NASARAWA STATE UNIVERSITY,
KEFFI, NIGERIA.

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Lectures Series
Volume 1

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Preface

An inaugural lecture, even from its very beginning at the University of Oxford, England where it originated as far back as 1623 (Omole as cited in Folorunso 2016:9), is meant to serve, at least, three major but purely academic purposes: (1) an account of the professor's stewardship in the academia and to inform the audience of the essence of his/her work to date, including current research, (2) stating his/her future plans especially the scheme of research which the professor proposes to do while occupying the chair, and (3) to talk about the state of the discipline; charting its progress, discussing its current health and problems, as well as examining its intellectual outputs which justify its inclusion in the university academic curriculum.

In line with the tradition, an inaugural lecture is a public presentation at which the professor is expected to tell the world what he/she professes in a language that is devoid of professional jargons and esoteric registers. The simplicity of language is important because an inaugural lecture provides the professor with the opportunity to address three blocks of audience simultaneously: his/her professional colleagues, the entire university community and the general public. With eighteen (18) of such lectures in a series in our university, one can attest or speak of an established tradition of inaugural lectures in Nasarawa State University, Keffi. The contribution(s) of each of the lectures is clear but the decision to edit into volumes (ten lectures in one volume), is informed by the desire to preserve the pieces of information contained in the lectures in one piece for unity of purpose, uniformity of preservation format and best practices. It is to allow the pieces of information to hang together rather than hanging separately; the more the merrier.

Of the eighteen (18) inaugural lectures presented so far in the series, this volume contains the first ten lectures in the series comprising three from the Faculty of Agriculture, two from Arts, another two from the Faculty of Natural and Applied Sciences, and one each from the faculties of Administration, Environmental Science and Social Sciences. These are inaugural lectures presented from 26th March, 2008 when the first of such lectures in the university entitled 'Soil Husbandry: Lifeline for National Food Security and Economic Empowerment' was presented by Prof. Olusola O. Agbede of the Faculty of Agriculture to 18th November, 2015 when the tenth Inaugural Lecture was presented by Prof. Folorunso A. Ajayi of the same faculty.

Agbede's lecture which is the first both in the series and in this volume, concerns itself with how our soils must be carefully and wisely used to attain food security in Nigeria. The second in the series and in the volume was presented by Prof. Obaje of the Faculty of Natural and Applied Sciences. Obaje's lecture entitled 'Geology and Mineral Resources of Nigeria: Development Options for Economic Growth and Social Transformation' (13th August, 2008) presents options that will enhance optimal exploitation of the mineral resource wealth of the nation for its economic growth and socio-political transformation. 'Before we Set the House Ablaze: Let Us Consult Our Oracle (History)' presented by Prof. Olayemi Akinwumi of the Faculty of Arts on 11th December, 2009 is

the third in the series. It was an eye-opener to the fact that if Nigeria is to be truly a great nation, we must go back to our sense of history; for the nation suffers which has no sense of history. This was followed by the fourth, 'Farm Production Efficiency: The Scale of Success in Agriculture' by Prof. Abdul Rahman of the Faculty of Agriculture presented on 26th June, 2013. Its major preoccupation was to describe farm as a system that produces agricultural commodities under certain restrictions as well as the interrelated factors that determine success in the entire agricultural sector of the national economy. The fifth in the series and in this maiden edition was MAINOMA (Most Acceptable Index Needed of Measuring Accountability) presented by Prof. Mainoma of the Faculty of Administration on 8th January, 2014. It seeks to provide the most acceptable model or index for measuring accountability.

'Researching Criminal Justice and Security Administration in Nigeria: Issues, Challenges and Opportunities' is the sixth in the series. It was presented on the 12th March, 2014 by Prof. Sam O. Smah of the Faculty of Social Sciences. The focus of the lecture was to draw attention to the fact that inaccuracy of available data due to lack of expertise by statistical officers, weak or poorly framed information gathering techniques and instruments, poor documentation attitude, inadequate analysis and storage are the banes of effective and efficient criminal justice and security administration in Nigeria. The seventh and eighth in the series were presented by Prof. Kwon-Ndung of Natural and Applied Sciences and Prof. Zaynab Alkali of the Faculty of Arts on the 17th September, 2014 and 17th December, 2014 respectively. Whereas the former shows how the presenter's research works in Plant Genetics and Breeding have contributed in the search for national and global food security, the latter dwells on the relevance of Gender Studies in Nigeria's Higher Institutions of Learning. The ninth Inaugural Lecture entitled 'Habitats and our Habits, Ecological Community and Common Unity' was presented by Prof. H. K. Ayuba on the 22nd April, 2015. It draws attention to the manifestations of unfolding economic, social and environmental catastrophes, which were largely due to pressures from human activities and economic necessities. It suggests a paradigm shift towards sustainable environmental management. The tenth in the series and the last in this volume was presented on 18th November, 2015 by Prof. Ajayi of the Faculty of Agriculture. The lecture entitled 'Insects, Plants and Humanity: The Organic Agriculture and Stored Products Protection Axis' is essentially an overview of the interplay between man and insects, highlighting that much of the crop harvests are lost to obnoxious insect pests during storage. It enunciates the factors that can enhance food security through better management of postharvest losses, propagating the use of traditional plant products as a means of protecting stored produce. In all, the divergent views and the varying thematic preoccupations of the lectures notwithstanding, one is left with the impression that though celebrations may vary from one place to another, true politeness is everywhere the same. In other words, methodology and approaches may vary but truly good scientific research is so recognized in every discipline.

Editing inaugural lectures which appear somewhat like finished products from seasoned professors who are authorities in their own rights was a daunting task. What we did was more of language editing to minimise grammatical and typo errors wherever found.

Even as it is, we do not guarantee uniformity in styles of content presentation and referencing but we have done the best that is possible given the circumstance in which we have found ourselves. I wish to thank all who had assisted in one way or the other in the editing and/or proofreading of the manuscripts.

I wish to use this medium to thank the Vice-Chancellor of our great university, Prof. M. A. Mainoma, and his Management Team for the all-round support and encouragement we have received from them since we came on board as the University Inaugural Lecture Committee, especially the provision of the fund for this publication. I thank the Inaugural Lecturers whose lectures have been published in this maiden edition of the NSUK Inaugural Lectures Series for the permission to do so. Congratulations! I thank the Information and Protocol Unit under the leadership of Abraham Ekpo who had been very helpful in organizing the University Inaugural Lectures Series. Thank you all.

Prof. G. S. Omachonu, PhD, FAvH, FICSHER
Editor/Chairman, Inaugural Lectures Committee
Keffi, 3rd July, 2018.

Foreword

Nasarawa State University, Keffi is known for upholding core University Academic Traditions, one of which is the Inaugural Lectures series. As many of us are aware, inaugural lecture provides an academic an opportunity to tell the world what he professes. It is a moment to celebrate excellence and breakthroughs with family, friends and colleagues. It is a testimony of one's contribution to the body of knowledge and his identification of his own building blocks in the system. It also affords the larger society opportunity to know researches that were carried out, those ongoing and the future plans. It also provides an opportunity to share with the audience how he/she used the knowledge of his/her chosen profession to advance the cause of the society especially in problem solving. To my mind, besides their contributions to knowledge, what Professors in NSUK have done thus far, presenting their inaugural lectures, is to really address societal problems using the insights and knowledge from their respective disciplines or professions.

The Nasarawa State University, Keffi Inaugural Lecture series Vol. 1 presents an opportunity to put together the first 10 inaugural lectures that were presented in the University. These are:

S/N	Presenter	Title of Lecture	Date
1	Prof. Olushola O. Agbede, Professor of Soil Science	Soil Husbandry: Lifeline for National Food Security and Economic Empowerment.	26th March, 2008
2	Prof. Nuhu G. Obaje, Professor of Geology	Geology and Mineral Resources of Nigeria: Development Option for Economic Growth and Social Transformation.	2nd February, 2009
3	Prof. Olayemi D. Akinwumi, Professor of Inter-Group Relations	Before we Set the House Ablaze, Let's Consult the Oracle (History)	11th December, 2013
4	Prof. Shehu Abdul Rahman, Professor of Agricultural Economics & Extension	Farm Production Efficiency: The Scale of Success in Agriculture.	26th June, 2013
5	Prof. Muhammad Akaro Mainoma, Professor of Accounting and Finance	Most Acceptable Index Needed Of Measuring Accounting (MAINOMA)	8th January, 2013
6	Prof. Sam O. Smah, Professor of Criminology Studies	Researching Criminal Justice and Security Administration in Nigeria: Issues, Challenges and Opportunities.	12th March, 2014

7	Prof. Emmanuel Hala Kwan-Ndung, Professor of Plant Genetics and Breeding	Unlocking Genetic in Search of Food Security	17th September, 2014
8	Prof. Zaynab Alkali, Professor of Literature and Literary Studies	The Relevance of Gender Studies in Nigeria's Higher Institutions of Learning: Why Gender Studies?	17th December, 2014
9	Prof. Haruna Kuje Ayuba, Professor of Biogeography and Environmental Science	Habitat and our Habits, Ecological Community and Common Unity	22nd April, 2015
10	Prof. Folorunso Abiodun Ajayi, Professor of Agricultural Entomology/Crop Protection	Insects, Plants and Humanity: The Organic Agriculture and Stored Products Protection Axis	18th November, 2015

This publication is intended to provide easy reference material to the academic community, policy makers and the general public. It is hoped that we shall continue with this tradition with subsequent editions.

While congratulating those that are part of this publication, I recommend this publication, to the professional colleagues of the inaugural lecturers, University community, policy makers and the general public.

Professor M. A. Mainoma
Vice-Chancellor

Table of Contents

4

FARM PRODUCTION EFFICIENCY: THE SCALE OF SUCCESS IN AGRICULTURE

PROFESSOR SHEHU ABDUL RAHMAN
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PROFESSOR OF AGRICULTURAL PRODUCTION ECONOMICS

26th June, 2013

Protocol
Vice-Chancellor
Deputy Vice-Chancellor (Academic)
Deputy Vice-Chancellor (Administration)
Registrar and other Principal Officers
Members of the Governing Council
Dean of Postgraduate School
Dean of my Faculty – Faculty of Agriculture
Other Deans of Faculties
Professors of Nasarawa State University and those of other Universities
Head of my Department – Agric. Economics and Extension
Other Heads of Department
Other members of the Senate
Members of the Congregation
Members of Nigerian Association of Agricultural Economists
Members of Farm Management Association of Nigeria
Members of Agricultural Society of Nigeria
My Lords, Spiritual and Temporal
Students Union Government of Nasarawa State University, Keffi
Gentlemen of the Press
Other Distinguished Guests
Ladies and gentlemen

Preamble

I begin this Inaugural Lecture in the name of Allah. I am grateful to Almighty Allah for granting me the ability to adhere to the virtues of excellence, patience and tolerance in my academic career which earned me several opportunities without lobbying. These opportunities include my appointment

as an Examination Officer, Postgraduate Seminar Coordinator, Head of Department, Professor, Dean of Faculty, Chairman, Association of Deans of Faculties of Agriculture in Nigerian Universities, Deputy Vice-Chancellor (Administration) and my present position as Vice-Chancellor of Federal University Gashua. I was appointed into all these positions on merit.

Mr. Vice-Chancellor. Sir, let me take us down the memory lane of my movement to Nasarawa State University, Keffi. I joined the service of this university precisely in January, 2003 after several consultations with relatives, friends, and colleagues. I left Ahmadu Bello University, Zaria for the Nasarawa State University, Keffi when my services were highly required in my Department at the Ahmadu Bello University, Zaria. My Head of Department (Prof. T. K. Atala) reluctantly recommended my leaving. He wrote on my letter of withdrawal of service forwarded to the Vice-Chancellor Prof. Abdullahi Mahadi "Sir, Dr. Rahman is the most serious, most energetic and most productive young academic staff in the Department. His leaving will be a big loss to the Department. Though, he has made up his mind to leave and I therefore, most reluctantly recommend his leaving." I did not know of these qualities in me. I realized later that it was a great opportunity for me to know the level of my seriousness and productivity in my career. I have been praying to God to grant me the ability to continuously demonstrate these core values of hard work and honesty. I was also confronted with one major question – "Why are you leaving a Federal University for a newly established State University? You have taken a wrong decision. My quick and simple response was "it is not where you work, but what you can deliver. To some of my colleagues this response was not satisfactory. Few years later, my election as the Chairman, Association of Deans of Faculties of Agriculture in Nigerian Universities and my present position not just as Vice-Chancellor, but as a pioneer Vice-Chancellor of Federal University Gashua made my leaving for NSUK more meaningful to them.

It is customary in the University system for a professor to give accounts of his/her academic journey to the rank of professor for the public to appreciate the contents and quality of academic activities and research outputs in his/her specific discipline. My efforts in teaching and research have given birth to the title of this inaugural lecture – farm production efficiency: the scale of success in agriculture which describes a farm as a system that produces agricultural commodities under certain restrictions and interrelated factors that determines success in the entire agricultural sector of national economy.

1. INTRODUCTION

Majority of farmers in Nigeria lives in rural areas where poverty is more pronounced. The only weapon available for the farmers to fight this poverty is farming. Efficiency of farm production is central to poverty alleviation in the rural areas. The objective of this inaugural lecture is to draw our attention to the following questions:

i. Do we really know what exactly to measure as success in agriculture?
ii. Why is farm production efficiency a scale in measuring success in agriculture?
iii. Do we really have efficient farms in the Nigerian agriculture?

In the Nigerian agriculture, the common scales of success being used by our governments and other stakeholders are:

- Amount of money spent by government in procuring fertilizers;
- Quantity of fertilizer distributed by government based on political affiliation;
- Number of tractors purchased by government and distributed, even to those with farm size of zero hectare.

Mr. Vice–Chancellor Sir, I wish to say that these are wrong scales for measuring success in agriculture. They are not scales of success but scales of corruption and failure in agriculture. Measurement of success in agriculture should start from farms and not from political farm inputs like fertilizers and tractors. Nowadays, little or no attention is paid to efficiency of farm production. An increase in the efficiency of farm production could present wide range of hope and lead to an improvement in the welfare of farmers and consequently reduce poverty and enhance food security.

Measurement of farm production efficiency is important in three areas. Firstly, it is a success indicator and performance measure for evaluating farms. Secondly, the sources of efficiency differential can only be identified by measuring efficiency and appreciating its effects. Thirdly, identification of sources of inefficiency will enable the public and private establishments to improve farm performance.

2. WHAT IS FARM PRODUCTION EFFICIENCY?

Farm production efficiency is the ability of a farm to produce a given level of output with the lowest amount of resources. The efficient method of producing a product is the one which uses the least amount of resources to get a given amount of output. Efficient farms make better use of existing resources to produce maximum output or incur the lowest cost, thus, achieving the food security objective. There are six features of efficient farm:

i. Zero waste

ii. Least cost
iii. Minimum risk
iv. Maximum output
v. Best quality produce
vi. Maximum profit

How many of our farms in Nigeria possess these properties?

3. ASPECTS OF FARM PRODUCTION EFFICIENCY

There are several aspects of production efficiency for measuring farm performance. The common ones include, technical, allocative, cost, economic, scale and profit efficiencies.

Technical efficiency: is a major component of productivity being used in measuring farm performance. It is used to measure the ability of a farm to obtain maximum output from a given set of inputs. A technically efficient farm operates on the production frontier while a technically inefficient farm operates below the frontier and could be made efficient by increasing its output with the same input level or using fewer inputs to produce the same level of output. As such, the closer a farm gets to the frontier the more technically efficient it becomes (Ogunyinka and Ajibefun, 2003).

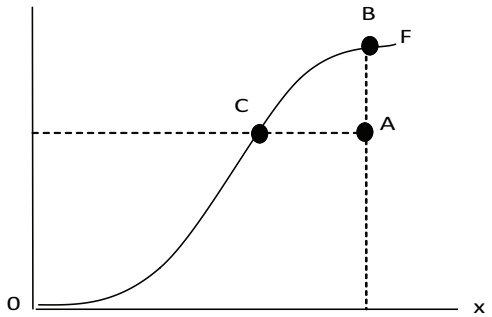

Fig. 1: Production Frontier

Figure 1 shows a simple production process in which a single input (x) is used to produce a single output (y). The curve 'OF' represents the production frontier, which is the maximum output attainable from each input level. It reflects the current state of technology in the farm. All points between the production frontier and the x-axis form the feasible production set or space. Technically Efficient Decision Making Units (DMUs) operate on the frontier, and inefficient ones operate below it. For example, Point 'A' represents an inefficient point whereas points 'B' and 'C' represent efficient points. The DMU operating at point 'A' is inefficient because technically it could increase output to

the level associated with the point 'B' without requiring more input or it could reduce input to the level associated with the point 'C' without reducing any output. With more than one inputs, the concept is the same, but the figure has three or more dimensions (Shih et al., 2004).

Allocative efficiency, reflects the ability of a farm to use inputs in optimal proportions given their respective prices and the production technology (Chirwa, 2003). Under competitive conditions, a farm is said to be allocatively efficient if it equates the marginal returns of factor inputs to the market price of output (Fan, 1999). Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost (Akinwumi and Djato, 1996).

Cost efficiency refers to the ratio of the minimum cost at which it is possible to attain a given level of production to the actual cost incurred. The costs of a farm depend on the output level (y), the price of inputs (w), the level of cost inefficiency (u) and a set of random factors (v) which incorporate the effect of errors in the measurement of variables. Thus, the cost function is expressed as: C = $C(y, w, u, v)$

Economic efficiency is derived from product of the technical and allocative efficiency (that is, Technical efficiency x Allocative efficiency). Economic efficiency is concerned with the realization of maximum output in monetary term with the minimum available resources. It occurs when a farm chooses resources and enterprises in such a way to attain economic optimum (Ellis, 1988; Akinwumi and Djato, 1997). A farm that is economically efficient should by definition be both technically and allocatively efficient. However, this is not always the case as Akinwumi and Djato (1997) pointed out. It is possible for a farm to have either technical or allocative efficiency without having economic efficiency. The reason may be that the farmer, in this case, is unable to make efficient decisions as far as the use of inputs is concerned. In some cases, a farmer may fail to equate marginal input cost to marginal value of product. If technical and allocative efficiency occur together, they are both necessary and sufficient conditions for economic efficiency. This implies that the farmer made right decision to minimize costs and maximize profits implying operating on the profit frontier.

Scale efficiency can arise from spreading the cost of production, particularly fixed costs over a large number of outputs. It would not be cost effective if a farm opts to produce a few outputs within a year when it is capable of producing a large number of outputs to achieve low cost per unit. The production unit reaps economies of scale when it experiences substantial cost savings at relatively high output. For the calculation of the scale efficiency (SE)

as suggested by Coelli et al. (1998), scale efficiency assumes the value of Technical Efficiency (TE) measures under both Constant Return to Scale (CRS) and Variable Return to Scale (VRS). If there is a difference between scores of technical efficiency under CRS and VRS, the difference indicates scale inefficiency. Scale efficiency can be calculated by dividing the total technical efficiency by pure technical efficiency. $SE = \frac{TE_{CRS}}{TE_{VRS}}$

Scale efficiency can be interpreted as follows:

- ✍ if SE = 1, then a farm is scale efficient. i.e. its combination of inputs and outputs is efficient both under CRS and VRS
- ✍ if SE < 1, then combination of inputs and outputs is not efficient.

Profit efficiency is defined as the ability of a farm to achieve the highest possible profit, given the prices and the levels of fixed factors (Ali and Flinn, 1989). Farm specific profit frontier is obtained with interaction between farm-specific prices and levels of fixed factors. Profit inefficiency is defined by the proportion by which farm's operation deviate from the profit frontier given the prices and resource endowments. Profit efficiency is a broader concept than cost efficiency since it takes into account the effects of the choice of a certain factor of production both on costs and on revenues. Given the input and output prices a farm maximizes profits by adjusting the amounts of inputs and outputs (Rahman, 2003).

3. DETERMINANTS OF FARM PRODUCTION EFFICIENCY

Determinants of farm production efficiency are categorized into three based on nature of relationship that exist between a farm and some factors within and outside the farm. The three aspects of the relationship that influence efficiency of farm production are:

a) Farm – farmer relationship
b) Farm – institution relationship
c) Farm – production relationship

Farm – farmer relationship: This describes the influence of farmer's socio-economic characteristics on farm production. Age, farming experience, farm size, education, household size, income, cooperative participation and land ownership status of farmers have been identified as factors that influence farm production efficiency (Lau and Yotopolous, 1971; Ajani, 2000; Adeoti, 2002; Ajibefun and Abdulkadiri, 2004; Ogundari et al., 2006 and Idiong et al., 2007).

It is expected that as a farmer becomes older, his or her productivity will decline. Farmers with high level of education adopt new technologies easily and use them effectively to enhance productivity. Farmers with more years of farming experience tend to be more efficient in farm production. The land ownership status is also important because farmers that own parcels of land for farming tend to be more productive.

Farm – Institution Relationship: In developing countries, improvement of agricultural production, efficiency and sustainability depends on the supports given to the farmers which enable them to adopt new technologies and decide wisely in the management of their farms. Some institutions are established to drive production efficiency (**see** Figure 2) by the rendering essential services in the areas of Agricultural extension, credit, research, infrastructure, etc.

Agricu1tural extension through advisory services and programmes forges to strengthen the farmers' capacity to develop by providing access to agricultural information. Extension services can contribute to improvement in agricultural development and enhance good living condition of farmers in rural areas. Agricultural research will remain largely academic unless extension workers provide input in terms of the identified and as-yet unsolved field problems of the farmers. Research focuses on the technical aspects for generating useful technologies, while extension focuses on the acceptance and adoption of those technologies by users. Research institutions need strong extension services to work in a field problems-oriented mode, and the extension services need the backstopping of strong agricultural research institutions to effectively serve the farming communities.

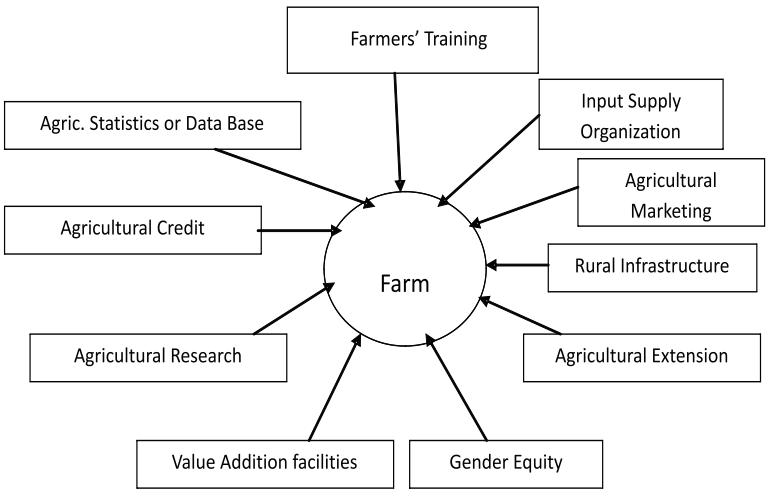

Fig. 2: Farm efficiency driven system

Access to agricultural credit has particular importance for improving and sustaining production efficiency of farms. The need for agricultural loan among the small scale farmers cannot be over emphasized as it enables them to establish and expand their farms. According to Ojo (1998), one of the problems confronting small-scale enterprises including farmers in Nigeria is inadequate capital despite the fact that small-scale farmers produce the bulk of the food consumed locally and some export crops which generate foreign exchange for the country. Farm credit has for long been identified as a major input in the development of the agricultural sector in Nigeria. It determines access to all of the resources on which farmers depend (Shephard, 1979).

Agricultural marketing is a main driving force for economic growth and development and has a guiding and stimulating impact on production and distribution of agricultural produce. Agricultural marketing acts as an agent of rural development. Moreover, agricultural marketing plays a coordinating role, steering supply and demand with respect to place, time and form utilities. A properly functioning market (such as pricing system) for agricultural products is generally perceived as the best organizational structure to achieve more efficient production, in terms of type, quantity, quality and consumption decisions (Bardhan, 1990). The possible increment in output resulting from the introduction of improved technology can not be exploited in the absence of convenient marketing conditions. Efficient, integrated and responsive market mechanism is of critical importance for optimal use of resources in agriculture and in stimulating farmers to increase their output (Andargachew, 1990).

One of the major of marketing is the bridging of the time gap between production and consumption through adequate storage facilities. Experience in Nigeria is that a lot of primary products, particularly agricultural produce are wasted every year due to inadequate storage facilities. This contributes to fluctuations in the prices of the country's abundant agricultural perishables. Closely related to storage problem is the low level of processing of agricultural produce. The net effects of all these is that the farmers do not have adequate value for their efforts.

Value addition is a factor that promotes efficiency and prosperity of farm business. It has almost become a magic formula for sustainable agricultural investments. An agricultural value chain consist of a series of activities that add value to agricultural produce beginning with production, linking with processing and getting the final product to the end user or consumer. Value addition has a particular importance in that, it offers a strategy for transforming an unprofitable enterprise into a profitable one.

The importance of good infrastructure for agricultural development is widely recognized. Insufficient infrastructure is one of the key bottlenecks to

agricultural development. Where infrastructural facilities are provided, economic returns on input use is always high. Several econometric studies have estimated the effects of infrastructural investment on agricultural output and productivity with results of most of these studies showing a positive and significant effect (Fan and Zhang, 2004). An integrated world class farm can be established as a centre for training and excellence to open opportunity for transferring skills to local farmers. Example of this kind of facility is the Songhai farm.

Farm-Production Relationship: Production of farm produce involves different relationships between inputs and outputs. Production relationship provide tools for analyzing problems of production and resource – use efficiency. The farm production efficiency may be analyzed under three micro-economic relationships.

- Factor – Product relationship in which the economists try to determine the most profitable amount of resource to use to produce a given level of output or to determine the most profitable amount of output to produce at a given level of input.
- Factor – Factor relationship for determining the most profitable combination of inputs in producing a given level of output (cost minimization) or to determine the most profitable level of output to produce at a given combination of resources (output maximization).
- Product – Product relationship which determine the most profitable level of input to use to produce a given combination of products or to determine profitable combination of products at a given level of input.

4. RESEARCH ACTIVITIES ON FARM PRODUCTION EFFICIENCY

My collaborators, my associates and I have carried out some field works which focused on four major areas in which certain analytical techniques were used to determine farm production efficiency. These include:

- Production economics of crops and livestock
- Farm management economics
- Applications of econometric models
- Gender issues in agriculture

Mr. Vice-Chancellor, Sir, with my little effort I have participated in over 115 field works wroth about 65 percent of them involved analysis of some aspects of production efficiency. I had the privilege of working with many scientists and technicians who have demonstrated passion for excellent ideas. I would like to mention some of my field works as follows:

- An Evaluation of Indigenous and Conventional Insecticides for cowpea production in selected villages of Katsina and Zamfara States, Nigeria (Ogungbile and Rahman, 1996).
- Resource – use efficiency in wheat production in Kadawa village of Kano State, Nigeria (Rahman et al., 1998).
- On-station evaluation of the performance of maize-sorghum mixture under different plant population and planting patterns (Mani and Rahman, 1999).
- The effects of Neem Leaf extracts as insecticides on cowpea production in Daudawa village of Katsina State, Nigeria (Rahman and Macaver, 2000).
- Comparative economic analysis of maize production under organic and inorganic fertilizers in Daudawa village of Katsina State (Rahman et al., 2001).
- The use of a grafted polynomial function in forecasting maize production trend in Nigeria (Rahman, 2001).
- Economic analysis of maize – based cropping systems in Giwa Local Government Area of Kaduna State, Nigeria. (Rahman and Lawal, 2003)
- Estimating the level of women interest in Agriculture: the application of logit regression model (Rahman and Alamu, 2003).
- Agronomic and economic evaluation of popcorn varieties grown under different NPK fertilizer rates and irrigation levels in Sudan Savannah zone of Nigeria (Mani and Rahman, 2004).
- Diversifying crop production to minimize income variability in a farming community of Northern Nigeria: Application of risk aversion model (Rahman, 2004).
- Estimating resource productivity in sorghum – based cropping systems in Giwa Area of Kaduna State, Nigeria (Rahman, 2005).
- Technical efficiency in sorghum – based cropping systems in Soba Area of Kaduna State, Nigeria (Rahman et al., 2005).
- The status of commercial poultry egg production in Nasarawa State, Nigeria (Rahman and Yakubu, 2005).
- Yield and economic return of Quality Protein Maize (QPM) under different NPK fertilizer rates, irrigation intervals and sowing dates at Kadawa, Nigeria (Mani and Rahman, 2005).
- Measurement of Technical Efficiency in irrigated vegetable production in Nasarawa State, Nigeria (Rahman and Adeniji, 2006).
- Gender analysis of labour inputs to the cropping systems in Kaduna State of Northern Nigeria (Rahman and Marcus, 2006).
- Resource productivity and return in soyabean production in Kaura

Local Government Area of Kaduna, Nigeria (Musa and Rahman, 2006).

- Productive efficiency in fish farming in Nasarawa State of Nigeria (Rahman and Okunsebor, 2006).
- Yields and benefit-cost of cereal-legume rotations in the guinea savanna of Northern Nigeria (Rahman, 2006a).
- Productivity of Forage Legumes grown in mixture with maize and their acceptability as fodder to livestock in savanna zone of Nigeria (Rahman and Ogungbile, 2006).
- Micro level analysis of maize yield response to fertilizer application in Soba Area of Kaduna State, Nigeria (Rahman, 2006b).
- Socio-economic study of gender role in farm production in Nasarawa State Nigeria (Rahman et al., 2007).
- Yield and cost-benefit analysis of cowpea production using three botanical pesticides and one synthetic insecticides at different periods of application (Ajayi and Rahman, 2007).
- Women's involvement in agriculture in Northern and Southern Kaduna State, Nigeria (Rahman, 2008).
- Measurement of Technical Efficiency and its determinants in crop production in Lafia Local Government Area of Nasarawa State, Nigeria (Rahman and Umar, 2009).
- Gender participation in commercial poultry production in Karu and Lafia Areas of Nasarawa State, Nigeria (Okoh et al., 2010).
- Gender-based analysis of labour productivity in sesame production in Doma Local Government Area of Nasarawa State, Nigeria (Umar et al., 2010).

I have mentioned these field works in this lecture to demonstrate the level of my involvement as a scientist and a member of several research teams in the investigation of relevant issues in farm production efficiency for assessing performance of farms in different parts of Northern Nigeria.

5. ANALYTICAL TECHNIQUES

There are several approaches to efficiency measurement in farm production as presented in figure 3. These approaches can be classified into two broad categories: – econometric techniques and mathematical programming techniques.

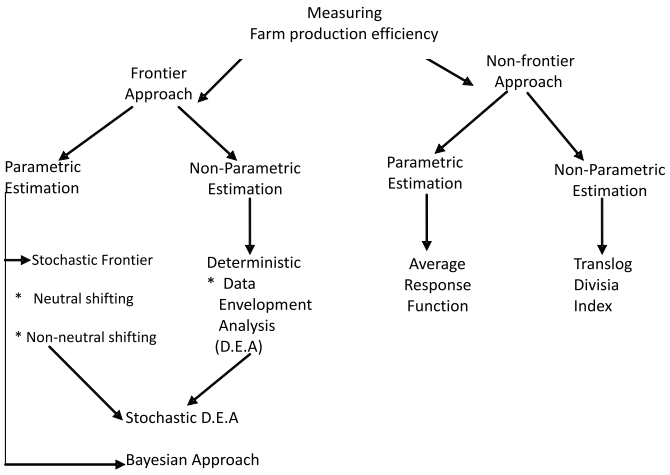

Fig. 3 Methods for measuring farm production efficiency

✍ **Econometric techniques** involve measurement or estimation of economic relationship. The econometric technique applies statistical tools on mathematical models of economic theories to estimate parameters for explaining economic relationship. From the econometric analysis five features can be obtained to describe economic relationship.

✍ Existence (when the coefficient is not zero)
✍ Direction (sign of the coefficient)
✍ Magnitude (size of the coefficient)
✍ Structure (functional form)
✍ Significance (statistical test)

The major statistical tool in econometrics is regression analysis. The econometric approach to efficiency measurement is concerned with use of production function and stochastic frontier model.

The Production Function is the technical or physical relationship estimated for further analysis of technical and economic maximum of output in a production process. When the economic maximum is established, resource – use efficiency can be determined. The ratio of Marginal Value Product (MVP) to Marginal Factor Cost (MFC) is the measurement for resource – use efficiency (r). That is

$$\mathbf{r} = \frac{MVP}{MFC}$$

The Stochastic Frontier Model

The stochastic frontier function embraces inefficiencies of the production process and the probabilistic random effects leading to productive inefficiency. In this sense, there is a composite error term involving inefficiency and random effects (Kopp, 1981). Therefore, stochastic frontier functions enable

the researcher to measure both the efficiency and impact of measurement errors or factors that are not directly related with production process itself (Kolawole, 2006). The estimated function appears as a frontier or benchmark with the parameter estimates indicating whether the enterprise or production unit is producing at the production, cost or profit frontier (Lengemeier and De Lano, 1999).

A number of properties are attributable to frontier functions. Frontier functions allow parametric estimates of factor elasticities, efficiency scores and are amenable to tests of various models and technologies. Parametric estimation of a frontier function dates back to the pioneering work of Aigner and Chu (1968) who took up Farrell's suggestion of computing a parametric convex hull of the observed ratios of input and output based on a homogeneous Cobb-Douglas production frontier and thus requiring all observations to be on or beneath the frontier.

a. Stochastic Frontier Production Function

The Stochastic frontier production function according to Battese and Coelli (1992) assumed that a random sample of farms is observed over T period such that the production of the N farms over time is a function of given input variables and random variable which involve the traditional random error and non-negative random variables which are associated with technical inefficiencies of production. For a given combination of input leve1s, it is assumed that the realized production of a farm is bounded above by the sum of a parametric function of known inputs, involving unknown parameters, and a random error, associated with measurement error of the level of production or other factors, such as the effects of weather, strikes, damaged product, etc. The greater the amount by which the realized production falls short of this stochastic frontier production, the greater the level of technical inefficiency (Battese and Coelli, 1993).

An appropriate stochastic formulation is:

$y_i = f(x_i)\, TE_i\, e^{vi}$.

Where y_i is the output, x_i is input, TE denotes technical efficiency and v_i is unrestricted. The latter term embodies measurement errors, any other statistical noise, and random variation of the frontier across farms. The reformulated model is

$\ln y_i = \alpha + \beta x_i + v_i - u_i$

$u_i > 0$, but v_i may take any value. A symmetric distribution, such as the normal distribution, is usually assumed for v_i. Thus, the stochastic frontier is $= \alpha + \beta x_i + v_i$ and u_i represents the inefficiency.

b. Stochastic Frontier Cost Function

Specification of cost function involves alteration of error term from (V_i – U_i) to ($V_i + U_i$).

For example, this substitution would transform the production function into cost function: $Y_i = X_i \beta (v_i + u_i), i = 1, \ldots\ldots\ldots\ldots N$

Where y_i is the cost of production of the i^{th} farm;

X_i is a k x 1 vector input prices and output of the i^{th} farm;

β is a vector of unknown parameters

The v_i are random variables which are assumed to be iid $N(0, \delta_v^2)$ and independent of the u_i which are non-negative random variables which account for the cost inefficiency in production often assumed to be iid/$N(0, \delta_u^2)$/, in this cost function the u now defines how far the firm operates above the cost frontier.

c. Stochastic Frontier Profit Function can be specified as,

$\pi_i = f(p_i, z_i) \exp(\varepsilon_i)$ Where π_i is the normalized profit for i^{th} farm obtained as profit divided by the price of output. p_i, represents price of i^{th} variable inputs divided by output price and z_i is the fixed factor used by i^{-th} farm. The error term is composed of two components: $\varepsilon_i = v_i - u_i$

Where v_i is normally independently and identically distributed [i.e., v_i ? $N(0, \delta_v^2)$] two sided error term representing various random shocks and effects of measurement error of variables. The other component u_i is the non-negative or one-sided residual representing farm- specific profit inefficiency. Hence if $u_i = 0$, the farm's profit inefficiency is nonexistent, i.e., the farm makes maximum possible profit (being on the frontier) given its input prices and fixed factors. Conversely, $u_i > 0$ indicates that the farm forgoes profit due to inefficiency (Ali and Flinn, 1989).

Mathematical Programming Techniques

Mathematical programming has a rich history usage in production economics. Simple linear programming models have been used extensively to investigate optimal producer behavior given technical and other types of constraints. Mathematical programming has been used to undertake total factor productivity and efficiency assessments through applications of Data Envelopment Analysis (DEA).

Data Envelopment Analysis: is non-parametric frontier which uses mathematical programming methods. Programming methods can simply handle disaggregated inputs and multiple output technologies. Being non-stochastic, the DEA approach does not differentiate data noise and inefficiency

(Coelli, 1996). The DEA method is a frontier method that does not require specification of a functional or distributional form, and can accommodate scale issues. This approach as first used by Farrell (1957) as a piecewise linear convex hull approach to frontier estimation and later by Boles (1966) and Afriat (1972). This approach did not receive wide attention till the publication of the paper by Charnes el al. (1978), which coined the term data envelopment analysis. The data envelopment analysis technique uses linear programming methods to construct a non-parametric frontier. The technique also identifies efficient production units, which belong to the frontier, and inefficient ones which remain as follows:

The DEA problem can be expressed in the envelopment form. The formulation of this model is specified as follows:

Consider a set of N homogenous decision-making units (DMU) employing 'm' inputs $X_i = (X_{1i} \text{----} X_{mi})$ (inputs) to obtain 's' outputs Y_i (Y_{1i}----------Y_{si}). Each pair of vector (X_i, Y_i) constitutes a productive process of each DMU, then the following linear programme needs to be solved.

$$x_{ji}\,\theta_o^{g} - \sum_{i=1}^{n} x_{ji}\,\lambda_i \geq 0,\ j = 1 \ldots\ldots\ldots\ldots m$$

$$-\,y_{rio} + \sum_{i=1}^{n} y_{ri}\,\lambda_i \geq 0,\ r = 1 \ldots\ldots\ldots\ldots\ldots s$$

$$\lambda_i \geq 0\ ,\ \forall_i$$

Where, the objective function θ_0^g is a scalar that represents the minimum level to which the use of inputs can be reduced without altering the output level. It is the global technical efficiency score (GTE) for the DMU. If this index is equal to one, the production unit is considered technically efficient. If it is less than one there is some degree of technical inefficiency. θ_0^g index equal to one ensures that the use of all inputs cannot be reduced at the same time, although a variation in the use of one of them may improve efficiency. A further condition to guarantee technical efficiency is that the slack variables equal zero.

λ_i (i= 1, 2….n) are constants that represent the weights to be used as multipliers for the input levels of a reference production unit to indicate the input levels that an inefficient unit should aim at in order to achieve efficiency. The scalar θ_0^g is the estimated measure of technical efficiency for the analyzed production unit. The DEA efficiency evaluation of DMU is conducted by reference to solutions that do not exhibit reductions in any of their outputs or increases in any of their inputs.

6. EMPIRICAL RESULTS

I have decided to present results of some of my studies in order to substantiate that inefficiency in farm production is a major problem in the Nigerian agriculture.

Resource Productivity and Returns in Crop Production

Agricultural productivity could be defined as the ratio of farm output to the quantity of a farm input used in a given production process. The major goal of any production system is the attainment of an optimally high level of output with a given amount of effort or input. Input-output relationship in farm production is important for the measurement of resource productivity or production efficiency. The measurement of productivity could be in either physical or monetary terms. The basic concepts in productivity measurement are Average Product (AP), Marginal Product (MP). Marginal Rate of Substitution (MRS), Elasticity of Production (EP) and Returns to Scale (RTS).

a) Resource – Use Efficiency in Wheat Production

In a study on resource – use efficiency in wheat production in Kano State, positive signs of the estimated parameters for all the inputs in a production function revealed direct relationship between the inputs used and wheat yield. The relationship between output and input for labour and fertilizer was significant at 5% and 1% level respectively while that of seed was not significant. This possibly reflected the insignificant variation in the quantities of seed used by the farmers (Table 1). All the ratios of Marginal Value Product to Marginal Factor Cost were greater than unity indicating that the resources were used at sub-optimal levels for the wheat production (Table 2).

Table 1: Regression Coefficient, t-value and level of significant of three independent variables related to wheat grain yield

Variable	Regression Coefficient	Standard Error	t-value	Level of Significance
Labour (X_1)	0.254	0.116	2.196	0.05
Seed (X_2)	0.322	0.083	0.389	NS
Fertilizer (X_3)	0.160	0.041	3.940	0.01
Constant(a)	4.189	0.683	6.135	0.01

Source: Rahman et al. (1998)
R2 = 0.774 DF = 24
NS = Not significant

Table 2: Marginal physical products and Marginal Value Products for labour and fertilizer inputs.

Variable	MPP (kg/unit input)	MVP (₦)	MFC (₦)	MVP/MFC
Labour (X_1)	0.553	22.12	20.00	1.11
Fertilizer (X_3)	0.851	34.04	25.00	1.36

Source: Rahman et al. (1998)
Note: MPP = Marginal physical product
MVP = Marginal Value Product
MFC = Marginal Factor Cost

b) Resource – Use Efficiency in Maize Production

In Katsina State of Nigeria, a study was conducted to compare the economics of maize production under organic and inorganic fertilizer, the study revealed that about 86% and 79% of the variation in maize output among the sampled fields for the inorganic and organic fertilizers respectively were explained by the factors included in the production model. For both fertilizer conditions (organic and inorganic) the signs of the regression coefficients estimated were positive to all the inputs. Land and seed inputs were significant factors at 1% level (see table 3). Under the condition of inorganic fertilizer application, a unit increase in land size, seed and fertilizer would result to extra maize output of 1264.47, 91.55 and 4.39kg respectively, provided other variables remain constant. While under the condition of organic fertilizer application, a unit increase in land size, labour and seed would separately result in additional maize output of 768.30, 1.43 and 56.90 kg respectively (see table 4). For the two technologies, there was inefficiency in the use of resources.

Table 3: Double-log regression results for four independent variables related to maize output under organic and inorganic fertilizer conditions.

Variables	Organic Fertilizer Condition				Inorganic Fertilizer Condition			
	X_1	X_2	X_3	X_4	X_1	X_2	X_3	X_4
Regression Coefficient	0.364	0.554	0.554	0.052	0.523	0.194	0.722	0.106
Standard Error	0.073	0.162	0.162	0.075	0.118	0.235	0.133	0.035
t-value	5.000	2.730	3.400	0.690	4.435	0.826	5.430	3.020
Level of Significance	0.01	0.05	0.01	NS	0.01	NS	0.01	0.01

Source: Rahman et al. (2001)
Constant (a) = 0.852 7.185
R^2 = 0.790.86
Note:X_1 = Land size X_2 Labour used X_3 = Seed input X_4 = fertilizer input
NS = Not significant at 5% level of probability

Table 4: Marginal physical and marginal value products for land, seed, labour and fertilizer product in the maize production.

Variables	Organic Fertilizer Condition				Inorganic Fertilizer Condition			
	Land	Labour	Seed	Fertilizer	Land	Labour	Seed	Fertilizer
MPP (kg)	1264.47	*	91.55	4.39	768.30	1.43	56.90	*
MVP (₦)	44256.45	*	3204.25	153.65	26890.50	50.05	1991.50	*
MFC (₦)	3500.00	*	40.00	40.00	3500.00	20.00	40.00	*
MVP/MFC	12.64	*	80.11	3.84	7.68	2.50	49.79	*

Source: Rahman et al. (2001)
* = Not computed because of insignificant coefficient

c) Resource Productivity in Soyabean Production

A study was conducted in Kaduna State on resource productivity and returns of soyabean production. The study revealed that about 84% of the variation in the soybean output among sampled farms was explained by the variable inputs included in the production model. There was direct relationship between inputs and output of soyabean (see table 5). The relationship was significant at 1% level for land and seed inputs and 5% for fertilizer. Essentially, soyabean is a cash crop and farmers always ensure food security for the family first; thus at that critical period they might use the labour more for the food crop leading to insignificant relationship between labour and soyabean output.

The marginal value product for each input was divided by the price of unit input (Marginal factor costs) to determine whether the inputs were used efficiently (see table 6). All the resulting ratios were greater than unity indicating that the resources were used at sub-optimal levels for the soyabean production.

Table 5: Regression coefficients, t-values and level of significance of four independent variables related to soyabean output.

Variable	Regression Coefficient	Standard Error	t-value	Level of Significance
Farm size (X_1)	0.519	0.118	4.399	0.01
Seed (X_2)	0.290	0.085	3.407	0.01
Fertilizer (X_3)	0.300	0.119	2.517	0.05
Labour (X_4)	0.113	0.132	0.953	NS
Constant	4.920	0.701	7.022	0.01

Source: Musa and Rahman (2006)
NS =Not significant
R^2=0.849
F=6.71

Table 6: Marginal physical and marginal value product for the inputs used in soyabean production

Variable	MPP (kg)	MVP (₦)	MFC (₦)	MVP/MFC
Farm size (X_1)	14.0805	14.081	1000	14.1
Seed (X_2)	14.40	144	15	9.5
Fertilizer (X_3)	41.09	417	36	11.6
Labour (X_4)	4.76	48	16	3.0

Source: Musa and Rahman (2006)
Note: soyabean farm-gate price = ₦10.00 per kg.

d) Resource Productivity in Rice Production

A study was conducted in Nasarawa State on resource productivity in rice production. The study revealed that about 95% of the variation in the rice output among sampled farms was exp1ained by the variable inputs included in the production model. The signs of coefficients for all the inputs, reveal direct relationship between inputs and the output of rice (See Table 7). The relationship was significant at 1% level for labour and 5% for seed. The resources were under-utilized as reflected in the MVP-MFC ratios of values greater than unity (see table 8)

Table 7: Regression results from Cobb-Douglas production function for paddy rice production

Variable	Regression Coefficient	Standard Error	t-value	Level of Significance
Labour (X_1)	0.518	0.113	4.564	0.01
Seed (X_2)	0.779	0.254	3.072	0.05
Capital	0.244	0.262	0.934	NS

Source: Rahman et al. (1998)
Contant (a) = 2.507
R^2 = 0.957 DF = 24
D.f=19
NS=Not significant at 10% level of probability

Table 8: Marginal physical products and marginal value products for labour and seed inputs

Variables	MPP (kg/unit input)	MVP (₦)	MFC (₦)	MVP/MFC
Labour (X_2)	0.862	21.12	20.00	1.056
Seed (X_4)	15.008	367.70	27.00	13.619

Source: Rahman et al. (1998)

e) Resource Productivity in Crop Mixtures

The common crop production practices in most parts of Africa is intercropping. In a study conducted in Kaduna State on economic analysis of maize-based cropping system, it was revealed that the seed and labour were

significantly related to output in maize/soyabean mixture. Labour and fertilizer were significant factors in maize/groundnut mixture; while only seed was a significant factor in sole maize (see table 9).

The elasticities of production of the inputs used in maize-based cropping system were less than one. The elasticity of production of fertilizer input was highest in sole maize with a value of 0.909. The maize-based cropping system had decreasing rate of returns to scale (see table 11). It was observed that labour was over utilized in maize-legume mixtures as reflected in the MVP-MFC ratios which were less than unity (see table 12).

Table 9: Estimated Cobb-Douglass production function for maize-based cropping system in Giwa Local Government Areas Nigeria.

Cropping system	Regression Coefficients			Other parameters		
	Seed	Labour	Fertilizer	Constant	R^2	F
MZ	0.023*	0.049*	0.909	3.118*	0.64	13.14*
	(3.112)	(0.432)	(1.053)	(6.523)		
MZ/CP	0.018*	0.018*	0.243	4.522*	0.68	15.82*
	(2.596)	(2.499)	(3.004)	(4.689)		
MZ/GT	0.007	0.016*	0.311*	6.418	0.57	28.14*
	(0.643)	(3.108)	(2.718)	(1.444)		
MZ/SB	0.041	0.066*	0.145	5.083	0.61	19.65*
	(0.814)	3.755)	(1.241)	(1.342)		
MZ/SG	0.033	0.351	0.323	2.131*	0.55	12.30*
	(1.231)	(1.011)	(1.140)	(3.942)		

Source: Rahman and Lawal (2003)
* Significant at 5% level of probability
Figures in parenthesis are t-values
MZ = Maize CP = Cowpea GT = Groundnut SB = Soyabean SG = Sorghum.

Table 10: Marginal product of inputs in maize–based cropping system in Giwa LGA

Input	Marginal physical products (MPP)				
	MZ	MZ/CP	MZ/GT	MZ/SB	MZ/SG
Seed	1.108	0.939	1.495	0.969	1.442
Labour	1.010	0.406	0.366	0.406	1.152
Fertilizer	4.733	2.553	5.138	2.258	3.888

Source: Rahman and Lawal (2003)

Table 11: Elasticity of production of inputs in maize–based cropping system in Giwa LGA

Input	Marginal physical products (MPP)				
	MZ	MZ/CP	MZ/GT	MZ/SB	MZ/SG
Seed	0.023	0.018	0.007	0.041	0.033
Labour	0.049	0.332	0.016	0.066	0.351
Fertilizer	0.909	0.243	0.311	0.145	0.323
Σ^{b}_{i}	0.981	0.593	0.334	0.252	0.707

Source: Rahman and Lawal (2003)

Table 12: Resources-use efficiency determined from ratio of marginal value product (MVP) to marginal factor cost (MFC in maize–based cropping system in Giwa LGA.

Resource	Estimate	Maize-based cropping systems				
		MZ	MZ/CP	MZ/GT	MZ/SB	MZ/SG
Seed	MVP	33.25	31.92	46.33	30.03	36.04
	MFC	35.00	38.00	41.00	39.00	34.00
	MVP/MFC	0.95	0.84	11.13	0.77	1.06
Labour	MVP	30.30	13.80	11.70	12.60	28.80
	MFC	30.00	30.00	30.00	30.00	30.00
	MVP/MFC	1.01	0.46	0.39	0.42	0.96
Fertilizer	MVP	142.00	86.80	164.40	70.00	97.20
	MFC	40.00	40.00	40.00	40.00	40.00
	MVP/MFC	3.55	2.17	4.11	1.75	2.43

Source: Rahman and Lawal (2003)

In Soba area of Kaduna State, it was revealed in a study that farm-specific technical efficiency varied between 0.32 to 0.85 for the overall sorghum-based cropping system with average of 0.62, 0.74, 0.64, 0.71 and 0.58 for sole sorghum, sorghum/cowpea, sorghum/groundnut, sorghum/soyabean and sorghum/millet respectively. Thus, in the short-run, there was tendency for increasing output by 38, 26, 36, 29 and 42 percent in the sole sorghum, sorghum/cowpea, sorghum/groundnut, sorghum/soyabean and sorghum/millet respectively, through adoption of the best practices in sorghum-based cropping system (See table 13).

Table 13: Maximum likelihood estimates of the stochastic frontier production function and the technical efficiency for the sorghum-based cropping system

Variables	Regression coefficients				
	SG	SG/CP	SG/GT	SG/SB	SG/ML
Constant	2.922	3.314*	3.113*	3.105*	3.084*
	(1.763)	(1.295)	(1.333)	(1.270)	(1.782)
Land (X_1)	0.643*	0.492*	0.752*	0.583*	0.840*
	(0.266)	(0.231)	(0.248)	(0.265)	(0.337)
Seed (X_2)	0.128	0.262	0.096	0.136	0.167
	(0.092)	(0.214)	(0.058)	(0.104)	(0.163)
Fertilizer (X_3)	0.084*	0.063	-0.114	0.096	0.055
	(0.029)	(0.058)	(0.099)	(0.064)	(0.037)
Labour (X_4)	0.266*	0.065*	0.219*	0.204*	0.157*
	(0.084)	(0.075)	(0.088)	(0.087)	(0.064)
Σ	0.306*	0.318*	0.194*	0.256*	0.231
	(0.130)	(0.141)	(0.078)	(0.122)	(0.095)
ϕ	0.721	0.801	0.682	0.738	0.625
Log Likelihood	-72.623	-68.138	-61.192	-58.181	-52.645
Average TE	0.62	0.74	0.64	0.71	0.58

Source: Rahman *et al.* (2005)
* Significant at 5 percent level.
Figures in parentheses are standard errors
TE = Technical Efficiency

Economics of Fishery and Livestock Production

For the livestock and fishery industry to continue to support the balanced diet of ever- growing population in the face of climate change, increasing global population and limited resources, production efficiency need to continue rising. The current level of food insecurity calls for proper assessment of livestock and fishery sub-sector of the economy because the greatest problem associated with food insecurity is that of inadequate animal protein in the diet of most people especially in the developing countries like Nigeria.

SG= Sorghum, CP= Cowpea, GT= Groundnut, SB= Soyabean, ML=Millet

Farm-specific technical efficiency in poultry egg production industry was examined in Nasarawa State. The average technical efficiency for the whole State was approximately 66 percent. Thus, in the short run, poultry egg production in the State could be increased to maximum by about 34 percent, if the best inputs and management practices were employed. The allocative efficiency of the poultry farms was 62.60 percent. The average economic efficiency of the commercial poultry was 41.36 percent (see table 14). This indicates that the poultry farms were economically inefficient.

Table 14: Technical, Allocative and Economic Efficiencies of Poultry Farms in Nasarawa State

Zone	Efficiency (%)		
	Technical	Allocative	Economic
Nasarawa South	62.71	59.88	37.55
Nasarawa North	66.35	61.32	40.69
Nasarawa West	69.14	66.60	46.05
All zones	66.07	62.60	41.36

Source: Rahman and Yakubu (2005)

The technical, allocative and economic efficiencies in fish farming in the three senatorial zones of Nasarawa State were examined in 2006 and observed to vary widely across farms. The statewide average values of technical, allocative and economic efficiencies observed were 59, 56 and 33 percent respectively (See Table 15).

Table 15: Technical, Allocative and Economic Efficiencies of Fish Farms in Nasarawa State

Zone	Predicted Efficiency (%)		
	Technical	Allocative	Economic
Nasarawa South	65	61	40
Nasarawa North	59	56	33
Nasarawa West	53	52	28
All zones	59	56	33

Source: Rahman and Okunsebor (2006)

7. Gender Issues in Farm Production

The need for sustainable agricultural development for food security and improved standard of living justifies the need to improve women contribution in farm production. Findings from some studies revealed that women make significant contribution to food production and to the processing of food stuff (Rahman et al., 2004). They provide 60-80 percent of agricultural labour and are responsible for 80 percent of food production (Ingawa, 1999; Mgbada, 2000; Rahman et al., 2004). FAO records that women produce between 60-80 percent of the food in most sub-Saharan African countries and are responsible for half of the world's food production (FAO. 1998). Women produce and process food and use diverse coping strategies for ensuring food security for their households.

Despite the significant role women play in society, they are left out in development programmes and policy making. They have not been given opportunity to realize their full economic potential in agricultural development

programmes. This is as a result of traditional gender-based subordination and disparity between men and women in the size of landholdings and other agricultural resources, Women's subordination has limited their access to and control over productive resources. The contribution of women to agricultural development could be maximized through full integration of women into agricultural and rural development programmes for the purpose of efficiency and sustainability (Rahman et al., 2005).

Gender-Labour Productivity in Farm Production

Given the gender division of labour and differences in the access to land, labour, finance and education, the technological needs of women farmers are in many ways distinct from those of men. One of the greatest needs of rural women is time-saving technologies which will lighten their excessive workloads and reduce the length of their working day thereby increasing their productivity.

In Nasarawa State of Nigeria, a study of farm households revealed considerable differentials in labour productivity between men and women (See Table 16). The same study concluded that, every one hour spent by man on farm works produced more extra output compared to the case of women. This could be attributed to the fact that men have more access to productive resources compared to women. Also, some reports (Cf. Gabriel, 1991; Rahman et al., 2004) have shown that women carry the major responsibility for both farm production and domestic works which negatively affect their labour productivity in the farm production.

Table 16: Gender-labour productivity differentials (N/man-hours) in crop production in Nasarawa State, Nigeria

Estimate	Nasarawa South		Nasarawa North		Nasarawa West		All Zones	
	Male labour	Female labour	Male labour	Female labour	Male labour	Female labour	Male labour	Female labour
Minimum	15.41	6.13	11.30	5.23	8.70	3.15	8.70	3.15
Maximum	48.33	33.12	41.78	29.62	45.33	29.00	48.33	33.12
Average	24.50	18.55	20.11	15.43	26.17	20.32	23.59	18.10
St. deviation	7.99	4.67	3.76	3.11	10.50	5.94	7.19	4.50
CV (%)	32.61	25.16	18.72	20.13	40.11	29.22	30.48	24.84
Differential	5.95		4.68		5.85		5.49	

Source: Rahman *et al.* (2007)

8. Concluding Remarks

From the foregoing, it is obvious that success in agriculture depends on efficiency of farm production. The inefficiency in farm production is one of the major factors responsible for stagnation in agriculture and food insecurity in most developing economies.

Mr. Vice-chancellor Sir, distinguished academics, ladies and gentlemen, permit me to conclude this lecture by saying that we have no efficient farms in the Nigerian agriculture. This is because of the following reasons:

- Farming is regarded largely as a way of life rather than a business.
- Nigerian agriculture is dominated by small holders and aged farmers who use rudimentary production techniques
- Input supply not under farmers' control but under the control of politicians and middlemen thereby increasing costs and delays to timely farm operations.
- Very poor infrastructural supports. Marketing and distribution left to individual farmers' preferences and efforts
- High incidence of pests and diseases of crops and animals
- Poor access to improved technologies
- Most farmers do not specialize in what they produce
- Most children of farmers and graduates of agriculture are not attracted to agriculture.
- Consistent low budgetary allocation to agriculture by government
- Inconsistent government policies on agriculture
- Inappropriate land ownership system
- Poor knowledge of farmers in management, accounting and marketing
- Low capital base of farmers due to poverty.

9. RECOMMENDATIONS

An inefficient farm is wasting of resources because it does not produce the maximum attainable output or revenue from the given quantity of inputs. Government and stakeholders should assist farmers beyond input supply by creating effective services and enabling environment for efficient utilization of inputs on farms. The support should cover the followings:

a. **Agricultural Credit:** Agricultural credit plays an important role in making farming sector more productive because it addresses capital constraint faced by the farmers and encourages adoption of modern technologies. Most of the modern inputs are purchased by farmers through cash or on credit, thus, more and more farm households depend upon credit markets. Therefore, provision of adequate credit facilities will ensure timely and adequate utilization of agricultural inputs for improvement in farm production efficiency.

b. **Agricultural extension:** Agricultural extension not only accelerates the diffusion and adoption of new technologies, but also improves the managerial ability of farmers and promote efficient utilization of

existing technologies by improving farmers' knowledge and skills. For research to be effective there must be an efficient mechanism whereby its result can be used effectively by the end users. Participatory approach of extension services should be adopted in order to facilitate farmers' learning, technology development and transfer for rapid agricultural development. Agriculture extension institutions should be adequately funded to improve the number and quality of extension agents.

c. **Agricultural research:** Investment in agricultural research is very important and vital for increasing productivity among resource poor farmers in developing countries. Agricultural research and technological improvements will continue to be prerequisites for increasing agricultural productivity and income generation for farmers. It can promote the introduction and the adoption of improved ways of farm operations. Farmers who adopt new technologies often succeed in lowering their production costs per unit of output and therefore compete better in the market. There is need to adequately fund agricultural research institutes for effective research activities.

d. **Rural infrastructure:** Productivity increase in agriculture is an effective driver of economic growth and poverty reduction both within and outside agricultural sectors. Such productivity increase depends on good rural infrastructure such as well functioning domestic markets, roads and other social amenities (Anderson and Shimokawa, 2007). Poor infrastructure affects cost of production and value of produce negatively hence**,** adverse impact on farm production efficiency. Poor transport for example limits market access for many farmers in the developing countries. Nigeria's rural road network is one of the least developed in sub-Saharan Africa. The poor tends to live in isolated villages that become virtually inaccessible during the rainy seasons. When there is a post-harvest marketable surplus, it is not always easy to reach the markets. Limited accessibility also cut off small-scale farmers from sources of inputs, equipment and new technologies. Crop yields are, therefore, low because farmers lack these inputs. Development of rural areas where farming is the major economic activity should be intensified by providing basic infrastructure.

e. **Storage facilities:** Postharvest loss of food crops grown by farmers in developing countries is a serious problem due to inadequate storage facilities and poor harvesting practices. The increasing need for storage facilities cannot be overemphasized. Farmers in the developing countries face challenges of storage, processing and market at the end of

production. This is worst for the producers of most perishable commodities like vegetables. Simple and cheap storage technologies should be developed to help in reducing post-harvest losses among the farmers.

f. **Farmers' training:** Knowledge acquired through training may enhance farm productivity directly by improving the quality of labour and management skills. Songhai farm is the best agricultural model that can serve as farmers' training centre. The one developed under Songhai Rivers Initiative in River State of Nigeria is an integrated world class farm and a centre of excellence. Every state should be encouraged to have such facility for:
   - o youth entrepreneurship in agriculture
   - o enterprise training and transfer of skills to local farmers
   - o research into agricultural techniques and varieties.,
   - o sustainable livelihoods and rural transformation.

g. **Agricultural Statistics and Data Base:** Many agricultural programmes and policies failed in Nigeria because of insufficient information at planning stage. For any agric programme to achieve its goals certain information about produce, farms and farmers must be documented and utilized in planning the programme. This will enable policy makers to understand the basic requirement for the programme to be executed and to facilitate adequate arrangement. It is, therefore, necessary for agricultural statistics to be recognized and utilized in decision and policy making. Every farm and farmer should be registered with relevant information documented. This is because information is an indispensable factor in almost every activity related to farming and it is the basis of extension service delivery.

h. **Value Addition:** For farmers, value addition has a particular importance for transforming an unprofitable enterprise into profitable one. Value-added activities are critical to the long-term survival of most small farms in developing countries. In addition to good economic growth potential, value-added activities can help diversify the economic base of rural communities. Local agricultural producers and community leaders need to work together to attract agribusiness ventures for value-added activities that will utilize local resource to encourage improvement in quantity, quality and efficiency of production in farming communities.

i. **Gender equity:** For one to be productive, you need to have access to resources and to markets. Traditionally it is easier for men to have access to resources, when actually women do about 70 per cent of work in

agriculture. There is need to improve productivity among women. Agricultural development programmes and policies should respect gender equity to improve accessibility to resources and transform productivity among women farmers.

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5. BRIEF PROFILE OF PROF. S. A. RAHMAN

Shehu A. Rahman is a professor of Agric. Economics and former Dean of Faculty of Agriculture in Nasarawa State University, Keffi. He obtained a B. Agric. degree in 1993, M.Sc. Agric. Economics in 1998 and a Ph.D. in Agric. Economics in 2001, all from Ahmadu Bello University, Zaria. His working experience spans from Assistant Lecturer at Ahmadu Bello University, Zaria in 1994 to Professor at the Nasarawa State University, Keffi in 2008 (at the age of 40). He has served in various capacities rendering administrative and community development services in addition to teaching and research. His research activities produced over ninety-five (95) publications in both National and International Journals of repute. He has presented over forty-five (45) papers at various seminars, workshops and conferences. He has served as a consultant to GTZ and World Bank. He has taught in the fields of production Economics and Econometrics at both Ahmadu Bello University, Zaria and Nasarawa State University, Keffi; and has been an External Examiner of both undergraduate and postgraduate students at various universities in Nigeria. He was the Chairman of Association of Deans of Agriculture in Nigerian Universities for two years (May, 2010- May, 2012) and Deputy Vice-Chancellor (Administration) in Nasarawa State University, Keffi (February, 2012 to February, 2013). He is currently a visiting Professor of Agricultural Economics to Ahmadu Bello University, Zaria and Vice-Chancellor of Federal University, Gashua. In recognition of his involvement in many cultural and developmental activities in Umaisha Chiefdom he was turbaned as Shetima of Opanda on the 31st December, 2011