



# **AGRICULTURAL SUSTAINABILITY IN THE DRYLANDS OF NIGERIA: REALITIES & PROSPECTS**

**Professor Essiet Unanaowo Essiet**

Faculty of Agriculture  
Bayero University, Kano-Nigeria

**Wednesday, May 22nd, 2013**

**Bayero University, Kano, Inaugural Lectures Series  
No. 11**



**PROFESSORIAL INAUGURAL LECTURE**

**PROFESSORIAL INAUGURAL LECTURE**  
**AGRICULTURAL SUSTAINABILITY IN THE DRYLANDS**  
**OF NIGERIA: REALITIES AND PROSPECTS**

**Professor Essiet Unanaowo Essiet**

Faculty of Agriculture  
Bayero University, Kano – Nigeria

22<sup>nd</sup> May, 2013

*Bayero University, Kano Inaugural Lecture Series*  
*No. 11*

Inaugural Lecture No. 11



Published for Bayero University, Kano  
By the Public Lecture Series Committee

ISBN: 978-978-932-528-6

OF NIGERIA: REALITIES AND PROSPECTS  
AGRICULTURAL SUSTAINABILITY IN THE DRYLANDS  
PROFESSORIAL INVAUL 6-8-2528-6

Professor Essiet Unnanowo Essiet  
Faculty of Agriculture  
Bayero University, Kano - Nigeria

*Bayero University, Kano Inaugural Lecture Series  
No. 11*

22<sup>nd</sup> MAY 2013

Bayero University, Kano Inaugural Lecture Series  
No. 11

## **SUMMARY OF PRESENTER'S BIODATA**



### **PERSONAL DATA**

Name: Professor Essiet Unanaowo Essiet  
Marital Status: Married  
Number of Children: Five (5)  
Date of Birth: February 13, 1951  
Place of Birth: Ndukpoise; Nsit-Ubium,  
Akwa Ibom State

### **ACADEMIC QUALIFICATIONS**

Ph.D. Soil Survey and Land Evaluation (University of  
Aberdeen, Scotland, U.K)

B.Sc. Plant/Soil Science (University of Nigeria, Nsukka)

### **SCHOOLS ATTENDED**

University of Aberdeen, Scotland, U.K.	1976-1979
University of Nigeria, Nsukka	1970-1974
Methodist Boys' High School, Oron, Akwa Ibom State	1964-1969

### **WORKING EXPERIENCE SINCE FIRST DEGREE**

Professor of Soil Science, Bayero University, Kano	2000 to Date
Associate Professor, Bayero University, Kano	1997-1999
Senior Lecturer, Bayero University, Kano	1985-1998
Lecturer 1, Bayero University, Kano	1981-1984
Lecturer 11, Bayero University, Kano	1979-1980
Junior Research Fellow, University of Nigeria, Nsukka	1975-1979

Professor Essiet Unanaowo Essiet was a Visiting Scholar, University of Cambridge, England in 1994; Visiting Scholar, University of Sussex, England in 1999 and 2002; and Junior Research Fellow at the University of Nigeria, Nsukka, a fellowship that took him to University of Aberdeen for the Doctorate Programme. Professor Essiet won the best graduating B.Sc Honours Student Prize in Plant/Soil Science Department, University of Nigeria, Nsukka in 1974. Professor Essiet has to his credit Thirty [30] works published in local and international reputable academic journals, chapters in collective volumes, monographs and published proceedings and summaries. He has also attended conferences locally and internationally, and presented scholarly papers. Professor Essiet had held several responsibilities within and outside the university. These include, Chairman, Investigation Committee on Students' Disturbances in 1998; Chairman, Maintenance Committee from 1981-1985; Chairman, Central Scheduling Committee from 1999 to 2006; Chairman, Academic Staff Development Committee from 2004 to 2006; Head, Academic Sub-Committee on the Establishment of the Faculty of Agriculture; and Member, Mac Arthur Grant Implementation Committee. Others include, Founding Dean, Faculty of Agriculture, Bayero University, Kano; Dean, Faculty of Social and Management Sciences from 1994-1996; Deputy Dean, Faculty of Social and Management Sciences from 1985 to 1986; Sub-Dean, Faculty of Social and Management Sciences from 1982 to 1984; Head, Department of Agronomy from 2003 to 2005; and Ag. Head, Department of Geography from 1987 to 1988. Professor

Essiet has assessed several Educators to the positions of Associate Professors and Professors at Ahmadu Bello University, Zaria, University of Maiduguri, Maiduguri; Nassarawa State University, Keffi; University of Agriculture, Makurdi, Ekiti State University; and Federal University of Technology, Minna. He was External Examiner [for undergraduate and postgraduate programmes] at Usmanu Danfodiyo University, Sokoto from from 1992 to 1996. Professor Essiet was on the NUC Accreditation Team to Anambra State University and Ekiti State University in 2012. Professor Essiet has supervised some 800 undergraduate dissertations, 27 Master of Science dissertations, and 05 Ph.D. Theses. Professor Essiet is a Reviewer / Referee of Journal of Social and Management Sciences, Bayero University, Kano; Savanna, Ahmadu Bello University, Zaria; Nigerian Journal of Soil Research, A.B.U. Zaria; Journal of Sustainable Tropical Agricultural Research, University of Uyo; and Editor - in - Chief, Faculty of Agriculture Journal Committee. Professor Essiet was the President of the Nigerian Union, Aberdeen [U.K.] from 1977 to 1978. He organized the first ever NIGERIA DAY in Scotland in 1978. From 1992 to 2004, Professor Essiet was actively involved in Contract Research and Consultancy for the World Bank, Federal Government of Nigeria, Chevron Petroleum Nigeria Limited, Elf Petroleum, Nigeria Limited, Shell Nigeria Petroleum Company and so on, on different aspects in his areas of specialization. Professor Essiet's current research interest is on Sustainable Agricultural Production in the Drylands of Nigeria - an academic interest that forms the thrust of this Inaugural Lecture.

## **PROFESSORIAL INAUGURAL LECTURE**

### **AGRICULTURAL SUSTAINABILITY IN THE DRYLANDS OF NIGERIA: REALITIES AND PROSPECTS**

#### **Introduction**

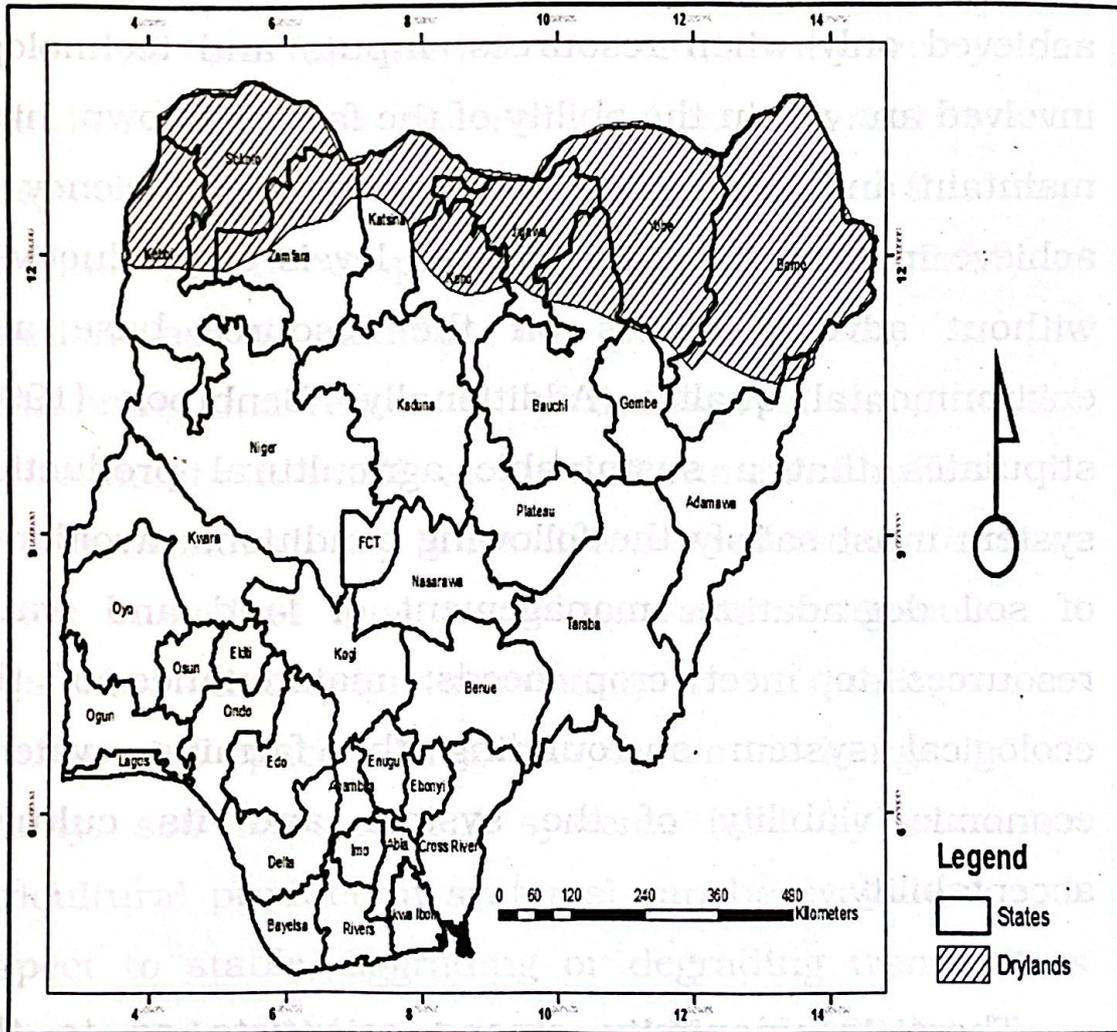
The production of sufficient food to meet the demands of an ever increasing population is one of the greatest challenges facing mankind today. This need has been recognized by the United Nations by the inclusion of the elimination of hunger among the Millennium Development Goals (MDGs). In the bid for enhanced food production, a balance has to be maintained between increased agricultural productivity and environmental quality.

In Nigeria, the need to strike a balance between food production and environmental quality is recognized everywhere especially with soil erosion in the south and desertification in the northern ecological zones. In the past, agricultural land was ample in the country. Issues relating to agricultural sustainability were either played down or largely ignored. However, contemporary realities indicate that agricultural land is a scarce resource in Nigeria and so matters pertaining to agricultural

sustainability must be taken seriously. To neglect them could prove perilous.

The drylands of Nigeria are found in the Sudano-sahelian parts of the country between latitudes 11°N and 13°45'N. They are characterized by marginal climate and fragile ecosystems. This condition is further exacerbated by recent increase in aridity thus forcing the farming population to resort to adaptation strategies which may be changed on annual basis in some cases. It is perhaps in the drylands of Nigeria that agricultural sustainability is most crucial for the following reasons:

- (i) The soils are moderate to poor in fertility and soil degradation is widespread (Essiet, 1990)
- (ii) The rainfall regime is variable and has diminished by about 25 percent since the relatively wet 1960s (Mortimore, 1989)
- (iii) Human population is increasing; the annual growth rate for the Nigerian population is estimated at between 3.0 and 3.5 percent (World Fertility Survey, 1984)



**DRYLANDS OF NIGERIA**

Carto Lab Geography Department BUK(2013)

## **Agricultural Sustainability**

A sustainable agricultural production system is defined as a dynamically stable and continuous production system that achieves a level of productivity satisfying prevailing needs and is adapted continuously to meet future pressing demands for increasing the carrying capacity of the resource base (Okigbo, 1990).

This definition further states that sustainability can be achieved only when resources, inputs and technology involved are within the ability of the farmer to own, hire, maintain and orchestrate with increasing efficiency to achieve in perpetuity, the desired levels of productivity without adverse effects on the resource base and environmental quality. Additionally, Benbrook (1990) stipulates that a sustainable agricultural production system must satisfy the following conditions: avoidance of soil degradation, management of land and water resources to meet crop needs; maintenance of the ecological system surrounding the farming system; economic viability of the system and its cultural acceptability.

There is unanimity among scientists as to the imperative for agricultural sustainability. However, there is no agreement as to what constitutes a sustainable agricultural production system irrespective of how such a system is defined. This lack of agreement arises from the highly subjective nature of qualitative characterization of sustainable agriculture. In an attempt to forge agreement among scientists as to what constitutes a sustainable agricultural production system, Larson and Pierce (1991) developed the Soil Quality Model for quantitative estimation of agricultural

sustainability. Soil quality can be defined as the capacity of a soil to function both within its ecosystem boundaries and with the environment external to that ecosystem (Larson and Pierce, 1991). Defined this way, soil quality can be specifically related to its ability to function as a medium for plant growth, in the partitioning and regulation of the flow of water in the environment and finally as an environmental buffer.

The overall quality of a soil is determined by the sum of the individual qualities of its various attributes. It thus follows that a dynamic change in soil quality occurs in time and space. Using this dynamic change in soil quality, soil management systems (and by extension agricultural production systems) can be evaluated with respect to stable, aggrading or degrading trends thus (equation adapted from Larson and Pierce, 1991)

$$\frac{\Delta Q}{\Delta t} = \sum \left( \frac{q_i - q_0}{q_0 \times \Delta t} \right)$$

Where

$\Delta Q$  = change in overall soil quality (Q) of the soil;

$\Delta t$  = difference in time between the present and when the change was first initiated; and

$q_0$  and  $q_i$  = the quality levels of individual soil variables before and after the initiation of a change, respectively.

Under this scheme, for an agricultural production system (or practice) to be sustainable  $\frac{\Delta Q}{\Delta t}$  must be equal to, or greater than zero. In other words, for an agricultural production system or practice to be sustainable, the soil quality must be stable or observed to be aggrading.

### **Approaches to Soil Quality Evaluation**

There are basically two approaches to the determination of soil quality: where historical data exist (e.g. feasibility studies), the usual approach is to return to the site to collect and analyse soil samples to obtain data. These data would then be compared with the feasibility studies data to determine the direction of change. For such comparison to be meaningful, the period during which a change had taken place should not be less than 10 years. Such an approach has been successfully used to study agricultural sustainability in the Kadawa Irrigation Project in Kano State. This is called Longitudinal Approach.

Secondly, where historical data do not exist, the Spatial Analogue Approach is usually adopted. This consists of comparing data from a plot of land that has

not witnessed any change (e.g. cultivation) for at least the past 10 years with data from a similar plot in the same environment where change has taken place for at least 10 years. This approach has been adopted for the study of northeastern Nigeria covering Yobe and Borno States. Irrespective of the approach that is used, it must first be established that the soil forming factors of climate, vegetation, parent material and time are uniform or similar over the study area thus leaving the biotic factor (human interference) as the only component that could bring about differences in soil properties and quality.

### **Agricultural Sustainability in the Drylands of Nigeria**

The drylands of Nigeria are characterized by an array of farming practice regimes which are a direct response to an ever changing environment brought about by erratic rainfall and increase in aridity. Some of these farming practices have been described by Essiet (1995).

The Soil Quality Model above was used to characterize agricultural sustainability in the drylands. Three (3) broad categories of farming practices were involved based on: (i) method of fertilization/nutrient regeneration (ii) Crop/crop combination and (iii) method of land preparation. The indices used in these studies

were soil physical and chemical parameters which are known to play a significant role in agricultural production in the drylands. Based on these three categories, some farming practices were identified. These include: (1) organic fertilizers only (2) inorganic fertilizers only (3) organic plus inorganic fertilizers: hand cultivated (4) organic plus inorganic fertilizers: tractor ploughed (5) grain/legume mixtures and (6) sorghum only. The findings of the studies are summarized in Table 1.

1. Organic fertilizers only: This farming practice is sustainable. It is however characterized by losses of nutrients and fine soil particles.
2. Inorganic fertilizers only: This practice is characterized by losses of clay and most nutrients and therefore not sustainable. Even though inorganic fertilizers are known to improve soil fertility, they do not enhance agricultural sustainability when used to the exclusion of other soil amendment materials like manures.
3. Organic plus inorganic fertilizers; hand cultivated: With a sustainability index of 0.34, this farming method is the most sustainable in the drylands. The two fertilizer materials act in a complementary manner to improve soil physical and chemical properties and in consequence agricultural sustainability. In addition, hand cultivation

ensures less disturbance of the soil and so soil conservation and agricultural sustainability are enhanced.

4. Organic plus inorganic fertilizers; tractor ploughed:

This practice is similar to the previous one except for the fact that tractors are involved in land preparation for planting. The introduction of heavy ploughs in land preparation leads to the breakup of soil aggregates, smearing and compaction all of which encourage soil erosion and general land degradation. This reason is responsible for the significant decrease in agricultural sustainability index from 34% to 12% (table 1). Thus the practice of minimum or zero cultivation would be of immense benefit in the drylands of Nigeria.

5. Grain/legume mixtures: This is a widely adopted farming practice in the drylands and is believed to enhance soil conservation (Essiet, 1991; 1995). This belief is further strengthened by an observation by Essiet (1989) that of all the farming practices under study in the drylands, this farming practice was the only one where no loss in the soil clay content was recorded. An additional benefit that could accrue from this practice is the enhancement of soil nitrogen status through nitrogen fixation by the root nodules of legumes.

6. Sorghum only: This farming practice is characterized by serious degradation resulting in losses of fine soil particles as well as nutrients. Thus it is not sustainable. The cultivation of sorghum as the sole crop is widely practiced in the drylands. In as much as this practice may be desirable from the economic and mechanization point of view, it is however not beneficial from agricultural sustainability view point since the sorghum crop does not offer enough protective cover for the soil. In order to ensure sustainability therefore, sorghum should always be grown in mixtures with legumes.

**Table 1: Farming Practices and Sustainability Indices for the Drylands of Nigeria**

Farming Practice	Sustainability Index( $\Delta Q/\Delta t$ )
1. Organic fertilizers only	0.16
2. Inorganic fertilizers only	- 0.08
3. Organic plus inorganic fertilizers: hand cultivated	0.34
4. Organic plus inorganic fertilizers: tractor ploughed	0.12
5. Grain/legume mixtures	0.15
6. Sorghum only	- 0.23

Source: Essiet, (1991, 1995, 1998, 2001, 2003)

Summary: We can therefore summarize as follows:

- (i) Not all the farming practices found in the drylands of Nigeria are sustainable.
- (ii) The sustainable practices are those that incorporate organic fertilizers into their soil fertilization schedules, ensure adequate soil cover and preserve soil aggregates.
- (iii) Inorganic fertilizers when used on their own lead to soil degradation; thus they should be used in combination with organic fertilizers to ensure agricultural sustainability.
- (iv) The planting of sorghum as the sole crop does not ensure sustainability and should be cultivated in mixtures with legumes to optimize soil conservation and agricultural sustainability.
- (v) The use of heavy machinery in land preparation is destructive of the soil and therefore detrimental to agricultural sustainability. Land preparation should involve the use of less disruptive equipment like harrows and chisel ploughs. The practice of minimum or zero cultivation should be encouraged.

Soil losses observed in farming practices in the drylands could be categorized into two: pedological and

fertility losses. The pedological losses include losses in fine particles like silt and clay while fertility linked losses include losses in nutrients such as exchangeable nutrients, total nitrogen, available potassium and phosphorus, etc. Fertility related losses can easily be corrected by management through the application of fertilizers (both organic and inorganic). Pedological losses, on the other hand, are more difficult and take a longer period to correct. Moreover, pedological losses could adversely affect the manifestation of management measures e.g. losses in soil clay content would reduce the efficiency of added fertilizers. It therefore follows that pedological losses carry greater and more severe consequences for agricultural sustainability than management related problems. This realization calls for great emphasis to be placed on soil conservation directed at checking the menace of soil erosion. This view is supported by the following relationship (Essiet, 2001):

$$Y = 0.0026 + 0.024C \quad (r = 0.66^{***})$$

Where  $Y$  = sustainability,  $C$  = % clay

### **Future Prospects of Sustainable Agriculture in the Drylands of Nigeria**

Out of the 6 farming practices earlier considered, 4 of them were sustainable while the other 2 were not. Among the sustainable practices, the highest level of

sustainability achieved was 34% (table 1). The indication here is that there is much room for improvement. Efforts aimed at enhancing the prospects of sustainable agriculture in the drylands should take into consideration the following:

- (1) Efforts should be concentrated on farming practices that are sustainable. Rigorous extension services should be embarked upon to get farmers to adopt those practices that encourage sustainability.
- (2) Future enhancement of soil quality would of necessity involve the use of inorganic fertilizers in greater quantities than at the moment. Except for South America, Africa has the lowest use of chemical fertilizers per hectare of cultivated land. As observed above, inorganic fertilizers should be used in conjunction with organic fertilizers to avoid the degradation of soil. In order to achieve this, some farming habits would have to change. For example, the practice of gathering residues and burning them in the course of land preparation would have to stop. Rather, residues should be incorporated into the soil to increase its organic matter content. Additionally, the practice of planted fallows should be encouraged as opposed to bare fallow as presently practised. Moreover, the

huge amounts of wastes that litter our urban areas should be turned into organic fertilizer materials. Most of our municipal and a good number of our industrial wastes have potential as soil amendment materials (Essiet and Tudun-Wada, 1999; Tudun-Wada and Essiet, 2006).

(3) Presently, mechanization is viewed as being synonymous with the use of heavy machines during land preparation. This perception has to change to the adoption of relevant or appropriate technology in farming operations. Such technology should be the type the farmer can easily own, hire, maintain and operate without any detrimental effect on the resource base (i.e. the soil). For example, operations such as sowing of seed, pest control and harvesting could be mechanized using simple machines.

## References

- Benbrook, C. M. 1990. "Society's stake in sustainable agriculture" in Edwards, C. A., Lal, R., Madden, P., Miller, R. H. & House, G. (Eds.), *Sustainable Agricultural Systems*. Iowa: Soil and Water Conservation Society.
- Essiet, E. U. 1989. "The impact of irrigation on soil properties in Kano State". Proc. 2<sup>nd</sup> Workshop on Land Administration and Development in Northern Nigeria, pp. 157 – 163
- Essiet, E. U. 1990. "A comparison of soil degradation under small-holder farming and large-scale irrigation land use in Kano State, northern Nigeria" in *Land Degradation and Rehabilitation*, 2 : 209 – 214
- Essiet, E. U. 1995. "Soil management and agricultural sustainability in the small-holder farming system in northern Kano, Nigeria" in *Journal*

of Social and Management  
Sciences, vol. 2. 37 – 46

Essiet, E. U. 1998. "Farming Techniques and Soil Quality in the Drylands of northern Nigeria" in Ukpong, I. E. (Ed.), *Geography and the Nigerian Environment: A Book of Readings*, 251 – 257

Essiet, E. U. and Tudun Wada, I. Y. 1999. "The effect of solid urban wastes on soil fertility in Kumbotso Local Government Area, Kano State" *Journal of Social and Management Sciences*, vol. 5&6, 55 – 63

Essiet, E. U. 2001. "Agricultural sustainability under small-holder farming in Kano, northern Nigeria" in *Journal of Arid Environments*, 48,1-7

Essiet, E. U. 2003. "Managing soil resources for sustainable production in the semi-arid northeastern Nigeria (SANEN)" in: Onokola, P. C., Phil-

Eze, P. O. and Madu, I. A. (Eds.),  
*Environment and Poverty in  
Nigeria*, Jamoe Enterprise, 74 – 85

Larson, W. E. and Pierce, P. J. 1999. Conservation and  
Enhancement of Soil Quality:  
Evaluation for Sustainable Land  
Management” in Developing  
World, vol. 2. Bangkok:  
International Board for Soil  
Research and Management

Mortimore, M. J. 1989. *Adapting to Drought: Farmers,  
Famines and Desertification in  
West Africa*. Cambridge:  
Cambridge University Press

Okigbo, B. N. 1990. “Sustainable agricultural systems  
in tropical Africa” in: Edwards, C.  
A., Lal, R., Madden, P., Miller, R.,  
& House, G. (Eds.), *Sustainable  
Agricultural Systems*. Iowa: Soil  
and Water Conservation Society

Tudun-Wada, I.Y. and Essiet, E. U. 2006. "The effects of tannery sludge on the content of some trace and Heavy metals in the soils of Challawa Industrial Estate, Kano State". Proc. 31<sup>st</sup> Annual Conference, Soil Science Society of Nigeria, 456 – 460

World Fertility Survey 1984 "Nigerian Fertility Survey 1981 – 1982: A summary of findings". *International Statistical Institute*, London