FACULTY OF AGRICULTURE LECTURE SERIES

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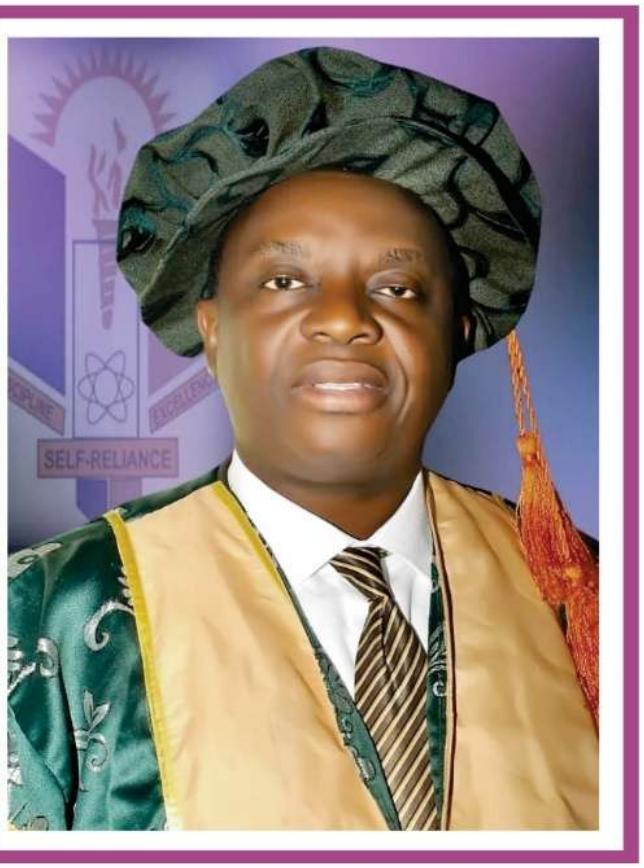

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FOREWORD

I see the instituting of the Faculty of Agriculture (FAG) lecture series and its compilation and publication as part of the Faculty's contributions towards the attainment of my vision as the Vice-Chancellor of Nnamdi Azikiwe University, which is to: *pilot the University to become the best University in Nigeria, among the ten best Universities in Africa and among the best two hundred Universities in the world*, otherwise known as *project 200*. Obviously, these cannot be achieved *in vacuo*: it requires the input of the operating units and the individual Staff and Students.

This lecture series offers an opportunity for the academic staff of the Faculty to share their research findings and research goals with a view to aligning it to *project 200* and making the Faculty the best Faculty of Agriculture in Africa, as is the goal of the Faculty. It is considered the equivalent, at the Faculty level, of the University inaugural lecture series.

The quality of the six lectures in the instant publication is quite cerebral and would make very interesting reading for staff and students of agriculture across Nigeria as well as for persons in commercial agriculture.

I commend the Faculty for the bold step of this maiden lecture series publication and urge them to sustain this and other activities that would mark out the Faculty as the best Faculty of Agriculture in Africa.

Prof. Charles O. Esimone, *FAS, FPSN*
Vice-Chancellor

PROFESSOR CHARLES O. ESIMONE, FAS: B. Pharm, M. Pharm, Ph.D, FAVH, MIPAN, MPSN, FNA Pharm, FPSN
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FROM THE DEAN'S DESK

Prof. Ernest Chukwusoro IGWE
Dean Faculty of Agriculture, Nnamdi Azikiwe, University, Awka, Anambra State

Opportunities for Extension of Frontiers of Knowledge to All

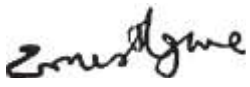
The **novel conception, inception** and **methodical follow-up-execution** of the Faculty of Agriculture (FAG) Lecture Series was due to my belief that the *most apparently successful* in the society are **not** just those with higher cerebral content than others, but are also those who have been given the opportunities. Regrettably, all facets of the Nigerian system does not provide such opportunities to most people as no part or section of the Nigerian society is spared of this anomaly. Numerous examples abound.

Worried by the fact that Nigerian universities in so many ways have become or are becoming ivory towers that the ivories have been removed and armed with the belief that only criticism does not solve problems, immediately I won the FAG Deanship election on June 10, 2021, I promised myself to be part of the restoration of this "stolen" or "deliberately removed" ivories in the "towers" called Nigerian universities. The institution of this FAG-Lecture Series is the product of such belief, positive thinking and action and with the encouragements of FAG and university managements whose supports and push were critical to the realization of what is before us. I am grateful to them as well as staff, students of FAG, Lecture series presenters, Chairmen of occasions, Guests as well as university and outside general publics that have always graced these lecture series.

The uniqueness of this FAG Lecture Series, which is equivalent to Faculty Inaugural lectures is that **unlike** the larger university inaugural lecture series, it gives opportunities for not only the professors but as well, other senior lecturers and above to voice-out and disseminate their research findings and positions on critical issues. As part of mentorship and leadership by example, the professors have kick-started the lectures with so many academics at the lower rung eager to follow up. I am also happy to announce that though the two calendar-year period of my administration was hampered and distracted by COVID-19 pandemic as well as the **unavoidable** nation-wide strike by the Academic Staff Union of Universities (ASUU) that took about one year off the period, I make bold to state that five of such lecture series have been delivered with so many on the pipeline.

Also gladdening to my heart is that the take-off of this FAG-Lecture Series has so far yielded so much fruits. It is **positively contagious** to other Academic Faculties in Nnamdi Azikiwe University. The result is that similar lecture series have started in sister faculties and are also rejuvenating in faculties where they existed but have gone comatose and even moribund. In this regard my unsung happiness knows no bound. To GOD is the glory.

My earnest prayer is that successive administrations after mine shall keep the flame glowing and the flag flying. Only commitment and progressive mindset can sustain this. Finally, I encourage students, scholars and practitioners of agriculture and allied disciplines to make use of this publication as it is a great asset to enrich their knowledge of the discipline and profession of agriculture and related disciplines.



Prof Ernest Chukwusoro IGWE
(Fifth Dean, FAG)

PREFACE

The Dean, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Professor Ernest Chukwusoro Igwe, conceptualized the faculty lecture series when he observed that many lectures delivered by senior academics in the seven departments (Agric Economic and Extension, Animal Science and Technology, Fisheries and Aquaculture Technology, Food Science and Technology, Forestry and Wildlife Management and Soil Science and Land Resources Management) which constitute the faculty are translational in contents but not yet harmonized. The dean opined that such lectures would be more beneficiary to the staff and students of the faculty should there be nexus between them.

This first edition of the lecture documentary span recent advances in agriculture and safe dieting practices. It has five chapters. Chapter one covered Small Ruminant Production: A Neglected Veritable Solution to Food Insecurity in Nigeria; chapter two discussed Animal Protein in Human Nutrition: The Facts and The Conjectures; chapter three took a hard look into Digging Our Graves with Our Teeth, chapter four explained Discovering the fighters of Food Security. Finally, chapter five dwelt on Organic Soil Amendment: An Emerging Trend in Plant Health Technology.

This edition cannot cover the vast edifying lectures in stock, but it is hoped that this publication of lecture series is a continuum.

The editors are grateful to the authors who despite the limiting time pilled with work pressure have written and delivered the lectures with passion. Our unreserved gratitude goes to our amiable vice chancellor, Professor C.O. Esimone, who has been giving us all manner of support since the inception of the faculty lecture series.

It is hoped that this book will beef up the understanding of reader on good agriculture practices, food and nutrition security. I am optimistic that practitioners of nutrition, entrepreneurs, fighters of food insecurity and policy makers will find the book educative.

Professor Charles N. Ishiwu
(Chairman, Faculty Lecture Series)

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RESUME

Taiwo Babatunde B. A. was born at ALAGBADO village along Lagos road in 1950. He started elementary school at Vocational Institute, Iju-Agege in 1955 finishing primary school at Ansar-Ud-Deen Practicing School, Ota his hometown in 1960. Owing to delayed help, he started secondary education in 1964 at Baptist Boys' High School, Abeokuta finishing as the Senior Prefect in 1968. He had his higher school at Christ's School, Ado-Ekiti where he rose to be the House Prefect of Mason House in the Upper Sixth form in 1970. He attended the prestigious University of Ibadan 1971-74 reading Agriculture with Second Class Upper Division Honours in Animal Science.

He served NYSC in 1974/1975 in the then East Central State under Governor Ukpabi Asika at Ezillo/Nkalagu State farm. Thereafter, he worked briefly as Pupil Research Officer at National Cereals Research Institute, Moor Plantation, Ibadan, before returning to UI on UI Bursary to read Animal Breeding and Genetics finishing Ph.D in April 1980.

Taiwo has been a teacher all his life, starting in 1971 after HSC and teaching in Primary, Secondary Teacher Training College, College of Education and four Universities before Unizik.

In University administration, he has been HOD of Departments severally, Dean of Faculty twice and Provost of College of Agric Sciences. He was the HOD of Animal Production Department when NUC started accreditation of Agricultural Sciences in 1990 and OOU College of Agric Sciences was the only University among universities offering Agriculture that got full accreditation in 1990. To date, OOU has been fully accreditation every five years. Taiwo has served twice as Congregation Representative in OOU Council, Director of OOU Consult, Director of OOU Sports Council to mention but a few.

He has travelled severally within and outside Nigeria for sabbatical learning and conduct of examination for WAEC, Polytechnic and Universities.

Taiwo B.B.A is an ordained Minister in RCCG, Life Members of Full Gospel Business Men's Fellowship International and Gideon's' International in Nigeria. His calling is Evangelism.

Taiwo is happily married to Professor (Mrs) OlusolaTaiwo – a Professor of Marine Ecology and the marriage is blessed with two men. To God be all Glory.

SMALL RUMINANT PRODUCTION: A NEGLECTED VERITABLE SOLUTION TO FOOD INSECURITY IN NIGERIA

TAIWO BABATUNDE B.A*

INTRODUCTION

Agriculture is the most disliked profession in Nigeria. It does not command much respect among the populace. But agriculture is an indispensable profession as everyone must be adequately fed, properly clothed and housed. Therefore, nobody can do without agricultural products. Why? Gorge Malkmus, Peter and Stowe Shockey in their book, "Hallelujah Diet" reported that human body is made of about 100 trillion living cells which constantly die and they replace themselves at the rate of 300 million cells every minutes of everyday of our lives. But as cells die and are replaced, they depend on building materials available within the body, the quality of the building materials determines the quality of the new cell. Only agriculture can provide proper building materials with which to build new, vital, vibrant and healthy living cells.

Food security can be defined as, when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2013). But food insecurity can be chronic when food supplies are persistently insufficient or transitory because of instability in production, price increases or income shortfalls.

To have food security, agricultural production must match population increase. But food production is unpredictable due to climate variability, declining soil fertility, soil nutrients mining, soil erosion and reduced moisture retention (Ariyo 2009).

*An invited visiting Professor of Animal Breeding from Animal Production Department, College of Agriculture, OlabisiOnabanjo University, Ayetoro Campus, Ayetoro, Ogun State.

Policies aimed at improving food insecurity must address food availability, food accessibility and food utilization. Therefore, when food is regularly available to all, and people have sufficient resources to obtain it and the food has nutrient value, then there is food security.

Aihonsu (2017) enumerated fifteen programmes of the Federal Government aimed at boosting Agricultural Production from 1926 to date. But none of the programmes achieved the set objectives because of inadequate level of production, low level of technology, inconsistent policy measures, quality of labour and inadequate funding of research and development (Eze et al 2010) besides the programs being skewed to crop production.

Demand for Food

Farm animals are classified as ruminants and non-ruminants. Because of their greater turnover rate, less land requirements for buildings and other facilities that can be simpler and cheaper, non-ruminants can make a rapid transformation in animal protein intake. But the astronomical cost of feed has seriously limited non-ruminant production. Ruminant animals therefore offer the

cheapest source of domestically produced animal protein because of their ability to live on roughages, crop and agro-industrial residues and rangeland grasses.

The Small Ruminants

Small ruminants are mainly sheep and goats reared to supply meat, milk, hair and skin (Coffey et al 2008). There are 1,314 breeds of sheep and 570 breeds of goats all over the world, but Nigeria has three breeds of goats namely West African Dwarf (WAD), Red Sokoto (RS) and Sahel and four breeds of sheep namely: WAD,Yankasa, Ouda and Balami

These small ruminants are more evenly distributed in the various ecological zones in Nigeria than cattle (Taiwo 2018). The attributes of small ruminants that make them a veritable solution to food insecurity are:

- Ability to graze and utilize wide range of poor quality forages and browses.
- Ability to distinguish between bitter, sweet, salty and sour tastes with a higher tolerance for bitter taste than cattle.
- Ability to go deep into desert for the preferred aromatic herbs
- Highly adaptable to broad range of environments, arid and semi-arid zones.
- Short generation interval of twelve months compared to three-four years in cattle.
- Highly prolific with multiple births
- Have small carcass easily marketed and handy for communities without electricity for cold storage.

Food Products in Small Ruminants

Nigeria has a goat population of near 21.0m, providing 6.38m carcass annually, yielding 65,686 tons carcass weight with average carcass weight of about 10kg. Goat carcass yields 44% lean meat, 30% offal, 9.6%, 13.4% bone and 3% skin, in all, goat provides 25.5% total lean meat in Nigeriacoming second to cattle in total meat supplied.

Table 1shows Nigeria as 4th among top goat producers in the world while Table 2 shows that Nigeria consumes all her goat meat. But Nigeria has potentials to produce beyond home consumption. The high prolificacy and short generation interval of small ruminant (SR) if given improved management would led to rapid meat yields which would ameliorate insufficient animal protein intake in Nigeria.

Table 1: Top Goat Producers

1. China
2. India
3. Pakistan
4. Nigeria
5. Bangladesh
6. Sudan
7. Iran
8. Indonesia
9. Mali

Table 2: Top 10 Goat Exporters

1. Australia
2. China
3. France
4. Pakistan
5. Ethiopia
6. New Zealand
7. Bulgaria
8. Spain
9. Sudan

10.	Greece	10.	India

Source: Aina, 2012.

RESEARCH EFFORTS AIMED AT INCREASING SMALL RUMINANTS (SR) PRODUCTION

1. National Survey

No meaningful improvement programme can be made without accurate number of people planned for or the available livestock number to use. Hence a national SR Survey directed by the Federal Ministry of Science and Technology was undertaken, January 1984 to April 1985 to obtain baseline data on performance and prevalent diseases of SR in Nigeria. This survey covered humid, sub-humid and semi-arid zones. A total of 10,027 SR farmers were covered at farm level, institutional farms and markets.

This study showed that: SR were kept mainly for commercial purposes under extensive, semi-intensive and intensive systems. Animals were grazed and also given supplementary feed. Age at first kidding or lambing was 12-18months but with a high abortion, 22% and dystocia, 47%.

Pre-weaning mortality was 32.3% for goats and 28.1% for sheep and was highest during rainy season.

On institutional farms, animals were culled throughout the year for breeding and slaughter.

Various breeds were brought for sale and their age ranged from 23 and 28 months.

The study observed that improvement in health, feeding and financial assistance to SR farmers would boost production. However, this study suffered a serious follow-up programme.

2. Survival of Small Ruminant (SR)

Nigeria in 1983 had 26m heads of goats which was 6% of world goat population and still could not meet her animal protein needs from all livestock sources. The problem then was not inadequate animals number but low productivity arising from a complex of factors of which mortality was prime. Adu et al (1979) reported 30.8% mortality in Red Sokoto goat up to 3 months of age. Ngere et al (1984) reported 32.5% mortality in West African Dwarf goats and 41.5% in Red Sokoto goat.

In sheep, mortality among lambs and older animals reduce economic returns from sheep enterprises. Many workers (Hill 1960, Dettmers et al 1976 and Orji 1976) reported high pre-weaning loss in Nigerian Dwarf sheep while Taiwo et al (1981) reported post-weaning loss of 28.4%.

From the foregoing, mortality is a major constraint to SR production, and pre-weaning mortality is a uniquely serious problem.

From studies on sheep, Taiwo and Buvanendran (1985) and Taiwo et al (2005) on Red Sokoto goat, it was observed that:

Type of birth and season of birth influenced survival rate, multiparous ewes reared more lambs pre-weaning than primiparous ewes, but after weaning, the latter were better than the former.

Birth weight was linearly related to survival pre-weaning. Balami, an indigenous heaviest sheep breed had the lowest survival at 3-12months and at 12-36monts.

Table 3: Adjusted mean survival rates at three stages of growth of lambs

	0.90 days		91-365 days			366-1095 days		
Overall mean		0.85		0.75		0.91		0.58
Year of birth	N	Adj. mean	N	Adj. mean	N	Adj. mean	N	Adj. mean
1978	327	0.88ab	284	0.69a	198	0.93a	327	0.56a
1979	274	083a	229	0.79b	182	0.81b	274	0.53a
1980	249	0.90b	223	0.73ab	151	0.96a	249	0.62ab
1981	142	0.73c	109	0.89c	99	0.99a	142	0.66b
Season of Birth								
Dry	729	0.85ab	617	0.70b	433	0.91a	729	0.54a
Wet	77	0.78a	55	0.85a	43	0.86a	77	0.57a
Harmattan	186	0.92a	173	0.88a	154	0.89a	186	0.7ab
Birth Type								
Single	633	0.90a	568	0.71a	409	0.90a	633	0.58a
Twin	359	0.77b	277	0.83b	221	0.93a	359	0.59a
Dam Breed								
Yankasa	362	0.85ab	305	0.78ab	237	0.93a	362	0.62a
Uda	298	0.78a	236	0.82b	178	0.92a	298	0.59a
Crossbred	302	0.92b	281	0.66a	197	0.88a	302	0.54a
Balami	30	0.77a	23	0.74ab	18	0.81a	30	0.44a
Parity								
1	253	0.86a	228	0.87a	188	0.94a	253	0.70a
2	739	0.85a	617	0.70b	442	0.90a	739	0.54b

Value within each subclass with different letters differ significantly at the P<0.05 level of significant according to Duncan's Multiple Range Test. Adj. mean, adjusted mean.

Where seasonal breeding is practised, with one parturition annually, it is best to breed SR so that parturition occurs during harmattan season.

Also farmers are advised to breed Red Sokoto goat older than one year to kid preferably during harmattan (October – December) so that they can be weaned (3 months later) to a period of fresh pasture growth in order to enhance survival. Farmers should breed does and ewes that have had 2-4 parities after flushing and pregnant females should be steamed up in the last trimester to increase birth weight and to ensure better survival.

3. Reproductive Wastage

The increasing demand for mutton and goat meat given the rising human population in Nigeria and the attractive price of this meat has led to unhealthy practice of slaughtering young breeding males and pregnant females in most abattoirs.

Ojo (1994) reported 16.50% foetal wastage out of 3057 does aged 1-5 years slaughtered in Zaria while Sanusi et al (2006) reported 57.86% gravid does and 61.39% gravid ewes in Bauchi and Plateau Sates respectively. Mohammed et al (2007) reported that 34% pregnant sheep and 26% pregnant goats were slaughtered daily in Kano.

Also, Taiwo et al (2013) investigated the frequency of slaughtering gravid does in four abattoirs within Port Harcourt metropolis. The abattoirs were at: Trans-amadi, Mile 3, Eastern bye pass and Rumuokoro. Location of abattoir and breed of goat affected total number and sex of goat slaughtered and the number of foetus wasted. More female than male goats were slaughtered in all abattoirs. More fetuses were wasted in Trans-amadi than other abattoirs. Mile 3 wasted more foestus than Eastern bye pass and Rumuokoro. On the average, about a foestus was wasted per day of the study and 47% of the foestus were in the second trimester (51-100days) of pregnancy which was avoidable.

Continued slaughter of gravid animals portends great danger for demands for meat and meat products in Nigeria because of the gradual reduction in potential breeding animals.

Table 4: Frequency distribution of age of foestus wasted

Age of foestus	Frequency	Percent frequency
First trimester 1-7 weeks	29	36.71
Second trimester 8-14 weeks	37	46.84
Third trimester 15-21 weeks	13	16.46

4. Assessment of Small Ruminant for meat Production

Thirty ewes aged 2-5years and thirteen young rams were serially slaughtered for carcass evaluation, organ analyses and blood parameters (Dettmers et al, 1976). The study showed that:

- Young West African Dwarf ewes were superior to young rams in dressing percent (yield) and primal cuts.

- Ewes dressed 44% compared to 40% in rams
- The retail cuts contained 67% muscle and 26& bone against 65% muscle and 28% bone for ewes and rams respectively.
- The primal cuts made up 85% of adult West African Dwarf ewes
- Best carcass came from ewes aged two and four years

But compared with mutton sheep of temperate zone, the Dwarf sheep stands only 4/5 as high and 2/3 as long weighing only ¼ to 1/3 European sheep. Hence it was concluded the Dwarf sheep would need improvement in their growth.

5. Assessment of indigenous and imported sheep for crossbreeding

Introduction of new breeds may be advisable when productivity of indigenous breed is low and the imported breed from available records has superior traits. However, before the use of imported breed, there is a need to compare both breeds for productive traits under the same environment where both breeds would be used. In our study, Adu et al (1985) in a comparison of imported Desert Sudanese sheep with indigenous Balamimade at MargubaLivestock Improvement and Breeding Centre, Borno State showed that:

- Balami was superior in litter size (1.22 v 1.2)
- The number of lambs born per ewe per annum was similar
- But lambing interval was shorter in Desert Sudanese sheep
- Balami lambs were heavier at birth and weaning

Given these findings, Desert Sudanese sheep would shorten the interval of production thus increasing overall productivity while Balami with higher litter size should encourage crossbreeding between the two breeds.

6. Growth and Survival of Crossbred Lambs

The Nigerian Dwarf Sheep (NDS) is the forest variety of the West African Dwarf sheep. It is the smallest of the Nigerian breeds of sheep and is much smaller than the Northern breeds such as Yankasa, Uda and Balami. They are commonly found in Southern Nigeria. They are highly prolific and they almost stop growing at about two years of age (Dettmers et al, 1976). Hence attempts were made to improve their productivity by crossbreeding with fast growing, larger indigenous breeds – Yankasa (Y), Uda (U) and imported breed, Permer (P) during early rainy season, April – June (ERS) and early dry season, October – December (EDS).

At birth, Taiwo et al (1982) found that the crosses were heavier than NDS. This weight advantage was carried till 12 months, Table 5. Maximum growth of lambs occurred pre-weaning (0-3months). Within this phase, growth was highest between 0-1 month.

The average daily gain (ADG) from birth weaning at 3 months were 0.085, 0.102, 0.099 and 0.101kg for NDS-NDS, P-NDS, U-NDS and Y-NDS respectively.

At 3 months, NDS-NDS mean weight was 48.4% of its 12^{th} month weight compared with 40.4% and 45.4% in P-NDS and U-NDS respectively.
The crosses consistently grew faster than NDS-NDS attaining NDS 12^{th} month weight of 20.17kg in 9 months.

Among the crosses, P-NDS grew fastest followed by U-NDS and Y-NDS.

Table 5: Least square mean (LSM) weight (kg) for Nigerian Dwarf sheep and their crosses at five stages of growth.

	Birth		3 month		6 month		9 month		12 month	
Overall mean		2.35		11.08		10.95		17.16		23.49
Genotype	N	LSM	N	LSM	N	LSM	N	LSM	N	LSM
NDS	44	2.07b	41	9.76	30	9.41[a]	12	14.71[ac]	11	20.17[a]
P-NDS	51	2.34[a]	43	10.63	35	12.50[b]	21	19.63[b]	17	26.30[b]
U-NDS	36	2.03[a]	29	10.99	23	10.93[c]	15	16.97[bc]	15	23.92[ab]
Y-NDS	41	2.46[a]	33	12.92	26	11.01[c]	13	16.73[ac]	10	23.57[ab]
Type of birth										
Single	61	2.58[a]	54	12.25	42	12.34[a]	24	19.78[a]	23	26.35[a]
Twin	111	2.12[b]	92	9.91	72	9.56[b]	37	14.54[b]	30	20.63[b]
Sex										
Male	87	2.42[a]	80	11.36	61	11.37[a]	35	18.62[a]	31	25.76[a]
Female	85	2.28[b]	60	10.80	53	10.53[b]	26	15.70[b]	22	21.22[b]
Ewe age (Yrs)										
2	26	2.29[a]	26	9.69	21	10.48	19	15.09[a]	17	19.61
3	46	2.18a[b]	27	13.39	23	11.98	8	20.10[b]	6	27.73
4	100	2.57b	93	10.28	70	10.47	34	16.68a	30	23.43
Season										
ERS	97	2.43[a]	97	12.27	68	13.40[a]	--	--	--	--
EDS	75	2.27[b]	47	9.89	46	8.50[b]	--	--	--	--

Value within each subclass with different superscripts differ significantly (P<0.05)

7. Carcass traits of Nigerian Dwarf Sheep and their crosses

Nigerian Dwarf Sheep are kept primarily for their meat and occasionally for other social rites. In spite of the superiority of this breed in prolificacy, Taiwo et al (1981) reported most farmers do not consider them economical for large scale farming because of their slow growth rate. Dettmers and Loosli, (1974) considered this breed to be of poor conformation and to lack finish. This necessitated crossing this breed with indigenous bigger breeds – Uda (U), Yankasa (Y) and imported Permer (P).

Taiwo et al (1983) examined the body size and carcass components of forty Nigerian Dwarf Sheep and their crosses with Permer, Uda and Yankasa breeds. The crosses had larger body size Table 6, and dressed better than pure Nigeria Dwarf Sheep, Table 7.

Table 6: Mean body measurements of Nigerian Dwarf Sheep and its crosses at 12 months.

Genotype	Animals number[1]	Heart girth, cm	Height at withers, cm	Body length, cm
NDS	10	61.20^{ab}	56.36^{a}	51.11^{ab}
P-NDS	10	72.25^{de}	61.21^{abd}	57.89^{ce}
U-NDS	10	68.87^{bce}	65.47^{cd}	56.37^{ade}
Y-NDS	10	65.33^{acd}	62.75^{bc}	54.06^{bcd}
S.E		2.44	1.68	2.02
Sex				
Male	16	69.61^{a}	64.34^{a}	57.94^{a}
Female	16	64.48^{b}	58.39^{b}	52.07^{b}
Wether	8	67.32^{ab}	62.72^{a}	55.34^{ab}
S.E		2.22	1.54	1.84

Values within each subclass different superscripts differ significantly (P<0.05)

Table 7: carcass yields from the crosses with local Uda compared quite favouraby with imported Permer. The crosses were generally heavier than NDS at 12 months but only crosses with Permer and Uda were significantly (P<0.05) heavier than NDS.

	Slaughter weight (kg)		Chilled weight (kg)	Dress %	Carcass (kg) per day of age	Lean: bone	Lean: fat	Unadjusted shear value (kg)
Overall mean	11*	24.51	10.67	45.43	0.029	3.05	3.43	3.01
Genotype								
NDS-NDS	10	19.18^{a}	8.01^{a}	43.73^{a}	0.022a	3.02^{a}	4.06^{a}	2.80^{a}
P-NDS	10	29.98^{c}	13.35^{c}	46.64^{a}	0.036c	3.32^{a}	2.58^{a}	3.15^{a}
U-NDS	10	26.26^{bc}	11.59^{bc}	46.46^{a}	0.032bc	2.81^{a}	2.85^{a}	3.12^{a}
Y-NDS	10	22.61^{ab}	9.72^{ab}	44.99^{a}	0.027ab	3.06^{a}	4.23^{b}	2.96^{a}
Sex								

Ram	16	27.01[b]	11.98[b]	46.73[a]	0.033b	3.20[a]	3.72[a]	2.91[a]
Ewe	16	21.63[a]	9.14[a]	43.79[b]	0.025a	3.05[a]	3.25[a]	3.26[a]
Wether	8	25.27[ab]	11.10[ab]	46.15[a]	0.030ab	2.94[a]	2.47[a]	2.71[a]

Table 7: Adjusted mean values of carcass characteristics of NDS and their crosses
Values within each subclass with different superscripts in a column differ significantly (P<0.05).
**Values denoted the actual number in each subclass. The mean number per subclass for sex was the harmonic mean of the numbers in the different subclass.*

In conclusion, this presentation shows numerous potentials of our neglected ubiquitous small ruminants which if properly harnessed can ameliorate food insecurity in Nigeria.

May I advise my listening audience to keep a male and a female of either sheep or goat in your compound, and in six months' time, you will be in quality food that your neighbours can benefit from.

ACKNOWLEDGEMENT

I am most grateful to Prof. Joseph E. Ahaneku, FAS the Vice-Chancellor who approved my visiting Professorship to Unizik. The immediate past Dean of Faculty of Agriculture Prof. Charles Onugu who enthusiastically received me on phone and introduced me to Dr. Taiwo Abdullahi who welcomed me to Akwa and sourced for accommodation for me and even housed me for a week until my apartment was ready. His brothers with whom I stayed then were worthy of thanks.

Prof. Ben Marire of ESUT whom I last saw at NAPRI, Ahmadu Bello University in 1987 blessed my stay at Unizik while the incumbent head of Animal Science Department, Prof. J.C. Okonkwo eased my office problems.

The Dean of the Faculty, Prof. E.C. Igwe is worthy of mention for being there at all times to get things right.

I appreciate the immense contributions of members of the Committee of the Faculty Inaugural Seminar and the Coordinator of that day. The physical presence of representative of the Vice Chancellor is acknowledged.

The final year Animal Science students of 2018/2019 session were a delight to teach for their preparedness to learn, infact one of them my dear daughter in the Lord Glory Ifeoma Igwe typed the PowerPoint for this seminar and I will always remember them.

Thanks for listening.

REFERENCES

Adu, I.F., Buvanendran, V and Lakpini, C.A.M. (1979) The Reproductive Performance OfRed Sokoto Goats in Nigeria. Journal of Agricultural Science, Cambridge 93:563-566

Adu, I.F., Taiwo, B.B.A and Buvanendran, V. (1985) Reproductive and Lamb Growth Performance of Balamiand Desert Sudanese Sheep in Sahelo-Sudan Savanna Zone OfNigeria. Journal of Animal Production Research 5(1):67-76.

Aihonsu, J.O.Y. (2017) Addressing Nigeria's Food Shortage Dilemma: The Cooperative Agenda. 78th InauguralLecture. OlabisiOnabanjo University, Ago-Iwoye.

Aina, A.B.J. (2012) Goat (Capra hircus): A Misunderstood Animal. 35th Federal University of Agriculture, Abeokuta. Inaugural Lecturer Series.

Ariyo, O.J. (2009) Genotypeand Environmental Interplay in Crop Production. 25th Inaugural Lecture. University Of Agriculture, Abeokuta Pp 64.

Coffey, K., Margo, H. And Ann, W. (2008) Goats Sustainable Production Overview. In Goat-Wikipedia, the Free Encyclopedia Pp 12.

Dettmers, A., Loosli, J.K (1974) Live Performance and Carcass Characteristics of West African Dwarf Sheep. 1st Annual Conference Nigerian Society of Animal Production, March 25-27, Kano

Dettmers, A, Loosli, J.K, Taiwo, B.B.A and Nkemeatu, J.A (1976) The West African Dwarf Sheep. II Carcass Traits, Mutton Quality. Nigerian Journal of Animal Production 3(2):25-33.

Eze, C.C, Lemchi, J.I., Ugochukwu, A.I, Eze, V.C. Awulonu, C.A.O and Okon, A.X. (2010) Agricultural Financing Policies and Rural Development inNigeria. 84th Annual Conference of Agricultural Economics Society, Edinburgh.

FAO (2008) Food and Agricultural Organization. World Agriculture, an FAO Perspective.

Hill, D.H. (1960) Animal Breeding Improvement in Nigeria. Faculty of Agriculture, Division of Animal Husbandry and Health, University College, Ibadan.

Mohammed, I.R., Ashiru, R. And Abdullahi, A.Y. (2007) Implication of the Slaughter of Pregnant Ewes and does to Future Stock in the Semi-Arid Urban Abattoirs. Journal of Animal Veterinary Advance 6(6):819-822.

Ngere, L.O., Adu, I.F. And Okubanjo, A.O (1984) The Indigenous Goats of Nigeria. Animal Genetics Resources Information 3:1-9 FAO Rome.

Ojo, S.A. (1994) A Survey of Pathological Condition in Slaughtered Goats in Zaria Slaughter House. Small Ruminant Network, Uganda, Kampala, Pp 139-141.

Orji, B.I. (1976) Studies onthe Biology of Reproduction oftheNigerian Dwarf Sheep. Ph.D. Thesis University ofIbadan. Ibadan.

Sanusi, M., Abubakar, M. And Luka, B. (2006) Incidence Of Foetal Wastage In Ruminant Animals In Bauchi And Jos Abattoirs, Proceeding Of 31st Annual Conference Of Nigerian Society For Animals Production. BayeroUniversity, Kano, Pp 102-106.

Taiwo B.B.A (2018) Small Ruminant Production: A neglected panacea to food insecurity in Nigeria. 80th Inaugural Lecture, Olabisi Onabanjo University, Ago-Iwoye.

Taiwo, B.B.A, Ngere, L.O. And Adeleye, I.O.A (1981) Reproductive Performance ofNigerian Dwarf and Imported Permer Sheep at University Of Ibadan. NAPRI Seminars 3:145-158.

Taiwo, B.B.A, Ngere, L.O andAdeleye, I.O.A (1982) Comparative Growth Performance ofNigerian Dwarf Sheep and Its Crosses with Permer, UdaandYankasa. World Review ofAnimals Production 18(1):57-63.

Taiwo, B.B.A, Ngere, L.O andAdeleye, I.O.A (2005) Carcass Characteristics ofNigerian Dwarf Sheep and Their Crosses. Journal of Agriculture, Forestry andthe Social Science 3(2):132-138.

Taiwo, B.B.A, Iriso, V.B and Ajayi, F.O. (2013) Frequency of Slaughtering Gravid Does In Some Port Harcourt Abattoirs And Its Implication. Moor Journal of Agricultural Research 14:23-29.

Citation of the Profile of Professor CordeliaIfeyinwa Ebenebe

Professor CordeliaIfeyinwaEbenebe is the third Child of Chief Thomas Ikechukwu Osungwu and Mrs Helen EjerimmaOsungwu

from UmuOkarafor, Umdioka, UmuohiOkija. She attended the famous Anyogu Primary School Onitsha for her primary education and Ado Girls'Secondary School Onitsha for her secondary education. Her intellectual prowess was first discovered in her secondary school where she represented her school in many inter-school quiz competitions both in Sciences and Arts as she was found to be an all-rounder. She later proceeded to Federal University of Technology, Akure (FUTA) the pursuit of first degree in Animal Science B. Agric. Tech. (Animal Production and Health Technology). At FUTA she became **a University Scholar from her second year to her final year owing to outstanding performance and being among the students on the Dean's list for having the highest CGPA in the Faculty.** She also graduated from the FUTA with three prizes

i. University Scholarship Award

1986/1987 University Scholar: Student that entered the Dean's List for Obtaining the Highest Cumulative Grade Point Average (CGPA)

1987/1988 University Scholar: Student that entered the Dean's List for Obtaining the Highest Cumulative Grade Point Average (CGPA)

1988/1989: Student that entered the Dean's List for Obtaining the Highest Cumulative Grade Point Average (CGPA)

ii). University Prize (1989): Student that had the Highest Cumulative Grade Point Average (CGPA) in the Department of Animal Production and Health Technology (**1989 Graduating Set)**

iii). Departmental Prize (1989): Student that had the Highest CumulativeGrade Point Average (CGPA) in the Department of Animal Production and Health Technology (1989 Graduating Set)

iv). University Women Prize (1989): Best Female Graduating Student in the 1989 Graduating Set

There after she proceeded to University of Ibadan for Master's degree in Animal Science which ended with PhD Mark and later to NnamdiAzikiwe University, Awka for Ph.D in Biological Conservation from the Bioconservationoption in the Department of Zoology after a period of nine years during which she taught as an Agricultural Science teacher at Dennis Memorial Grammar School Onitsha (1996 to 1999) and Agricultural Science lecturer at NwaforOrizu College of Education Nsugbe (1999-2005).When she defended her PhD in 2005, the Department of Zoology was so impressed and became instrumental to her gaining employment into the department as a lecturer. In 2011, she became the pioneer HOD, of the Department of Animal Science when the Faculty of Agriculture was established. She rose through the ranks to become Professor of Animal Production and Management in 2017. She has helped in an immeasurable way in the development of that department.

Her interest in the development of Micro and Minilivestocktook her tomany countries of the world for training, research and conferences including Abu Dhabi, Philippine, Egypt,Sudan, Republic of Benin, Ghana, United States of America, Canada, Netherlands and Belgium. Her current research focus is on edible and economic insects especially black soldier fly larvae for

feed and for maintenance of environmental health, cricket and African palm weevil for improving nutrient content foods.

Professor Cordelia Ifeyinwa Ebenebe has held many administrative positions within and outside the University

- **Chairman,** Animal Research Ethics CommitteE (2019 to Date)
- **Faculty Representative**, Quality Assurance Committee (2020 to Date)
- **Senate Representative**, Vice Chancellor Search team
- **Head of Department of Animal Science** (2010 - 2014, 2014 -2015 and 2017-2019),
- **Faculty Subdean** (2014-2015)
- **Faculty Post Graduate Sub Dean** (2015 to 2019)
- **Chairman**, Post Graduate Synopsis Vetting Committee (Sciences) (2015 to 2019)
- **Deputy Director**, Biotechnology Centre, UNIZIK (2015 to 2019)
- **Chairman**, Insect Farming for the Eradication of Rural Poverty
- **Chairman,** Women Academics in Agriculture
- **Chairman**, Organization for Women in Science in the Developing World (OWSD), UNIZIK, Chapter (2019 to Date)
- **Secretary,** Committee on Establishment of Diploma Programme **(2008)**

Membership of University Committees

- Inaugural lecture Committee (2019 to date)
- PG Workshop Committee (2021)
- Unizik Farms Committee now Unizik Farms Co-operative Society (2018 to Date)
- Board member, Centre for Community and Rural Development
- NAU Park Development Committee (2020 – to date)
- Directorate for Research and Industrial Relations (2015 to 2019).
- Committee on Development and Production of Prospectus and Hand Bill for the School of Post Graduate Studies **(2015 to Date)**
- Ad-Hoc Committee to Investigate PG Matters in the Department of Human Kinetics and Health Education **(2016)**
- Ad-Hoc Committee to Investigate PG Curriculum Matters in the Department of Environmental Management **(2016)**
- Curriculum Harmonization Committee, Faculty of Agriculture (**2011)**

National Services/ Global Services

- **Chairman**, of the **Livestock and Environment Discipline in the 5th Council of Nigerian Institute of Animal Science (2020 to Date)**
- **Consultancy**
- Consultant with the **Federal Ministry of Environment** on Ecology and Bio-conservation matters from 2008 to Date.
- **National Treasurer**, Network on Giant African Land Snails Now **Nigerian MalacologicalSocietys**
- **Member,** National Feed Summit, of the Federal Ministry of Agriculture and Rural Development
- **Associate Editor,** International Journal of Tropical Insects, Springer Nature, UK

Fellowship Award

- In she was called into the board of Fellows and decorated as a **Fellow of the College of Animal Scienctist of Nigeria (FCASN)** by the Nigerian Institute of Animal Science.

Attraction of Research Grant:

- **TETFUND Research Grant 2012.**
- **Team leader and designer of the Research Project** "Studies on the Ecology, Biology and Culture of the Water Snail (*Pila spp.*)" that worn TETFUND Research Grant 2012.
- Tetfund Book Development for the Development of the Book: Poultry Biology and Management Techniques: A Compendium ISSN (In Process)

External Examination

- Appointment as External Examiner for Higher Degree Oral Examination (PhD) Exam 3rd April, 2019, University of South Africa (UNISA)
- Appointment as External Examiner for Higher Degree Oral Examination (M.Sc.) Exam conducted on 16th March, 2017 at the Department of Animal Science, University of Calabar, Calabar
- Appointment as External Examiner for Higher Degree Oral Examination (Ph.D and M.Sc.), Exam conducted on 23rd and 24th of February, 2017 at the Post Graduate School, University of Agriculture Makurdi, Nigeria
- Appointment as External Examiner for Higher Degree Oral Examination (Ph.D and M.Sc.), Exam conducted November, 2019 at the Post Graduate School, University of AgricultureMakurdi, Nigeria

Professorial Appraisal

i. Springer Nature Training for Journal Editors (On-going)

i. Appraisal of Dr. Machebe of the Department of Animal Science, University of Nigeria, Nsukka Professorial Rank

ii. Appraisal of Dr. Abioja of the Department of Animal Science, Federal University of Agriculture, Abeokuta to a Reader

Resource Verification

Chairman, Resource Verification Team to Michael Okpara University of Agriculture, Umudike

Workshop Trainings

- **Training by the Professional Leadership Practitioners Institute on Moving Towards aTop Ranked University: Education for Social Impact(Project 200) Organized by the University Management at** NnamdiAzikiwe University Auditorium, Awka for University administrators 8th to 9th July, 2019.
- **Leadership Training on Moving Towards Project 200**Organized by the University Management for All Newly appointed Administrators 4th to 5th December, 2019 at NnamdiAzikiwe University Auditorium , Awka
- **Training by the United States Government Global Hunger and Food Security Initiative (Feed the Future)** on Issues in Agriculture and Development held at Delta State University, 14th to 16th January, 2016
- **Training on Animal Production and Health (Sustainable Tropical Dairying)** Organized United Nations Training and Research Online Training (UNITAR) 2018
- **Training on Mass Production of Black Soldier Fly as Replacement for Fishmeal in Fish and Livestock Feeds,** 2nd to 11th October in the Netherlands Organized by UnitedStates International Development Agency (USAID, Nigeria, Market II Project), Netherlands Enterprise Agency and Next Generation Nutrition, Netherlands.

- **Biotechnology Workshop on Molecular Diagnosis 2017.** A Workshop/ Conference Organized by Biotechnology Research Centre, NnamdiAzikiwe University, Awka, 1st to 5th, Nov. 2017.
- Training on Intellectual Property Right, Organized by Directorate For Research Innovation and University Industrial Relation in Collaboration with National Office for Technology Acquisition and Promotion (NOTAP) 2017, Digital Library, NnamdiAzikiwe University, Awka (2017)
- **Digital Appreciation Programme For Tertiary Institution (ADAPTI):** Statistical Package For Social Sciences Organised by **International Centre for Information and Communication Centre, facilitated by Digital Bridge Institute, at NnamdiAzikiweUniversity, Awka (2017)**
- **United Nations Training and Research On line training on Innovative Collaboration for Development, Food and Agricuture Organization (2016)**
- **Web 2.0. and Social Media for Development Training by Technical Centre for Agriculture, Netherlands (2016)**
- **2016 Post Graduate Research Workshop: Train the Trainers, Chisco Hall, NnamdiAzikiwe University, Awka**
- **Applied Molecuar Biology, organized as an event under the 21st Africa Association of Insect Scientists (AAIS) Conference, held at the International Institute for Tropical Agriculture, Republic of Benin**
- **Training on Food Processing, Mushroom production and Effective Microorgainsm(EM) in Agriculture and Farming at Republic of Benin, Songhai Centre, Port Novo, Benin**
- **United Nations Training and Research Online Training (UNITAR) on Climate Change**
- **Strategic training Organized by Rural Finance (Rufin)(World bank) for stake holders on the 12th May, 2015** at Gracious Hotel, 29 Okemesi Crescent, Near Old Central Bank Building, Gariki, Abuja
- **West African Agricultural Productivity Programme (WAAPP) Assissted Training** on Organization and Management of Agricultural Value Chain Innovative Platforms (VCIPs), **20th to 21st April, 2015 at FCT, Abuja**
- **West African Agicultural Productivity Programme (WAAPP) Assissted Trainingon** Gender, Diversity and Management in Agriculture at FCT Abuja, **14th to 15th of April 2015.**
- **Nigerian Institute of Animal Science Mandatory Continuing Professional Education Certificate (2017)**
  - Livestock Business Financing
  - Farm to Export- Regulationd and Requirements in Export of Livestock Products

xix. **Nigerian Institute of Animal Science Mandatory Continuing Professional Education Certificate (2016)**
  - Entreprenureship in Animal Agriculture in Nigeria
  - Fodder Production, Hay and Silage as A Business
  - Animal Feed Risk Assessment

xx. **Nigerian Institute of Animal Science Mandatory Continuing Professional Education Certificate (2015)**

▶ Concept Note and Grant Writing

- Standards in Livestock Industry in Nigeria

xxi. **Nigerian Institute of Animal Science Mandatory Continuing Education (2014)**

xxii. Nigerian Institute of Animal Science Consultancy Services Ltd (17th to 18th October, 2012)

- Microtracer Technology and its Application in Feed Milling Industry

xxiii. **Nigerian Institute of Animal Science Mandatory Continuing Professional Education Certificate (2011)**

- Feasibility Report Writing
- Role of Animal Science in the Economy of a Developing Country Nigeria
- Livestock Development Planning in Nigeria
- Hazard Analysis and Critical Control Point in Animal Science

xxiv. **Grasscutter Husbandry Workshop**, Adu Agro- Allied Enterprises, **9th July to 8th May 2002** at AdagroGrasscutter, Farm Centre of Excellence in Wildlife Farming and

Key note Addresses/ Lectures as a Resource Person

i. **Keynote Address:** AgriculturalBiotechnology**:** A Panacea for Industrial Development, held at Crystal Hotel, Asaba

ii. **Plenary lecture**: Uses of Snail, Invited paper at the 5th Conference of Research Network on GiantAfrican Land Snails, held at Federal University of Technology, Akure -

iii. **Faculty Lecture**: Animal Protein in Human Nutrition: The Facts and The Conjectures (April, 2020)

iv. **Faculty Workshop and NIAS Livestock and Environment Discipline**: Production of Black Soldier Fly Larvae A Veritable Tool in Sustainable Livestock and Fish Feed Supply 5th and 6th May, 2021 respectively

v. **Faculty Workshop and ASAN, Anambra StateMicrolivestockSummit**: Profitable Commercial Grasscutter Farming Venture (2019 and 6th May, 2021respectively)

Publications

- **Books**
  - **Ebenebe, C.I. Grasscutter Biology and Captive Management Techniques** GT Publishers 2017, Onitsha (**Published 2017**)
  - **Ebenebe, C.I. (2013). Hatchery Technology and Management Operations ISBN**:**978-978-938-495-2.** DJompol Int'l Printers and Publishers, Onitsha **(Published 2013)**.
  - **Ebenebe, C.I. and Ufele A.N. (2012). Anatomy and Physiology of Farm AnimalsISBN**: **978-970-931-295-5**. Edumaco Communication Ltd. Onitsha. (**Published 2012**).
  - Okeke J.J., Anizoba M.A. and **Ebenebe, C.I.** (**2009**) **Practical Invertebrate Zoology for the Tropics: A Student Guide. ISBN**: **978- 978-8415-20-6.** Eunique Press and Computers, Awka. (**Published 2009**).
  - Anizoba, M.A., **Ebenebe C.I.** and Okeke J.J. (**2008**). **Basic Ecological Exercises: A Student Guide to Field work and Analysis-. ISBN**: **978-078 195-1,** SCOA Heritage System Publ. Awka. (**Published 2008)**

- **Ebenebe C.I. (2015)**. **Poultry Biology and Management Technique: A Compendium ISBN**: 978-978- 938-496-9. DJompol Int'l Printers and Publishers. Onitsha. **(Selected for Tetfund Book Development)**
- **Ebenebe C.I.** and Ufele A.N. **Snail Biology and Production Techniques Published 2018**

- **Journals**
  - 62 Peer Reviewed Journal Articles
- **Conference papers**
  - 67 Conference papers

Post Graduate Supervision

- Graduated One PhD currently a lecturer at Kashere University, Gombe
- One (1) On going Supervision of PhD, currently employed as a lecturer at Admiralty University, Ibuzo
- Graduated Ten (10) M.Sc . Students
- Two (2) on –going MSc. Supervision

Membership of Academic Society

She is a member of many academic societies including Nigerian Society for Animal Production (NSAP), Animal Science Association of Nigeria (ASAN), Nigerian Institute of Animal Science (NIAS), World Poultry Science Association (WPSA), World Rabbit Congress, African Association of Insect Scientists (AAIS) and Organization for Women in Science in the Developing World (OWSDW).

Professor Cordelia Ifeyinwa Ebenebe

(FCASN, RAS, MNSAP, MASAN, MNIAS)

Animal Protein in Human Nutrition: The Facts and the Conjectures

Faculty of Agriculture Lecture Series No 2

Delivered by

Professor Cordelia Ifeyinwa Ebenebe

At the FAG Hall 1

On

12th November, 2019

Introduction

It is a great honour to be here today to present the second paper in the Faculty of Agriculture lecture series. The Faculty lecture started from the time of Late Professor Nnabuife but was not accorded the seriousness which the current Dean and his team has infused into it. I must say the Faculty lecture with all the paraphernalia to make it grandiose has made it appear like a mini inaugural lecture and the topics chosen by academics are pointers to the fact that the lectures are both insightful and informative. The lecture today will not be devoid of these characteristics, as the lecture is aimed at presenting the facts and the conjectures surrounding the association of many animal proteins with certain health challenges as well as environmental pollution and more precisely climate change challenges. On this basis, I will like to start this discourse by first addressing the words that make up the title of this lecture

The term Animal Protein

Animal protein refers to proteins emanating from any member of the animal kingdom other than man. Thus animal protein sources include meat, fish, poultry, eggs, milk and some other dairy. Animal proteins are said to be complete protein sources because they contain all of the essential amino acids the body needs to function effectively.

i. Meat: Lawrie (2006) defined meat as animal flesh that is eaten as food. Encyclopedia Britannica, defined meat as the flesh or other edible parts of animals (usually domesticated cattle, swine and sheep) used for food, including not only the muscles and fat but also tendons and ligaments.

Types of meat and production level in Nigeria

Beef: Beef is the flesh of mature cattle that normally weigh from 450 – 540kg and yield 55 -60% of their weight in meat. Cattle population is estimated at 15.3 million. Indigenous breeds in Nigeria include White Fulani, Red Bororo, Sokoto Gudali, Adamali Gudali, Wadara, Azawak, Muturu, Keteku, Ndama and Kuri (Umar, 2007, Umar et al., 2008)

Veal: The flesh of calves (young cattle of 8-12 weeks) is much less fatty than beef and more or less white flesh

Pork: Pork refers to the flesh from pig. The pig is the world's second largest provider of meat, pigs weigh between 90 – 135kg and provide about 70-75% of that weight in meat. Population of pig in Nigeria is about 4.4 million. 78% of these are found in the sub-humid zones of the Northern and Southern Guinea (Shaib et al., 1997)

Mutton: The meat from lamb and sheep. They are produced on a much smallerthan either beef or pork, lambs weigh 14 to 18kg and yield 48-50% of their weight in meat. Sheep population in Nigeria is 13.2 million out of which 3.4 million are found in the southern/humid region, the rest from the North (Lawal- Adebowale 2012). Breeds of Sheep include WAD, Balami, Uda, Yankassa

Chevon: The meat from goat is called Chevon in Northern Europe, Capretto in Australia and Southern Europe and Cabrito in Hispanic and commonly referred to as goat meat in Nigeria. The goat meat has higher values in iron, potassium, thiamine together with less sodium than traditional meats (i.e. 50% less fat than beef, 45% less fat than lamb, 15% less than veal). Goat meat has less saturated fat and higher mono and polyunsaturated fat than other red meats. Goat population in Nigeria is 22-26 million out of which 6.6 million are found in the south (Lawal- Adebowale, 2012). Breeds include WAD, Sahel/ Desert also known as West African Long Legged goat, Sokoto Red/ Maradi. Kalahari of South Africa is also getting adapted to Nigeria

Poultry meat: Nigeria poultry meat tonnage grew from 45,600 tonnes in 1968 to 201, 493 tonnes in 2017 growing at an average annual rate of 3.35%. Sahel Newsletter put the estimate of poultry population at 165 million birds which produce 650,0000MT of eggs and 290,000 MT of poultry meat in 2013.

Rabbit meat: The meat from rabbit, it has a high percentage of easily digestible protein. Rabbit meat is one of best sources of meat, with the lowest amount of fat, almost cholesterol free. It also has comparatively lower sodium content and higher calcium and phosphorus than other conventional meats. Nigeria is estimated to have up to 1.7 million rabbits (RIM, 1992).

Congo meat/ snail meat

Bush meat/Venison: Meat from wild animals, some are now domesticated like grasscutter, kob, antelope. Grasscutter meat is a white meat similar to the rabbit in nutrient composition.

ii. Dairy products: Milk, Yoghurt, Ice cream, Whey. Cows in Nigeria produce 1.5 to 2 Litres of milk per day, compared to cows in Kenya which produce up to 30 litres per day, cows in Israel produce 45 -60 litres per day. Nigeria's milk production accounts for only 13% of West African production and 0.01% of global dairy output (Udegbunam, 2019).

iii. **Egg and egg products:** An average of 16 medium sized eggs can weigh 1kg

iv. Fish

Fish makes up around 40% of the country's protein intake, with fish consumption at 13.3 kg/person/per year. The majority of this fish is consumed domestically, while around 10% is exported. Emefiele, the CBN Governor recently stated that about $1.2 billion worth of fish is being imported annually into the country, while current fish production stands at 0.8 million metric tonnes with a deficit of 1.9 million metric tonnes. Nigeria's demand for the commodity is 2.7 million metric tonnes annually.

Capture fisheries production: measures the volume of fish catches landed by a country for all commercial, industrial, recreational and subsistence purposes. The value for Capture fisheries production (metric tons) in Nigeria was 710,331 as of 2015.Record of the past 55 years showed a maximum value of 759,828 in 2014 and a minimum value of 52,837 in 1961.

Table 1: World Egg Production Data (Million tonnes/ Annuma)

World	63.8

America	13.1
Asia	38.1
Europe	10.6
Oceania	0.30
Africa	*Nigeria is the highest egg producer in Africa
Nigeria	533, 000
South Africa	435, 000
Egypt	240, 000
Moscow	200, 000
Algeria	185, 000
Tunisia	85, 000
Kenya	69, 000
Libya	60,000

Global egg consumption:145eggs/head/year i.e. 9/1kg/head/year
Consumption level in the United States= 300eggs/head/year
Japan = 300 eggs/head/year
Nigeria = 20-42eggs/head/year

Aquaculture is understood to mean the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Aquaculture production specifically refers to output from aquaculture activities, which are designated for final harvest for consumption. The value for Aquaculture production (metric tons) in Nigeria was 316,727 as of 2015. Recordsover the past 55 years showed a maximum value of 316,727 in 2015 and a minimum value of 2,005 in 1960. (FAO)

In line with the aim of this lecture to show the facts and the conjectures relating to animal protein in human nutrition, the lecture will compare vividly animal protein and plant protein in all the discourse.

Animal Protein

Protein according to Lexicon dictionary is a class of nitrogenous organic compounds which have large molecules composed of one or more long chains of amino acids; they are essential part of all living organisms, especially as structural components of body tissues such as muscle, hair /feathers, enzymes and antibodies. The word protein originated from the Greek word "Proteios" meaning prime or primary. British Nutrition Foundation stated that protein is essential for growth, repair of body tissues and maintenance of good health. Kubala (2018) stated that amino acids are the building blocks for proteins and are also needed for other vital processes like synthesis of hormones and neurotransmitters. Li (2007) stated the need for amino acid in the development of immune system. Enzymes that catalyze most metabolic activities in the body are all proteins.

Amino acids are physiologically essential precursors for the synthesis of proteins, peptides, and low-molecular weight substances (e.g., glutathione, creatine, nitric oxide, dopamine, serotonin, melanin, melatonin, and nucleotides) with enormous physiological importance, The human body needs twenty (20) amino acids, nine (9) of which are essential, i.e. they cannot be synthesized by the body. Kubala (2018) list of the essential amino acids include histidine, isoleucine, lysine, methionine, phenyalanine, threonine, tryptophan and valine.

Thus, amino acids are essential for the optimal growth, development, reproduction, lactation, and health and total well-being of humans. This is indicated by the fact that severe deficiency of protein leads to a metabolic disorder called kwashiorkor while severe deficiency of protein and energy results in another condition known as marasmus in humans, particularly in many children of developing nations. Dietary requirements of humans for amino acids are affected by dietary, environmental, physiological and pathological factors. For example, exercise enhances the oxidation of amino acids to carbon dioxide and, therefore, higher dietary requirements for amino acids (and proteins).

Protein also provides energy: 1 gram provides 17 KJ (4Kcal). Wu (2016) reported that on the basis of short term nitrogen balance studies the Recommended Dietary Allowance of protein for the healthy adult with minimal physical activity is currently 0.8 g protein/kg bodyweight/day, which represents only minimum daily average dietary intake that meets the nutrient requirements of nearly all (97.5%) healthy adults

Protein Assessment

According to Hoffman and Flavo (2004), the quality of a protein is vital when considering the nutritional benefits that it can provide. Protein quality is determined by assessing its essential amino acid composition, digestibility and bioavailability of amino acids (FAO/WHO, 1990). The methods used for protein quality assessment includes **protein efficiency ratio**, **biological value**, **net protein utilization** and **protein digestibility corrected amino acid score**. Hoffman (2004) described each of the methods as follows:

Protein Efficiency Ratio (PER)

The protein efficiency ratio (PER) determines the effectiveness of a protein through the measurement of animal growth. This technique requires feeding rats a test protein and then measuring the weight gain in grams per gram of protein consumed. The computed value is then compared to a standard value of 2.7, which is the standard value of casein protein. Any value that exceeds 2.7 is considered to be an excellent protein source. However, this calculation provides a measure of growth in rats and does not provide a strong correlation to the growth needs of humans.

Biological Value (BV)

Biological value measures protein quality by calculating the nitrogen used for tissue formation divided by the nitrogen absorbed from food. This product is multiplied by 100 and expressed as a percentage of nitrogen utilized. The biological value provides a measurement of how efficient the body utilizes protein consumed in the diet. A food with a high value correlates to a high supply of

the essential amino acids. **Animal sources typically possess a higher biological value than vegetable sources due to the vegetable source's lack of one or more of the essential amino acids.** There are, however, some inherent problems with this rating system. One problem of biological value is the fact that it does not take into consideration several key factors that influence the digestion of protein and interaction with other foods before absorption. Besides, biological value also measures a protein's maximal potential quality and not its estimate at requirement levels.

Net Protein Utilization (NPU)

Net protein utilization is similar to the biological value except that it involves a direct measure of retention of absorbed nitrogen. Net protein utilization and biological value both measure the same parameter of nitrogen retention, however, the difference lies in that the biological value is calculated from nitrogen absorbed whereas net protein utilization is from nitrogen ingested.

Protein Digestibility Corrected Amino Acid Score (PDCAAS)

Hoofman and Flavo (2004) based these assessment on joint position the Food & Agriculture Organization and World Health Organization (FAO/WHO) in 1989 in which they stated that protein quality could be determined by expressing the content of the first limiting essential amino acid of the test protein as a percentage of the content of the same amino acid content in a reference pattern of essential amino acids (FAO/WHO, 1990). The reference values used were based upon the essential amino acids requirements of preschool-age children. The recommendation of the joint FAO/WHO statement was to take this reference value and correct it for true fecal digestibility of the test protein. The value obtained was referred to as the protein digestibility corrected amino acid score (PDCAAS). This method has been adopted as the preferred method for measurement of the protein value in human nutrition (Schaafsma, 2000).

Table 2: U.S Dairy Export Council, Reference Manual for U.S. Cited in (Hoffman and Falvo 2005)

Protein Type	PER	BV	NPU	PCAAS
Beef	**2.9**	**80**	**73**	**0.92**
Black beans	**0**		**0**	**0.75**
Casein	**2.5**	**77**	**76**	**1.00**
Egg	**3.9**	**100**	**94**	**1.00**
Milk	**2.5**	**91**	**82**	**1.00**
Peanuts	**1.8**			**0.52**
Soy protein	**2.2**	**74**	**61**	**1.00**
Wheat gluten	**0.8**	**64**	**67**	**0.25**
Whey protein	**3.2**	**104**	**92**	**1.00**

Table 3: Proximate Composition of Some Animal Protein

Food Items	Carbohydrate	Protein	Fat	Ash	Water
1. Snail	2.93	20.7	1.21	1.49	73.7
2a) Beef	-	17.5	22.0	0.90	60.0

b). Pork	-	11.9	45.0	0.60	42.0
c). Lamb	-	15.7	27.7	0.80	56.0
3. Poultry					
a). Chicken	-	0.2	12.6	1.00	81.8
b). Duck	-	16.2	30.0	1.00	68.0
c). Turkey	-	20.2	20.2	1.00	79.5
4. Milk (Whole)					
a). Cow milk	5.0	3.50	3.80	0.70	87.3
b). Goat milk	4.5	3.80	4.80	0.80	86.4
5a) Egg white	-	10.5	Small	1.00	88.0
b). Egg yolk	-	15.5	33.5	1.00	49.5

Sources (Wosu, 2003)

It is imperative to assess the value of each of the animal protein sources on the basis of the measurements

Animal and Plant Protein Sources

Animal protein sources include

- Fish
- Egg
- Dairy product (Cheese, milk, whey)
- Red meat from cows, bison, deer, sheep, goat
- Poultry meat (Chicken, turkey, duck, quail)
- Meat from less common sources including pig, rabbit, hare, horses, donkey

Plant protein sources include

- Most legumes: Soya beans, Cowpea, black beans, groundnut, peas
- Wheat gluten
- Lentils
- Hemp
- Some grains including Maize,
- Nuts

Table 4: Protein quality rankings

Protein Type	PER	BV	NPU	PDCAAS
Beef	2.9	80	73	0.92

Black beans	0	0	0	0.75
Casein	2.5	77	76	1.00
Egg	3.9	100	94	1.00
Milk	2.5	91	82	1.00
Peanuts	1.8			0.52
Soy protein	2.2	74	61	1.00
Wheat gluten	0.8	64	67	0.25
Whey Protein	3.2	104	92	1.00

Adapted from: U.S Dairy Export Council, Reference Manual for U.S. Cited in (Hoffman and Falvo 2004)

Table 5: Amino Acid Profile of Plant and Animal Proteins

Food items	Carbohydrate	Protein	Fat	Ash	Water
1. Snail	2.93	20.7	1.21	1.49	73.7
2a) Beef	-	17.5	22.0	0.90	60.0
b). Pork	-	11.9	45.0	0.60	42.0
c). Lamb	-	15.7	27.7	0.80	56.0
3. Poultry					
a). Chicken	-	20.2	12.6	1.00	81.8
b). Duck	-	16.2	30.0	1.00	68.0
c). Turkey	-	20.2	20.2	1.00	79.5
4. Milk (Whole)					
a). Cow milk	5.0	3.50	3.80	0.70	87.3
b). Goat milk	4.5	3.80	4.80	0.80	86.4
5. Egg					
a) Egg white	-	10.5	Small	1.00	88.0
b). Egg yolk	-	15.5	33.5	1.00	49.5

- **Source: Wosu (2003)**

Complete Versus Incomplete Protein

A protein source that has all the nine essential amino acids (**histidine, isoleucine, lysine, methionine, phenyalanine, threonine, tryptophan and valine**) is said to be a **complete protein,** the food sources that do not contain the nine essential amino acids are referred to as **incomplete** protein.

- All animal proteins are Complete proteins

- Most plant proteins are Incomplete proteins (Few plant proteins lie Quinoa and Buckwheat has Complete protein)

Seven Important Nutrients Usually lacking in Plant Proteins

Foods that contain animal protein tend to be high in several nutrients that are often lacking in plant

protein sources. Arnarson (2017) reported on seven nutrients that cannot be obtained from plants

to include

- **Vitamin B12:** Vitamin B12also known as Cobalamin is mainly found in fish, meat, egg and dairy products. It is a water soluble vitamin involved in the development of red blood cells, maintenance of nerves and normal brain function. Vegetarians who do not take supplements of Vitamin B12 are at high risk of deficiency (Pawlak et al., 2013). The symptoms include weakness, impaired brain function (Tangney et al, 2011), neurological disorder (Grober et al., 2013), psychiatric disorder (Zucker et al 1981 cited in Arnarson (2017), neurological disorderin babies of breast feeding mothers Grattan-Smith et l., 1997) megaloblastic anaemia, Alzheimer's disease and sometimes heart disease (Woo et al, 2014). A few plants contain trace amounts of bioactive vitamin B12: Nori seawed, a typr of marine algae (Takenaka et al., 2001) and fermented soy product called tempeh (Denter and Bisping 1994)

- **Vitamin D:** Vitamin D is found in oily fish, eggs and dairy. Some plants contain it, but the type found in animal foods is better used by your body. Deficiency of Vitamin D is associated with Osteoporosis (Dobnig 2011) and rickets, Cancer (Lappe et al, 2007), heart disease (Giovanucci et al., 2008), multiple sclerosis (Faridar et al., 2012), depression (Kjaergaard et al., 2012), impaired brain function (Annweller et al., 2010), muscle wasting and reduced strength in old people (Stockton et al, 2011).

- **DHA:** Docosahexaenoic acid (DHA) is an essential omega-3 fat found in fatty fish. It is important for brain health and brain function. Inadequate in pregnant women adversely affects brain development in the child (Helland et al., 2003). It is hardly found in plant sources. However, Omega 3 fatty acid ALA found in high amount in Flaxseeds, Chia seed and Walnut can be converted to DHA, though the conversion is not efficient Zwarts et al., 1999). Thus, vegetarians have lower DHA than meat eaters (Sanders and Reddy 1992)

- **Heme-iron:** Heme-iron is **predominantly found in meat, especially red meat**. It is much better absorbed in the body than non-heme iron from plant foods (Valenzuela et al., 2009). The heme iron according to Arnarson (2017) stated that the heme iron is not only well absorbed but also improves absorption of non heme iron from plant foods. The phenonmenon is not well understood and is therefore called the **"meat factor".** The heme iron is not affected by anti-nutrients such as phytic acid often found in plant foods.

- **Creatinine: Creatinine according to Arnarson (2017) is a molecule found in animal foods, most of which is stored in the muscle, but significant amount is also found in**

the brain. Graham and Hatton (1999) stated that it functions as an easily accessible energy reserve for muscle cells giving them greater strength. Mawer (2017) reported that creatinine is the most effective supplement for increasing muscle mass and strength. Creatinine is not found in any plant based foods, so vegetarians only get it as supplements

- **Carnosine:** Carnosine is an antioxidant found in the muscle and brain. Its presence is very important in muscle function**.** Van et al., (2009) and Derave et al. (2007) observed that high levels of Carnosine in muscles are linked to reduced muscle fatigue and improved performance. Carnosine is only found in animal based foods. It is synthesized in the body from two amino acids: histidine and beta –alanine.

- **Taurine:** Taurine is a sulfur compound found in the brain, heart and kidney. It is only found in animal foods such as fish, seafoods, meat, poultry and dairy products. Although its function is not very clear, but scientisits believe it play some role in muscle function, bile salt formation and anti-oxidant defences. Vegetarians only get it through the use of supplements.

Other Usefulness of Animal Protein

Normal growth and formation of foetus

- Suboptimal growth was reported by United Nations Children's Fund, World Health Organization and World Bank Group (2016) cited in Pimpim et al (2019) as the most common forms of under-nutrition worldwide with manifestation including low birth weight, low childhood height and weight, stunting and wasting. Allen and Dror (2011) stated that for normal growth of fetus, sufficient dietary protein during pregnancy and early childhood is critical, in particular from animal sources due to their complete amino acid profile, contents, bioavailability of lysine, sulfur amino acids and threonine and associated insulin-like growth factors, iron, zinc and vitamin B12.

- **Enhancement of Liver function**
  Protein is important for the liver not only in promoting tissue repair, but to provide lipotropic agents such as methionine and choline for the conversion of fats to lipoprotein for removal form the liver (Navder and Leiber, 2003a). The importance of high protein diets has also been acknowledged for individuals with liver disease and who are alcoholics. High protein diets may offset the elevated protein catabolism seen with liver disease (Navder and Leiber, 2003b), while a high protein diet has been shown to improve hepatic function in individuals suffering from alcoholic liver disease (Mendellhall et al., 1995).

- **Height of a Nation is determined by their Animal Protein Consumption**

  Height is a complex trait, resulting from the interaction of the genes you inherit from your parents and the environment in which you grow and develop. While genetic variation explains between 60-80% of the variation in human height, the influence of the environment should not be underscored. A child's growth may fail to reach its genetic potential in an environment with nutritional and immunological challenges. This

was clearly demonstrated over 100 years ago by anthropologist Franz Boas who found that children born in the U.S. were taller than their foreign-born parents. Boas argued that the study of human growth was analogous to the study of the human condition. This thinking still predominates today because the United Nations (through the World Health Organization) uses height as a measure of health in developing countries and at-risk populations in developed countries. Human biologists study variation in height across populations found out that the Dutch and Montenegrins are the tallest men in Europe, measuring in at an average height of just over six feet (1.83 m). Scientists have been investigating the reason behind the above average height in two countries separated by nearly 2000 miles. Grasgruber et al (2016). Using data from 42 European nations, as well as the U.S., New Zealand, and Australia, found that the strongest predictor of male adult height was the population's protein index – **the amount of protein consumed from animal sources, such as dairy and pork, compared to proteins consumed from vegetable sources, such as wheat.** Thus, the above average height has been found not to be by genes on their Y-chromosome, but by a nutritional factor **called the protein index – the ratio of animal proteins to vegetable proteins.** From this discourse it is clear that t**he tallest populations were those that consumed more protein from milk, and less from plant proteins.**

The Fact and the Conjectures about Egg

Fig 1: Eggs

i. The Fact: Eggs are goldmine of Nutrients

Pigatto (2017) posited that one large egg has varying amounts of 13 essential vitamins and minerals, high-quality protein, all for 70 calories. He further stated that egg whites contain some of the eggs' high-quality protein, riboflavin and selenium, the majority of an egg's nutrient package is found in the yolk. Pigatto (2017) and many other researchers outlined the nutrients in yolk as follows:

- **Vitamin D**, critical for bone health and immune function. Eggs are one of the only foods that naturally contain vitamin D.

- **Choline**, essential for normal functioning of all cells, but particularly important during pregnancy to support healthy brain development of the fetus (Health Canada, 2012, Lewis et al. 2014). The choline in eggs plays an important role in breaking down the amino acid homocysteine which may contribute to heart disease (Mcintosh, 2019)
- **Folic acid:** Mcintosh (2019) report which was medically reviewed by Katherine Marengo showed that eggs contain folic acid which helps in maintaining a healthy pregnancy by preventing congenital disabilities such as spina bifida.
- **Lutein and zeaxanthin**, antioxidants that are believed to reduce the risk of developing cataracts and slow the progression of age-related macular degeneration, a disease that develops with age. One of the best ways to promote eye health is to eat a nutritious, balanced diet. Eggs are a source of lutein and zeaxanthin (252 mcg per large egg), two carotenoids important for eye health.
- **Vitamin A**: Health Canada (2012) stated that egg is an excellent source of Vitamin A, an important vitamin that helps to maintain healthy skin and eye tissue. It helps the immune system, the heart, the lungs and the kidney to work properly.
- **Iron**: An essential mineral for sense of wakefulness and alertness, needed for transport of oxygen in red blood cell is found in eggs/ Health Canada (2012). According to the report, both the heme and non –hem types of iron are found in eggs, making it readily absorbable by the body compared to plant proteins.
- **Omega 3- fatty acids**: Eggs also supply omega-3 fatty acids, mainly in the form of docosahexaenoic acid (DHA). DHA helps maintain brain function and vision (Mcintosh, 2019). These fatty acids are most common in oily fish. Eggs can provide an alternative source for people who do not eat fish.

Gunnars (2018) stated that egg is loaded with nutrients, some of which are rare in modern diets. According to him a single large boiled egg contains

- **Vitamin A** :6% of the RDA
- **Folate:** 5% of the RDA
- **Vitamin B5:** 7% of the RDA
- **Vitamin B12:** 9% of the RDA
- **Vitamin B2:** 15% of the RDA
- **Phosphorus:** 9% of the RDA
- **Selenium:** 22% of the RDA

This comes with 77 calories, 6 grams of protein and 5 grams of healthy fats. Other health benefits of eggs include: Jo Lewin a registered nutritionist at University of Westminster in 2010 stated that eggs are rich sources of selenium, vitamin D, B6, B12 and minerals such as zinc, iron and copper. According to her the egg yolk is a source fat-soluble vitamins A, D, E and K as well as lecithin a compound that enables emulsification in recipes such as hollandaise and mayonnaise.

Improved growth in young children: Iannotti et al. (2017) stated that early introduction of eggs significantly improved growth in young children, thus egg has the potential to contribute to global targets to reduce stunting. They further stated that giving young children just one egg a day for six months, alongside a diet with reduced sugar-sweetened foods may help achieve a healthy height and prevent stunting.

Healthy immune system: The vitamin A, vitamin B12 and selenium in eggs play a major role in keeping the immune system healthy (Mcintosh, 2019)

Skin health: Some vitamins and minerals in eggs help promote healthy skin and prevent the breakdown of body tissues. A strong immune system also helps a person look and feel well.

Weight loss and maintenance: The protein in eggs can help people feel full for longer. This can reduce the urge to snack and lower a person's overall calorie intake.

According to the United States Department of Agriculture (USDA), one medium boiled or poached egg weighing 44 g can provide the following nutrients:

- Energy: 62.5 calories
- Protein 5.5 grams (g)
- Total fat: 4.2 g, of which 1.4 g are saturated
- Sodium: 189 milligrams (mg)
- Calcium: 24.6 mg
- Iron: 0.8 mg
- Magnesium 5.3 mg
- Phosphorus: 86.7 mg
- Potassium: 60.3 mg
- Zinc: 0.6 mg
- Cholesterol: 162 mg
- Selenium: 13.4 micrograms (mcg)
- Lutein and zeaxanthin: 220 mcg
- Folate: 15.4 mcg

While meat can also be a good source of protein, it may contain high levels of less healthful elements, such as saturated fat.

ii. The Conjectures About Egg

▶ **High Cholesterol Content**

Cholesterol has been a fixture in dietary warnings in the United States at least since 1961, when it appeared in guidelines developed by the American Heart Association leading to 30% drop in egg consumption. One **medium egg typically contains 162 mg of cholesterol (Dawuda, 2016). Gunnars (2019) reported 186mg of cholesterol** which is 62% of the RDI. **In the past, experts recommended limiting the intake of eggs for this reason.** However, researchers have not found a link between egg consumption and the risk of heart There are two types of cholesterol: low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Dawuda (2016) stated that the liver synthesize 70-80% of cholesterol and the one made by the body has more LDL (Bad Cholesterol) which is more harmful

"Good Cholesterol" (HDL cholesterol) appears to reduce levels of "bad" LDL cholesterol. Cholesterol found in egg are more of HDL

Consuming eggs appears to increase levels of HDL cholesterol and reduce levels of LDL cholesterol (Dawuda, 2016)

US New Stand on Egg Consumption

The *Washington Post* on February 10, 2015 post delivered the message that "The U.S. government is poised to withdraw longstanding warnings about cholesterol**".** Scientific Report of the 2015 Dietary Guidelines Advisory Committee:

"Previously, the Dietary Guidelines for Americans recommended that cholesterol intake be limited to no more than 300 mg/day. The 2015 DGAC will not bring forward this recommendation because available evidence shows no appreciable relationship between consumption of dietary cholesterol and serum (blood) cholesterol, consistent with the AHA/ACC (American Heart Association / American College of Cardiology) report. Cholesterol is not a nutrient of concern for overconsumption

This information about cholesterol guidelines has been well known since Uffe Ravnskov, MD, PhD blew open the Pandora'sbox when he published his book *Kolesterolmyten* (*"The Cholesterol Myths"*) in Sweden in 1991 and in Finland in 1992**.**

- **Hardick (2015) stated that all the report on "CHOLESTEROL GUIDELINES MISLED THE WORLD"**
- **Dr. Steven Nissen, chairman of cardiovascular medicine at the Cleveland Clinic, told CNN: "The idea we need to limit saturated fat and cholesterol shifted Americans from a well-balanced diet to high-sugar diets, which made people eat more and get fatter."**
- **The reality, according to Nissen, is that only 15% of circulating cholesterol in the blood comes from what you eat. The other 85% comes from the liver. "So if you go on a diet," he says, "you're not changing your cholesterol very much**

iii. **Conjectures About Vegetarian Diet**

Conjectures that vegetarian diet

- Help to lower body weight, cholesterol and blood pressure levels.
- Lower risk of stroke, cancer and death from heart disease than non-vegetarians
- Reduced Risk of Type 2 Diabetes
- Protection Against Weight Gain

Seven important nutrients in animal protein that are not found in plant protein according to Arnarson (2017) are already stated above, so vegetarians often use food supplements to make up for these nutrients. This means that it will be costlier to maintain a vegetarian life style, besides most of the nutrients are more absorbable in their natural forms than as synthetic supplements.

Health Challenges Associated with Vegetarian Diet

Apart from shortage of the seven important nutrients found only in animal protein, vegetarian diet has some other limitations, paramount in this discourse are the anti-nutritional factors such as

trypsin inhibitors, lectins, and tannins present in certain protein sources such as soybean meal, peas and fava beans which have been reported to increase losses of endogenous proteins at the terminal ileum (Salgado et al., 2002). These anti-nutritional factors may cause reduced protein hydrolysis and amino acid absorption. Other anti-nutritional factors in plant proteins include phytohaemaglutinins, goitrogen, glycosides. Vegetarians also suffer

- Zinc Deficiency
- Hair loss
- Deficiency of the heme factor in red meat

iv. **Conjectures about the Red Meat**

- **Several observational studies have linked red meat consumption to an increased risk of heart disease, CVD (Myocardical infarction, stroke**
- **Coronary heart disease, cancer and early death (Cross et al. 2007, Mcafee, 2010)**
- **Linked with type 2 diabetes (2011 Study by Harvard University)**
- **Shortened lifespan** (**Melone 2014)**
- Zeraatkar, (2019) and other authors observed inconsistencies in all the studies that associated red meat with CVD diseases. According to him,

i. Studies did not specify the amount or portion of meat used when determining the risk for CVD

ii. In many of the studies there was no correlation between cholesterol in the blood and red meat consumption

iii. Traditional population like Masai have eaten more red meat than the average Westerner but remained in excellent health

Of all the red meats the most commonly eaten is beef, Arnarson (2017) posited that beef contains 26-27% crude protein and a major source of five B Complex vitamins: (Thiamin, riboflavin, niacin, vitamin B6 and B12)

- One hundred gram(100g) portion of raw ground beef contains (10% fat)
- Vitamin B3 (niacin): 25% of the RDA
- Vitamin B12 (cobalamin): 37% of the RDA (this vitamin is unattainable from plant foods)
- Vitamin B6 (pyridoxine): 18% of the RDA
- Iron: 12% of the RDA (this is high-quality heme iron, which is absorbed much better than iron from plants)
- Zinc: 32% of the RDA
- Selenium: 24% of the RDAPlenty of other vitamins and minerals in smaller amounts
- Red meat is also rich in important nutrients like creatine and carnosine. Non-meat eaters are often low in these nutrients, which may potentially affect muscle and brain
- Grass-fed beef is even more nutritious than grain-fed beef, containing plenty of heart-healthy omega-3s, the fatty acid CLA and higher amounts of vitamins A and E

An American Nutritionist Michael Joseph that publishes the Nutrition Advance website in the US which provides independent, evidence-based nutrition and health information backed by peer-

reviewed studies as evidence of the benefits of beef in human nutrition. He listed eleven benefits of beef in human nutrition. According to him,

i. *Beef Provides a Large Source of L-Carnitine*

L-carnitine is an amino acid that occurs naturally in meat products. The table developed by Michael Joseph below shows the L-carnitine content of beef compared to some other animal and plant foods;

L Carnitine Food Source	Amount of L-Carnitine (mg)
Asparagus (1/2 cup)	0.1
Beef (4oz)	**56 – 162**
Cheese	2
Chicken Breast (4oz)	3 – 5
Cod (4oz)	4 – 7
Ice-Cream (1/2 cup)	3
Whole Milk (1 cup)	8
Whole Wheat Bread (1 slice)	0.2

Among other functions, L-carnitine plays a part in fat metabolism.

As part of this, L-Carnitine does the job of transporting fats into our mitochondria for burning.

It's important to clarify that our body can synthesize sufficient amounts of L-carnitine for general needs; this makes it a non-essential amino acid. The body synthesizes L-Carnitine within the liver and the process relies on the amino acids L-lysine and L-methionine Pekala et al 2011).

As a result, deficiencies are rare. However, research suggests that a higher dietary intake of L-Carnitine may have some positive health impacts. Song et al (2017) reported that L-carnitine is associated with a 27% reduction in all-cause mortality in heart failure patients while Casariego (2013) reported that higher L-carnitine intake in type 2 diabetes patients improves fasting glucose levels and the overall cholesterol profile **in diabetic patients. Similarly,** Pouyandjoo **et al (2016)following a**systematic review and meta-analysis of nine randomized controlled trials, stated that subjects using L-carnitine supplementation lost "significantly more weight" than the control group According to them,there are many L-carnitine supplements around, the absorption

rate is poor in comparison to beef.The body only absorbs around 14-18% of the **synthetic form** of the nutrient.

2. Beef Provides the "Master Antioxidant" Glutathione

Joseph Pizzorno, Editor in Chief of Integrative Medicine: A Clinical Journal stated that glutathione is a master antioxidant and reported five major benefits of glutathione

- Anti-aging benefits
- Increasing longevity
- Preventing illness
- Reducing the risk of chronic disease
- Strengthening the immune system

According to Wu et al (2004) a deficiency in glutathione contributes to oxidative stress and inflammation, keeping glutathione levels high is important for our overall health. Lim et al (2007) showed that the body needs adequate levels of the amino acids cysteine, glutamate, and glycine foe endogenous production of glutathione, these amino acids are known as glutathione precursors and each of the amino acids is present in beef

3. Beef is Extremely Rich in Minerals

Joseph (2017) reported that beef is relatively nutrient-dense in minerals and eighty percent 80% lean beef has the following array of minerals

Mineral Name	Amount per 6oz portion (% RDA)
Calcium	4
Copper	8
Iron	26
Magnesium	10
Manganese	2
Potassium	18
Phosphorus	38
Selenium	52
Zinc	72

4. Eating Beef Helps Prevent Iron Deficiency Anemia

Joseph (2017) reported on two types of irons available in foods: **Heme and Non-Heme Iron. While the**Heme iron is the most bioavailable form of iron, and meat and other animal foods exclusively contain it., the non heme iron is found in plant based foods such as fruit, vegetables, and nuts. The heme iron have been reported to be easily absorbable compared to non heme iron. According to Joseph (2017), one of the best health benefits of beef meat is that it contains a substantial amount of heme iron.

5. Beef Contains Carnosine, a Potent Amino Acid

Another important health benefit of beef as reported by Joseph (2017) is the abundance of carnosine. Carnosine (beta-analyl-L-histidine) is an amino acid found throughout the body, and it has several important roles in human health. Beef is one of the highest sources of carnosine (containing about 50% more than poultry), this is another health benefit (Joseph 2017).

Carnosine reduces the harms of a process called 'glycation' which involves advanced glycation end-products (AGES) which is central to aging and progressive damages to the body, leading to atherosclerosis and various other chronic diseases (Bingul et al 2017). Carnosine also boosts the immune system and at the same time help to reduce inflammation (Aydin et al 2015).

6. Beef is Full of Vitamins

There are many important vitamins in beef (Joseph 2017) but the ones present in significant amounts include the range of B vitamins

Vitamin Name	Amount Per 6oz Portion (% RDA)
Vitamin B12	82
Vitamin B3	50
Vitamin B6	36
Vitamin B2	18
Vitamin B5	14

Vitamin B12 (cobalamin) is a notably essential nutrient, and it is available only in foods of animal origin. Pawlak et al., (2013) outlined the health benefits of Vitamin B12, while Tangney et al, (2011) listed the health implications of its deficiency. Joseph (2017) stated that 6oz serving of beef provides almost 100% of the recommended amount of B12. Additionally, beef also contains smaller amounts of vitamins E and K.

7. Conjugated Linoleic Acid (CLA)

CLA, conjugated linoleic acid is a naturally occurring trans-fat which helps to improve insulin sensitivity. CLA appears to promote fat loss Riserus et al (2001). Lehnen et al (2015) stated that the bulk of available research evidence suggests that getting CLA from real food is better than supplementation and the major top sources of CLA include meat and dairy products.

8. Beef Contains the Performance Enhancer Creatine

Dietary supplementation of creatine is very common, but beef contains creatine too, According to Purchas et al (2005) beef typically contains 350mg creatine per 100g

Joseph (2017) listed the health benefits of creatine to include

- Improved exercise performance
- Creatine assists in muscle growth and development
- Provides muscles with greater energy supply and improves endurance
- Increased muscular size

Creatine precursors include arginine, glycine, and methionine and Brosnan et al (2011) noted that all of these amino acids are not only present in beef, but beef is one of the single most significant dietary sources for them. Thus eating beef gives you a decent amount of dietary creatine, and it helps your body to produce it too.

Processed Versus Unprocessed Red Meat

- Processed meats according to WHO definitions are any meats that are not fresh. People typically think of processed meat as only referring to pork and beef, but this category can also include poultry (chicken, turkey, duck) and fish
- Meats that are modified from its natural state, either "**through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservatio**n includes sausages, hot dogs, corned beef, beef jerky, canned meat, meat sauces, lunch meats and bacon

Processed meats

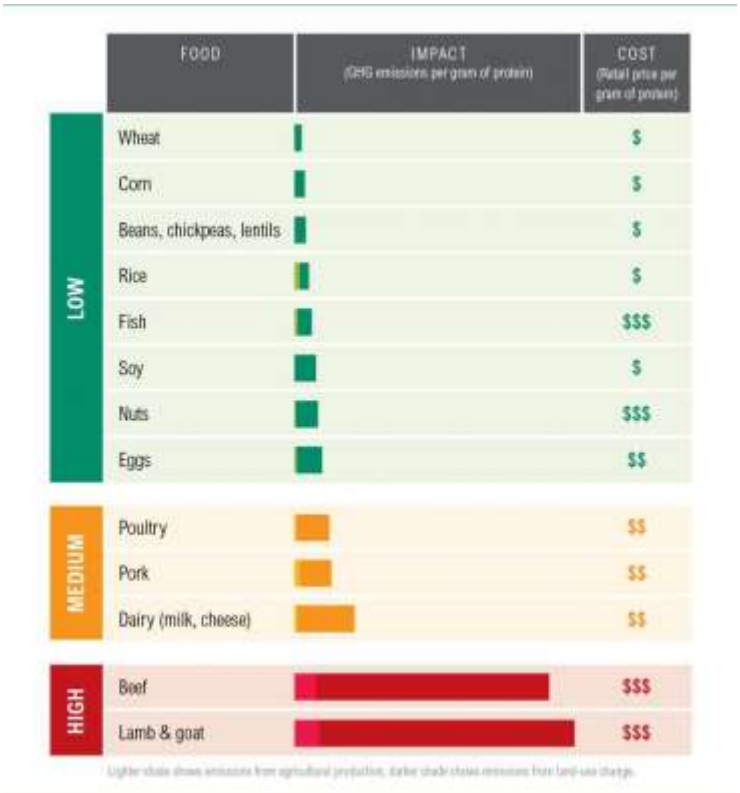
However, further research has suggested that the problem is not with all red meat, but rather with PROCESSED RED MEAT. In a large observational study including 448,568 individuals, processed meat was linked to an increased risk of death, with no effect for unprocessed red meat. Another study involving over 34,000 women made similar observations. In this case, processed meat was associated with heart failure. Also, a large review of 20 studies found that processed meat was associated with an increased risk of heart disease and diabetes. Again, no association was found for unprocessed red meat.Dr George Mann 1964 cited in Gunnars , 2018, earlier stated that unprocessed red meat consumption is not linked to heart disease because the Masai people eat red meat all through their lives and hardly suffer heart related diseases like artherosclerosis. Even though, Thomas Campbell of Centre of Nutrition Campbell took a closer look in his paper titled "Masai and Inuit High-Protein Diets: A Closer Look", but he concluded without any concrete evidence as for or against the claims of Dr. George Mann.

These types of studies can only demonstrate correlation, or that two variables are associated or linked. They can tell us that individuals who eat a lot of red meat are more likely to get sick, but they cannot prove that red meat is the cause. One of the main problems with such studies is that they are plagued by various confounding factors. For example, people who eat red meat are less health-conscious and more likely to smoke, drink excessively, eat more sugar, and exercise less. People who are health-conscious behave very differently than people who are not, and it's impossible to correct for all of these factors. Another problem with observational studies is that they're usually based on food frequency questionnaires, in which people are expected to remember what they ate in the past. **There is difficulty in accurately measuring meat intakes, since in the modern world meat is typically consumed as part of a composite meal, containing various non-meat components such as vegetables, pasta, legumes or potatoes**

Recent findings showed that earlier assessment of total meat intakes failed to account for the weight of non-meat components of meat dishes and products resulting in a 43% overestimation of total meat intakes by the NSIFCS and a 32% overestimation by the National Survey of Health and Development (NSHD) (Prynne, et al., 2009).

Animal Protein Production and the Environment

The Nutrition Source a publication of Harvard T.H. Chan School of Public Health noted agriculture is a major contributor to GHG emissions and that different foods can have different inputs on human health and also different impacts on the environment. The report also showed that the production of animal based foods contribute more GHG compared to producing plant-based foods and dairy



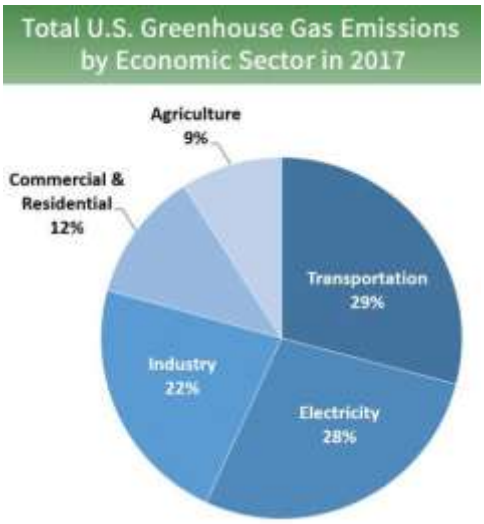
Source: World Resources Institute, www.wri.org/proteinscorecard

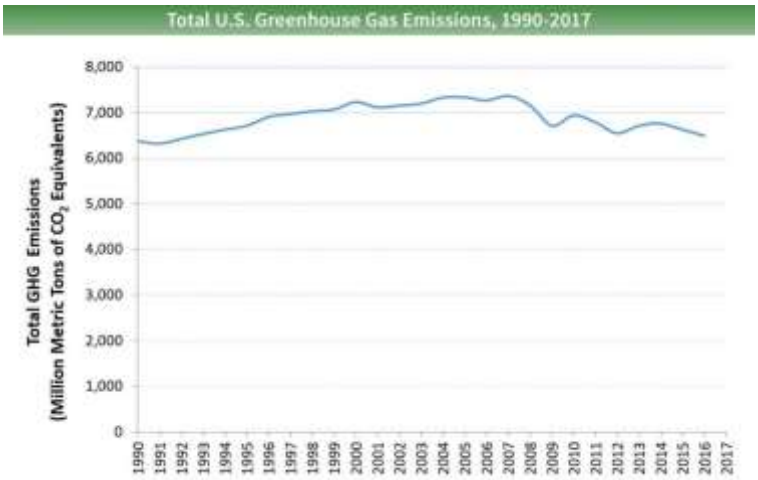
The World Resource Institute (WRI, 2018) scorecard illustrated the differing GHG emissions per gram of protein from both animal and plant based protein foods. This Scorecard of 2018 posited that making one pound (454 grams) of lamb generates five times more GHGs than making a pound of Chicken and around 30 times more than making a pound of lentils. Carol Smith of United Nations University in her publication of 2014 titled "New Research Says Plant- based Diet Best for the Planet and the People" also reported that emissions per gram of protein for beef and lamb are about 250 times greater than those of legumes, pork, chicken, dairy and fish. She also stated that 20 servings of vegetables have fewer emissions than one serving of beef, Similarly, Culinary Institute of America and Harvard T.H. Chan School of Public Health in 2016 stated that beef accounted for 36% of all foods related GHG emissions. The livestock sector requires a significant amount of natural resources and is responsible for about 14.5% of total anthropogenic greenhouse gas emissions (7.1 Gigatonnes of carbon dioxide equivalents for the year 2005; Grossi et al. 2017). The most important greenhouse gases from animal agriculture are methane and nitrous oxide. Methane, mainly produced by enteric fermentation and manure storage, is a gas

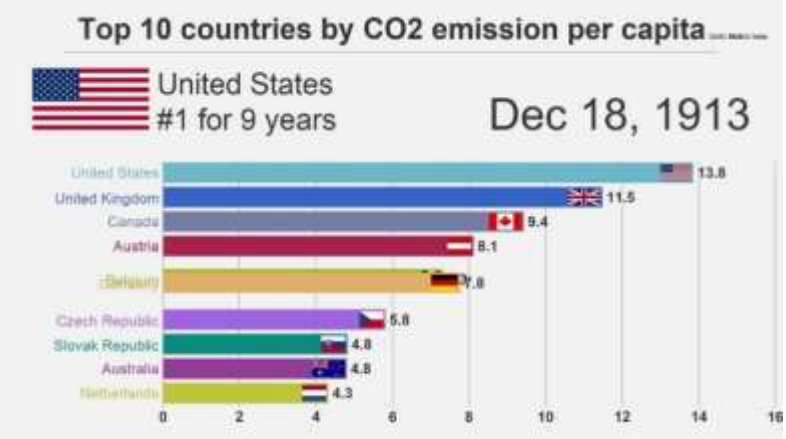
which has an effect on global warming 28 times higher than carbon dioxide. Nitrous oxide, arising from manure storage and the use of organic/inorganic fertilizers, is a molecule with a global warming potential 265 times higher than carbon dioxide. The carbon dioxide equivalent is a standard unit used to account for the global warming potential (IPCC, 2013 and Grossi et al. 2017). Soil carbon dioxide emissions are due to soil carbon dynamics (e.g., decomposing plant residues, mineralization of soil organic matter, land use change, etc.), the manufacturing of synthetic fertilizers and pesticides, and from fossil fuel use in on-farm agricultural operations (Goglio et al., 2018). Nitrous oxide emissions are emitted when organic and inorganic fertilizers are applied to the soil.

Another ancillary of the livestock industry implicated in GHS is the feed production and processing units which contributes about 45% of the whole sector (3.2 Gigatonnes of carbon dioxide equivalents). Enteric fermentation producing about 2.8 Gigatonnes (39%) is the second largest source of emissions. Manure storage with 0.71 Gigatonnes accounts for about 10% of the total. The remaining 6% (0.42 Gigatonnes of carbon dioxide equivalents) is attributable to the processing and transportation of animal products (Gerber et al., 2013).

United States Environmental Protection Agency






Top 10 countries by CO2 emission per capita
United States
#1 for 9 years
Dec 18, 1913
United States
United Kingdom
Canada
Austria
Belgium
Czech Republic
Slovak Republic
Australia
Netherlands
13.8
11.5
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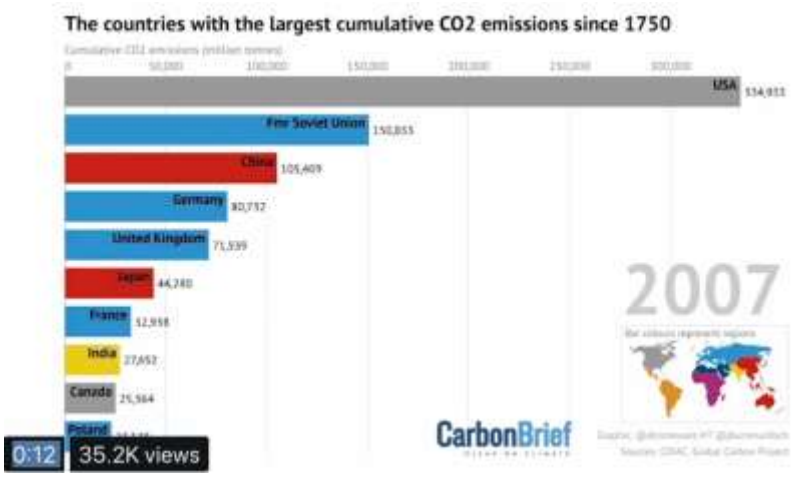
The countries with the largest cumulative CO2 emissions since 1750
USA
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Japan
France
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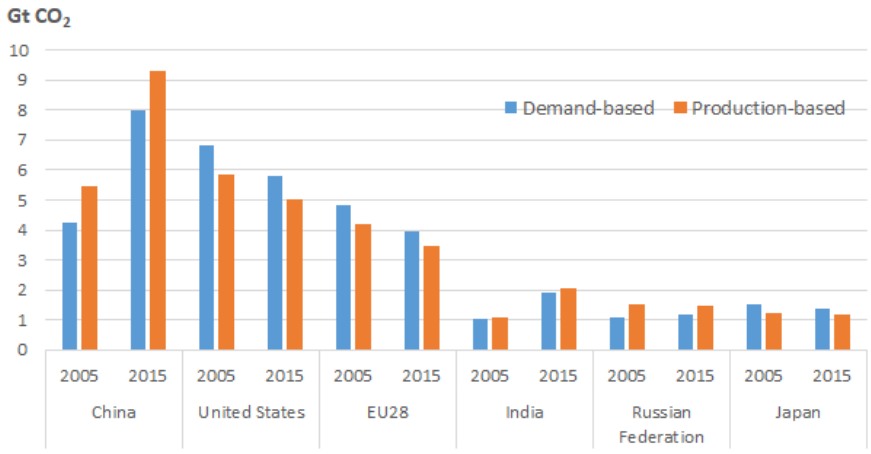
Gt CO2
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Demand-based
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India
Russian Federation
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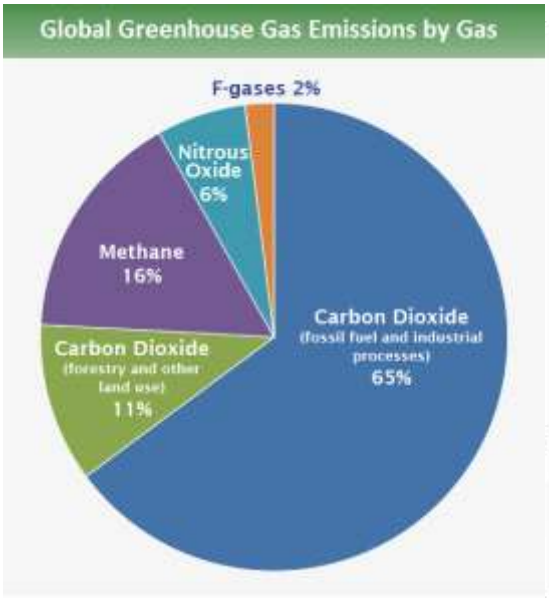
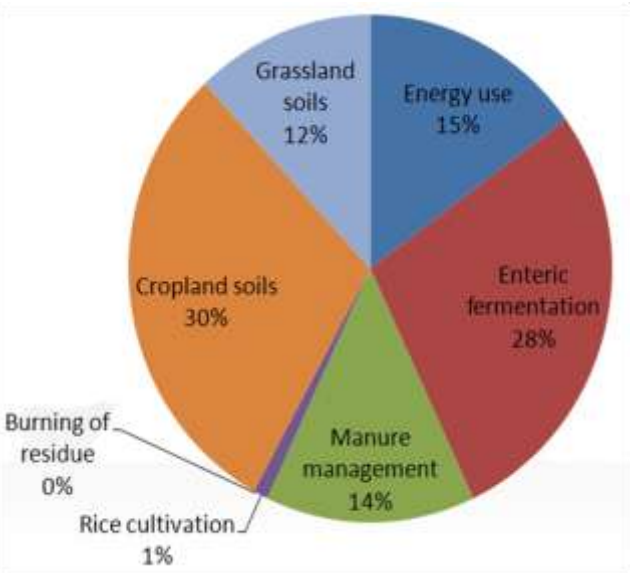




Other Remarkable Quotes Corroborating Emissions from Livestock Industry

- A cow on the average release between 70 and 120 kg of Methane per year.
- The negative effect on the climate of Methane is 23 times higher than the effect of CO2. Therefore, the release of about 100 kg Methane per year foreach cow is equivalent to about 2,300 kg CO2 per year.
- According to the *Food and Agriculture Organization of the United Nations* (FAO) agriculture is responsible for 18% of the total release of greenhouse gases world-wide (this is more than the whole transportation sector).
- Henning Steinfeld, Chief of FAO's Livestock Information and Policy Branch and senior author of the report: "Livestocks are one of the most significant contributors to today's most serious environmental problems. Urgent action is required to remedy the situation.

1 kg of meat from	Produces kg CO2e
Beef	**34.6**
Lamb	**17.4**
Pork	**6.35**
Chicken	**4.57**

- A Japanese study showed that producing a kilogram of beef leads to the emission of greenhouse gases with a global warming potential equivalent to 36.4 kilograms of carbon dioxide (CO2).
- Around 1.6-2.7 billion tonnes of greenhouse gases each year, mostly methane, are produced from livestock digestion (Herrero, 2016a)
- Another 1.3-2.0 billion tonnes of nitrous oxide come from producing feed for livestock. (Herrero, 2016b)
- The final 1.6 billion tonnes comes from land use changes, such as clearing for animal pastures.
- Emissions from livestock production vary across the globe. The developing world accounts for 70% of emissions, mainly because of the large numbers of animals used for a variety of purposes beyond production of meat, milk and eggs.

GHG Mitigation Measures in the Livestock Industry

Herrero et al. (2016b) publication in Nature on Climate change titled Green House Mitigation Potentials in the Livestock Sector" noted that the livestock sector supports 1.3 billion producers and contributes 40-50% of agricultural GDP and the mitigation potentials within the sector is large but might be costly and thus they propose more research and investment that will increase the affordability and adoption of themitigation measures.FAO 2013 gave a rundown of all mitigation measures necessary in reducing GHG emissions from the livestock sector.

It seems likely that emissions from livestock could be reduced by around 2.4 billion tonnes of greenhouse gases each year through technology and management. The Department of Primary Industries and Regional Development of Agriculture and Food in the Government of Western Australia posited that there are four main approaches to mitigating livestock GHG emissions

- **Husbandry (animal breeding, feed supplements, improved pastures)**
- **Management systems (stocking rates, biological control)**
- **Numbers of livestock**
- **Manure management**

i. Husbandry

a). Animal Breeding

According to the Department of Primary Industries and Regional Development of Western Australian Government, there are variations among animals in methane emissions per unit of feed intake and these variations suggest that there may be heritable differences in methanogenesis (methane production). Trials suggest that animal breeding could achieve a 10–20% reduction in methane emissions. Haque (2018) reported that several studies have demonstrated a substantial variation in CH_4 production in sheep and cows (Clark et al 2005), which may be linked to phenotypic traits and heritability. This animal variation in CH_4 production suggests a possibility of breeding animals with low CH_4 emission. Some authors believe that breeding for reduced methanogenesis may not be compatible with other breeding objectives, however, breeding for

improved feed conversion efficiency (lower net feed intake) should be compatible and is likely to reduce methane emissions and the greenhouse gas intensity of animal products

b). Feed Supplements

A range of dietary supplements and feed alternatives is being tried to assess whether they can reduce methane emissions from livestock. Supplements being considered include oils, fats, tannins, probiotics, nitrates, enzymes, marine algae

- **Fat supplementation**

Cattle farmers has traditionally used fat supplementation in increasing the dietary energy content to meet the energy demand of high-producing dairy cows. Today scientists are employing this measure CH_4 mitigation. The idea is that if the energy supplementation in a ruminant's diet is changed from carbohydrate to fat, then less fermentation and CH_4 production will occur. According to Haque (2018) suppressing mechanism of fat is induced by reducing organic matter fermentation, fibre digestibility and consequently the methanogenic pathway and by the direct inhibition of methanogens in the rumen via the hydrogenation of unsaturated fatty acids

- **Organic acids**

Many researchers have also proposed the usefulness of organic acid the intermediate of carbohydrate degradation in reducing GHG emissions in ruminant Oliveira (2011) posited that organic acids stimulate propionic acid production in the rumen by acting as an H_2 sink, thereby reducing the amount of CH_4 Newbold (2005) tested 15 propionate precursors in vitro and concluded that the structure appears to be more effective as an H_2 sink that can reduce CH_4 up to 17%.

- **Essential oils**

Essential oilsderived from thyme, oregano, cinnamon, garlic, horse radish, rhubarb and fragula (Benchar et al. 2011) have been found capable of reducing GHG emissions in ruminants. Essential oils are part of plant secondary metabolitesdescribed with certain characteristics: volatile compounds and aromatic lipophilic compounds with very strong antimicrobial properties with the ability to inhibit the growth and survival of most of microorganisms in rumen. Ku- Vera (2020) described essential oils as volatile consituents of terpernoids or non terpenoid origin which impair energy metabolism of archea capable of reducing enteric methane emissions in ruminants up 26%. Thus decrease in methanogenesis with the application of essential oil is due to reduction in microbial populations. Methane abatements of 10–25% are possible by feeding ruminants dietary oils, with 37–52% abatement achieved in individual studies (Eckard et al., 2010)

- **Exogenous enzymes**

Beauchemin and Kreuzer et al (2008) reported that enzymes, such as cellulase and hemicellulase, are currently being used in ruminant diets and that when properly formulated, can improve fibre digestibility and animal productivity. This is because enzymes can improve fibre digestibility thus lowering the acetate: propionate ratio in the rumen, ultimately reducing CH_4 production. Thus, Beauchemin, and Kreuzer (2008) suggested the possibility of developing a commercial enzyme additive to reduce CH_4. However, searching for potential enzymes for methane abatement warrants future research.

c). Improved pasture

Improved forage quality with lower fibre and higher soluble carbohydrates can reduce methane production in livestock. Being structural fibres, cellulose and hemi-celluloses ferment more slowly than non-structural carbohydrates and yield more methane per unit of feed digested.

Pasture quality can be improved in several ways including by plant breeding, changing from C4 tropical grasses to C3 temperate grasses can lower methane emissions. Suybeng (2019) that ruminants fed on C4 grasses produced 17% methane asL/kg unit increases..

Legume rich forage tend to reduce GHG emissions. Ku-Vera et al. (2020) stated that legumes containing tannins such as *Leuceana leucocephala* have shown a good methane mitigating effect when fed at levels of up to 30-35% of ration dry matter in cattle as a result of effect of condensed tannins on rumen bacteria and methanogens. Other tropical legumes with GHG mitigating potentials are *Enterolobium cyclocarpum*, and*Samanea saman* which contain saponins. Saponins disrupt the membrane of protozoa thus decreasing the numbers of both protozoa and methanogens. Plant secondary compounds, such as condensed tannins, saponins etc can reduce methane production by 13–16%, mainly through a direct toxic effect on methanogens (Min and Brauer 2020).

iv.Management Systems

a). Stocking Rates

- Reducing the number of unproductive animals on a farm can potentially improve profitability and reduce greenhouse gas emissions. If productivity increases through nutritional and breeding strategies, the number of livestock can be reduced without losing the quantity of meat that is currently produced.
- Strategies such as extended lactation in dairying – where cows calve every 18 months rather than annually – reduce herd energy demand by 10%, and so potentially reduce methane emissions by a similar amount. With earlier finishing of beef cattle in feedlots, slaughter weights are reached at a younger age, with reduced lifetime emissions per animal and proportionately fewer animals producing methane.

b) Biological Control

Three biological control methods are being examined for their ability to reduce methane production from livestock

- Using viruses to attack the microbes which produce methane

- Specialised proteins to target methane-producing microbes

- Other microbes (methanotrophs) to break down the methane produced in the rumen into other substances.

Bovine somatotropin and hormonal growth implants– does not specifically suppress methane formation, but rather improves the animal's performance and reduces the greenhouse gas intensity of the products.

iii. Manure management

It has been reported (Department of Primaries and Industries Australia) that urine and manure of livestock are significant sources of methane and nitrous oxide when broken down under anaerobic conditions**.** Measures to mitigate these two GHGs in livestock farms include

- Breeding animals to improve nitrogen efficiency
- Manure stockpile should be turned regularly for aeration and composting reduces emissions
- Adding urease inhibitors to manure stock pile to reduce rate of conversion of urea to nitrous oxide
- Use of manure for vermiculture, black soldier fly farming and maggot production
- Treatment of waste with effective microorganism technology (EMT)
- Capture of methane from waste into useful biogas

iv. **Insect Protein: For Augmentation of Animal Protein**

FAO (2008) (cited in Van Huis (2013) recommended insects as alternative source of food, capable of meeting the animal protein demands of a growing population while preserving the environment. As a follow up to the FAO workshop in Chiang Mai in 2008, the Non-Wood Forest Products Programme of the FAO Forestry Department and the Wageningen University and Research Centre (WUR) (Laboratory of Entomology) initiated a collaborative effort to promote entomophagy;The Royal Geographical Society report on the food benefits of edible insects and entomophagy stated that nearly one third of the grain harvested worldwide is used to feed livestock and the efficiency of conversion of feed to protein is not as efficient as that of insects : approx. 10 kg of feed = 1 kg of beef

Insects possess much higher levels of efficiency (approx. 10 kg of feed = 9 kg of crickets), and unlike cattle and poultry, insects can be fed on organic waste and plant material which would otherwise be discarded. Insects require much less water and energy to farm and can be cultivated at much higher densities than conventional livestock. Besides, animal protein production from insect is environmentally friendly.

Livestock also requires large amount of water, grains used in feed formulation required about 1000 - 5000kg of water to grow depending on the region (Chapagain and Hoekstra, 2003). Livestock itself contains between 5 and 20 times more water per kg product (Chapagain and Hoekstra, 2003).

Nutritional, medicinal values and industrial uses of some edible insects (Ekpo and Onigbinde, 2004; Ekpo and Onigbinde, 2005; Banjo et al., 2006; Edijala *et al*., 2009; Alamu, 2014; Mba and Elekima 2007; Ebenebe and Okpoko, 2014, Schabel,2010). According to Braide *et al.* (2010) protein content of edible insects ranged from 21 – 65% and therefore compares favourably with meat and fish proteins. Igwe *et al.* (2011) also reported that insect larvae are rich in essential amino acids like lysine and threonine which are deficient in grain and cereals. Similarly, Ekpo and Onigbinde (2004) had earlier reported that edible insect larvae are rich in essential fatty acids like linoleic and linolenic acids. Igwe *et al.* (2011) reported on vitamin content of edible insects.

Apart from the nutritional and medicinal benefits, there are other ecological, magical and spiritual benefits of insects;

v. The Divine Angle

Who Is Wiser Than God

- Leviticus 11: 1 – 26 (KJV)

  [1]And the Lord spake unto Moses and to Aaron, saying unto them, [2] Speak unto the children of Israel saying, these are the beasts which ye shall eat among all the beasts that are on the earth

- **[3]Whatsoever parteth the hoof and is cloven footed and cheweth the cud, among the beasts, THAT YE SHALL EAT**

- Prov 27:27And thou shalt have goats' milk enough for thy food, for the food of thy household and for the maintenance for thy maidens

- Mark 7: 15

"There is nothing from without a man, that entering into him can defile him; but the things which come out of him, those are they that defile the man".

Luke 11: 11b- 12

"If he asks a fish, will he for a fish give him a serpent? 12 Or if he shall ask an Egg, will he offer him a scorpion

And finally 1 Timothy 4:3 talking about those that have departed from the faith says *"**Forbidding to marry and commanding to abstain from meats, which God hath created to be received with thanksgiving of them which believe and know the truth**"*

Conclusions

Animal protein needs in human nutrition cannot be overemphasized; there are seven remarkable nutrients in animal proteins that cannot be found in plant proteins. While the vegetarian diet promoters bloat the demerits of animal protein utilization, often with unverified data, it becomes important that the records are kept straight. Animal proteins like meat and eggs are more useful in human health maintenance and good living contrary to findings of research based on correlational researches that are far from absolute truth. Animal protein production, however, contributes to GHG implicated in global warming. Scientists have proposed a number of mitigation measures, I therefore call on all who have stopped eating of animal protein based on conjectures and fear to go back and eat their meat and egg with joy, while animal air contribute to global GHG emissions, mitigation measures are fully available, besides, cars and other automobiles are also implicated in GHG emissions, yet new cars, buses, motorcycles etc are being produced every day and many more designs are on the desk of manufacturers. God says eat your meat with thanksgiving. Go ahead and eat your meat.

References

Alamu, O. T.1, Amao, A. O.1, Nwokedi, C. I.1, Oke, O. A.2 and Lawa, I. O.3, Diversity and nutritional status of edible insects in Nigeria: A review. *International Journal of Biodiversity and Conservation* Vol. 5(4), pp. 215-222, April 2013. DOI: 10.5897/IJBC12.121

Annweller C., Schott A.M., Allali G. et al (2010). Association of Vitamin D with Cognitive Impairment in Older Women: *Cross-Sectional Study*. *Neurology* 74 (1): 27-32

Arnarson A. (2019). Seven Nutrients That You Can't Get From Plants. Healthline.com

Aydın, A.F., Çoban, J., Doğan-Ekici, I., Betül-Kalaz, E., Doğru-Abbasoğlu S. and Uysal M (2016). Carnosine and taurine treatments diminished brain oxidative stress and apoptosis in D-galactose aging model. *Metabolic Brain Disease* volume 31, pages337–345

Banjo A.D., Lawal O.A., Songonuga E.A. (2006). The nutritional value of 14 species of edible insects in SW Nigeria. *Afr. J. Biotechnol*. 5: 298–301.

Beauchemin K.A. and Kreuzer M, O'Mara F. and McAllister T.A. (2008). Nutritional Management for Enteric Methane Abatement: A Review. *Australian Journal of Experimental Agricultue*48:21-27.

Bingül I, Yılma Z, Aydın A.F., Çoban J, Doğru-Abbasoğlu S., Uysal M. (2017). Antiglycation and anti-oxidant efficiency of carnosine in the plasma and liver of aged rats *Geriatr Gerontol Int*. Dec;17(12):2610-2614. doi: 10.1111/ggi.13126. Epub 2017 Aug 4.

Braide, W., 2012. Perspectives in the microbiology of the leaves of three plant species as food for an edible caterpillar of an emperor moth. *International Journal of Research in Pure and Applied Microbiology* 2: 1-6.

Byeng R.M….. and Braver D.( ). Dietary Mitigation of Enteric Methane Emission from Ruminant.: A Review of Plant Tannins Mitigation Option. *Animal Nutrtion* 6 (3): 231-246.

Chapagain, A.K. and Hoekstra, A.Y. (*2003)* Virtual Water Flows between Nations in Relation to Trade in Livestock and Livestock Products. UNESCO-IHE, Delft, The Netherlands

Clark H. , Pinares- Patino, C., Deklan C. (2005).*Methane and Nitrous Gas Emissions from Grazed Grassland.* In Grassland A Global ResourceEd/ McGalloway, Wageningen, Academic Press, Netherlands. Pp 279-294.

Cross AJ, et al. (2007). A prospective study of red and processed meat intake in relation to cancer risk. *PLoS Med.* ;4(12):e325.

Denter J. and Bisping B. (1994). Formation of B-Vitamins by Bacteria During the Soaking Process of Soyabeans for Tempe Fermentatin. *Int. J. Food Microbiology* 22 (1): 23-31.

Dobnig H. (2011). A Review of the Health Consequences of the Vitamin D Deficiency Pandenmic *J. of the Neurological Sciences* 311(1-2): 15-18.

Derave W., OZdemir M.S., Harris R.C. et al (2007). Beta-Alanine Supplementation augments Muscle Carnosine Content and Attenuates Fatigue During Repeated Isokinetics Conntraction Bouts in Trained Sprinters. *J. Applied Physiol* 103 (5):1736-43.

Dror D.K. and Allen L.H. (2011). The importance of milk and other animal-source foods for children in low-income countries *Food Nutr Bull*.;32(3):227-43.

Ebenebe, C. and Okpoko, V.O. (2015). Edible Insect Consumption in the South Eastern Nigeria. *International Journal of Scientific & Engineering Research*, Volume 6, Issue 6, June-2015.

Ebenebe, C. and Okpoko, V.O. (2015). Edible Insect Consumption in the South Eastern Nigeria. *International Journal of Scientific & Engineering Research*, Volume 6, Issue 6, June-2015.

Ebenebe, C. and Okpoko, V (2015).Microbiological quality of raw and roasted African palmweevil (*Rhynchophorus phoenicis*) consumed in the south eastern Nigeria. *Animal research international*. 12(2):2159-2165

Ebenebe, C. I., and V. O. Okpoko. (2016). Preliminary studies on alternative substrate for multiplication of African palm weevil under captive management. *Journal of Insects as Food and Feed* 2 (3):171–77. https://doi. org/10.3920/JIFF2015.0089

Eckard R.J., Grainger, C. and deKlein, C.A. (2010). Options for the abatement of methane and nitrous oxide from ruminant production: A Review. *Livestock Sci* 130:47-56. Doi:10.1016/j.livsci.2010.02.010

Edijala T.K., Eghogbo O., Anigboro A.A. (2009). Proximate Composition and cholesterol concentrations of *Rhyncophorus phoenicis and Orytces monocerus* larvae subjected to Different Heat Treatments. *African Journal of Biotechnology* 8 (10): 2346 -2348.

Ekpo K.E. and A.O. Onigbinde (2004). Pharmaceutical Potentials of *Rhyncophorus phoenicis* larval oil. *Nigerian Annals of Natural Sciences* Vol. 9 (2): 28-36.

Faridar A, Eskandari G., Sahraian M.A., Minagar A., Azimi A, (2012). Vitamin D and Multiple Sclerosis: A Critical Review and Recommendation on Treatment. *Acta Neuro; Belg* 112(4):327-333.

Gerber P.J., Mottet A., Opio C.I. Falucci A. and Teillard F. (2015). Environmental impacts of beef production: Review of challenges and perspectives for durability. *Meat Science*Volume 109. Pp. 2-12.

Grossi G., Goglio P Vitali A and Williams A.G. (2018). Livestock and climate change: Impact of livestock on climate and mitigation strategies. Animal Frontiers 9(1) DOI: 10.1093/af/vfy034

Giovanucci E., ScD M.D,, Liu Y, MS, Holllis B.W et al. (2008). 25-Hydroxyvitamin D and Risk of Myocardial Infarction in Men. *Arch.Intern. Med*. 168 (11): 1174.

Goglio P., Smith W.N., Grant B.B. and Williams A.G. (2018). A comparison of methods to quantify greenhouse gas emissions of cropping systems in LCA. *Journal of Cleaner Production 17*2 DOI: 10.1016/j.jclepro.2017.03.133

Graham A.S. and Hatton R.C. (1999). Creatine: A Review of Efficacy and Safety. J.Am. Pharm Asso. (Wash) 39 (6): 803-10.

Grober U., Kisters K and Scmidt J. (2013). Neuroenhancement with Vitamin B12 Underestimated Neurologiical Significance. *Nutrients* 5 (12): 5031-5045.

Grasgruber P., Sebera M., Hrazdíra E. and Kalina T. (2016). Major correlates of male height: A study of 105 countries Economics and Human Biology 21: DOI: 10.1016/j.ehb.2016.01.005

Gunnars K. (2019). Top 10 Health Benefits of Eating Eggs. https://www.healthline.com/nutrition/10-proven-health-benefits-of-eggs

Hardick B.J. (2015). Are Cholesterol Guidelines "Misguided?"in Whole Food Nutrition . https://www.drhardick.com/cholesterol-guidelines

Haque M. N. (2018). Dietary Manipulation: A Sustainable Way to Mitigate Methane Emissions From Ruminants. *Journal of Animal Science and Technology* 60 (15). http://doi.org/10.1186/s40781-018-9175-7

Helland I.B., Smith L., Saarem K., Saugstad O.D. and Drevon C.A. (2003). Maternal Supplementation with very Long Chain N-3 Fatty Acids During Pregnancy and Lactation Augments Children's IQ at 4 Years of Age. *Peadiatrics*. 111 (1):39-44

Herrero M., Henderson B.,…. Stehfest (2016). GreenHouse Gas Mitigation Potentials in the Livestock Sector. *Nature Climate Change* 6: 452-461

Hoffman J.R. and Falvo M. J. (2004). Protein – Which is Best? J.Sports Sci. and Med. 3 (3): 118-130

Iannotti L.L., Chessa K. L, . Stewart C.P., Gallegos Riofrío C.A., Malo C, Reinhart G., Palacios A, Karp C., Chapnick M, Cox K. and Waters W.F. (2017). Eggs in Early Complementary Feeding and Child Growth: A Randomized Controlled Trial140 (1) e20163459; DOI: https://doi.org/10.1542/peds.2016-3459

Igwe C.U., Ujowundu C.O., Nwaogu L. A., Okwu G. N. (2011). Chemical Analysis of an Edible African Termite, Macrotermes nigeriensis; a Potential Antidote to Food Security Problem. *Biochem and Anal Biochem* 2011; 1:105. doi:10.4172/2161- 1009.1000105

IPPC 2013: Intergovernmental Panel on Climate Change publishes full report Climate Change 2013: The Physical Science Basis

Joseph M. (2017). Eleven (11) health benefits of eating beefhttps://www.beefcentral.com/news/community-and-lifestyle/beef-nutrition/11-health-benefits-of-eating-beef/

Kjaegaard M., Waterll K., Wang C.E. , Almas B et al (2012).Effect of Vitamin Supplement on Depression Scores inPeople with low levels of Serum 25-Hydroxyvitamin D:Nested Case-Control Study and Randomised Clinical Trial. Br J/ Psychiatry 201(5): 360-8.

Kubala J. (2018). Essential Amino Acids: Definitions, Benefits and Food Sources. Healthline. https://www.healthline.com/nutrition/essential-amino-acids

Lappe J.M., Travers-Gustafson D., , Davies K.M.. Recker R. R. and Heany R.P. (2007) . Vitamin D and Calciumd trial Supplementation Reduces Cancer Risks: Results of Randomized Trial. The American J of Clinica Nutrition 85 (6): 1586-1591

Lawal-Adebowale (2012). Dynamics of Ruminant Livestock Management in the Context of the *Nigerian Agricultural System* . Doi:10.10.5772/52923

Lawrie R.A. and Ledward D. (2006). *Lawrie's Meat Science*. 7th Edition.Woodhead Publishing Limited. 415pp

Lehnen T.E. , Ramos da Silva M., Camacho A., Marcadenti A., and Lehnen A.M. (2015). A review on effects of conjugated linoleic fatty acid (CLA) upon body composition and energetic metabolism *J. Int. Soc. Sports Nutr.* ; 12: 36. doi: 10.1186/s12970-015-0097-4

Li P. Yin Y.L., Kim S.W. and Wu G.. (2007). Amino Acids and Immune Function. *Br. J. Nutr.* 98 (2): 237-252. Doi:10.1017/S000711450769936X

Lim J. Li L. ; . Jacobs M.D., ; Kistler J; Donaldson P.J. (2007). Mapping of Glutathione and Its Precursor Amino Acids Reveals a Role for GLYT2 in Glycine Uptake in the Lens Core.Investigative Ophthalmology & Visual Science November 2007, Vol.48, 5142-5151

Mawer R. (2017). Creatinine Supplementation 101- The Ultimate Guide. Rudymawer.com

Mbah, C.E., and G. O. V. Elekima (2007) Nutrient composition of some terrestrial insects in Ahmadu Bello University, Samaru, Zaria Nigeria. *Science World Journal* 2 (2): 17-20.

McAfee, A. J., McSorley, E. M., Cuskelly, G. J., Moss, B. W., Wallace, J. M., & Bonham, M. P. (2010). Red meat consumption: An overview of the risks and benefits. Meat Science, 84(1), 1–13. http://dx.doi.org/10.1016/j.meatsci.2009.08.029 (S0309- 1740(09)00251-4).

Mcintosh J. (2019).Everything you need to knoe about eggs https://www.medicalnewstoday.com/articles/283659

Mendenhall C, Roselle GA, Gartside P, et al. Relationship of protein calorie malnutrition to alcoholic liver disease: A reexamination of data from two Veterans Administration Cooperative Studies. *Alcoholism: Clinical and Experimental Research.* 1995;19(3):635–641

Melone L.(2014).10 Reasons To Stop Eating Red Meat. https://www.prevention.com/food-nutrition/healthy-eating/a20436097/1

Navder, K.P. and Lieber, C.S. (2003a) *Nutritional support in chronic diseaseof the gastrointestinal tract and the liver.* In: Nutritional Aspects and Clinical Management of Chronic Disorders and Diseases. Ed: Bronner, F. Boca Raton, FL: CRC Press. 45-68.

Navder, K.P. and Lieber, C.S. (2003b) Nutrition and alcoholism. In: Nutritional Aspects ansd Clinical Management of Chronic Disorders and Diseases. *Ed: Bronner, F. Boca Raton, FL*: 307-320.

Newbold C.J., McIntosh F.M., Williams P. Losa R and Wallace R.J.(2004). Effect of Specific Blend of Essential Oil Compounds on Rumen Fermentation. *Animal Feed Science Technol*. 114:105-12

Oliveira J.S…..Viana Bayao G. F. (2011). Effect of Propionic and Lactic Acids on in Vitro Ruminal Bacterial Growth. *Ruminants.R. Bras. Zootech* 40 (5) 2011

Pigatto A. (2017) Eggs are a Nutrient Goldmine! Adapted from: http://www.eggnutritioncenter.org/blog/healthy-aging-month/

Pawlak R., Parrot S.C., Raj S., Cullum-Dugan D. and Lucus D. (2013). How Prevalentis Vitamin B12 Deficiency Among Vegetarians. . Nutrition Reviews 71 (2): 110-117

Pekala J., Patkowska-Soola B., Bodkowski R., Jamroz D., Nowakowski P. et al (2011). L-Carnitine –metabolic functions and meaning in human life. *Curr Drug Metab* 12 (7):667-78.

Pimpin l, Kranz S, Liu E, Shulkin M., Karageorgou D, Miller V, Fawzi W, Duggan C, WebbP, Mozaffarian D. (2019). Effects of animal protein supplementation of mothers, preterm infants, and term infants on growth outcomes in childhood: a systematic review and meta-analysis of randomized trials . *The American Journal of Clinical Nutrition*, Volume 110(2): 410–429.

Pouyandjoo M., Nouhi M., Bidar S.S. and Olyaeemanesh A., (2016). The effect of (L-)Carnitine on weight loss in adults: A systematic review and meta-analysis of randomized controlled trials.*Obes Rev* 17 (10):970-976.

Purchas R.W. and …..Busboom J.R. (2005). The effect of Production System and Age on Levels of Iron, Taurine, Carnosine, Coenzyme Q10 and Creatine in Beef Muscles and Liver. *Meat Science* 70 (4):586-596.

Prynne, C., Wagemakers, J., Stephen, A. *et al.* Meat consumption after disaggregation of meat dishes in a cohort of British adults in 1989 and 1999 in relation to diet quality. *Eur J Clin Nutr* **63,** 660–666 (2009). https://doi.org/10.1038/ejcn.2008.7*World Resource Institute* 2018

RIM (1992).Nigerian National Livestock Resource Survey. Report by Resource Inventory Management Limited (RIM) to Federal Department of Livestock and Pest Control Services (FDL and PCS) Abuja, Nigeria 432pp.

Risérus U, Berglund L, Vessby B. (2001).Conjugated linoleic acid (CLA) reduced abdominal adipose tissue in obese middle-aged men with signs of the metabolic syndrome: a randomised controlled trial *Int J Obes Relat Metab Disord*. 25(8):1129-35.doi: 10.1038/sj.ijo.0801659.

Salgado P., Montagne L, Joa o P. B. Freire, Ricardo B. Ferreira, Artur Teixeira, Ofe´ lia Bento, Manuel C. Abreu, Rene´ Toullec and Lalle J. (2002). Legume Grains Enhance Ileal Losses of Specific Endogenous Serine-Protease Proteins in Weaned Pigs . *American Society for Nutritional Sciences*. 1913-1920/

Sanders T.A. and Reddy S. (1992). The Influence of Vegetarian Diet on the Fatty Acid Composition of Human Milk and the Essential Fatty acid Status of the Infant. *J. Pediatr*. 120 (4:2): S71 -7.

Schabel, H**. (**2006). Forest-based insect industries. *In* H. Schabel, ed. *Forest entomology in East Africa: forest insects of Tanzania*, pp. 247–294.

Shaib B., Aliyu A and Bakshi J.S. (1997). Nigerian National Agricultural Research Strategy Plan 1996-2010. Federal Ministry of Agriculture and Natural Resources, Abuja, Nigeria 335pp

Song X., Qu H., Yang Z., Rong J., Cai W and Zhou H. et al (2017). Efficacy and Safety of L-Carnitine Treatment for Chronic Heart Failure: A Meta – Analysis of Randomized Controlled Trials. *Biomed Res. Int*. Doi. 10.1155/2017/6274854

Stockton K.A., Mengrsen K., Paratz J.D et al (2011). Effect of Vitamin D Supplementatin on Muscle Strength : A Systematic Review and Meta-Analysis. *Osteoporos. Int* 22 (3): 859-71.

Suybeng B., Charmley et al (2019). Methane Emissions and the use of Desmanthus in Beef Cattle Production in Northern Australia. *Animals* 9(8):542

Takenata S., Sugiya S., Ebara S., Miyamoto E., Abe K., et al (2001). Feeding Dried Purple Laver (Nori) to Vitamin B12 –deficient Rats Significantly Improves B12 Status. *Br Nutr* 85 (6):699-703

Government Area of Borno State. MSc. Thesis, Ahmadu Bello University, Zaria Nigeria

Udegbunam O. (2019). Nigeria: Milk Production in Nigeria Below Expectation-Official. Premium Times (Abuja). Aaafrica.com

Umar A.S.S. (2007). Financial Analysis of Small Scale Beef Fatteniing Enterprise in Bama Local

Umar A.S., Alamu J/F/ and Adeniyi O.B. (2008). Economics of Small Scale Cow Fattening Enterprise in Bama Local Government of Borno State, Nigeria.

Vidal- Casariego A., Burgos-Pelaez R., Martinez-Faedo C. et al (2013). Metabolic Effects of L-Carnitine on type 2 Diabetes Mellitus: Ststematic Review and Meta-Analysis. *Exp. Clin. Endocrinol Diabetes* 121 (4):234-8.

Valenzuela C., D.I. de Romana, M. Olivares, M.S. Morales and F. Pizzarro. (2009). Total Iron and Heme Iron Content and Their Distribution in Beef Meat and Viscera. *Biological Trace Element Research* 132 (1-3) :103-111.

Van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology* 58:563–83. https://doi.org/ 10.1146/annurev-ento-120811-153704.

Van Thienen R., Van Proeyen K. et al (2009). *Med Sci Sports Exerc* 41 (4):898-903.

Woo K.S., Timothy C.Y Kwok and Celemajer D.S. (2014). Vegan Diet, Subnormal Vitamin B-12 Status and Cardiovascular Health**. Nutrients** 6 (8): 3259-3273.

Wosu, L. O. (2003). Commercial snail farming in West Africa- A Guide. AP express Publishers, Nsukka- Nigeria

Wu G. (2016). Dietary protein Intake and Human Health. *Food Funct.* 7(3): 1251-1265. Doi:10.1039/c5fo01530h

Wu G., Fang Y., Yang S., . Lupton J. R. , . TurnerN.D. (2004). **Glutathione Metabolism and Its Implications for Health.** *The Journal of Nutrition*, Volume 134, Issue 3, March 2004, Pages 489–492,

Zeraatkar D., Johnston B.C., Bartoszko J. et al,. (2019).Effect of Lower Versus Higher Red Meat Intake on Cardiometabolic and Cancer Outcomes. A Systematic Review of Randomized Trials. *Annals of Internal Medicine*, 171(10):72-731Obesity Reviews 17(10) DOI: 10.1111/obr.12436

BRIEF CITATION ON PROFESSOR ERNEST CHUKWUSORO IGWE

Preamble

It is with happiness and all sense of humility that I present to you a friend, distinguished scholar, a unionist, critic, discussant, teacher and academic. He is also an innovative scholar with radical ideas and a University administrator. Prof. Ernest, the vocal an altruistic critic is in the recent times not an unknown name in his avowed subject area of study, the Nigerian Food Science and Technology Circle. He is an objective religious and family man.

Mr. Chairman, Guest of Honour and other guests, Ladies and Gentlemen permit to introduce to you our third Faculty of Agriculture lecturer, own Dear Professor Ernest Chukwusoro IGWE.

Birth and Early Education

Ernest Igwe, a native of Achalla, Umuchu, Aguata Local Government Area of Anambrawas born in 1962 to the family of late Mazi Bennett Nduka and Oriaku Philomena Amuche IGWE.

Ernest could not start his primary education as and when due because of the unfortunate Nigerian Biafran civil war. Resident at Umuahia Abia State, the Biafran capital, the lad Ernest was busy learning how to "Take-Cover" – A term used to ask everybody to lie flat on the ground to avoid detection by the Enemy (Nigerian) war plane. A trauma that has till date been with him.

Eventually, when Umuahia fell to the hands of the Federal forces, the boy Ernest now found himself in his home town, Umuchu, where he started his kindergarten in 1969 and was in primary one when the civil war ended in 1970.

Ernest, then relocated to Umuahia his second home where he was enrolled in Loretto primary school and later christened Urban school III. In 1974, he passed common entrance from primary five in the then East Central State and started his secondary education at Anglican Grammar School later renamed Ibeku High School, Umuahia where he obtained his West African School Certificate in 1979. From there he proceeded to Federal Government College Port-Harcourt where obtained his High School Certificate in 1981. He later joined his father in business majoring mainly in trading in building materials as well as building construction. However, the parents objected to this seriously and forced him out of it to continue with his education. Hence, he then took and passed JAMB to University of Nigeria to study Food Science and Technology, which he believed would launch him back to business, a dream he rejected later in life.

In 1982, he graduated (B.Sc Hons.) from University of Nigeria and also obtained his M.Sc. in 1991; MPA in 1993, all from University of Nigeria and Ph.D. in Food Science and Technology in 2011 from Michael Okpara University of Agriculture, Umudike.

His Career

Professor Ernest IGWE apart from teaching in Boys Secondary School in Umuchu to rekindle his brain so as to be able to pass JAMB after being forced out of

business by his parents, has in all his career been a lecturer and only in the University.

He has taught in Federal University of Technology, Yola and Nnamdi Azikiwe University on full time basis while his visiting (adjunct) lecturing has taken him to Kano University of Science and Technology, Wudil, University of Uyo and Chukwuemeka Odumegwu Ojukwu University, Igbariam.

Ernest has supervised over ten dozen students at undergraduate and postgraduate levels as well being involved in external examinations at B.Sc., M.Sc. and PhD levels in many Universities in Nigeria. He has also been involved in professorial external assessment.

His research interest lies in the domain of Food Microbiology, chemistry and toxicology with a bias in animal products technology bordering mainly on Dairy and Meat Science and Technology.
Ernest is a member of several professional bodies ranging from Nigerian Institute of Food Science and Technology (NIFST), Nutrition Society of Nigeria (NSN) as well as Nigerian Society of Animal Production (NSAP).

As an administrator, he has held several positions in several universities both as Head of Department, Committees' membership and presently Dean, Faculty of Agriculture, Nnamdi Azikiwe University, Awka.

Community Service.
At various times, he has offered his services to State Governments and his communities and the church. They range from Anambra State Government Blueprint on Agriculture as well as being a member of Anambra State Agricultural Transformation and implementation committee among others. He also featured prominently in the drafting of Anambra State / UNICEF sponsored blueprint on nutrition

He has also served as Chairman of several Local Organizing committees, both academic and in society in general.

He authored monographs, textbooks, book chapters, several journals and conference paper both within and outside Nigeria. He has also attended conferences, too numerous to mention both within and outside Nigeria.

Ladies and gentlemen, irrespective of his achievements, Prof Ernest has a sense of humility and responsibility; knowing fully well that he is not only accountable to his immediate boss, but also to His Creator. He is a team player and above all blends well with all manner of people. He is an amazing person and belongs to the group of people who refuse to settle for less than the best. He is married to his heart throb Obiageli Christiana and the marriage is blessed with a child.

Hobbies

Prof Ernest is a member of Scrabble Society of Nigeria and Chess where sometimes in the past has won prizes. He enjoys discussions, footballing, unionism and social criticisms.

Presentation

Finally, I have the honour and privilege of introducing my class mate, brother, friend, confidant and above all a critic who will never compromise evil for good no matter the circumstance.

Thank you.
Prof James Obiegbuna
(Citation Reader)

DIGGING OUR GRAVES WITH OUR TEETH

Ernest Chukwusoro IGWE

Professor of Food Science and Technology,
Department of Food Science and Technology, Faculty of Agriculture,
Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

Being Third Faculty of Agriculture Lecture Series Presented at the Faculty of Agriculture Hall, Nnamdi Azikiwe University, Awka on the 28th January, 2020

1.0 Executive Summary

The justification for the reality of the fact that on daily basis mankind through her actions and / or inactions regarding consumption of food, dig her grave with her teeth. The causes of these negative practices of human beings include Poor nutrition, Hunger, Poverty and Ignorance, Naturally occurring toxicants in foods, Ultra-Processed Foods, Unhygienic food practices and Negative cultural food Practices. Others are claims on Food Faddism and Functional Food practices, Personal (food) idiosyncrasies, Globalization and Urbanization, Unwholesome agricultural and food processing practices as well as Government inaction and bad policies.

The consequences of digging ones grave with the teeth are several illnesses including communicable and non-communicable diseases as well as malnutrition, etc. Furthermore, loss of man hours and finances as well as social cost to the populace is also mentioned. Several ways out of these problems were advocated on the ground that Food Safety is everybody's business. Hence the roles of consumers, food producers, regulators, and supra-national agencies as World Health Organization (WHO), Food and Agricultural Organization (FAO), professional bodies and others in ensuring food safety is advocated. The Nigerian case scenario of digging our graves with our teeth is highlighted. The paper then advocated far reaching measures that include advocacy, attitudinal changes, etc. that will help ensure that though digging our graves with our teeth is inevitable, but control and amelioration of the problem is within human reach.

Keywords: Teeth, grave, digging, food lifestyle and death

2.0 Preamble: Major Highlights

When the third Faculty of Agriculture lecture series topic was announced as "Digging our Graves with our Teeth" reactions from different people were mixed. While most scholars hailed the article as incisive and exploratory other extremes viewed it as funny and laughable questioning how the teeth could be used to dig the grave. Therefore, my job in this presentation is to make a detailed and convincing explanation of the reality and importance of the topic while further expanding the frontiers of this all important discourse.

At this juncture, the all-important questions begging for answers are:

i) How can one dig his or her grave with his or her teeth?
ii) What type of teeth or grave are we talking about?
iii) Is this topic figurative?

There is only one answer to the above myriad of questions and that simply and indirectly put is that "*the longest journey in life starts by a single step*". With regards to the topic of discussion, it suggests that what we eat or do not eat and how

and when we eat them or not determines how long or short the journey to our graves (death) would take us both as individuals and groups as the case may be.

For easier comprehension of the subject matter (Digging our Graves with our Teeth), there is the need to give the operational definition or what I may regard as the contextual meaning of some keywords used in this write up. They include:

A. Teeth

This is not only the teeth in the mouth but also includes lifestyle and safe and unsafe behavioural food practices that could positively or negatively affect our health.

B. Digging

This is the actual practice of eating of food and also includes food behavioural practices. Here, it connotes a negative food practice.

C. Graves

These are negative consequences resulting from unsafe food practices that eventually lead to illnesses (morbidity) and death (mortality). The illnesses include nutritional related ailments, communicable and non-communicable diseases, etc.

D Food Life Style

These are food behavioural practices such as what one eats or do not eat, level of indulgence, personal idiosyncrasies, etc.

E. Death

Death is the permanent cessation of all biological functions that sustain a living organism and the phenomena which commonly bring about death include aging, predation, malnutrition, disease, suicide, homicide, starvation, dehydration, and accidents or major trauma resulting in terminal injury. The signs of death or strong indications that a human being is no longer alive include respiratory arrest (no breathing), cardiac arrest (no pulse) and brain death (no neuronal activity).

At this point, a further critical review of the under-listed excerpts would assist us to take an informed position on the assertion and claim that *every day we dig our graves with our teeth*.

- *Through our lifestyles and unwholesome practices especially feeding habits, we dig our graves daily with our teeth*

- *It is our quest to have food in a more convenient way with unique and acceptable organoleptic qualities that has led mankind to use additives and other techniques to process foods.*

- *Every "safe food" most especially processed foods (and drugs) contains relative amounts of toxin.*

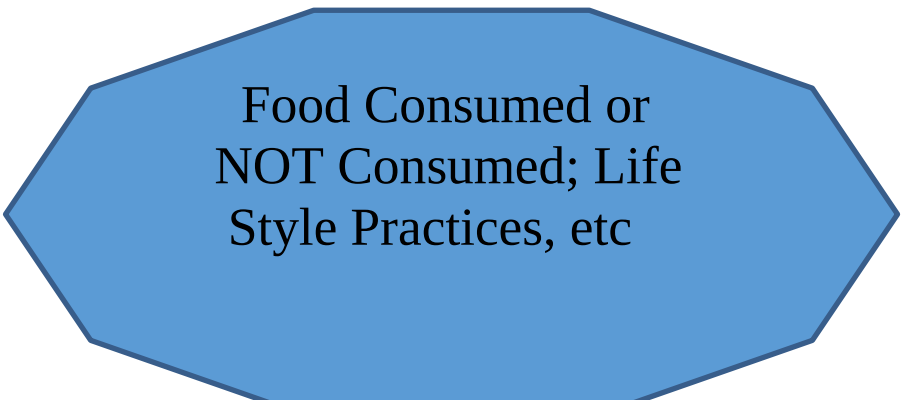
- *Each year, 1 in 10 people get ill by eating unsafe food.*
- *Where there is comfort, discomfort swells*
- *As you solve one problem, you create many more problems.*

The above statements no doubt suggests that in as much as we need food to stay alive, that it is the same food that is responsible for several illnesses that eventually cause death among mankind. Worse still is the global report that annually ten percent of the populace suffer illnesses from consumption of unsafe foods and that about half of these illnesses result to death occurring mostly among children. This is exclusive of the more important long term irreversible slow and steady danger of civilization diseases (obesity, diabetes, hypertension, kidney and liver problems, etc.) that emanate from consumption unsafe foods. It is also reported that only about 1% of illnesses and death from consumption of unsafe foods are reported to the hospital for statistical purposes. This is mostly true in developing nations where most illnesses and deaths appear attributed to unnatural causes as poisoning (Igwe, 2000).

Surmised from above, even the doubting Thomas will unmistakably agree that wittingly or unwittingly, mankind all over the world dig her grave through foods consumed or neglected. This is the major reason for the choice of topic for this presentation.

3.0 Conceptual Framework of Study

This represents the line of thinking / thought of this presentation. Here it is believed that what one eats or those not eat affects the health status positively or negatively. This, at the macro-level is shown in figure 1 and at the micro-level is represented in figure 2. It zeroes on those negative unwholesome and unhealthy food practices (teeth), their consequences such as the communicable and non-communicable diseases (digging of grave) and eventually death (grave).



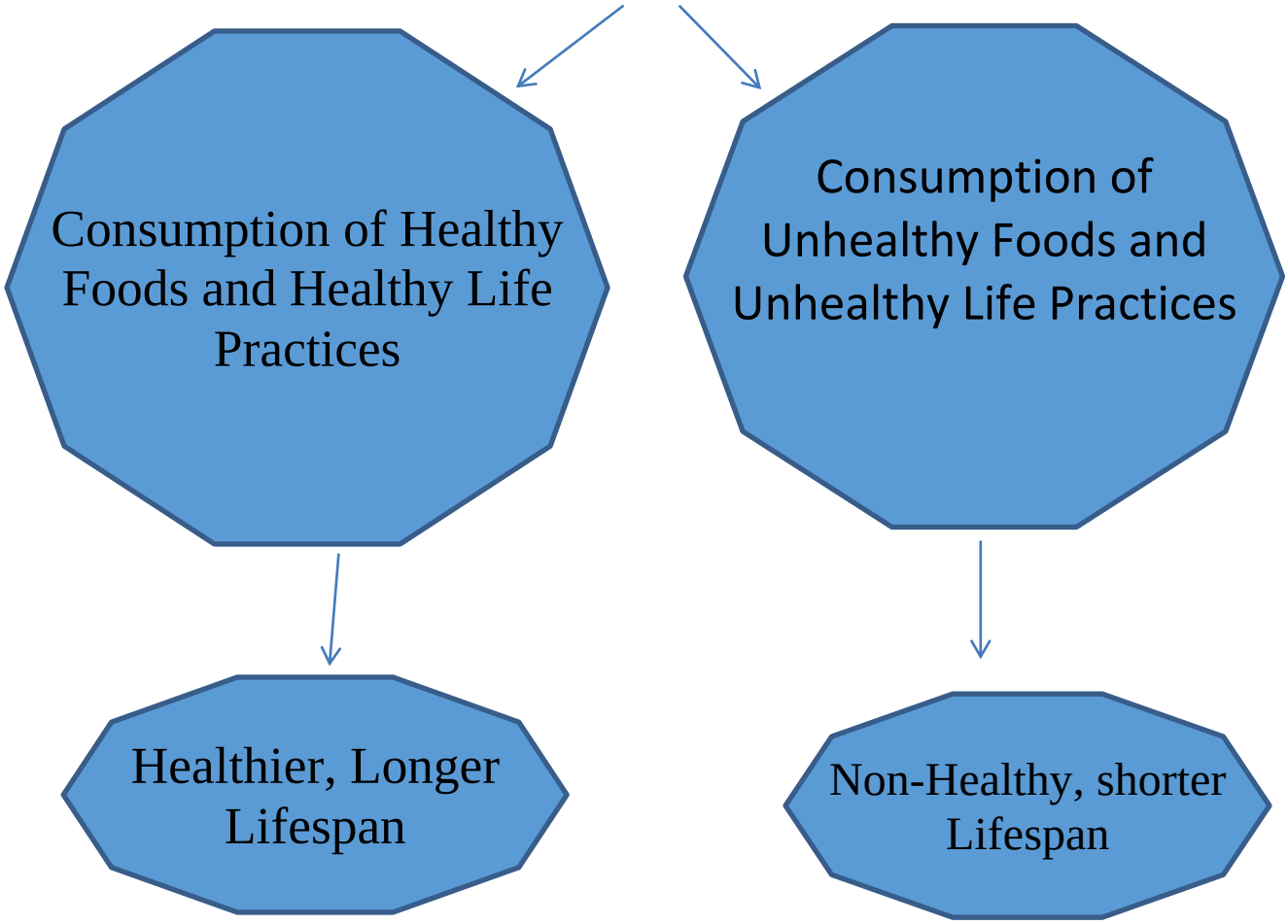


Figure 1: *Influence of foods consumed or not consumed on the health status and lifespan of mankind.*

TEETH

- Unhygienic Food practices;
- Consumption of Ultra-processed foods;
- Abuse of Food Faddism practices;
- Abuse of Functional Food practices,

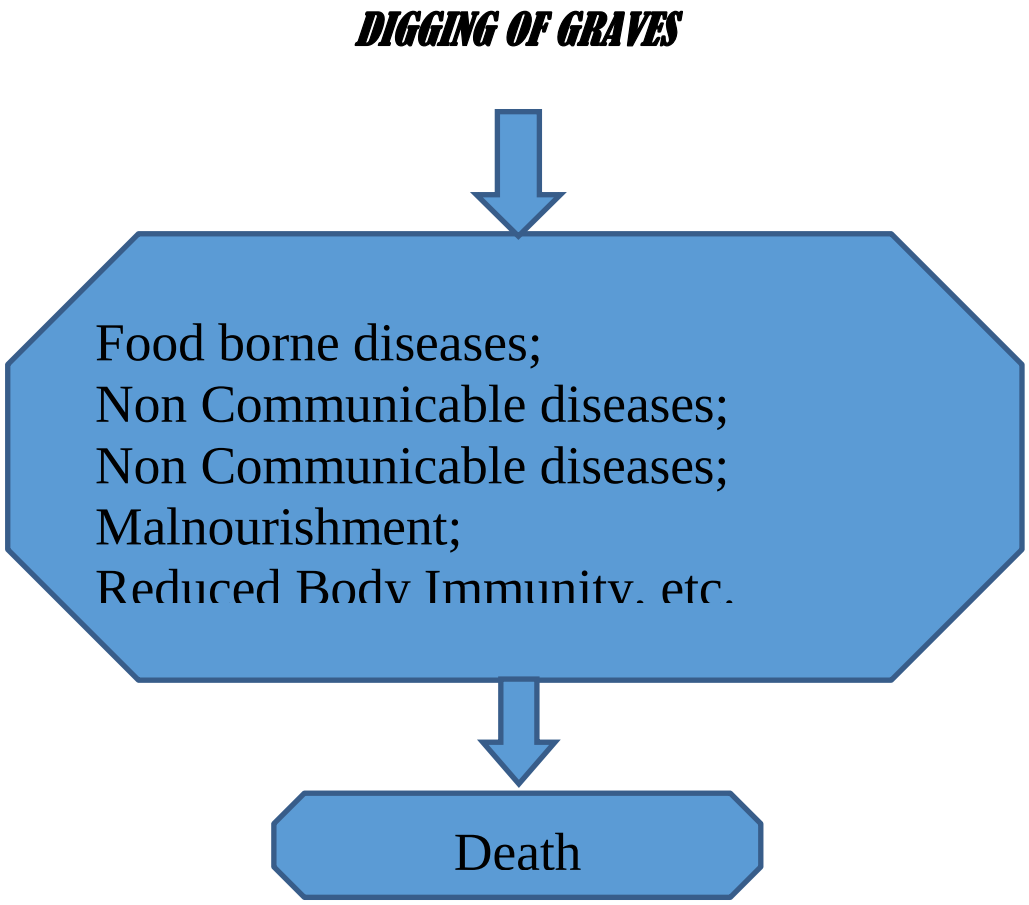


Figure 2: *Relationship between Teeth, Digging of Grave and Death*

4.0 How and Why We Dig Our Graves with Our Teeth?

This section deals with the how and what food we eat or do not eat as well as lifestyles and food habits and practices we indulge in that causes us illnesses and eventual deaths with their attendant consequences. This falls within the domain of food safety.

Food safety refers to the concept of keeping food safe for human and animal consumption. The concept of food safety covers the entire food chain from production to consumption, and, at each stage, there are associated hazards. Therefore, acts by us that are inimical to ensuring the safety of foods that we consume is the same as *digging our graves with our teeth*. They include:

i. Hunger, Poverty and ignorance
ii. Poor nutrition
iii. Naturally occurring toxicants
iv. Ultra-Processed Foods

v. Unhygienic food practices
vi. Negative cultural food Practices
vii. Food Faddism and Functional Food practices
viii. Personal (food) idiosyncrasies
ix. Globalization and Urbanization
x Unwholesome agricultural practices
xi. Unwholesome food processing practices
xii. Government inaction and bad policies

4.1 Hunger and Poverty

➢ Food safety is only of concern to those who can afford to buy these foods that are considered safe for human consumption. Nigeria being the **capital of world poverty** (No thanks to former British Prime Minister and some United Nations agencies) no doubt implies that availability, accessibility and affordability to a wholesome and nutritious food supply (Food Security) to a large segment of her populace is grossly inadequate. This is further worsened by the rising external debt, fiscal and monetary instability, insurgency, kidnapping, etc.

➢ Consequently what is important is **availability of foods andNOTwholesomeness of food supply**. The populace is faced by the devil's alternatives of starvation or partaking in consumption of unwholesome foods. These two options entail **digging our graves with our teeth**.

4.2 Poor nutrition

➢ Poor diet is the leading risk factor for deaths from lifestyle-related diseases in the majority of the world, according to new researches.

➢ What's driving this? As a planet we don't eat enough healthy foods including whole grains, nuts, seeds, fruits and vegetables. At the same time, we consume too many sugary drinks, too much salt and too much processed meat.

➢ Bad nutrition otherwise known as malnutrition results to nutritionally related ailments and these are caused by deficiencies or excesses of essential and / or micro-nutrients in the diet of a people.

➢ Malnutrition is the impaired function that results from a prolonged deficiency—or excess—of total energy or specific nutrients such as protein, essential fatty acids, vitamins, or minerals. This condition can result from fasting and anorexia nervosa; persistent vomitingor inability to swallow; impaired digestion

and intestinal malabsorption; or chronic illnesses that result in loss of appetite (e.g., cancer, AIDS).

- Malnutrition can also result from limited food availability, unwise food choices, or overzealous use of dietary supplements.

- **Nutritional diseases are** nutrient-related diseases and conditions that cause illness in humans. They may include deficiencies or excesses in the diet, obesity and eating disorders and chronic diseases such as cardiovascular disease, hypertension, cancer, and diabetes mellitus.

- Nutritional diseases also include developmental abnormalities that can be prevented by diet, hereditary metabolic disorders that respond to dietary treatment, the interaction of foods and nutrients with drugs, food allergies and intolerances, and potential hazards in the food supply.

- Apart from the so-called civilization diseases (heart disease, stroke, cancer and diabetes) the most significant nutrition-related disease is chronic under-nutrition, which plagues about 20% of the world population.
-
- Under-nutrition is caused by insufficient food to meet energy needs and its main characteristics include weight loss, failure to thrive, and wasting of body fat and muscle. Others include low birth weight in infants, inadequate growthand development in children, diminished mental function, and increased susceptibility to diseases.

- Chronic under-nutrition manifests primarily as protein-energy malnutrition (PEM), which is the most common form of malnutrition worldwide. Also known as protein-calorie malnutrition, PEM is a continum in which people—all too often children—consume too little protein, energy, or both. At one end of the continuum is **kwashiorkor**, characterized by a severe protein deficiency, and at the other is **marasmus**, an absolute food deprivation with grossly inadequate amounts of both energy and protein.

- Marasmus is extremely underweight and has lost most or all subcutaneous fat. The body has a "skin and bones" appearance, and the child is profoundly weak and highly susceptible to infections.

- The cause is a diet very low in calories from all sources (including protein), often from early weaning to a bottled formula prepared with unsafe water and

diluted because of poverty. Poor hygiene and continued depletion lead to a vicious cycle of gastroenteritis and deterioration of the lining of the gastrointestinal tract, which interferes with absorption of nutrients from the little food available and further reduces resistance to infection. If untreated, marasmus may result in death due to starvation or heart failure.

- Kwashiorkor, characterized by insufficient protein and mainly carbohydrate food source, in children this disease is characterized by a swollen belly due to edema (fluid retention), sufferers are weak, grow poorly, and are more susceptible to infectious diseases, which may result in fatal diarrhea.

- Other symptoms of kwashiorkor include apathy, hair discoloration, and dry, peeling skin with sores that fail to heal. Weight loss may be disguised because of the presence of edema, enlarged fatty liver, and intestinal parasites; moreover, there may be little wasting of muscle and body fat.

4.3 Naturally occurring toxicants

- Some naturally occurring toxicants in foods include:

i. Glycosides
ii. Alkaloids
iii. Hemmaglutinins
iv. Gossypol
v. Antivitamins
vi. Bio-toxins

- Improper processing to remove the toxins naturally inherent in them (detoxification) leads to unsavory consequences such as cumulative organ damage and death.

4.4 Ultra Processed Foods

- The term "ultra-processed" refers to food products that manufacturers have put through industrial processes and contain a range of ingredients. They are generally high in energy, fat, and sugar or salt, and low in fibre, which helps explain their links to disease risk. However, on top of this, they tend to contain a range of artificial ingredients that might also play a role in some conditions. Some examples include sugary drinks, breads, ready-made meals, confectionaries, and processed meats.

- Ultra-processed foods include not only "junk food" like chips, sweets and fast food but also the breads, processed meats, jarred sauces and frozen meals that many people consider staples.

- People who get many of their meals from packages may have heightened risks of heart disease, strokeand premature death, two large studies suggest.

- Scientists have linked ultra-processed products with a range of conditions, including "obesity, hypertension, and cancer."

- Negative roles of chemicals produced in-situ such as when people cook some foods at a high temperature; it can produce acrylamide, which some experts think may be carcinogenic.

- **Overall, a 10 percent increase in the amount of ultra-processed food consumed equated to a 14 percent increase in mortality risk.**

- Some scientists believe that the negative impact of ultra-processed food on longevity is likely due to high sodium, fat, sugar, and salt content, low fiber, and a range of artificial additives such as emulsifiers, which, according to some studies, might be linked with metabolic syndrome and obesity.

- In one study, researchers followed more than 100,000 French adults for about five years. They found that the more ultra-processed foods people ate, the higher their odds of a first-time heart condition or stroke: Those who ate the most processed foods were 23% more likely to suffer cardiovascular trouble compared to those with the lowest intakes.

- The above findings may only be due to those foods were loaded with sugar, salt or fat or because those people were heavier, exercised less or had other unhealthy habits. Instead, there might be other things about highly processed foods that take a health toll, according to the researchers.

- Some other studies by researchers hinted that additives or contaminants formed during food processing have negative effects on metabolismand the cardiovascular system.

- Though these researchers stressed that their study cannot prove the cause and effect of these assertions, but taken along with other research linking processed

foods to ill health effects, they said the message is strive to eat more "whole" and minimally processed foods.

4.5 Unhygienic food practices

- Foodborne illnesses are usually infectious or toxic in nature and caused by bacteria, viruses, parasites or chemical substances entering the body through contaminated food or water.

- Chemical contamination can lead to acute poisoning or long-term diseases, such as cancer. Foodborne diseases may lead to long-lasting disability and death. Examples of unsafe food include uncooked foods of animal origin, fruits and vegetables contaminated with faeces, and raw shellfish containing marine bio-toxins.

4.6 Negative cultural food Practices

- People of all cultures prescribe and proscribe some foods and its practices during some health status of some individuals

- A child is born into a family incapable of deciding for himself, hence he / she absorbs all aspects of food cultural practices

- Such negative and unhealthy sociocultural practices include:

i. Sniffing and use of hands to respectively assess freshness and weights before purchase of foods e.g. meats.

ii. Tasting directly of drinks with the mouth to prove to the receiving audience that it is not poisoned.

iii. Giving of meats and egg to only adults within the family circles instead of to children since these children needs these proteinous foods for growth more than the adults.

4.7 Functional and Faddism Food practices

Functional foods refer to those foods that have health functions that is when taken will contribute to boosting the health status of the consumer while food faddism as used connotes unverified and most often abused claims of health functions of food when consumed.

With prevalent and persistent poverty and ignorance as well as get-rich-quick syndrome, the business of most people selling preparations containing several herbs with the **unverifiedclaims** of one or several **health functions** abound in Nigeria.

The questions calling for answers about these claims of health functions of these herbs include:

i. To what extent are these claims true?
ii. What are the required doses of these herbal preparations?
iii. What damages to the organs and body tissues most often resulting in terminal sicknesses are caused by consumption of these herbal food preparations?
iv. Who knows how many people (Nigerians) have died from consumption of these herbal food preparations?
v, Why is this thriving business in Nigeria despite the presence of regulatory agencies?

No doubt most of our graves are dug by consuming or not consuming as well as the extent of consumption of these herbal food preparations.

4.8 Personal Idiosyncrasies

- This refers to the **likes** and **dislikes** of individuals about consumption particular foods and food habits.

- Most people dig or do not dig their graves through their personal idiosyncrasies about foods. These food choices are influenced by several factors some of which include income, education, sociocultural backgrounds, ignorance, education and food safety and nutrition awareness.

4.9 Unwholesome agricultural practices

Overuse and misuse of antimicrobials in veterinary and human medicine has been linked to the emergence and spread of resistant bacteria that enter the food chain through the animals (e.g. *Salmonella* through chickens). They render the treatment of infectious diseases ineffective in animals and humans with such adverse consequences.

There is the problem of carryover of pesticides and fertilizers in from the farm to the foods. These substances have unwholesome consequences to human health.

4.10 Unwholesome food processing practices

Unwholesome food practices stems from inability of most food processing establishments to institute safety guards that will ensure produced foods are not hazardous to human health. Such measures include:

i. Hazard Analysis and Critical Control Points (HACCP);
ii. Good Manufacturing Practices (GMP);
ii. Standard Operating Procedures (SOP)

➢ In developing countries including Nigeria, most foods are produced outside are produced outside official controls. This makes adherence to global best practices that would produce most wholesome and acceptable standard foods very difficult.

4.11 Globalization and Urbanization

➢ Urbanization and changes in consumer habits, including travel, have increased the number of people buying and eating food prepared in public places. Globalization has triggered growing consumer demand for a wider variety of foods, resulting in an increasingly complex and longer global food chain.

➢ As the world's population grows, the intensification and industrialization of agriculture and animal production to meet increasing demand for food creates both opportunities and challenges for food safety. Climate change is also predicted to impact food safety, where temperature changes modify food safety risks associated with food production, storage and distribution.

4.12 Government inaction and bad policies

➢ Lack of appropriate enabling environment and infrastructures such as water and electricity supplies;

➢ Compromises by regulatory agencies

5.0 Consequences of digging our graves with our teeth

➢ The burden of foodborne diseases to public health and welfare and to economy has often been underestimated due to underreporting and difficulty to establish causal relationships between food contamination and resulting illness or death.

➢ Consider a report from the Center for Strategic and International Studies, which notes: "Worldwide, malnutrition costs $3.5 trillion annually, with overweight- and obesity-related non-communicable diseases, such as cardiovascular disease and type 2 diabetes, adding $2 trillion."

- World Health Organization (WHO) reported that food containing harmful bacteria, viruses, parasites or chemical substances is responsible for more than 200 diseases, ranging from diarrhea to cancers. About 11 million deaths a year are linked to poor diet around the globe. According to one large new study, eating more ultra-processed foods — such as sugary drinks and ready-made meals — increases the risk of all-cause mortality.

- Chronic persistent hunger affects those living in poverty in both industrialized and developing countries. It is reported that the largest number of chronically hungry people live in Asia, but the severity of hunger is greatest in sub-Saharan Africa.

- At the start of the 21st century, approximately 20,000 people, the majority of them children, died each day from under-nutrition and related diseases that could have been prevented. The deaths of many of these children stem from the poor nutritional status of their mothers, as well as the lack of opportunity imposed by poverty.

- Unsafe food can cause illness either through infection (contamination with biological agents such as bacteria, viruses and parasites or toxication (contamination with chemicals).

- Food poisoning usually manifests as fever, headache, nausea, vomiting, abdominal pain and diarrhea and is most commonly caused by salmonella, Escherichia coli (E. coli) and campylobacter.

- These bacteria are mostly found in milk, raw or undercooked poultry and drinking water (campylobacter), unpasteurized milk, undercooked meat and fresh fruits and vegetables (E. coli), eggs, poultry and other products of animal origin (salmonella).

- There is continuous increased impact of poor diets on the risk of death from diseases including heart disease, certain cancers and diabetes.

6.0 The Way Out Panacea

Food can become contaminated at any point of production and distribution, and the primary responsibility lies with food producers. Yet a large proportion of foodborne disease incidents are caused by foods improperly prepared or mishandled at home,

in food service establishments or markets. Not all food handlers and consumers understand the roles they must play, such as adopting basic hygienic practices when buying, selling and preparing food to protect their health and that of the wider community.

➢ Digging our graves very slowly and thereby ensuring quite a longer lifespan is everyone's business; hence all hands must be on deck to make it a success. Steps to these include:

i. Increased food and nutrition education awareness certainly will impact on positive food safety practices and ensure slower digging of our graves with our teeth.
ii. Good governance that brings prosperity and hence encourages food safety practices.
iii. Rejection of negative cultural practices while adopting the food safety enhancing ones.
iv. Patronage of natural diets as against ultra-processed diet. It is suggested that consumption of processed foods with longer shelf life, the shorter the lifespan of the consumer. Based on the overall body of research, it has been reported that the most heart-healthy diet is one rich in whole foods, particularly plant-based foods like fruits and vegetables, legumes, whole grains and nuts.

➢ As stated that everyone can contribute to making food safe. It important at this juncture to delineate expectations from several groups (Policy-makers, food handlers and consumers and WHO) involved in fostering these positive and effective actions:

A. Government through her Policy-makers could:

a) build and maintain adequate food systems and infrastructures (e.g. laboratories) to respond to and manage food safety risks along the entire food chain, including during emergencies;

b) foster multi-sectoral collaboration among public health, animal health, agriculture and other sectors for better communication and joint action;

c) integrate food safety into broader food policies and programmes (e.g. nutrition and food security);

d) Think globally and act locally to ensure the food produce domestically be safe internationally.

➢ Therefore, Policy makers should ensure that any plan of reducing the frequency and intensity of digging our graves with our teeth has to encompass food safety in all ramifications, encompassing the farm-to-table approach and including foodborne diseases of zoonotic origin. Therefore, all references to "food safety" or "foodborne diseases" comprise aspects or diseases of non-communicable and communicable origin, including foodborne zoonoses.

B. Food handlers and consumers can:

a) Know the food they use (read labels on food package, make an informed choice, become familiar with common food hazards);

b) Handle and prepare food safely, practicing the WHO Five Keys to Safer Food at home, or when selling at restaurants or at local markets. These five keys are:

i. Keep clean
ii. Separate raw and cooked
iii. Cook thoroughly
iv. Keep food at safe temperatures
v. Use safe water and raw materials

C. WHO response to ensuring food safety through:

a) Facilitation of global prevention, detection and response to public health threats associated with unsafe food;

b) Ensuring consumer trust in their authorities, and confidence in the safe food supply through helping Member States build capacity to prevent, detect and manage foodborne risks by:

i providing independent scientific assessments on microbiological and chemical hazards that form the basis for international food standards, guidelines and recommendations, known as the Codex Alimentarius, to ensure food is safe wherever it originates;

ii. assessing the safety of new technologies used in food production, such as genetic modification and nanotechnology;

iii. helping improve national food systems and legal frameworks, and implement adequate infrastructure to manage food safety risks. The International Food Safety Authorities Network (INFOSAN) was developed by WHO and the UN

Food and Agriculture Organization (FAO) to rapidly share information during food safety emergencies;

iv. promoting safe food handling through systematic disease prevention and awareness programmes, through the WHO Five Keys to Safer Food message and training materials; and

v. Advocating for food safety as an important component of health security and for integrating food safety into national policies and programmes in line with the International Health Regulations.

7.0 The Nigerian Case Study

➢ Increasingly, many Nigerians are dying, ironically, from what ought to sustain and indeed, keep them alive. Here are few excerpts:

i. *3,000 Nigerians die daily of hunger* (NGO by Xinhua (01 March 2004)
ii. *Red alert over rising cases of food poisoning, deaths*. (Guardian Newspaper 04 March 2015)
iii. *Akanji says 99% of Nigerians eat outside, adverse events under reported, wants manufacturers to acquire formal HACCP training to meet technical specifications* (Guardian Newspaper 04 March 2015)
iv. *Mother, children, dogs die in Ekiti after eating amala* (September 19, 2019 by Josiah Oluwole)
v. *Family of seven dies of Alleged Food Poisoning in Lagos* (http://saharareporters.com/2019/09/04)
i. *Five die after eating Amala In Ondo* (Health–Nairaland https://www.nairaland.com/1032363/five-die-after-eating-amala

➢ As Nigerians, food is an important part of our culture, and food safety has a significant impact on our health. We should all make an effort to understand what is already in place to ensure food safety and demand more accountability in this area.

➢ Food vending and negative cultural food practices as well as unwise food handling techniques are major ways Nigerians Dig their graves with their teeth.

➢ The National Agency for Food and Drug Administration and Control has the responsibility for ensuring that processed food produced, sold or used in

Nigeria is safe for human consumption and has produced guidelines and regulationsto support this. It is difficult to say how stringently these are followed, as there were no statistics available on the NAFDAC website as at the time of preparing this presentation.

- This paper advocates a splitting of NAFDAC into the Drug and Food sectors as a way of addressing the structural imbalances that hinders efficiency in her mandate of being regulators of food practices. The agencies functions is highly skewed to drugs rather than foods.

- There has been some progress in the past few years, in relation to putting in place some of the structures and processes for improving food safety in Nigeria. But much needs to be done.

8.0 Conclusion

- Food safety, nutrition and food security are inextricably linked. Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, young children, elderly and the sick.

- Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade.

- Food supply chains now cross multiple national borders. Good collaboration between governments, producers and consumers helps ensure food safety.

- WHO reported that unsafe food containing harmful bacteria, viruses, parasites or chemical substances causes more than 200 diseases from diarrhea to cancers. In addition, an estimated 2 million people are killed annually by food and waterborne diarrheal diseases, many of them, children.

- At a time when 800 million people around the world do not get enough to eat, and 1.9 billion people weigh too much, it is important to remember that hunger and obesity are both forms of malnutrition. And the costs are staggering.

- WHO has revealed that new threats to food safety that pose challenges to national food safety systems are constantly emerging and they include:

- Changes in food production, distribution and consumption;
- Changes to the environment;
- New and emerging pathogens and

❖ Antimicrobial resistance.

➢ Access to sufficient amounts of safe and nutritious food is key to sustaining life and promoting good health.

➢ Research report has it that generally, the countries that have a diet close to the Mediterranean diet, which has higher intake of fruits, vegetables, nuts and healthy oils [including olive oil and omega-3 fatty acids from fish] are the countries where we see the lowest number of [diet-related] deaths.

➢ The Mediterranean pattern of eating is linked to a reduced risk of heart attacks and memory decline.

➢ Regrettably in virtually all countries of the world, we have a mismatch between what we should be eating, and what we are producing. Hence concerted efforts through agricultural and food policies re-engineering to correct this anomaly. Here, a range of initiatives may be needed, including nutrition education and increased access to healthy foods, as well as rethinking agricultural production.

➢ Finally, I will like to conclude with the following philosophical words from the famous *Steve Jobs (who died of cancer) on the Death bed*:

i. When a person goes into the operating room, he will realize that there is one book that he is yet to finish reading – "Book of Healthy Life"
ii. Material lost can be found. But there is one thing that can never be found when lost – "Life".
iii. Eat your foods as your medicines. Otherwise you have to eat medicine as your food.

My dream is that government should strengthen the regulatory agencies especially breaking up of NAFDAC into foods and drug sections so as to live up to their biddings as watch dogs in food safety programmes.

Thank you for listening

Ernest Chukwusoro IGWE
Professor of Food Science and Technology,

Nnamdi Azikiwe University, Awka, Nigeria.

Some References Consulted

Food safety: https://www.who.int/news-room/fact-sheets/detail/food-safety 30th Dec., 2019.

Promoting safe food handling: https://www.who.int/activities/promoting-safe-food-handling

How Safe Is Our Food? https://nigeriahealthwatch.com/how-safe-is-our-food/#.XglldUdKjIU
By Nigeria Health Watchon April 7, 2015 EventsHealthNigeria

Deaths from food poisoning**:**
https://www.thisdaylive.com/index.php/2016/07/13/deaths-from-food-poisoning/ 30122019

Ultraprocessed foods may increase death risk:
https://www.medicalnewstoday.com/articles/324423.php#1

'Highly Processed' Food Linked to Earlier Death
https://www.webmd.com/diet/news/20190530/highly-processed-food-linked-to-earlier-death

Amy Norton (2019), Health Day Reporter THURSDAY, May 30, 2019 (HealthDay News)

BRIEF PROFILE OF PROFESSOR NKIRU THERESA MELUDU (PHD, STA, NF, OKF, LKSP)

Prof. Nkiru Theresa Meludu was born from the family of Ochudo Charles Nwankwo and Monica Chinwe Onuorah of Orofia Abagan in Anambra State Nigeria in the year Nineteen Hundred and Sixty five, April 6. She attended Immaculate Primary School and Queen of the Rosary Secondary School both in Onitsha, Anambra State, Nigeria. She graduated from the then Bendel State University, Ekpoma 1990 and proceeded to University of Ibadan, Ibadan where she obtained her MSc. in 1992 and Ph.D University of Ibadan, Ibadan 1997. She rose through the ranks to Professor cadre in 2010 from the University of Ibadan. She transferred to Nnamdi Azikiwe University, Awka in 2018 after her Sabbatical and accumulative in 2015/2016 and 2017/2018 academic sessions respectively. She served as Head; Department of Agricultural Economics and Extension, Faculty of Agriculture, Nnamdi Azikiwe University from 2018 to 2021. Her areas of specialization include Food and Nutrition Security, Agricultural Extension/Advisory Services/Community Development, Home Economics, Gender, Ecological Organic Agriculture, Climate Change.

She had served as a MSc, PhD examination and assessment of both Associate Professors and Professors for both national and international Universities, and also a member of both national and international associations to mention but a few: Agricultural Extension Society of Nigeria (Treasurer 2016 to 2021 and now the current vice President), Rural Sociology Association of Nigeria (ones Fin. Sec.), Association of Organic Practitioners of Nigeria (NOAN) (Editor), International Federation of Organic Agriculture Movement, International Society for Organic Agriculture Research, International Federation of Home Economics, Home Economics Council of Nigeria, Home Economics Research Association of Nigeria, Society for Home Economics Nigeria, Nutrition Society of Nigeria, Nigeria Forum for Agriculture Advisory Services, African Forum for Agriculture Advisory Services, Global Forum for Agriculture Advisory Services, Apiculture Society of Nigeria. She undertook a post-doctoral fellowship in Japan 1998 to 2000 at the National Institute of Agricultural Research, Tsukuba, sponsored by Japanese International Science and Technology Exchange Centre. She had scholarship to participate in certificate courses on Food and Nutrition Security/HIVAIDs in Wageningen University Netherlands (Netherland Fellowship Program- NFP) in 2013; Orange Knowledge Fellowship (OKF), March 2019 on Governance and Food Safety in International Food Chains in Wageningen University Netherlands. She won the University of Ibadan Senate Research Grant for individual 2005 and inter-faculty researches for two consecutive times on sweet potato value addition 2005, 2006, Co-investigator tetfund grant 2015, Investigator on HIV/AIDs sponsored by ARPAN-Winrock International USA 2004, also received Idachaba Foundation for Research and Scholarship grant 2006.

Prof Meludu joined the Association of Organic Agricultural Practitioners of Nigeria (NOAN) in 2010. She is serving in Exco for more than five years as an Editor of the association magazine-producing about 10 issues. Introduced organic agriculture to many secondary schools in Ibadan Oyo state and Anambra state- teaching them the principles and standards of organic agriculture. She also introduced the association to Anambra state and joined in the establishment of the Chapter. She also brought some people from other parts of south east and south-south to organic agriculture. She established Youth Organic Summer School in Ibadan where the famous organic Anthem was composed. "Organic is life". She campaigned for the hosting of the 2nd NOABS in 2017 at Awka, this earned Governor Willie Obiano (Apkokuedike Global a National Organic Best Governor award in 2018 at NOABS ceremony in Lagos.

She is the Vice Chairperson of the National Stirring Committee of the Ecological Organic Agriculture Initiative-Nigeria. She is the Project Coordinator for Healthy Foods for Consumers Initiative that consulted for International Research on Ecological Organic Agriculture for Africa (2012, 2014 -2018) Swedish Society for Nature Conservation (SSNC) and SIDA. Where, the Community Based Organization and Extension Agents were trained in all the LGAs in Oyo state. She facilitated the establishment of "Farmers and Consumers Forum" a Radio programme for the Department of Agricultural Economics and Extension which is currently running in Unizik FM 94.1 since 2016 to date. She is also a consultant for Knowledge Centre on Organic Agriculture, sponsored by German Cooperation- GIZ through AGRECOL Africa 2021.

A consultant /facilitator for IFAD Value Chain Development Programm (VCDP) Nutrition Intervention (Nutrition Sensitive Agriculture) sensitization of Extension Agents, VCDP Staff and Farmers in Anambra State August 2018, 2019 and November 2020. Nnamdi Azikiwe University contact person for RUFORUM since 2019 and also, served as Chairman of team for two consecutive times and member of teams for three times on accreditation to NUC in Nigeria and Ghana and member of team to review accreditation guideline, facilitator for National Open University of Nigeria, Tetfund and several universities. She has attended conferences and scientific meetings in USA, Germany, Switzerland, Korea, South Africa, Tanzania, Kenya, Mali, Ghana, **Côte d'Ivoire**, Australia, and Turkey just to mention a few. Chairperson for the Faculty Wellness committee UI., Faculty representative on University Curriculum Committee 2012 -2015 UI. She joined in the validation of National Policy on Agricultural Extension and Advisory Services.

She has supervised 39 undergraduate students, three Postgraduate Diploma students UI, Two M.Phil Degree UI, 32 MSc UI, Seven PhD.UI with over 87 peer reviewed articles/books to her credit.

She is a Lady of the Knight of ST Paul and married to Sir, Prof S.C. Meludu and blessed with lovely children and a grandchild.

DISCOVERING THE FIGHTERS OF FOOD SECURITY

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APRIL 14, 2021

Protocol
The Vivce Chancellor Prof Charles Esomone, represented by Prof Joseph Ikechebelu (DVC Admin)
The chairman of the Occasion – Prof. Eric Ofoedu (Director Quality Assauance)
The Dean, Faculty of Agriculture,
The Head of Department, Agricultural Economics and Extension,
Erudite Professors,
Heads of Departments,
The Faculty Officer,
Prof Samuel C. Meludu (My King)
The Media,
Distinguished Lecturers, Ladies and Gentlemen.

Preamble
I am immensely grateful to God Almighty for His goodness and mercies over my life. Most especially, for the great privilege to present the faculty lecture in its first progression.

It is an immeasurable honour, great privilege, and so with a deep sense of humility I stand before this esteemed audience to deliver the 4th Faculty of Agriculture Lecture. Going down memory lane, the Faculty Lecture started in 2019 and very impacting lectures were presented by:

- Prof. B.B.A. Taiwo (RAS) of the Department of Animal Science and Technology – "Small Ruminant Production: A Veritable Solution to Food Insecurity in Nigeria" on 24 September, 2019.
- Prof. Cordelia I. Ebenebe of the Department of Animal Science and Technology – "Animal Protein: The Facts and Conjectures" on 26 November, 2019.
- Prof. Ernest C. Igwe of the Department of Food Science and Technology – "Digging our Graves with our Teeth" on 28 January, 2020.

This 4th lecture would have been presented in 2019, but for the busy schedule of the University, coupled with industrial actions by the University Unions. Hopes were high that the lecture will be delivered in 2020, unfortunately COVID-19 pandemic struck, and the government lockdown kept people away from the citadel of knowledge. However, we give all Glory to God that we are alive to witness this presentation.

A faculty lecture is a typical university tradition. It is an opportunity to introduce a Senior Lecturer to showcase his/her line of thought in scholarship. However, today, a Professor of 10 years standing will be presenting our Faculty Lecture. Perhaps, I could have been the next to present inaugural lecture in my department had I continued my service at the University of Ibadan, where I started my career. Nevertheless, I feel great. I wish to express my profound admiration of the Deanfor his doggedness and resilience despite all odds; I support more series of this lecture as the faculty continues to soar higher.

A superficial look at the titles and focuses of the first three Faculty Lectures by the three erudite Professors showed that food is very crucial for the survival of mankind - be it of plant or animal source. Thus, the title of my Faculty Lecture today "**Discovering the Fighters of Food Security"** is a chronological and logical follow-up to the first three food-related scholarly presentations. This is also the first from the Department of Agricultural Economics and Extension.

Mr.VC Sir, permit me to start from the beginning.
"In the beginning, there was the Word, and the Word was with God and the Word was God".
God spoke the word; "Let the earth produce all kinds of plants, those that bear grains and those that bear fruits" and it was done (Genesis 1:1 Good News Bible). I consider God being mindful of food security, which is a fundamental right of every human being and living organism.

Introduction

Mr.VC Sir, Is food everywhere? Even food dense and less dense communities have issues of food security. Food security has become a challenge of global dimension as the world population gear towards 10.5 Billion by 2050 (United Nations, 2011). Global food security is a growing concern with rising food prices due to growing consumers demand, increasing bio-fuel demand, industrial uses and increased weather variability (Tijani-Eniola 2016). Food shortage has continued to affect mental and psychological development, national development and development agenda (Tarasuk *et al*., 2013). Achieving food security in Nigeria is of great importance to national development, as it can boost other sectors of the economy. It is a common saying that a hungry man is an angry man; therefore, a nation with a fragile food security will have a fragile internal security. This could produce nothing better than a population of people with bottled anger, awaiting explosion, therefore, no country can truly be a great nation if it is not capable of feeding its citizens. The number of hungry people in the country is estimated to be over 50 million, whereas the country's total population of about 160 million, out of which about 52 percent live under the poverty line (Akinwumi, 2015).

Conceptualization of Food Security

Several concepts of food security have emerged over some decades, with researchers considering many dimensions to be able to tackle issues bordering on food insecurity. Therefore, the main goal of food security is for individuals to be able to obtain adequate food needed at all times as well as utilize the food in multifaceted dimensions.

Food security is often defined in terms of food availability, food accessibility and food utilization (USAID, 1995). In the year 2000, the World Bank identified three pillars that can be underlined in planning food security progammes. These include; **Food availability, Food accessibility and Food utilization.** Food availability is achieved when sufficient quantities of food are consistently

available to all individuals within a country. Such food can be supplied through household production, domestic outputs, commercial imports or food assistance. Food accessibility is ensured when households and all individuals have adequate resources to obtain appropriate food for a nutritional diet. Access depends on income available to the household, the distribution of income within the household and the price of food. Food security according to Food and Nutrition Technical Assistance FANTA (2002) encompasses three dimensions: *availability* (a measure of food that is and will be physically available in the relevant vicinity of a population during a given period); *accessibility* (a measure of the population's ability to acquire available food during a given period); and *utilization* (a measure of whether a population will be able to derive sufficient nutrition during a given period). According to Idachaba (2004), food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their daily needs. For a nation to be food-secured, the following must be noted:

- Suitable agricultural methods which produce crops and livestock of high nutritive value.
- Economic situation which makes it possible to produce the necessary food at a cheaper rate and available to all.
- Controlled industrial procedure.
- The conscientious and informed home – maker to manage.

Unfortunately, food security definition in terms of availability, affordability and accessibility of food to the populace is not applicable. By this definition, competition is inevitable. The poor does not have all it takes to compete with the rich to guarantee daily bread. Considering the fact that food could be available, is it within the reach of the poor? A situation where market forces are allowed to determine ability to pay seems very dangerous for the poor. The rich and poor alike all need the same type of staple food prevalent in every locality. The crux of the matter is that it is not just having access to food that matters; equally of importance is its availability and affordability to both the rich and the poor, without which food security will continue to be a mirage until deliberate policy is put in place for its measurement having indigenous content.

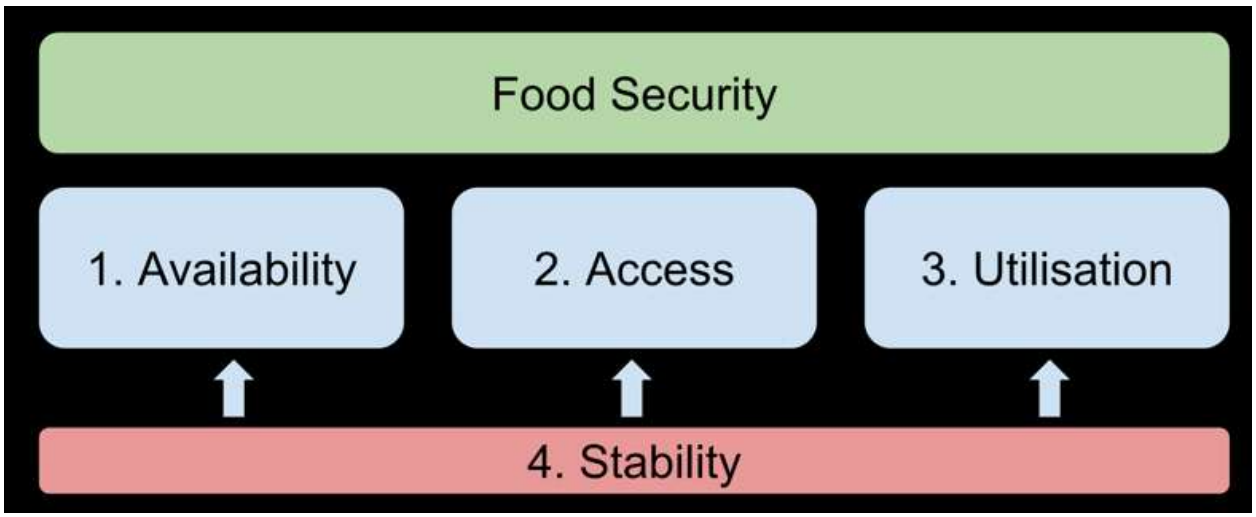


Fig. 1 Components of Food Security

Food security exists when all people, at all times, have physical, social, economic and adequate access to sufficient, safe and nutritious food which meets their dietary needs for an active and healthy lifestyle (Nwakapa, 2015). Ogundare (2015) opined that food security is the ability of people to meet their required level of food consumption at all times coupled with access to social protection and services.

Some scholars however see stability as a separate cross-cutting factor. For a society to be food secured, these components must be sufficiently present (Fig. 1). It is one thing to produce food and another to make such food available on the table on sustainable basis and adequate. However, issues of Safety and adequacy is very germane to be spelt out in the concept of food security. In Africa most especially in Nigeria, food is being produced in large quantity on an annual basis. Surprisingly, these foods are not readily available on the table to be consumed as a result of many factors (ranging from inadequate post-harvest activities to conflicts and violence). Erdman (2018) reported that 795 million people are hungry and another two billion people are still expected to join the undernourished people by 2050. This is as a result of uncontrolled population growth and lack of food diversity. The number of people who experience food insecurity in Nigeria is on the increase. The population of Nigeria is more than 160 million people with the undernourished increasing from 10 million in 2010 to almost 13 million (20.8%) in 2012; sadly, the rate keeps growing. Unfortunately, the population of the malnourished rose to 830 million globally in 2020, as a result of the COVID-19 pandemic (FAO, 2020) and 30 – 40 percent of all food is wasted.


A


B

Plate 1A & B: Malnourished Children

The inability to feed the entirety of the world's population is often due to food waste. This is as a result of inadequate infrastructure and knowledge to preserve food after production. Leading chronic under-nutrition, which contributes to poor growth in children less than five years of age (Plate 1). This means that such children may not meet the specified requirements at that age, which can have long-term negative impacts on health and development of children. Also, acute under-nutrition contributes to wasting in children less than five years of age and results in children being too thin for their height

Measurement of Food Security

The data used for Africare's measurement were Months of Adequate Household Food Provisioning (MAHFP). The first method, Months of Adequate Household Food Provisioning (MAHFP) was developed by Africare in the late 1990s. It is a tool for identifying vulnerable groups and measuring the impacts of Africare Title II funded programmes on increasing or diminishing the number of people classified as the most vulnerable groups. The MAHFP guidance was revised at the 2004 food security workshop. Data generated were based on that guidance (Africare 2005). The second method for identifying food insecurity is relatively new and is questionnaire-based (hereafter referred to as the FANTA/Cornell questionnaire method). It was developed, pilot tested, and validated on the Africare/ZFSI project by a collaborative research agreement between the USAID Title II-funded Food and Nutrition Technical Assistance (FANTA) project and the Cornell University Division of Nutritional Sciences. A proxy indicator dietary diversity, defined as the number of unique foods consumed over a given period of time, measures household food access. Dietary diversity would appear to show promise as a means of measuring household food access, monitoring changes and impact, particularly when resources for such measurement are scarce (FANTA, 2002). The Food Insecurity Experience Scale (FIES) is one of two indicators used for measuring progress toward achieving one of the Sustainable Development Goals (SDGs), Goal 2, which relates to ending hunger and ensuring food access (SDGs, 2016). This indicator is currently used by FAO and a growing number of countries to monitor national and global food security trends.

Brinkman, et al. (2020) draws inspiration from the concept of food security employed by the Food and Agriculture Organization (FAO). The FAO food security concept has four basic components covering availability, access, utilization and stability. Thus individuals are considered food secured if they have uninterrupted access to adequate and nutritious food all year round. Availability refers to supply of food; access refers to the ability (effective demand) to purchase food (economic access) and closeness to market (physical access); utilization refers to the processing of food into consumable forms which partially relates to dietary quality; stability refers to the three components being stable at all times to ensure food security (FAO, 2008; Devereux, Béné, and Hoddinott, 2020).

Food Systems

Food systems (FS) cover the entire spectrum of actors and their relationship (intra- and inter-linkages) in value-chain activities including production, agro-processing, distribution, final consumption and post-harvest activities involving storage and disposal of food commodities emanating principally from agriculture, forestry (FAO 2018). HLPE (2017) defined FS to include actors embedded within components of wider economic, social and natural built environments. This is made up of sub-systems (input, production, waste management) that interact with other major systems (health, trade, energy). The FS include activities related to production, harvesting, processing, storage, distribution, food preparation and consumption. FAO (2018) justified that a FS approach is required because of the dynamism involved in the food system particularly in the context of changing consumption patterns, climate change and variability, population growth, changes in natural resources management and urbanization. Also, it is due to the limitations of current non-food systems' approaches that are unable to deal with the complexities taking place within food systems.

Traditional food security system approaches emphasized a production-focused approach dwelling so much on increasing food supply. However, given the rapid changes taking place within broader food systems, a focus on production potentially neglects other sectors equally engaged in complex interactions that influence food and nutrition security(FAO, 2018), situation that further exacerbates risks and problems in other sectors that go unnoticed. FAO (2018) indicated that the concept of Sustainable Food System (SFS) should ensures food and nutrition security at all times through interactions in economic, social and environmental components that does not compromise food security and nutrition security of future generations. A combination of the food security and food system both as a conceptual and theoretical framework stands potentially very useful in understanding the effects of food insecurity.

Importance of Food

Food is of dominant importance to the survival and growth of every human being and very crucial to life without which death is certain. Food is consumed for definite purposes: physical, emotional, and mental stability of the person. It improves alertness of the mind and builds resistance against infections and various kinds of diseases. Food is use to express good social relationship especially during parties such as weddings, naming ceremonies, funerals as well as for symbolic values and used for libation (Meludu, 2010). Food according to Idiok, Idiong, Brown, Okon and Okon (2014), is defined as any edible substance ingested to supply energy or nourishment to the body to maintain life and growth.

Every family has its own peculiar meal pattern, which is governed by the social class to which such families belong, their economic status, religious beliefs and social attitude. Food has brought about an integration of different cultures, race, ideals and thinking of people through mutual acceptance and relishing of others dishes. Therefore, having a healthy diet requires an understanding of the five food groups. The United State Department of Agriculture (USAID, 2020) suggested that eating at least half of grain should come from whole grains, such as in whole wheat bread. USDA advised that individuals should choose the lean cuts of beef and poultry when eating these protein sources. Furthermore, food is needed to repair and replace the body tissues, build heal thy body, supply energy for the body, maintain body temperature, build new cells, maintain life and stimulate growth. Food is usually of plant or animal origin, and it contains essential nutrients such as carbohydrates, fats, proteins, vitamins, minerals and water. Nutrients are chemical substances found in foods that are essential to human growth and function. The nutrient is furtherdivided into three categories which are plant nutrient, animal nutrient and a mixture of plant and animal nutrient. The first class of the nutrient is ‘Rich’, the second class of the nutrient is ‘poor’ while the third class is regarded as ‘nutrient barren’ Nevertheless, they all serve different purposes in the body (Development Initiative, DI; 2018; WHO, 2020).

Food security is a complex sustainable development issue that is related to health through malnutrition, not excluding sustainable economic development, environmental improvement and trade (WHO, 2020). Improved food security for the poor with enlarged diversity in their food basket using choice of vegetables, fruits, root crops and supplementation to address hidden hunger is essential for addressing food insecurity. In this context, this lecture provides a brief background to food and nutrition and issues of hidden hunger to enable adequate understanding of food security and the proper measurement scales.

Classification of Food Nutrient

The six nutrient components (carbohydrate, proteins, fats & oils, vitamins, minerals and water have certain functions that target different body part and together they ensure good state of the overall health (Fig. 2 & 3).

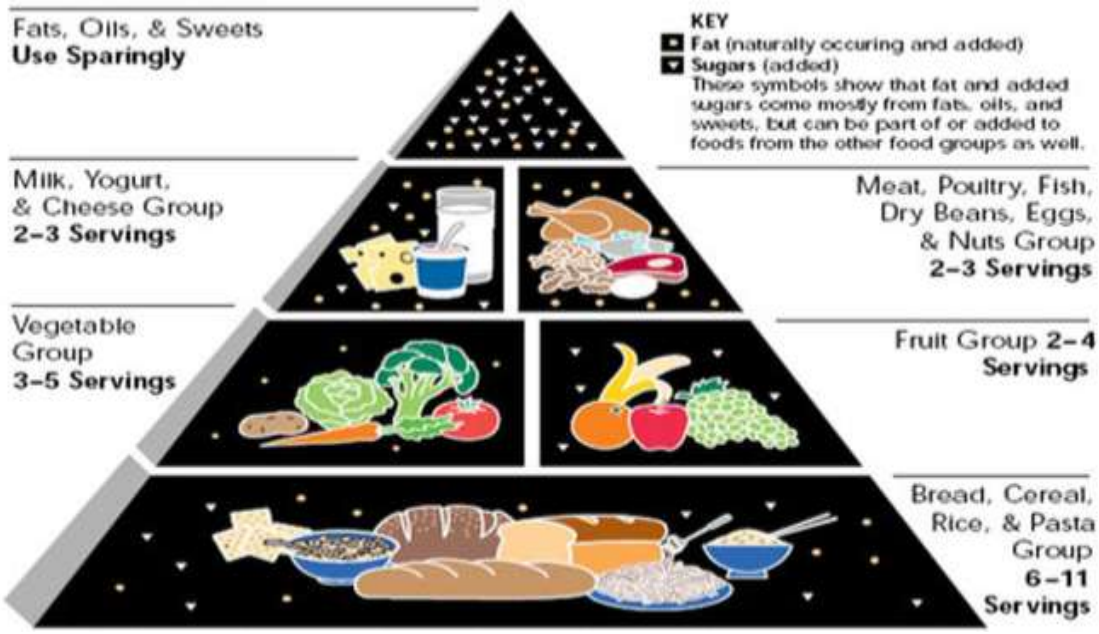


Fig.2: Food pyramids
Source: US Department Agriculture/US Health and Human Services

Fig.3: My Plate My Life

Food Security and National Development

Food security is an essential tool for national development. Most of what the Nigeria needs to attain a high level of food security is within her reach. For instance, Nigeria has one of the best climate and land resources to produce food, which would adequately serve the population in areas of consumption, exportation and industrial uses. Different scholars over the years have advanced different definitions for development from different perspectives to serve different areas of interests. For instance, Marcellus (2009) described development as an improvement or to become more advanced, more mature, more complete, more organized and more transformed. This implies a positive transformation or move from the status quo. Such positive change could be at the level of an individual, community, society or nation. Development to an individual shows enhanced skills and capacity, greater freedom, creativity, self-discipline, responsibility, stable food and material well-being. Furthermore, Uji (2015) felt that development is a "social and personal change that moves towards consciously chosen goals'

At a larger scale however, Dannefer andPerlmutter (2019) conceptualized development as a multi-dimensional process involving the reorganization and reorientation of the entire economic and social system. This involves in addition to improvement of income and output, radical changes in institutional, social and administrative structures as well as in popular attitudes, customs and belief. According to Adekoya and Ajilore (2012), development is the socio-cultural, political, economic and the spiritual well-being of a society. In a really developed state there is guarantee of good quality of life, exercise of all human rights and freedom to participate in the democratic process (Dunu & Onoja, 2016). From the foregoing, development implies enhanced quality of life, equity and justice, as it takes into consideration the well-being, growth and advancement of individuals within the society, of which food security should be the ultimate.

National development could mean a sustainable growth and development of a nation to sustainability. Its accomplishment is dependent on the impact it has in improving the lot of the masses (Adekoya and Ajilore, 2012). Comparable argument was advanced by the third National Development Plan of 1980 (Adekoya and Ajilore, 2012) stating that:

True development must mean the development of man, the unfolding and realization of his creative potentials, enabling him to improve his material conditions of living through the use of resources available to him. It is a process by which man's personality is enhanced, and it is that improved personality creative, organized and disciplined-which is the moving force behind the socioeconomic transformation of any society.

The crucial goals of every development effort should therefore be to:

- Increase availability and widen the distribution of basic life sustaining goods such as food, shelter, health and protection.
- Raise levels of living in addition to higher incomes, the provision of more jobs, better education, and greater attention to cultural and human values, all of which will serve not only to enhance material well-being but also to generate greater individual and national self esteem.
- Expand the range of economic and social choices available to individuals and nation by freeing them from servitude and dependence, not only in relation to other people, states and nations but also to the forces of ignorance and human misery (Anaeto and Anaeto, 2010).

Unfortunately, most African countries, Nigeria inclusive, are still struggling to attain the desired level of national development as stated above. As a result, the country has remained largely underdeveloped despite huge mineral and human resources endowments. Although there are diverse opinions on why and the extent to which Nigeria remains underdeveloped. It is ecclesiastically clear that the country has not attained her full potentials in most of her developmental scorecards in spite of her abundant human and natural resources (Dunu and Onoja, 2016). For instance, even though Nigeria is the largest producer of cassava in the world with total production of 45.72, 43.41 and 44.58 million tonnes in 2006, 2007 and 2008 respectively (FAOSTAT, 2009) and a global market share of 19 percent (Phillips *et al*, 2004; Hillocks, 2002). In 2017, Nigeria produced 59 million tonnes which translate to 20 percent of the global production but exports just about 3.2 million tonnes annually (IITA, 2019).

Uninterestingly, the country is still submerged in extreme poverty, unemployment, debilitating hunger, food insecurity, malnutrition, export deficit, rising foreign and domestic debt abysmal health services as well as attendant social frustration and unrest (Suberu, 2007, Okwu, *et al*., 2016). Similarly, across the world, development has been enhanced or hampered by the nature and degree of attention given to agriculture, local food processing and value addition efforts in different regions and times. Regrettably, since the discovery of oil in commercial quantity, Nigeria had paid little attention to agriculture. The country has not fully considered the processing into finished products. It is against this background that this lecture was conceivedto reflect on the issues of food insecurity that is steering at us. You will agree with me that this is quite germane for national development in a period of protracted economic recession the country is facing currently.

Mr. VC Sir, achieving adequate food security is a necessary stride towards further general development objectives of improved human wellbeing (USAID, 2020) based on its multifaceted nature (EIU, 2018). There are increased food deficit levels in the country and the number of people who suffer hunger keeps growing as shown by the Global Hunger Index – (State of Food Insecurity in the World, 2014, 2021; FAO/IFAD/WFP, 2015 and Action against Hunger, 2021). Hunger is associated with lack or low level of food security – this being the availability and accessibility of adequate food in socially acceptable ways. The number of hungry people in the world hascontinued to increase geometrically from 75 million in 2007 to 100 million in 2008 (FAO, 2009) and currently 690 in 2021 (Action against Hunger, 2021) with majority living in rural area and predominantly farmers.

In an attempt to find lasting solution to poverty epidemic, unemployment, food security crises rampaging the country; successive Nigerian government at various times had embarked on and implemented several agricultural policies and programmes some of which are defunct or abandoned, and some restructured while others are still in place. Prominent among them are Farm Settlement Scheme; National Food Accelerated Production Programme (NAFPP); Operation Feed the Nation (OFN); Green Revolution – School to Land, state-wide Agricultural Development Programmes (ADP's), Directorate of Food Roads and Rural Infrastructures (DFFRI) and Agricultural Transformation Agenda. Also, the Nigerian domestication of MDGs culminated into programmes such as (Nigeria Economic Empowerment Development Strategy) (NEEDS, 2004), National Poverty Eradication Programme (NAPEP), Vision 2020, the Seven Point Agenda, Agricultural Transformation Agenda (ATA) and Fadama I, II and III Projects with policy focus

on enhancement of food security within the populace, particularly, the rural dwellers among other vulnerable groups. Despite all these interventions, the nation's food security level is still low with its attendant large number of hungry people. In tackling issues of this nature, it is pertinent that insight into agenda and guide to sustainable development goals is considered.

Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)

The 17 Sustainable Development Goals (SDGs) (fFig. 4) born in 2012 are geared to meet the urgent environmental, political and economic challenges needed to transform the world in all ramifications These goals include:Goals 1: No Poverty, 2: Zero Hunger, 3: Good Health and Well-being, 4: Quality Education, 5: Gender Equality, 6: Clean Water and Sanitation, 7: Affordable and Clean Energy, 8: Decent Work and Economic Growth, 9: Industry, Innovation and Infrastructure, 10: Reduced Inequality, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 13: Climate Action, 14: Life Below Water, 15: Life on Land, 16: Peace and Justice Strong Institutions, 17: Partnerships to achieve the Goals (United Nations Development Programme (UNDP, 2021; UN, 2017; IITA,2017; Otekunrin et al. 2019a,b).

These goals are interwoven and the achievement of one leads to the achievement of the order. They were formulated on the principle of "leaving no one behind" (Meludu and Akaninyene, 2021). It is a holistic approach to achieving sustainable development for everyone. The adoption of SDG 2 creates an opportunity to systematically engage with major food deficient countries and to inform as well as adjust national policies towards effective, sustainable models of food security and governance. Food and agriculture lie at the heart of the 2030 agenda and its goals of ending poverty and hunger, responding to climate change and sustaining natural resources (United Nations Department of Economic and Social Affairs (UNDESA, 2015). It is therefore worrisome that with less than nine years left for the achievement of all the goals as stipulated therein, little has been achieved so far in Nigeria as per zero hunger including clean water supply (Meludu and Akaneyene, 2021).

Fig. 4: Sustainable Development Goals

Zero hunger is the second SDG that must be achieved by 2030. It was referred to as eradicating hunger in Millennium Development Goal (MDGs) of 2015. So many reasons were given why it was not possible for hunger to be eradicated. Uninterestingly, some of the ugly situations are still raising their ugly heads today (Meludu, 2019), how workable is it by 2030. So, to end hunger is to ensure that all people, the poor, vulnerable (infants, pregnant and nursing mothers, people living with HIV/AIDs and corona virus) have access to safe, nutritious and sufficient food. "So help us God".....Amen. The two words "safe and nutritious" mentioned above are very crucial in the bid to achieve zero hunger and attain food security. It means that the sources of food consume must be known to determine whether it is safe or not. Is the food produced, processed, stored, packaged organically and safe, free from contaminants (through agricultural value- chain)? So, for food to be nutritious, the focus must be on "hidden hunger" – the micro-nutrients. The following should be done through "promoting responsible consumption for sustainable national survival: creativity, innovation and researches". Kalanda-Joshua, Ngongondo, Chipeta, Mpembeka (2011) identified food security measurement to leverage on indigenous knowledge.

Concept of Hunger

The number of hungry people rose from 785 million in 2015 to 822 million in 2018 (Robinson, 2019). The challenge posed by hunger is multifaceted and different expressions are used to describe its various forms. Hunger is usually conceptualized to refer to the suffering associated with a lack of sufficient calories. The Food and Agriculture Organization of the United Nations (**FAO, 2017)** defines food deprivation, or undernourishment as the consumption of too few calories to provide the minimum amount of dietary energy that each individual requires for living of a healthy and productive life, given the person's sex, age, stature and physical activity level (FAO, 2017). Under-nutritiongoes beyond calories and signifies deficiencies in any or all of the following; energy, protein, and/or essential vitamins and minerals. It is the result of inadequate intake of food in terms of either quantity or quality, poor utilization of nutrients due to infections or other illnesses or a combination of these immediate causes. These in turn are caused by a range

of underlying factors which include household food insecurity; inadequate maternal health or childcare practices; inadequate access to health services, safe water and sanitation. Malnutritionrefers more broadly to both under-nutrition (problems caused by deficiencies) and over-nutrition (problems caused by inadequate diets, such as consuming too many calories in relation to requirements with or without low intake of micronutrient-rich foods). Over-nutrition, resulting into being overweight, obesity and non-communicable diseases is becoming increasingly common throughout the world with dire implications for human health, government expenditures as well as food systems development. While over-nutrition is an important concern, the Global Hunger Index (GHI) focuses specifically on issues relating to under-nutrition which include: Undernourishment, child wasting, child stunting and child mortality (Global Hunger Index, 2019).

The Hidden Hunger

Hidden hunger is linked with lack or low level of food security – this being the non-availability and inaccessibility to adequate food in socially acceptable ways. Meeting global food security needs remains a challenge, as food and protein demand increases at a rate even faster than the population growth (Ozgul, Alessandro, Stefania, Lorenzo Bellù & Ralph, 2019). Poor diet is a common source of hidden hunger. Increasing dietary diversity by providing foods with adequate amounts of micronutrients is one of the most effective ways of sustainably preventing hidden hunger. Hidden hunger also occurs when the quality of foods people eat do not meet their nutrient requirements, such foods are said to be deficient in micronutrients such as vitamins and minerals required for their growth and development (WHO, 2014). Women and children in families with low-income often fail in getting enough vitamin A, iodine, iron, and other essential nutrients in their nutrition. This limits their growth, development, health and working capacity.

The signs of hidden hunger, such as night blindness due to vitamin A deficiency and goitre from inadequate iodine intake become visible once deficiencies become severe. Significant proportions of our population are negatively affected by this less obvious "invisible" phenomenon in terms of their health, growth and development. This is why micronutrient deficiencies are referred to as hidden hunger. The global hidden hunger crises is revealed to impact more than two billion people worldwide (FAO, IFAD and WFP, 2014; WHO, 2014). Although a larger proportion of the burden of hidden hunger is found in the developing world, micronutrient deficiency, particularly iron and iodine deficiency are also widespread in the developed world. If high level of hidden hunger is prevalent in a country, such nation cannot be considered as being food secured.

Causes of Hunger

Many factors responsible for food insecurity and hunger are often being intertwined. In general, the principal causes of hunger include the following inadequate post-harvest handling activities, poverty, conflicts, insurgency, civil unrest, environment (climate change), poor governance, population explosion, inadequate investment in agriculture, unstable markets and disease outbreak (World Food Programme, 2018; Mizzi, 2019) and COVID-19 pandemic.

Poverty

Poverty is a principal cause of hunger in Africa and other climes. Individuals living in poverty often cannot afford food of sufficient quality or quantity to live a healthy life. According to the World Bank (2013) 42.3% of the population of sub-Saharan Africa lived on US$1.90 or less per day, a principal factor of widespread hunger. Children exposed to long-term under-nutrition are often stunted, leading to long-term consequences including decreased labour productivity and

income-earning potential (FAO, 2017). Indeed, when poverty is prevalent, food security is threatened.

Conflict

Conflict and violence can have direct and indirect impacts on all levels of the food system, leading to hunger and food insecurity. Conflicts often put constraints on employment and income opportunities, which affects an individual's ability to acquire food. Conflict can also affect exports and imports, which can lead to limited food availability and affordability. Availability of food can also be affected if available resources (land, agricultural input) used to produce food are destroyed during times of conflict.

Environment

Environmental challenges like erosion, desertification, deforestation, drought and water shortages can have detrimental effects on food security. FAO reported in 2019 that 55 countries experienced food crises due to climate and weather conditions. Two-thirds of these countries were in Africa. The impact of the crises affected approximately 32 million people (Food Security Information Network, 2018). Deforestation, for example, is due to the excessive exploitation of forests by humans seeking new places to live, farm, or obtain firewood. Drought, water shortage and desertification across Africa have reduced agricultural productivity and thus, influenced food availability.

Governance and Political Instability

Poor governance, political instability, and poorly implemented policies also lead to hunger and food insecurity by creating a system where there is insufficient access to food. Many countries have seen progress in reducing hunger among their citizens after implementing policies that enhanced food security. For example, in the early 2000s, Ethiopia invested in agricultural research and extension, leading to increases in food availability. The increased investment in infrastructure helped move crops to markets, increasing food access (IFPRI, 2017).

War

The protracted war against insurgency and terrorism being prosecuted by the Government of Nigeria has led to the fleeing of farmers and farm workers from the fields. The remaining people in the affected areas are unable to continue their farming activities in the areas which had resulted in the alteration in the agricultural value-chain in the country thereby resulting in reduction of food production. Over 650,000 people in Borno State alone face extremely limited access to agricultural land, labour opportunities and are heavily dependent on humanitarian assistance (Isabella, 2018). When fertile lands are exposed to harmful chemicals used for manufacturing the weapons, the essential minerals are destroyed and lost rendering the lands infertile for food production (FAO, 2017).

Urbanization

Like other countries of the world, increasing rural-urban migration due to urbanization play major roles in the emerging food insecurity crises in Nigeria. According to Food and Agricultural Organization (FAO) by year 2050, 70 percent of the world population is expected live in cities.

By this, there is bound to be disruptions in agricultural production thereby worsening the food insecurity menace.

Population growth

Presently, Nigeria is the 6th most populous country in the world with an estimated population of about 178 million people and annual growth rate of 3 percent. This has raised the demand for food products just like other countries of the world. Africa's population also has increased rapidly from 221 million in 1950 to 1.2 billion in 2018. It is estimated that more than half of the global population growth between now and 2050 will occur in Africa (United Nations, 2018). Rapid population growth can also negatively affect per capita income leading to widespread poverty and hunger.

Poor Agricultural Sector Development

Modernization of agricultural practices and adoption of more productive and sustainable agricultural technologies in Nigeria is low(Zero Hunger Strategic Review, 2016) are problems that poses great threat to food security in Nigeria and Africa. Most African countries including Nigeria do not have adequate agricultural policies capable of enhancing food security in the long run; even the few that are available are poorly implemented. This is because Nigeria and most African countries do not have stable leadership until recently resulting in policy somersaults. The political instability led to inconsistencies in policies that could have placed the country on a positive track that could ensure that there was uninterrupted food supply. However, the opposite is the case as successive governments engaged in new agricultural policies that led to the revocation of the pre-existing ones. Even when the extant ones proved prosperous and sustainable, they were scrapped.

Climate Change

In the last few decades, climate change has gained grounds as a major drawback to agricultural productivity and livelihood realities of man (Olakojo, 2018). Climate Change is another reason why there is food shortage (Meludu, 2019), which has changed the productivity pattern. The rain and availability of water are less predictable now than before. The rain comes either too late or too early or for a shorter period or longer period which affected certain food crops that could not withstand water-logging. Farmers are often confused and do not know when to cultivate their grains and other vegetables. Sometimes, the rain comes too early and when grains are planted, the rain stops and the grains get rotten under the ground.

Inadequate Postharvest Handling Activities

Postharvest handling activities are another major factor causing food wastage in Nigeria. These activities starts from harvesting, pre-cooling, sorting and grading, food packaging, storage, processing and transportation. Most of these activities are poorly handled by the stakeholders (farmers and marketers) as a result of inadequate knowledge and rural infrastructures in place. Food security is threatened when post-harvest handling of produce is faulty.

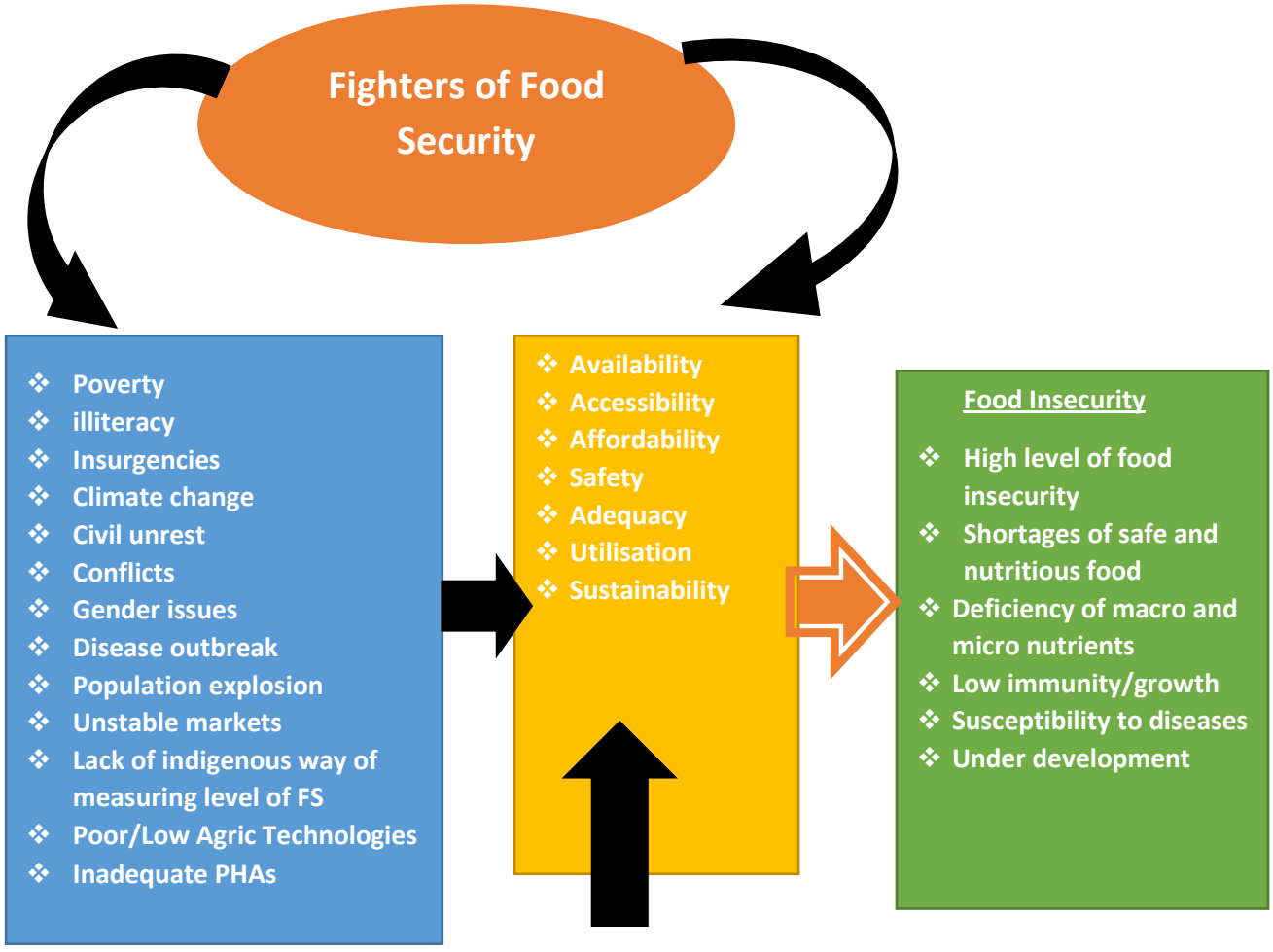
Disease Outbreak: COVID -19 Pandemic

As the coronavirus pandemic unfolds, disruptions in domestic food distribution chains and other shocks in food production loss of incomes and allowances continues to create strong tensions and food security risks in many developed and developing countries (Meludu and Abolade, 2021).

Malnutrition and reduced immune system increase vulnerability to numerous food borne pathogens and toxins capable of worsening the burden of food borne diseases (Meludu, 2011). While poor nutrition is associated with the increasing trend in non-communicable diseases (NCDs), ongoing scientific efforts have investigated and established the potential links between food safety hazards and NCDs (Velmurugan *et al.*, 2017).

This lecture takes another inspiration from the combined framings employed by FAO (2008) and Devereux, Béné, and Hoddinott (2020), which considered availability (supply of food), accessibility (ability, effective demand and purchase food as well as economic access and closeness to market, physical access), utilization (processing of food into consumable forms which partially relates to dietary quality), and stability (being stable at all times to ensure food security). These concepts will be utilized in understanding food security theories and measurement, while a policy recommendation will be deduced from this lecture.

My postulation is that, looking at the conceptual framework (Fig. 5) that shows the fighters of food security, there must be grassroots/stakeholders input as well as adequate policy, effective and efficient agricultural system throughout the value chain. Food must be available, easy to access/afford, safe (devoid of any chemical or additives), adequate (nutrient-rich food through diversification), utilized for active participation in social and economic activities, sufficient stable for sustainable living. There is a universal knowledge that adequate food enhances immunity, good health and proper intellectual development of children. Agreeably, there is the need to make sure that all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary and food preferences for an active and healthy lifestyle in a sustainable way without interruption



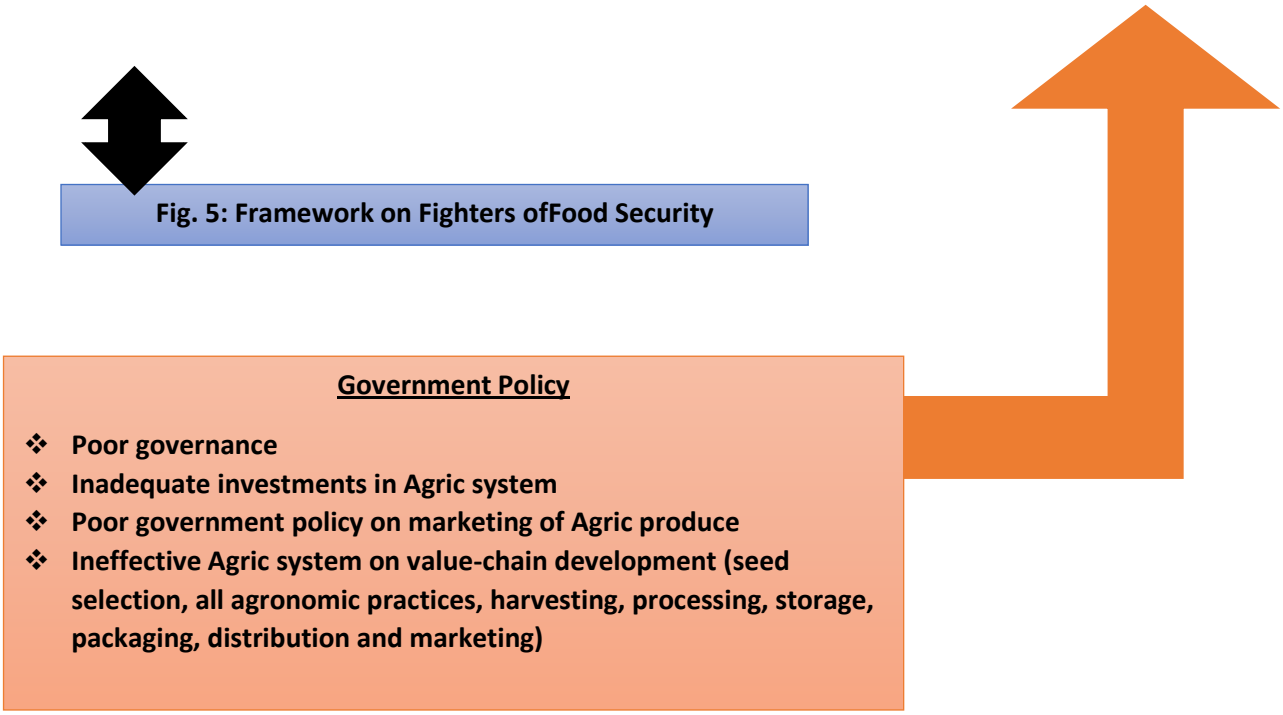


Fig. 5: Framework on Fighters ofFood Security

It can never be overemphasized that food security is an essential tool for national development. As a follow-up, achieving food security in the country is of great importance to sustainability of national development as it can boost other sectors of Nigerian economy. Therefore, is itnot imperative to discover the "fighters"- that is, all elements working against achieving food security? Therefore, the areas covered so far are best described as part one, scene one. The next part will delve into **"fighting the fighters of food security"**. So the stakeholders are the "troops" to begin war and take legal action against food security fighters!

My Contribution to Issues of Food Security

My contributions towards ameliorating the challenges of food security cut across major areas of specialization. They are GeneralAgriculture, Home Economics with specialtyon food and nutrition security in addition to Agricultural Extension and Rural Development, which builds the capacity to disseminate information on adoption of innovation on food and nutrition security. My contributions have several dimensions since the issues relating to food security are diverse.

Mr. VCSir, one of my PhD students - Oyebade (2013) worked on the "Effects of Social Capital on Rural Households' Food Security in South-western Nigeria" using three indicators - availability, affordability and adequacy to explain household food security. A list of food 70items was presented to the respondents. Food adequacy measurement adopted in this study was a post-mortem statistical analysis of the different classes of food consumed by the population. For adequacy and frequency of consumption of the different classes of food nutrients was employed. Simple descriptive statistics revealed that the mean score of frequency of consumption for protein

and starch food items were about even. The study showed that the population consumed more of vegetables than other classes of food. This is reasonable in the sense that the group of food items that came under vegetables were wider than other classes of food. The focus group discussions also corroborated this fact that leafy vegetables were very paramount in the menu of the study population. Also, social capital endowment (affordability and availability) of the population was found to be in two major categories of low and medium, having significant effect on the household food security levels of the respondents in which 63.6% of the population were in the food-insecure category. This study identified three categories of high (4.3%), moderate (54.6%) and low (41.06%) social capital endowments respectively. This result indicates that most rural households (54.6%) had moderate social capital endowment while 41.06% had low social capital endowment. Social capital endowment is a reflection of how well entrenched the members of households are and their potentiality to reap benefits from the network of associations in their community. Female-headed rural households were more prone to food insecurity. Therefore, increase in social capital endowment in rural areas will definitely enhance household food security levels.

Another doctoral student investigated "Influence of Food Preferences on Rural and Urban Households' Food Security in South-western Nigeria". Food preferences of rural and urban households were constrained by availability of food. In addition, while rural households' food preferences were constrained by cost of food, urban households' food preferences were affected by their health status. Notwithstanding, urban households were better off in their food security status compared to rural households. Knowledge influences food security in rural households, particularly for the elderly. Food security of rural and urban households were influenced by their food preferences. Combination of respondents' preferences for some food groups contributed to their food security. In-other words, food diversity plays a key role in attaining food security.

One exciting research I conducted with an MSc student (**Meludu and** Obule, 2009) was on the willingness to accept unified standardized unit of measurement in South-West Nigeria. This is a crucial factor in marketing of grains and granules. It is a known fact that there are different measuring units all over the world but that of Nigeria are numerous. The fraudulent practices by agricultural produce/product sellers coupled with variation in units of measurements across the country and difficulty to consume food based on Dietary Reference Intake stimulated this research. The findings of the study showed that "willingness to accept unified standardized measuring unit has significant relationship with sex" ($\chi^2 = 0.257$, $p = 0.015$). The study further revealed that there was no significant relationship between level of education ($r = 0.090$, $p = 0.621$), age ($r = -0.110$, $p = 0.234$), awareness of kilogram ($\chi^2 = 0.109$, $p = 0.498$), utilization of kilogram ($\chi^2 = 0.096$, $p = 0.591$) and grains and granules' seller's willingness to accept unified standardized measuring unit. There is a significant difference between grains and granules' sellers in the six markets and willingness to accept unified standardized unit of measurement ($F = 1.468$, $MS = 117.562$). Based on the findings of the study, the Price Control Board should provide special containers with inscription of the unit it represents as a unified unit of measurement. This will reduce or eradicate the incidence of retail fraud and should be verified by legal backing.

In a study by **Meludu (**2010) on "Proximate Analysis and Potentials of Sweet Potato Toasted Granules as a Dietary Supplement for the Diabetics", sweet potato was processed and toasted into granules. The proximate analysis performed on the toasted granules showed protein, fat, ash,

fibre, starch, moisture and low sugar content after processing. It was discovered that the more fermented the paste before toasting, the lower the sugar content and more acceptable the taste. Therefore, the remarkable low sugar content indicates its potential usefulness as a dietary supplement for diabetic patients. Its fibre content will add bulk and aid digestion, thus preventing constipation. Thus, awareness should be created on this innovation for the management of diabetics and the use by all for sustainable food security. This research was supported by the University of Ibadan Senate Research Grant.

Meluduand an MSc student also carried out a study on "Sensory Evaluation ofDiversified Sweet Potato Drinks among Consumers: Implication for Malnutrition Reduction in Nigeria" (Meludu and Fakere, 2013). Diversification of through processing of crops is a very important way of reducing food insecurity, perishability of most perishable crops and generating varieties. The study considered diversifying the crop into different drinks by combining with different high nutrient acceptable cereals.
Sensory evaluation was done after carrying out various experiments to produce the drinks. The drinks produced were given to respondents to taste and structured questionnaires were also administered after respondents tasted the drinks. The result showed that all (100%) the respondents consumed sweet potato; although a high proportion (60%) of the respondents did not consume it frequently. Most (80%) of them had never consumed any drink produced from sweet potato. The result of the sensory analysis showed that all the drinks were accepted, though drink 2 (sweet potato flour and *zobo* flour) and drink 3 (sweet potato paste, millet paste and *zobo* flour) were more acceptable. The most preferred drinks by majority (60%) of the respondents were sweet potato paste, millet paste and *zobo* flour drink. There was a significant relationship between the educational background of the respondents and level of acceptability of the sweet potato drinks ($\chi^2 = 1.033$ and $P = 0.05$). There was also a significant relationship between the previous consumption of any drink produced from sweet potato and level of acceptability of the sweet potato drinks ($\chi^2 = 5.000$ and $P = 0.025$). Interestingly, there was significant relationship between the most preferred sweet potato drink by the respondents and level of acceptability of the sweet potato drinks ($r = 0.394$, $P = 0.031$). The high level of acceptability of the drinks will lead to enhanced production of the crops required for the drinks. This would enhance income generation as well as alleviating food and nutrition insecurity.

Diversification of Sweet Potato Blends and Utilization for Malnutrition and Poverty Alleviation was conducted by Ladele, Meludu, Ezekiel, Olaoye, and Okanlawon, (2015). Value addition to agricultural produce is a possible potential in reducing poverty, improving food security and malnutrition. Hence, there is the need to develop small and medium enterprises for intensive sweet potato production in the country. Determination of the acceptability of sweet potato (*Ipomea batatas*) and grains such as yellow maize (*Zea mays*), millet (Pennisetum glaucum), soybean (*Glycine max*), bambara groundnut (*Vigna subterranean*), guinea corn (*Sorghum vulgare*), wheat (*Triticum aestivum*), and roselle (*Hibiscus sabdariffa*) blends was carried out through sensory evaluation. Sweet potato (*Ipomea batatas*) roots were processed using oven and sun drying methods. The blends were assessed in terms of functional, chemical and colour properties. Most acceptable blends include BAW (80:20 of sweet potato/wheat), BBC (80:20 of sweet potato/guinea corn), AAB (60:40 of sweet potato/guinea corn), YTE (100% soybean), TYG (100% sweet potato), KTN (100% wheat flour), XGP (80:20 of sweet potato/soybean), XAX (60:40 of sweet potato/wheat), LSS (100% Roselle), CHK (100% Guinea corn), and ABC

(60:40% of sweet potato/yellow maize). Chemical analysis revealed that sweet potato has high percentage of vitamins A and C, potassium (K), manganese (Mn), calcium (Ca), magnesium (Mg) and iron (Fe) and fibre contents. There was an increase of vitamin A and iron in the blended products. The research was supported by the University of Ibadan Senate Research grant.

Mr.VC Sir, the conceptualization of food security cannot be achieved without a concern for organic agriculture. I have made significant contributions to organic agriculture through the Ecological Organic Agriculture Initiative for Africa since 2012. These include: Training programmes on organic agriculture for ADP staff in all the States in Oyo state, in many secondary schools in Ibadan, Oyo State, selected UI and UNIZIK students, Unizik-Go organic and Anambra State ADP staff, Apiculture of Nigeria-Anambra State Chapter. The teachers and students were taught the principles and standards of organic agriculture. I established the Youth Organic Summer School in Ibadan where the famous organic Anthem "Organic is life" was composed in Ibadan.

"Organic is life
Organic is life
Using organic standards organic is life
Organic is life
Organic is life
Farming without synthetics organic is life
Organic is life
Organic is life
For healthy farmers organic is life
Organic is life
Organic is life
For healthy consumers organic is life
Organic is life
Organic is life
For healthy environment organic is life
Organic is life
Organic is life
That is why I'm saying that organic is life"

Discussion continues on shelf life of orange flesh flour and processing into toasted granules and drink to contribute to diet diversification for achieving food security

Contributions of the Department of Agricultural Economics and Extension in Value Addition for Sustainable Food Security

The mission of the Department is to expand frontiers of knowledge in Agricultural Economics and Extension in the digital global ideology and sustainably raise human capital in the agricultural sector through problem-oriented, research-driven capacity building and societal services. The Department of Agricultural Economics and Extension commenced the Farmers' and Consumers' Forum in Unizik FM 94.1 on Wednesday, 5 July 2017 (Facilitated me)and invited all the Heads of Department to participate. This programme is geared towards public enlightenment on

agricultural transformation through the value chain for sustainalbe food security. It also includes introducing innovative ideas and other related information as regards the activities in the Faculty to be aired on radio. This has the capacity of attracting large audience (University community, farmers and communities around the University), and also educating the intending fresh students (Jambites) to consider picking course from any Department in the Faculty of Agriculture as course of study. The programme comes up every Wednesday live from 3.30 pm to 4.00 pm. When it is difficult and not convenient to air the programme, it can be recorded the previous day. This is what project 200 has leveraged on to introduce innovative platform in Unizik FM; this cuts across all the faculties. I appreciate the Director for this great opportunity accorded the Department, Faculy and University. We have invited some eminet farmers to this Radio Forum like Prof Carol Umeayo (Forme DVC Adim) andrecently Dr Jude C. Obi the Country Rep for Knowledge Centre for Organic Agriculture in Africa (Sponsored by GIZ Germany) who has a lot of programmes for the faculty.

A secondary school student in one of the schools I went to teach organic agriculture approached me that she would like to study Agricultural Extension in the University. I said oh great! What subjects are you offering in school? Lo and behold, they were all arts subjects. She was so disappointed when I told her that the subject combination is not suitable to study Agricultural Extension. How would she know?

Rural and Community Development (RCD) programme was carried out to sensitize the rural communities around the University (Gown-town initiative) on healthy food consumption and issues bordering on the use of poisonous substances in food ripening and storage. Also, the use of cancer causing materials in cooking food was discouraged.

The Department has produced up to five customized products for entrepreneurial development of our students and staff. The Department will not relent in its efforts but would rather consolidate on all her previous achievements, with the addition of more activities so as to be more visible and support Project 200.

Curriculum Committee at the meeting of 14th November, 2019 approved the curriculum I facilitated the developement- Home Science/Hospitality. I facilitated the development of MSc and PhD in Human Ecology and Rural Tourism approved by SPGS in 2018. More recently, the development of nutrition and Dietetice curriculum for a department.

Also in the bid to create more awareness onthe issues of food security I accepted the invitation of the Center for Sustainable Development (CSD) and Center for Migration Studies (CMS) where I was able to produce a chapter in CSD book and an article in CMS during COVID-19 pandemic. I also proposed for the inclusion of Food Security and Migration as a course in the programme, The curriculum has been developed and the programme just started online facilitation. These are the channels of creating awareness on the fact that food security matters a lot.

At the university level I facilitated the membership of the University to Regional University Forum - One of the advantages of RUFORUM is the **Mobility programmes** which is an exchange activity that allows academic staffto be engaged in another university in Africa to teach or carry out research and also for younger faculties to carry out their MSc and PhD in another

university in Africa without paying school fees but will be employed as Graduate Assistant while the home university will continue to pay salary and also provide stipend.

The younger faculties especially women

It is demanding being an academic not to talk of being a woman of child-bearing age. While in Japan for postdoctoral fellowship, some Japanese could not understand my mission as a researcher and a woman of child bearing age. Thank God, it went well, when my husband came for his own second postdoctoral fellowship.

In my early career, it amazed me when I see Professors with 10 to 20 pages of curriculum vitae. When mine was just only two pages! The question I put to myself was, is it possible for me to ever have a CV of over 14 pages? To achieve such is possible but only with great efforts on one's part. You must be ready to burn midnight candles or use rechargeable torchlight. You need to collaborate with colleagues both in your department, other departments, within and between universities and equally attend seminars, workshops, inaugural/faculty lectures, faculty and departmental board meetings. In addition, one needs to search for fellowships and grants for certificate training, research and conferences. Remember, "Publish (classified journals) or perish, the goal post is not static". Please, do not waste your time gossiping, it is time wasting and fruitless. Rather, engage in fruitful ventures so as to enjoy being promoted as and when due. I bet, when you would have done your work consistently and well, nobody will be able to ever pull you down. So, search for information through all available means now that we are all on information super highway and make yourself visible. You can reach me both physically and online through different social media platforms such as Twitter, Facebook, LinkedIn, WhatsApp, YouTube, email. I urge the younger faculties to abide by the University rules and regulations. Follow the ethics so that you will not put yourself into trouble ask questions where necessary. *"Onye ajuju adighi efuuzo"*.

Conclusion

Mr. VC Sir, food security is at the low and medium levels in Nigeria. This can be blamed on consequences of having chronic "fighters" of food security such as political instability, inadequate government policy, depressed economy, poor infrastructural endowments, poor storage and processing facilities, grassroots' illiteracy, poverty and complex measurement criteria etc. Food security as earlier stated is an essential tool for national development sustainability. Malnutrition leads to decreased energy levels, delayed maturation, growth failure, impaired cognitive ability, diminished capacity to learn, decreased ability to resist infections and illnesses, shortened life expectancy, increased maternal mortality, and low birth weight. Food insecurity can lead to political instability. Food-insecure individuals may manifest feelings of alienation, powerlessness, stress, and anxiety. Also, they may experience reduced productivity, reduced work and school performance, and reduced income earnings.

The concurrence of the value of indicators of food security together with the difficulties in obtaining detailed information on concept and measurement affect having data on various households' food security status in Nigeria. Unfortunately, justifiable measure of the food security components such as availability, affordability, accessibility, safety, adequacy, utilization and stability are not explicitly interpreted and emphasised among consumers. As I continue to discover more fighters of food security my next target is to develop strategies to fight the fighters.

Recommendations

The desire to fight the challenging impacts of food insecurity in Nigeria, the "fighters" of food security must be seriously ascertained. It is therefore recommended that:

1. Food safety and adequate education must be added to food programmes. It must be emphasized that education will lead the world toward sustainable food security. This is followed by how inclusive the university curriculum should be. Necessary courses should be included as general courses; for example, introduction to organic agriculture principles and standards; introduction to food consumption pattern/adequacy and indigenous knowledge to contribute to variables for measuring food security.
2. Food security being a human right issue should be ensured by all stakeholders. Therefore, political and legal framework is needed to ensure the right of the poor people to have access to, and control over locally available foods, through nutrition sensitive agriculture. Consequently, the need for campaign on utilization of more indigenous foods supplementation as daily staple foods and changing food habit. Capturing these foods and turning them into products that are not just appetizing to consumers but low costs-high nutritional foods for the poor. This should be done through organized certificate courses/workshops/training by Community Rural Development (CCRD) in this University and should be anchored by the faculty. Through this initiative, Internally Generated Revenue (IGR) can also be generated for the faculty and University.
3. Bottom-up approach for the development of food security policies to capture the grassroots' way of life. This can be done through agriculture for development by agricultural advisory services. This is very important if food security will be achieved. Also, people need to be educated on birth control measures to reduce birth rate.
4. Mentorship is germane to enhanced academic development of the younger faculty. This helps in the manner of approach and relationships, in research teams; it builds on the existing works of the professors and continuity in filling the gap in research. Having orientation, trainings, workshops and a regular Faculty Board are forms of mentoring avenue.
5. Subsequently, each faculty lecture should be published into a book and sold to the audience on the day of the lecture to serve as IGR for the Faculty.

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God's faithful and His mercies endures in my life. Glory be His Holy name.

Having served in the University of Ibadan (UI) for two decades, NnamdiAzikiwe University is like home coming for me. Interestingly, I made a lot of wonderful friends; as much as I have been motivated by lot of mentors. They all contributed in no small measure to mould, inspire and make me who I am today.

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Great is Thy faithfulness, O God my Father
There is no shadow of turning with Thee
Thou changest not, Thy compassions, they fail not
As Thou hast been Thou forever wilt be

Great is Thy faithfulness, great is Thy faithfulness
Morning by morning new mercies I see
All I have needed Thy hand hath provided
Great is Thy faithfulness, Lord, unto me

References

Africare. (2005). How to Measure the Months of Adequate Household Food Provisioning? *(MAHFP) in Food Security Interventions (FSI).* Revised February. Unpublished Internal Guidance. Washington D.C.: Africare/Headquarters. *In Simeon* Nanamai and Karim Souliii (2007). Two Methods for Measuring Household Food Security and Vulnerability- Evidence from the Zondoma Food Security Initiative, Burkina Faso. Africare Food Security Review. September. USAID.

Adeloye, Florence Fadeke (2020). Influence of Food Preferences on Rural and Urban Household's Food Security in South-western Nigeria. A PhD thesis submitted to the Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan, Oyo State, Nigeria. PP 5-70

Ballard, T.J., Kepple, A.W. & Cafiero, C. (2013). *The food insecurity experience scale: developing a global standard for monitoring hunger worldwide.* Technical Paper. Rome, FAO. (available at http://www.fao.org/economic/ess/ess-fs/voices/en/). Date accessed January 2020.

Dannefer D., Perlmutter M. (2019). Development as a Multidimensional Process: Individual and Social Constituents. *JournalHuman Development.* 1990;33:108–137 (DOI:10.1159/000276506)

Development Initiatives. (2018). 2018 Global Nutrition Report: Shining a light to spur action on nutrition. Edited byJen ClaydonBristol, UK: Development Initiatives.

Economist Intelligence Unit (EIU) (2018). Global food security index (2018) Building resilience in the face of rising food-security risks. A report from The Economist Intelligence Unit. Paarlberg, R. L. 'Politics and Food Insecurity in Africa', Review of Agricultural Economics, 21(2): 499–511.

Hoddinott, John and Yisehac Yohannes. (2002). Dietary Diversity as a Household Food Security Indicator. Washington, D.C.: Food and Nutrition Technical Assistance (FANTA)Project, 360, pp1-31.

Food and Agricultural Organization (FAO).The state of food insecurity in the world (2015). Retrieved on April 6, 2020 fromhttps://www.researchgate.net/scientific-contributions/2122483643_Food_and_Agriculture_Organization_FAO

FAO (2020). Corona virus disease 2019 (COVID-19) Addressing the impacts of COVID-19 in food crises April–December 2020 FAO's component of the Global COVID-19 Humanitarian Response Plan.

Ikelegbe, OO & DA Edokpa (2013). Agricultural Production, Food and Nutrition Security in Rural Benin, Nigeria. *AJFAND* Vol. 13 No. 5 (2013)eISSN: 1684-5374 print ISSN: 1684-5358

Meludu,N.T., Obule, B.M. and Ukwe, C. (2009). Willingness to Accept Unified Unit of Measurement by Agricultural Product Seller in South West Nigeria. *Journal of Home Economics Research*. Vol. 11. 103-113. Nigeria.

Meludu, N.T. (2010). Proximate Analysis and Potentials of Sweet potato Toasted Granules as a Dietary Supplement for the Diabetic. *African Journal of Biomedical Research*, Nigeria. Vol. 13 (89-91). January

Meludu, N.T. and Ewebiyi, I.O. (2010). Policy Development and Opportunities in ICT for Sustainable Food and Nutrition Security in Nigeria. *African Journal for the Psychological Studies of Social Issues.*Ibadan, Nigeria.Vol. 13(1), 137-151. April.

Meludu, N.T. (2011). Farmers' Awareness and Utilization of Disaster Management Strategies and Training Needs for Sustainable Food Security and Livelihoods in Nigeria. In Disaster and Human Health Risk II: Reducing Risk, Improving Outcomes. Edited by C.A. Brebbia, A.J. Kassab and E.A. Divo. WIT Press Southampton, Boston USA. 303-19.

Meludu, N.T. (2005). Food Insecurity and Coping Strategies of Women in Rural Community of Oyo State. *Nigerian Journal of Rural Sociology*. Vol. 5 Nos. 1&2. 42-52. Nigeria.

Meludu, Nkiru Theresa and Abolade Toyin. (2020). Coronavirus, Climate Change and Food Security. In *African Handbook of Climate Change Adaptation*. Walter Leal Filho. Springer. Page 233

Meludu, N.T. (2009). Food Insecurity and Nutritional Status of Children in Rural Households. (A case of Iddo LGA, Oyo State). *Nigerian Journal of Social Work Education.* Nigeria. Vol. 8, 40-60.

Meludu, N.T. and Ewebiyi, I. O. (2010). Policy Development and Opportunities in ICT for Sustainable Food and Nutrition Security in Nigeria. *African Journal for the Psychological Studies of Social Issues.* Ibadan, Nigeria. Vol. 13(1), 137-151. April.

Meludu, N.T. (2011). Farmers' Awareness and Utilization of Disaster Management Strategies and Training Needs for Sustainable Food Security and Livelihoods in Nigeria. In Disaster Management and Human Health Risk II: Reducing Risk, Improving Outcomes. Edited by CA. Brebbia, A.J. Kassab and E.A. Divo. WIT Press Southampton, Boston USA. 303-19.

Meludu, Nkiru T. (2019). Communicating knowledge of climate change in achieving zero hunger – Sustainable Development Goal (SDG). Paper presented at the one-day media round table discussion to the University on Communicating Knowledge on Climate Change Information for Sustainable Decision Making in Nigeria. By Centre for Sustainable Development, Nnamdi Azikiwe University, Awka, May. Pp 1-4.

Meludu, Nkiru Theresa and Patrick O. Akaniyene (2021). Effect of COVID-19 on Water Resources and Food Security. In University-Led Knowledge and Innovation for Sustainable Development. Book Series on Sustainable Development. Edited by Felicia Azuoma Anyaogy, Cecilia Amaoge Eme and John Agbo Ogbodo. Pp. 150 -160 ISBN (ONLINE) 978-978-988-790-3.ISBN (PRINT) 987-987-989-478-9.

Olaitan, F.O., Awodele, R.I., Meludu N.T. and Alaka, F.A. (2012). Attitude of Farm

Household towards Adequate Food Consumption Pattern in Ikenne Local Government Area, Ogun State, Nigeria. *Nigeria Journal of Rural Sociology.* Vol. 13, No 1, November.

Meludu, N.T., Uzoukwu, E.K., and Abolade, T.J. (2013). Level of Awareness on the Nutrient Contents and Utilization of *Moringa Oleifera* in Oyo State Nigeria. *Journal of Home Economic Research Association of Nigeria*. Vol 18. 244-252.

Meludu, N.T. and Fakere Bosede Felicia (2013). Sensory Evaluation of Diversified Sweet Potato Drinks among Consumer: Implication for Malnutrition Reduction in Nigeria. *Journal of Agriculture, Bio-systems and Engineering*Vol. 7.

Ladele, A.A.; N. T. Meludu, O. Ezekiel, T. F. Olaoye, O. M. Okanlawon (2015). Diversification of Sweet Potato Blends and Utilization for Malnutrition and Poverty Alleviation.World Academy of Science, Engineering and Technology International Journal of Nutrition and Food Engineering Vol:9, No:9,

Mizzi, Leonard (2019). "We need to put food systems high on the political agenda." In stemming youth migration: opportunities in Agriculture: A global perspective on agribusiness sustainable agriculture. Published by CTA SPORE 193 June to August, p40.

Ozgul, Alessandro, Stefania, Lorenzo Bellù & Ralph. (2019). The Future Challenges of Food and Agriculture: An Integrated Analysis of Trends and Solutions.

Oyebade, Olusegun Emmanuel (2013). Effects of Social Capital on Rural Households' Food Security in South-western Agricultural Zones, Nigeria. A PhD thesis submitted to the Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan, Oyo State, Nigeria. PP. 8-50

Otekunrin, O.A., Momoh, S., Ayinde, I. A andOtekunrin, O.A. (2019a). How far has Africa gone in achieving theSustainable Development Goals? Exploring theAfrican dataset. Data in Brief, 27, 1-7.https://doi.org/10.1016/j.dib.2019.104647.

Otekunrin, O.A., Otekunrin, O.A., Momoh, S and Ayinde, I.A. (2019b). "Assessing the Zero Hunger TargetReadiness in Africa: Global Hunger Index (GHI)patterns and Indicators": Proceedings of the 33rdAnnual National Conference of the FarmManagement association of Nigeria (FAMAN),7th-10th October, 2019, 456-464.

Robinson Mary. (2019). Climate justice: A new Narrative for action in global hunger index. The challenge of hunger and climate change (eds). Klaus von Grebmer, Jill Bernstein, Fraser Patterson, Miriam Wiemers, Reiseal Ni Cheilleachair, Connell Foley, Seth Gitter, Kierstin Ekstrom, and Heidi Fritschel. Dublin/Bonn.

UN (2017)."Sustainable Development Goal 2".https://sustainabledevelopment.un.org/sdg2. Tarasuk V., Mitchell A., McLaren L., McIntyre L. 2013. Chronic physical and mental health conditions among adults may increase vulnerability to household food insecurity. J. Nutr.143:1785–1793. doi: 10.3945/jn.113.178483.

Velmurugan, G., Ramprasath, T., Gilles, M., Swaminathan, K. and Ramasamy, S. (2017). Gut microbiota, endocrine-disrupting chemicals, and the diabetes epidemic. *Trends in Endocrinology and Metabolism*, 28(8): 612–625. doi: 10.1016/j.tem.2017.05.001

WHO and FAO (2014). "Better nutrition, better lives" Second International Conference on Nutrition (ICN2) 19-21 November, Rome, Italy.

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Professor Gabriel Onyenegecha Ihejirika, a Fellow of Institute of Resources and Scientific Management, was born into the Anglican family of Pa Amos Ibeanusi and Mama Rosita Chimaonyenodozi Ihejirika all of blessed memory in Umunwaughala kindrade, in Umuonunaka in Ikeduru L.G.A. Imo State on the 21st of February, 1966.

He attended Owu Amakohia Community Primary School in Ikeduru LGA 1974–1980 and from his primary 1 to 6; he performed one leading function or the other such as Class monitor, Prefect etc. with excellent performances.

He then attended Amuzi Community Secondary School Ahiazu LGA 1980–1985, still based on his excellent performance; he was made the Senior Prefect of the School.

He later attended the Federal University of Technology, Owerri 1988 – 1993. He holds a bachelor degree in Crop Production with Second Class Honours (Upper Division), Masters of Science in Agronomy Crop Protection (Plant Pathology) and a Doctorate Degree in Crop Protection with specialization in Plant Pathology (Mycology) all fromFederal University of Technology, Owerri (FUTO). His excellent performance earned him a Lecturing appointment at Federal University of Technology, Owerri.

MEMBER OF PROFESSIONAL BODIES

Prof. Gabriel Ihejirika is a member of several professional bodies including:

FELLOW: Institute of Resources and Scientific Management (FIRSM)

Member: American Phytopathological Society (APS)

Member: Nigerian Society of Plant protection (NSPP)

Member: Agricultural Society of Nigeria(ASN)

Member: Research and Development Network (RDN)

Member: Horticultural Society of Nigeria(HORTSON)

Member: Crop Science Society of Nigeria (CSSN)

Member: Global Food Crisis (GFC)

Member: Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN)
Member: National Executive Council of Nigerian Society for Plant Protection (NSPP) 2016 – 2019.

Primary research interests: Identification of microorganisms associated with field and storage diseases of tropical crops and their control; Fungi toxicity of natural plants and organic soil amendments as protectants against fungal diseases of crops.

BOOK AUTHORS
Prof. Gabriel Onyenegecha Ihejirika has **co-authored a number of books** including:

1. Agricultural Extension in the Tree Crop Sub-sector in Nigeria.
2. Agrarian Science for Sustainable Resource Management in Sub-Saharan Africa. Support Africa International. PETER LANG Edition.
3. Awareness of the Causes and Environmental Implication of Climate Change phenomena in selected countries of Sub-Saharan Africa. Support Africa International Studies in Sub-Saharan Africa PETER LANG Edition.
4. Antifungal Properties of Plant Extract and Density on Some Fungal Diseases and Yield of Cowpea; Chemistry for Sustainable Development in Africa. Health; Biodiversity Utilization, Springer-Verlag Berlin Heidelberg.
5. Strategies for fostering Subsistence Agriculture: Food Supplies and Health in Sub-Saharan Africa. PETER LANG Edition.
6. Tree Crop Genetic Resources Conservation through Sustainable Tree-Food Cropping System for Adaptation to Climate change in the Southeastern Agroecology of Nigeria. **Book from TETFund Sponsored Project.**

Prof. Gabriel Ihejirika has attended and presented research papers in more than 70 national and International Conferences/Workshops including Crop protection strategies for safe production of grains in Shenyang Agricultural University, People's Republic of China; and he has made well over 80 publications in both national and International Journals.

HONOURS/AWARDS:
Prof. Gabriel Onyenegecha Ihejirika has received a number of Honours/Awards including:

a. **Fellow**: Institute of Resources and Scientific Management.
b. **Ezi Nwa**: St. John's Anglican Church, Owu Amakohia Ikeduru Imo State.
c. **Husband of the year award**: UmuotunwanyiOwu Amakohia Owerri Branch.
d. **Meritorious Service award**: NYSC 1993/94 Ife South L.G.A., Osun State.
e. **Meritorious award**: National Association of Agric. Students, FUTO Chapter 1993.
f. **Meritorious Award** as HOD, Crop Science and Technology, FUTO byNational Association of Agronomy Students, F.U.T.O. Chapter 2015.
g. **Ideal Couple Award:** St. Michael and All Angels Anglican Church, Uratta, Women Organization Diocese of Owerri.
h. **Award of Excellence:** EBIRI TU UGO AGE GRADE, Umuonunaka Owu-Amakohia Ikeduru L.G.A. Imo State.
i. **Award of making a Difference** by Kiwanis Club International Indiana Polis USA.

j. **Knight** of St. Christopher Anglican Communion, Diocese of Owerri.

Prof. Gabriel Ihejirika has supervised well over

i. 60 undergraduates.
ii. 12Master'sDegree graduates and 3 awaiting External examination.
iii. 6 Ph.D. graduates and 2 awaiting External examination.
iv. Guest Lecturer/External Examiner and Assessor for Promotion of candidates to the Rank of Associates and Full Professors for some Universities.

CONSULTANCY /COMMUNITY DEVELOPMENT ACTIVITIES

Professor Gabriel Onyenegecha Ihejirikahas been involved in a number of consultancy and Community development activities including:

1. **President:** Kiwanis Club Owerri Nigeria. A Charity Organization with its Headquarters in Indiana Polis USA.
2. **Consultant:** Foundation for Healthy Environment and Human Development (FHEHD). Partners in the Execution of European Union Micro-Projects Programme in Six States of the Niger Delta MPP6.
3. **Consultant:** OGANANO AGROCELLS LTD. Centre for Organic Agriculture production and marketing.
4. **Consultant:** AGRI-BUSINESS REVOLUTION: Sustainable Agribusiness Workshop. Owner of Agric. Village Enugu, Enugu State.
5. **Financial Secretary:** Central Working Committee 2020 SYNOD, Diocese of Owerri Anglican Communion.
6. **Bishop Nominee:** 2020SYNOD Diocese of Owerri Anglican Communion.
7. **President:** Amuzi Community Secondary School Oldboys, 1985 Set.
8. **Vice- President**: Men's Ministries, St. Michael and All Angels Anglican Church Umuorii, Diocese of Owerri Anglican Communion.
9. **Member:** Anglican Christian Father's Fellowship of two dioceses: Diocese of Ikeduru and Diocese of Owerri Anglican Communion.
10. **Chairman:** St. Michael and All Angels Anglican Church 2021 Petron's Day Celebration.
11. **Member:** Uratta Archdeaconry Inauguration/ Thanksgiving Committee.
12. Series of Newspaper Publications in areas ofCrop Pests/Diseases and Control, Organic Agriculture etc.
13. **A Knight** in the Anglican Communion.

Prof. GabrielOnyenegecha Ihejirikaishappily married to **Lady Patricia Nka Ihejirika**and the marriage is blessed with three children.

ORGANIC SOIL AMENDMENT: AN EMERGING TREND IN PLANT HEALTH TECHNOLOGY

5th
Lecture Series

Faculty of Agriculture
NnamdiAzikiwe University, Awka, Anambra State.

Delivered on Tuesday, May 11, 2021

By

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Preamble:
TheVice-Chancellor
Deputy Vice-Chancellors
Other Principal Officers of the University
Deans, Directors and Distinguished Professors of the University
Heads of Departments and Coordinators of Units
Distinguished and Special Invitees
My Lords Spiritual and Temporal
Staff and Students of the University
Members of the Print and Electronic Media
Distinguished Ladies and Gentlemen.

I wish to start this lecture with a prayer to the Lord Almighty, the Creator of the Universe, the Am That I Am, Mighty man in battle, the Unchangeable Changer, the most Teacher, the Beginning and the End, the Lord our God who is sited at the heavens and His glory fills the heavens and the earth! Receive all the glory, honour, adoration and thanksgiving for this day you have made for us to rejoice and be glad. By your mercy O'Lord, grant us joyful lecture in the name of our Resurrected Jesus Christ. Amen.

It is with gratitude to Almighty God that I am standing before you today to deliver the Fifth Lecture Series of Faculty of Agriculture of this citadel of learning. This lecture is the first from the Department of Crop Science and Horticulture. It is indeed a wonderful opportunity for me to express some of my views and experiences in the discipline I am professing before this galaxy of scholars and eminent professionals. I believe that the choice of the topic of this lecture is timely considering the present situation where Nigerians and most developing countries are facing problems of agricultural stagnation, environmental pollution, and low quality of crop produce resulting to food shortage, malnutrition and poverty.

Toxic residues and heavy metal accumulation on harvested crop produce and its effect after consumption have necessitated the need to use organic soil amendments instead of chemical fertilizers and inorganic pesticides. This is coupled with side effects they have on soil, water bodies and other beneficial organisms in the ecosystem. Many researchers have found out from their investigations that organically produced crops contain significantly higher amount of certain antioxidants, higher dry matter and reduced incidence and severity of diseases and insect pest attack than conventionally produced crops.

AMENDMENTS:

Common agricultural practices such as excessive use of agro-chemicals, deep tillage and luxury irrigation have degraded soils, polluted water resources and contaminated the atmosphere. There is increasing concern about interrelated environmental problems such as soil degradation, desertification, erosion, and accelerated greenhouse effects and climate change. The decline in organic matter content of many soils is becoming a major process of soil degradation. Degraded soils are not fertile and thus cannot maintain sustainable production and thus negatively affect plant health. At the same time, the production of urban and industrial organic waste materials is widespread.

Therefore, strategies for recycling such organic waste in agriculture become imperative. Organic amendment comes from something that is or was alive. It is derived from plants or plant products that occur naturally (peat moss from peat bogs), or are the by-products of processing plants or mills (sawdust, woodchips, bark, bagasse, rice hull) or waste disposal plants (compost, grass clippings, processed sewage sludge, biosolids). Organic soil amendments maintain plant health and subsequent production of healthy plants and plant products. In heavy clay soils, they improve drainage and aeration and increase the ability of the soil to hold and release essential nutrients and promote the activity of earthworms and soil microorganisms beneficial to plant growth and improve seed emergence.

The reason for soil amendment is to provide a better environment for roots and plant growth: this includes the improvement of the soil structure and water holding capacity, the availability of nutrients, and the living conditions for soil organisms, which are important for the plants to grow. Furthermore, a better soil texture and better root growth avoids soil degradation during heavy rains or in windy regions. It also supports the nutrient cycle when organic amendments are used (e.g. manure). Beside soil amendment, there are several methods to provide soil moisture conservation such as soil cover and reforestation (living plants), mulching or several tillage techniques. Of course it is also very important that a crop is planted which is suitable for the given climate.

Basically, any organic or inorganic material that is added to the soil and improves its quality can be considered as soil amendment. The type of amendment chosen depends entirely on how the soil needs to be changed. By using soil amendment, almost every type of soil can be made fertile (WEST COAST SEEDS, 2011).

Organic Amendments: Both inorganic and inorganic substances can be added into the soil. Organic substances consist of materials derived from living things e.g. plants, whereas inorganic substances are mined or man-made.

Inorganic Amendments: These areInorganic substances such as vermiculite, perlite, tire chunks, pea gravel and sand. In general, they must be bought, which makes them more expensive than organic amendments. Additionally, the industrial production process needs a great deal of energy. Therefore, these substances do not have the same degree of sustainability as organic

amendments. Most are relatively sterile (with regard to plant pathogens) and many are relatively inert.

Uses of Inorganic Amendments: Inorganic amendments are used to:
a. increase aeration
b. increase drainage
c. decrease excessive water holding capacity
d. decrease or increase weight.

Tomato produced Conventionally

Tomato produced Organically

Watermelon produced Conventionally

Watermelon produced Organically

Purpose of Organic Amendment:

The main purpose of using organic amendments is to loosen the soil and create large pores to increase aeration, drainage, Usuable water holding capacity, nutrient holding capacity and decrease growing medium weight compared to soil.(REED 2007).

By far, the most important organic soil amendments worldwide are compost and animal dung (e.g. chicken, cow). Compost and animal dung are most often easily available and economically affordable.In professional agriculture, the most commonly used organic amendment is peat moss (e.g. sphagnum peat moss which is the highest quality, but also hypanaceous or domestic peat). Other organic amendments include wood chips, grass clippings, straw, compost in general (produced in large or small scale facilities), manure (see also use of compost, use of dehydrated faeces or terra preta), processed sewagesludge (biosolids), sawdust, etc. Normally, there are more organic substances available than inorganic substances and generally they are cheaper.

(GIZ, 2010).

Practicing good crop rotations and choosing the correct crop improves soil amendment.Before incorporating into ground beds, most organic amendments, especially sawdust, cedar chips, bark and bagasse, should be composted or aged, and sterilized before use if possible. All of these amendments have a high C:N ratio. Use of amendments which are not composted and have a high C:N ratio will deplete N from the soil, may cause a salt or an ammonia/ammonium burn, or may cause damage due to heat buildup.Amendments with a low C:N ratio will release N upon further decomposition, thus act as an organicfertilizer. However, organic matter with a low C:N ratio also should be composed to avoid rapid ammonia/ammonium release and toxicity (REED, 2007).

Humic acid is a principal component of humic substances, which are the major organic constituent of organic soil amendments. Organic soil amendments (humus) have been known by farmers to be beneficial to plant growth for longer than recorded history. It was supposed that humus was used directly by plants, but it was shown later that plant growth depends upon inorganic compounds.

Therefore, many soil scientists held the view that organic matter was useful for fertility only as it was broken down with the release of its constituent nutrient elements into inorganic forms. At the present time, soil scientists hold a more holistic view and at least recognise that humus influences soil fertility through its effect on the water-holding capacity of the soil: the spongy structure of organic matter is able to bind water and some inorganic molecules which act as micro- or macro-nutrients. Consequently, humic acids also slow water evaporation from soils. This is especially important in soils where clay is not present or in a low concentration, in arid areas, and in sandy soils without the capability to hold water. The oxygen end of another water molecule bonds with the hydrogen end of another, until the evaporation rate is reduced by 30% (NUTRANETICS, 2000).

An additional benefit of organic amendments is also the fact that organic matter feeds soil microbes, which in turn release nutrients into the soil, thereby increasing soil fertility.Soil amendments improve the physical properties resulting in better conditions for water storage, root development and soil ecosystems and enhance soil aeration.

Soil amendments can be produced locally, especially organic amendments (e.g. compost), which are cheap to produce.

Soil amendments can be applied almost everywhere by almost anybody

Disadvantages of Organic Amendment:
Wood products can tie up nitrogen in the soil. The incorporation of the soil amendment (especially of organic amendments) can be time consuming. If too many nutrients or organic matter are put into the soil, they can be released and cause an outflow of nutrients into the groundwater and sur-rounding rivers and lakes, which can result in water pollution

Factors to Consider When Choosing an Amendment
There are at least four factors to consider in selecting a soil amendment:
i. How long the amendment will last in the soil?
ii. Soil texture
iii. Soil salinity and plant sensitivities to salt
iv. Salt content and *pH* of the amendment

(Davis and Wilson, 2005)

Laboratory tests can determine the salt content, *pH* and organic matter of organic amendments.

The quantity of bulk organic amendments for large-scale landscape uses can then be determined

The amendment you choose depends on your goals.

a. Are you trying to improve soil physical properties quickly? Choose an amendment that decomposes rapidly
b. Do you want a long-lasting improvement to your soil? Choose an amendment that decomposes slowly
c. Do you want a quick improvement that lasts a long time? Choose a combination of amendments.

RESEARCH INVESTIGATIONS
Cultivation system versus the content of minerals in carrot (*Daucuscarota* L.) roots
This analyzed the effect of cultivation system on the content of minerals in carrot roots of two carrot cultivars (Koral and bolero) grown in organic plantation and plantation maintained according to integrated agricultural guidelines. Thermal and moisture condition differentiated the content of macro and micro elements more than the cultivation system or genotype specific traits of cultivars. A significantly higher content of analyzed minerals was observed in the first year of the experiment. Carrot grown in the integrated system contained higher amounts of Nitrogen, Magnesium, Copper, Zinc and Manganese while organic Phosphrus, Iron and Lead.
Larger changes in the content of N, Na, Mg, and Ca dictated in carrots from organic plantation while P and K differed more from integrated system (Wierzbowska*et. al.*, 2018).

Determination and comparation of vitamin C and Potassium in four selected conventionally and organically grown fruits and vegetables:
Masomba Judge Kingsley and Nguyeh Minh, (2010) conducted above research using cabbage, carrot, Cos lettuce and Valencia orange and these fruits and vegetables were conventionally and organically grown. The fruits and vegetables harvested were subjected to laboratory analysis to determine and compare their Vitamin C, Calcium and Potassium contents of the fruits and vegetables conventionally and organically produced respectively.

Results showed that vitamin C content of vegetables conventionally produced were higher that organically produced ones while organically produced fruit had higher vitamin C than that produced conventionally.
Calcium and Potassium contents of vegetable organically produced were higher than conventionally ones, while conventionally produced fruit had higher Calcium and Potassium content than organically produced ones

Table 1: Vitamin C content in mg per 100g fresh weight of sample (n=6) of conventionally and organically grown fruits and vegetables:

Sample	Conventional	Organic
Cabbage	32.1 ± 0.8	31.3 ± 0.8
Carrot	4.9 ± 0.3	4.8 ± 0.2
Cos lettuce	10.3 ± 0.4	10.3 ± 0.4
Valencia Orange	43.4 ± 0.7	51.8 ± 1.7

Table 2: Potassium content (mg/100g) (n=6) of conventionally and organically grown fruits and vegetables

Sample	Conventional	Organic
Cabbage	253.2 ± 2.3	287.7 ± 3.1
Carrot	320.7 ± 4.2	326.8 ± 2.3
Cos lettuce	278.3 ± 2.7	326.2 ± 3.3
Valencia Orange	192.0 ± 1.4	189.5 ± 1.9

Table 3: Calcium content in (mg/100g) (n=6) of conventionally and organically grown fruits and vegetables

Sample	Conventional	Organic
Cabbage	39.0 ± 0.4	44.0 ± 1.4
Carrot	31.7 ± 1.0	36.3 ± 1.2
Cos lettuce	30.7 ± 1.2	35.7 ± 1.2
Valencia Orange	54.5 ± 1.6	51.8 ± 1.7

(Masomba and Nguyen, 2010).

PLANT HEALTH

A plant is healthy only if it continues to perform all its normal physiological and metabolic activities to the best of its genetic potential. These activities include:

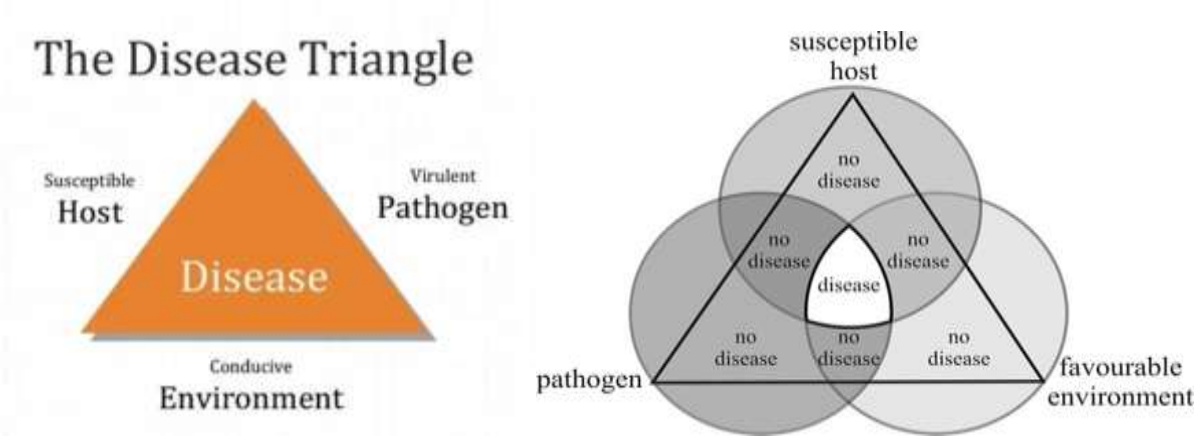
1. Normal cell division
2. differentiation and development
3. Uptake of water and nutrients from the soil
4. Synthesis of food from the sunlight through photosynthesis
5. Translocation of water and food
6. Metabolism of synthesized material and
7. Reproduction

Any plant that fails to perform one or more of the above is **diseased.** Disease is a deviation from normal physiological and/or metabolic activities. It cause damage by reducing yield and/or quality of plants and/or plant products

Types of Disease: Disease can be categorized into two broad groups

a. Pathogenic disease: This caused by biotic agents and they are infectious. The causal agents are the pathogens or microbes such as bacteria, fungi, viruses, nematodes and mycoplasma like organisms.

b. Non-pathogenic disease: This on the other hand, is caused by abiotic agents and they are not infectious. They include nutrient deficiencies, lack of or excessive soil moisture, too low or too high temperature, air pollution, soil acidity or alkalinity and/or mechanical damage.



Factors responsible for Disease development:

a. Host
b. Pathogen
c. Environment

Host factors

a. Susceptibility of host
b. Disease proneness of the host

Pathogen factors

a. Virulence/aggressiveness of the pathogen
b. High multiplication rate of the pathogen
c. Proper inoculum potential

Environmental factors

a. Temperature
b. Relative humidity
c. Moisture

Beneficial Soil Microbial Processes

In addition to their role in cementing soil aggregates mentioned above, soil microbes are of paramount importance in cycling nutrients such as carbon (C), nitrogen (N), phosphorus (P), and sulfur (S). Not only do they control the forms of these elements [e.g. specialized soil bacteria convert ammonium N (NH_4^+) to nitrate N (NO_3^-)], they can regulate the quantities of N available to plants. This is especially critical in systems relying on organic fertilizers. It is only through the actions of soil microbes that the nutrients in organic fertilizers are liberated for plants and use by other microbes. Soil microbiologists call this process mineralization [the conversion of organic complexes of the elements to their inorganic forms, e.g., conversion of proteins to carbon dioxide (CO_2) ammonium (NH_4^+) and sulfate ($SO_4^=$)].

It is perhaps the single-most important function of soil microbes as it recycles nutrients tied up in organic materials back into forms useable by plants and other microbes. In fact, the so-called Principle of Microbial Infallibility (popularized by Dr. Martin Alexander of Cornell University) states that for every naturally occurring organic compound there is a microbe or enzyme system that can degrade it. Note that this applies to naturally occurring compounds. It is obvious that some our persistent pesticides did not conform to this principle and even some naturally

occurring compounds are fairly resistant to microbial attack. It is through the process of mineralization that crop residues, grass clippings, leaves, organic wastes, etc., are decomposed and converted to forms useable for plant growth as well as converted to stable soil organic matter called humus. Herein lies another important role for the larger soil animals like earthworms.

The large organisms function as grinders in that they reduce the particle size of organic residues making them more accessible and decomposable by the soil microbes. The soil microbial population also further decomposes the waste products of the larger animals. Thus, the activities of different groups of soil organisms are linked in complex "Food Webs".
One beneficial process carried out exclusively by soil microbes is called nitrogen fixation, the capture of inert N_2 gas (dinitrogen) from the air for incorporation into the bodies of microbial cells. In one well-known form of this process, symbiotic nitrogen fixation, soil bacteria such as Rhizobium and Brady rhizobium actually inhabit specialized structures on the roots of leguminous plants (soybeans, cowpeas, beans clovers, etc.) where they fix substantial quantities of nitrogen that becomes available to the host plant.

Unfortunately, the root nodule system is not found in the grasses so we cannot rely on it for "free" nitrogen. Nevertheless, free-living (nonsymbiotic) nitrogen-fixing bacteria do associate with roots of grasses where they fix small quantities of nitrogen using carbon compounds (root exudates, sloughed root cells, etc.) produced from the roots as energy sources to drive the energy-expensive nitrogen-fixing enzyme system. Another factor limiting the utility of free-living N_2 fixers is the fact that they will not fix N_2 when exposed to even very low levels of fertilizer nitrogen. Thus in fertile turfgrass soils this process is of limited importance whereas in unfertilized prairie soils the 10 to 25 pounds of N fixed per acre per year is ecologically relevant. (Agwe *et.al*., 2007).

Another benefit of soil microbes is their ability to degrade pest control chemicals and other hazardous materials reaching the soil. Thus through the actions of the soil microflora, pesticides may be degraded or rendered nontoxic lowering their potential to cause environmental problems such as ground and surface water contamination. Of course, there is a "downside" to this microbial capability. In some instances, soil microbes have been shown to degrade soil-applied pesticides so rapidly as to reduce the ability of the chemicals to control the target pests. This phenomenon is known as enhanced degradation and usually results from repeated applications of a chemical to the soil. One way around this problem is to vary the use of pest control chemicals.

Another factor of great importance for decomposition of carbon in soil is the level of available nitrogen. When large amounts of available carbon are added to soils low in N, nitrogen becomes tied up, or immobilized, in the cells of the degraders. The net effect here is to induce nitrogen deficiency for plant growth due to swamping the system with available carbon. Careful attention should be paid to the carbon to nitrogen (C/N) ratio of organic materials added to soils for this reason. (Abbott and Murphy, 2007).

Organic Soil Amendment approaches to Plant health:
Apart from organic soil amendment contribution to plant nutrient, many researchers have found that it reduces the incidence and severity of many plant diseases thereby ensures healthy plant

growth and development. Incorporation of Neem leaves into soil to control bacterial wilt of Tomato caused by *Rhyzotoniasolanacearum* (Farad Hanaa*et al*., 2011).
Dry and fresh neem leaves were incorporated in the soil in different amounts (0, 20, 40, 60, 80 and 100 g) and kept in it for different periods of time (0, 15, 30, 45 and 60 days). After each of these periods, seedlings inoculated with *R. solanacearum* were transplanted in the amended soil
Results showed positive effects in the disease control by incorporating neem leaves, with a reduction of wilting symptoms up to 100% with dry leaves and 78% with fresh leaves.

Organic Soil Amendment controls Meloidogyne and Fusarium in Guava:
Guava decline disease is a complex disease involving *Meloidogyneenterolobii* and *Fusariumsolani*. Several strategies have been sought to control the nematode. The use of organic soil amendments is currently the best approach to manage this disease. Guava decline disease, a complex disease involving *Meliodogyne mayaguenensis* and *Fusarium solani* Keratitis has been greatly managed in a commercial guava plantation and a major yield gains were obtained by the applications of cow manure and poultry compost (Gomes *et.al*., 2010).
Organic and inorganic nitrogenous amendments improve soil fertility and offered good nematicidal effects against plant-parasitic nematodes (Oka, 2010).

Effect of farming system on pathogen infection and content of phenolic compound in carrot (*Daucus carota* L.) Sub sp: *sativus* (Woffn.) roots
Bozana *et.al.*, 2014 conducted a research on the severity of Black rot, crater rot, Sclerotinia rot and soft rot on the root Cv koral grown in plantation under integrated and organic farming system. Chemical analysis were performed to determine the content of Phenolic acids in harvested carrot roots grown in 2010 – 2012 in seven locations in Poland

Results revealed that carrot roots with disease symptoms were encountered more frequently in integrated plantation. Chemical analysis showed higher concentrations of phenolic compounds in organically grown carrots in comparison with the integrated farming system. The organic farming systems seem preferable for growing carrots.

Table 4: Disease Severity on the roots of carrots at harvest - Integrated

Location	***Alternaria*sppinfection index li (%)**				***Rhizoctoniacarotae*index li (%)**				***Sclerotiumsclerotiorum* *Pectobacterium* spp % wt. of affected crop**			
	2010	2011	2012	Mean	2010	2011	2012	Mean	2010	2011	2012	Mean
Krolikowo	1.0b	0.5c	0d	0.5	1.0d	2.0c	0e	1.0	4.2b	11.0a	0d	5.1
Mielno	0d	0.7bc	0d	0.2c	1.5cd	1.3cd	0e	0.9	0d	4.6b	0d	1.5
Rywociny	0d	3.0a	0d	1.0a	4.3b	10.7a	0e	5.0	2.2c	1.0d	0d	1.1
Mean	**0.3**	**1.4**	**0**		**2.3**	**4.7**	**0**		**2.1**	**5.5**	**0**	

Values followed by the same letters are not significantly difference

Table 5: Disease Severity on the roots of carrots at harvest – Organic farming systems

Location	***Alternaria*** **spp infection index li (%)**				***Rhizoctonia carotae*** **infection index li (%)**				***Sclerotium sclerotiorum*** **spp % wt of affected crop**			
	2010	2011	2012	Mean	2010	2011	2012	Mean	2010	2011	2012	Mean
Godki	0.5c	1.0b	0d	0.5	0e	1.3c	5.3a	2.2	2.0b	0c	0c	0.7
Tovaskowo	0d	0.5c	0d	0.2	0e	0e	3.1b	1.0	2.2b	2.2b	4.0a	2.8
Tomaszkowo	0d	1.5a	0d	0	0e	0.7d	1.3c	0.7	2.0b	0c	0c	0.7
Zgnilobloly	0d	1.5a	0d	0.5	0e	1.3c	0.7d	0.7	2.5b	2.3b	0c	1.6
Mean	**0.1**	**0.8**	**0**		**0**	**0.8**	**2.6**		**2.2**	**1.1**	**1.0**	

Values followed by the same letters are not significantly difference.
(Bozana *et.al*., 2014)

Organic soil Amendments had marked reduction in Termite damage of fresh Yam tubers: A study conducted on the effects of different organic and inorganic manures on the yield of yam tubers in termite infested soil of Owerri Imo State, South Eastern Nigeria carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri in 2004 and 2005 cropping seasons respectively **(**Ogbedel *et. al*., (2007), on soil naturally infested with three types of termite genera, namely: *Microtermes*, *Ancistrotermes* and *Macrotermes*, revealed that plots treated with organic manures generally showed marked reduction in termite damage especially with municipal wastes when compared with other treatments.

Results revealed that there was a marked reduction in termite damage especially with municipal wastes when compared with other treatments. Similarly, plots treated with organic manures gave higher soil pH after tuber harvest than inorganic manures.

Organic Amendment and Fungal disease reduction in Maize field:
Field Experiments conducted in Federal University of Technology, Owerri Nigeria, during therainy season of2004 and 2005 (Ihejirika *et. al*., 2007), on the effects of mulch material and plant density on some fungal diseases and yield of maize indicated that mulch material was statistically significant on leafspot disease 1.66; 1.45, blight 1.10; 1.04, Rust 0.012; 0.050 and grain yield 0.55; 0.63 tons/ha in 2004 and 2005, respectively. Grass mulch recorded highest plant height 90.10; 89.73 followed by live mulch 70.81; 76.60 when no mulch (control) recorded the lowest plant height 56.25; 57.74. Same trend was observed on grain yield. Grass mulch had 1.20; 1.23 when control recorded lowest 1.00; 0.87 in 2004 and 2005, respectively.

Table 6: Effects of mulch material and plant density on Plant height, Leafspot, Blight and grain yield of maize in 2004 and 2005

Treatments	Plant height		Leafspot		Blight		Grain yield (t/ha)	
Mulch Material	2004	2005	2004	2005	2004	2005	2004	2005
No mulch	56.25	57.34	1.11	1.06	1.50	1.86	1.00	0.87
Life mulch	70.81	76.60	1.46	1.28	1.25	1.35	1.36	1.02
Wood shaving	60.43	56.20	1.82	0.79	1.20	1.16	1.10	1.07
Grass mulch	90.10	89.73	1.00	0.60	1.08	1.10	1.20	1.23
LSD 0.05	***7.700***	***8.340***	***0.772***	***0.510***	***0.350***	***0.284***	***0.526***	***0.314***
Plant density								
25 x 75	82.30	79.88	1.52	1.33	1.62	1.85	1.65	1.43
50 x 75	68.50	66.29	1.00	1.08	1.54	0.50	0.82	0.71
50 x 50	70.40	74.68	1.00	1.23	1.40	1.25	1.22	1.19
75 x 75	62.15	59.03	0.96	1.00	0.88	0.10	0.65	0.48
LSD 0.05	***6.710***	***8.435***	***0.906***	***0.823***	***0.115***	***0.210***	***0.224***	***0.314***

Disease infected maize leaves

Organic Soil Amendment and Groundnut Leafspot disease reduction:

A two-season experiment conducted in 2003 and 2004 at Federal University of Technology, Owerri Nigeria on the current options for improving the severity of leafspot disease and yield of groundnut in the Ultisiols of Imo State. (Ihejirika, 2008), showed that organic manure significantly reduced the severity of leafspot disease (P50.05; 0.52 and 0.66). It also significantly influence stalk yield (t/ha) and yield (t/ha) 11.00; 12.86; 14.05; 15.82 in 2003 and 2004, respectively. Fowl droppings significantly reduced the severity of leafspot disease 0.38; 0.50 in comparison with cow dung 0.66; 0.88 which were lower in 2003 and 2004, respectively. However, control (O-treatment) recorded the highest severity of leafspot disease 0.92; 1.30 in 2003 and 2004, respectively.

Organic Soil Amendment and Field disease development of Kola:
Kola (*Cola nitida*) is a very important crop. The seeds are used as food in ceremonies and chemical industries. It also supplies building materials like planks, plywood and boards as well as furniture, implements and decorations. A research was conducted in the Center for Agricultural Research of Federal University of Technology, Owerri, Imo State, to determine the effect of using organic soil amendments and cropping systems as a protectant of Kola seedling transplant against some field diseases.

Ihejirika*et. al*., (2009), observed that organic manure, cropping systems and their interactions was highly significant on kola seedling blight, Anthracnose, kola mosaic and kola leaf curl at 5% probability level. 20t/ha poultry manure treated plots recorded lowest seedling blight 0.75 when no manure (control) recorded highest 1.65. Also kola/maize/cassava/melon intercropped plots recorded lowest kola blight 0.72 when sole kola had the highest 1.69. 20t/ha recorded lowest kola Anthracnose 1.1 when control had the highest 1.97. Sole kola recorded highest Anthracnose 2.13 when kola/maize/cassava/melon had the lowest 0.55. Similarly, 20t/ha recorded lowest mosaic disease and kola leaf curl, when 0t/ha had the highest severity of mosaic and leaf curl. Kola/maize/cassava/melon recorded lowest severity of kola mosaic and leaf curl when sole kola had the highest severity of these diseases irrespective of the age of the plant after transplanting.

Table 7: Effects of Soil amendments on Kola Mosaic and Leaf curl in Kola based cropping systems at 8, 16 and 24 Weeks after Transplanting

Treatments	**Mosaic**			**Leaf curl**		
	Weeks after Transplanting			**Weeks after Transplanting**		
Poultry	8	16	24	8	16	24
0	1.01	1.95	2.30	1.01	1.36	1.85
5	0.85	0.92	1.20	0.70	0.82	1.11
10	0.53	0.88	1.45	0.62	0.68	0.88
20	0.40	0.70	0.96	0.45	0.50	0.70
LSD 0.05	0.170	0.156	0.65	0.14	0.22	0.195
Intercropping						
Sole Kola	0.98	2.01	2.80	0.64	0.82	1.35
Kola/maize	0.81	1.25	1.60	0.70	0.95	1.02
Kola/cassava	0.72	0.95	1.41	0.66	0.70	0.75
Kola/melon	0.88	1.02	1.70	0.72	0.98	1.20
Kola/cassava/maize	0.65	0.80	0.85	0.45	0.65	0.72
Kola/cassava/melon	0.70	0.76	1.11	0.60	0.74	0.80
Kola/melon/maize	0.66	0.81	1.11	0.51	0.62	0.80
kola/maize/cassava/melon	0.22	0.45	0.61	0.20	0.50	0.66
LSD 0.05	**0.124**	**0.610**	**0.715**	**0.135**	**0.178**	**0.125**

Control of Rice Blast (*Magnaporthe grisea*) disease using various Organic manures

Research was conducted on the above at Teaching and Research Farm of FUTO in 2011 using four Upland rice: OFADA 9 (Local), NERICA 1, NERICA 3 and NERICA 9. (Obilo *et.al*., 2012). The treatments include: Poultry droppings, cattle dung, Pig slurry and No manure (control). After 50 days of sowing, the highest plant height was recorded by plants treated with poultry droppings (73 cm) and cattle dung (65 cm) which was significantly different from pig slurry (44 cm) and control (43 cm). Plots applied with pig slurry had least blast incidence and severity (9%) than other treatments, followed by poultry droppings (12%) and control (19%) was the highest.

Table 8: Effect of different manures on the Disease severity (%) of Rice Blast at 30, 40, 50 and 60 Days after sowing (DAS)

Treatments	30 DAS	40 DAS	50 DAS	60 DAS
OFADA X PM	3	9	7	13
OFADA X PS	-	-	-	-
OFADA X CD	6	7	18	20
OFADA X Control	0	7	14	18
NERICA 1 X PM	3	7	10	11
NERICA 1 X PS	7	9	11	12
NERICA 1 CD	0	20	23	24
NERICA 1 Control	0	10	22	22
NERICA 3 X PM	0	6	15	10
NERICA 3 X PS	0	3	13	14
NERICA 3 X CD	0	7	28	32
NERICA 3 X Control	3	7	7	20
NERICA 10 X PD	0	3	11	12
NERICA 10 X PS	0	6	15	8
NERICA 10 X CD	0	7	27	29
NERICA 10 X Control	0	7	10	20
LSD0.05	***NS***	***NS***	***11.41***	***13.52***

Key: PD = Poultry dropping; PS = Pig Slurry; CD = Cattle dung.


Rice Brown Leafspot


Rice Blast

Effect of Organic Soil Amendment on some fungi disease and Yield of Soybean:
Research was conducted in the Federal University of Technology Teaching and Research Farm, Owerri in 2007 to evaluate organic soil amendment and varietal differences on some fungi diseases and yield of soybean (Ihejirika, 2012).

Result showed that cow dung performed best when compared to pig slurry not only on the yield but severity of all diseases investigated. Cow dung recorded the lowest disease severity (11.99 %) when control (no emendment) had the highest. Interaction of local variety and cow dung recorded lowest disease severity while highest severity was observed in the control plots. *Cercospora, Penicillium* and *Fusarium* species were identified with diseased soybean.

Table 11: **Effect of organic amendment and varietal differences on Leafspot disease (%) of *Soybean***

Treatments	**Weeks After Planting**		
	4 WAP	**8 WAP**	**12 WAP**
Organic Amendment			
Control	10.78	15.22	21.11
Cow dung	8.09	11.99	14.11
Pig Slurry	8.33	12.22	16.11
LSD 0.05 (Organic Amendment)	**2.56**	**4.69**	**4.05**
Variety			
V1(MAX 32)	8.89	14.11	18.11
V2(MAX 34)	8.56	13.69	16.33
V3(Local)	7.78	11.56	13.00
LSD 0.05 (Variety)	**2.56**	**4.69**	**4.05**

Table 12: Effect of organic amendment and varietal differences on Rust disease (%) of *Soybean*

Treatments	Weeks After Planting		
	4 WAP	8 WAP	12 WAP
Organic Amendment			
Control	2.78	11.44	14.78
Cow dung	1.76	9.56	12.78
Pig Slurry	1.56	10.56	13.22
LSD 0.05 (Organic Amendment)	**1.42**	**2.04**	**1.67**
Variety			
V1(MAX 32)	2.22	10.11	14.45
V2(MAX 34)	2.00	10.11	13.60
V3(Local)	1.86	9.89	12.10
LSD 0.05 (Variety)	**1.89**	**2.04**	**1.63**

Effect of Palm Bunch ash and Neem (Azadirachta indica A. Juss) leaf powder on termite infestation in groundnut field in Owerri Ultisols, South-eastern Nigeria.

Research conducted in the Research plot of the Department of Crop Science and Technology, FUTO. (Ogbedeh *et.al.*, 2019), investigated on three levels of Palm Bunch ash 0 t/ha, 10 and 20 tons/ha respectively on three levels of Neem leaf powder: 0.0, 1.0 and 2.0 tons/ha in a Randomized Complete Block Design in four replications.

Results showed that at harvest, palm bunch ash, neem leaf powder and their interactions were statistically significant ($P \leq 0.05$) on termite incidence, termite severity and number of perforated pods/stand. Also, the higher the rate of palm bunch ash and neem leaf powder, the lower the termite incidence and severity on harvested groundnut.

Table 13: Effect of Palm bunch ash and Neem (*Azadirachta indica* A. Juss) leaf powder on termite incidence and severity and number of perforated pods/stand of groundnut

Treatment	Incidence (%)	Severity (%)	No. of Perforated pods/stand
PBA at 0.0t/ha (control)	34.78	2.22	28.71
PBA at 1.0t/ha	27.00	1.78	20.12
PBA at 2.0tons/ha	24.56	1.44	21.63
LSD 0.05	***4.92***	***0.30***	***3.88***
NLP 0.0t/ha (control)	35.78	2.22	31.78
NLP 1.0t/ha	26.67	1.67	20.83
NLP 2.0tons/ha	23.89	1.56	17.86
LSD 0.05	***4.92***	***0.30***	***3.88***
PBA 0.0t/ha + NLP 0.0t/ha	48.67	3.00	40.33
PBA 0.0t/ha + NLP 1.0tons/ha	27.33	1.67	24.10
PBA 0.0t/ha + NLP 2.0tons/ha	28.33	2.00	21.70
PBA 1.0t/ha + NLP 0.0t/ha	30.67	2.00	22.67
PBA 1.0t/ha + NLP 1.0t/ha	35.33	1.67	19.07
PBA 1.0t/ha + NLP 2.0tons/ha	25.00	1.67	18.63
PBA 2.0tons/ha + NLP 0.0t/ha	28.00	1.67	32.33
PBA 2.0tons/ha + NLP 1.0t/ha	27.33	1.67	19.33
PBA 2.0tons/ha + NLP 2.0t/hs	18.33	1.00	13.23
LSD 0.05	***8.52***	***0.53***	***6.73***

Keys: PBA = Palm Bunch Ash, NLP = Neem Leaf Powder

Termite infested groundnut

Disease infected groundnut

Cultivar differences and Soil Amendment on the field disease development and yield of *Telfairia occidentalis* in Imo State.

The above research conducted in the Teaching and Research Farm FUTO (Ihejirika *et.al*., 2021) investigated on two cultivars of Telfairia.C2: Ugu ala and C2: Ugu elu, on three types of soil amendment which include: B1: Poultry manure, P2: Green manure and P3: No manure or control, in a 2 x 3 Factorial experiment in Randomized Complete Block Design at 3 replications.

Leaf spot was assessed by visual observation and scoring as described by Ihejirika, (2012).
All data were analysis using analysis of variance (ANOVA) and significant means were separated using least significant difference (LSD) according to SAS, (2009) at 5% level of probability.
Investigation revealed that Cultivars and Amendments were statistically significant on the growth, yield, leafspot and blight severities at 5% probability level respectively. Plots amended with green manure recorded highest moisture content (18.26%), ash (18.80%), leaf yield (105.2%) and pod weight (38.850 kg/ha) respectively. Cultivar 1 (Ugu-ala) performed better than Cultivar 2 (Ugu-elu) on leafspot and blight reduction, growth and yield. Plots amended with green manure recorded the lowest leafspot and blight diseases while no amendment (control) had the highest leafspot and blight diseases but lowest growth and yield of Telfairia.

Table 15: Effect of cultivar difference and soil amendment on Blight severity of Telfairia at 4, 8 & 12 Weeks After Planting (WAP)

Cultivar	Amendment	Weeks	After	Planting
		4	8	12
C 1	Poultry	3.0	3.6	4.0
C 1	Green manure	1.6	2.5 3.0	
C 1	Control	4.0	4.3	4.9
C 2	Poultry	2.7	3.4	4.1
C 2	Green manure	1.8	2.8	3.4
C 2	Control	3.8	4.2	4.8
LSD 0.05		***0.860***	***1.250***	***0.985***

Table 16: Effect of cultivar difference and soil amendment onLeafspot severity of Telfairia at 4, 8 & 12 WAP

Cultivar	Amendment	Weeks	AfterPlanting	
		4	8	12
C 1	Poultry	1.88	2.70	2.85
C 1	Green manure	1.20	1.85	2.00
C 1	Control	2.24	3.50	3.95
C 2	Poultry	2.00	2.44	2.75
C 2	Green manure	1.44	1.66	1.86
C 2	Control	2.80	3.50	4.50
LSD 0.05		***0.255***	***1.230***	***0.450***

Table 17: Effect of cultivar difference and soil amendment on Leaf yield and Pod weight of Telfairia

Cultivar	Amendment	Leaf Yield	Pod Weight
C 1	Poultry	99.50	26.60
C 1	Green manure	104.4	39.80
C 1	Control	90.31	22.40
C 2	Poultry	100.2	27.62
C 2	Green manure	106.0	37.90
C 2	Control	80.50	22.23
LSD 0.05		***12.155***	***9.856***

Blight disease

Leafspot disease

Soil Amendment and Septorial leafspot of Tomato:

The attempt by man to improve crop yield in order to produce enough food for consumption by the increasing population is a decision in the right direction which has led to search of biopesticides of plant origin. The research work conducted in Federal University of Technology, Owerri Nigeria, (Obilo *et.al*., 2011), on the effect of different rates of garlic juice in the control of septorial leaf spot of tomato caused by the fungus *Cercospora sp.* and also other plant extracts were compared with garlic so as to ascertain the effectiveness of garlic in the control of these leaf spots.

Result showed that the 0.5L of garlic (*Allium sativum*) spray produced the least number of infected leaves in all the different rates of applications. The utazi (*Pergularia spp.*) spray was significantly different ($P<0.05$) from the bitter leaf (*Vernonia amygdalina*) and garlic (*Allium sativum*) spray and produced significantly lower number of infected leaflets (0 – 1.5) than that of the bitter leaf (1.5 – 3.0) and garlic (2.7 – 3.7) spray throughout the 6 weeks.

Incorporation of Neem leaves into soil to control bacterial wilt of Tomato:

Experiment conducted in a greenhouse of the State University of Maranhão (Brazil). (O'Neill, *et. al*., 2014), where dry and fresh neem leaves were incorporated in the soil in different amounts (0, 20, 40, 60, 80 and 100 g) and kept in it for different periods of time (0, 15, 30, 45 and 60 days) showed positive effects in the disease control by incorporating neem leaves, with a reduction of wilting symptoms up to 100% with dry leaves and 78% with fresh leaves.

Tomato Leaf Blight

Tomato Blight

Organic Soil Amendmentand Plant Pathogens:

Reliable control of plant pathogens and parasitic nematodes with organic soil amendments is facilitated through their coordinated use within a systems-based approach to the management of soil borne pests. (Chellemi, *et. al*., 2014). Their effectiveness is improved when they are combined with other cultural practices that support the establishment and growth of pest suppressive soil microbial communities and promote the development of vigorous, stress-free root systems of the plant hosts. Crop rotation, soil solarization, and host resistance are examples of other pest management tactics that when used in conjunction with organic soil amendments, enhance their performance. Selection of organic amendment should include consideration of carbon and nitrogen sources that selectively promote functional groups of soil microbes directly related to pest and pathogen control.

Establishment of soils with resilient/stable populations of disease and nematode suppressive micro-organisms through the use of organic amendments can be monitored by genomic or enzymatic profiling of soil microbial communities and identifying substrate-mediated shifts in their composition. Use of organic amendments within a systems-based approach to manage an economically threatening soilborne pest is provided through an example of the management of sting nematode (*Belonolaimus longicaudatus*) on strawberry (*Fragaria ananassa*). With this example, crop damage from sting nematode was mitigated through the combined use of chitin-based organic amendments with a beneficial cover crop of sunn hemp (*Crotalaria juncea*), soil solarization, and a crop termination treatment at the end of the previous cropping cycle to reduce over-seasoning nematode populations. Termorshuizen and Jeger, (2014).

Compost as a soil amendment

Compost is used as an organic amendment to improve physical, chemical, and biological properties of soils. Adding compost will increase the moisture-holding capacity of sandy soils, thereby reducing drought damage to plants. When added to heavy clay soils, compost will improve drainage and aeration, thereby reducing waterlogging damage to plants. Compost increases the ability of the soil to hold and release essential nutrients and promotes the activity of earthworms and soil microorganisms beneficial to plant growth. Other benefits of adding compost include improved seed emergence and water infiltration due to a reduction in soil crusting. Over time, yearly additions of compost will create desirable soil structure, making the soil much easier to work. He *et.al*., (2001); Pugliese *et.al*., (2014); Agresourse, (2012).

Alternative to Composting

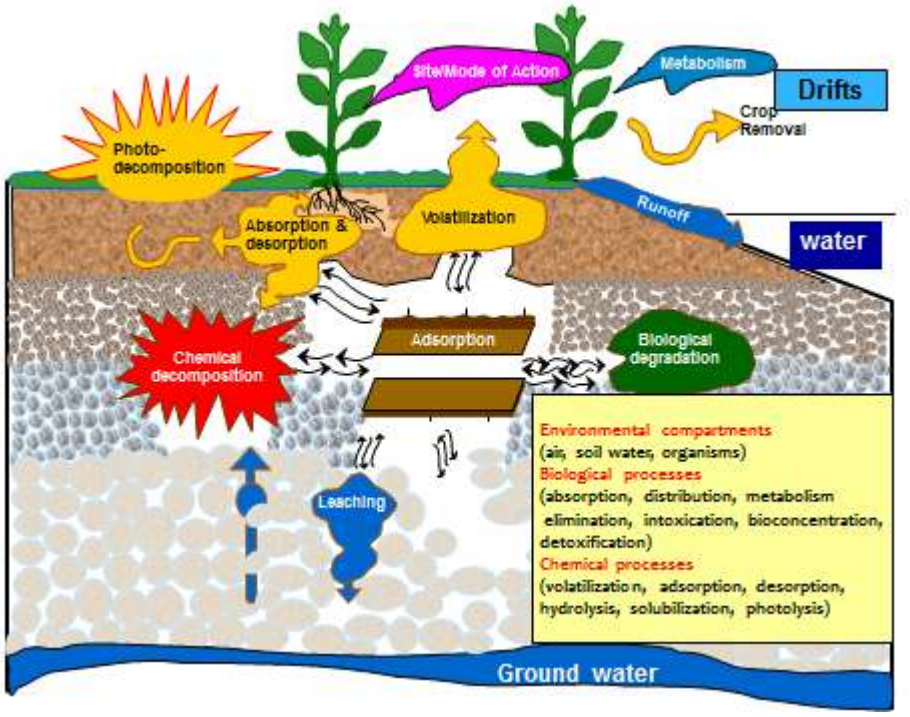
When proper lawn management is used, there is no need to collect grass clipping. As long as the grass is not excessively long and clippings do not thickly cover the lawn surface after mowing, there is normally no need to collect the clippings. Aside from reducing the work involved in lawn maintenance, leaving the grass clippings benefits the turf by returning nutrients and organic matter to the soil. If evenly distributed, clippings left on the lawn can be equivalent to one fertilizer application per year. To keep your lawn looking healthy and control the amount of clippings generated, several maintenance practices should be followed. It is important that mowing height be properly adjusted. The best cutting height depends on the turfgrass varieties present in the lawn and whether the lawn is in sun, full shade, or a combination of both. Lawns in full sun have the greatest potential for quick recovery after mowing and can therefore be cut shorter. Those in the shade need the entire available leaf surface possible for photosynthesis. Thus, grass in the shade should be cut slightly higher than grass in the sun. Where both conditions are present, an intermediate height is recommended. If used as mulch, care should be taken not to over-apply fresh clippings as they tend to inhibit moisture and oxygen penetration into the soil, and may produce offensive odors. Mixing fresh clippings with compost provides an excellent mulching material. Does not use grass clippings as mulch if the lawn has recently been treated with herbicides.

Organic Soil Amendments and the Health of the Rhizosphere

The rhizosphere is defined as the soil which is under the influence of the roots. The roots absorb water and nutrients in that area. This area of the soil is rich in microorganisms which increase nutrient availability, immobilize nitrogen in the root zone and reduce nitrate leaching. This biological fraction in the rhizosphere conserves nutrients and is responsible for organic material breakdown and nutrient cycling. The soil microorganisms are responsible for formation of soil structure, improve aeration, and improved drainage.

During photosynthesis; sunlight, carbon dioxide, and water, through the action of the chloroplasts and chlorophyll, yield carbohydrates, oxygen, and water. These carbohydrates are utilized by the plant to sustain growth and life functions and are stored in the roots forreserve. Every living organism in existence needs carbon for survival. The roots are not photosynthetic and are 100% dependent on the photosynthetic energy captured in the leaves and shoots. The amount of energy captured depends on such things as the duration of light, the extent of stress, and the amount of leaf surface. Modern day superintendents, in order to satisfy the wants of their golfers for green speed, simply cut their greens so low and so often that there is very limited leaf surface.

In an ordinary situation a plant will store 1/2 of all the carbohydrates produced in the root and utilize 1/2 for sustaining life functions. Around 1/2 of the carbohydrates reserve in the root is then excreted back into the rhizosphere as a microbial sub-straight called exudates. These exudates sustain the life of the complex micro-community and the microbes in turn make nutrients available to the plant. Great teamwork! Since the roots are largely responsible for the organic matter in the soil via exudates, then managing for maximum root growth becomes very important. The products may contain various types of carbohydrates, protein, glucose and other sugars, sea weed extracts, yucca extracts, organic acids, amino acids, or organic humates such as humic or fulvic acid and organic extracts of composted manure or lenordite. These may be sold individually or in combination products. With everyone making claims and little research forthcoming, you need to choose products made by companies which have good science behind them, make quality products, and are willing to stand behind them. You must judge whether or not they are helping. Abvien *et. al*., (2008).Organic amendments are used to improve physical, chemical, and biological properties of soils. Below is a typical diagrammatic representation of Biological and chemical processes in an environment.



Conclusion and Recommendations:

Organic soil amendment is a sure way of ensuring healthy growth, development and production of good taste, flavour, nutritional crop produce which are also free from toxic chemicals and if managed carefully, can be applied everywhere.

Recommendations:

I recommend the following:

i. Organic crop production for sustainable growth, development and subsequent production of healthy crops.
ii. The government at all levels, Institutions and Agencies especially Federal Environmental Protection Agency (FEPA) should promote and enforce environmental policies aimed at using environmentally friendly alternatives for quality crop production.
iii. Poverty and suffering is a constraint. Therefore, farmers should be provided with loans, grants and subsidies to encourage more people to go into organic agricultural production.
iv. Government should establish laboratories in research institutes and tertiary institutions to assess the level of residues, molecular components of the amendments and site of action.
v. Most research and development efforts on crop produce should focus on further use and improvement of organic soil amendments for high crop yield and quality.

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References

Abbott L.K., Murphy D.V. (2007). What is soil biological fertility? In: Abbott L.K., Murphy D.V. (Eds.), Soil biological fertility — A key to sustainable land use in agriculture. *Springer*, pp. 1–15, ISBN 978-1-4020-6619-1.

Abiven S., Menasseri S., Chenu C. (2008). The effect of organic inputs over time on soil aggregate stability — A literature analysis, *Soil Biol. Biochem.* 41, 1–12.

AGRESOURCE (Editor) (2012): Protecting Local Water Resources by Amending Soil with Compost. Amesbury: *Agresource* Inc.

Agwe, J.; Morris, M.; Fernandes, E. (2007): Africa's Growing Soil Fertility Crisis: What Role For Fertilizer? . *Washington, D.C.: The World Bank.*

BosenaCwalina-Ambroziak, RyszardAmarowicz, J. Tyburski, Michal Adam Janiah (2014). Effect of farming system on pathogen infection and content of phynolic compound in carrot (*Daucuscarota* L.). *Journal of Animal and Plant Sciences*. 24(4): 1183 – 1189.

Chellemi, D.O., Noling, J.W. and Sambhav, S. 2014. Organic Amendments and Pathogen Control: Phytopathological and Agronomic aspects. *Acta. Hort.* (ISHS) 1044:95-103.

Davies G., Lennartsson M. (2005) Organic vegetable production. A complete guide, Henry Doubleday Research Association, *The Crowood Press Ldt*., ISBN 1 86126 788 6.

Davis, J.G.; Wilson, C.R. (2005): Choosing a Soil Amendment. *Fort Collins: Colorado State University.*

Epa, U. S. (2006): The Use of Soil Amendments for Remediation, Revitalization, and Reuse. Washington DC: *United States Environmental Protection Agency* (U.S. EPA).

FaragHanaa, Zeinab, A. Abdou, Dawlat, A. Salama, Mervat Ibrahim (2011). Effect of neem and willow acqueous extracts on Fusarium wilt disease in tomato seedlings. *Annuals of Agricultural Sciences* 56(1): 1-7.

GIZ, (2010).Organic Agriculture in Saudi Arabia.Saudi National Organic Regulation and Standards. Saudi Arabia.

He Z., Yang X., Kahn B.A., Stoffella P.J., Calvert D.V. (2001) Plant nutrition benefits of phosphorus, potassium, calcium, magnesium, and micronutrients from compost utilization, in: Stoffella P.J., Kahn B.A. (Eds.), *CRC Press LLC*, Compost utilization in horticultural cropping systems, pp. 307–317, ISBN 1-56670-460-X.

Hue, H.V.; Silva, J.A. (2000).Organic Soil Amendments for Sustainable Agriculture: Organic Sources of Nitrogen, Phosphorus, and Potassium: Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture. *Honolulu*, 133-144.

Ihejirika, G. O., M. I. Nwufo, M. C. Ofoh and V. N. Onyia, (2007). Effects of Mulch Materials and Plant Density on some Fungal Diseases and Yield of Maize.*Journal of Plant Sciences*. 2 (2): 238-242.

Ihejirika, G.O. (2008). Current options for improving leafspot disease resistance and yield of groundnut in an Ultisols.*Archives of Phytopathology and Plant Protection.*1-6.

Ihejirika, G. O., Ibeawuchi, I. I., Obiefuna, J. C., Obilo, O. P. and Nkwocha, V. I. (2009). Organic Soil Amendments as a Protectant for Kola seedlings Transplant against some field diseases in Kola based cropping systems. *Int'L Journal of Agric and Rural Development*. *(IJARD)*.Vol. 12.100-109.

Ihejirika, G.O.(2011). Determination of anti-microbial properties of *Ocimum viride* concentrations on *Rhizopus stolonifer* infection and germination of soybean (*Glycin max* L. Merill).*Archives of Phytopathology and Plant Protection*.Vol. 44, No.s. 17 – 20: 1894 – 1900.

Ihejirika, G.O. (2012). Fungicidal effects of Organic Soil Amendments on some Fungal diseases and Yield of Soybean (*Glycine max*). *Journal of Yeast and Fungal Research.* 3(3): pp. 25 – 29.

Ihejirika, G.O., Ojiako, F.O., Onyia, V.N., Mba, P.C. and Ihemhuru, C. P. (2021).Cultivar differences and soil amendment on the field disease development and yield of *Telfairiaoccidentalis* in Owerri, Imo State. Paper presented at the *46th Ann. Conf. of Nigerian Society for Plant Protection*. Federal University of Technology, Owerri.Pp. 14.

Masomba, K. J. and Nguyen, M. H. (2010). Determination and Comparation of Vitamin C and Potassium in four selected conventionally and organically grown fruits and vegetables. *African Journal of B. Technology*.7(16).

NUTRANETICS (Editor) (2000): Humic Acid Structure and Properties. Stockton: *Nutranetics ProBio Solutions*.

Nwokeji, E. M., Duruigbo, C. I. **Ihejirika, G. O**., Obilo, O. P., Chigbundu, I. N., Echereobia, C. O., Ogwudire, V. E. and Peter-Onoh, C., (2011). Field Evaluation of Various Plant Biocides in the control of Black Sigatoka Disease in Plantains. *International Journal of Agriculture and Rural Development.* Vol. 14(2): 712-715.

Obilo, O. P., **G. O. Ihejirika**, M. O. Ofor, K. O. Ogbedeh, E. R. Onuoha, K. C. Uzosike, V. C. Ilozumba and O. P. Ibeh, (2011). Efficacy of Garlic and other plant extracts in the control of Septorial Leafspot of Tomato (Lycopersicon esculentum). *International Journal of Agric and Rural Dev.* Vol. 14(2): 627 – 629.

10**.** Obilo, O.P., Danniel, A.E. **Ihejirika, G.O**., Ofor, M.O. and Adikuru, N.C. (2012).Control of Rice Blast (*Magnaporthegrisea*) Disease using various organic manure. *International Journal of Agric and Rural Development (IJARD)*. Vol. 15(3): 1198 – 1205.
Ogbedeh, K.O., M. C. Ofoh, C. M. Agu, **G. O. Ihejirika**, O. P. Obilo, E. M. Nwokeji and C. I. Duruigbo (2007). Effects of Organic and Inorganic Manures on the yield of yam tubers in Termite infested soils. *International Journal of Agriculture and Rural Development*. 9 (1): 66-70.

Ogbedeh, K.O., Ekwe, C.P., **Ihejirika, G.O.**, Dialoke, S.A., Onyewuchi, O.P., Anyanwu, C.P., Bosah, B.O., Kalu, I.E., Cookey, C.O. and Nnebue, O.M. (2019). Effect of palm bunch ash and Neem (*Azardirachtaindica* A. Juss) leaf powder on termite infestation in groundnut field in OwerriUltisols, South-eastern Nigeria.*Life Science Journal.* 16(5):79 -85.

Okay Y. (2010). Mechanism of nematode suppression by organic soil amendments: A review. *App. Soil Ecol.* 44: 101 – 115.

O'Neill, T.M., Deery, S.J., Scott, G. and Dickinson, M. (2014).Monitoring Tomato Root Microorganisms.*Acta. Hort.* (ISHS) 1044:81-88
http://www.actahort.org/books/1044/1044_8.htm.

Pugliese, M., Gullino, M. L., Garibaldi, A. and Benetti, A. (2014).Use of Compost from different origins to control Soil borne pathogens in potted vegetables. *Acta Hort*. (ISHS) 1044:145-148. http://www.actahort.org/books/1044/1044_17.htm

REED, D. (2007): Horticulture Workshops: Plant Propagation, Soil and Soilless Growing Media, Simple Soil and Water Testing. Texas: A&M University.

SAS, 2009: (2009).Stastistical Analysis System (1999) Update.Personal Guide. SAS Inc. USA.
Termorshuizen, A.J. and Jeger, M.J. (2014).Assessing Inoculum of Soil borne Plant pathogens: Theory and Practice in decision-making for soil disinfestations. *Acta. Hort.* (ISHS) 1044:75-80. http://www.actahort.org/books/1044/1044_7.htm.

United States Department of Agriculture, National Organic Program, (2019). USDA: Organic Regulation. *Sunset Review.*53577-53578.

WEST COAST SEEDS (Editor) (2011): Soil Amendments and How to Use Them. Ladner: West Coast Seeds.

Wierzbowska, J., Rychcik, B. and Swiaty, A. (2018).The effect of different production systems on the content of micronutrients and trace elements in potate tubers.*ActaAgriculturaeScandinavica,* Section B- *Soil and plant sciences* 68(8), 701 – 708.