminant or polygastric animals (like cattle, sheep, goats including camels; giraffes).

A look at Table 8 shows the neglect of this important sub-sector and explains why the livestock value chain is still, poorly, developed in Nigeria despite the significant role it plays in our socio-economic life, livelihood and support for industry like the leather, hides and skin business, and bone

meal as ingredient for poultry feeds. In the priority areas listed, only fish, poultry and cattle (meat and milk) were mentioned.

There is, the urgent need to begin to consider livestock species value chains development just as we have for different crop types. For example, we should have beef cattle value chain, milk value chain or goat value chain, which could also have meat and milk value chains. Also, the plantain value chain will, really, impact the livelihood of the farmers and other formal and informal chain actors in Nigeria and, especially, in the Niger Delta.

Table 8: Key priority agricultural value chains identified by the Federal Ministry of Agriculture and Rural Development in Nigeria

Gap 1 (Domestic market)	**Gap 2 (Export market)**
- Rice - Wheat	- Cowpeas - Cocoa
- Maize - Soya beans	- Cashew - Oil palm
- Horticulture (fruits/vegetables)	- Horticulture (fruits/vegetables)
- Sugar - **Fish** (aquaculture)	- Ginger - Sesame - Yams
	- Cassava (starch/chips/ethanol)- Cotton
- Poultry - **Cattle** (dairy/milk)	- **Cattle** (beef/meat)
Strategy: - engage private investors - improve distribution system - develop the value chains	**Strategy:** - engage private investors, farmers, processors, marketers - improve supporting infrastructure - Build high quality brands

Source: FMARD (2016)

Challenges of Animal Agriculture in Nigeria

In Nigeria, over 80% of livestock farmers can, safely, be classified as smallholder farmers. Such resource-poor farmers are again dominated by farmers who tried to reduce their farming risks by combining different farming enterprises, especially, as mixed crop and livestock farmers. This is in agreement with the findings in the humid tropics where a study concluded that, about 80 percent of farmers in the humid tropics are smallholder crop and livestock farmers (Herrero *et al*., 2010). Yet, the impacts of this critical farming group often go unnoticed.

A major obstacle to livestock productivity in Nigeria is inadequate nutrition or feeding especially in the dry season therefore, more attention ought to be given to this important aspect of Animal Agriculture (Bogoro, 2020). This is because, the mixed crop and livestock farmers, or simply put integrated farms produce food (animal-source proteins) for human consumption under production systems characterised by inadequate funding yet, they show promise of being:

i) **sustainable**; allowing them to use their pieces of land over a long period because, they are not over-exploited.
ii) **more profitable;** helps them meet their basic needs.
iii) **organic;** a recent study revealed that, the smallholder goat farms followed the principles of organic farming although, not still well structured (Simon, Ingweye and Etela, 2018).
iv) **socially acceptable;** compatible with their lifestyle and traditions as well as those of others.
v) **environment-friendly;** low rate of degradation with the natural attenuation process fast enough to prevent adverse ecosystem changes.
vi) **safe;** food safe and nutritious for human consumption

In a pilot survey conducted by Etela and Okoro (2011) in Rivers State, a humid rainforest zone,the results showed that:

a) 37.5 percent of crop farmers practised mono-cropping;
b) 62.5 percent of crop farmers practised mixed-cropping;
c) 57.1 percent of the farmers utilised crop residues as feed, and
d) Integrated crop-livestock farming gave better profit margins.

Although the integrated farming or mixed crop and livestock farming is more attractive, most farmers do not seem to engage in it for the following reasons:

Knowledge: ignorance or lack of awareness about the complementary roles of crop and livestock. Ajayi *et al*. (2019) from their study on coping strategy reported that, the major challenges faced by the pastoralists were cattle poisoning and insufficient feed during the dry season, while the crop farmers reported farm invasion by animals and reduction in crop yields. They identified crop residue feeding as the alternate to grazing during the dry season.

Attitude: unwillingness to adapt to changes due to extant indigenous knowledge.

Genderissues: poor gender mainstreaming for women in crop-livestock farming.

Environmental: i) prefer crop residues or foliages as mulches or green manure for crop production or ii) preference for crop residue use as feed for livestock than, applying manure preferably, in composted form for recycling nutrients into the soil to support crop production (Figure 3). Akaranta (2007) highlighted how different agro-wastes including crop residues

serve as industrial raw materials and dry season feeds for ruminants.

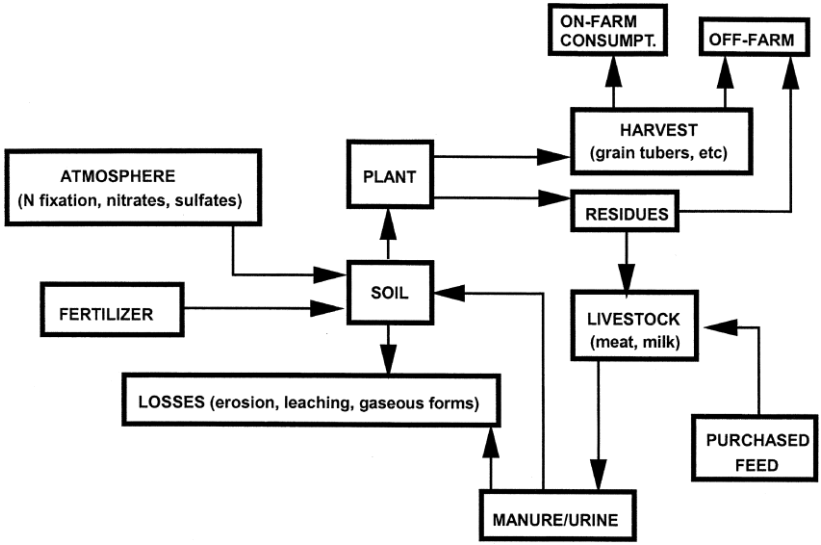

Figure 3: Pathways of nutrient flow in mixed crop-livestock farming systems (Stangel, 1995)

Livestock Value Chain Development

a) Opportunities in the Livestock Value Chains

Mr. Vice Chancellor, Sir, permit me to draw the attention of this auspicious gathering to the numerous opportunities available in the livestock value chain that, have remained untapped. Each of the underlisted livestock value chains has several windows that could engage anyone interested. And if, identified, mapped and developed it would create the employment required to curb or reduce youth unemployment. The livestock enterprises depicted in Figure 4 are just a few.

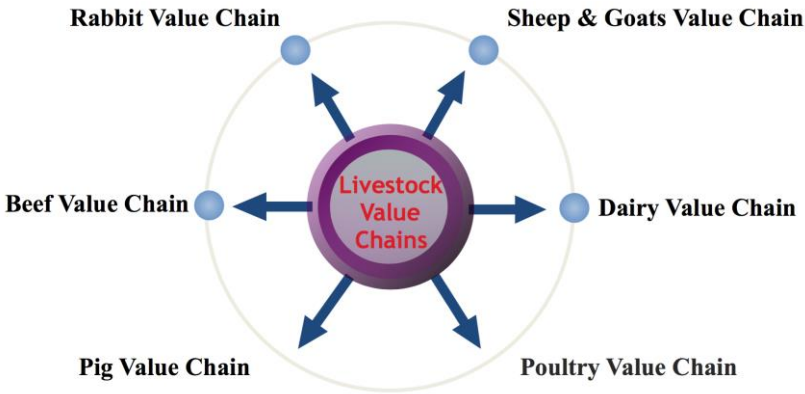

Figure 4: Common livestock value chains to exploit

These have been highlighted because, they remain the ones well-known to most persons but, their value chains are yet, to be fully developed. Generally, whatever the livestock value chain of interest, value addition through product development can be attained in the following areas:

- **Meat**- fresh, minced, dried, veal.
- **Milk**- fresh, dried, skim, yoghurt, cheese.
- **Egg**- fresh, powdered - product development.
- **Feed production and marketing**- concentrates, vitamin premix, pasture cultivation and conservation (silage, hay).
- **Livestock by-products and wastes collection and utilisation**- blood, bone, leather, feathers, faeces.
- **Livestock extension services and consultancy**
- **Livestock ranching and fattening -** cattle grazed on vast topography of natural pasture is an opportunity for ranching (Plate 2) and fattening.

Plate 2: Cattle grazing on a piece of land requiring light fence and good drinking water source

- **Livestock research for development** - the ever-changing Animal Agriculture ecosystem throws up new environmental, social and economic challenges demanding relevant research to solve them. With increasing competition for raw materials between the food and feed industries, the drive for alternate feed resources through research for development must continue and so with increasing vigour too (Mordor Intelligence, 2021).

- **Livestock training and capacity building** - Improved training, especially, in the area of practical hands-on capacity building through specialised vehicles like the Agribusiness Incubator Centres (AICs). This approach through a strategic plan to develop the livestock value chain and improve our agricultural procurement (purchasing and supply chain) infrastructure is expedient. Improved agricultural procurement and supply chain management promises to develop the livestock value chain such that, the pastoralist is willing to patronise the farmer who produces crop residues and vice versa.

- **Livestock entrepreneurship -** Farmers who raise farm animals, especially, ruminant animals like cattle, sheep and goats need increased knowledge about running their enterprises as businesses. For example, the global cattle feed market size was estimated to have a value of USD 74.8 billion in 2019 and is expected to grow at a compound annual growth rate (CAGR) of 3.2% from 2020 to 2027 (Grand View Research, 2020). Certainly, the market is huge and this approach can improve the livestock value chain. Similarly, Mordor Intelligence (2021) conducted a study on the African ruminant feed market and observed that, the market was, largely, untapped and unorganised yet, it is projected to increase from 2020 to 2025, making Africa and indeed Nigeria a potential livestock feed agribusiness hub.

- **Livestock transportation and marketing** - A key challenge to the growth and development of Animal Agriculture in Nigeria and other developing nations is poor handling of live animals to the slaughter house (Plates 3 and 4). Such acts can affect the quality of the meat like being too tough or not, properly, bled. Following the negative impacts of the COVID-19 Pandemic on feed availability and spike in feed prices, most smallholder farmers resorted to on-farm feed mixing.This is because, they considered it reasonable and environment-friendly to provide specific nutrients to their ruminants in the required quantity in line with the principles of green economy (Mordor Intelligence, 2021). The report further indicated that, the Asia-Pacific region hosts the fastest growing ruminant feed market, while Europe has the largest ruminant feed market. Clearly, the potentials for the ruminant feed market in Africa and, of course, Nigeria is huge (Ekwe *et al.*, 2020).

Plate 3: Cattle transport on motor bike shows a gap for opportunity in haulage

Plate 4: Goat transport on motor bike shows a gap for opportunity in haulage

• **Livestock Faeces for Soil Amendment and Bioremediation** - Several studies have indicated the role of cattle dung or sheep/goat faeces as ecosystem-friendly agent for soil amendment and bioremediation. Oludele *et al*. (2021) demonstrated from their studies that, cattle dung could be used for enhancing bioremediation of crude oil contaminated soil.

b) **Constraints to Livestock Value Chain Development**

• **Lack of institutional support -** consistent preference for specific crop value chains development to specific livestock species value chain development by most national, regional and international organisations.

• **High initial investment cost**- unit cost for livestock is, relatively, more expensive. Studies on the use of crop residues and by-products have shown improved animal performance and reduced feed cost per kg weight gain when cassava peel was fermented for four days, dried, milled and included at 20% inclusion level (Audu *et al.,* 2019). The diet was 20.0% processed cassava peel meal, 56.7% sorghum, 19.3% groundnut cake, 2.0% bone meal, 1.0% common salt, 1.0% premix.

• **Poor access to quality control facilities** - Bogoro (2021) proposed strengthening quality infrastructure, establishing and upgrading food safety systems, and harmonising standards and certifications to reduce cost of food businesses, among others, to address this issue.

• **Gender inequality in market access** - it is important to allow equal access by male and female players in the livestock value chain (Onoja, Agbomedarho, Etela, and Ajie, 2019).

- **Inadequate infrastructure to support the business**- deliberate increased investments in Animal Agriculture can trigger economic transformation, increase crop production and other units of the farm (Bogoro, 2020).

- **No free flow of vital market information** - deploying information and communication technology (ICT) through social media Apps will be helpful here.

- **Livestock-related conflicts** - *"And there was a strife between the herdmen of Abram's cattle and the herdmen of Lot's cattle: and the Canaanite and the Perizzite dwelled then in the land."* (Genesis Chapter 13 and verse 7). Present realities of shrinking lands available for free access by pastoralists, the competing need for increased crop production and the demands for more quality animal-source proteins to feed the increasing human population generate issues. Brottem (2021) identified population pressure, changes in land use and resource access as key drivers of increased farmer-herder violence in Nigeria. Saleh (2018) identified pasture development strategy as key for preventing farmers-herders conflicts.

- **Animal-source-free or Plant-based Proteins** - Figure 5 illustrates that, Agriculture contributes 10% of total greenhouse gas emissions in the USA with greenhouse gas emissions from industry, electricity and transportation each accounting for 23%, 25% and 29%, respectively (EPA, 2019). Innovations in alternates to animal-source proteins are being promoted but, how sustainable are such plant-based proteins when we need so much fossil fuel to prepare them? Reason behind it being the drive to reduce the about 20% greenhouse gas emission from Agriculture alleged to come from Animal Agriculture with the claim that, if people reduce meat consumption, the attendant reduction in Animal production will increase Omni Meat.

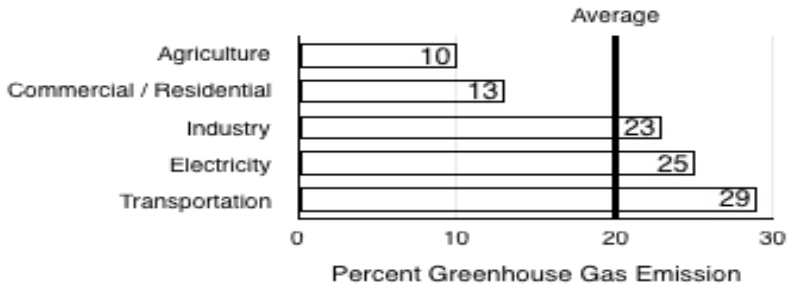

Figure 5: Greenhouse gas emissions by economic sectors in 2019 (EPA, 2019)

Climate Smart Animal Agricultural (CSAA) Practices

Mixed (crop and livestock) farming is an ideal CSAA practice because, it gives room for using available feed resources that can ensure optimal animal productivity. Relative to other global greenhouse gas abatement opportunities, reducing enteric methane through productivity gains is the lowest cost option and has a direct economic benefit to farmers (Gerber *et al*., 2013). The use of available alternate feed resources based on understanding their nutrient compositions and nutrient utilisation levels can support development of sustainable feed budgeting and feed balancing for crop and livestock farmers (Onoja *et al.*, 2019; Amole, 2021).

To this end, I have initiated a collaborative research with a team of researchers from the Centre for Information and Telecommunications Engineering (CITE),Uniport led by the Director, Dr. B. Omijeh in the area of Smart Agriculture. At the moment we are putting a joint proposal together on how to develop models for precision ruminant nutrition using data from research conducted in Nigeria.

The idea behind this is to create a feeding system that is powered by ICT with the multiple advantages of reducing

overall feed cost (at the moment about 70% of production cost in livestock and poultry is used for feeding), minimise excretion of excess nutrients into the ecosystem in the form of urine, faeces and even air through animal fart or eructation or belching, as well as attract the youth.

Support for Animal Research and Development

Mr. Vice Chancellor, Sir, in the Book of Genesis Chapter 4, verse 4, the Holy Bible described the Animal Scientist and what makes the profession favourable: *"And Abel, he also brought of the firstlings of his flock and of the fat thereof. And the LORD had respect unto Abel and to his offering:"* This could only be possible because, the flock was well fed knowing that, a poorly fed flock cannot have enough flesh not to talk of having fat, at all. Animal farmers' groups can come up with their common challenges and provide the seed grant for action research to find suitable solution they can, easily, adopt.

This is what obtains in the more advanced economies of the world. We cannot expect solutions without paying a price or making the necessary sacrifices. Thus, to understand some of the challenges as it relates to raising livestock without adversely impacting the ecosystem, efficient use of livestock for research is essential.

Although there is no known perfect replacement for animal subjects in pure and applied biological research, Animal Rights Groups worldwide insist on the "three Rs" for use of animals in research:

(a) **Replacement:** non-animal methods for achieving similar scientific aim.
(b) **Reduction:** obtain comparable volume of information from fewer animals.
(c) **Refinement:** enhance research animals welfare – minimise suffering / distress.

Mr. Vice Chancellor, Sir, below are some techniques used for ruminant nutrition and production research with their merits and demerits towards environment-friendly, cost-effective and time efficient approaches. They are:

1) ***In situ*** - work with the animal in the field and take measurements, directly. Requires animal subject.

2) ***In vivo*** - this also involves using the animal but, usually, housed in a pen where the relevant parameters are measured. Requires animal subject.

3) ***In sacco*** - the animal could have cannula inserted at either the oesophagus, rumen and abomasum to study how the test diets are degraded in these parts. It is, also, called nylon bag technique.

4) ***In vitro*** - this involves the use of test tubes where the rumen ecology is simulated. This technique has the advantage of not needing animals as experimental units. However, rumen liquor required must be obtained through the fistula or cannula from a candidate animal with a healthy rumen ecology.

5) **Near Infrared Reflectance Spectroscopy (NIRS)** - this is a non-invasive technique that, neither requires the use of animals nor the use of laboratory chemicals for feed evaluation. The technique has several applications in different disciplines from agriculture to engineering to medicine and even in archaeology for determining the age of items. It is, entirely, environment-friendly, easy to apply and very rapid for getting desired results. NIRS study was used for screening 16 cassava and 13 sweet potato varieties for feed value of their fodder and dried pulps as well as the possibility of using the technique to predict

beta-carotene contents in sweet potato. Table 9 shows results for screening sweet potato types using NIRS for potential to produce starch and flour as raw materials for the confectionery industry (Etela *et al*., 2009b).

Table 9: Mean **v**ariations in tuber and flour yields, and starch contents of orange-fleshed and white-fleshed sweet potato germplasms

Parameter	Orange-fleshed	White-fleshed
Tuber dry matter (g/100 g)	60.80	55.74
Fresh tuber yield (t/ha)	13.17	11.77
Flour yield (g/100 g)	36.90	38.71
Starch content (g/100 g)	22.60	27.35

Source: Etela *et al*. (2009b)

Research for Development Experience

My experience in conducting livestock nutrition and production research in the developing world got to its turning point when I was privileged to work with Dr. Asamoah Larbi, a renowned Forage Agronomist of international repute at the International Livestock Research Institute (ILRI) first, at the Onne sub-Station and later at ILRI-Ibadan, Nigeria (later renamed ILRI-West Africa). The research works from 1996 to 2000 were in the area of ruminant nutrition and production.

Ruminant nutrition, simply put, is the art and science of balancing daily feed intake with nutrient digestibility in relation to the animal's daily requirements for the targeted physiological stage and/or production level. My research works at ILRI were funded under a series of, nationally, coordinated

smallholder crop and livestock integrated studies between selected partners.

The partners involved were: three universities in Nigeria (Rivers State University of Science and Technology; University of Benin; Ahmadu Bello University), three national agricultural research institutes (National Animal Production Research Institute-Samaru; National Root Crops Research Institute-Umudike; Institute for Agricultural Research-Samaru/Zaria), and two CGIAR centres namely: International Institute of Tropical Agriculture (IITA) and ILRI-West Africa.

In these studies, I had the privilege of handling the nutritional evaluation component for crop residues utilisation as feed by ruminant livestock. This complemented the agronomic and socio-economic studies conducted on the same food and feed crops by other research collaborators. Experience from these studies exposed me to the benefits of multidisciplinary collaborative research and the significant role integrated crop and livestock farming systems play in the livelihoods of resource-poor mixed farmers in Africa, Asia, South America and the Caribbeans.

And since acquiring this professional skill on smallholder integrated crop and livestock farming systems, I have continued on that path of research. My research have been on nutritional evaluation of crop residues from food crops (cowpea, groundnut, sweet potato), and crop-by-products (palm kernel cake, brewer's dried grains, spent mushroom substrate). Others include conducting on-farm adaptive studies using browse plants, grasses, forage legumes (calopogonium, centrosema).

The studies were conducted using chemical analyses, *invivo* digestibility, *insacco* (nylon bag) degradability and *invitro* gas production technique. Recently, the use of near infrared reflectance spectroscopy (NIRS) technique has been explored for screening sweet potato varieties for starch, flour and predicting feed quality and other feed attributes like *beta*-carotene and Vitamin A contents.

Contributions to Knowledge and Society

Part of my contributions to knowledge and society was the humbling experience at ILRI-West Africa when I was first exposed to the idea of using NIRS technique intended to be part of my doctoral studies then. Gladly, my eventual sojourn to study the possibility of using NIRS technique for food / feed quality prediction in cassava and sweet potato was realised. The study was funded through a six-month ACU Titular Fellowship 2006/76 (Ref.: NGDF-2006-08) as visiting researcher to the University of Manitoba in Canada from 4th December 2007 to 3rd June 2008, with positive results.

Being part of the multidisciplinary research for development team that, worked on the following three key dual-purpose food / feed crops namely: cowpea, groundnut and sweet potato, was most rewarding. Please, permit me to highlight the key findings from the studies and others conducted, subsequently.

a) Studies on Dual-Purpose Food and Feed Crops

i) Cowpea fodder research

Cowpea (*Vigna unguiculata* (L.) Walp.) is a leguminous food crop, which produces grains and fodder that, farmers consider of equal importance. Four cowpea varieties (IT89KD-391, IT86D-716, IT86D-719, IT81D-994) were evaluated for dual-purpose attributes; substantive grain and quality fodder

production. West African dwarf rams were used for the study. Figure 6 shows significant differences in 48-h DM degradability, DM digestibility and daily live weight changes (Etela *et al*., 2007; Etela and Larbi, 2011). Cultivar IT81D-994 recorded the highest grain yields and possessed good quality stover with greater potential as diet for rams.

Technology adoption: IT81D-994 and IT89D-391 (SAMPEA 12), with large brown grains and average grain yields of 2t/ha were later released to farmers and are now being cultivated by farmers (NACGRAB, 2021).

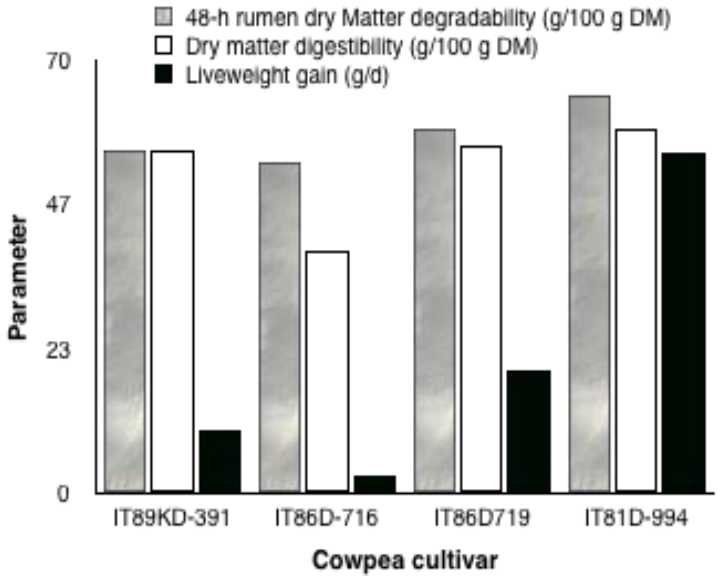

Figure 6: Variations in 48-h dry matter degradability, digestibility and live weight changes in West African dwarf rams fed cowpea fodder

ii) Groundnut haulms research

Groundnut (*Arachis hypogaea* L.) is a widely grown legume cultivated for its seeds and the crop residues (haulms; husk) suitable as dry season fodder for ruminants (cattle, sheep, goats). The studies involved selecting the groundnut varieties for dual-purpose attributes to produce high grain yields for human consumption and substantive quantities of fodder for feeding ruminants.

A study to select 38 late-maturing dual-purpose groundnut varieties for high seed yields and nutritious fodder that could be used for feeding cattle in crop-livestock systems was demonstrated (Larbi, Olorunju, Dung and Etela, 1998). The results showed mean seed yields of 1,247 kg/ha, fodder yields of 4,547 kg/ha, and leaf: stem ratio of 34%.

Groundnut stover from six elite varieties (M170-80I, M554-76, M572-80I, RMP-12, UGA-2, UGA-5) were later sole-fed to West African Dwarf sheep for live weight changes and rumen dry matter degradability characteristics. Figure 7 shows differences in the recorded parameters with varieties M170-801, UGA-2 and UGA-5 recording promising dual-purpose traits for crop-livestock farming systems (Etela *et al.*, 2007; Etela and Dung, 2011). Thus, in addition to grain sales, the groundnut stover could be sold for cash as extra income.

Technology adoption: RMP-12 (SAMNUT-10) and M554-76 (SAMNUT-16) were released as high grain yielding with 55% to 60% oil content on DM basis. UGA-2 (SAMNUT-21) and M572-80I (SAMNUT-22), are dual-purpose varieties with high seed and forage yields and quality. All four varieties are now being cultivated by farmers in Nigeria (NACGRAB, 2021).

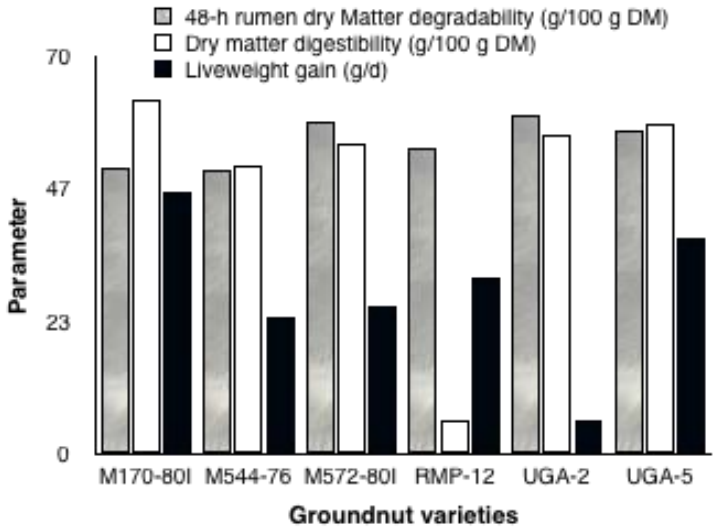

Figure 7: Variations in 48-h dry matter degradability, digestibility and live weight changes in West African dwarf rams fed groundnut stover

iii) Sweet potato vines research

Sweet potato (*Ipomoea batatas (*L.) Lam.) is a perennial food crop whose tuberous roots and tender leaves are consumed as green vegetables by humans in some socio-cultural settings. Agronomic, socio-economic and nutritional evaluation studies were conducted on newly bred cultivars for dual-purpose attributes. A two-year study was conducted to determine tuber and fodder yields and quality for 18 sweet potato varieties at four maturity stages (8, 12, 16, 20 weeks after planting; WAP).

Results showed differences in chemical composition, tuber and fodder yields, and higher effective degradability when harvested at 12 WAP than 20 WAP (Larbi, Etela, Nwokocha, Oji, Anyanwu, Gbaraneh, Anioke, Balogun and Muhammad, 2007). The study identified cultivars TIS-8470, TIS-8164, TIS-87/0087 and TIS-82/0070.OP.120 as high potential cultivars

for use at both the savanna zone (12 and 16 WAP) and the humid forest zone (20 WAP). Table 10 shows summary of the results from two ecozones.

Table 10: Mean **v**ariations in tuber and fodder yields (kg/ha) for 18 sweet potato varieties at two ecozones

Ecozone	**Tuber Yields**	**Fodder Yields**
Humid Forest	3.21 - 7.47	4.18 - 5.62
Sudan Guinea Savanna	4.05 - 8.41	2.52 - 4.43

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

Further studies were conducted on the sweet potato vines using the N'Dama and White Fulani or Bunaji breeds of cattle to further characterise the four identified cultivars as suitable dual-purpose cultivars. To address the issue of poor quality Guinea grass (*Panicum maximum*) during the dry season, a study was set up to evaluate the potential of fodder from the four identified sweet potato cultivars to be used as supplements.

Another study to compare milk yield and composition by White Fulani (Bunaji) and N'Dama cows, fresh sweet potato foliage was fed as supplement in early lactation to evaluate their feed value as supplements.

The results showed that, fresh sweet potato foliage could totally or partially replace conventional supplements like dried brewer's grains (DBG) or cottonseed meal (CSM) as cost-effective supplements to improve the quality of dry season Guinea grass (Etela *et al.*, 2009a). Table 11 below shows the mean milk composition recorded for the two breeds of cattle.

Table 11: Milk composition (g/100 g) for two cow breeds

Cattle Breed	Total Solids	Ash	Protein	Fat	Lactose
1. Bunaji	14.79	0.80	3.85	4.13	6.02
SE (df = 6)	0.096	0.013	0.068	0.122	0.204
2. N'Dama	11.93	0.71	3.34	3.50	4.38
SE (df = 6)	0.061	0.011	0.054	0.114	0.204

***Source**:* Etela *et al*. (2009a)

Stall-fed lactating White Fulani cows and growing calves were sole-fed dry season Guinea grass and sweet potato fodder from three cultivars (TIS-87/0087; TIS-8164; TIS-2532.OP.1.13). Results showed differences in DM intake from 131 $g/W_{kg}^{0.734}$ for TIS-87/0087 to 152 $g/W_{kg}^{0.734}$ for TIS-8164, while milk yields increased 2% for TIS-87/0087 and 5% for TIS-8164 but, decreased 5% for TIS-2532.OP.1.13 and 19% for the control grass (Etela *et al*., 2008b).

Other studies with local and crossbred calves fed milk and foliage from the three cultivars showed that, Panicum recorded improvements in *in sacco* rumen degradation characteristics when supplemented with sweet potato fodder (Etela *et al*, 2008a). The studies on sweet potato identified two out of the three sweet potato varieties (TIS-87/0087 and TIS-8164) that have since been released to farmers in Nigeria.

Technology adoption: TIS-87/0087 (gives economic yields, good for fries and chips), TIS-8164 (high yields, vines highly relished by livestock and fishes, good for starch production) and TIS-2532.OP.1.13 (very large tuberous roots with white flesh) were all released and being cultivated by farmers in

Nigeria (NACGRAB, 2021).

iv) Cassava leaves and peels research

The research was carried out to determine the feed quality of leaves and peels from ten cassava varieties using *in vitro* gas production technique. The samples were obtained from the International Institute of Tropical Agriculture (IITA), Onne Sub-Station in 2018. Table 12 shows differences in crude protein, neutral detergent fibre, DM digestibility and fermentation efficiency (Okoro, Iriso, Lamidi, Anyanwu and Etela, 2021). Fermentation efficiency (FE) was above 1.00 for both leaves and peels. Varieties TMS 98/0510, TMS 98/0505 and TMS 92/0326, appear to be potential feed resources for sustainable livestock production based on their high CP, NDF, and DMD but, low CH_4 emission.

Table 12: Mean **v**ariations in chemical composition (%), digestibility (%) and methane gas emission (mL) of cassava leaves and peels from ten varieties

Parameter	**Cassava Leave**	**Cassava Peel**
Crude protein (CP)	30.0 ± 0.02	6.8 ± 0.02
Neutral detergent fibre (NDF)	67.1 ± 0.01	55.7 ± 0.01
Acid detergent fibre (ADF)	50.7 ± 0.01	40.7 ± 0.01
Hydrogen cyanide (HC)	46.6 ± 0.01	25.5 ± 0.01
Dry matter digestibility (DMD)	63.8 ± 2.59	52.7 ± 2.66
Organic matter digestibility (OMD)	58.8 ± 0.74	60.4 ± 0.76
Fermentation efficiency (FE)	1.98 ± 0.088	1.39 ± 0.900
Methane gas (CH_4) emission	20.2 ± 0.72	20.6 ± 0.75

Source: Okoro *et al*. (2021)

b) Studies on Multipurpose Trees and Shrub Species

In addition to the above, other research works still border around crop residues and agro-by-products utilisation as a way to minimise agricultural footprints in the environment (Etela *et al.*, 2009b; Etela and Anyanwu, 2011). The studies have shown that, multipurpose trees and shrubs (MPTS) are reliable dry season fodder (Bamikole, Ikhatua, Arigbede, Babayemi, and Etela, 2004; Larbi, Anyanwu, Oji, Etela**,** Gbaraneh and Ladipo, 2005; Anyanwu and Etela, 2013).

c) Other Research Works

A study on spent mushroom substrates demonstrated the use of the material as feed for ruminants to help to mitigate greenhouse gas emission (Etela *et al*, 2018). Recent studies also bordered on understanding the impacts of nitrogen fertilisers, often used for establishing pasture (Wanjala, Odokuma, Etela, Ramkat, Odogwu, Boadu, andKoranteng-Addo, 2021). The study shall enable us understand the impacts of nitrogen excretion via urine and faeces of livestock.

d) Agribusiness-related Research

In 2017, a study on incentivising e-agriculture and agribusiness incubators for youth employment in Nigeria reported the huge potentials for information and communications technology (ICT) in Agriculture to improve agricultural productivity, support the training of youth farmers and create a critical mass of impact entrepreneurs in Agriculture (Etela and Onoja, 2017).

The study observed that, poor implementation of agricultural policy can hinder establishment of functional Agribusiness Incubator Centres (AICs) in Nigerian universities with Faculties of Agriculture. This is in spite of the fact that, it can

result to 87 and 970 commercialised agro-technologies, 596 and 3,500 interns trained, 565 and 3,300 agribusiness incubatees mentored, and create 15,000 and 42,000 jobs, respectively for Nigeria (in particular) and Africa (in general).

It must be emphasised that, AICs can only be functional under an educational system, which promotes agricultural research with potentials for commercialisation of agro-technologies (Bogoro, 2021). The University of Port Harcourt can use the recent drive for reinvigorating the UniPort Technology Park as a platform for making this a reality.

Mr. Vice Chancellor, Sir, ladies and gentlemen this is the evidence-based decision platform that informed the recent move to split the Department of Agricultural Economics and Extension into two: (1) Department of Agricultural Economics and Agribusiness Management, and (2) Department of Agricultural Extension and Development Studies. This is in line with the current thinking, globally, to afford UniPort the opportunity to meet contemporary social needs.

Agribusiness Incubator Centres (AICs) in Africa

In 2015, the Forum for Agricultural Research in Africa (FARA), under her flagship project tagged, the Universities, Business and Research in Agricultural Innovation (UniBRAIN), promoted agribusiness incubation in Africa by facilitating establishment of six AICs, as consortia along six specific agricultural value chains in five African countries.

These AICs were: Ghana (1-Livestock); Kenya (1-Sorghum); Mali (1-Non-timber forestry products); Uganda (1-Banana, 1-Coffee), and Zambia (1-Horticulture). Thereafter, the FARA-UniBRAIN was replaced with the African Agribusiness Incubators Network (AAIN: *http://new.africaain.org*), which is coordinated by the Global Agribusiness Incubators Network

(GABI).

Vice Chancellor, Sir, to further build my capacity to, successfully, establish and manage AIC, I and another colleague (Mr. Boniface B. Dumpe) secured the Association of African Universities (AAU) 10-day "Senior Executive Attachment Programme" (Plate 5). The programme was for agro-technology uptake at the Consortium for University Responsiveness to Agribusiness Development Limited (CURAD), Kabanyolo, Uganda; a Coffee Value Chain development AIC.

Unfortunately, Nigeria with her youthful population had none because, there was no national policy for AICs (Etela and Onoja, 2017). But, by the end of 2017, Association of Deans of Agriculture in Nigeria (ADAN) in collaboration with FMARD established AICs for training students of Agriculture and related courses on agripreneurship, especially, during the undergraduates practical years.

Thus, the first five AICs were established, namely: University of Ibadan, Ibadan; Umaru Musa Yar'adua University, Dutsin-Ma; University of Maiduguri, Maiduguri; Niger Delta University, Wilberforce Island, and Federal University of Agriculture (Markurdi).

In 2018, four new AICs (Federal University, Dutse; Ebonyi State University, Abakaliki; Federal University of Agriculture, Abeokuta; Bayero University, Kano)were approved and established. In 2019, four additional AICs were approved (University of Abuja, Abuja; University of Benin, Benin City; Federal University of Agriculture, Umudike; Ahmadu Bello University, Zaria) but, are yet, to be established. The University of Port Harcourt is still missing on the list.

Plate 5: Newly acquired state-of-the-art coffee factory equipment at CURAD, Makerere University, Kampala, Uganda
(L-R: BonifaceDumpe; Moses Katta (CURAD); Ibisime Etela)

UniPort Agribusiness Incubator Centre (AIC)

Based on my experience as the Pioneer Faculty Students Industrial Work Experience Scheme (SIWES) Coordinator for the Faculty of Agriculture from 2008 to 2011, I began to nurture the idea of making our Industrial Training programme in the Faculty of Agriculture, UniPort to be able to support graduates and other clients. So, when in 2013, as Director of the Institute of Agricultural Research and Development (IARD), the opportunity presented itself for me to lead a team to develop a proposal for a World Bank Centre of Excellence, we came up with a proposal on establishing a Centre for Food, Agripreneurship and Sustainable Livelihood (CeFASL).

The meeting hosted by the Pioneer DVC (Research and Development) in UniPort and in Nigeria as a whole, Professor

B.W. Abbey, and facilitated by Professor O. Akaranta (the then Director, Centre for Research Management - CEREM) and under the leadership of Professor J.A. Ajienka (the 7th Vice Chancellor) supported us to submit the proposal. The other team leads were Professor O.F. Joel of the Centre for Oilfield Chemicals Research (CEFOR) and the one on Health Sciences championed by Late Professor A. Okpani.

Mr. Vice Chancellor, Sir, ladies and gentlemen, it was that process that, gave rise to the first World Bank Centre of Excellence (ACE-CEFOR) in 2014. Although very well rated at that time, CeFASL could not be awarded for the simple reason that, the Faculty of Agriculture had not commenced postgraduate training programmes. Thus, establishing AIC in UniPort now shall be the best decision at the right time.

Ruminant Nutrition and Production Research Issues

Mr. Vice Chancellor, Sir, there are still researchable areas in ruminant nutrition and production because, we have not yet, provided solutions to all known challenges. The continuous demands by society for resolving existing problems requires the academia to, actively, engage with key players in the private and public sectors for solution. The issues of access to quality feed and market access all demand attention.

Although much is always expected from livestock, the chain players are not willing to pay for that all-important service. This, Mr. Vice Chancellor Sir, ladies and gentlemen, is the remote cause of the unending ASUU-FGN confrontations as it affects Higher Education Institutions. Sadly, Management at all levels in most economies of Sub-Saharan Africa (SSA) appear to exhibit similar apathy towards research and development. To this end, the recent drive to institutionalise research and development in Nigeria is a welcome initiative (Bogoro, 2021).

Permit me, Sir, to duff my cap for reinstituting the Office of the Deputy Vice Chancellor (Research and Development). Let me place on record that, it was the effort from that office under Professor B.W. Abbey as Pioneer DVC (R&D) that UniPort almost attracted two Africa Centres of Excellence (ACE) under the ACE I Project. The vision of the 7th Vice Chancellor, Professor J.A. Ajienka, in creating that office, which was at that time, the first ever in the Nigerian University System (NUS), is indeed, visionary.

a) Future Research Areas

Future research areas building on the above contributions to knowledge shall be in five broad areas, namely:

1) Explore further the aspect of farmers and herders perception about crop-livestock farming system and develop strategies for promoting crop-livestock farming system as a livelihood source due to its relevance as climate-smart and resilient approach.
2) Carry out comprehensive inventory and nutritional characterisation of available feed resources with the goal of developing evidence-based feed budgeting and balancing for crop-livestock farming systems.
3) Institute research in the area of precision livestock nutrition under intensive production system for improved livestock productivity and environmental protection for sustained ecosystem services. Already, a collaborative multidisciplinary project is being cultivated in partnership with the Centre for Information and Telecommunications Engineering (CITE), UniPort to promote smart agriculture.
4) Conduct on-farm action researches to support farmers in developing the agribusiness skills through value chain identification and mapping for intensive crop-livestock farming systems for market access. Agricultural procurement and supply chain management shall be promoted.

5) Promote smallholder organic livestock farming under intensive crop and livestock integrated farming system.
6) Support studies on the changing socio-economic status of smallholder livestock farmers with increasing intensification system.

b) Ongoing Team Projects

1) 2019-2029: Project on PhD Training on *"Energy including Renewable Energy" by "Partnership for Applied Sciences, Engineering and Technology (PASET) - Pan-African Regional Scholarship and Innovation (RSIF) Africa Host.*

2) 2019-2022: Project on *"Strengthening Institutional Infrastructure for an Innovation Ecosystem" - UP-ECOSIN Project by PASET/RSIF.*

3) 2020-2022: Project on "Public-Private Partnership to Develop the Agriculture Sector in Nigeria" by Organisation for the Development of Agriculture in West African Countries (ODAWAC), USA/ Association of Deans of Agriculture in Nigeria (ADAN)/UniPort.

4) 2020-2024 (Renewal): Project on "World Bank Africa Centre of Excellence for Oilfield Chemicals Research, UniPort (ACE-CEFOR) byWorld Bank Africa Regional Project on Education.

5) 2021-2023: Project on *"Production of Natural Antimicrobials and Growth Promoters from Periwinkle and Snail Shells for Livestock and Fisheries" by TETFund to Lead Institution, UNIIBEN.*

Conclusion

Several feed resources like forage legumes and grasses, browse plants, crop residues and agro-industrial by-products are available to livestock farmers. The studies reported have shown the possibility of using crop residues from improved food and feed crops like cowpea, groundnut and sweet potato fodder as dry season feed resources. Unlike other crop residues that might require biological, chemical or even physical treatment before usage, the fodder used in the studies were used without any form of biological or chemical treatment thus, promises to have minimal foot prints. As dual-purpose crops they serve as income sources from the primary products, grains and tuberous roots, and from the sale of crop residues in places where the crop residues feed market exists or are emerging. A gradual shift to smart livestock feeding or nutrition can help make Animal Agriculture attractive to youths and can be achieved using functional Agribusiness Incubator Centres (AICs) established at our various Faculties of Agriculture as the development vehicles. Please, permit me to add that hazards associated with handling livestock range from possibility of being attacked to contracting zoonotic diseases including exposure to laboratory risks. Thus, the animal workers deserve Hazard Allowance and should be so favourably considered.

Recommendations

From the foregoing, Mr. Vice Chancellor, Sir, distinguished ladies and gentlemen, I make the following actionable recommendations:

1) Comprehensive inventory on current forage resources, crop residues and by-products outputs is required to develop appropriate model for feed budgeting and balancing in Animal Agriculture.
2) The University of Port Harcourt should support the formal establishment of the Centre for Food, Agripreneurship and

Sustainable Livelihood (CeFASL) to take advantage of the ongoing drive for agribusiness development in Nigeria.

3) In line with the recent recommendations at the Agrepreneurship Summit 2021 for Nigerian Youths and the 64th Association of Deans of Agriculture in Nigeria (ADAN) Annual Conference in Nassarawa State University, Keffi on 16-17 August 2021, Agribusiness Incubator Centres (AICs) be established in each Faculty of Agriculture in Nigerian Universities for hands-on **"earn while you learn"** model for students of Animal Agriculture.
4) Promote workable models for public-private partnership (PPP) to increase investments in Animal Agriculture at Faculties of Agriculture in Nigeria.
5) Animal Scientists, livestock attendants / farm hands should be paid Hazards Allowances, as appropriate because, they are daily exposed to risks of attacks and contracting zoonotic diseases from the animals and laboratory accidents, during sample collection and analyses.

Mr. Vice Chancellor, Sir, distinguished ladies and gentlemen, thank you, for your esteemed presence and attention.

References

Abbey, B.W. (2006) *Bridging the Protein Gap with What You Have*. Inaugural Lecture Series No. 48, University of Port Harcourt. 59 pp.

Ajayi, M.O., Akinola, A.J. and Babayemi, O.J. (2019) Coping strategy among crop and livestock farmers in agrarian community of Fashola, Oyo State, Nigeria. *Nigerian Journal of Animal Science*, 21 (3): 160-171.

Akaranta, O. (2007) Agro Waste Utilisation: The Chemist's Input. Inaugural Lecture Series No. 55, University of Port Harcourt. 47 pp.

Amakiri, A.O. (2018) Environmental Pollution Hazards, Like Man, Animals Are Also At Risk: The Animal Scientist Perspective. Inaugural Lecture Series No. 56, Rivers State University. 60 pp

Amole, T. (2021) Animal-human interphase and environmental factors for sustainable animal husbandry. Paper presented at the Mandatory Continuing Professional Education (MCPE) Programme, Uyo, Akwa Ibom State, 6th September 2021. NIAS / ILRI.

Anyanwu, N.J. and **Etela, I.** (2013) Chemical composition and dry matter degradation characteristics of multi-purpose trees and shrubs in the humid lowlands of southeastern Nigeria. *Agroforestry Systems*, 87 (4): 747-754. **DOI** 10.1007/s10457-012-9593-6.

Andreoli,V., Bagliani, M., Corsi, A. and Frontuto, V. (2021) Drivers of protein consumption: A cross-country analysis. *Sustainability*, 13 (13), 7399. *https://doi.org/10.3390/su13137399*.

Ari, M.M., Ogah, D.M. and Luka, E.G. (2016) Livestock value chain development in Nigeria: Institutional framework and opportunities for chain actors. *Journal of Biology, Agriculture and Healthcare*, 6 (9): 34-40.

Audu, R., Amin, A.B., Abdullahi, A.M., Kundi, U. and Tijani, A. (2019) Effects of diets containing processed cassava peel meal on performance and feed economies of growing Red Sokoto bucks. *Nigerian Journal of Animal Production*, 46 (4): 244-251.

Babayemi, O.J. (2020) *The Wonders of Ruminants*, 481st Inaugural Lecture of the University of Ibadan, Oyo State, Nigeria.

Bamikole, M.A., Ikhatua, U.J., Arigbede, O.M., Babayemi, O.J., and **Etela, I.** (2004) An evaluation of the acceptability as forage of some nutritive and antinutritive components and of the dry matter degradation profiles of five species of Ficus. *Tropical Animal Health and Production*, 36 (2): 157-167.

Borogo, S.E. (2020) Reclaiming Nigeria's Laggard Livestock Subsector: A Modern Dairy Value Chain in Perspective. Keynote Address at the 9th Joint Annual Meeting (JAM) of Animal Science Association of Nigeria (ASAN) and Nigerian Institute of Animal Science (NIAS), Abuja-FCT. TETFund, 32 pp.

Bogoro, S.E. (2021) Research for Development in Agriculture Sector: The Role of Research Institutes in Innovative Value Chain Transformation. First Annual Lecture of the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Obafemi Awolowo University. TETFund RDSC. 35 pp.

Brottem, L. (2018) The growing complexity of farmer-herder conflict in West and Central Africa. *Africa Security Brief No. 39*, Africa Centre for Strategic Studies, USA. 8 pp.

ChartsBin statistics collector team 2011, *Daily Protein Intake Per Capita*, ChartsBin.com, viewed 13th September, 2021, <http://chartsbin.com/view/1155>.

Chiba, L.I. (2007) Microbiology of the rumen: Rumen Microbiology and Fermentation. In: *Animal Nutrition Handbook.* p. 56-73.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courboi, C. (1999). Livestock to 2020 – The Next Food Revolution. *Food, Agriculture and the Environment Discussion Paper 28*. IFPRI, Washington D.C. 83 pp. *http://www.fao.org/ag/AGAinfo/resources/documents/lvst2020/20201.pdf.*

EPA (2019) Sources of Greenhouse Gas Emissions.United States Environmental Protection Agency (EPA). *https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.*

Ekwe, O.O., Ali, O.O., Nwadi, C.C. and Ukpanah, U.A. (2020) Forage species availability, food preference and grazing behaviour of goats in southeastern. *Nigeria. Nigerian Journal of Animal Science*, 22(2): 147-154.

Etela, I. (2015) Agriculture business: An Alternative Tool, Agriculture for Sustainable Livelihood through Agribusiness Development. *The Entrepreneur*, The Magazine for Inventor, Innovators and Investors, Vol. 1 (1): 27-29.

Etela, I., Afuape, S.O., Paliwal, J. and Nwauzor, E.C. (2009b) Sweet potato germplasm screening for starch, flour and feed quality characteristics. *Fruit, Vegetable and Cereal Science and Biotechnology*, 3 (1): 62-67.

Etela, I. and Anyanwu, N.J. (2011) Variation in fodder and tuber yields of three sweet potato varieties and the 48-h rumen dry matter degradation in N'dama steers. *American-Eurasian Journal of Agriculture and Environmental Science (JAES)*, 11 (5): 712-716.

Etela, I. and Dung, D.D. (2011) Utilization of stover from six improved dual-purpose groundnut (*Arachis hypogaea* l.) cultivars by West African Dwarf sheep. *African*

Journal of Food, Agriculture, Nutrition and Development (AJFAND), 11 (1): 4538-4545.

Etela, I. and Larbi, A. (2011) Dual-purpose cowpea (*Vigna unguiculata* (L.) Walp.) straw as sole diet for West African dwarf rams. *Animal Production Research Advances (APRA)*, 7 (3): 214-220. www.tapasinstitute.org/journals/apra.

Etela, I. and Okoro, K.N. (2011) Crop residues utilization as livestock feed in Emohua and Obio-Akpor Local Government Areas of Rivers State, Nigeria. *International Journal of Tropical Agriculture and Food Systems (IJOTAFS)*, 5 (2): 106-114. www.tapasinstitute.org/journals/ijotafs.

Etela, I. and Onoja, A.O. (2017) Incentivizing e-agriculture and agribusiness incubators for youth employment in Nigeria. *Nigerian Agricultural Policy Research Journal*, 2 (1): 42-54. http://www.aprnetworkng.org/Journal/Paper%204.pdf.

Etela, I., Bamikole, M.A., Ikhatua, U.J., and Kalio, G.A. (2008b) Sweet potato and Green panic as sole fodder for stall-fed lactating White Fulani cows and growing calves. *Tropical Animal Health and Production*, 40 (2): 117-124, DOI: 10.1007/s11250-007-9070-9.

Etela, I., Larbi, A., Bamikole, M.A., Ikhatua, U.J., and Oji, U.I. (2008a) Rumen degradation characteristics of sweet potato foliage and performance by local and crossbred calves fed milk and foliage from three cultivars. *Livestock Science*, 115 (1): 20-27, doi: 10.1016/j.livsci.2007.06.004.

Etela, I., Larbi, A., Ikhatua, U.J., and Bamikole, M.A. (2009a) Supplementing Guinea grass with fresh sweet potato foliage for milk by Bunaji and N'Dama cows in early lactation. *Livestock Science*, 120 (1-2): 87-95, doi: 10.1016/j.livsci.2008.04.010.

Etela, I., Larbi, A., Ikhatua, U.J., Bamikole, M.A., Oji, U.I., Tarawali, S.A., Dung, D.D. and Olorunju, P.E. (2007) Characterising improved dual-purpose groundnut and cowpea cultivars for fodder traits. *Tropical Journal of Animal Science*, 10 (1&2): 435-440.

Etela, I., Ogbeide, A., Ukanwoko, A.I. and Adedokun, O.M. (2018) Spent substrates from three species of mushroom as alternative feed resources for ruminant livestock. *The Journal of Solid Waste Technology and Management*, 44 (1): 15-20. http://ingentaconnect.com/contentone/jswt/jswt/2018/00000044/00000001/art00002#expand/collapse.

FAO. (2021) The State of Food Securityand Nutrition in the World 2021: The world is at a criticaljuncture. http://www.fao.org/state-of-food-security-nutrition/en/.

FAOSTAT. (2018) FAOSTAT, www.fao.org/faostat/en/ Rome: FAO.

FAOSTAT.(2021) Food and Agriculture Organisation of the United Nations Statistics, FAO. *http://www.fao.org/faostat/en/#country*.

FMARD. (2016) *The Agriculture Promotion Policy (2016-2020) - Building on the successes of the ATA* (Agricultural Transformation Agenda), Closing key gaps. Policy and Strategy Document. FMARD (Federal Ministry of Agriculture and Rural Development).

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. and Tempio, G. (2013). *Tackling Climate Change through Livestock – A global assessment of emissions and mitigation opportunities*. Food and Agriculture Organization of the United Nations (FAO), Rome.

Grand View Research (2020) Cattle Feed Market Size, Share & Trends Analysis Report By Ingredients (Wheat,

Corn, Additives), By Application (Dairy, Beef), By Region (North America, Asia Pacific)And Segment Forecasts, 2020-2027. Report ID: GVR-4-68039-142-8, 80 pp. https://www.grandviewresearch.com/industry-analysis/cattle-feed-market.

Herrero *et al*. (2010) Drivers of change in crop-livestock systems and their potential impacts on agro-ecosystems services and human well-being to 2030. Presentation at the Nairobi Forum, ILRI, Nairobi, 21 September 2010. Nairobi, Kenya: ILRI.

Larbi, A., Anyanwu, N.J., Oji, U.I., **Etela, I.**, Gbaraneh, L.D., and Ladipo, D.O. (2005) Fodder yield and nutritive value of browse species in West African humid tropics: response to age of coppice regrowth. *Agroforestry Systems*, 65 (3): 197-205.

Larbi, A., **Etela, I.,** Nwokocha, H.N., Oji, U.I., Anyanwu, N.J., Gbaraneh, L.D., Anioke, S.C., Balogun, R.O., and Muhammad, I.R. (2007) Fodder and tuber yields, and fodder quality of sweet potato cultivars at different maturity stages in the West African humid forest and savanna zones. Animal Feed Science and Technology, 135 (1&2): 126-138.

Larbi, A., Olorunju, P.E., Dung, D.D., and **Etela, I.** (1998) Selecting groundnut varieties for crop-livestock systems? Do not forget the farmer's cattle! *Arachide Infos*, 8: 12-14.

Mordor Intelligence (2021) Ruminant feed market - Growth, Trends, COVID-19 Impact, and Forecasts (2021-2026), *https://www.mordorintelligence.com/industry-reports/global-ruminant-feed-market-industry*.

NACGRAB. (2021) Crop Varieties Released and Registered in Nigeria. National Centre for Genetic Resources and Biotechnology (NACGRAB). https://www.nacgrab.gov.ng.

Okoro, C.G., Iriso, V.B., Lamidi, A.A., Anyanwu, N.J. and **Etela, I.** (2021) Screening ten varieties of cassava leaves and peels for feed quality using *in vitro* gas production. *Proceedings of the 64th Annual ADAN Conference/AGM and Agripreneurship Summit 2021 with Theme: "Catalyzing Post COVID-19 Economic Recovery through Agripreneurship Development: The Agribusiness Incubation Centre (AICs) Model", held at the Assembly Hall, Nasarawa State University, Keffi on Monday, 16th August 2021 and at Agripreneur Academy, Shabu Farms, Kokona-Keffi on Tuesday, 17th August 2021*.

Oludele, O.E., Wyse, E., Odeniyi, K. and Kugbogbenmowei, M. (2021) Bioremediation of crude oil contaminated soil using cow dung. *International Journal of Sciences*, 10 (1): 25-34. DOI: 10.18483/ijSci.2427.

Onoja, A.O., Agbomedarho, J., **Etela, I.** and Ajie, E.N. (2019) Profitability of cassava based farms adopting climate smart agriculture (CSA) practices in Delta Sate, Nigeria. In: Castro, P., Azul, A., Leal Filho, W. and Azeiteiro, U. (eds.) *Climate Change-Resilient Agriculture and Agroforestry.* Climate Change Management. Springer, Cham. pp. 73-88. *https://doi.org/10.1007/978-3-319-75004-0_5*.

Oyediji, G.O. (2010) Animal Science Practice in Nigeria: The Journey to Professionalism: Animal Science Association of Nigeria and the Nigerian Institute of Animal Science. Revised Edition. 123 pp.

Saleh, K.M. (2018) Pasture plan for livestock development as a strategy for conflict resolution in Sudano-Sahelian Zone of Nigeria. *Nigerian Journal of Rural Sociology*, 18 (1): 72-79.

SDSN (2013) Solutions for Sustainable Agriculture and Food Systems - Technical Report for the Post-2015

Development Agenda. Thematic Group on Sustainable Agriculture and Food Systems of the Sustainable Development Solutions Network (SDSN).

SDGC-A and SDSN (2020) Africa SDG Index and Dashboard Report 2020, Kigali and New York, SDG Center for Africa (SDGC-A) and Sustainable Development Solutions Network (SDSN).

Shiawoya, E.L. and Tsado, D.N. (2011) Forage and fodder crop production in Nigeria: Problems and prospects. *World Journal of Life Sciences and Medical Research*, 1 (4): 88-93.

Simon, B.P., Ingweye, J.N. and **Etela, I.** (2018) A case for smallholder organic goat farming in Rivers State, Nigeria (Review). In the Proceedings of the 7thAnnual Joint Conference of the Animal Science Association of Nigeria (ASAN) and the Nigerian Institute of Animal Science (NIAS), held at Ilorin. Kwara State, Nigeria.

Stangel, P.J. (1995) Nutrient cycling and its importance in sustaining crop-livestock systems in Sub-Saharan Africa. p. 37–59. *In* J.M. Powell et al. (ed.) Livestock and sustainable nutrient cycles in mixed-farming systems of Sub-Sahara Africa. Volume II: Technical papers. Proc. Int. Conf., Addis Ababa, Ethiopia. 22–26 Nov. 1993. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia.

Steinfeld, H. (1998) Livestock and their interaction with the environment: An overview. p. 53–66. *In* M. Gill et al. (ed.) Foods, lands and livelihoods—setting the research agendas for animal science. Powell, M., Pearson, R.A. and Hiernaux, P. (2010)Crop–Livestock Interactionsin the West African Drylands, Occasional Publ. 21. *British Soceity of Animal Science*, Penicuik, Midlothian, Scotland.

Wanjala, M.P., Odokuma, L., **Etela, I.,** Ramkat, R., Odogwu, B.A., Boadu,, K.O. and Koranteng-Addo, E.J. (2021) Impact of nitrogen fertilizer use on soil ecosystem integrity in the Greater Port Harcourt Region, Nigeria. *Open Academic Journal of Advanced Science and Technology*, 5 (1): 1-12. DOI: 10.33094/5.2017.2021.51.1.12.

Wisser, D., Odunze, E., Boussini, H., Mikecz, O. and Pica-Ciamarra, U. (2019) Africa Sustainable Livestock 2050: Transforming Livestock Sector Nigeria - What Do Long-term Projections Say? FAO (Food and Agriculture Organisation of the United Nations). 10 pp. *http://www.fao.org/3/CA3374EN/ca3374en.pdf.*

CITATION

Prof. Ibisime Etela, *RAS*
LmNSAP, mASAN, mNIAS, mAPRNet, mSOGREDEN, mNMS, mCIPS - UK

Professor Ibisime Etela was born 23rd October 1970 to the family of Late Chief Josephus Etela Jackson and Late Madam Makinyeba Gwendoline Georgewill both of Ifoko Town in the Asari Toru Local Government Area (LGA) of Rivers State. He commenced his nursery education at Aunty Ayo's Preparatory School, Lagos; primary education at St. James Primary School, Ifoko (1978-1981), and secondary education at the Government Sea School, Isaka in Okrika LGA, Rivers State (1982-1986). Prof. Etela holds a doctorate (2006) degree in Animal Science from the University of Benin, Nigeria, as well as master's (1999) and bachelor's (1992) degrees from the Rivers State University of Science and Technology (now Rivers State University), Nigeria.

Prof. Etela is a registered animal scientist *(RAS)* and a founding member of the Regional Centre of Expertise Port Harcourt (RCE Port Harcourt), which was acknowledged by the United Nations University - Institute for the Advanced Study of

Sustainability (UNU-IAS), Tokyo, Japan in June 2015. He was Research Advisor to the Shell Petroleum Development Company of Nigeria Limited (SPDC) from January to December 2015. He joined the University of Port Harcourt, Nigeria (UniPort) as Lecturer I (2005), became Senior Lecturer (2008), Associate Professor (2012), and Professor (2016).

He was Community Liaison Officer (CLO) with the SPDC (2002-2005), Research Fellow with the International Livestock Research Institute (ILRI), Ibadan (1998-2000), and Graduate Research Assistant with ILRI (1996-1997). Prof. Etela teaches both undergraduate and postgraduate level courses including modules on research methods and proposal report writing.

He is Dean, Faculty of Agriculture, UniPort (2020-date), Member, 5th Governing Council of Nigerian Institute of Animal Science (NIAS) as Representative Dean SS (2020-date), elected PRO, Association of Deans of Agriculture in Nigeria Universities; ADAN (2021-date), and Member, representing Senate on the Development Committee of the Governing Council, UniPort (2021-date).

He was member representing Senate on the Search Team 2021 for the 9th Vice Chancellor of UniPort.

Other administrative experience include, being Director, Institute of Agricultural Research and Development, UniPort (2012-2014), and Head, Department of Animal Science and Fisheries, UniPort (2010-2012). Also, he is Steering Committee member of the World Bank-funded Africa Centre of Excellence in Oilfield Chemicals Research, UniPort (2014-date).

His academic honours and awards include: receiving the AAU (Association of African Universities) Senior Executive Attachment Grant for Technology Uptake in 2015, DAAD (German Academic Exchange Service) part-funding for training on Internal Quality Assurance of Higher Education Institution in Anglophone West Africa from 2014-2016; IFS First Research Grant in 2008 and the prestigious ACU (Association of Commonwealth Universities) Titular Fellowship to the University of Manitoba (Canada) in 2007. He was one of the recipients of the 2015 UniPort Distinguished Merit Award.

He is an external examiner for graduate programmes and external assessor for professorial assessment to public and private universities in Nigeria. Prof. Etela has supervised 8 doctoral (3 completed; 5 ongoing), 3 masters and 23 bachelors projects. He has published 47 journal articles, 5 book chapters, over 20 conference papers, and has attended and presented invited papers at different national and international agricultural and agribusiness fora, seminars and workshops.

He is member: Nigerian Malacological Society (NMS); Society for Grassland Research and Development in Nigeria (SOGREDEN); Agricultural Policy Research Network of Nigeria (APRNet); Nigerian Institute of Animal Science (NIAS), Animal Science Association of Nigeria (ASAN), Nigeria Society for Animal Production (NSAP - *Life Member*), and Chartered Institute of Procurement and Supply of United Kingdom (CIPS - UK). He is a Comrade Dean!

Prof. Etela has travelled to several African countries, and a few in North America and Europe. Extra-curricular activities include: public enlightenment workshops on dangers of pipeline vandalism, benefits of social inclusiveness, techniques

for academic exploits, peace building, and conflict resolution and management.

He is a Christian and grew up as a member of Christ Church, Ifoko. Other Kingdom Services in God's Vineyard include: serving as a member of the Hospitality Service Group, Deacons Board Chairman (2013-2015); Chairman, Church Welfare Committee (2016-2017); Secretary, Church Board (2017-2021), and Chairman, Local Church Council (2021-date) all at the Living Faith Church (a.k.a. Winners Chapel), Rumuibgo District.

Prof. Etela is married to Mrs. Warigbani Ibisime Etela and the marriage is blessed with two kids (Hadriel-8; Janice-4). His hobbies include: listening to music, travelling, writing, football and swimming.

Vice Chancellor, Sir, distinguished ladies and gentlemen, I present to you, an unassuming academic with a tinge of professional and industry experience, a progressive mind, a teacher, an administrator, a social worker, a Deacon, Animal Scientist, husband and father, **Professor Ibisime Etela**, to deliver the 174th Inaugural Lecture of the University of Port Harcourt titled: ***Feed My Flock!***

Professor Owunari A. Georgewill
Vice Chancellor