UNIVERSITY OF ILORIN

THE ONE HUNDRED AND SEVENTIETH (170th) INAUGURAL LECTURE

"ASSURING FOOD SECURITY: THE ROLE OF THE CROP PROTECTIONIST"

By

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THURSDAY, 15th JUNE, 2017

This 170th Inaugural Lecture was delivered under the Chairmanship of:

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15th June, 2017

ISBN: 978-978-53222-7-9

Published by:
The Library and Publications Committee,
University of Ilorin, Ilorin, Nigeria.

Printed by:
Unilorin Press, Ilorin, Nigeria.

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Distinguished Ladies and Gentlemen.

Behold!

Plate 1: A collection of disease symptoms and insect pest injuries on some crops on the field

Preamble

Mr. Vice-Chancellor sir, observing contrasting appearance of leaves such as the ones shown in the foregoing Plate 1, as a young man growing up on my father’s farm, always got me curious and wondering aloud. Why would the leaves of the same type of plants vary so much in coloration and in some cases so much in size when they were planted on the same day? Some looked good naturally while others were simply unthrifty. My dad, in his own wisdom, would simply tell me that it was the work of God and moreover no two fingers were the same in size. I would often be pacified, but not for long. More questions, not too long thereafter, would often elicit mild rebuke in the form of “continue with your work and stop complaining about the appearance of crops". My younger siblings would sometimes be pleased with Papa's admonition and burst out laughing and soon they labelled me '*Baba onikokoro'*. At that moment, little did my father and I realize that a crop protectionist in the mould of a plant pathologist, nay virologist, was in the making.

My interest in plant health and related issues got me more interested in Biology and Agricultural Science as a student in the great St. Kizito's College, Isanlu. Indeed, I eventually emerged as the best Agricultural student of the 1979/80 graduating set. I gained admission, by Direct Entry, to read Agriculture in the then recently established Faculty of Agriculture of this Better by Far University- Unilorin, in 1983. After four years, I graduated with a Bachelor of Agriculture with limited specialization in Crop Protection. My Academic and Research career was born at that material time.

The opportunity to carve a new niche for myself in crop protection, however, came in 1993/94, by way of a Monbusho Graduate Scholarship award by the Japanese Government. My sojourn in Japan saw me first in the Tokyo Institute of Technology for basic Japanese language studies. This was preparatory to my being admitted as a doctoral student of the United Graduate School of Agriculture, Tokyo University of Agriculture and Technology (TUAT), Japan. It was there that I had my training in plant virology, carrying out research on host-viral interactions leading to a Ph.D. conferred on me in the spring of year 2000.

Mr. Vice-chancellor sir, the brief elaboration of my background in crop protection became necessary because it determined my research patterns and hence my various contributions to assuring food security over the past two to three decades. Therefore, this lecture will take the following forms;

(i) Clarification of concepts in food security and crop protection;
(ii) Pests and diseases of arable and cash crops that contribute to food insecurity;
(iii) My research contributions to general plant pathology and specifically plant virology;
(iv) My contributions to the training of young agriculturists, crop protectionists, plant pathologists and to Community service; and
(v) Recommendations on how crop protection could continue to enhance food security.

Food and its Importance to Man

Food can be described as a nutritious substance that is ingested by man and processed through the various systems of digestion and assimilation to be utilized by the body for the release of energy for day to day activities and for the growth and wellbeing of individuals. Food can be animal or plant based. The major nutrients in foods include carbohydrates, fats and proteins. Other substances derivable from food include vitamins and minerals.

Food has certain values which make them important to man. These include biological, social, economic and political values.

Food is utilised for body building, growth, health maintenance etc. It also eliminates hunger in individuals. Besides, food imputes social importance on those who have it. Self-esteem is assured /maintained and this may prevent certain misdemeanours such as theft and interpersonal aggression. After all, it is usually said that ‘a hungry man is an angry man’.

Furthermore, food can be exchanged for money to be utilized by owners (producers/marketers) for acquisition of perquisites of life. In fact, it has been recognised that food is not an ordinary commodity in a food secure nation. Rather, it is a powerful instrument of state policy that can be employed to punish enemy and recalcitrant nations, reward friendly States, and influence the political and economic decisions of other nations.

Food Security and Insecurity

Two commonly used definitions of food security come from the United Nations’ Food and Agriculture Organization (FAO) and the United States Department of Agriculture (USDA). According to FAO, food security is said to exist when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The USDA considers food security for a household as having access by all members at all times to enough food for an active, healthy life. Food security includes at a minimum (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (that is, without resorting to emergency food supplies, scavenging, stealing, or other coping strategies). It can be deduced from the two definitions that food security has 5 components (the so called 5A’s) viz; Availability, Accessibility, Affordability, Adequacy and Ability to utilize food (food safety).

In 2006, USDA introduced new language to describe ranges of severity of food insecurity. Even though new labels were introduced, the methods used to assess households' food security remained unchanged. The USDA's labels describe ranges of food security as follows: **High food security** describes a situation of no reported indications of food-access problems or limitations; **Marginal food security** describes a situation of one or two reported indications – typically of anxiety over food sufficiency or shortage of food in the house. However, there is little or no indication of changes in diets or food intake; **Low food security (**hitherto known as food insecurity without hunger) reports reduced quality, variety, or desirability of diet. However, there is little or no indication of reduced food intake; and **Very low food security** (hitherto known as food insecurity with hunger) reports multiple indications of disrupted eating patterns and reduced food intake. Along with economic, environmental, health, physical and political security, food security is a core component of **human security**, which aims at ensuring freedom from fear, freedom from want, and freedom to live in dignity.

Mr. Vice-chancellor sir, may I also state that **Food insecurity** is a major factor contributing to hunger and under nutrition in the world. It is the condition, which exists when people lack sustainable physical or economic access to enough safe, nutritious, and socially acceptable food for a healthy and productive life. This condition could be chronic, seasonal, or acute. It could also occur at the individual, household, regional, or national levels. According to FAO (2003), around 852 million people, worldwide are chronically hungry due to extreme poverty, while up to 2 billion people lack food security intermittently due to varying degrees of poverty. The root cause, especially in developing countries also include war, civil conflict, corruption, national policies that do not promote equal access to food for all, environmental degradation, insufficient agricultural development and crop pests and diseases. The Food and Agriculture Organisation (FAO), in its State of Food Insecurity in the World in 2006, reported that Nigeria had about 12 million under nourished citizens (about 9% of the population) as at 2003. The present day statistics would surely look more gruesome, no thanks to the bout of security challenges in the country.

Providing sufficient, affordable, and safe food for the increasing world population is one of the biggest challenges the international agricultural community faces. FAO had projected that food demand will double by 2050. To meet this, cereal yields in developing countries will have to increase by 40% and an additional 100-200 million hectares of land may be needed. However, the provision of additional agricultural land is substantially limited, as it would have to happen mostly at the expense of forests and the natural habitats of wildlife etc. (Anon, 2017).

What then can be done to ensure the continuing survival of the human race through food security?

Crop Protection to the Rescue

It has been advocated that rather than the unbridled and possibly impossible expansion of cultivated land, increasing productivity on existing land is by far the better choice and can be achieved.

> ***One of the most logical steps in this direction is the reduction of current yield losses***

caused by pests, pathogens, and weeds in the field and during storage (Anon, 2017).

Integrated Pest Management (IPM) that utilizes traditional as well as modern crop protection methods plays an important role in ensuring crop productivity worldwide. Without any pest control, yield losses would be considerably higher than they are today. Therefore, a lack of improvement in IPM in the future in the developing world will lead to more marginal and forested land being brought into cultivation to feed the growing populations.

What is Crop Protection?

Crop protection is an aspect of Crop Production. It is concerned with all processes involved in ensuring that crops and crop produce are safe from potential and real threats of damage by abiotic and biotic factors (animal pests, weeds and pathogens) that can lead to loss of quantity and quality on the field, in transit and in the stores during the post-harvest period.

Without preventive protection with pesticides, natural enemies, host plant resistance and other nonchemical controls, 70% of crops could have been lost to pests (Anon, 2017). This, of course, would have tremendous effect on human life on earth. Even now, the number of people without enough food to eat on a regular basis remains stubbornly high, at over 800 million, and this is not falling significantly. Meanwhile, over 60% of the world's undernourished people live in Asia, and a quarter in Africa. The proportion of people who are hungry, however, is greater in Africa (33%) than Asia (16%). There are 22 countries, 16 of which are in Africa, in which the undernourishment prevalence rate is over 35% (FAO, 2003). The figures for the present decade are sure to be much higher owing to unrelenting factors that contribute to food insecurity. Chief among the factors are pests and diseases of crops that supply the bulk of food consumed by man and his domesticated animals on earth.

The processes, involved in crop protection may be socio-cultural, physical, biological, chemical and biotechnological among others. They are deployed both preventatively and curatively to achieve desired results. For some pests and diseases, no effective control measures are yet known, and only a combination of cultural practices and the use of somewhat resistant varieties make it possible to raise a crop. For most plant diseases, however, as long as we still have chemical pesticides, practical controls are available, even though some losses may be incurred, despite the control measures taken. Table 1 shows a comparison of the estimated world -wide crop losses for some important food crops with and without pest control measures.

Table 1: **Estimated world-wide crop yield losses as a percentage of attainable yields**

Crop	% Loss without Pest control	% Loss with a combination of mechanical, biological and chemical control measures
Rice	77	37
Wheat	50	28
Potato	75	40

Source: Oerke, E.C. (2006): Crop losses to pests. *Journal of Agricultural Science* 144: 31-43. Cambridge University Press.

Although pest control significantly reduces loss on a world- wide basis, there are big differences in the efficacy considering regions. For instance, in Northwest Europe, from 2001 to 2003, efficacy was as high as 71%, in North America 63%, in South Asia 42%, in West Africa 43%, and in East Africa 32%. These figures indicate that in the regions with the highest need for additional food (Asia and Africa) there is still a great deal of room for increasing productivity simply by reducing yield losses through improved crop and postharvest protection (Anon., 2017).

Crop losses from biotic stresses (pests and diseases) are likely to increase from future attempts to intensify agricultural production. These attempts will include the use of varieties with higher yield potential, large-scale cropping with genetically uniform plants, reduced crop rotation, and expansion of crops into marginal land. In addition, because of climate change many weeds, pests, and diseases will reproduce faster and spread more widely causing significant yield losses over what is experienced today (Anonymous, 2017).

Pests and Pathogens as Enemies we Combat as Crop Protectionists

The enemies that we combat as crop protectionists are mainly pests and pathogens. Pests, in a broad sense, can be described as organisms, which through their various activities injure and damage crops and thereby constitute social and economic menace to the interests of man. Adopting this broad definition, therefore, we can classify pests as plants or as being animate in nature.

Those pests that are plants in nature include weeds. Weeds can be defined as plants that are growing in a place where they are not wanted at a particular time period. Weeds can be grass and sedge (monocots) or broadleaf (dicots). A good example of grass is spear grass, *Imperata cylindrica*. The purple nut sedge, *Cyperus* spp is sedge, while goat weed –*Ageratum conyzoides* is a broad leaf weed. Weeds cause tremendous loss in crop yield and quality, annually. It has been estimated that yield losses due to weed can amount to billions of dollars every year.

According to the **Weed Loss Committee of the Weed Science Society of America (WSSA),** on an annual basis, potential loss in value for corn (Maize) is $27 billion and for soybean is $16 billion based on data from 2007 to 2013. Overall, average % yield loss with no weed control in corn is 52% and in soybean it is 49.5%. Plate 2, following, shows weeds as a formidable enemy, when a farm is left unkempt.

Plate 2: Left, A maize plot that had no weeding. Right, A maize plot that was treated with pre- emergence herbicide. It is important to note here that the two plots were planted on the same day at the Teaching and Research farm, Unilorin in 2015.

The animals that constitute pests (animal pests) may be micro or macro in nature. They include such microscopic animate pests as plant- parasitic nematodes of which the most common genera in Nigeria are *Meloidogyne*, *Pratylenchus*, *Helicotylenchus*, *Tylenchorynchos*, *Scutellonema*, and *Heterodera* among others. The macroscopic animate pests may be grouped as invertebrates such as arthropods (e.g. insects and mites), and vertebrates such as mammals (e.g. rodents and monkeys), avians (birds) and to some extent reptiles (lizards) and amphibians (toads). Plate 3 shows a rat ready for attack on a sugarcane plant.

Plate 3: A rat (macro-animate, mammalian pest) caught red-handed climbing a sugarcane plant ready to destroy the leaves and stalk.

It is important to note that even domesticated animals (e.g. cattle and goats) may attain pest status if they deliberately attack, or are made to attack, and destroy cultivated crops. Indeed, man himself may become pest through deliberate activities that injure or inflict socio-economic damage to crops belonging to other farmers.

Another important group of enemies that crop protectionists battle are pathogens, which are essentially pests because of their destructive nature. However, they are mostly microorganisms that, through their activities, cause diseases in crops. Pathogens upon successful infection of the host plants derive various benefits from the host thus eliciting myriads of responses from them. All these processes eventually lead to disease, which is a ‘harmful deviation from normal functioning of physiological processes in the infected plant’ (Agrios, 2005).

Plant pathogens are mostly fungal, bacterial and viral in nature. Other groups however, are mycoplasmas, oomycetes and viroids as well as some macro-organisms such as parasitic/pathogenic weeds (e.g. *Striga* and Orobanche). Plate 4 shows the different structure of plant viruses.

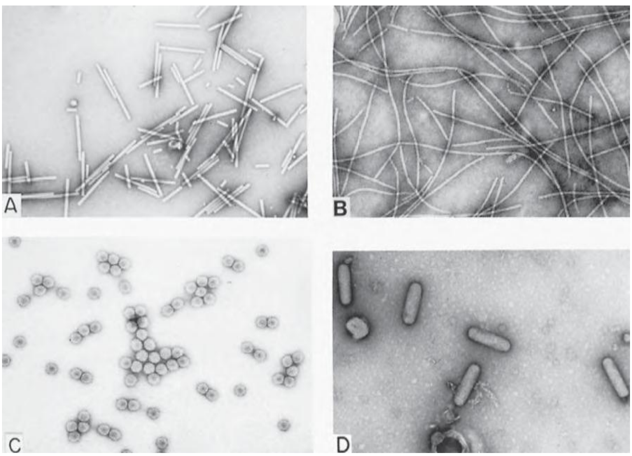


Plate 4: Electron micrographs of the various shapes of plant viruses. (A) Rod-shaped virus (*tobacco mosaic virus*) (36,000X). (B) Flexuous thread virus (*sugarcane mosaic virus*) (80,000X). (C) Isometric virus (*cowpea chlorotic mottle virus*) (100,000X). (D) Bacilliform rhabdovirus (*broccoli necrotic yellows virus*) (28,500X). (Agrios, 5th edition 2005).

Plate 5, following, shows various stages of destruction caused by a pathogenic plant (*Striga* spp) attack on corn and sorghum plants.

Plate 5: Top Left; *Striga hemontheca* attaching itself to a corn plant. Top Right; A sorghum field infested with *Striga* spp. Below; Eventually, striga-infected sorghum and maize plants die prematurely producing virtually no grains.

All the aforementioned enemies (pathogens, weeds and animal pests), operate in diverse ways to inflict injuries and damage on our beloved crops and the environment in general. They contribute in no small measure to food insecurity, directly and indirectly, because of their influence on components of food security such as availability, affordability, utilization and safety of food. Another way by which pests and diseases contribute to food insecurity is that they may cause financial losses to growers (primary producers), handlers and marketers.

Aspects of Crop Protection through which Food Security is Assured

Crop protectionists contribute to food security assurance through research and other activities in the areas of (a) general crop and environmental protection technology (b) entomology (c) weed science and (d) plant pathology.

Crop protection technology can further be broken down into areas of Pesticide Science (Formulation and toxicologies of chemicals and botanicals), Pollution Studies (Environmental Pollutants and their control), Application Equipment Engineering (Design, Fabrication and Maintenance) and Organic Agriculture-based Protection Strategies.

Entomology is the study of insects and other such animals, which belong in the Phylum Arthropoda. Research interests can be further categorized into General Entomology, Economic Entomology, Ecological Entomology, Storage Entomology and Applied Genetics including Biological Control Strategies. Insects are important, not only as direct pests causing injury on plants but also for their abilities to predispose their hosts to microbial invasion leading to serious diseases. Some also serve as vectors to pathogens such as viruses. Meanwhile, some insects are natural enemies, serving as predators and parasites of other insects, which make them useful as biological control agents. Others are pollinators and producers of honey.

Although Weed Science is domiciled in some institutions in the Department of Agronomy or Plant Science, it is essentially an important aspect of Crop Protection. Weeds constitute a menace to crops in arable lands, orchards, and even in forest plantations all over the world. Research efforts in Weed Science nowadays centre mainly on aspects of weed ecology, weed biology, and weed control and management. Other aspects include interactions between weeds and crops, weeds and pathogens among others.

Plant Pathology, is an area that has witnessed the most tremendous developments in recent years. Research in Plant Pathology aims at unravelling the complex issue of disease causation, pathogens involved, their mode of operation, and strategies for their management and control. The term plant pathology is a contraption from three words viz; Phyto = Plant; Pathos= suffering and logy/logos= study. Literally speaking, plant pathology, therefore, can be said to be the study of the suffering plant. Well, disease to the earlier scientist is tantamount to suffering. However, whether plants do suffer or not in the real sense of it is a difficult assertion to affirm. At any rate, we do know that diseased plants exhibit certain features that apparently make them different from the normal healthy plants.

Classified under Plant Pathology are the sub-disciplines of Mycology, Virology, Bacteriology and Nematology. The mycologists, of course, concentrate most of their research efforts on Fungi and Fungi-like organisms such as the oomycetes. The virologists concentrate mostly on viruses, viroids and other virus-like organisms. In the same vein, the bacteriologist deals mainly with bacteria and possibly mycoplasmas while the nematologist deals mainly with plant-parasitic nematodes.

It is important to point out here that by virtue of the nature of our training in Nigeria, first as Agriculturists, who later specialise in Crop Protection and furthermore in any of the sub -disciplines, it is not unusual to have most researchers feeling at home in many aspects of plant pathology. In the fight against diseases, however, plant pathologists partner with other professionals such as crop geneticists and breeders to develop improved plants that are tolerant, or out-rightly resistant, to diseases.

My Specific Contributions in Plant Pathology

For the purpose of this discourse, I will like to summarise my roles in food security assurance through the following contributions: contributions through research in basic and applied plant virology; contributions through research in basic and applied plant pathology; and contributions through the training of students and community service.

Contributions through Research in Basic and Applied Plant Virology

Research in basic plant virology has afforded me the opportunity of understanding the biology of the pathogens concerned and hence serves as reference point for proffering practical and sustainable solutions to disease problems. For the purpose of emphasis, my contributions to basic research in plant virology include but are not restricted to the aspects of host-pathogen and pathogen-pathogen interactions, epidemiology and screening of new accessions for susceptibility or otherwise to viruses.

Host-pathogen and Pathogen-pathogen interactions in Tomato-Viral Model

In various host-pathogen interaction studies, I have been able to document the various patterns of viral disease manifestation using a tomato host model under conditions in a greenhouse environment. Tomato was chosen for these studies because of the apparent ease of propagation all year round among other considerations. In these experiments, tomato seedlings were usually infected singly or doubly with *Potato* X *Potexvirus* (PVX) and *Tobacco Mosaic Tobamovirus* (TMV) or *Tomato Mosaic Virus* (ToMV). It was found through repeated experiments that doubly infected tomato plants, which were susceptible to any of the *Tobamoviruses*, always manifested aggravated symptoms of disease compared to those infected alone by either of the viruses.

The symptoms included severe mosaic, crinkling, extensive necrosis, stunting and general unthriftiness of the diseased plants. Such poorly developed plants had delayed flowering and produced little or no flowers as well as intense flower abortion, which ensured little or no fruit production. Indeed, there was up to 90% loss of edible fruit yield (number and weight-wise) in mixed infected plants compared to the healthy control. The losses under single infection, though lower, were always significant (between 30 and 50%). The projection of these crop failures, to a field situation, portended a grim reality of what awaited a grower and indeed potential consumers were there to be such a devastating scenario on a large scale. These results were published in reputable journals (Balogun, 1999, 2002, 2003b and Balogun et al., 2002).

The findings on varying disease symptom severity elicited my interest in elucidating the metabolic and physiological processes of protein, nitrogen and carbohydrate metabolism in the host milieu. The results of replicated experiments showed consistent general decline in photosynthesis, host soluble proteins, nitrogen accumulation and total soluble carbohydrates in the infected plants. The extent of loss corresponded to disease severity as it was higher in mixed infected plants than in singly infected and control plants. It was then concluded that the observed severe stunting of infected plants, relative to healthy ones was, in large part, due to the observed alterations in the afore-mentioned metabolic processes (Balogun, 1999).

The understanding of the role of alteration in metabolic and physiological processes in disease development led to further study of happenings in the realm of patterns of replication and accumulation of the virion (complete virus particle) of infecting viruses in the host milieu. Comparison of the levels of accumulation of viral components such as Coat Proteins (CPs), Movement Proteins (MPs) and RNAs in the inoculated primary leaves with what obtained in the systemically infected upper leaves was also made.

Results of infectivity assays and Enzyme linked immunosorbent assay (ELISA) led to findings that Potato Virus X (PVX) virion concentration was significantly enhanced (> 6x) in systemically infected upper leaves of plants mixed infected with PVX and the tobamoviruses, compared to what obtained in plants singly infected with PVX in susceptible tomato hosts (Balogun, 2002; Balogun et al., 2002). No enhancement was recorded in the inoculated lower primary leaves.

Results of Western immunoblot analysis equally showed that the levels of CP and MP of PVX were significantly enhanced in systemically mixed infected leaves compared to the singly infected ones (Balogun, 2003a,b,c). Plate 6 shows varying intensity of coat protein bands of PVX and ToMV as well as the MP of PVX on nitrocellulose filter membrane, after electrophoresis on poly acrylamide gel, electro-transfer, and western blot analysis.

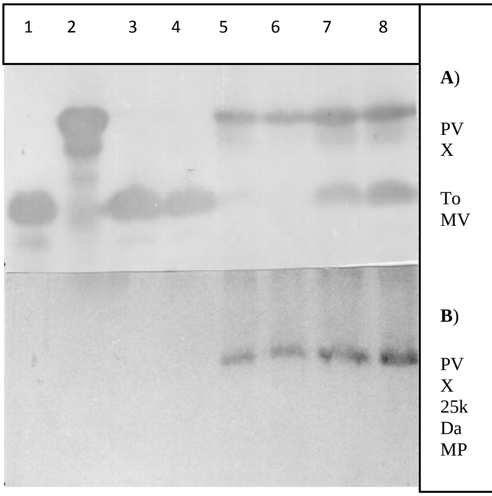


Plate 6: Western blot analysis of some accumulated viral proteins in leaf 5 and 7 of singly and doubly infected leaves of tomato cv Fukuju no 2 plants 12 days after inoculation with PVX and ToMV-L. Lanes: 1- Purified TMV; 2- purified PVX virion, 3- TMV alone in leaf 5; 4- TMV alone in leaf 7; 5- PVX alone in leaf 5; 6- PVX alone in leaf 7; 7- PVX+TMV-L in leaf 5; 8- PVX-TMV-L in leaf 7; A) coat proteins of both PVX and TMV-L; B) PVX 25 kDa protein in the same samples. The positions of PVX and TMV bands are shown.

In another experiment, an RNA probe, complementary to 350 nts of the PVX coat protein gene, inserted into T7 plasmid vector and labeled with digoxigenin (DIG) (Boehringer Mannheim) according to the manufacturer's instructions, was hybridized to the total RNA in Northern blot hybridization analysis. The results also showed alterations in the accumulation of PVX RNA in tomato hosts singly or mixed infected with *Potato* X *Potexvirus* and *Tobacco Mosaic Tobamovirus* (Balogun, 2003a,b; Balogun et al, 2002). The observed Enhanced PVX viral proteins and RNAs were in line with the pattern obtained for the earlier reported virion accumulation (Balogun, 2002).

The afore-mentioned findings on Virion, CP, MP and RNA accumulations clearly showed that the PVX-enhancement process was a significant factor in the observed variations in disease severity on infected plants. In fact, it was concluded that any procedures that prevent PVX enhancement would automatically prevent the development of severe synergistic disease on the tomato host and hence improved plant growth leading to high yields, which is a necessary step towards food security assurance.

Studies aimed at understanding the influence of age of plant at infection, and the sequence of infection of the viruses on their relative accumulation and subsequent disease development also revealed quite interesting facts. The results as detailed in publications (Balogun, 2003c and Balogun, 2008) showed that both factors did influence accumulation of viruses and the disease severity.

Furthermore, the results pointed to a possible viral disease control strategy, i.e., preventing plants from being infected young by various cultural and chemical control approaches. As observed, such preventive approaches could confer on infected plants a competitive advantage against the disease. Plate 7 compares the appearance of plants at different times in cultivar GCR 236 (+/+) tomato plants following mock, or mixed inoculation with PVX and ToMV-L at various stages of growth. In short, it is apparent that severe infection, too early in a plant's life, is tantamount to death sentence.

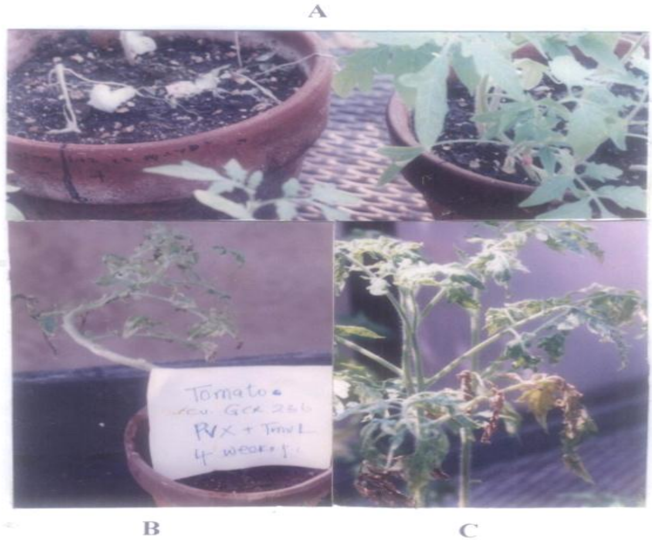


Plate 7: Appearance of cultivar GCR 236 (+/+) tomato plants following mock, or mixed inoculation with PVX and ToMV-L at various stages of growth

(A) From left: Dead seedlings (simultaneously inoculated with PVX plus ToMV-L); and healthy ones at 15 days after seedlings at the 2-3 leaf stage (2 wks after germination) were inoculated. (B) Severely affected plant, 28 days after simultaneous inoculation with PVX +ToMV-L at the 5-6 true leaf stage (4 wks after germination). (C) Plants at 28 days after the initial inoculation of ToMV 4 days before PVX at the 5-6 true leaf stage.

The role of seasonal variations in weather elements on the disease process was also investigated. Experiments were carried out to compare summer and winter crops with regard to their growth and yield responses to single and mixed infections with PVX and strains of Tobacco mosaic virus and Tomato mosaic virus (ToMV). Relative virus concentrations were also measured in both seasons. The results showed that PVX accumulation was significantly favoured more in winter and generally cold seasons than in summer. The accumulation of TMV and ToMV, on the other hand, was less influenced by the season of growth. The enhancement of PVX by TMV/ToMV was actually found to be more significant by mixed inoculation under high temperature regimes. The findings (Balogun, 2004 and 2010) are significant for tropical countries, such as Nigeria, because summer-like conditions are always present here. If a synergistic disease induced by mixed infection by PVX and a *tobamovirus* outbreak were to be witnessed, therefore, it could be quite disastrous. Prevention therefore, as they say, is far better than cure.

Studies aimed at understanding the Time-Course accumulation of phenols were carried out due largely to earlier observations on some cultivars responding in different ways to infection. Could phenols, previously known to influence resistance of hosts in fungal-host interactions, be also at work in the viral-host set up? The results showed differing accumulation patterns in plants inoculated with the different viruses or a mixture of them. In summary, it was observed that injury and infection (single or mixed) equally elicited high accumulation of phenols in the first 72 hours. However, whereas increased accumulation was witnessed thereafter for another one week in infected plants, the levels in non- infected plants (whether injured or not) remained stable (Balogun and Teraoka, 2004).

Another remarkable finding was that attenuated ToMV-L11A (which when singly inoculated produced no symptoms) and PVX (which alone produce mild symptom) elicited the highest levels of phenolics, while relatively lower levels were recorded in mixed infected plants and in plants inoculated with wild TMV strain, as time progresses. It is noteworthy that the sudden decrease after about one week coincided with the onset of severe or synergistic symptom manifestation.

The import of the findings is that viral infected plants invariably do their utmost initially to ward off disease by biochemical defence mechanism. Nevertheless, viruses almost always win the battle in susceptible hosts in the long run. The findings suggested a possible role for ability to elicit and maintain for long, phenols accumulation in host, as a gene manipulation-based control strategy. This is a useful contribution to potential collaborative works with geneticists and breeders.

Experiments leading to the finding of an unusual host-pathogen phenomenon, i.e. the breakdown of the TMV resistance gene in tomato cultivar, and the mechanisms involved was reported (Balogun et al., 2004, 2008). The results of those studies showed that a supposedly wild TMV-resistant cultivar of tomato, which had the Tm-1 gene incorporated in it (cv GCR 237 Tm-1), was actually susceptible to an attenuated TMV strain L11A that normally elicits no symptoms even in strongly susceptible tomato cultivar such as cv GCR 236 (+/+). It was essentially a case of the underrated enemy proving to be the most dangerous enemy.

At first, the result appeared improbable that a cultivar that had been fortified to withstand the strongest arsenal of the wild ToMV-L could so easily crumble in the face of attack by the extremely watered down version or the attenuated ToMV (i.e. ToMV-L11A). Repeat experiments, however, confirmed the previous results. It also showed that mixed infection of PVX with the attenuated ToMV- L11A led to PVX's enhancement in the host (ca 4x), as was witnessed in ToMV- L and PVX mixture in susceptible cultivars (e.g. Fukuju no.2 and GCR 236 (+/+). This was at variance with the result of inoculating PVX and wild ToMV-L in the same fortified cultivar (GCR 237 Tm-1), in which the wild ToMV-L could not replicate and hence there was no enhanced PVX accumulation.

Mr. Vice-Chancellor sir, this particular finding broadened the then limited understanding of the whole PVX-enhancement saga in the host plants when mixed infected with unrelated viruses. It showed that the simultaneous presence of TMV/ToMV and PVX in the host was not enough, in itself, to elicit PVX enhancement. Rather, there was a need for the right ToMV strain to be present, at the right time and actively replicating in the host, to be able to significantly induce PVX enhancement, which is believed to result in synergistic disease manifested as severe leaf mosaic, necrotic spots on stems and most times substantially distorted and stunted plants as seen in Plate 7. It also showed that host cultivars do influence disease and viral accumulation dynamics in tomato singly or doubly infected with Potato Virus X and a *Tobamovirus* (Balogun et al., 2005, 2008) (See Plates 8 and 9).

Plate 8 shows an array of seedlings of three tomato cultivars and their symptomatic reactions to simultaneous mixed inoculation with the same type of viruses.

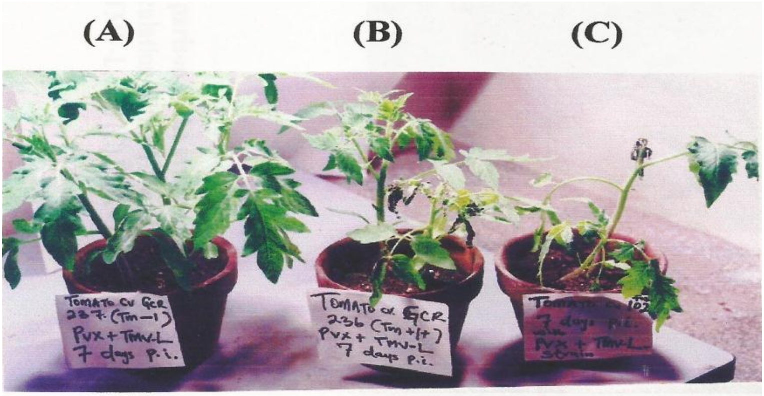


Plate 8: Seedlings of different cultivars of tomato 7 days after simultaneous inoculation with PVX and TMV-L (ToMV). A: cv GCR 237 (Tm-1); B: cv GCR 236(+/+) and C: cv Fukuju no.2.

Plate 9 a, b and c show the coat protein accumulation profile of the same set of tomato plants that are shown in Plate 8. Note that the severely infected cultivars Fukuju no.2 (A) and GCR 236 (B) have bold PVX and ToMV- CP signals, while the cv GCR 237 (C), with the Tm-1 resistance gene has only one set of bands (PVX- CP) since ToMV-L did not replicate in the cultivar. The corresponding discrepancy in growth is readily visible in Plate 8.

The import of these findings is that geneticists and breeders must not relent in partnering with pathologists, nay protectionists, while developing plant varieties that will be resistant to particular diseases. Such collaborations, of course are necessary to enhance food crop production through efficient plant disease and pest management strategies.

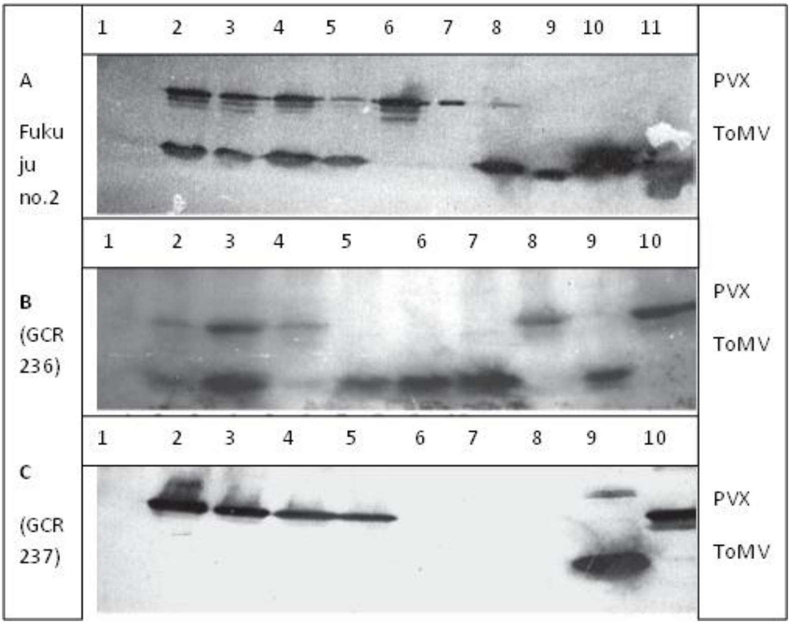


Plate 9: Western blot analysis of accumulated viral coat proteins in the inoculated leaf of different tomato cultivars under single or mixed infection with PVX and different strains of ToMV. (A) Fukuju No. 2 at 5 dpi. Lane 1, Control; 2, P+L+ L11A; 3, P+L; 4, P+L11A; and 5, P+OM. Lane 6, PVX (P) alone; 7, purified PVX; 8, L11A alone; 9, OM alone;10, L alone and 11, purified ToMV-L. (**B**) GCR 236 at 7 dpi. Lane 1, control; 2, P+ L11A; 3, P+L; and 4, P+OM. Lane5, OM alone; 6, L11A alone; 7, L alone; 8, P alone; 9, purified TMV-L and 10, purified PVX. (**C**) GCR 237 at 7 dpi. Lane 1, control; 2, P alone; 3, P+L; 4, P+L11A; 5, P+ OM; 6, L11A alone; 7, OM alone; 8, L alone; 9, purified ToMV-L and 10, purified PVX. All bands were visualised using combinations of polyclonal antibodies raised against the individual viruses in rabbits.

My Other Contributions in Plant Virology

Mr. Vice-Chancellor sir, my other important contributions to food security through applied plant virology are in the area of screening new crop cultivars for their responses to important viruses in Nigeria. It is very important to do this as it helps the identification and selection of good candidate accessions for further genetic improvement that ensures better disease tolerance or resistance and ultimately higher yields. Worthy of mention here is the screening of both local and exotic sugarcane germplasm from the Unilorin Sugar Research Institute for their susceptibility, or otherwise, to sugarcane mosaic virus, genus *potyvirus*. It had been found and reported that although many of the germplasm screened were susceptible, severity varied significantly among cultivars (Balogun et al., 2008, 2016; Aliyu et al., 2017). This is an indication that many of the cultivars are good candidates for further improvement through breeding programmes. (see Plate 10).

Plate 10: Left, A sugarcane mosaic disease -susceptible local sugarcane variety and Right, an apparently healthy local variety some 5 months after planting.

Other experiments that I have carried out solely or jointly with other workers focused on possible viral disease mitigation strategies such as use of fertilizer, and weed management practices. (see Plates 11 and 12).

Plate 11: Comparative appearance of sugarcane mosaic diseased sugarcane plants under varying fertiliser regimes. From Left: No fertiliser at all; fertiliser applied once; fertiliser applied twice; fertiliser applied thrice in 6- month duration.

Plate 12: Comparative appearance of sugarcane mosaic diseased sugarcane plants under varying weeding regimes. From Left: No weeding at all; weeded once; weeded twice; kept weed free for 6 months.

It is worthy of note that despite being infected, fertiliser application and appropriate weeding regime significantly improved plant growth and subsequent yield attributes.

Research in Epidemiology i.e. occurrence and prevalence of important viral diseases and evaluation of possible cultural control strategies has also engaged my attention over the years. The area is receiving a fresh boost in many parts of the world, Nigeria inclusive, as new diseases of arable, cash and forest crops are being discovered while those hitherto thought to be eradicated are staging a comeback due, in part, to varying environmental challenges ranging from climate change to global warming. Along with some of my undergraduate, postgraduate and doctoral students, I have carried out field surveys and documented the incidence and severity of viral diseases and cultural control strategies on, Yam, cassava, Cowpea, Soybean, Rice, Sorghum, Maize, Pepper, Tomato, Okra, Egg plants and many other vegetable species in Kwara state as well as in some states in South-western Nigeria. Some of the published works include (Balogun and Akinlade, 2004; Balogun and Bewaji, 2004; Balogun and Aliyu, 2005; Balogun and Fawehinmi, 2008; Balogun and Dada, 2009; Arogundade et al., 2012; Aliyu et al., 2012, 2013, 2014, 2015, 2016; Aliyu and Balogun, 2010, 2011, 2014; Banji et al., 2015).

In summary, we found from these studies that manipulating planting density, date/time of planting, weeding and insecticidal application as well as planting of resistant and tolerant varieties among other cultural strategies are generally effective in significantly reducing viral disease incidence and severity on the field, and thus improving crop growth and eventual yield output. Hence, the crop protectionist contributes to assuring food security, not only through research into disease mechanisms, but also through research into low cost and sustainable disease management and control strategies.

My Contributions through Research in Basic and Applied Plant Pathology

Mr. Vice-Chancellor sir, apart from carrying out research in Virology, which is my core area of interest, I have also had opportunity of documenting quite a number of important findings in other areas of Plant Pathology such as Mycology and Nematology. The pathogenic effect of *Meloidogyne incognita*, a cosmopolitan nematode, otherwise known as the root- knot nematode on arable crops engaged my attention, especially in the early years of my career. Its effect on *Corchorus olitorius* (Ewedu), okra, celosia and other vegetables, as well as yams, singly and jointly with fungi have been documented. Some of the publications are (Balogun and Babatola, 1990; Balogun and Odutola, 2003; Hinmikaiye et al., 2015).

Research findings on understanding the predispositional effect of insects and injury on plants to fungal attack and some control strategies, using conventional insecticidal and fungicidal sprays, have also been published (Balogun and Babatola, 1999; Balogun, 2000; Balogun and Tanimola, 2001).

The efficacy of alternative control strategies, involving little or no chemical usage, has also been studied over the years. Balogun et al. (2004) reported the comparative inhibitory effects of *Chromolaena odorata, Khaya senegalensis, Ocimum gratissimum* and *Piper guineense* on the growth of *Fusarium moniliforme* and *Cladosporium* spp. isolated from stored maize grains. All the botanicals significantly inhibited the fungi mycelial growth and sporulation, indicating that they can, at the right dosage, control seed infection and infestation with the fungi. In the same year, Balogun et al. (2004) also reported the efficacy of some botanicals against *Aspergillus* spp, another stored-seed fungus known to produce aflatoxin, a mycotoxin that could be very deadly. The use of plant residues (agricultural wastes) as soil amendment in cowpea production for soil microbes' control, and good yield, has also been studied and reported (Yusuf et al., 2011). In an experiment, using *Moringa* stem bark extract, as soil drench and sprays, we have also observed and reported its efficacy on prevention of seedling infections of soybean by fungal pathogens (Aliyu et al., 2014).

Screening for responses to pathogens and pests in crops is an essential process of crop protection that facilitates crop improvement and consequent good growth and yield, hence assuring food security. In recent years, I have carried out extensive research on two fungal diseases of sugarcane i.e. smut and red rot, which have the potential of sending growers out of business in endemic areas. Smut is caused by a pathogen known as *Ustillago scitaminea (Sporisorium scitamineum).* The disease is characterised by a prominent manifestation of smut whip where the stalk should have been elongating (Plate 13). Of course, susceptible varieties have very poor growth and yield including sucrose content attributes when infected.

Plate13: From Left; An artificially inoculated sugarcane seedling manifesting smut whip; Middle: Natural smut symptom manifestation on a seedling on the field; Right: a sugarcane field virtually destroyed by extensive smut infection.

Worthy of note, however, is our finding that hot water treatment along with pre-planting application of some fungicides on the cane setts could significantly delay or prevent smut manifestation in the crop plants leading to good growth and enhanced millable stalk yield.

Red rot occurs in various parts of the cane plant but it is usually considered a stalk and a seed-piece disease. It is caused by a fungus, *Colletotrichum falcatum*. Its symptoms are highly variable depending upon the susceptibility of the sugarcane variety and the environment. Diagnostic symptoms can best be observed by splitting the stalk lengthwise (Plate 14).

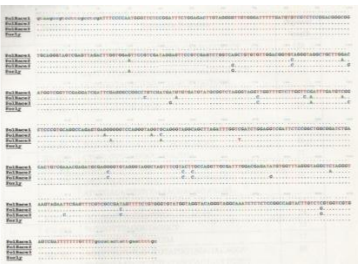
Plate 14: A split sugarcane stem showing red rot infection

I have screened many of the new sugarcane introductions as well as native germplasm collections in USRI for susceptibility to both smut and red rot diseases, both in the main crop and the ratoon stages, on the field and in the screenhouse using potted plants. Although many of our collections are susceptible, many have also been found to be apparently resistant or very tolerant.

Molecular Techniques in the Study of Host-Pathogen Interactions and disease diagnosis in a Tomato-Fungal Model

Mr Vice-chancellor sir, organic and inorganic chemicals have once been the main stay of the struggle against pathogens and diseases generally. Factors ranging from undesirable side effects on non-target organisms, the environment and even man himself, as well as pesticide resistance have, however, necessitated a redirection of focus. The molecular approach, which feeds biotechnology, is now being vigorously pursued because it addresses issues ranging from understanding the ways pathogens operate at the genetic level, to developing an acceptable and enduring programme of action that will keep the activities of pathogens under subjection.

The many races (i.e., 1, 2, 3) of *Fusarium oxysporum* f.sp *lycopersici*, and *radicis lycopersici* the vascular wilt fungus, which have the potential to wreak havoc on tomato, a very important fruit vegetable world-wide, were used in a study to evaluate the efficacy of some molecular techniques in elucidating the vascular wilt disease mechanisms. Balogun (2007a, 2007b, 2008a and Balogun et al., 2008) detailed the various techniques employed and the results of experiments carried out to distinguish between the races of *F. oxysporum* f.sp *lycopersici* based on the nucleotide sequences of their ribosomal intergenic spacer region (rIGS) (Plate 15).



Region	Position	Nucleotide Sequence	Segment length
1	1-129	gtaagccgtccttcgcctcgATTTCCCCAATGGGTTCT CCGGATTTCTGGAGACTTGTAGGGGTTGTGG GATTTTTGATGTGTCGTCTCCGGACGGGCGGT GCAGGGTAGTCGAGTTAGACTTGGTGGA	129
2	164-181	GCTGTGTGTTGGACGGTG	18
3	183 -197	AGGGTAGGCTGCTTG	15
4	201-234	ATGGTCGGTTCGAGGATCGATTCGAGGGCCGGCC	34
5	246-270	TGTGATGTATGCGGTCTAGGGTAGG	25
6	301-321	CTCCCGTGCAGGCCAGAGTGA	21
7	341-364	CAGGGTAGGCAGCTTAGATTTGGT	24
8	366-422	GATCTGGAGGTCGATTCTCCGGCTGGCGG ATCTGACACTGTCGAAACGAGATGCGAG	57
9	424-446	GGTGTAGGGTAGGCTAGTTTCGT	23
10	451-474	GCCAGGTTGCGATTTGGACGAGAT	24
11	476-493	TGTGGTTTAGGGTAGGCT	18
12	510-526	TCGAGTTTCGTCGCCGA	17
13	528-590	AGTTTTCTGTGGGTGTATGGTAGGTACAGGG TAGGCAAATCTCTCTCCGGCCAGTACTTGTCT	63
14	592 -638	GTGGTCGTGAGTCGATTTTTTTGTTTTgccatac tattgaattttgc	

Plate 15: **Top from Left**; Genomic DNAs from Races 1,2,3 and *radicis lycopersici* (rly) of *Fol* on 1% Agarose gel, **Middle**; Nested trace windows of Sequence Electrophoregram of the M13 fragment of recombinant pGEM-IGS of *Fol* Race 1DNA,**Right**;The decoded IGS sequence of Race 1. **Below Left:** Similarity alignment of IGS sequences of the four isolates. Dots represent similar sequences with Race 1. **Right**; Consensus/Conservation analysis within the rIGS fragment using the Race 1 as the benchmark. The *Gene Amp 3130X Genetic Analyzer* was used for the sequencing while *BIOEDIT Sequence Analysis program for Windows* was used to analyze the sequences based on homology and complementary searches with the Primers Sequences and Alignments.

Along with conventional symptomatology, molecular analysis could serve as a useful diagnostic and identification tool in disease studies. To this end, Polymerase Chain

Reaction (PCR), using race specific primers (sp13 and sp23) was employed to analyse disease in tissue samples of infected tomato cultivars at two critical stages of disease development i.e. before and after symptom manifestation.

The results showed that random sampling of the lower leaves or root parts of tomato plants was sufficient to detect fusarial DNA in apparently healthy plants as Signal bands of PCR amplicons appeared with varying intensities. This method, which enables symptom development to be predicted, has the added advantage of leaf sampling being less disruptive to the plant than root sampling. The import of these findings is that more reliable and possibly more cost-efficient ways of molecular diagnosis of disease is achievable even in fund-challenged laboratories such as those found in the developing world, Nigeria inclusive.

Plate 16: **Left**; Agarose gel electrophoretic analysis of the PCR products of Primers sp13 (lanes 2,3,4), sp23 (lanes 5,6,7), and the universal primer (lanes 7,8,9) using purified *Fol* races 1, 2 and 3 as templates. Lane 1=100bp DNA Marker. **Middle**; Appearance of cv. Momotaro tomato plants with different level of *Fol* inoculum: 1= with Race 1 alone; 2=Race 2 alone and R1+2) at 24dpi. **Right**: PCR products from specific primers sp13 and sp23 on DNA extracts from cv. Momotaro plant tissues at 24dpi. Lanes 1&2= Purified Race 1 and 2 (marker), 3&4= Root sample infected with R1alone and R2 alone, 5&6= Races 1+2 (sp13) and Races 1+2(sp23). L7 &8= Leaf sample with Race 1 alone and Race 2 alone.

It is noteworthy that even though Cv Momotaro remained symptomless under Race 1 infection, Race 1 DNA was, however, amplified but only in the roots, while Race 2 was amplified both in the roots and in the lower leaves. From these observations, it is plausible to infer that the restriction of the upward colonization movement of the Race 1 DNA in Momotaro (by some factor) is surely one of the mechanisms by which the cultivar stays insensitive to Race 1. On the other hand, the absence of such a restriction on Race 2 DNA must have resulted in the uninhibited colonisation movement in the pathosystem, and hence the vascular wilt symptom response observed. This submission, as far as I know, has remained uncontested since its publication in a reputable Journal of plant pathology by Balogun et al. (2008).

My Contributions through Training of Students and Community Service

Mr. Vice-Chancellor sir, as it is conventional to do on occasions like this, permit me to dwell briefly on my contributions to the training of students and community service, which are essential aspects of a lecturer’s work profile in this citadel of academic excellence. Moreover, the training of agricultural students is to ensure that the future is secure even after our generation would have moved on.

At the undergraduate level, I have handled courses singly and jointly in General crop protection, Introduction to the study of Arthropods and Microorganisms and General plant pathology. Others include Plant disease management, Crop protection Technology and Pollution Studies and Farm practical training programme. I have also handled courses such as Plant Bacteriology, Pathogenic Mycology, Plant Virology, Methods in Plant Pathology Research, Computer Appreciation and Application for Agricultural Students, Food Security, and Environmental Management and Human Security at the postgraduate level.

In the area of project supervision, I have initiated and successfully supervised over One hundred undergraduate and Master's projects, while at the doctoral level,13 Ph.D. theses in Agriculture and Peace and Development studies have been, or are being supervised by me.

On the aspect of Community service, I have had the privilege of serving in various capacities at the Departmental, Faculty and University-wide levels. I have served as Departmental Examinations and Seminar Co-ordinator, Postgraduate co-ordinator, and as Acting and Substantive Head of Department. Presently, as the Director of the University Sugar Research Institute, one of my contributions is co-ordinating the setting up of one of the largest, if not the largest, Sugarcane Biofactories in Nigeria, in our Permanent site at Jimba Oja, in Kwara State, on behalf of the National Sugar Development Council and the University of Ilorin. This project, which is conceived to run on commercial basis upon completion, will ensure an unbroken flow of supply of high quality tissue-cultured sugarcane seedlings to sugar estates as well as their out-grower farmers across the country. It is hoped to contribute immensely to the Nigeria Sugar Master Plan (NSMP), aimed at achieving self sufficiency in sugar production.

I have served as the Mayor of the Senior Staff Quarters on the Main campus and presently serve as Staff Adviser to the National Association of Agricultural Students (NAAS). I must not forget to mention that I have also served and continue to serve on various Committees (Senate Research Grants, Admissions, Communications, and Business Committee of Senate (BCOS) (to mention but a few) that are statutorily set up for the smooth running of the University. I thank God for all these opportunities.

At the Town and Gown level, I have had interactions with local farmers and community heads across the Senatorial districts of Kwara State (see Plate 17), understudying their crop pest and disease challenges, as well as enlightening them on how to overcome by adopting recommendations of our research findings and especially the Integrated Pest/Disease Management approach. All these endeavours are important aspects of my humble contributions, as a crop protectionist, towards ensuring Food security in Kwara State in particular and Nigeria at large.

Plate 17: At some community service endeavours. Top left: At Fadama farmers field in Ajasse-Ipo, Kwara South, Top Right: With some farmers at Shonga, Kwara North; Below Left: With some Rice Farmer groups (Ganaza Rice), at Lafiagi, Kwara North and Below Right: With some women vegetable farmers along Otte road at Asa LGA, Kwara Central. These visits were facilitated, in large part, by the Kwara State Agricultural Development Project.

Conclusion and Recommendations

In conclusion, Mr Vice-chancellor sir, I make bold to say that crop protection is an essential part of crop production with its processes transcending the whole production efforts from land preparation to post harvest operations. It is my candid opinion, therefore, that since crop produce and products constitute the bulk of the food that man consumes to lead a healthy and active life, the issues concerning the discipline and the scholars / practitioners of crop protection should be taken seriously by all stakeholders. This is more so because, no protection translates to no good crop growth, no good yield, no good harvest, low food output and inevitably food insecurity with its attendant biological, socio-cultural, economic and political implications.

Furthermore, I like to submit that the role of the Crop protectionist to plants' health is like that of a general medical practitioner to human beings, while the practitioners of the various sub-disciplines of crop protection are like the specialist doctors. Logically taken, therefore, if the human health practitioners, and indeed their animal health counterparts, are regarded as indispensible in the society and their welfare issues are not taken for granted, why then should the plant health practitioners' case be any different?

Certified protectionists, therefore, should be able to make good money for themselves. To this end, I implore all relevant stakeholders (especially the Nigeria Society for Plant Protection) to initiate and facilitate the registration of plant protection as a recognized profession, backed by an Act of the National Assembly. In short, the Institutionalization of Plant Protection is long overdue. This, I strongly believe, will go a long way to regulating the practice of plant protection in Nigeria, thereby assuring food security not only through food availability (quantity-wise) but more importantly through food safety (quality-wise).

Opportunities should therefore be open to trained crop protectionists to make careers as Plant Health Consultants and Extension Agents with the Ministry of Agriculture, Agricultural Development Projects and other relevant Agencies so as to contribute to the dissemination of quality crop protection technologies to the primary producers to enhance their productive capacities.

Research efforts in Crop Protection, like other disciplines, should be geared continually towards applicability and their outputs should be made readily available and accessible to the end users. Crop protection research is normally laboratory, greenhouse or field-based. However, notwithstanding the experimental location, the scale of the research usually depends on the objectives of the study and the available funding. It may involve single individual efforts but these days most are joint efforts by research groups that are not necessarily based in the same institution. It is therefore not uncommon, to find papers emanating from joint efforts having sometimes ten or more authors. What I am emphasizing, in essence, is that collaborative efforts among scientists is the in-thing in the world of present day crop protection research and this has to be encouraged if we must make meaningful headway in this part of the world too.

More young people should be encouraged to take up career opportunities as next generation researchers in the various sub-disciplines of Crop Protection and as field practitioners. In this regard, pest control services stand out as the most favourite option open. It is unfortunate, however, that this aspect of protection is still largely practiced by those with little or no formal training in the discipline. Little wonder, we have increasing cases of food poisoning from pesticide abuse and misuse. This trend should be discouraged and effectively checkmated.

The issue of adequate funding of research activities in Crop Protection and Agricultural Science in general, should be accorded priority attention. Modern research efforts require advanced equipment and reagents. The traditional 'hoes and cutlasses' are just not enough any longer.

Finally, Mr. Vice-Chancellor sir, I believe that crop and environmental protectionists will forever remain relevant for as long as there are crops and the environment to protect and hungry citizens to feed. Well, I cannot conceive of a time when these elements will cease to exist. For if they cease, God forbid, then, humans too are essentially no more.

Acknowledgements

My gratitude goes first to the Almighty God, the Creator of Heaven and Earth for His unflinching faithfulness to me since my coming into this world. He only is worthy of adoration for what He has made me to become, though born into a peasant farmer's family some five decades ago. Who would have thought that a good thing could 'come out of Nazareth'? Halleluyah!

On this earthly realm, I will like to acknowledge the individuals who had contributed to my success in the areas of my upbringing, through informal and formal trainings, at home and abroad, my educational career and my working career culminating in the success of this lecture. My sincere gratitude goes first of all to my wonderful parents; Pa Gabriel Ige Balogun (a foremost farmer and palm wine tapper) and Madam Esther Oye Balogun (a petty trader) who despite the enormity of the economic challenges of those days ensured that I had my informal and basic formal

education (primary and secondary schools) under their loving care. Indeed, my father's farm was my first Practical Agriculture laboratory, while my mom's petty trade afforded me the opportunity of being exposed to making money through petty trading. May their gentle souls continue to rest in perfect peace. Amen.

I acknowledge the contributions of all my other family members, both nuclear and extended. You have been very supportive. Thanks for the secret and open 'admiration' of my younger siblings, which nudged me on towards becoming a formally trained 'pest and disease man' instead of the seemingly derisive appellation; "*Baba onikokoro*" of yesteryears. My gratitude equally goes to the very loving women in my life: Cleonice Yumi (Mama Peace) (*Iroiro, osewa ni narimashita. Kore kara mo yoroshiku onegai moshiagemasu*), Titilayo, Nifemi, Yumiko and Harumichan. May God continue to bless you all. You sweeten the home front, thus enabling me to focus properly at work.

I say a big thank you to all individuals under whom I have had the opportunity of receiving formal training right from my primary school days to University level both here in Nigeria and abroad. Elder J. Ogunleye, Elder S.B. Arogbonlo, and Elder (Hon) D.O. Olorunshola stand out as teachers per excellence during my primary school training. May you live long in good health. I must not forget to mention Mr. Kolawole (aka Double) and Pa Abe, who taught me Agricultural Science in the great St. Kizito's College, Isanlu. I recognize the roles of my various lecturers and colleagues at the Zungeru College of Advanced Studies, Bida and the Faculty of Agriculture, University of Ilorin, both serving and retired. In this category, are Professors J.O. Babatola (rtd), A.A Adesiyun, J.A. Ogunwale (rtd), J.A Olofintoye (rtd), the late EEA Oyedunmade, Tai Fagbemi, F. Oluleye (rtd), O.O. Balogun (rtd), J.O Atteh, K.L Ayorinde, J.K. Joseph, E.T.O Oyatoye (rtd), O.A Omotesho and Dr. J.A. Awopetu (rtd). Others include Professors E.O. Salawu (rtd), A.A Adeloye, G. Olaoye and M.A Belewu.

Equally worthy of my gratitude are my colleagues in the Faculty of Agriculture today. Professors Adekunle, Adewumi, Ogunlade, Bolu, Bada, Raji, Kareem and Tiamiyu. I also acknowledge all the staff of the Department of Crop Protection and indeed all other Departments in the Faculty, as well as the members of staff of the Centre for Peace and Strategic Studies, Unilorin. May God continue to guide us all.

I remain grateful to the late Professor Daijiro Hosokawa (my main PhD supervisor), Professor Tohru Teraoka, Professor Yasuhisa Kunimi, Professor Hideki Takahashi and Professor Tsutomu Arie. They contributed in no small measure to moulding me as a plant pathologist, and crop protectionist, in their laboratories in Tokyo University of Agriculture and Technology, Japan. *Honto ni Arigatou gozaimashita. Ii omoide ni narimasu.* I am equally grateful to the Federal Governments of Nigeria and Japan for the various scholarships and fellowships, which enabled me pursue postgraduate trainings at different times.

I acknowledge my past and present project students and staff of the sugarcane fields and office of the USRI, who had contributed in no small way by keying into my research and work plans and assiduously doing their own parts as expected of them. Together with many of them, who have become professional colleagues in this Better By Far University, we have made impressive findings, which have been and are still being published in reputable journals. I say more power to your elbow.

Finally, Mr. Vice-chancellor sir, I say a big thank you to the management of this great University for the opportunities granted me to serve in various capacities in the University, to deliver this lecture, and for continuing to believe in me. May the star of Unilorin continue to shine brighter in the comity of academic institutions in this country and far beyond. Amen.

I thank you all for coming and for listening attentively. I wish you all God’s continual blessings and a safe journey back to your respective destinations. Amen.

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