UNVEILING THE BEAUTY OF AN UNFORBIDDEN FRUIT

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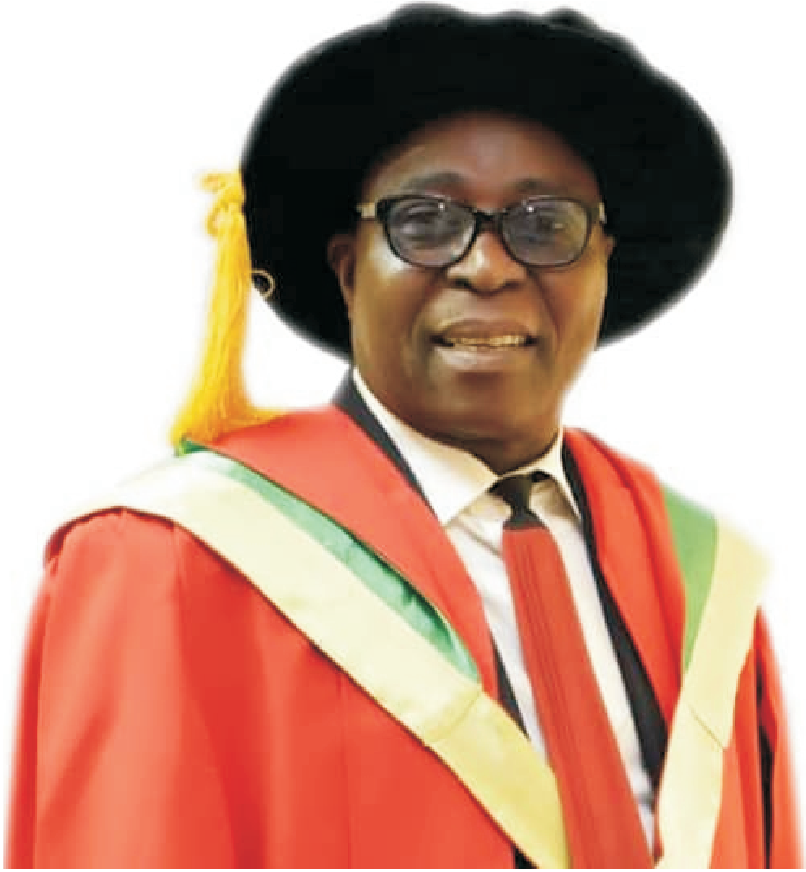

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FUNAAB
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UNVEILING THE BEAUTY OF AN UNFORBIDDEN FRUIT

The Vice Chancellor;
Deputy Vice Chancellors (Academic and Development),
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Deans of other Colleges and postgraduate School,
Members of the University Senate,
All Academic and Non-teaching Staff,
My Lords Spiritual and my Lords Temporal,
All Special Guests and Friends of the University,
Distinguished Ladies and Gentlemen,
Fellow Scholars,
Gentlemen of the Press,
Great FUNAABITES

1.0. PREAMBLE

Mr. Vice Chancellor Sir, the opportunity of an Inaugural Lecture is subject to institutional approval, support and facilitation. Therefore, after my gratitude to God for making this one come through, I appreciate your nod of approval that this lecture can hold today.

There have been diverse definitions of an Inaugural Lecture. A school of thought says it literarily establishes a professorial life, others say it is a collection of how a professor is made, and is given at a point in a professor's academic career. Yet others go by the belief that it is an opportunity for a professor to inform colleagues in the University as well as the general public on his/her research career progression and give an update on current and future research directions.

Regardless of the diverse definitions however, an Inaugural Lecture has become a tradition in which a Professor gives an account of himself or herself in terms of research, teaching, breakthrough, contribution to knowledge as well as services for national and international development. It is considered an obligation a professor has to fulfil at a point in his academic life. It is my lot today to be at the center of this tradition in our great and green university, the Federal University of Agriculture, Abeokuta, Nigeria.

I sincerely feel honoured to have been permitted to deliver the 5th Inaugural Lecture from my unique Department, the Department of Horticulture, the 10th from my respected College, the College of Plant

Science & Crop Production and the 59th in our great University, the Federal University of Agriculture, Abeokuta.

2.0 INTRODUCTION

As a horticulturist, I have vested the focus of today's discourse on the subject of ' FRUIT'. In the science of the study of plants (botany), a fruit is regarded as a seed-bearing structure, developed from the fertilized ovary of a flowering plant. Fruit formation is indeed one of the most dramatic and interesting developments in plant morphogenesis.

Very early in the record of creation of the universe as found in the Holy books, it is indicated that a beautiful garden was established by our Creator, and there He put the man (Adam) that He had created (Plate 1). The Lord God planted the garden in Eden, in the east, placed there the man whom He had formed. And from the ground, the Lord God caused to grow every tree that was pleasing to the eye and good for food, with the tree of life in the middle of the garden, and the tree of knowledge of good and bad (Genesis 2$^{8-9}$). The location of this garden, Eden, in Aramaic language, means ''fruitful, well watered''.

Plate 1. Pictorial Impression of the Garden of Eden

Source: Pininterest (Accessed 08/04/19)2

This garden had in it the best of fruits but God told Adam that not every fruit of the garden was for man to eat because He instructed Adam later saying 'You are free to eat from any tree in the garden but you must not eat from the tree of the knowledge of good and evil, for when you eat it, you will surely die' (Genesis 2:16-17). Thus some fruits were forbidden in the midst of others, even in the beautiful Garden of Eden.

Beyond creation, history is rich with the record of the early man's activities of gathering and selection, choosing some as good and others as not. This continues till our contemporary times as we still classify fruits as, some fit and others unfit for our health, Thus it is common to hear of 'pepper less' diets where the pepper fruit is literarily forbidden. We do hear of 'astringent' or 'acidic' fruits, considered not too good for eating, thus somehow forbidden.

One fruit, however stands out with friendly characteristics in nutrition, almost in absolute terms, a fruit of universal adoption, attractive and appealing, a component of most food recipes, nourishing and good for the human body. That is the tomato fruit, which is derived from the tomato plant (*Lycopersicon esculentum* Mill, Syn.*Solanum lycopersicum L*), a member of the *Solanaceae* family of flowering plants. It is botanically a berry-type fruit and utilized as a culinary vegetable. The fruit is classified as a functional food because of its high levels of vitamins, minerals and lycopene, a carotenoid pigment that provides antioxidant qualities (Alvarenga, 2004). Tomato is utilized in diverse ways; as ingredient of soups, sauces, salads and drinks. As a major source of human dietary minerals (especially calcium) as well as vitamins A, C and E (Fig. 1).

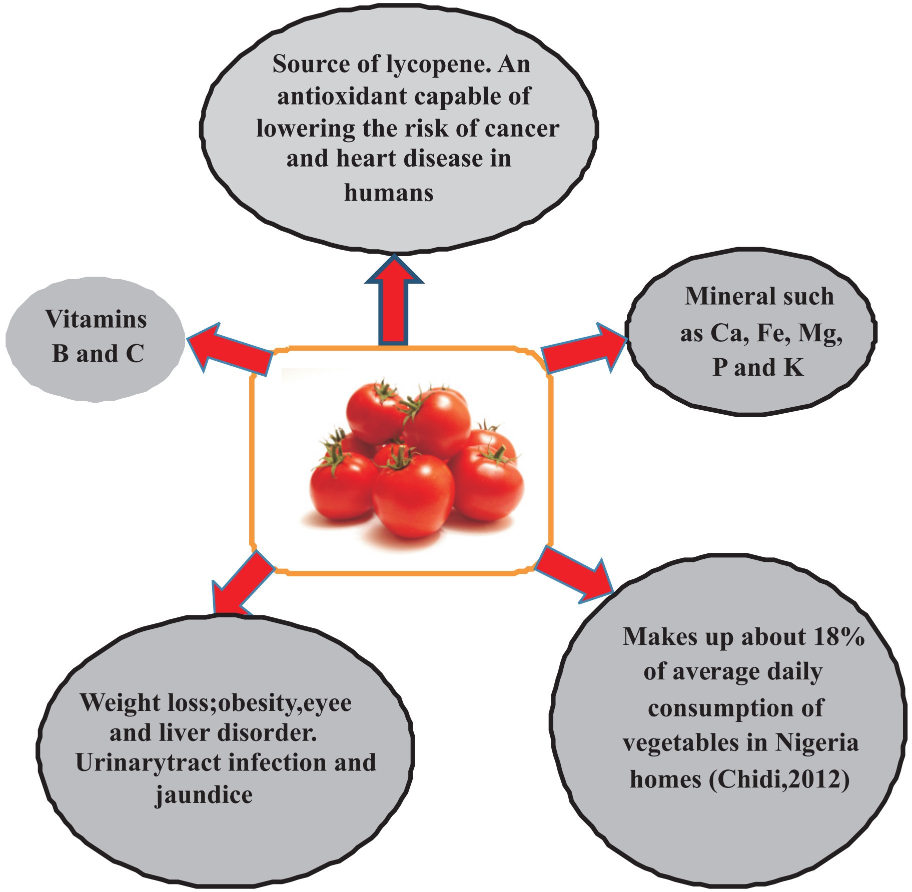

Figure 1: Nutritional Benefits of Tomato
Source: Shankara et al., 2005

Tomato is therefore considered vital, almost inevitable in human nutrition, thus qualifying as one un-forbidden fruit, among others.

The exact date of domestication of the tomato crop is unknown but by 500 BC, it was already being cultivated in Mexico (Jan, 2011). The Spanish probably were responsible for the spread of tomato to their colonies in the Caribbean and Philippines. The introduction of tomato to Europe was probably by Columbus or Cortez before dissemination by the Spanish explorers and it was not accepted as an edible fruit until about 1840 (Paran and van der Knaap, 2007). Popular consumption of tomato in Britain was observed from the mid 18th century as the fruit was considered poisonous and unfit for eating before then.

Early knowledge of the tomato in Italy was about its use as an ornamental crop mostly utilized as table top decoration until the late 17th century when it was incorporated into the local dietary recipe. Its introduction to Africa may have been through Morocco and Egypt by the Portuguese between the 16th and 17th century (Osei., et al. 2013).

3.0 TOMATO PRODUCTION IN NIGERIA

3.1 Production Statistics

Nigeria currently ranks the 3rd country in global tomato production in terms of land area under cultivation, after China and India. Nigeria thus has the largest area harvested in Africa (574,441 ha), followed by Egypt that cultivates 199,712 ha. (Table 1). The large area cultivated in Nigeria however is under the lowest yield per hectare regime in Africa and among the poorest yield performance in the world, about 4- 5 t/ha, compared to Egypt that records a yield of 39.7 t/ha and South Africa with 78.7 t/ha (FAOSTAT, 2016).

In the whole of Africa, only Egypt ranks among the first six tomato-producing nations of the world which are China, India, United States of America, Turkey, and Egypt , in that order (Figure 2).

Table 1. Tomato Production as Area Harvested and Yield Across Twenty Countries

Country	Area Harvested (ha)	Total Production (t)	Fruit yield (t/ha)
China	1,003,992	56,423,811	56.2
India	760,000	18,399,000	24.2
Nigeria	**574,441**	**2,243,228**	**3.9**
Egypt	199,712	7,943,285	39.8
Turkey	188,270	12,600,000	66.9
Iran	159,123	6,372,633	40.0
United States	144,410	13,038,410	90.3
Russia	118,451	2,986,209	25.2
Italy	103,940	6,437,572	61.9
Mexico	93,376	4,047,171	43.3
Cameroon	92,626	1,182,114	12.8
Ukraine	74,300	2,229,690	30.0
Brazil	63,980	4,167,629	65.1
Pakistan	60,307	575,923	9.5
Indonesia	57,688	883,242	15.3
Spain	54,203	4671807	86.2
Ghana	47,000	366,772	7.8
Sudan	46,746	617,400	13.2
Benin	40,177	335,412	8.3
Tanzania	39,409	539,914	13.7
Mean	3,922,151.	146,061,222	35.7

Source: FAOSTAT (2016)

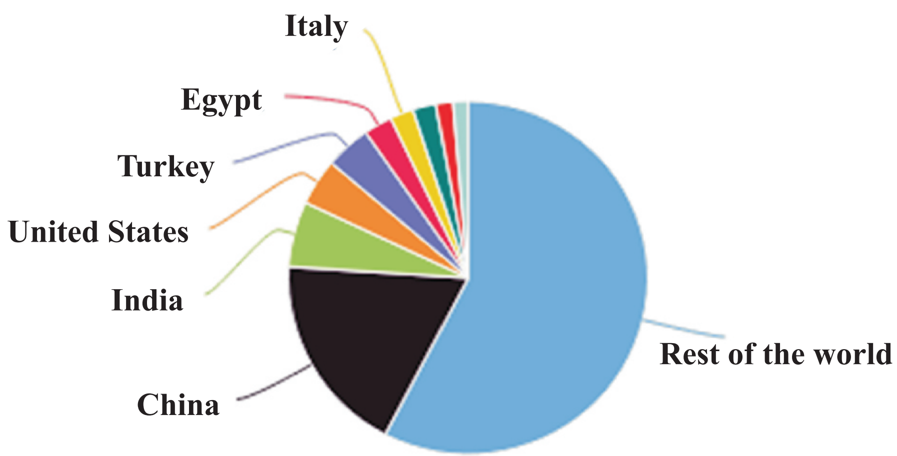

Figure 2. Six Leading Tomato Producers in the World
Source: FAOSTAT (2016)

4.0 TOMATO PRODUCTION, DEMAND AND ASSOCIATED ROBLEMS IN NIGERIA

4.1 Production Level versus Demand

Tomato cultivation in Nigeria is concentrated in the northern part where irrigation facilities abound for dry season production. Thus, about 80 % of tomato fruit output in Nigeria is from major producing states like Kano, Jigawa, Bauchi, Gombe, Kaduna and Taraba. Low productivity in Nigeria has been attributed to environmental and managerial factors. While the very humid and damp environment of the southern savanna and rainforest agro-ecologies enhances disease incidence, the hot and dry environment of the northern savanna regions is unfriendly to an all-year-round good growth and development of tomato plant. Managerial factors are traceable to an almost generally low level of Good Agricultural

Practices (GAP) in terms of choice of variety, seed quality, appropriateness of planting time, quality of field cultural practices, timeliness of harvest, harvest technique and subsequent postharvest handling.

These factors conspired to make Nigeria a producer of just 2 % of the total world output of tomato fruits in spite of the huge total land area cultivated (Figure 3). This has implications on meeting the Nigerian demand for tomato which is an average of 2.45 million metric tons per annum while the country produces 1.8 million metric tons, just a little above half of her

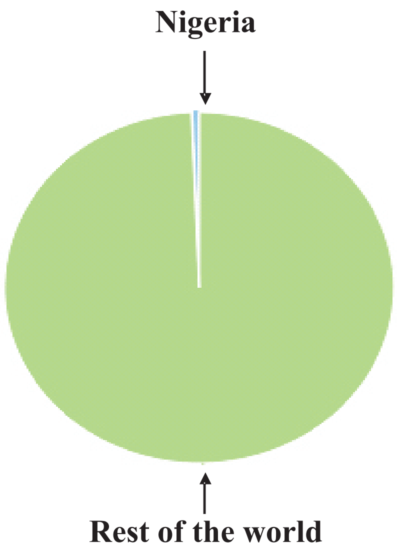

Fig. 3. Nigeria in the World Production of Tomato
Source: FAOSTAT, 2016

Vice Chancellor, Sir, on account of the low production and the dietary compulsion of this ingredient in culinary use, a number of abuses, detrimental to human health had been observed in an attempt to make tomato products available in meeting demand in Nigeria. This includes the importation of sub-standard tomato paste and the consumption of rotten tomato fruits often called *esha* in tomato markets of south western Nigeria. A national tabloid reported Elemo (2015) as saying 'Don't be deceived, most of the so-called canned tomato out there are mostly starch, additives, colourants and a little percentage of the real tomato' (The Nation Newspaper, 2015, Plate 2). This is the story of some of the tomato paste and puree imported into Nigeria, 91.1% of which, according to NAFDAC (2015), failed to meet the required standard. It is noteworthy that most of the paste are imported as concentrates in drums and big cans from Italy, India and China. They are usually diluted, packaged and finally canned by various canning industries in Nigeria. Some of the imported paste could contain up to 50% starch before dilution in Nigeria when an additional 15% starch is often added. The Federal Institute for Industrial Research, Oshodi (FIIRO), Lagos alerted consumers on this discovery in 2015

CONSUMER Watch

THE NATION ON S

Beware, fake tomatoe paste in circulation

OVER the years, a lot of people have erroneously believed that tomatoe paste and puree are just beautifully blended and packaged 'tomatoe'.

Don't be deceived, most of the so-called canned tomatoe out there are mostly starch, additives, colourants and a little percentage of the real tomatoe!

That much was revealed by Dr. Gloria N Elemo, the Director General of the Federal Institute of Industrial Research Oshodi [FIIRO].

The scientist made this disclosure during the working visit of members of the West African Agricultural Productivity Programme [WAAPP-IB] to FIIRO.

•Elemo

increase the volume and extend the shelf life."

It is however instructive to

sumer of tomatoe paste hence it forms a key destination market for especially Chinese tomatoe paste.

Fresh tomatoes are grown in many towns especially in the northern part of the country, but lack of infrastructure results in high post harvest losses hence consumers have adapted to the convenience offered by tomatoe paste.

NAFDAC has on several occasions expressed concern on tomatoe paste adulteration.

Investigation conducted by NAFDAC on tomatoe paste in Nigerian market revealed that 91.1 per cent of the brands failed to meet the required standard with virtually all the

Plate 2: Awareness Creation by FIIRO on Fake Tomato Paste Importation in Nigeria (Source: The Nation on Sunday, May 15, 2015)

This prompted the Association of Agricultural Products and Equipment Manufacturers in Nigeria to call on the Federal Government of Nigeria, through the relevant agencies (NAFDAC and SON) to stop the importation of tomato paste into Nigeria (The Nation on Sunday, 2015).

The implication of a ban on importation of tomato paste, however, is the need for an increased level of production of fresh tomato fruits and an increase in productivity per land area harvested, as well as the possibility of a viable processing factory. It indeed throws a challenge on indigenous Nigerian industrialists to explore value addition for tomato fruits particularly the conversion to paste.

It was in this direction that in the year 2015, the Dangote Group inaugurated a tomato paste factory worth ₦2.5 billion in Kadawa, Kura local government area of Kano State. The factory was meant to directly employ more than 200 Nigerians and indirectly impact on more than 40,000 families engaging in tomato farming.

Plate 3. Awareness Creation on the Advent of the Dangote Tomato Processing Factory in Nigeria

This initiative prompted the Dangote group to make a call on government not to allow importation of tomato paste because it could kill the ambition of the farmers as well as that of indigenous processing manufacturers. Following this appeal, the Federal Government expressed its readiness to end the importation of processed tomato paste into the country. In the opinion of the Staple Crop Processing Zone Development (SCPZD) of the Federal Ministry of Agriculture and Rural Development, the Dangote Tomato processing factory would increase dependence on locally-made tomato products rather than on imported ones, with specific reference to tomato paste. The initiative, even with the huge investment, did not have an immediate success due to challenges of inadequate supply of fruits to meet the capacity of the processing plant. However, it seems that this challenge has been overcome as the factory resumed production in March 2019.

Further risen hope in this direction was manifest in February 2016 when Erisco Foods, an indigenous food processing company in Lagos launched what was described as the first tomato paste processing plant in southern Nigeria, with capacity to produce 450,000 metric tons a year. With the advent of this processing plant, the Chief Executive of Erisco, Eric Umeofia also urged government to place a total ban on importation of tomato paste and encourage local production of the fruits for processing (The Nation on Sunday, 2015, Plate 4).

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Business

EriscoFoods revolutionises tomato paste production

HISTORY was made last Thursday, as the first-ever tomato paste processing and producing plant in Nigeria was inaugurated by Hajiya Aisha Muhammed, the wife of President Muhammadu Buhari.

The plant, Erisco Foods, located at Oregun, Alausa Lagos is touted to be the first of its kind in Africa and the fourth largest tomato plant in the world that has the capacity of producing about 450,000 metric tons per annum from farm fresh tomatos planted, nurtured and harvested from the Nigerian soil.

The event which was rather significant for many reasons, among which is the wide campaign by the importers of triple paste tomato concentrate in Nigeria that tomatoes farmed in Nigeria are very poor in quality and as such

•Wife of the president, Hajiya Aisha Buhari, inaugurated a 450,000 tonnes tomato paste processing plant built by ERISCO Foods recently in Oregun, Lagos State.

will provide jobs for our people and make our farmers richer like their counterparts in developed world."

Refuting what the importers of tomato paste said, he avowed that "Nigerian tomato is richer in quality and content. It is healthier than any imported tomato paste," while adding that the country is uniquely blessed with a special climatic condition which allows farmers to grow tomato more than twice in a year.

On job creation in the tomato industry, Chief Umeofia regretted that importers of triple paste tomato concentrate were exporting jobs which Nigerians could be doing to China and other Asian countries by not engaging Nigerians in the growing, and processing of tomato into paste.

ment and prosperity for 50,000Nigerians within three years while off takers and our distributors and retailers will be in hundreds of thousands."

Speaking further, he said that because of the huge capacity of the tomato plant, it is open to genuine tomato paste companies in Nigeria, "as we can process and package their paste for them in their brand names."

While inaugurating the plant, Mrs. Buhari tasked government regulatory agencies to check the importation of foreign and substandard foods into the country. "I think we have imported enough and we have to change that culture of importing things we can produce."

She asserted that local food manufacturers have to be encouraged to grow, as that

Plate 4. Official Commissioning of Erisco Tomato Paste Processing Factory, Lagos Nigeria

4.2. Production constraints

Apart from factors traceable to the plant, tomato growth and productivity largely depend on the environment. Though the cultivated tomato would grow under a wide range of environmental variation, its flowering and fruiting would require a somewhat narrow range of specific indices of the environment. Generally, environmental factors that have implications on tomato growth, development and productivity include soil and air temperature, root/soil medium moisture, relative humidity and light irradiance. All these are factors that change with weather and are of high relevance in field cultivation of tomato. Specifically in Nigeria, rainfall, relative humidity and temperature delineate the ecological distribution of tomato cultivation, though the influence of some secondary factors like soil-borne pathogens might be of relevance.

5.0 MY RESEARCH FOCUS

5.1 Genesis of my Research Focus

Vice-Chancellor Sir, I started my academic career at the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria as a Graduate Assistant in 1983. It was, and it is still, the policy of that Institute that a researcher adopts a crop commodity on which to conduct research in any of the numerous research programmes of the Institute, with the application of his/her basic academic discipline on the adopted commodity. I was attached to the Horticultural Crops Research Programme of the Institute. It was at a time that a researcher on tomato improvement, Dr. J.G. Quinn, an expatriate staff, was leaving the Institute and I had to inherit his research focus. Thus, as a Pupil Crop Physiologist, my research focus was going to be on physiological crop improvement of tomato. Therefore, in my postgraduate studies, my Masters degree research addressed tomato growth environment while my PhD was on the actual understanding of tomato growth and development dynamics.

5.2 Environmental Stress Mitigation in Tomato

The most noticeable challenge to tomato productivity in the mandate area of IAR, the savanna agro-ecology was, and is still the high temperature of the late dry season. The tomato crop is heat-intolerant as day and night temperature, respectively beyond 35^0C and 20^0C, over a period of time would result in the stigma extrusion beyond the position of the anther in the floral arrangement.

This implies that pollens released by such anther would not get to the stigma for pollination, though the tomato plant has a complete flower, that is, male and female components in the same inflorescence. The stamen wraps the pistil which has a long style carrying a stigma that often extends beyond the surrounding stamen, especially under heat stress. This architecture is often inimical to the expected subsequent pollination, fertilization and fruit development. Self-pollination potential of tomato, which is normally to the tune of about 98%, is impaired under this situation, thus manifesting a subsequent direct effect on fruit yield (Plate 5).

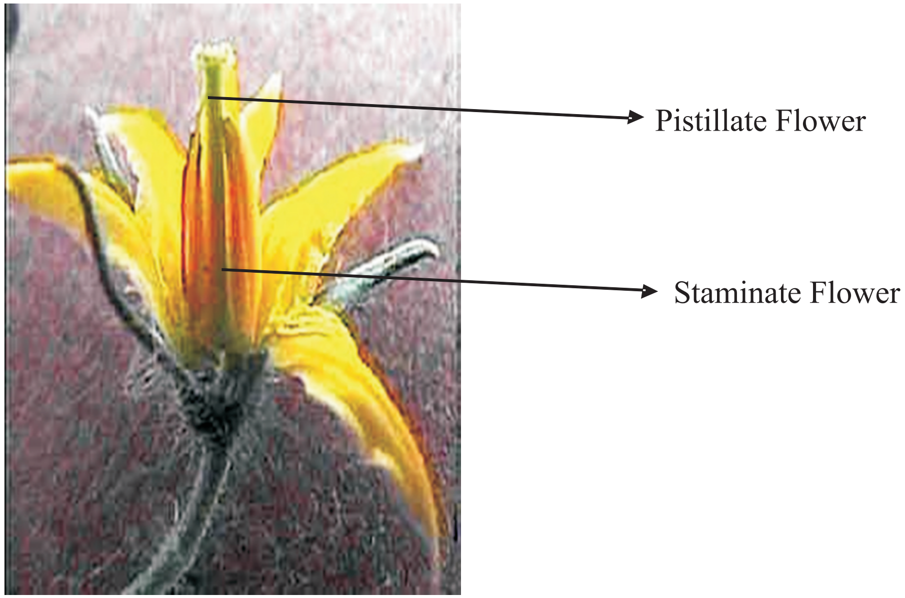

Plate 5. Tomato Flower Showing Male and Female Components

5.2.1 Amelioration of High Temperature Effects

The Kadawa Irrigation Research Station, which is a nucleus location for tomato production in Kano state, and an outstation of the Institute for Agricultural Research, Zaria, was chosen for research which aimed at heat stress remediation through cultural practices in tomato production. The location is characterized by maximum temperature usually above the critical level for tomato productivity (35^0C) from the month of February/March through May and minimum temperature above the critical threshold of 20^0C (Fig. 4)

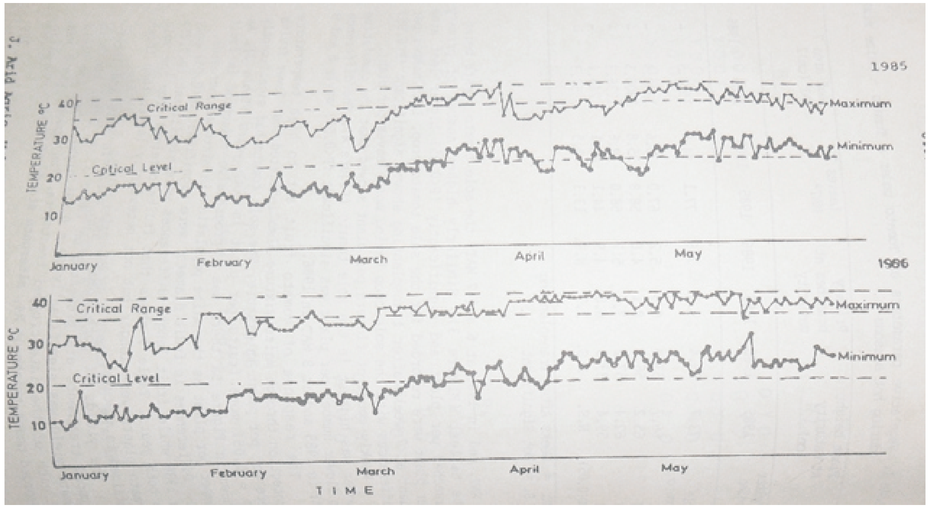

Figure 4. Daily Maximum and Minimum temperatures from January to May at Kadawa (1985 and 1986)

Source: Bodunde and Olarewaju, 1988.

The implication of this temperature regime is that tomato sown in the nursery between the month of December and February and transplanted between January and March would experience poor or zero fruit set because the flowering and fruiting phases would coincide with the period of supra-optimal temperature regime, the minimum temperature being the more critical. The southern part of Nigeria often experiences the practical implication of this reduction in yield as it affects the supply of tomato fruits almost on annual basis, as witnessed in the scarcity of tomato fruits and the attendant high prices between the months of May and July.

5.2.2 Use of Protective Companion Crop

Adopting the cultural practices approach as a possible means of minimizing the impact of heat stress, a protective cultural practice was conceived by Bodunde and Olarewaju (1988) through an intercrop of tomato with maize during hot seasons. The objective was to determine if the presence of a taller crop *(Zea mays)* as an intercrop with tomato would play a protective role by minimizing the impact of high temperature on a heat-sensitive tomato variety by slightly intercepting sunlight. Tomato was thus planted with varying spatial relationships with maize stands during the peak temperature period (Fig 5). The choice of maize was premised on its leaf shape and architecture, both of which were considered as not likely to be very preventive of solar incidence on an underneath crop (tomato).

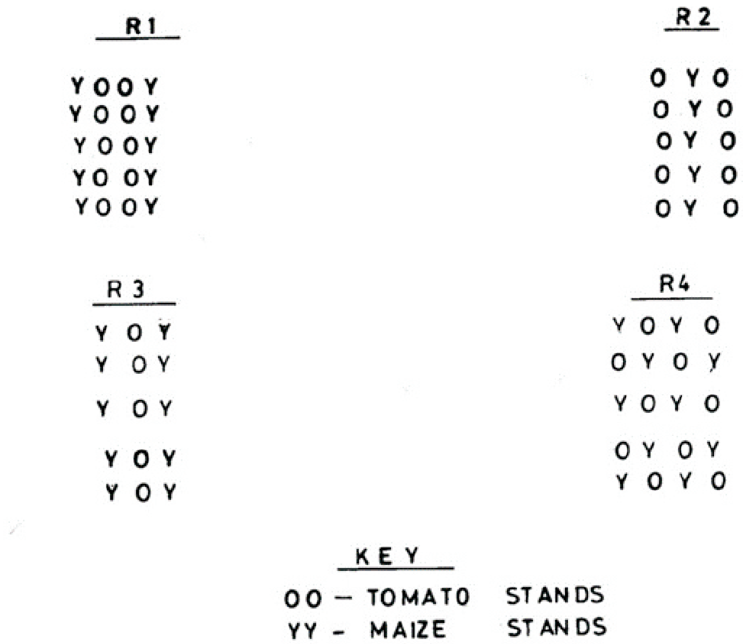

Figure 5. Spatial Relationship of Tomato and Maize in Intercrop during Hot Season
Source: Bodunde and Olarewaju, 1988

Results showed the inefficacy of this approach in combating heat stress in tomato as the vegetative growth, fruit set and yield of the sole tomato were better than found under mixture with maize for any of the spatial arrangements in both years of trial (Tables 2 and 3 and 4). The negative effect of the partial shade from maize stands on tomato fruit yield suggested that the tomato crop is very shade intolerant especially at the flowering and fruiting stages.

Table 2. Vegetative Parameters of Tomato Under a Tomato-Maize Mixture During Hot Season

	Plant height at maturity (cm)		Primary branches at maturity		Leaves 7 WAT*		
Shelter Regime	1985	1986	1985	1986	1985	1986	1985
Sole Tomato	73.7	59.4	9.3	7.6	77.1	44.0	1538.5
R1	66.7	53.0	6.9	5.2	67.0	33.6	1349.9
R2	65.2	56.8	8.1	4.6	58.8	35.8	1305.5
R3	62.4	57.2	7.0	5.7	58.0	29.6	1236.3
R4	59.4	33.0	6.8	4.9	44.1	28.1	243.4
LSD (0.05)	NS	NS	2.3	NS	13.3	8.5	57.3

*WAT = Weeks After Transplanting
NS = Not Significant
R1 - Two rows of tomato sandwiched by one row of maize on both sides
R2 – One row of maize between two rows of tomato
R3 – One row of tomato sandwiched by one row of maize on both sides
R4 – Alternating stands of tomato and maize on same row
Source: Bodunde and Olarewaju, 1988

Table 3. Fruit Set and Fruit Characters of Tomato Under a Tomato-Maize Mixture During Hot Seasons

	Fruit Set (%)		Fruit Diameter (cm)		Fruit Length (cm)	
Treatment	1985	1986	1985	1986	1985	1986
Sole Tomato	24.0	28.4	3.6	1.9	6.1	4.9
R1	21.0	26.3	2.6	1.7	5.3	4.7
R2	19.4	28.1	2.5	2.3	5.2	3.4
R3	18.4	26.5	2.7	2.1	5.2	4.7
R4	13.7	11.3	2.7	1.9	4.9	4.1
LSD (0.05)	3.9	10.1	NS	0.3	0.6	0.7

NS = Not Significant
R1 - Two rows of tomato sandwiched by one row of maize on both sides
R2 – One of maize between rows of tomato
R3 – One row of tomato sandwiched by one row of maize on both sides
R4 – Alternating stands of tomato and maize on same row
Source: Bodunde and Olarewaju, 1988

Table 4. Tomato yield (kg/ha) under varying spatial arrangements with maize during hot seasons of 1985 and 1986

Treatment	Fruit Yield (t/ha)	
	1985	**1986**
R1	9.9	14.1
R2	10.2	13.5
R3	9.9	13.5
R4	4.3	6.9
Sole Tomato	16.8	14.2

R1 - Two rows of tomato sandwiched by one row of maize on both sides
R2 – One row of maize between rows of tomato
R3 – One row of tomato sandwiched by one row of maize on both sides
R4 – Alternating stands of tomato and maize on same row
Source: Bodunde and Olarewaju, 1988

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5.2.3 Plant Arrangement in Irrigation Water Lines

In furtherance of efforts to explore cultural practices management in combating heat stress, tomato plant arrangement in different irrigation water lines in a way that foliage configuration could differ was examined by Bodunde, et al. (1991). The expectation was that different configurations would have varying effects on shoot and possibly root temperatures. Using two standard varieties of tomato (Ife 1 and Harvester), plants were arranged in single and double irrigation water lines as well as sunken beds during hot seasons of 1986 and 1987. Fruit set and retention, as determined by number of fruits per plant, as well as marketable fruit yield, were higher in plants arranged in double water line and sunken beds for both varieties in both years (Table 5). The practical implication of this finding is that hot season tomato cultivation under irrigation would be more productive with a double water line plant arrangement, that is, plants on both ebbs of the furrow or the use of sunken beds. Both arrangements ensure a canopy cover that could impact on both shoot and root temperatures, thus mitigating high temperature effect on stigma extrusion and fruit set.

Table 5. Number of Fruits per Plant and Marketable Fruit Yield ($t\ ha^{-1}$) of two Cultivars of Tomato During Hot Seasons at Kadawa Under Irrigation in Different Arrangements.

Cultivar	No. of fruits per plant						Marketable fruit yield ($t\ ha^{-1}$)					
	1986			1987			1986			1987		
	SWL	DWL	SB	SWL	DWL	SB	SWL	DWL	SB	SWL	DWL	SB
'Ife 1'	9.9	16.1	18.6	6.0	9.8	8.3	10.9	12.5	12.4	8.6	9.6	9.6
'Harvester'	11.6	16.2	16.5	6.0	14.8	11.7	6.9	10.2	11.6	5.4	10.7	9.9
Mean	10.8	16.2	17.6	6.0	12.3	10.0	8.9	11.4	12.0	7.0	10.2	9.8
LSD 0.05 (Arrangement)		3.05			2.61			2.83			2.40	
LSD 0.05 (Cultivar)		NS			NS			3.18			NS	

Legend:
SWL – Single irrigation water line. **SB-** Sunken bed.
DWL – D
Source: Bodunde, et al., 1991

5.2.4 Evaluation of Accessions Across Locations

To complement the cultural practices approach in variety evaluation under high temperature cultivation, a performance index efficacy for line rating was applied by Bodunde (2002) to screen tomato genotypes under high natural environments temperature across locations in the southern and northern savanna ecologies. This evaluation method was borne out of the identified shortcomings of the often used statistical test of significance, such that error of judgement in rating entries (genotypes) based on performance is minimized. This could enhance accuracy in selecting adapted ones among tested genotypes under environmental stresses such as high temperature.

Under this approach, the number of significantly inferior entry means is used to arrange all the entries in order of superiority. For an '*n'* number of genotypes evaluated in any particular trial, the maximum value '*m*' corresponding to the best entry would be n-1. The Performance Index 'P' is estimated as

$$P = \frac{100m}{n-1}$$

where;
P = Performance index value
m = number of significantly inferior means by LSD rating
n = total number of entries
(Fasoulas, 1983)

Decision making about which genotype to select is objectively based on P value by fixing a cut off for a desired value of P. Some of the entries cut off under this approach could be statistically superior to the check but not necessarily meeting the Performance Index set standard (Table 6).

Tomato lines introduced from the Asian Vegetable Research and Development Centre (AVRDC), Taiwan, were evaluated for heat tolerance in two high-temperature environments, Talata Mafara in Zamfara State and Azare in Bauchi State in three consecutive years, using this approach. Performance index across years was used in rating the entries in both locations.

The strength of this approach, relative to the conventional use of statistical significance, was evident in both locations where four out of the six genotypes were indeed statistically superior to the check but only two of the four passed the set standard of the Performance Index across locations.

Fixing acceptable P value at 50, two genotypes, TI 204 and TI 206 were found most adapted for cultivation in high-temperature environments with two other lines that were adjudged unsuitable even when they were statistically superior to the check, SAMTOM-7, a heat sensitive (intolerant) standard variety. The relatively high value of P (50) eliminates cultivars that might be unstable in time and space.

Vice Chancellor Sir, efforts directed at genotype evaluation for adaptation to high temperature growth and productivity resulted in the recommendation for the release of four heat-tolerant tomato varieties in 1993 by Bodunde *et al.* at the Institute for Agricultural Research, Samaru, Zaria, following a screening and evaluation that lasted seven years across northern Nigeria. These varieties, now domiciled in the National Institute for Horticultural Research (NIHORT), Ibadan are SAMTOM 13, SAMTOM 14, SAMTOM 15 and SAMTOM16

Table 6. Yield Rating of Tomato Genotypes in High Temperature Environments Using Performance Index Rating Method

	Azare		
	Three –Year Mean Fruit		
Genotype	Yield(t/ha)	M	Py
TI-204	13.0	6	100
TI-206	10.7	3	50
TI-207	10.0	2	33
TI-205	9.2	2	33
TI-203	8.8	1	17
TI-221	7.5	0	0
SAMTOM-7	6.1	0	0
LSD (0.05)		1.69	
	Talata–Mafara		
TI-206	9.4	5	83
TI-204	8.8	4	67
TI-205	8.5	3	50
TI-221	7.9	1	17
TI-207	7.6	1	17
TI-203	7.6	1	17
SAMTOM-7	6.4	0	0
LSD (0.05)	0.83		

Source: Bodunde, 2002

5.3 Genotype Evaluation for Low Moisture Tolerance

Based on the phenomenon of cross adaptation, which according to Arora (1998), is applicable to tomato, genotypes which included the heat-tolerant lines were evaluated for low soil moisture tolerance. This is because conditions of heat stress are often associated with low soil moisture regimes. Cross adaptation is usually indicated by the existence of linkages between abiotic stresses in crop plants. In this case, the possibility of heat-tolerant lines being tolerant of low root zone moisture content was investigated. Bodunde and Ogunwole (2000) examined genotypes response under low water potential, measured using yield reduction ratio as a Drought Susceptibility Index (DSI). It was estimated using the relationship described by Araghi and Assad (1998) as;

$$Y = 1 - Ys/Yn$$

Where: Y = Yield reduction ratio
Ys = Yield under low soil moisture
Yn = Yield under optimum soil moisture

The genotypes evaluated in this trial were strikingly different in performance under low soil moisture condition. The DSI values were relatively low for the indeterminate and semi-determinate types, indicating higher tolerance relative to the determinate lines (Table 7).

A tolerant genotype should necessarily have a low DSI value, which could sometimes tend towards zero for highly tolerant genotypes. All the indeterminate genotypes had DSI values less than 0.5 while the determinate types ranged between 0.6 and 0.7. When considered alongside the actual percentage fruit yield reduction, the indeterminate

types had a relatively low percentage yield reduction of between 40 and 47, the determinate ranged from 59.4 to 71.4 % yield reduction under low soil moisture regime. The superior performance of the indeterminate types is attributable to the expected prolific root growth and attendant superior water uptake at deeper soil layers.

5.4 Yield Determination in Tomato

A clear understanding of dry matter production and partitioning in the tomato plant was considered vital to the improvement of the crop for high yield in different environments on the premise that the ability of a plant to produce a high level of photosynthates and to allocate a high proportion of same to the organ(s) of economic importance, is a physiological index of high productivity. A study on dry matter partitioning as it relates to fruit yield in tomato in the two major production seasons, wet and dry seasons, was reported by Bodunde (2001).

Dry matter allocation, measured as proportion partitioned to plant morphological parts was similar in both seasons. Distribution pattern in the two seasons showed a higher efficacy of dry matter allocation in favour of the reproductive organs of flowers and fruits (Table 8).

Table 7. Yield Reduction Ratio and Yield Reduction in Determinate and Indeterminate Tomato Genotypes Grown under Low Soil Water Potential

Genotype	Growth Habit*	Drought Susceptibility Index (DSI)	% Yield Reduction
T1-420	I	0.419	40.0
T1-244	I	0.498	47.7
SAMTOM-16	SD	0.383	61.1
SAMTOM-7	D	0.712	71.4
T1-563	SD	0.538	54.8
T1-521	D	0.626	63.6
T1-581	D	0.638	64.8
T1-423	D	0.602	59.4
T1-579	SD	0.539	54.9
T1-570	I	0.417	41.6
T1-410	I	0.437	42.7
T1-468	I	0.427	47.2

***I-** Indeterminate

D- Determinate

SD- Semi-determinate

Source: Bodunde and Ogunwole, 2000

Table 8. Dry matter allocation among morphological parts of tomato plant during wet and dry seasons at Samaru, Nigeria

	Sampling Time (WAT)				
	DRY SEASON				
Plant part	4	5	6	7	8
Leaf	53.9	57.1	58.0	51.0	55.7
Stem	30.0	30.9	31.2	27.4	22.3
Root	16.2	11.0	9.1	12.1	9.2
Flower/Fruit	0	2.1	2.2	11.0	12.8
			WET SEASON		
Leaf	60.7	61.5	54.0	47.0	45.6
Stem	23.1	23.1	22.1	22.1	23.4
Root	14.2	12.2	18.0	12.2	10.2
Flower/Fruit	1.0	4.3	5.9	18.8	20.9

Source: Bodunde, 2001

The wet season crop had relatively high total dry matter yield and the observed differences at any phase of the crop growth was statistically significant (Table 8). In explaining why crop dry matter production could significantly vary with season, Snyder and Carlson (1984) had opined that soil water and mineral levels, light and temperature are environmental factors that could influence dry matter production. In an earlier report by Rudich et al (1981), it was observed that plant water deficit would directly reduce plant biological yield. Wet and dry season conditions have direct implications on all these factors. Relative humidity (RH) often distinctly differs between seasons and low RH condition would result in inefficient and slow dry matter accumulation rate (Adams and Holder, 1992).

The amount of dry matter in the leaves at any sampling time was higher than 50% of total dry matter (TDM).

The onset of fruiting marked the beginning of a progressive decrease in dry matter allocated to the root in both seasons, following the principles of source-sink relationship. The observation corroborates the description of the tomato plant root as a very weak metabolic sink such that net root growth may even cease at the peak of fruiting (Hurd and Price, 1977).
In that same study, negative correlations were established between fruit yield and amount of dry matter in each of leaf, stem and root (Table 9). This implies that dry matter partitioning to these morphological organs is largely at the expense of fruit yield. However, relating economic yield to dry matter distribution in the tomato plant is difficult, considering the amount of water in the proximate constituent of the fresh fruit.

Table 9. Correlation Coefficient (r) for Fruit yield (kg/plant) and Plant Morphological Parts Dry Matter during the Dry and Wet season

	Leaf	Stem	Root	Flower/ Fruit	Fruit yield
DRY SEASON					
Leaf	-				
Stem	-0.691	-			
Root	-0.665	0.454	-		
Flower/fruit	0.001	-0.205	-0.521	-	
Fruit yield	-0.317	-0.499	-0.021	0.088	-
WET SEASON					
	Leaf	Stem	Root	Flower / Fruit	Fruit yield
Leaf	-				
Stem	-0.305	-			
Root	-0.557	-0.117	-		
Flower/fruit	-0.401	-0.176	-0.111	-	
Fruit	-0.159	-0.166	-0.033	0.085	-

Source: Bodunde, 2001

In another study, Bodunde (2001) reported the controlling influence of agronomic and some related parameters on fruit yield of tomato. Parameters perceived as probably having influence on fruit yield include number of leaves at first flowering, plant height and days to maturity. A good knowledge of the relationship between these traits and fruit yield is a desirable prerequisite for a crop improvement programme aimed at high yield in tomato. Though an association type, as may be given by correlation coefficient value, would reveal mutual relationship between traits, it does not give a clue on the magnitude of contribution of the independent to the dependent trait. Uguru (1996) was explicit in stating that correlation between traits would bring out the direction of inter-relationship of characters, it may not indicate the often-existing sources of indirect relationships all of which concertedly determine yield. Characters that have direct and indirect contributions to fruit yield were examined in standard tomato varieties SAMTOM-4 and SAMTOM-7. The number of leaves at the onset of flowering, as well as fruit diameter, manifested a positive and significant correlation with fruit yield while plant height at first harvest had positive but non-significant correlation with fruit yield (Table 10)

Table 10. Correlation Coefficients of Some Agronomic Characters and Fruit Yield in Tomato

	Leaves at First Flowering	Plant Height	Fruit Length	Fruit Diameter	Days to First Harvest
Fruit Yield	0.7106*	0.5684	0.4002	0.6321*	0.1392
Leaves at first Flowering		0.6090*	0.3531	0.6889	0.2304
Plant Height			0.4272	0.5550	-0.1433
Fruit Length				0.6443*	-0.1591
Fruit Diameter					-0.1764

Source: Bodunde, 2001

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The association type between leaves at onset of flowering and fruit yield is indicative of a required minimum level of vegetative growth before flowering as a necessary prerequisite for high fruit yield in tomato. This is in line with the principle of growth correlation for phenological development in plants.

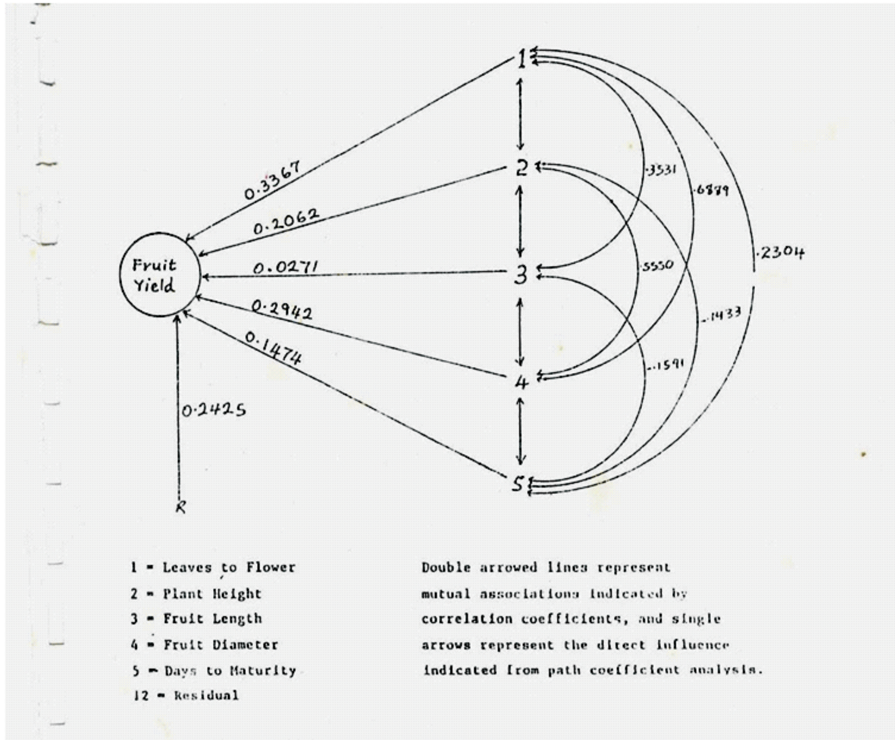

Fig 6. Inter-relationship between yield and potential yield determinants in tomato
Source: Bodunde, 2002

Partitioning of the correlation into direct and indirect contributors further confirmed that fruit yield in tomato is directly and largely influenced by number of leaves at first flowering, accounting for 33.7 % of direct contribution. The closest contributor to what is recorded as yield is the individual fruit diameter, a trait that showed 29.4 % contribution (Fig. 6)

The three obvious yield determinants, which are leaves before flowering, plant height at maturity and fruit diameter, are regarded as key traits in tomato crop improvement, to the extent that if used as selection indices, they should be concertedly considered. The overall residual effect of 24.3 % in this study gives indication that the traits examined are largely of relevance to determining yield as they all account for over 75% of contributors to yield determination in tomato.

Mr. Vice Chancellor Sir, there were relative rigours involved in the dispensation of agricultural research in Nigeria in years past, in terms of the absence of facilities for precise estimation of parameters especially for vegetable crops. One major limitation in the growth studies on tomato was the unavailability of appropriate instrument for its leaf area measurement. This was complicated by the morphology of its compound leaf, giving it an irregular shape unlike the simple and regularly shaped leaves of many arable crops, where alternative non-automated means of leaf area estimation were possible. Thus, Bodunde and Olarewaju (2003) reported an evaluation of the accuracy of the adoption of the fundamentals of leaf rectangular area (LRA) method on the irregularly shaped leaf of tomato. The aim was to establish the precision level and

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judge whether or not the method could be used in lieu of the instrument-dependent estimation methods, where appropriate facilities are limiting as speculated by Son and Cholakov (2002).

Actual and rectangular leaf area, of an initial leaf sample, were determined and the leaves were oven-dried. A proportion between area and weight was established using the modified form of Nwachukwu and Ene (1987) method. As a result of the irregular shape of the tomato leaf, rather than use the broadest leaf width as Nwachukwu and Ene did, the mean of top, middle and bottom widths was used to avoid having an exaggerated breadth. The LRA value was regressed over actual leaf area, based on significant linear relationship, a regression equation was evolved to describe the relationship between LRA and Actual Leaf Area. Based on information that an appreciable variation exists in the morphology and physiology of the tomato plant at different growth stages, fit equations were written for two distinct growth stages of tomato, at 4 Weeks After Transplanting (WAT) which marks the beginning of active vegetative growth and at 8 WAT, the stage at which vegetative growth begins to subside. Derived fit equations were;

For 4 WAT: $Y = 14.46 + 0.79X$
For 8 WAT: $Y = 1.47 + 1.09X$
Y represents Leaf Area at a given value of LRA which is X
The coefficient of determination for linear regression (r2) value was high for both phenological growth phases, indicative of a significant linear

relationship between actual and rectangular area and the reliability of the use of LRA. These fit equations have been extensively used by researchers on tomato to surmount the inadequacy of instrumentation that still pervades our research environment.

5.5 Production season as a dominant factor

The concept of 'cropping season' derives directly from the controlling effect of prevailing weather factors on crop growth and development. Though the cultivated tomato can grow under a wide range of environment, aspects of its optimal development requires a somewhat narrow range of temperature, soil moisture, relative humidity and light irradiance requirements.

5.5.1 Cropping Season as a Determinant of Yield

Three varieties of tomato, differing in growth habits, were evaluated for growth and yield performance in the wet and dry seasons by Bodunde (2003). The varieties were SAMTOM-4 which is a determinate, processing type tomato, SAMTOM-7, a semi-determinate high-yielding cultivar and SAMTOM-10, an indeterminate fresh market type. The magnitude of the differences in the responses of varieties under two diverse weather variables; the cool wet (rainy) season and the dry (hot) season was examined.

The number of fruits as well as marketable fruit yield (weight) per plant were higher in both genotypes and for both years in the wet season crop

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(Table 11). Consideration of the fruit diameter and length as yield determinants showed that the diameter is a more relevant yield determinant than the length. The fruit diameter was higher for both genotypes in the wet season of both years in line with the higher yield observed in that season (Table 12).

Result of this work showed that the ideal production environment for tomato is one devoid of an atmospheric humidity high enough for the growth of pathogenic organisms especially fungi. It also requires an environment cool enough in favour of the physiological processes involved in flower development into fruits as well as a growth medium moisture enough to sustain metabolism. Where there are irrigation facilities, these conditions are best met during the early dry season.

Table 11. Cropping season effect on mean number of fruits and marketable fruit yield per plant

	Number of fruits per plant				Marketable fruit yield (Kg/Plant)			
	Wet Season		Dry Season		Wet Season		Dry Season	
	1997	1998	1997	1998	1997	1998	1997	1998
SAMTOM-4	27.8	32.7	12.7	17.9	0.77	0.82	0.36	0.45
SAMTOM-10	19.4	29.4	7.7	9.1	0.56	0.71	0.27	0.33
SAMTOM-7	19.3	31.1	11.0	8.9	0.64	0.94	0.48	0.27
LSD 0.05 (Season,1997)		10.01					0.32	
LSD 0.05 (season, 1998)		13.03					0.39	

Source: Bodunde, 2003.

Table 12. Cropping season effect on fruit Diameter and Fruit length

	Fruit diameter (cm)				Fruit length (cm)			
	Wet season		Dry season		Wet season		Dry season	
Cultivar	1997	1998	1997	1998	1997	1998	1997	1998
SAMTOM-4	3.1	2.8	2.3	2.1	5.4	5.1	5.4	4.7
SAMTOM-10	3.5	3.3	3.4	3.1	3.9	3.0	3.4	3.3
SAMTOM-7	2.9	2.5	2.4	2.2	5.7	5.8	5.6	5.5
LSD, 0.05 (Both years)			Ns				Ns	

Source: Bodunde, 2003

5.5.2 Fruit Setting Rate Response to Production Season

Fruit setting rate measures the proportion of the total number of flowers that eventually translates to fruit formation. It is an indication of how favourable the environmental factors are for pollination, fertilization, fruit formation and development. In both years of trial by Bodunde (2003), conditions of the wet season were found more favourable for high fruit set (Table 13).

In an investigation of cropping season and cultivar effects on tomato yield and fruit characteristics, Bodunde (2003) observed that cropping season had an overriding influence on number of fruits per plant and the individual fruit diameter while cultivar determined only the fruit

diameter. Both the number of fruits and fruit diameter are essential yield (Table 14). determinants of tomato. Season of cultivation is therefore a major determinant of yield in tomato cultivation.

Table 13. Fruit setting rate (%) under both cropping season

	1997		1998	
Cultivar	Wet season	Dry season	Wet season	Dry season
SAMTOM-4	53.9	24.2	55.0	33.1
SAMTOM-10	25.1	17.4	42.2	12.4
SAMTOM-7	26.0	27.3	34.9	12.3

Source: Bodunde, 2003

Table 14 . Cropping Season and Cultivar Influence on Fruit Characteristics and Fruit Yield of Tomato

Source of variation	Number of fruits (per plant)	Fruit diameter (cm)	Fruit length (cm)	Fruit yield (kg/plant)
1997				
Season	607.15**	0.94**	0.13	0.40*
Cultivar	73.74	1.16*	6.84**	0.04
Season X Cultivar	18.84	0.07	0.10	0.03
1998				
Season	786.05**	0.48	0.11	0.55*
Cultivar	67.77	0.92*	8.11**	0.24
Season X Cultivar	14.04	0.15	0.09	0.17

*Significant at P=0.05 **Significant at P=0.01
Source: Bodunde, 2003

5.6 Postharvest management of Tomato Fruits

Vice Chancellor sir, even as we contend with the enormous production constraints of tomato, a great threat to our limited production and poor productivity is the loss observed in the postharvest handling chain which is reliably put as close to 50 % of total fruits produced. Major links in this chain, at which points losses are incurred are, the farmers' level, transit, storage and marketing. Focus in this direction has been on extending the shelf life of harvested fruits through pre-storage handling practices and storage medium modification.

5.6.1 Consideration of Harvest Maturity Index

A major pre-storage consideration is the magnitude of maturity at harvest, aptly described as harvest maturity index. Three distinct harvest maturity indices are often employed in decision making related to timing of fruit harvest, usually dependent on expediency of expected time of utilization. The three harvest indices are sequential progressions of the physiological maturity stages.

The first index, defined as Breaker stage is the earliest visible sign of readiness to harvest. It is the initiation of ripening, manifesting as beginning of colour change from green, usually shown on the fruit shoulder, that is, the closest to the point of attachment to the fruit stalk. The second stage, known as 'turning' is an advancement of ripening, whereby 10 – 25% of the fruit surface, from the shoulder have changed colour from green to pink/yellow. The third phase is a somewhat very

advanced level of ripening, with more than 30% of the fruit surface changing colour to pink/light red/full red (Plate 6).

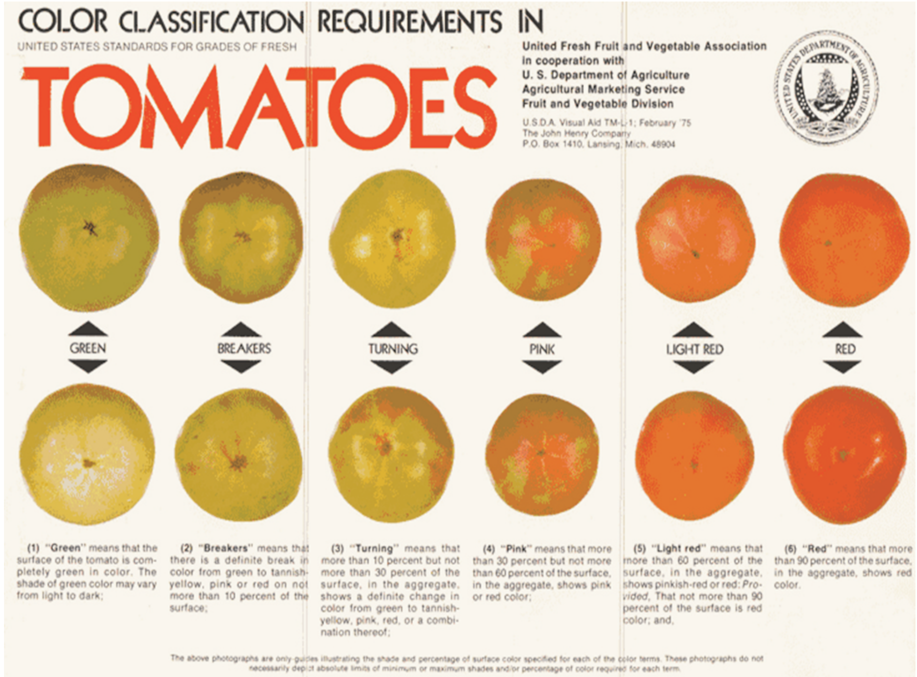

Plate 6: USDA Tomato Colour Chart

Source: (2014)://postharvest.ucdais.edu

5.6.1.1 Pre and Post-storage quality of tomato fruits harvested under three maturity indices

Three recognized harvesting stages were explored in evaluating tomato fruits for post harvest shelf life in open shelf storage and under treatments aimed at ameliorating the action of ethylene (the hormonal gas that enhances fruit ripening rate) as well as biochemical and nutritive properties. Both the pre and post-storage quality attributes of fruits harvested at the three maturity indices did not differ in terms of lycopene content, Vitamin C and Total Soluble Solid (TSS) at full fruit maturity (Table 15). A preferred harvest index would therefore not significantly determine the critical nutritive quality indices of tomato fruits at the point of utilization.

5.6.1.2 Harvest Maturity Index and Days to Spoilage

Both the appearance of spoilage signs and the eventual total spoilage were influenced by the maturity stage at harvest. Fruits harvested at full ripe stage manifested storage signs at about seven days earlier than those harvested at either breaker or turning stages and the trend was similar for the attainment of full spoilage (Table 16).

Table 15. Pre and Post-storage quality of tomato fruits harvested at three maturity indices

	Lycopene (µg/100g)			Vitamin C (mg/100g)			TSS		
	Pre storage	Post storage	Open shelf	Pre storage	Post storage	Open shelf	Pre storage	Post Storage	Open shelf
Breaker Stage	3133.8	2841.3	2275	6.735	7.1	7.1	5.2	5.5	5.3
Turning Stage	2300.8	1008.3	2429	6.705	7.2	6.9	5.5	5.6	5.5
Full ripe Stage	2423.8	2912.4	2253	6.55	7.1	7.0	5.5	5.4	5.7
LSD (0.05) *	Ns	Ns	Ns	Ns	Ns	ns	Ns	Ns	ns

***ns – not significant**
Source: Ogunleye, 2016

Table 16. Days to Spoilage as a Measure of Shelf Life of Tomato Fruits as Influenced by Harvest Maturity Index

	Days to Spoilage		
Maturity Index	**1st**	**50%**	**100 %**
Breaker	20.76	30.69	37.31
Turning	20.53	28.64	34.93
Full Ripe	14.44	23.33	31.69
LSD(0.05)	3.02	2.16	1.72

Source: Ogunleye, 2016

5.6.2 Ethylene Remediation

Ethylene is an un-saturated hydrocarbon, a 2-carbon volatile alkene. Ethylene gas in fruit ripening medium is auto-catalytic, a little amount of it produced by a ripening fruit would trigger the production of more.

5.6.2.1 Use of Remediation Substances and Tomato Fruit Shelf-life

The remediation treatments explored by Ogunleye et al. (2016) were the use of substances that would either absorb or adsorb emitted ethylene or inhibit its synthesis in stored fruit. Substances used in storage media for this purpose were KMnO4 solution in two concentrations of 5% and 10 % as well as Zeolite and Silical gel.

Results of these trials showed that tomato stored in medium laden with KMnO4 at 5% concentration or medium with Zeolite, sustained marketable quality of stored tomato fruits for 42 days before total spoilage as against 10 days for the untreated, that is, fruits stored in open shelf (Table 17). The merit of this result lies in the fact that these remediation substances do not necessarily have physical contact with the tomato fruits as their action is on the ethylene production by stored fruits. Fruits harvested at breaker had longer shelf-life compared to harvesting at the usual full ripe stage.

Table 17. Days to Spoilage as a Measure of Shelf Life of tomato Fruits Under Ethylene Remediation Treatments

	Days to Spoilage		
Ethylene absorber *	**1st**	**50%**	**100%**
5 % concentration	23.07	34.33	42.15
10 % concentration	21.15	31.81	39.96
$KMNO_4$			
Silical gel	19.85	28.93	38.30
Zeolite	23.00	34.96	42.33
Open Shelf	5.30	7.74	10.48
LSD (0.05)	3.90	2.79	2.22

Source: Ogunleye, 2016

5.6.3 Produce Conversion as Solution in Postharvest Handling

Produce conversion changes the state of the produce, especially from its normal living state to a processed state incapable of the metabolic activities associated with the produce primary state. This new form of the produce disposes it to manageable packaging forms with less cumbersome handling. It is an effective means of glut management in produce handling.

5.6.3.1. Effect of Crop Variety on Some Paste Attributes of Tomato

Although a large number of varieties would normally be required in screening for suitability for processing into paste, two varieties, one determinate and the other indeterminate, were assessed for paste quality. The determinate variety (Roma vf) was found to be superior to the indeterminate variety (Beske) in paste quality only in terms of TSS as pH, Vitamin C and viscosity were similar (Table 18).

Table 18. Effect of Crop Variety on Some Paste Attributes of Tomato

Variety	TSS (%)	pH (mg/100mol)	Vitamin C	Viscosity (cP)	Colour L*
Beske	3.63	4.77	154.26	2876.63	50.24
Roman Vf	4.76	4.85	153.58	2737.27	50.00
LSD(0.05)	0.89	0.88	0.87	31.54	0.64

L* - the higher the L value, the lighter the colour
Source: Shobo et al., 2017

5.6.3.2 Influence of Production Season on Some Paste Quality Traits of Tomato Fruits

The interplay of factors of the environment could influence fruit proximate content as well as the paste derived from such fruits. Therefore, paste from fruits produced in the two major production seasons, wet and dry cropping seasons were assessed for quality. Paste derived from fruits harvested in the late season was observed to be high in pH, titrable acidity and vitamin C. Paste derived in the late season were observed to be high in TSS and low in moisture content (Table 18).

5.6.3.3. Crop Nutrition and Paste Quality

Taking cognizance of the expected effect of crop nutrition on proximate and biochemical integrity of the tomato fruit, it was perceived that the resulting paste from the fruit may equally be influenced by nutrition level. Paste derived from fruits harvested from plants grown with NPK fertilizer and poultry manure were compared with those derived from plants without fertilizer application. All the paste quality attributes, except moisture content, were similar across the nutrition amendment types (Table 19). Future work in this respect would address varying rates of both the organic and inorganic fertilizer sources.

Table 19: Tomato Paste Quality Response to Source of Crop Nutrition

Fertilizer Type	MC (%)	TSS (%)	pH	Vitamin C (mg/100ml)	Viscosity (cP)	Colour L*
Poultry Manure	82.67	3.74	4.52	151.07	2845.4	46.47
NPK	95.98	3.76	4.52	151.5	2733.8	47.26
Control	82.94	3.90	4.82	151.43	2646.8	44.43
LSD (0.05)	11.3	NS	NS	NS	NS	NS

L* - the higher the L value, the lighter the colour
Source: Shobo et al., 2017

6.0 CONCLUSION

Tomato remains an essential commodity of trade and domestic requirement in Nigeria as it is in most parts of the world. A high proportion of my academic research attention was devoted to tomato as a crop and as a commodity produce. It however, appears as a case of the more you address the problems associated with tomato production, the more problems you discover waiting for attention. I see this scenario as the life of a research scientist anyway.

My research efforts that span over three decades on tomato have convincingly yielded some fruits by way of a increasing the comprehension of tomato growth environment, understanding the crop growth dynamics and its relationship with productivity, as well as creating an in-road into solving the notorious challenge of spoilage vulnerability of the produce. I am particularly pleased that many of my postgraduate trainees were successfully inducted into adopting tomato as a crop of research interest, an assurance that after me, research in my focus of interest will continue.

Vice Chancellor Sir, that this lecture was dedicated to tomato research does not imply that my research did not touch other horticultural commodities. I actually digressed into research on other high-value horticultural crops like plantain, onions, garden eggs and roselle, especially in the postharvest handling.
My academic sojourn has clocked 35 years, like the fulfilled earthly

ministry of our Lord Jesus Christ which was just 33 years, in my 35byears of academic ministry, I believe I am, to the best of my ability, been fulfilled in research, teaching and community development. The students I trained over the years shall eternally remain my strongest legacy. Each student that passed through me at any level found a father and a friend in me, found my office room as a study and the facilities in my office as a common wealth. The greatest failure in this vocation of ours is leaving a vacuum when exiting the system, Vice Chancellor Sir, If I leave this system today I am confident that no vacuum is left in terms of who continues wherever I stop, because I have graduated students in their numbers across all strata of degrees from Bachelors to Doctor of Philosophy (PhD). To God alone be the glory.

6.0 RECOMMENDATIONS

Vice Chancellor, Sir, it is a routine that is religiously observed to have recommendations emanating from inaugural lectures in academia, one often wonders, however, if anybody adopts these recommendations for the expected purpose. Notwithstanding, I wish to add a few to the earlier recommendations waiting for attention.

1. The Federal University of Agriculture, Abeokuta, endowed with huge human and material potentials, can and should promote interest in research along the tomato value chain, through IFSERAR. This can make a difference in tomato availability in south western Nigeria.
2. Universities and Research Institutes should encourage researchers' adoption of crop commodities for crop-based research to reap the benefit of comparative advantage of in-depth knowledge of individual crops towards improving research and adding value to research results.
3. Nigeria has a diverse ecology that guarantees a national self-sufficiency in virtually all important food and industrial crops. However, we still love to import what indeed we have resources to be exporters of, tomato inclusive. I make a clarion call to government to enforce more, the ban clauses on various agricultural products particularly tomato paste.
4. Investment in tomato canning industry by the private sector and government in Nigeria is strongly advocated. This should be in terms of enhanced production of appropriate varieties and installation of processing machines, both of which would go a

long way in changing the status of Nigeria in the tomato production scale, as well as impact on the state of postharvest loss resulting from glut in seasons of tomato production.

5. There currently exists in Nigeria, a very poor state of research-industry linkage. This has its implication on the non-flourishing state of the tomato processing factories in Nigeria. Government should firm-up policy on industry and research linkage such that most conducted research would be demand-driven.
6. Research funding remains a huge limitation to agricultural development in Nigeria. I call on relevant arms of government to treat agricultural research funding as a concurrent responsibility for Federal, State and even Local Government tiers.
7. Government should consider a complementary and functional means of funding agricultural research in Nigeria through an arrangement similar to how education funding is complemented/subsidized by the Tertiary Education Trust Fund (TETFUND). This can improve the interest of stakeholders contributing to the fund in research because where your treasure is, there your mind shall be. Such stakeholders should include industries who are the potential beneficiaries of research results while the levy implementation should follow the TETFUND model.

7.0 ACKNOWLEDGEMENTS

Vice Chancellor sir, Goke Bodunde is a product of an extremely humble background, a case of the proverbial growing from grass to grace. I, therefore, want to amplify my gratitude to God Almighty, the only Maker that makes and it remains made. He saw me through a path of providence. May His name remain exalted forever (Amen).

I came for the interview for appointment in the then UNAAB on December 23, 1998. The interview panel was under the chairmanship of the then Vice Chancellor, Prof. Julius A. Okojie. Two of us, classmates and friends, were interviewed for the single vacancy advertised for the Department of Horticulture. We invariably knew that only one of us would succeed in terms of choice for appointment even if both of us were found appointable but to our surprise, both were appointed. It was much later we were privileged to know that Prof. Okojie was impressed much by the performances of the two of us, such that he, as the Vice Chancellor caused another vacancy to be created at the then Research and Development Center (RESDEC), so that both of us could come to UNAAB. He was quoted as saying that he couldn’t afford to let any of us go. I am, therefore, deeply grateful to him because his action gave the opportunity for those two classmates to be Professors of FUNAAB today.

I worked with virtually all subsequent Vice Chancellors after Prof Okojie. Prof Israel Folorunso Adu, a good brother indeed. I was the Chairman of the Teaching Farms Management Committee (TEFAMAC)

under him. He wouldn't let me proceed on sabbatical leave in 2005 on account of this. My experience in the administration of the Farm Practical Year during this assignment remains rewarding. I thank Prof Adu for his friendly disposition while this assignment lasted.

Prof Adamson, as Acting Vice Chancellor, met me on the TEFAMAC assignment, he was a good boss in facilitating my duties, he actually approved my sabbatical leave in early 2007 and granted me the privilege of deferring my appointment as Head of Department to after my return from sabbatical leave.

On returning from sabbatical leave in 2008, Prof. Olaiya Balogun was on ground as Vice Chancellor. He inherited the processing of my 2007 Professorial promotion. He saw it through only by God's grace. I also worked with him as Dean of the College of Plant Science and Crop Production. God again saw us through our working relationship. I thank him for tolerating me as one of his Deans.

I am grateful to Prof. Olusola Oyewole, he inherited me as Dean in May 2012. His tenure brought me close to University Management as I became the Chairman of the Committee of Deans and Directors under his regime. We were cordial and his margin of respect for me as his subject was wide. He also expressly approved my request for a sabbatical leave in 2017. I am indeed grateful to him.

I was away in 2017 when my brother, Prof Ololade Enikuomehin became the Acting Vice Chancellor, I, however, returned from sabbatical leave during his brief stay and he welcomed me back to the system. May God bless him.

Our current Vice Chancellor, Prof. Felix Kolawole Salako, as much my friend as my Vice Chancellor, I want to thank you, sir, as you agree with fate that I have this lecture under your regime. Your tenure shall be peaceful and FUNAAB shall ascend to greater heights in your time.

In the making of an academic, after God is the teacher. I remember with gratitude all my teachers particularly those who had practical input in my academic sojourn. My Agriculture teacher in the secondary school, Mr. Ajiboye (a.k.a. Baba Chemical) ignited my early interest in agriculture. My English teacher, Mr Ogundiran, of blessed memory made that subject, English, my second love, after agriculture. I acknowledge Prof. Nimbe Adedipe whose confidence and stylish teaching of Crop Physiology in my undergraduate days sharpened my interest in that specialization such that when the opportunity for postgraduate study came, I did not hesitate on having my Masters and PhD in Crop Physiology. The father of horticulture in Nigeria, Prof. M.O. Fawusi of blessed memory, made me a horticulturist. He brought that study option to the Department of Agronomy, University of Ibadan at a point my set was to pick option between Soil Science and Crop Science. It looked strange to all of us, being the first time of hearing of such in any university in Nigeria. However, with the brief from Prof Fawusi, seven of us veered into this seemingly unknown world. Three of those seven are Professors of Horticulture today, with two of the three in the Federal University of Agriculture, Abeokuta. I owe a depth of gratitude to my postgraduate supervisor, Prof Duro Olarewaju, now retired but still agile. He was also my boss during my career at the Horticultural Crops Research Programme of the Institute of Agricultural Research, Samara. If you fault my style of smooth and free relationship with my students today, that is the man to blame. As his student, we would take tea together in his office without an obvious line drawn between supervisor and me, the student. I remember my other teachers at Ahmadu Bello University, Zaria; the late Professor Ilesanmi Dele Erinle, a Plant pathologist of note, he taught me to be in love with research field, late Professor Chris Nwasike, a renowned Plant Breeder, young at heart and always carrying us along as young academics then.

The list of my academic colleagues could be endless; Profs Dayo Philip, F.O. Olasantan, Ore Aiyelaagbe, Kehinde Elemo, J.K. Adewumi, Akin Omotayo, Candidus Echekwu, Ololade Enikuomehin, Kehinde Okeleye, D.K. Ojo, Femi Onifade and W.O. Alegbeleye. These and a host of many others not listed, are appreciated for sustaining friendship and academic development. I specially appreciate Profs. Segun Lagoke, Segun Osinowo and Bola Okuneye for being there in different ways. I thank Prof. T.A.O. Ladeinde, the Dean of COLPLANT on my assumption of duty in the University, God knows how he identified me as a suitable choice as his Deputy Dean just a few months of my stay in the college. I

have a glowing gratitude for Prof. M. T. Adetunji, my humble brother with whom I closely worked as his Deputy Dean. He was God sent at a point in my career.

I thank my current Dean, Prof O.M. Atayese and all staff of COLPLANT, my Head of Department, Dr. Wale Salau and other members of the Horticulture family; Professor E.A. Makinde, Dr. O. Okelana, Dr O. Olubode, Dr. L.A Hammed, Dr Tunde Olosunde, Mrs Tunrayo Adekunle-Joseph and Dr. Olubukola Odeyemi. You are all wonderful people to share a space with.

I acknowledge all the non-teaching staff who supported me in my various appointments in the university; Dr Kazeem Bello, Julius and Paul at TEFAMAC, Mrs Lolade Adeyoola in the Department of Horticulture, Mrs Toyin Dawodu, Mr.K.A. Adenekan, Mrs. Oluwakemi Banuso, Mrs Emi Alawode, Mr. Ojoye, Mrs Tope Oyerinde and Mrs Funke Makanjuola, all of who were, at different times, my College Officer as Dean. Secretaries that worked with me and contributed to my success as Dean include; Mrs. Toyin Akinsanya, Mrs Yemisi Olaniyi, and Mrs Adebola Aina. I thank all of you.

To my former and present students, you remain the greatest of my achievements and academic assets. Many of you, now PhD holders have literarily become my colleagues. You are not just a good complement to me but equally potential replacements for us when we eventually step aside in this academic calling. I thank God for using me to positively touch your lives. Where I stopped, God will start in elevating you more. You remain my pride.

Members of my Catholic faith, particularly the St. Rita family, I appreciate your spiritual support, standing in gap as necessary in forging ahead. God bless all our spiritual leaders at different times, Rev. Fathers Patrick Feyisetan, Yemi Sobiye, Simon Akinyemi, Mark Omene, Patrick Oke, Joseph Ochigbo and Gregory Fadele. I pray for the repose of the soul of Monsignor Christopher Ajala, he passed on in the course of preparing this script.

The Notre Dame Alumni members with special reference to the Class of '73, I appreciate you as my friends of old, still standing. We nurtured our various career plans together and I thank God for still keeping us together.

A profound appreciation to the Bodunde dynasty. My late father, Chief Thomas Bodunde did not have the privilege of western education but he was thoroughly educated in native intelligence. When I had my School Certificate Examination result in 1973, he asked me how the result was and I said it was good. Not satisfied with a summarized answer, he asked again if it qualifies me for admission into the university and I said, yes sir. He responded, 'then it is good' and congratulated me. He was called to the great beyond a year later even before I could gain admission to a

higher institution. May his soul continue to rest in peace. My mother, Mama Victoria Ominike Bodunde, also of blessed memory, a caring mother, sacrificial in loving. She witnessed all my academic progression until she was called to join the saints triumphant in 2013. I am grateful to both of them for giving their all in parental care for me and my siblings. I thank the current head of our family, Chief William Bodunde, a lover of progress, full of filial love. Similar gratitude to my senior brother, Mr Adesayo Bodunde and wife Mrs Folake Bodunde, my early grasp of social life came through him, I owe a load of gratitude for his support.

When I had admission to the University of Ibadan in 1976, I felt I should abandon the offer on account of the earlier loss of my father who had been my source of finance. One voice changed my hopelessness, it was the voice of my senior sister, Chief (Mrs) Elizabeth Yinka Afe. On telling her that I was offered admission but with the look of things in the family, it was not feasible to accept the admission because of the obvious financial limitation, she retorted 'it shall be feasible, you will go'. That was the height of my excitement as a young boy now sure of going to the university. She sacrificed all throughout my undergraduate study and she remains a caring mother to date. I am eternally grateful to this woman with a man's spirit and strength. My other siblings are full of love for me; Aunty Rachael Tala Akinyemi, Aunty Lucy, Simon, Mary, late Bola Oluboba, Pastor (Mrs) Tayo Jegede, Lanre Bodunde, Segun Babs, Pastor Tunde Afe, Dr. Femi Afe and all my nephews and nieces, I love you all. My in-laws from both the Oluboyede and Omoyajowo families have been wonderful. My father-in-law, late Pa S.K. Oluboyede, of blessed memory, a wonderful father-in-law indeed. I am lucky to still have my mother-in-law, Mama Victoria Oluboyede, the only parent I now claim, she is old but not ageing. God will continue to strengthen her. Mr and Mrs Emmanuel Omoyajowo have simply enlarged my family size. My other brothers and sisters in-law, your love is always an assurance and I appreciate you all.

Finally, Mr. Vice Chancellor, sometimes in 1981, a few months to my final examination at the University of Ibadan, providence brought me in contact with a young, beautiful and charming lady. We got talking and I realized she was visiting from the Adeyemi College of Education, Ondo, where she was also a final year student. We struck a deal and both proceeded on NYSC during which the deal matured. God eventually stamped it that we became husband and wife on April 6, 1985. I am publicly acknowledging my God-given Damsel, Helen Aduke Bodunde (nee Oluboyede), the greatest asset of my life. Sometimes soon by God's grace our sitting position shall be reversed in this same hall. God bless you.

The Lord has been gracious in blessing our union with adequate fruit of Matrimony, I thank God for Tolulope, an Electrical Engineer, still on the ladder of higher heights in academic pursuit, Tunde and Oluwatomilola Omoyajowo, and Temiloluwa, the baby of the home. God assisted us in giving all of you quality education beyond the basics and I pray that He

will build upon the foundation that you all have. Wonderful children that you are. My little Oluwatemisire remains a source of joy, reminding me of the toddler years of Oluwatomilola. God bless you all.

Mr. Vice Chancellor, sir, my story has been thus thoroughly summarized, kindly permit that we end in praise of the Alpha and Omega.

Immortal, Invisible God

1. Immortal, invisible, God only wise,
In light inaccessible hid from our eyes,
Most blessed, most glorious, the Ancient of Days,
Almighty, victorious, Thy great name we praise.

2. To all life Thou givest, to both great and small;
In all life Thou livest, the true life of all;

3. We blossom and flourish as leaves on the tree,
And wither and perish, but nought changeth Thee

4. Great Father of Glory, pure Father of Light
Thine angels adore Thee, all veiling their sight;
All praise we would render, O help us to see:
This only the splendor of light hideth Thee.
Amen

I thank the entire audience for listening, God bless.

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