OBAFEMI AWOLOWO UNIVERSITY . ILE-IFE . NIGERIA

Inaugural Lecture Series 119

SOIL AND NIGERIAN FOOD SECURITY

by

J. A. Adepetu
Professor of Soil Science

OBAFEMI AWOLOWO UNIVERSITY PRESS LIMITED

J. A. Adepetu
Professor of Soil Science

SOIL AND NIGERIAN FOOD SECURITY

by

J. A. Adepetu
Professor of Soil Science

An Inaugural Lecture delivered at the
Obafemi Awolowo University, Ile-Ife.
On Tuesday 14th October, 1997.

Inaugural Lecture Series 119.

OBAFEMI AWOLOWO UNIVERSITY PRESS LIMITED
ILE-IFE, NIGERIA.

ISSN 0189-7845

Printed by
Obafemi Awolowo University Press Limite[redacted]
Ile-Ife, Nigeria.

SOIL AND NIGERIAN FOOD SECURITY

The Nigerian Population Commission forecasts that the population of this country will grow by about 3.6 million people next year, bringing the population to over 110 million people in 1998. At the current 3.3% annual rate of growth, Nigeria's population would have doubled to 226 million in just about twenty-two years time i.e in the year 2020; and by the year 2050 we may have over 600 million people in this country. During this period the land mass of Nigeria will remain what it has always been: 91.2 million ha or 912,000km². That is if we are lucky and the Cameroons Republic dooes not snatch from us the Bakasi peninsula.

Of the 91.2 million ha of land in Nigeria, only about 70 million ha or 73% can be put under cultivation. Thus the amount of cultivable land available per head in our country today is just about 0.85ha. In the coming years, this will progressively diminish to 0.77 in year 2000, 0.41 in 2020 and 0.15ha per head in year 2050. Of course, the trend worldwide is a diminishing land size per head because of the ever growing population. The amount of land available for agriculture per head is dwindling globally from about 0.5 ha in 1950 to a projected value of about 0.12ha in year 2050. However, the real bad news is that, while the level of food production per head in virtually all regions of the developing world (such as Asia and South America) have been rising unabated over the past 20 years, that of Africa has been falling, also unabated. In Nigeria, although the total annual food production increased by an average of 3.1% between 1989 and 1993 (Federal Office of Statistics, 1994), this food production growth has failed to meet up with the 3.3% annual population growth rate of the same period.

Food Security: Definition.

It is a situation where a country has sufficient resources to acquire adequate food for is citizens to lead active and healthy life. Food, in the sense of this definition, can be acquired by directly producing it or by importation. However, real security in food availability will be such that very small fraction or none of the food required *must* be imported, and it has a component of strategic food (grain) reserve which can sustain the country for at least three (3) months. This is the condition that our country should aspire to and sustain, as a minimum social imperative. The following are my reasons:

(i) Historically, countries around the world have used food as political weapon against one another; America against Soviet

Union, Britain against Argentina, and now the entire World against Iraque. This weapon can be used against Nigeria.

(ii) Governments the world over are not as benevolent or Godly as we tend to assume. For, while people in some parts of the world are dying of starvation, in some other parts, governments are destroying surplus food and farmers are rewarded for reducing or even halting food production. Witness the avoidable hunger and dying currently going on in North Korea. According to the *Time Magazine* of 25th August, 1997, up to about 5 million out of the 24 million people of this unfortunate country may eventually starve to death, while international political interests play cruel games with their food weapon. A few years ago, North Korea was a very proud country that could feed itself. Two unfortunate years marked with catastrophic flooding, followed by an unending drought and extra-ordinary heat, has brought North Korea to its knees. Nigeria has displayed so much political arrogance in recent years that, I am afraid, nobody will come to our aid if we are confronted with serious food supply crisis. We nearly had a drought this year!!

(iii) If today, for whatever reason, the Seme (Nigeria-Benin) border is closed for just three months, we will all be in serious trouble. Of course, daring smugglers will probably rise to that challenge; they will not fold their arms and watch us suffer!!

(iv) If we believe, as our government does, that it is our sacred duty to create crisis and fight wars in our neighbourhood (Liberia, Sierra Leone, Cameroon) we must also accept it our lot to provide food for our war ravaged neighbours. For, whether we like it or not, in time of crisis, Nigeria's ever resourceful business people will move our food to our neighbours, as they did in Liberia, even if we do not have enough to eat at home. Liberia probably contributed to the high food prices this country experienced between 1994 and 1996. For this reason, we must produce food not just for our need, but even more to take care of our Nation's exuberances.

So, today, we are faced with a great challenge of producing enough food for a rapidly growing population. As a matter of National priority, we need a vigorous programme of sustainable agricultural production for food security. We need greater and better technological input into agriculture.

Three levels of technological input into agricultural production have been defined by FAO, (1986) viz: low, intermediate and high input levels. These are defined as

(i) *Low input level:*

Low yielding crops; no fertilizer, no chemical pests, disease or weed control; no soil conservation measures; use of traditional implements (hoe and cutlass). Most of our farmers are at this level.

(ii) *Intermediate input level:*

Half optimum mixture of crop population and improved varieties; some but less than optimum pests, disease and weed control; some soil conservation measures; half optimum fertilizer application; manual labour with improved hand tools.

(iii) *High input level:*

Optimum mixture of crops and high yielding varieties; optimum fertilizer use; optimum pests and weed control; complete soil conservation measures; and mechanization.

Nigeria today hovers between low technology input and the bottom rung of the intermediate input ladder. This is demonstrated clearly if Nigeria is compared with five other countries selected randomly around the world. Nigeria applies an average of about 10kg fertilizer per hectare of its cropped land; this is about 8% of world-wide average, 16% of Zimbabwe or South Africa, 10% of U.S.A, 7% of Venezuela and 5% of Israel. Nigeria had the least pesticide and tractor use of the six countries. An FAO study (1986) shows that Nigeria must move higher in the intermediate input scale within a few years by year 2000), and between intermediate and high levels by year 2020 in order to achieve food security. Otherwise we will have to depend on food importation, with all the attendant risks.

The Soil Factor in Nigerian Food Production

Soil is the most important factor in agricultural production; its function as the medium for plant growth underscores this importance. At any location suitable for plant growth, the yield of crops, even varieties with the most high yielding potentials, depend on soil quality and soil management practices applied to cultivating the crop. For this reason, we must regard soil as our resource base for a sustainable future. Among Natural resources, soils are exceedingly responsive to human influence. With careful management we can improve their properties and productive potentials. But much more easily, soils can be destroyed and rendered less productive by misuse and thoughtless development. To attain food security, as defined above, we must find some sustainable, effective and affordable ways or using our soils.

Soils are derived from the break-down (weathering) of rocks. The parent rocks from which Nigerian soils are derived are very diverse. They include various types of igneous, metamorphic and sedimentary rocks as well as loess and alluvial deposits. They range in characteristics from those high in plant nutrients to those low in nutrient, but mostly low; and from highly acidic to highly basic rocks. As may be expected, soils derived from this diversity show variation in chemical and physical properties. This is evident in the soils' content of chemical elements which supply essential nutrients to growing plants. In addition to the generally low nutrient contents of the parent rocks, the rocks have been subjected to long processes of weathering (breakdown) under our tropical (hot and humid) climate; and the resulting soils have been extensively leached. This combination has lead to depletion or loss of a great fraction of plant nutrients in the soils. For these reasons, Nigerian soils are characterised by three important properties:

(i) relatively low fertility; deficient mineral reserves.

(ii) fragile physical structure; soil degradation is difficult to reverse.

(iii) predominance of low activity clay (LAC) particles, which results in low buffering capacity against acid formation, and low ability to retain nutrients (Cation Exchange Capacity) against removal by percolating rain water.

These properties are exhibited to varying degrees in different soils of Nigeria. It is this variation and its consequences that determine the varying productivity potentials of Nigerian soils and dictate the management required to achieve optimum crop yields on the soils.

On the basis of FAO's *Potential Productivity Classification Scheme*, Nigerian landmass has been assessed to consist of about 48% soils of low productivity, 46% of medium productivity, 6% soils of good productivity; it has virtually no soil with high productivity potential. This classification scheme is based on the physical and chemical properties of the soils, particularly nutrient contents, nutrient retention ability, water regime and ease of management.

Nigeria is not alone in having soils mostly of inherently low productivity potentials. This appears to be a general characteristics of tropical soils across the globe. However, as stated earlier, soils are highly responsive to human influence; it is the management and input applied to soils that ultimately determine the productivity level attainable. Obviously, Nigeria must move to an effective application of higher levels of input to our soil resources, in order to attain a sustainable food security; we need research to do this wisely.

Soil Resources Research at Ife

Soils research in this University has developed along four main areas of Soil Science:

(i) *Soil types and uses*: This involves grouping different soils according to their modes of formation and the agricultural uses into which they can be put.

(ii) *Soil Conservation:* concerns the development of practices or techniques which prevent degradation of agricultural land.

(iii) *Soil Improvement*: here we research into, and develop techniques which either provide adequate nutrients for optimum yield of crops or alleviate chemical and physical constraints that may limit crop growth and yield.

(iv) *Soil Microbiology:* this has to do with maintenance or enhancement of the population and activities of desirable soil micro-organisms, especially those whose activities influence nutrient availability to crops.

My own contribution has been in the area of soil improvement, specifically in the area often designated as Soil Chemistry/Fertility and Crop Nutrition. The main concern has been the availability of adequate nutrients from soil to crops growing in the soils, so that these crops can attain optimum yields. The focus has been the development of sound scientific basis for soil fertility evaluation and soil management advisory service in the country.

Appropriately, we started addressing this concern by assessing the general level of fertility of Nigerian soils. Fortunately, some other researchers had earlier carried out surveys along this line. These include Amon and Adetunji (1970), and Agboola and Corey (1973, 1975) then of this university. All we needed do at that time was to update the data of these earlier workers, since soil fertility changes over time whether in use or not. We conducted field sampling of soil and maize plants across southwest Nigeria, and determined in the laboratory the chemical contents of the samples. Aduayi, Adebayo of Soil Science Department, Alofe of Plant Science Department, and Adepoju and Adegbola of Animal Science Department participated in these studies which covered both the forest and the derived savanah zones of Southwestern Nigeria. We concluded from the studies that:

(i) N and P were generally deficient in the soils;

(ii) Although Zn was adequate in the forest vegetation soils, it was deficient in derived savanna soils;
(iii) All the other essential nutrients evaluated except K were adequate in the soils viz Ca, Mg Na, Cu, Fe and Mn.
(iv) While K level in the soils seemed to indicate a general deficiency, analysis of the maize plant samples indicated that K was adequate in the soils. We suspected that the contradiction arose either because the method of K availability determination in the soil or in plant was inappropriate for Nigerian soils, or the standard by which we judge adequacy of nutrients in the soils was inappropriate for Nigerian conditions.

The fund for the forest zone aspect of the study was provided by the URC (O.A.U. Research Fund) and that for the savanna grassland aspect provided by the UNDP/IAEA.

From these results, it was suddenly realised that two important research information were needed as a matter of very urgent priority, if we must proceed without stepping wrongly and making misleading conclusions about the chemical properties and the fertility management requirement of Nigerian soils. These are:

(i) the *chemical analytical methods* that are appropriate for Nigeria soils to determine the amounts of nutrient available to plant from soils.
(ii) the *critical soil values*: this is the level of a nutrient in soil, below which the soils is said to be deficient in the given nutrient and above which the soils is said to contain adequate amount of the nutrient for optimum crop yield.

Up till that time, the soil-test methods and the critical soil-test standards used in Nigeria were adopted from temperate countries mainly U.S.A.; yet it was recognised that each country must evolve the methods and the reference soil critical value standards appropriate to its own soil environment

For the first aspect, we realised early that there was a need to determine which fractions of a soil chemical element should be tested for, as index or predictor of nutrient availability to crops from soil. Working with my students notably Adetunji, Anyaduba, and Abimbola, in a series of studies, we determined that:

(i) At the early few years of long-term cultivation, soil organic-P is a good predictor or index of P availability to crop from soil; In subsequent years, Al-P plus Fe-P is the appropriate index.
(ii) Exchangeable-K plus fixed-K is a much better predictor of K availablility than the exchangeable-K alone commonly targetted, especially in igneous/metamorphic soils.
(iii) Water-soluble-S plus surface-adsorbed inorganic-S is the appropriate index of S availability, even when Org-S is 75% of total Soil-S;
(iv) Sorption characteristics of Nigerian soils, a physical phenomenon, influences the extent to which phosphorus fertilizer chemicals applied to soil will become available and useful to crops.

These information are important because, for the first time, we are reasonably sure of the soil chemical fractions from which crops obtain most of their nutrients in Nigerian soils. These are the appropriate fractions for which we should design chemical extractants which could be used in evaluating soil fertility. We did not bother to evolve chemical extractants because other researchers around the country were actively pursuing this.

With regards to critical soil-test values, we embarked on a series of field calibration studies, to generate standard values for Nigerian soil environment. In this regard, our studies in the Southwestern zone of the country was complemented by similar studies by colleagues in the Eastern and Northern parts of the country. These works were summarised (Adepetu and Adebusuyi, 1985) to evolve the critical soil-test values that have since been adopted as the standard values for assessing the fertility status of N, P, K, O.M, S, Mg, Zn, B and pH in Nigeria. A table of critical nutrient concentration in plants *(internal critical values)* was also produced for evaluating the nutritional status of the following important crops of Nigeria: Maize, Rice, Sorghum/millet, Cowpea and Cassava.

Critical soil-test standard is a very useful parameter in soil fertility evaluation. When a farm soil is tested, the data obtained is, to a farmer, just a number which is meaningless unless the farmer can interprete it in terms of whether the farm soil is deficient or adequate in the nutrient element tested e.g. P, and in terms of the extent of deficiency. Critical soil-test value is needed to determine whether the soil is nutrient deficient or not. It indicates if we should or should not recommend the application of the nutrient to soil as fertilizer. With it, data from soil testing can be evaluated, but only two fertilizer rate options can be considered:

(i) no fertilizer application; when soil test value is above the critical level.
(ii) application of fertilizer when soil test is below critical level; apply an amount deemed adequate which is the same for all degrees of deficiency.

Thus a uniform quantity of fertilizer is added in all cases when the soil test is below the critical value, and none is added when it is above. This is better than applying fertilizer to all soils without testing to determine if the soil needs fertilizer or not. However, the critical soil test value does not determine:

(a) the degree of nutrient deficiency in the soil
(b) the quantities of amendment e.g. fertilizer, needed to correct various degrees of deficiency.

The next step in our studies was to develop the criteria for classifying Nigerian soils into different degrees of nutrient fertility/deficiency. Funded again by the University Research Fund, we conducted field calibration studies in twenty-three different locations covering all the major soil types and ecological zones of southwestern Nigeria. While here at Ife, we concentrated our effort on P, K, O.M., and S, similar studies were conducted by our colleagues (Sobulo, Osinami, Banjoko) at IAR&T, Ibadan, in which they worked on N, Zn, Fe and B. Results from these studies were summarised and used in developing the criteria (soil-test ranges) for classifying soils into different fertility levels. It is this criteria which we developed that is used for soil fertility classification in Nigeria today (Sobulo and Adepetu, 1987). With these criteria, soil-test data in Nigeria can now be grouped into low, medium or high fertility classes. The quantity of additional plant nutrient needed in soil to effect optimum improvement of soil fertility is determined by the fertility class to which the soil belong. Low fertility class soil needs high rates of fertilization, while high fertility class soil requires little or no fertilizer application; A medium fertility class soil requires moderate fertilizer application rate. We have also determined the different rates of additional nutrients needed at different soil fertility levels for most arable crops of Nigeria.

The purpose of all we have been doing is to device a rational, accurate and scientific basis for developing an efficient soil-testing and soil fertility management advisory service for this country. Soil testing/soil management advisory service is regarded, world-wide, as an indispensable tool for attainment of sustainable food security. Efficiency of soil testing advisory service depends a lot on the credibility it has with farmers; which is a matter of providing accurate soil-test results and sound data interpretation, in time. The speed, accuracy and effficiency of soil-management advisory service has, in recent years, been enhanced in the developed world by the use of computers. Computer aided recommendation is not yet a common practice in developing tropical countries. However, with increasing availability and

use of personal computers in these countries, it is now possible to apply computer technology to soil-testing and soil management advisory service in the developing countries.

The first attempt at such a development in Nigeria was made here at Ife in 1987. In that study (Adepetu and Olufokunbi, 1987), we in Department of Soil Science collaborated with Faculty of Technology to develop a computer programme with which fertilizer recommendations are generated from soil test data, within seconds. All you need do is to input the soil-test value of the given farm and indicate the crop to be grown; the computer makes its recomendation instantly. We also developed a modified version of this programme, which was designed to provide graphical outputs that could be used, as reference charts, to determine fertilization rates whenever a computer facility is not available to a soil-testing laboratory. These charts are invaluable because, even now, most laboratories and agriculture extension personnels in this country have no access to computer facilities.

Soil-Testing advisory service and the Nigerian farmer

The purpose of soil testing programme is to enable the farmer uplift soil productivity by improving soil fertility through efficient utilization of fertilizer and other soil amendments. The conventional soil-testing operations for achieving this goal consists of:

(i) Soil sampling on farmers farm
(ii) Soil sample analysis in a soil testing laboratory
(iii) Evaluation and interpretation of soil analysis results; and fertilizer/soil management recommendation

These operations cost money. Therefore, the conventional soil-testing programme seems to be designed primarily for farmers who can afford the cost. This poses no problem in most developed, industrial world because in those countries, farming is itself a commercial enterprise. The situation in Nigeria is however different. Nigerian crop agriculture today is characterized by three categories of farmers:

(a) *Small scale peasant farmers:* with little funds available to invest on their farms. Such farmers may be unwilling or unable to pay for expensive soil-testing operations. This category of farmers probably account for over 90% of the National food-crop output.
(b) *Medium to large-scale commercial farmers:* who have sufficient fund and therefore can afford the cost of soil testing service. This group of farmers account for less than 3% of the national food crop production.
(c) *Cooperative farmers:* who operate medium to large-size collective

farmers, often on profit-making basis. They are willing to participate in soil testing programme (Jibowo and Adepetu, 1985) and they can afford the cost of soil testing service. This category account for probably less than 5% of the National food crop output.

Conventional Soil Testing programme will serve medium to large-scale commercial farmers, as well as cooperative farmers; it will probably exclude the small-scale farmers who produce over 90% of Nigerian food crop. Such a scheme can not succeed in making meaningful contribution to the attainment of food security for this country. Therefore the soil testing service strategies that can be productive here must be somewhat different from those practised in most Industrialised developed world, at least for now.

In 1988, I was invited to give one of the lead papers for the Soil Science Society of Nigeria annual conference, on the subject *"Soil testing for continuous Crop Production in Nigeria (Adepetu, 1988)"*. And I had this to say:

> "It appears necessary to re-examine the philosophy guiding our efforts in soil testing programme development in this country; and if necessary, revise our strategies in order to ensure relevance to Nigerian farmers. For, if the recommendations arising from all these research are not adopted and practiced by Nigerian farmers, our efforts are but a worthless academic exercise, with little benefit to the Nation"

I then went on to propose that two soil-testing systems be developed and operated, in parallel, as follows:

(i) A system of semi-specific recommendation based on soil-type/soil-fertility-class grouping of Nigerian soils. This will involve producing soil fertility classification maps that would be used, along with fertilizer response characteristics of soils, to determine the fertilizer needs of different farm locations in each zone. This is designed for small-scale farmers. The soil test would have been done and the results plotted on a map of the area, for the benefit of farmers. So farmers will not need to pay for costly soil test operations.

(ii) A system of farm-site specific soil-testing and fertilizer recommendation programme i.e. the conventional type, designed for commercial medium to large scale farmers.

By the time I made this proposal, we at Ife had already produced what we regarded as the *First Approximation* of the ***Soil-fertility-classification map of southwestern Nigeria;*** this was accompanied with a table of fertilizer recommendations for the component fertility zones of the mapped area (Adepetu, 1986). The fund for this work was provided by the Federal Ministry of Agriculture, and the work done during my sabbatical year at the Federal Department of Agricultural Land Resources, then at Kaduna. That work was published as a ***farmers' advisory handbook*** by the Federal Government; and today it is used as standard reference by agricultural extension workers and farmers. We also developed a step by step procedure for the Federal Department of Agricultural Land Resources, which has since been used to develop similar soil fertility improvement advisory guidelines for the other regions of the federation.

Emerging Problem: New Challenge

In the past, shifting cultivation and the fallow system had been a reliable strategy for maintaining soil fertility in Nigeria. This traditional system functions perfectly as long as demographic pressure does not intervene. However, as stated earlier, Nigeria's population is increasing and the size of land available per head for food production is diminishing fast. Consequently, today the traditional shifting and fallow system is no more efficient to maintain soil productivity, because the fallow period is either too short or non-existent. As evidence of this, a series of studies conducted by the IITA in Kaduna, Katsina, Sokoto and Bauchi states (Manyong and Carsky, 1994) showed that the fallow period had totally disappeared in 59% of the villages and declining in 26% others. The situation in Southern Nigeria is even more serious because fallow period is now less than three years in most of southwest and no more existing in most of Southeast of Nigeria. A minimum fallow period of 6 years in the South and 10 years in the North is required for soil fertility restoration. Obviously, future food availability will rely on intensive, continuous soil cultivation.

About 30 years ago, 1968, the Soil Science Department of Obafemi Awolowo University embarked on a long-term study to determine what changes in soil physical and chemical properties as well as soil productivity would take place when the soil is subjected to continuous cultivation with and without fertilization. The study was initiated by the late Dr. Olupelu Jaiyebo and Professor R B. Corey (my tribute to these fine researchers, to whom I owe a lot: Dr. Jaiyebo started the supervision of my M.Phil Postgraduate programme, and

Professor Corey took over and saw the programme through following the death of Dr. Jaiyebo). I have been the coordinator of the long-term study since 1975. My colleagues notably Professor Aduayi and Dr. Olu-Obi as well as several students - Mr Uponi and Miss Umoh participated in the project. The following main conclusions were reached after 18 years of the study:

(i) Nitrogen fertilizer application increased soil Acidity; the pH reduced by 30%;

(ii) Increased soil acidity resulted in about 60% Increase in P-adsorption by soil particles i.e. it limits P-availability to plant from soil.

(iii) The capacity of the plough layer of soil to retain nutrient Cations, so that it is not washed down by draining Rainwater, has been reduced by 70%. Also the Soil organic matter content had declined by about 75%; and surface soil clay content by 40%

(iv) Crop yields decline with years of cultivation, even when fertilizer is applied to the soils.

We seem to have created or at least exposed a new problem here. It baffled us that crop yields declined under intensive soil cultivation, even though fertilizer was added to maintain soil fertility. We suspected this to be attributable not just to changes in soil chemical properties, but probably also to some alterations in soil physical properties during intensive cultivation. Professor Aina of our Department was therefore invited to determine the physical changes that might have occured in the soil over the years of continuous cultivation, and evaluate the significance of such changes on soil productivity. The main conclusions from his study were that aggregate stability, pore space (porosity) and water-infiltration rate had declined significantly over those years of continuous cultivation (Aina, 1979). All of these would have combined with chemical soil degradation observed earlier to reduce soil productivity. Intensive soil erosion could be an added bonus.

We realised that the common factor to all these physical and chemical soil problems is the soil organic matter which, as noted above, declined by 75% during 18 years of cultivation. Before then, we had shown in our earlier studies that, within a year of opening a fallow land for cultivation, Nigerian soil undergoes about 30% O.M. decline and about 27% organic-P loss (Adepetu and Corey, 1975; 1977). The characteristic low O.M. content of Nigerian soils, coupled with its rapid rate of dissipation under cultivation suggests that Nigerian soils may be poorly adapted to continuous cultivation; unless of course, a reasonable amount of O.M. can be maintained in the soil. This is especially so because the soil clay content is dominated by low activity clays (LAC)

Several studies had, by this time, demonstrated that a combined application of organic materials and mineral fertilizer to soil benefit both the crop and the soil tremendously. Notable among such studies are those of Olayinka and Adebayo at Ife; Aina and his students also at Ife; Agboola and his students at U.I.; Lombin, Abdulahi and Yayock at A.B.U.; Adeoye also at A.B.U. and Okigbo at U.N.N. etc. The challenge is how this can be accomplished, in practice at the farmers' level. Even if we have an abundant source of O.M., how do we supply O.M. to a farmer conveniently and make him use it on his farm with minimum handling problem.

We decided to look into this by assembling an interdisciplinary team from faculties of Agriculture, Science and Technology. The team formulated a proposal for research which is now being funded by the National Agricultural Research Project (NARP) of the Department of Agricultural Science in the Federal Ministry of Agriculture and Natural Resources; and supported by the World Bank. The aim is to produce organic fertilizer from urban solid wastes, (the type found in waste dumps in cities across Nigeria) and introduce this to farmers. We hope to achieve the following by executing the project:

(i) develop local technology for manufacturing organic fertilizer from urban solid wastes.

(ii) using organic fertilizer so produced, develop management practices for sustainable optimum productivity of Nigerian soils under long-term, intensive cultivation

(iii) induce drastic reduction in the need for mineral fertilizer importation into the country.

(iv) provide avenue for beneficial and efficient disposal of urban wastes; ultimately promote public health.

I must confess that I do not know much about some of the things we are trying to do. All I have done is dream up the idea, and coordinate a team-effort to make the dream a reality. Members of the team include Professors P. O. Aina, Y. L. Fabiyi, J. O. Ilori and Dr. E. O. Laogun of the Faculty of Agriculture; Professor Layokun, Mr. Adewumi and Mrs. Olufokunbi from Faculty of Technology; and Professor Ako-Nai of the Faculty of Science. Since the project started we have seen the need for a further input from the Faculty of Technology; Professor Ige of that Faculty has agreed to provide technical advise on the mechanical engineering aspect of the project, whenever consulted. I am happy to report that we have made some encouraging progress, and there is a clear indication that the goals of the project will be attained. Two recent government policies since the study commenced have made a successful outcome of the study an important factor in the achievement of food security in this country:

(i) government has banned virtually all forms of inorganic fertilizer importation into the country. Yet local production does not meet domestic requirement, even at the low rate of fertilizer application that currently prevails. In 1994, total local production for domestic use was 0.8 million tonnes; the total amount consumed was about 2.5 million tonnes.

(ii) the official price of fertilizer has increased from N150.00 in 1996 to N2,000.00 in 1997. In doing this, government drew its inspiration from the "REMOVE SUBSIDY" creed of the I.M.F. Note that both the USA and the European Union engage in massive support (subsidy) of their agriculture, even today.

The consequence of these policies is that majority of our farmers may be unable and unwilling to use fertilizers for food production, unless cheaper, readily available alternatives or complimentary sources of fertilizer are developed

Observations and recommendations

(i) *Inconsistency in Agricultural Development Policies and Strategies*

One of the major barriers against growth in agricultural and food production in this country is the inconsistency or lack of continuity in the application or adoption of policies and strategies. Agricultural development policies and strategies are most successful when a long-term perspective is adopted rather than a short-term approach (Okigbo, 1986). Consistency does not rule out the need for periodic modification of strategy based on a thorough review of policy implementation. However frequent, unpredictable changes in policy, strategy and fiscal commitment in this country is inimical to agricultural growth. Paradoxically, it arises, most often because there is a change of government or change of minister in the same government. An example that touches on agricultural land use and soil management will illustrate this peculiar Nigerian way of doing things.

In 1991, the Federal Government established the National Agricultural Land Development Authority - NALDA - with the charge that it *facilitate optimum utilization of Nigerian soil resources for sustainable high productivity by addressing the chronic problem of low-level application of science and technology into agricultural land-use in Nigeria.* NALDA was to ensure minimum soil degradation, and promote soil testing service for soil management and ultimately promote sustainable productivity of Nigerian soil resources. The hope was that through its activities, NALDA would *contribute significantly towards the attainment of National food self-sufficiency and food security.* The strategy was to assist farmers in the art of using land productively under long-term continuous cultivation. NALDA had the target of assisting about 12,000 farmers to develop a total of about 50,000 ha of farmland in each state of the federation; each farmer having a maximum of 4 ha of farm. By 1995, the programme had taken off very successfully in many states of the federation, such as Kano, Niger, Bauchi, Ondo, Imo, Kwara etc. It was a great joy interviewing participating farmers on their farms and noting their awareness of the need for soil conservation and continuous soil improvement practices; as well as the importance of participating in soil testing programme.

Then, out of the blues emerged, at the end of 1996, a new government directive that more or less effectively stopped NALDA in its track. The directive nullified the independence of NALDA from the characteristic bureaucratic bottleneck of the Ministry, and also reduced to near-zero the level of financial commitment of the federal government to the programme. As of now, NALDA has virtually stopped all its field activities since the beginning of this year; and the participating farmers are left bewildered; the credibility of government and its agencies is at risk. For the sake of sustainable long-term soil productivity and the role this will play in future food security of this country, I wish to appeal that our government should renew its commitment to NALDA before it dies completely.

(ii) *Soil-testing and Soil Management Advisory Service*

Soil-testing and land use advisory service has developed too slowly in Nigeria, probably because the conventional soil-testing scheme on which we have concentrated most research efforts in the past two decades, is not appropriate for majority of Nigeria farmers, the small-scale farmers who provide over 90% of agricultural output of this country. There is a need to give greater attention to the development of credible, semi-specific soil-testing and soil improvement advisory programme, that can attract the acceptance of small scale farmers, and result in widespread increase in fertilizer use among these category of farmers. At the same time, we should continue to further develop and improve the efficiency of the conventional farm-site specific soil testing scheme for the country. A few years ago, the Federal Government showed keen interest in soil testing service by building National soil-testing Laboratories at Ibadan, Owerri, Kaduna and Jos, and sponsoring field calibration studies across the country. There is a need to renew this interest and commitment to development of soil-testing and soil management advisory service in Nigeria. Government should encourage and support the establishment of private, non-governmental soil testing laboratories to cope with future development in Nigerian Agriculture.

(iii) *Development of Organic Fertilizer Industry*

The future requires that we will farm the same piece of land continuously. We will be faced with the challenge of increasing food production on existing land that are already in cultivation; we will have to do this in a way that does not lead to soil degradation and diminished soil productivity. Combined use of chemical and organic fertilizers is required for sustainable soil productivity in this country under intensive continuous cultivation. Therefore government should encourage the development of organic based fertilizers, in pure form or fortified with chemical fertilizers.

(iv) ***Input Distribution** and Cropping **Calendar***

In June 1996, Osun State Government inaugurated a committee to plan the mode of distribution and sale of fertilizer to farmers for the 1996 cropping year. The cropping year started in March and by May/June both maize and yam were already being harvested. Osun State Committee on Fertilizer Distribution had its first meeting in July, 1996. Similarly, in 1997, the Federal Council of State, including all 36 Military Administrators and some Federal Ministers had what was called a very important meeting at Abuja. Chairmaned by the Head of State, the meeting lasted one week and ended 23rd June, 1997. The purpose was to deliberate on strategies of securing enough fertilizer and get this distributed to farmers for the 1997 cropping season. To put the decision reached at abuja meeting into effect probably took another one month i.e around early August, 1997. Note that Cropping season starts May in the North and March in the south. Government should recognize the importance of timeliness in input supply and input application to crop production achievement of the country.

(v) *Funding Soils Research*

Decline in soil fertility and productivity under intensive cultivation must be recognized as a serious problem that has implication for food security in our country. Every crop harvested from the land is accompanied with removal of plant nutrients away from our soils (nutrient mining); it robs the soil of its productivity; it exhausts the land. Every agricultural export from Nigeria therefore amounts to exporting some good fraction of our soils out of the country. I propose therefore that 1% levy be imposed by government on all agricultural produce exported out of this country, raw or processed: Cocoa, Palm produce, ginger, cassava/gari, Soybean, Sorghum, Cotton-seed etc. The proceed of this levy should be used strictly for research into appropriate methods of improvement, management and conservation of our soils. Long-term sustenance of food security for our country demands no less contribution from exporters of our agricultural produce.

Let me conclude this lecture by quoting from a statement made about fifty years ago by Lord John Boyd Orr, the first Director General of FAO (1948):

> "*Increases in agricultural production are possible through* modern methods. But those advances in science will be useless unless there is enough good land for farming. If the soil in which all agriculture and all human life depends is wasted away, then the battle to free mankind from want can not be worn".

Nigeria can attain long-term food security, but first we must recognize the crucial role of soil in that adventure. Our soil must be nurtured and protected, to enable it play its role effectively as the resource base of a sustainable food security.

Acknowledgement

First, I thank God for the privilege to look up to Him with hope in times of need and joyfully in times of abundance. My most sincere appreciation goes to my Dear wife, my counsellor and my friend, MRS. FUNMILAYO ABEKE ADEPETU, for her love and support; she is an Angel of admirable human quality. I wish to thank my children: Olukemi, Olubukola, Ayodeji and Adeyemi for their tolerance, love and support at all times; they are a priceless gift from above. My brother - Mr. Demola Adepetu and his family; and all my other brothers and sisters, for their support. My cousins - Arch. Wole Esan and Chief (Mrs.) Bola Adenuga have continually given moral support.

I appreciate the collaboration and encouragement of my academic colleagues and students in the Department of Soil Science and those others with whom I have collaborated throughout the University and elsewhere. My special appreciation goes to the laboratory and administrative staff of soil science department. I thank Mr. Kolade, the Manager, University Teaching and Research Farm and his staff for the valuable assistance rendered during our field calibration and fertility survey studies.

I acknowledge with gratitude the research grants provided by the University through the URC; as well as the research support by IAEA/UNDP; Federal Department of Agricultural Land Resources (FDALR); and the National Agricultural Research Project/the World Bank.

To all of you present here tonight, I say thank you for your attention. May God bless you all.

References

Adepetu, J. A. (1986). Soil Fertility and fertilizer requirement of crop in Oyo, Ogun and Ondo States. *FDALR/Fed. Min. Of Agric. And Rural Dev. (Publ.). 1986.*

Adepetu, J. A., (1980). Soil-testing for continuous crop production in Nigeria. *Soil Sci. Soc. Nig. Proc. 1988.*

Adepetu J A., A. A. Adebayo, E. A. Aduayi and C. O. Alofe. (1979). A preliminary survey of the fertility status of soils in Ondo State under traditional cultivation. *Ife J. Agric.* 1(2):134 -*149*.

Adepetu J. A. and B. A. Adebusuyi, (1985). Available data-base for soil testing programme in Nigeria, and further deficiency-evaluation required for its improvement. *Workshop on soil fertility survey of Nigeria, Jos, FDALR, 1985.*

Adepetu J. A., J. A. Adepoju and A. A. Adegbola, (1982. Responses of Guinea grass to P and Zn application in grassland soils of South Western Nigeria. *J. Trop. Agric and Vet. Med., 20(4): 371 - 378.*

Adepetu, J. A. and R. B. Corey, (1975). Organic phosphorus as a predictor of plant available phosphorus in soils of Southern Nigeria. *Soil Science, 122(3): 159 - 164.*

Adepetu J. A. And R. B. Corey, (1977). Changes in N and P availability and P fractions in Iwo soil from Nigeria under intensive cultivation. *Plant and soil. 46: 309 - 316.*

Adepetu, J. A. and K. C. Olufokunbi, (1987). Computer Model for determining the fertilization requirements of different crops for soil-test results. *Soil Sci. Soc. of Nig. Conf. Proc. 1987: 253 - 265.*

Adetunji, M. T. And J. A. Adepetu, (1990). Status and distribution of Sulphur fractions in soils of Southwestern Nigeria. *Nig. J. Sci. 24(1 and 2): 137 - 140.*

Adetunji, M. T. And Adepetu J. A. (1993). K supplying capacity of representative soils of South Western Nigeria as measured by Intensity, Quantity and Capacity factors. *Pertanika J. of Trop. Agric. Sci. 16(1): 71 - 74.*

Agboola, A. A. and R. B. Corey, (1973). Soil test calibration for NPK for maize in soils derived from metamorphic and igneous rocks of Western State of Nigeria. *J. West. Afr. Sci. Ass. 17: 93 -100.*

Agboola R. A, and R. B. Corey, (1976). Nutrient deficiency survey of maize in Western Nigeria. *Niger J. Sci. 10: 1 - 18.*

Aina, P. O. (1979). Soil changes resulting from long-term management practices in Western Nigeria. *Soil Sci. Soc. Amer J. 43: 173 - 177.*

Amon, B. O. E. and S. A. Adetunji, (1970). Review of soil fertility investigations in Western Nigeria. *Research Report No. 55. Research Division. M.A.N.R. Ibadan, 1970.*

Anyaduba, T. and J. A. Adepetu, (1983). Predicting phosphorus fertilization need of tropical soils; significance of the relationships among critical soil solution- P, P- sorption potential and free iron content of soil. *J. Trop Agric., and Vet. Med. 21(1) 21 - 30.*

Bukar Shaib, Adamu Aliyu and J. S. Bakshi, (1997). Nigerian National Agricultural Research Strategy Plan: (1996 - 2010.

Fairclough, J. A. (1988). Statement in: Agriculture in year 2000, the case of ACP countries. *International Forum Proc. Athens, 1988. CTA 1988 (Publ.).*

FAO Production year book, (1994). FAO Rome, 1994.

FAO, 1986. African Agriculture: The next 25 years. Annex II. The Land Resources base. *FAO Rome, 1986.*

Federal Office of Statistics, Review of Nigeria Economy, 1993: *Fed. Rep. Nig. (Publ.), 1994.*

Jibowo, A. A. and J. A. Adepetu, (1985). Fertilizer use and soil-testing in southwestern Nigeria. *Fed. Dept. Agr. Land Res. (Publ.) 1985.*

Nabhan H. (1996). Land Degradation and Food Security. *In Simple Soil, Water, and Plant Testing Techniques for Sol Resource Management. J. A. Adepetu, H. Nabhan, and O. Osinubi (ed) FAO Rome (Publ.) 1996.*

Sobulo R.A. and J. A. Adepetu (1987). Soil testing and fertilizer formulation for crop production in Nigeria. *In: Towards efficiency of Fertilizer Use and Development in Nigeria. Fed. Min. Agric. W.R. & R. D. Lagos (Publ.) 1987. Sobulo et al; (Ed.).*

Bruce W. Nelan, (1997). The Politics of Famine. *Time Magazine, August, 25, 1997. Pages 26 - 28.*