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4th Inaugural Lecture

"ROADMAP TO CANAAN: PRODUCTION EFFICIENCY AND INTEGRATION IN AGRIBUSINESS"

By

PROFESSOR BAMIRO O.M.

B. Agric. (Agric Econs), M.Sc. (Agric Econs), Ph.D (Production Economics)

Professor of Production Economics
Department of Agriculture,
College of Agricultural Sciences
Landmark University, Omu-Aran
Kwara State, Nigeria.

THURSDAY, 16th NOVEMBER, 2017

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This 4th Inaugural Lecture was delivered under the Chairmanship of:

The Chancellor, Landmark University
Dr. David O. Oyedepo

Host:
The Vice-Chancellor, Landmark University
Professor Adeniyi Olayanju

Thursday, 16th November, 2017

PROFESSOR BAMIRO O.M.

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PROFILE OF PROFESSOR OLASUNKANMI MOSES BAMIRO

Professor Olasunkanmi Moses Bamiro was born in 1963 to Late Mr. Jonathan Oluwole Bamiro and Mrs Aderonke Bamiro (of blessed memory) at Ijebu-Igbo in Ogun State, Nigeria. He attended St. John's African Church School, Ijebu-Igbo between 1968 and 1975. He ought to have completed his education in 1974 but for his parent's inability to pay one naira for the primary school leaving certificate examination fee. He was advised to opt for photography apprenticeship but he vehemently declined. Young Bamiro unfortunately lost his father on 1st August, 1975. This would have led to the end of his ambition to further his education, as family members were not in a good financial position to assist him. With dogged determination, he left for Lagos with his mother's blessings. He started Lagos life as a Tailoring Apprentice at 21, Araromi Street, Somolu, Lagos between February 1976 and September 1977.

The onset of a turning point in the history of his life began when he travelled to his hometown for Christmas celebration. One Mrs. A.O. Okunaiya made a statement that rekindled the burning zeal for education on his inside, ***"Your mates are in school while you are a tailor apprentice!"*** This prompted him to implore elders in his family to send him to school, even if they had to sell his own share of his father's inheritance. Unfortunately, he was told that the debt left behind by his father would not allow them to pay his tuition fees even if they had to search for a school that would collect as low as fifteen naira!

When he returned to Lagos and explained his plight to his uncle, under who he was a tailoring apprentice, the uncle in his magnanimity decided to enroll him at a private lesson in Bariga, Lagos. He faced several hurdles before he was able to complete

his secondary school education in 1983 in flying colours. When he thought he had reached the apex of academic success with his secondary school certificate, he received the shock of his life at an interview he attended at the Federal Ministry of Industry, Lagos where every member of the panel said, ***"young man, please go to school".*** He tried to explain to them how poverty had compelled him to seek employment, but all fell on the deaf ears of the panelists. Though it was a bitter pill for him to swallow then, now he can say they did him a lot of good by turning down his plea.

After all efforts to secure a lucrative job failed, a friend of his, Mr. Ramoni Abimbola introduced him to the then Principal of Beje High School, Ijebu–Igbo, who gladly employed him as a P.T.A. teacher in 1983 on a paltry monthly salary of One hundred and forty eight naira only. While in this school, he taught Physics, Chemistry and Mathematics and prepared the first and second sets of the School for WASCE in 1984 and 1985 respectively. Amongst the students then were Ademola Idowu, now a Medical Doctor and Consultant with Ekiti State University Teaching Hospital, and Tunde Ipaye, also a Medical Doctor and currently the Honourable Commissioner of Health in Ogun State.

Professor Bamiro is an Alumnus of Obafemi Awolowo University, Ile-Ife, University of Ibadan and University of Agriculture, Abeokuta, where he obtained Bachelor of Agriculture (Agricultural Economics), M.Sc. Agricultural Economics and Ph.D. Production Economics respectively. His areas of specialization include Production Economics, Consumer Studies, Livestock Economics and Agribusiness.

He had a stint of his career as a Credit Analyst in finance companies between 1991 and 1993, after which he began a career in academics as an Assistant Lecturer in the Department

of Agricultural Economics and Farm Management, Ogun State University, Ago-Iwoye (now known as Olabisi Onabanjo University) in 1995. He rose to the rank of a Senior Lecturer in 2008 and withdrew his service from the University in 2011. He joined the service of Landmark University as a Senior Lecturer in March 2011, after which he was promoted to the ranks of Associate Professor and full Professor in 2012 and 2015 respectively.

This erudite scholar has published extensively in reputable national and international journals and books with about fifty publications to his credit. He has also supervised several undergraduate and postgraduate projects. He has been an external doctoral examiner.

Professor Bamiro is a recipient of several prizes, honors and recognitions among which are: Exclusive Leadership Award by Nigerian Association of Agricultural Students, Olabisi Onabanjo University Chapter; Outstanding Services Award; Most Impactful Lecturer, 2012/2013 Academic Session by Landmark University Student Council; and Most Impactful Lecturer in the College of Agricultural Sciences (CAS) for three consecutive years at the CAS Hooding Events, Landmark University, Omu-Aran.

Since joining Landmark University, he has been privileged to serve in several capacities, notable among which are: Chairman, University Examination Committee, 2012-date; Member, Publication & Conference Committee 2011-date; Member, Students Disciplinary Committee 2012-date; Chairman, Admission Committee 2012-date; Member, Mock Accreditation Committee 2012-2015; Member, Ad-hoc Committee on Equipment Acquisition 2012-2013; Chairman, Farm Practical Year Organization Committee 2012-2014; Ag. Head, Department of Agricultural Economics and Extension 2013-2015 and Head, Department of Agriculture 2015-date.

Professor Olasunkanmi Moses Bamiro is happily married to Adepeju and blessed with wonderful children.

ESTABLISHED PROTOCOL

The Chancellor and Chairman, Board of Regents,

Landmark University, Dr. David Oyedepo; *FNAE*

The Vice-President (Education), Living Faith Church Worldwide,

Pastor (Mrs.) Faith Oyedepo;

The Esteemed Members of the Board of Regents,

Landmark University;

Education Secretary, Living Faith Church Worldwide,

Professor Bridget Sokan;

The Vice Chancellor, Landmark University, Professor Adeniyi Olayanju

The Registrar, Landmark University, Dr. Azubuike Ezenwoke

Other Principal Officers of Landmark University;

Deans of Colleges and School of Postgraduate Studies;

Members of Senate, Landmark University;

My Lords, Spiritual and Temporal;

Vice-Chancellors from other Universities

Registrars from other Universities

Invited Special and Esteemed Guests;

Kings and Queens, Landmark University;

Ladies and Gentlemen of the Press;

Distinguished Ladies and Gentlemen.

DEDICATION

This Inaugural Lecture is dedicated to the Lord Jesus Christ, the Savour of my soul, who by His mercy made me what I am today. Praise to His Holy name.

1.0 INTRODUCTION

There are five major roles that agriculture is expected to play in the sustainable development in every agrarian economy. The first, and the most crucial of these, is food supply, which is expected to be available at all times to all the people in adequate quantity and quality at affordable prices. Others include supply of raw materials to domestic agro-allied industries, generation of adequate and remunerative incomes for farming households to meet domestic demand, and generation of foreign exchange earnings through export of agricultural commodities.

For sub-Sahara Africa, including Nigeria, agriculture is the principal source of food, livelihood and foreign exchange earnings (Badiane & Deldago, 1995). As at Nigeria's independence in 1960, and throughout the period, over 70 percent of the Nigerian populace practiced agriculture and engaged in allied occupations as their means of livelihood (The Food and Agricultural Organization of the United Nations) (FAO, 2017). In those years, Nigeria produced the bulk of her food, and exported a sizable quantity of agricultural commodities such as cocoa, palm produce, rubber, groundnut, cotton, and hides and skins among others. These exports accounted for 60 - 70 percent of the nation's foreign exchange earnings but this decline to 1.2 percent in 2005 (CBN, 2005) The challenges of poverty, unemployment, crime and many of the socio-economic problems confronting the nation today were then at their lowest ebb.

The oil boom of the 1970s and early 1980s however brought a new paradigm into the economic activities of the country. Foremost on the economic drift was sharp increases in governments' revenue that provided the basis for increase in

public spending towards the expansion of infrastructure, industrial sector's productive capacity, human capital and repair damages caused by the civil war to the nation between 1967 and 1970 (FOS, 1996). However, rising wages and attendants demand-pull inflation due to increased public and private spendings, led to inflationary pressures that plunged profitability in agricultural and other non–oil production. The direct implication was capital flight from non-oil sector (mostly agricultural) which undermined its further expansion (Olisadebe, 1995; FOS, 1996).

The second important consequence of the oil boom was the rural-urban migration as a result of wage differential and emergence of consumer-oriented lifestyles. This led to the withdrawal of a substantial labour force from the agricultural sector, and the relative neglect of the agricultural sector by the government in pursuit of cheap oil money, culminating in a decline agricultural production index from 126 (1985=100) in 1970 to 116.1 in 1987 and increased to 258.2 in 2000 and nosedived to 175.5 in 2004 (CBN, 2005).

This notwithstanding, agriculture continues to be the largest sector of the Nigerian economy and employs 60 percent of her entire labour force, the production hurdles have significantly stifled the performance of the sector (CBN, 2002). Over the past 20 years, value-added per capita in agriculture has risen by less than 1 percent annually. It is estimated that Nigeria has lost USD 10 billion in annual export opportunity from groundnut, palm oil, cocoa and cotton due to continuous decline in the production of those commodities. Meanwhile, food production efforts have not kept pace with population growth, resulting in rising food imports and reduction in the national food sufficiency (FMARD, 2008). The factors undermining

agricultural production include reliance on rainfed agriculture, land use act, small land holdings, poor planting materials, inaccessibility to synthetic fertilizers application, and weak agricultural extension system amongst others.

It is paradoxical to note that while Nigeria is one of the largest producers of rice in Africa, it is the continent's leading consumer of rice and simultaneously one of the largest rice importers in the world. According to the Executive Secretary of Agricultural Research Council (ARCN) in August 2016, "Massive importation of food especially rice, wheat, sugar and fish has continued to bleed the nation's economy, with the four items accounting for a whooping N1 trillion loss annually" He also noted with dismay that Nigeria had remained a large food importer, inspite of massive uncultivated agricultural lands across the country. His view was corroborated by the Minister of Agriculture and Rural Development, Chief Audu Ogbeh who unfolded out worrisome statistics on the 16th August 2017 that showed that Nigeria spends over US$22 billion (N7trillion) annually on importation of various food items like wheat, rice, fish, and poultry products among others. The Minister also stated that milk and tomato paste importation gulps over one billion dollars (N300 billion) and $400m (N1.2 billion) respectively annually. This news is pathetic for a country that is replete with potential human, capital and land resources.

2.0 THE CANAAN: FOOD SECURITY

If you consider the natural endowments that the Lord has bestowed on Nigeria, one can confidently say that the promise of the Lord in Deuteronomy 8: 7 - 9 is fulfilled in this nation. It says:

> *For the LORD thy God bringeth thee into a good land, a land of brooks of water, of fountains and depths that spring out of valleys and hills;*
> *A land of wheat, and barley, and vines, and fig trees, and pomegranates; a land of oil olive, and honey;*
> *A land wherein thou shalt eat bread without scarceness, thou shalt not lack any thing in it; a land whose stones are iron, and out of whose hills thou mayest dig brass. Deut 8:7-9*

Nigeria is richly blessed with huge natural and human resources! She is endowed with about 91.1 million hectares of land – the 2nd largest in Africa and the 32nd largest in the World. The nation is also richly endowed with about 1.3 million hectares of inland water bodies and a coastline that extends over at least 853 kilometres (FAOSTAT data, 2017). As much as 83.7% of Nigeria's lands are suitable for agricultural production, with only 43% currently in use for arable & permanent crops production and merely 0.38% developed for irrigation (FAOSTAT data, 2017; Wikipedia, 2017). Despite these enormous potentials, Nigeria – like a prodigal child – still wallows in the wilderness of poverty, hunger and widespread food insecurity!

2.1 Concept of Food Security

The final report of the 1996 World Food Summit states that food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Household food security exists when all members, at all times, have access to enough food for an active, healthy life (USDA, 2013). Individuals who are food secure do not live in hunger or fear of starvation (FAO, 2012). According to United States Department of Agriculture (USDA, 2013), food insecurity, on the other hand, is a situation of limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire optimally nutritious foods in socially acceptable ways. In the years 2011-2013, an estimated 842 million people were suffering from chronic hunger. The Food and Agriculture Organization of the United Nations, identified four pillars of food security to include: availability, affordability (access), utilization, and access sustainability (FAO, 2013). These four pillars are discussed in details below:

2.2 Dimensions of food security

Food security has four main dimensions: availability, access, stability and health. Figure 1 presents the main elements of these dimensions, which are discussed in this section.

FOUR DIMENSIONS OF FOOD SECURITY

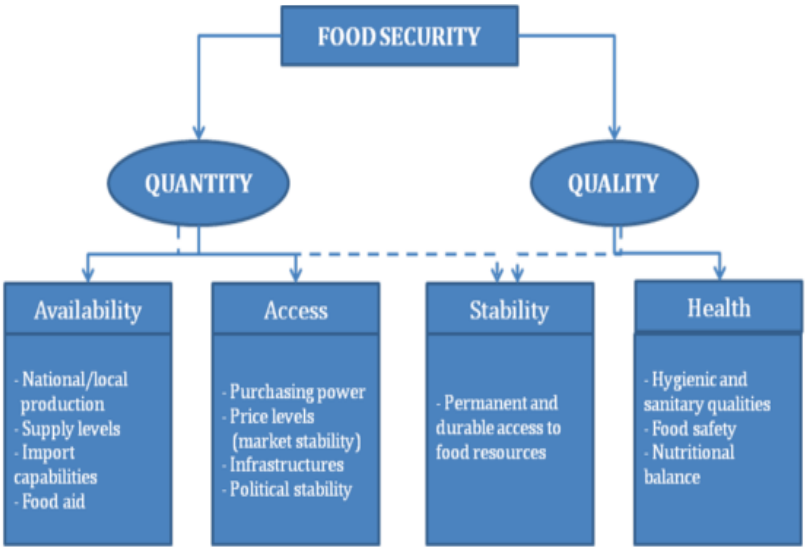


Figure 1: Four Dimensions of Food Security
Source: Momagri-Movement for a World Agricultural Organization http://www.momagri.org

Food Availability: The first of these four pillars, availability, requires "sufficient quantities of food to be available on a consistent basis" and as such, requires consideration of the supply chain of food through production, distribution, and exchange. "Production" is generally considered to refer to "production in sustainable ways" and includes considerations of many aspects, one of which is land use and natural resource management.

Food Affordability (Access)*:* An adequate supply of food at the national or international level does not in itself guarantee household level food security. Household food affordability (accessibility) is the ability to obtain sufficient food of definite quality and quantity to meet nutritional requirements of all household members. The food should be at the right place at the right time and people should have economic freedom or purchasing power to buy adequate quantity of nutritious food. Food access is determined by physical and financial resources, as well as by social and political factors. Concerns about insufficient food access have inspired a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives.

Food Utilization is commonly understood as the way the body makes the most of various nutrients in foods. Sufficient energy vibrance and nutrient intake by individuals is underscored by good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals.

Food Stability: This pillar refers to the stability of the other three dimensions over time Even if your food intake is adequate today, One is still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a decimation of one's nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have consequence on your food security status. For food security objectives to be realized, all four dimensions must be fulfilled simultaneously.

The interplay of all these variables determine whether an

individual, household, state or nation is food secure or not. Food security is therefore achieved "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Food security is, as such, complex and multi-dimensional. As defined, it encompasses food availability, access, utilization and stability. Clearly, this involves sectors beyond agriculture (which, under the FAO definition includes forestry and fisheries) to others, such as health, education, transport and trade policy.

2.3 Consequences of Food Insecurity

FAO (2001) defined food insecurity as a situation that exists when people lack secured access to sufficient amounts of safe and nutritious food for growth and development as well active and healthy life.

Food insecurity and hunger are preludes to nutritional, health, human and economic development problems. They connote deprivation of basic necessities of life. As such, food security has been considered a universal indicator of households' and individuals' personal well – being. The consequences of hunger and malnutrition are evident in the livelihood and well-being of a massive number of people across the globe undermining the development in many poor nations (Gebremedhin, 2000). Malnutrition affects one out of every three pre-school age children living in developing countries. According to United Nations Children's Education Fund (UNICEF) (2016), estimated that over 2.5 million Nigerian children were suffering from severe Acute Malnutrition, (SAM), warning that 20 percent of the number could die if urgent steps were not taken to address the issue.

This disturbing, yet preventable state of affair causes untold

stress and cripple manpower adequacy to the development process. It is associated with more than half of all child deaths worldwide. It is therefore the implicated as a major waste of resources and loss of productivity which are common occurrences in developing countries. This is because children who are malnourished are less physically and intellectually productive as adults. As such, malnutrition is declared a clear violation of a child's human rights (Smith et. al, 2003). More than 800 million people have too little to eat to meet their daily energy needs. Most of the world's hungry people live in rural areas and depend on the consumption and sale of natural products for both their income and food needs. Hunger tends to be concentrated among the landless or among farmers whose plots are too small to provide for their needs. For young children, lack of food can be perilous since it retards their physical and mental development and threatens their very survival. Over150 million children under five years of age in the developing world are underweight. In sub - Saharan Africa, the number of underweight children increased from 29million to 37 million between 1990 and 2003 (United Nations, 2005). Furthermore, poverty, hunger and malnutrition have been identified as some of the principal causes of rural-urban migration in developing countries. Unless these problems are addressed in an appropriate and timely manner, the political, economic and social stability of many countries and regions may well be seriously affected, with threat to world peace (FAO, 1996). This is because hunger and poverty can provide a fertile ground for conflict, especially when combined with factors such as unequal ability to cope with disasters.

Rural farmers, in particular, are faced with different constraints in their quest to meet food production target. There seems to be a consensus in literature that the access to micro credit in the rural

areas is a major constraint militating against rural farmers' agricultural production (Idachaba 2006; Olagunju & Adeyemo 2008; Ololade & Olagunju, 2013).
Amidst these financial constraints, there are still other problems faced by the rural farmers which have heightened the food insecurity challenges, one of which is the use of low level of productivity technology by the farmers in the country. These problems have changed the agricultural sector landscape of Nigeria by demoting her from a booming exporter trade in agricultural commodities, to an import dependent one. Subsequently, it has failed to generate significant complimentary foreign exchange, raw materials for agro allied industries, improve the living standards of farming households, and rural communities and provide effective demand for industrial goods and services.

Other factors that affect food crop production negatively include, but not limited to; government attitude towards agriculture and adverse climatic change such as erratic rainfall, which has worsened productivity both per unit of land and per farmer, and in turn, made agricultural work unattractive. These problems have also led to disenchantment with farming and enhanced the lure of the cities for the rural community youths. The interaction of these factors has heightened the problems of food insecurity in Nigeria and many developing countries.

Concerned about her singular dependence on a mono product (oil) for its foreign exchange since her independence in 1960, the Nigerian government has made several reviews of policies for the development of her agricultural sector so as to increase productivity. The First National Development Plan aimed at promoting export of agricultural produce was launched in 1962

and lasted till 1968. The Second National Development Plan (1970 – 1974) was designed to reconstruct areas ravaged by the civil war and to rehabilitate agricultural production. The National Accelerated Food Production Programme (NAFPP) was launched in 1970 to improve the production of staple food crops by peasant farmers through the introduction of modern farming equipment and the diversification of crops. The Third National Development Plan was launched in 1975 and lasted till 1980. Several interventions were invented through policies and programmes that have been executed by different governments. These have resulted in a number of agricultural institutions and programmes, perceptively having the rural farmers as the target of such programs (CBN 2005). Some of the programmes and projects through which agricultural production is encouraged include the River Basin Development Authority (1970); Agricultural Development Project (ADP, 1972); Operation Feed the Nation (1976); Green Revolution (1980); National Accelerated Food Production Projects (NAFPP) 1980; Directorate of Food and Rural Infrastructure (DFRRI) 1986; The National Directorate of Employment (1986), Better Life for Rural Women Programme (1987) and recently the Agricultural Transformation Agenda (2013). One of the central objectives of these programmes was and still is to increase food production thereby solving the problem of food insecurity and poverty in Nigeria.

Endemic corruption among government officials and project contractors as well as over-dependence on international donor agencies, lack of continuity and neglect of farmers who are the end users in the policy formulation have been identified as constraints to the success of agricultural and rural development programmes in Nigeria. Over-reliance on donor agencies as in the case of ADP has resulted to the collapse of programmes as soon as the foreign withdrew from the execution of the

aprogramme. Other serious constraints include; poor extension agent- to- farmer ratio, inadequate motivation and training for the few extension staff as well as inadequate supply of farm inputs and agricultural information to the rural people. Unfortunately, most of these programmes suffered one defect or the other and compounded the problem of food insecurity and poverty continues to linger. Apart from the defects associated with the implementation of these agricultural programmes, many factors that determine the efficiency of farmers were not considered in the planning and the implementation of the programmes.

The march to **Canaan-Food Security** by successive governments of Nigeria has remained a mirage resulting from either not knowing the way, or knowing the way but failing to conscientiously follow it. According to ***Ecclesiastes 10:15, "The labour of the foolish wearieth every one of them because he knoweth not how to go to the city".*** Majority of Nigerians are wearied by failure of past governments and the current one to lead the country to our desired food haven.What then are the roadmaps to Canaan that I have conceptualized in the course of the course of my academic career? The roadmap is marked by **Efficiency and Integration.**

3.0 CONCEPT OF PRODUCTION EFFICIENCY

The crux of the problem of growth in agriculture in the developing countries is how to increase productivity and enhance efficiency of the production systems (Singh, 1975; Yao & Liu 1998; Sarker, Abedin & Islam, 1999). In neoclassical economics, efficiency refers to making the optimum use of a given set of resources for a given set of prices and output markets. Growth can occur either by moving from a less efficient to a more efficient use of resources or by increasing productivity of resources so that more output can be obtained from a given level of resources. Efficiency is a measure of producer's performance, which is very often useful for policy purposes. There are two main reasons for measuring efficiency and productivity. Firstly, they are means by which success or performance of production units are evaluated. Secondly, efficiency and productivity measurement and separation of their effects from production and environmental effects enables us to explore and test the hypotheses concerning the sources of efficiency and productivity differentials.

Efficient farms make better use of existing resources to produce maximum output or incur the lowest cost, thus, achieving a food security objective.

Economists often mention three (3) main types of efficiency in production, namely: Economic, technical and allocative efficiency. Economic efficiency is a term applied to the concept of the overall efficiency of a production system, which has allocative and technical efficiency forming its component parts. Technical efficiency refers to achievement of maximum possible output from a given quantity of input(s), given the technical relationship between the input(s) and output(s) in production. In

other words, it refers to the ability to avoid waste by producing as much output as input usage allows, or by using as little input as output production allows. Hence the technical efficiency analysis has output augmenting orientation or an input conserving orientation.Technical efficiency is achieved only if it is impossible to increase the output given the bundle of inputs or achieve the same level of output if any of the input is reduced, all other things being equal.

Allocative (or price) efficiency refers to the allocation of resources taking into account market prices. The main intent of its measurement is the pursuit of profit maximisation, which is often judged by the following three criteria depending on production scenarios:
In cases involving use of one variable input being combined with other fixed inputs in the production of one product, the Marginal Value of Product (MVP) of the factor must be equal to its price.

i.e. $MVP_x = P_x$ ---- 1

(b) In cases involving two (or more) variable inputs being used to produce one product: The factors must be combined in such a way that the Marginal Physical Product (MPP) per naira spent on each of the factors are equal (least cost combination is achieved.

i.e. $$\frac{MPP_{X1}}{P_{X1}} = \frac{MPP_{X2}}{P_{X2}} = ... = \frac{MPP_{Xn}}{P_{Xn}} \quad \ldots\ldots \quad 2$$

(c) In a much more general cases where two or more variable inputs are used to be allocated among two or more enterprises (products), the factors must be allocated such that the Marginal Value of Products of all the factors are equal in all enterprises.

i.e. $MVPx_{1y1} = MVPx_{1y2} = \ldots = MVPx_ny_n$ - - - 3

In a free market society, this will represent desirable characteristics when market prices are true measures of relative scarcity and prices are determined in perfectly competitive market. However, when prices are distorted by monopolistic influences or when some goods remain outside the market system the role of prices in resource allocation will be greatly impaired.

3.1 Methods of Measuring Technical Efficiency

There are two basic methods of measuring technical efficiency: the classical approach and the frontier approach.

3.1.1 The Classical Approach

This method is based on ratio of output to particular input and is termed partial productivity measure because the output is compared with only one input at a time. The most commonly used ratios are output per man-hour, i.e. the labour productivity and output per unit of capital, i.e. the capital productivity, as well as crop yield from a unit of farm land i.e. land productivity.

3.1.2 The Frontier Approach

Dissatisfaction with the shortcomings of the classical approach led economists to develop advanced econometric and mathematical programming methods aimed at analysing technical efficiency and related issues. This generally entails comparing actual output (or input) achieved in production with the corresponding maximum possible output (or minimum possible input) defined by the production frontier at each given input (or output) level. Consequently, the frontier approach emerged.

The basic idea behind the frontier-based production efficiency analysis may be illustrated with Figure 2 for a production process in which a variable input (X) is used to produce an output (Y).

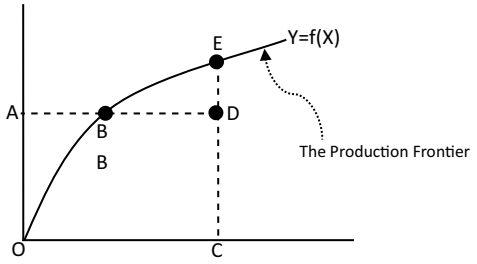


Figure 2: Illustration of production frontier-based efficiency measurement

The production frontier defines the maximum output achievable with any given level of input, given the technology. It defines the boundary of feasible and infeasible input-output combinations. All points along and below the frontier are technically feasible, while those above the frontier are infeasible, given the technology.

For a firm whose actual input-output combination is defined by point D, the frontier output, given the actual input use (OC), is the distance CE; while the frontier input, given the achieved output (CD) is the distance AB. Hence, this producer is technically inefficient since it is still possible for the firm to achieve higher output level (CE > CD) with the input quantity OC; or produce the same output level (CD) with fewer inputs (AB < AD). Depending on production orientation – that is, either to maximise output from a given input (***output orientation***) or minimise input in producing a given output

(***input orientation***), the level of technical efficiency (TE) of the firm, may be computed using the frontier approach as follows:

(a) Output Orientation

$$TE_O = \frac{AchievedOutput}{FrontierOutput} = \frac{CD}{CE} \quad (4)$$

(b) Input Orientation

$$TE_I = \frac{FrontierInputLevel}{ActualInputUsed} = \frac{AB}{AC} \quad (5)$$

Please note that the two measures of TE defined by equations 4 and 5 will be equal only if we have constant returns to scale in production, otherwise the values would be different.

The main development in efficiency analysis using the frontier based methods is in the development of various techniques for estimating the production (or the dual Cost) frontier. Two broad categories of methods currently exist: the parametric Stochastic Frontier Analysis (SFA) based on econometric estimation of the frontier, and the non-parametric Data Envelopment Analysis (DEA) employing mathematical programming techniques to construct the frontier.

3.1.3 The Stochastic Production Frontier

A Stochastic Production Frontier comprises a production function of the usual regression type with composite disturbance term equal to the sum of two error components (Aigner et al., 1977; Ajibefun et al., 2001). One error component represents the effect of statistical noise (e.g. weather, topography, disruption of supplies, measurement error,). The other error component captures systematic influences that are unexplained by the production function and are attributed to the effect of technical inefficiency.

Consider a farm using *n* inputs ($x_1, x_2, \ldots x_n$) to produce a single ouput *y*. Efficient transformation of inputs into output is

characterized by the production function $f(x)$, which shows the maximum output obtainable from various input vectors.
The Stochastic Frontier Production assumes the presence of technical inefficiency of production and may be expressed as:

$$Q_i = f(x_i;b) \exp(V_i-U_i)i \quad = \quad 1, 2, \ldots N \quad \text{---------- 4}$$

Where Qi is the output of the i-th farm; x_i is a vector of inputs; b is a vector of parameters to be estimated; f(x) is a suitable functional form, such as the Cobb-Douglas or translog, V is a symmetric random error that is assumed to account for measurement error and other factors not under the control of the farmer, *Ui* accounts for technical inefficiency in production 'Exp' stands for exponential function.

Technical efficiency of an individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology.

$$\text{Technical efficiency (TE)} = Y_i/Y_i^* \quad \text{-------5}$$

$$= f(xi;b) \exp(V_i - U_i) / f(x_i;b) \exp(V_i) \quad \text{--------6}$$

$$= \exp(-Ui).$$

3.1.4 Data Envelopment Analysis Approach

Data Envelopment Analysis or DEA is a non-parametric technique used in the estimation of production functions and has been used extensively to estimate measures of technical efficiency in a range of industries. Like the stochastic production frontiers, DEA estimates the maximum potential output for a given set of inputs, and has primarily been used in the estimation of efficiency. However, again like the SPF approach, DEA also can be used to estimate capacity utilization DEA can be described in terms of floating a piece-wise linear surface to rest on top of the observations (i.e. envelop the data).

More specifically, the key constructs of a DEA model are the envelopment surface and the efficient projection path to the envelopment surface. The projection path to the envelope surface is determined by whether the model is output-oriented or input-oriented. The choice of input- or output-oriented models depends upon the production process characterizing the firm (i.e. minimize the use of inputs to produce a given level of output or maximize the level of output given levels of the inputs). Data Envelopment Analysis is a method for measuring comparative or relative efficiency. It is relative efficiency because its measurement by DEA is with reference to some set of units we are comparing with each other. The efficiency score is usually expressed as either a number between 0-1 or 0-100%. A DMU with a score less than 100% is deemed inefficient relative to other units.

One major advantage of DEA over other approaches is that it easily accommodates both multiple inputs and multiple outputs. Hence, it is useful for analysis of multiple outputs because prior aggregation of the outputs is not necessary. Unlike stochastic production frontier (SPF), DEA does not require imposition of a specific functional form for the production process.

4.0 Meaning and Kinds of Integration

Integration means bringing together two or more parts into one. There are three basic kinds of integration:

(1) Vertical integration
(2) Horizontal Integration
(3) Circular Integration

Vertical integration occurs when a firm combines activities unlike those it currently performs which are related to them in the sequence of marketing and production activities. Horizontal integration occurs when a firm gains control over the firms performing similar activities at the same level in the production

and marketing sequence. Firms often expand both vertically and horizontally. If both vertical and horizontal operations are tied together this is called Circular Integration.

The most common of the three forms of integration in agribusiness is vertical integration. Details of vertical integration are presented below:

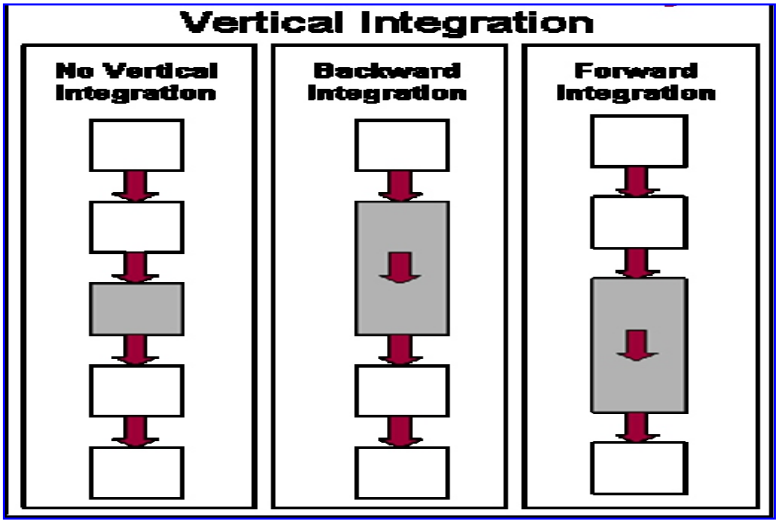
4.1 Vertical Integration

Vertical integration can be defined as the combination of two or more stages of a production marketing chain under single ownership. Backward integration occurs when a firm decides to make rather than buy an input from an independent supplier. Forward integration occurs when a firm decides to use rather than sell one of its products to independent customers. Conversely, vertical disintegration involves a decision to buy rather than make an input or to sell rather than use an input. Such integration could be illustrated by the meatpacker who decides to reach both backward toward the producer and operate his own livestock buying points in the countryside and forward toward the consumer and operate his own wholesale firm.

Vertical integration is one means of organizing a vertical transaction. A vertical transaction involves the transfer of an intermediate good or service from an upstream supplier to a downstream user. Vertical integration is defined to exist when the parties in a vertical transaction are commonly owned. A transaction between commonly owned parties is called **an intra-firm or internal transaction.** The alternative to an intrafirm or internal transaction is **a market transaction.** The distinguishing characteristic of a market transaction is the absence of a significant ownership linkage between the transacting parties.

The set of institutional arrangements within which a transaction is organized is called a **governance structure.** Vertical integration is also called unified governance. The alternative to vertical integration is market governance.

Fig. 3: Vertical Form of Integration



4.1.1 Vertical Integration Theories

There are many theories of vertical integration, which are differentiated by assumptions. For example, successive monopoly in a vertical market system provides a profit incentive for the upstream (downstream) firm to vertically integrate. Quantity is restricted at two levels in the vertical system, which reduces the profit earned by each monopolist. No profit incentive exists, however, if one of the firms behaves in a competitive manner. This is true except the elasticity of input substitution is not zero in the downstream firm. The downstream firm is able to substitute away from the upstream firm's output, which reduces

the upstream monopolist's profit and creates a profit incentive to vertical integration.

Casson (1984) groups the theories into the following general categories:

a. Theories that deal with one economic agent having undisputed price-making power in an external market;
b. Theories that assume that the exchange in the external markets takes place through bargaining;
c. Theories that deal with the dynamic aspects of vertical integration, which include the role of vertical integration in discouraging competitive entry and the changes in the extent of vertical integration over the life cycle of the industry; and
d. Theories that deal with the costs of vertical integration (e.g., financing costs and costs associated with setting up the internal coordination of previously independent units.

a. Single-Price Market

Theories that deal with single-price markets may result in a price that differs from the price attainable under vertical integration. These prices may be competitive, monopoly, or a price in-between. In all cases, a profit incentive exists which encourages vertical integration: "Wrong" prices can result from

(i) a disequilibrium price resulting from governmental regulation, imperfect information and a quota;
(ii) a price distortion through a sales tax which can be avoided through vertical integration;
(iii) a monopolist who sells to an industry whose production function exhibits variable proportions, which allows the buyers to substitute away from the monopolist's profit;

(iv) high fixed costs coupled with a high elasticity of demand (supply), which may result in the buyer (seller) not being able to cover fixed costs and which results in no trade;

(v) perfectly inelastic supply and demand , which causes an indeterminate price and results in self-interest bargaining; and

(vi) imperfect information, which results in uncertain supply and or demand in current and future time periods and in uncertain quality. These factors are likely to provide a profit incentive for vertical integration in lieu of external market exchange.

b. Price Discovery Exchanges. For example, bilateral monopoly is a situation in which the terms of trade are determined through negotiation. Williamson (1979) indicates that the cost of using the market mechanism is likely to be high if there is a small number of buyers and sellers, which allows for the different parties to advance self-interests and take advantage of others involved in the exchange process. The cost of market exchange is further increased as the terms of exchange become increasingly complex and based on imperfect information. The firm likely will integrate vertically if the cost saving from vertical integration relative to market exchange is greater than the cost associated with internalizing an additional production unit.

c. The Dynamics of Vertical Integration

If an upstream monopolist is unable to control a new entrant into a downstream industry, the monopolist may choose to integrate vertically into the downstream industry in order to discourage entry and to enforce vertical control over existing downstream

firms.

The life cycle of an industry can affect the degree of vertical integration exhibited at any point in time. When an industry is in its infancy and a new input is required for a new output, a firm likely will manufacture the input itself. As the market for the new input expands and other input firms can exploit the economies of scale associated with an expanded market, the firms in the infant industry find it less costly to purchase the input instead of manufacturing it. As the market for the output decreases and firms seek to cut costs and output prices, a new cost-cutting technology may be employed to manufacture the input in lieu of purchasing it.

d. Cost of Vertical Integration

The final section on theories of vertical integration contains factors that inhibit vertical integration. The costs of vertical integration include the acquisition costs of a new production unit, the financial and accounting consolidation, the managerial and organizational costs associated with the new production unit and the positive or negative synergistic effect on the firm as it existed before integration. These costs are not well
understood and require private firm information that is not readily available. Casson (op. cit) does identify two factors that are available. The degree of vertical integration is affected by the scale discrepancy between plants at different levels of the vertical system. Firms that vertically integrate may need to integrate horizontally in order to possess enough capacity in one production unit to handle the capacity from a vertical adjacent production unit after vertical integration. Diseconomies may be present in the horizontal integration to an extent, which makes vertical integration less attractive than external market exchange.

A second factor that negates the degree of vertical integration among industries is the requirement that one or more stages of production can operate efficiently only by producing many outputs and or using many inputs. This may result from economies of scope or technical complementaries of production. The need to manage effectively the many inputs/outputs may exhaust the managerial expertise of the firm.

There are however two broad and complementary approaches to the explanation of vertical integration. The first is the transaction costs approach; the second is the imperfect competition or neoclassical approach.

4.1.2 Transaction Cost Approach

Transaction costs are the cost associated with the process of exchange itself (Frank & Henderson, 1992). The transaction costs approach is concerned with how vertical transactions are organized, that is, with the choice of governance structure. The transaction costs approach assumes that exchange will be organized so as to minimize the cost of transacting (maximize the gain from exchange net of transaction costs). It attempts to predict the characteristics of transaction which is efficient to internalize, which is, transactions for which unified governance is less costly than market governance.

The transaction cost predicts that a necessary condition for vertical integration to occur is asset specificity (Grossman & Hart, 1986). That is, a necessary condition for a vertical transaction to be internalized requires either or both parties to make a specialized investment, the cost of which is not completely recoverable if the relationship is terminated. The specialized investment has the effect of locking-in the

transacting parties and making each vulnerable to the opportunism of the other.

Vertical integration reduces the incentive of the transacting parties to attempt to redistribute the gains from exchange. This is because the surplus resulting from an intrafirm transaction accrues to the same owner regardless of whether it is realized by the supplying or the using entity. In the simplest terms, by changing the incentives of the transacting parties, vertical integration alleviates the "hold up problem" in all its manifestations (McFetridge, 1994).

The extent of vertical integration is limited by scale and scope incompatibility and by incentive problems within the firm. Scale incompatibility implies that optimal scales at successive stages of production do not match. This is also called unbalanced through put. Scope incompatibility implies that product lines at successive stages of production do not match. In these cases, full vertical integration requires sacrifice of scale or scope economies at one or more stages of production (Grossman & Hart, 1986).

The alternative to full vertical integration is known as taper integration. In this case, scale and scope economies are realized by selling product in excess of that required for internal use on the open market. This can be useful in itself because it provides a benchmark of the competitiveness of internal suppliers. It also creates incentive problems with regard to the allocation of effort between the servicing of internal and open market requirements. More generally, it may be difficult to give divisional managers the same incentive to operate efficiently that would have as managers of independent suppliers or customers. This is known as managerial slack or shirking. The transaction costs approach

predicts that vertical integration will proceed to the point at which the benefits realized from alleviation of the hold up problem on vertical transactions are just equal to the costs of foregone scale and scope economies and increased shirking. Since the extent of the potential hold-up problem depends on the degree of specificity, the theory predicts that, other things being equal, the smaller the specialized investment associated with a transaction, the less likely it is to be internalized. (Williamson, 1979).

The transaction costs approach has the clear implication that if there are no vertical transactions to internalize, vertical integration (common ownership of successive stages of production) cannot be beneficial (McFetridge, 1994). Williamson (1992) concludes that vertical relations, however, that involve negligible degrees of bilateral dependency should not be integrated (for transaction cost economizing reactions). The rule is try markets, try hybrids and revert to vertical integration only for compelling cause the reason being that to integrate into related stages where dependency is negligible incurs cost without benefits.

4.1.4 Imperfect Competition Approach

The imperfect competition approach to vertical integration is concerned with the opportunities for vertical exchange that arise as a consequence of imperfect competition at one or more stages of production (Joskow, 1987). It is not concerned with how these transactions are organized. The more efficient of vertical integration or contractual vertical restraints is assumed to be chosen. It is concerned with their welfare consequences, which need not be positive (McFetridge, 1994)

Contractual vertical restraints include single product forcing

(minimum quantity) arrangements. A tying seller requires customers wishing to purchase their requirements of one or more other goods or services from him. It also includes various forms of non-linear pricing including price ceilings, price floors (resale price maintenance) and lump sum charges (franchise fees) (McFetridge, 1994).

There are textbooks situations in which imperfect competition at one or more stages of production makes either contractual restraints or vertical integration profitable and frequently, socially beneficial. One well-known example is the successive monopoly or successive marginalization problem. Absent internal incentives problems, the replacement of successive monopolies by a vertically integrated monopoly is both profitable and welfare increasing.

4.2 Merits of Vertical Integration

The reduction of transaction costs has formed an important argument in favour of vertical integration (Williamson, 1992; Kinnucan & Nelson, 1993). Transaction costs are characterized in terms of three dimensions that dictate whether market exchange or internal governance of transaction is most efficient. These are assets specificity, uncertainty and frequency (Ouden, Dijkhuisen, Huirse & Zuurbier, 1996). When transactions recur frequently and require high transaction specific investments, opportunistic behaviour is likely causing transaction costs to rise and markets to be replaced by more efficient internal organization of the exchange through vertical integration (Ouden et al, 1996).

In the same way that vertical integration reduces transaction costs, being the resources consumed in the exchange of

intermediate technological inputs, vertical integration may also reduce the amount of technological inputs itself. The argument of economies of internal control and co-ordination is often associated with the characteristic of vertical integration to assure supply in terms of reducing its uncertainty (Ouden et al, 1996). In this way the need for inventory or other slack built into the business may decline. Reduction of uncertainty is especially important to capital-intensive stages where shortages of material lead to low usage of expensive facilities.

Increased control over adjacent stages may also enhance the ability of a firm to innovate or differentiate product. Whereas forward integration gives the firm better or more timely access to market information, allowing a more rapid or specified adjustment of product characteristics, backward integration may allow the firm to obtain specialized inputs through which it may improve or at least distinguish its final product (Buzzel, 1983).

Although it is not clear that vertical integration should be characterized as necessary to reveal valuable information, once accomplished it should at least facilitate information exchange, for vertical integration increases likelihood and duration of exchange between stages (Henderson, 1992). Moreover, vertical integration may cause the firm to require less information, thereby reducing costs, for example, for collecting and processing information about the market (Ouden et al, 1996). Of course, those potential cost advantages must be balanced against the costs of possibly missing advantageous external opportunities (Mcfetridge, 1994)

As well as facilitating information transfer, the assurance of a stable relationship may encourage the development of more efficient, specialized procedures for dealing with each other.

Without a stable relationship, both buyer and seller would face the competitive risk of being dropped or specialized by the other party. In fact vertical integration may be both the cause and result of the establishment of transaction – specific assets (Williamson, 1989).

The more significant the net benefits arising from those economies of vertical integration, the greater the competitive advantage of the integrated firm over non-integrated firms and thus the greater the stimulus to other firms to integrate as well (Ouden et al, 1996). In the case of significant economies of scale or capital requirements to integrate, vertical integration creates entry and mobility barriers. Compared to a non-integrated entry, an integrated entry will also require managerial expertise at more than one stage (Buzzel, 1983). As well as discouraging potential new entrances, a dominant firm may use vertical integration to impair its competitors by raising their costs. Foreclosure of the market may subject competitors of an integrated firm to higher prices set by fewer remaining independent suppliers, to higher transaction cost from having to negotiate on contracts with remaining suppliers or buyer, or having to deal with remaining suppliers or buyers that are inferior to those secured by integrated firms. Moreover, an imperfect competitive firm, for example, a monopolist, may use vertical integration to practice price or quantity discrimination toward adjacent competitive stages, resulting in price or supply squeezes. On the other hand, the fear of foreclosure and countervailing of bargaining power may be primary motives for vertical integration (Romme, 1990).

Firms may integrate as a risk reduction strategy. "If supplies of an important input (e.g.; eggs) are uncertain, an incentive may exist for a downstream firms (e.g. an assembler /packer) to

purchase the upstream firm in order to obtain a better price of the uncertain input".

4.3 Motives / Arguments against Vertical Integration

According to Buzzel (1983), "A process inherent in combining various stages of production or distribution is the varying scale of operation that each stage may require for efficient functioning". Here, the firm contemplating vertical integration faces a dilemma. Either it must accept a cost disadvantage in operating on inefficient scales at one or more stages or it has to sell outputs or purchase inputs on the open market. Selling or buying excess output or demand on the market may be difficult because the vertical relationship implies that the integrated firm may have to sell or buy from its competitors. The latter may be reluctant to deal with the firm or even take retaliatory action (Romme, 1990). Moreover, the integrated firm may foreclose itself from access to independent suppliers or buyer research or know- how.

Vertical integration consumes capital resources (Ouden et al, 1996). To make vertical integration profitable high investments need to be offset by substantial cost savings or returns greater than or at least equal to the firm's opportunity cost of capital (Buzzel, 1983). High investments may raise exit barriers and reduced flexibility (Johnston & Lawrence, 1988). Changes in technology, product design, and market developments may cause the products or technologies of the integrated stage (s) to become more costly, inferior in quality or inappropriate compared with higher switching costs that would have been the case when it had contracted with independent partners.

Another risk of vertical integration is embodied in managing the various stages that may require distinctly different managerial approaches, for example, manufacturing compared with

marketing (Buzzel, 1983). Moreover, tightly linked, captive and assured relations between the stages within an integrated firm may cause dulled incentives. Compared with internal organization, in general, markets promote high-powered incentives and restrain bureaucratic distortions more effectively.

The minuses of vertical integration above has necessitated the advocacy for incomplete vertical integration known as vertical co-operation (Ouden et al; 1996).

4.4 Vertical integration in Agriculture

Vertical integration is one of several strategies that fall within the umbrella of "vertical coordination."Vertical coordination includes all of the ways that output from one stage of production and distribution is transferred to another stage. Farming has traditionally operated in an open production system, where a commodity is purchased from a producer at a market price determined at the time of purchase. The use of open production has declined, however, and vertical coordination has increased as consumers have become increasingly sophisticated and improvements in technology have allowed greater product differentiation (Martinez, 1994). A vertically integrated firm, which retains ownership control of a commodity across two or more levels of activity, represents one type of vertical coordination (Nijs, 2014). There are many examples of vertical integration in farming. Farmers who raise corn and hay as feed for their dairy operations are vertically integrated across both crop and livestock production. Similarly, poultry farmers who combine poultry production with feedmilling and maize production are vertically integrated backward. This will end

the herdsmen/farmer clashes in Nigeria. In the same vein, cattle producers who combine raising a cow-calf herd, backgrounding the animals to medium weights, and feeding cattle to slaughter weights are vertically integrated. As these examples illustrate, vertical integration can encompass changing the form of the product (corn into livestock), or combining stages in the production process under ownership by one entity (as in the cattle example).

From the farmer's perspective, the decision to integrate vertically depends on many complex factors, including the change in profits associated with vertical integration, the risks associated with the quantity and quality of the supply of inputs (or outputs) before and after integration, and other factors. In particular, the relationship between vertical integration and risk involves an evaluation of the expected returns and the variance and covariance of the farmer's return on investment for the current activity and the integration alternative (Logan). If the correlation is positive and large across activities, the gains in risk efficiency from vertical integration may be relatively low. In contrast, a negative correlation across activities implies that integrating vertically may well reduce risk for the farmer by internalizing processes within the operation. In practice, vertical integration in agriculture often involves ownership of both farm production and processing activities, particularly in certain parts of the livestock sector. Vertical integration is fairly common in the turkey industry, for example, where about 30 percent of production takes place on farms that perform multiple functions. On the largest operations, the enterprise mix may include a feed mill, a hatchery, a grow-out operation, a slaughter facility, and a packing plant. In such cases, integration moves both backward into inputs (feed manufacturing)and forward into the finished, consumer-ready product. Similarly, egg

producers with large operations may own their own feed mill, hatchery, laying operation, and freezing/drying plant for the processing of egg products.

Vertical integration of poultry production operations from the breeding stock through to further processing, which includes support services such as feed milling, allows for the optimum capacity utilization all the way up the production chain. Vertical integration in poultry not only makes poultry meat extremely competitive with other meats in the U.S., it also helps the industry's competitive position in poultry meat export market. According to Dobashi et al. (1999), in the poultry industry, there are three levels of integration. These are:

- Non-integrated - firms tend to act as individual business units. Non-integrated industries are likely to be found in developing countries. A small subsistence farm producing food only for the needs of the farm household would be an example of a non-integrated firm.
- Semi-integrated - involves the processor taking over some parts of the production process to control the quality and quantity of output. In the broiler industry, the firm rearing the poultry may be involved in the production of parent stock or in running the hatchery operation.

- Integrated - large corporate entities control all levels of the value chain from feed milling to delivery at the retail level. Firms involved in pigmeat production might own the feedmills used to manufacture the animal feed; they might also be involved in the breeding of pigs for the

fattening operation; these firms might also own the slaughtering facilities and retail outlets to sell the product.

Similarly, Bamiro (2008) identified three levels of integration in poultry industry in Nigeria which are non-integrated poultry farms; partially integrated poultry farms and fully integrated poultry farms.

1. Non-integrated – Poultry firms tend to act as individual business units. Poultry industry in Nigeria and many developing countries is dominated by Non-integrated poultry farms integrated poultry farms are commercial feed users

2. Partially integrated poultry farms –These are poultry farms that use privately produced feeds but mill their feed at commercial feed milling centers.

3. Fully Integrated poultry farms – These are large poultry farms that use privately compounded feeds that are milled in their own feed mill. A relatively few poultry farms i n this category have hatchery, slaughter facility and freezing or drying points.

This classification which is based on feed production is an indicator of the level of vertical integration in the poultry industry, which is the mostly integrated livestock subsector in Nigeria. The current extent of integration in the poultry industry limits the financial gain that accrued to poultry farmers due to vertical integration. A fully integrated poultry farms in developed countries have feed mill, slaughter facility, hatchery and processing and sometimes own maize farms that supplies maize, the critical inputs in feed production vis-a-vis poultry production.

4.5 Vertical Integration in Crop Production

In developed countries, vertical integration is also common in certain specialty crops particularly for fresh vegetable and potato operations. In these industries, vertical integration often encompasses not only production of the crop, but also sorting, assembling, and packaging products for retail sales. Large, vertically integrated vegetable growers, for example, often both pack and sell their own vegetables, displaying their private brand names on packages, and at times investing in research targeted at developing new varieties.

In developing countries on the other hand, crop husbandry are not vertically integrated except in the areas of mixed farming and mixed cropping.

The reasons for non-integration in crop husbandry and limited vertical integration in livestock industry in Nigeria are:

1. Lack of processing facilities to transform agricultural products from primary products to processed commodity.
2. Poor development of agricultural sector that can necessitate vertical coordination with or without contract.
3. Illiteracy- Majority of farmers in Nigeria are illiterates, hence they have no access to information on the issue of vertical integration.
4. Poor agricultural finance- Vertical integration is capital intensive, but the farmers have no access to adequate funds from financial institutions especially banks that always turn down the loan request of farmers under the pretext of vulnerability of farm enterprises to high risks and uncertainties.
5. The subsistence level of agricultural production in Nigeria

is a major limitation because vertical integration requires large production which will enable farmers to benefit from economies of scale and scope

4.6 Vertical Integration and Profitability

Profit is defined as naira value, which is found by calculating net farm income. Profitability on the other hand is concerned with the size of this profit relative to the size of the business or the value of the resources used to produce the profit. A business may show a positive profit but have a poor profitability rating if this profit is small relative to the size of the business.

The major goal of producers is profit maximization. The issue of profit maximization by an enterprise can be perceived in two ways: input approach and output approach. With respect to input approach, profit is maximized when the farmers used an input to the level where marginal value product is equal to the marginal factor cost (MVP = MFC). With respect to output approach, the quantity of the output that will maximize the profit is at the level where marginal revenue is equal to marginal cost (MR = MC). The farm measure of profit for the farm business is net farm income (NFI) and it represents the difference between the total revenue and total cost.

		=	TR – TC
Where		=	Profit
	TR	=	Total Revenue
	TC	=	Total Cost

Net farm income is the profit from the years operation and represents the return to the owner for personal labour, management and the capital used in the farm. From the above formula, it is obvious that whatever will reduce the total cost of production will consequently increase the farm profit. One

major import of vertical integration in the business world is to reduce cost. According to Consumers Union (2000), vertical integration was developed as a means of sharing risk and increasing profitability, which is enhanced when the cost of production is lowered. By integrating vertically, companies took advantages of economies of scale, and control all aspects of poultry production.

In many cases, a major objective of vertical integration is to minimize or at least greatly reduce, the transaction costs, that is the buying and selling costs incurred when separate companies own two stages of production and perhaps the physical handling costs as well. Having all phases of production under one company eliminates the need for every segment to maximize profit. In fact, vertical integration allows losses to be taken in one segment if it means that gains are made in another segment, such that overall profitability is increased (Consumers Union, 2000).

Buzzel (1983), proved the profitability of vertically integrated firm using the relationship between an adjusted value-added to sales ratio in which net profit is replaced by an average rate of return on each business unit's invested capital. He reports that the business in the database varied greatly in value-added to sales ratio ($^{VA}/_{S}$), from a low value of around 20% to a high 90%. With respect to impact of vertical integration on profitability, he reports that the differences in profit margin are modest up to $^{VA}/_{S}$ of 60%, but from that point, profit rise consistently with increasing integration. He reports that the "V" shaped relationship between $^{VA}/_{S}$ and return on investment suggests that profitability is highest at the two opposite extremes of the spectrum. Either a very low or a very high level of integration yields an above average rate of return, while earnings are lowest in the middle. He also demonstrated clearly that rising

investment requirements offset higher profit margin associated with intensified vertical integration and he concludes thus; "if integration can somehow be achieved without penalty of a proportionally higher investment rates, then increasing vertical integration should be efficiently beneficial" Buzzel therefore suggests some strategies that can make vertical integration to be a profitable venture:

1. **Beware of heightened investment needs**: When the high level of vertical integration hurts the rate of return on investment, it is usually because investment intensity is rising. No doubt the best way to ensure the investment base is to develop proprietary products or processes whose value derives from superior performance rather than from extensive in-house manufacturing or processing. And ideal strategy is one in which value-added increases but the investment base does not.
2. **Considered alternative to ownership**: In the traditional sense of the term, vertical integration is an arrangement based on ownership of activities linked up and down. In some cases, at least manufacturers can reap some of the benefits of integration without owning all the stages.
3. **Avoid "part way" integration:** The V shaped relationship between vertical integration and profitability suggests that some businesses may suffer because they don't carry their linking strategies far enough. This is because the most profitable businesses are those at the extremes of vertical integration spectrum. In general, the least profitable position is an intermediate one. The implication is that, on this dimension of strategy, a clearly defined position is most likely to succeed. In the vertical scope of a business, a

manager should be wary of taking gradual, piecemeal steps that can lead to the unrewarding middle ground.

4. **Carefully analyze scale requirement:** A significant risk in many vertical integration strategies is that a production or distribution stage has too small a scope to be run competitively against independent supply or customers. Presumably for this reason, the data show that the integration is much more likely to pay for businesses with quite large market shares.

5. **The skeptical claims that integration reduces raw material costs:** Economists have long questioned the idea that vertically integrated businesses or companies are somehow insulated from fluctuation in the cost of key raw materials. Unless it monopolized raw material supplied, they asked, why a vertically integrated enterprise should be able to supply itself at anything less than open market prices. The empirical study indicates that skepticism about cost advantage is often well founded.

5.0 MY CONTRIBUTIONS TO IDENTIFYING ROADMAPS

My contributions as a researcher along with my collaborators in identifying these roadmaps were in both crop and livestock production. In crop production, our tentacles were spread to food crops and forest based crop production and consumption. The findings are presented in the following order:

5.1 Roadmap 1- Efficiency

In a study on technical efficiency in upland and swamp rice production in Ogun State, Bamiro & Aloro 2013 discovered that swamp and upland rice productions were significantly influenced by land, labour (hired and family), seed and fertilizer. The mean technical efficiency of the entire swamp rice farm was estimated at 56%. This signifies that there exists a 44% potential for swamp rice farmers to increase their production by increasing the level of resources and technology. The mean technical efficiency of the entire upland rice farm on the other hand was estimated as 91% indicating substantial efficiencies in upland rice production. This signifies that there exists 9% potential for upland rice farmer to increase their production vis–a– vis their income at the existing level of resources and technology. This suggests that by operating at full technical efficiency level, upland rice farmers can increase their production by an average of 9% with the available farm resources and technology. Comparative analysis of technical efficiency of upland and swamp rice production indicates that the upland rice farmers were more technically efficient than the swamp rice farmers. Technical efficiencies in upland and swamp rice farms were significantly influenced by gender and volume of credit respectively. (See Table 1).

Profit Efficiency analysis of rattan cane enterprise in Lagos Metropolis (Bamiro, 2011) indicated that the rattan craftsmen showed a wide range of profit efficiency from 2% to 91% Despite wide variation in efficiency, about 75.3% of the rattan craftsmen seem to be skewed towards profit efficiency of 51% and above (See Tables 2 & 3). The implication of this is that, a considerable amount of profit can be obtained by improving technical, allocative and economic efficiency in rattan crafts production.

In another study on economic analysis of maize based farms in South West Nigeria, Bamiro and Onajole (2011) discovered that majority of farmers are technically inefficient in maize based farms in Ogun State. The mean technical efficiency of the sampled maize farms was estimated at 61% indicating substantial inefficiencies in maize-based production. This suggests that by operation at full technical efficiency levels, maize-based farms can increase their production by an average of 39% with available farm- resource efficiency in maize based farms was influenced by the socio-economic characteristics of the maize farmers. Farming experience and educational status have technical efficiency reducing effect while age and contact with extension agent have efficiency increasing effect. The determinants of efficiency and efficiency estimates are presented in Tables 4 and 5.

Table 1 Technical efficiency estimates of the Upland and Swamp Rice Farms

UPLAND RICE PRODUCTION			**SWAMP RICE PRODUCTION**		
Class interval	**Frequency**	**Percentage**	**Class interval**	**Frequency**	**Percentage**
Less than 80	4	4.1	Less than 50	7	7.4
80 – 84	14	14.7	50– 54	41	436
85 – 89	23	23.9	55– 59	27	28.7
90 – 94	24	25	60– 64	15	16.0
95 – 99	21	32	65– 69	3	3.2
			70 and above	1	1.1
Total	**96**	**100**	**Total**	**94**	**100**

Source: Computed from field survey data

Minimum T.E=77%

Maximum T.E=99%

Mean Efficiency = 91%

Minimum TE = 48%

Maximum TE = 71%

Mean Efficiency = 56%

Table 2: Profit Efficiency of Rattan Craft Enterprise in South-West Nigeria

Explanatory Variable	OLS	MLE
Constant	3.945	9.585***
	(0.973)	(4.763)
Ln Cane Cost	-0.916***	-0.886***
	(-2.671)	(-3.480)
Ln Wages	0.144***	0.114***
	(2.864)	(3.354)
Ln Processing Cost	0.428*	0.096
	(1.707)	(0.527)
Ln Firm Capital	0.280	0.126
	(0.521)	(0.362)
Inefficiency Model		
Constant (*d0*)		-1.669
		(-1.263)
Ln Age (*d1*)		-3.718**
		(-1.997)
Ln Sex (*d2*)		17.296**
		(2.962)
Ln Education (*d3*)		1.432*
		(1.750)
Ln Experience (*d4*)		-1.796*
		(-1.666)
Ln Marital Status (*d5*)		8.210*
		(1.905)
Sigma- Squared (σ^2)		41.885***
		(3.195)
Gamma (γ)		0.947***
		(51.582)
Log Likelihood Function		-100.943

Computed from field survey data

Table3: Profit Efficiency Estimates in Rattan Craft Enterprise

Range	Frequency	(%)
1 – 20	11	12.4
21 – 40	6	6.7
41 – 60	5	19.1
61 – 80	36	40.5
	19	21.3
Total	89	100.0

Source: Computed from field survey data

Minimum = 0.0149 Mean = 0.5988 Maximum = 0.9085

Table 4: Result of the Stochastic Production Frontier analysis on resource use and effect of socioeconomic factors on maize - based farms output.

Variables	Parameters	OLS Coefficients	MLE Coefficients
Production function			
Constant	ß0	0.64	3.30
		(0.44)	(3.48)
Cultivated land	ß1	1.04	0.928***
		(3.92)	(4.91)
Family labour	ß2	-0.01	0.39**
		(0.33)	(2.15)
Hired labour	ß3	0.99	0.147

		(0.33)	(0.71)
Quantity of seed cultivated	ß4	0.42 (1.78)	0.34** (2.24)
Quantity of fertilizer used	ß5	-1.22 (-26.53)	-1.38** (-38.04)
Quantity of herbicide used	ß6	0.11 (2.30)	00.49 (1.42)
Inefficiency Model		-	
Constant	Do	-	-2.94 (-2.05)
Education	d1	-	0.15*** (2.93)
Age	d2	-	-2.72** (-2.34)
Number of extension agent Visit	d3	-	-0.95*** (4.18)
Farming Experience	d4	-	2.63*** (2.64)
Household size	d5	-	-0.14 (-0.65)
Log likelihood function		-324.82	-0.27
Sigma square		3.97	9.04*** (6.64)
Gamma		0.83	0.94*** (67.83)
LR test of one sided error			113.48

Computed from field survey data

Table 5: Technical efficiency estimates of maize based farms

Technical efficiency distribution	Frequency	Percentage
0.5 or less	41	25.5
0.51-0.60	33	20.5
0.61-0.70	44	27.3
0.71-0.80	35	21.7
0.81-0.90	8	5.0
Total	160	100.0

Minimum TE=0.11 Maximum TE= 0.85 Mean TE=0.61

Computed from field survey data

5.1 Roadmap 2: Integration

Bamiro et al., (2013) in a study on Enterprise combinations in Livestock Sector in Southwest Nigeria discovered that the livestock farmer did not utilize the available resources optimally due to lack of technical knowhow. The budgetary analysis shows that the most profitable venture is integrated poultry/piggery enterprise combination while the enterprise that yielded the least net farm income is sole poultry enterprise. The profitability of livestock enterprises is limited by high cost of production in which the feed cost constitutes the lion's share (See Table 6). The optimal enterprise combination obtained using linear programming tool is integrated poultry/piggery enterprise followed by integrated poultry/fishery enterprise. The predicted farm specific technical efficiency range between 13% and 99% with a mean of 53%, which implies capacity of farmers to produce a pre-determined quantity of output, is relatively moderate. The observed distribution suggests that much

marketable outputs are wasted due to inefficient use of farm resources. With a mean efficiency value of 53%, the analysis revealed that production has not reached the frontier threshold. As such, within the context of efficient production, livestock production can still be increased. The result also indicates that an average livestock farmer in the area would enjoy increase in output of about 47.5% (1 – 0.53/0.99) if he or she attains the level of the most efficient farmer among the respondents. The most technically inefficient farmer will have an efficiency gain of 87.9% (1 – 0.13/0.99) in livestock production if he or she is to attain the efficiency level of the most technically efficient farmer in the study area. The decile range of the frequency distribution of the technical efficiency of the farmer further shows that about 36.7% of the farmers operate above the mean efficiency. The result further indicates that farmers that combined poultry and piggery were more technically efficient.

Table 6: Cost-Return Structure of Enterprise Combinations in Livestock Industries in South-West Nigeria

Description	Sole Poultry (₦)	Sole Fishery (₦)	SolePiggery (₦)	Poultry/fish (₦)	Poultry/pig gery (₦)	Poutry/fish/pig (₦)
Depreciation on building	5577.20	11,158.23	16,142.50	41,313.16	8,531.91	11,532.01
Depreciation on barrow	814.63	0.00	837.50	507.73	1,415.33	78.95
Depreciation on borehole	12178.47	7,000.00	2,147.38	15.71	3,920.67	6,650.72
Depreciation on generator	7846.06	0.00	1,880.95	5,086.73	23,432.14	3,551.44
Depreciation on shovel	174.20	0.00	869.64	15.71	1,228.33	367.11
Depreciation on machine	10645.16	0.00	0.00	12,551.02	0.00	13.16
Depreciation on scale	806.18	75.00	2,595.83	956.70	2,975.00	55.26
Tax	0.00	0.00	0.00	785.71	7,000.00	315.79
Total Fixed Cost	38,041.89	18,233.43	24,473.81	61,232.49	48,503.38	22,564.44
cost of stock	2,079.60	9,734.56	4,027.14	12,920.68	22,951.50	4,970.84
wage/manday	8,209.68	7,281.25	2,250.00	36,000.00	25,600.00	8,447.37
cost of vaccination	5,458.87	0.00	0.00	8,285.71	7,710.00	5,064.47
Cost Drug	0.00	1,250.00	0.00	9,830.71	0.00	0.00
Veterinary service	5,767.42	687.50	6,478.57	0.00	0.00	8,154.74
Water bill	158.06	3,125.00	2,62.14	1,371.43	1,850.00	236.84
Electricity bill	837.10	93.75	2,214.29	4,028.57	3,610.00	671.05
Transport cost	3,319.35	109.38	2,778.57	4,071.43	54,935.00	2,973.68
cost of feed	20,375.00	224,343.75	239,306.43	140,981.54	119,927.6	91,901.58
Total Variable Cost	46,205.08	246,625.19	259,667.14	217,490.07	236,584.1	122,420.58
Total Cost	84,246.97	264,858.62	284,140.95	278,722.56	285,087.51	144,985.02
Revenue from birds	70,483.87	0.00	0.00	205,000.00	63,264.95	286,481.47
Revenue from eggs	76,827.74	0.00	0.00	298,000.00	509,827.8	18,755.00
Revenue from fish	0.00	631,714.06	0.00	236,258.60	0.00	18,947.37
Revenue from Pig	0.00	0.00	668,550.00	0.00	260,000.0	57,684.21
Total Revenue	147,311.61	631,714.06	668,550.00	739,258.86	833,092.7	381,868.05
Gross Margin	101,106.53	385,088.87	408,882.86	521,768.53	596,508.6	259,447.47
Net farm income	63,064.64	366,855.44	384409.05	460,536.30	548,005.2	236,883.03
Profitability Analysis						
Profitability index (PI)	0.43	0.58	0.53	0.63	0.66	0.62
Operating ratio	0.31	0.39	0.41	0.29	0.28	0.32
Rate of return on investment(%)	174.86	238.51	222.78	265.23	292.22	263.38

Computed from field survey data

5.2.1 Vertical Integration and Profitability

Bamiro (2007) examined the effects of vertical integration on profitability in poultry industry in Ogun and Oyo States of Nigeria. Farms were classified into three categories, namely, non-integrated, partially integrated and fully integrated poultry farms. Non-integrated poultry farms are commercial feed users, partially integrated farms use privately compounded feeds, but mill their feeds at commercial feed milling centres. Fully integrated farms use privately compounded feeds that are milled in their own feed mill.

The non-integrated poultry farms in accordance with apriori expectation have the lowest gross margin/1000birds and profit/1000birds while the fully integrated poultry farms have the highest gross margin/1000birds and net farm income/1000birds (Table 7). The value added sales ratios for non-integrated poultry farms, partially integrated poultry farms and fully integrated poultry farms are 26%, 33% and 35% respectively. These values indicate the extent of integration as well as a measure of profitability. The higher the value-added sales ratio, the greater the extent of integration. It also shows the respective contributions or value additions of each system of production. The rate of return on investment also known as return to capital is highest for fully integrated poultry farms while the non-integrated poultry farms have the lowest return to capital. The rate of returns per 1000birds for non-integrated poultry farms, partially integrated poultry farms and fully integrated poultry farms are 23.30%, 35.64% and 43.40% respectively.

5.2.2 Enterprise Combinations, Profitability and Extent of Vertical Integration

In a bid to make effects of vertical integration on profitability

more vivid, the gross margin/1000birds, net farm income/1000birds and profitability indicators were examined on the basis of enterprise combinations vis-à-vis the extent of integration with the aim of showing the profitability of different enterprises with respect to the extent of vertical integration. The enterprise combinations are egg production enterprise, broiler production enterprise, egg, broiler production enterprise and egg, broiler and cockerel production enterprise. The descriptive statistics of each enterprise combination are presented and discussed in the following order:

(a) Egg Production Enterprise

The egg production enterprise refers to poultry farms that rear layers purposely for egg production. However, at the end of the laying period, the layers are culled and sold which is an addendum to the revenue and profit from the sales of eggs. The cost- return structure of egg production enterprise by level of vertical integration is presented in Table 8. The cost composition shows that feed consumes the largest share of the cost of production in all the three systems of production. The high share of veterinary service cost in non-integrated poultry farms might be due to low quality feed fed to the birds which rendered the birds susceptible to diseases and this might be the reason for the relatively low share of feed cost compared with what obtains in partially integrated poultry farms and fully integrated poultry farms. The feed cost, contrary to expectation increases with the level of integration. Feed a critical inputs in poultry production, constitutes about 62%, 64% and 70% in non-integrated poultry farms, partially integrated poultry farms and fully integrated poultry farms respectively.

Sales of egg and spent layers are the two sources of revenue in egg production enterprise. The bulk of the revenue was realized

from the sales of egg in both vertically disintegrated poultry farms and vertically integrated poultry farms. The gross margin per 1000birds of egg production enterprise is N865,265.61, N1,159,896 and N1, 018,975.90 in non-integrated poultry farms, partially integrated poultry farms and fully integrated poultry farms respectively. This implies that the partially integrated poultry farms have the highest gross margin while the non-integrated poultry farms have the least gross margin per 1000birds. The higher economic performance of the partially integrated poultry farms is unexpected but it might not be unconnected with scope and scale incompatibility and underutilization of machineries and equipment.

(b) Broiler Production Enterprise

The special feature that is peculiar to this enterprise is that there is no poultry farm that involved in sole broiler production that is fully integrated. Hence, Table 9 shows the economic performance of non-integrated poultry farms and partially integrated poultry farms. The gross margin analysis and all the profitability indicators are higher in non-integrated poultry farms than in partially integrated poultry farms. This could be due to half-way integration which does not allow full benefits of vertical integration to manifest. It can therefore be concluded that broiler production enterprise have higher economic performance when farmers source feed and other critical inputs from outside rather from within the poultry farm.`

(c) **Egg and Broiler Production Enterprise**

The third enterprise combination is egg and broiler production. The cost return structure of average egg and broiler production farm is presented in Table 10. The gross margin/1000 birds and net farm income/1000dirds of the fully integrated poultry farms are higher than that of partially integrated poultry farms which is

in turn higher than that of the non-integrated poultry farms. In the same vein, the profitability indicators, the value added-sales ratio, rate of return on investment and rate of return on fixed cost in this enterprise combination increases with the level of integration.

(d) **Eggs, Broilers and Cockerel Production Enterprise**

The fourth enterprise combination is egg, broiler and cockerel production. The cost return structure of an average broiler cockerel/cock production enterprise is presented in Table 11. The gross margin per 1000 bird, net income/1000birds and profitability indices is higher in partially integrated poultry farms than that of fully integrated poultry farms and as expected, the non-integrated poultry farms have the lowest values of all the profitability indicators and the gross margins. The relatively low gross margin/1000birds, net income /100birds and the profitability indices in fully integrated poultry farms might not be unconnected with unbalanced throughput, that is scale and scope incompatibility of the feedmilling and poultry production as well as underutilization of the installed capacity of the feed mill.

In conclusion, it is imperative and profitable for farms involved in this kind of poultry enterprise should endeavour to integrate partially by buying the feed ingredients and mill it at the commercial feed milling centres since this will prevent the farmers from tying down capital in form of physical assets. Full integration however is more profitable if the farmers can overcome the problem of scope and scale incompatibility.

In summary, egg production enterprise records the highest gross margin per 1000 birds, net farm income per 1000birds and profitability indices at all levels of integration. Closely linked to the egg production enterprise, as per the value of gross margin

per 1000 birds and profitability measures is egg, broiler and cockerel production enterprise. The broiler production enterprise records the lowest gross margin per 1000birds, net farm income per 1000birds; value added sales ratio and other profitability indices.

Amongst other enterprises that are combined with the egg production, the combination of egg, broiler and cockerel records the highest gross margin per 1000birds at all levels of integration while the egg and broiler production enterprise records the highest net farm income per 1000birds at full integration and non-integration levels.

Table 7 Costs and Returns Structure per 1000birds of an Average Poultry Farm in the Sample by Extent of Vertical Integration Adopted

Description	EXTENT OF INTEGRATION					
	Non-integrated		Partially integrated		Fully integrated	
	Amount (N)	Share(%)	Amount (N)	Share(%)	Amount (N)	Share(%)
Revenue						
• Egg	2426929.60	83.22[1]	2118227.80	80.14[1]	2182262.60	81.97[1]
• Broiler	77069.83	26.43[2]	117580.68	4.45[3]	61355.26	2.30[3]
• Cock/Cockerel	10460.98	0.36[4]	63611.66	2.41[4]	47141.93	1.77[4]
• Spent Layers	401896.86	13.78[3]	343840.05	13.01[2]	371390.28	13.95[2]
Gross Revenue	**2916357.30**		**2643260.10**		**2662150.10**	
Costs						
• Birds Stocked	431589.57	18.25[2]	327079.00	18.70[2]	260333. 52	15.38[2]
• Feed	148967.80	61.70[1]	1197936.50	68.32[1]	1295027.60	76.53[1]
• Veterinary services	29360.24	1.24[6]	22356.63	1.28[4]	20166.06	1.19[4]
• Labour	149052.01	6.30[3]	123955.22	7.07[6]	66075.58	3.90[3]
• Water	22378.93	0.95[7]	19265.07	1.10[5]	13393.29	0.79[5]
• Energy	29666.22	1.25[5]	18796.93	1.07[7]	8269.66	0.49[7]
• Transportation	30933.66	1.30[4]	20726.70	1.18[5]	11046.24	0.65[6]
• Others variable cost	5580.75	0.24[8]	3170.44	0.18[8]	2193.05	0.13[8]
Total Variable Cost	**2157529.20**	**91.23**	**1733286.50**	**98.86**	**1676505.00**	**98.84**
Gross Margin	**758828.07**		**909973.66**		**985645.12**	
Less: Fixed Cost	207284.56	8.77	198891.54	1.14	195650.57	1.16
Net Farm Income	**551543.51**		**711082.12**		**789994.55**	

Profitability Indicators			
• Value Added/Sale Ratio	0.26	0.33	0.35
• Rate of returns on investment	23.30	35.63	43.36
• Rate of returns on fixed cost	358.92	440.92	490.36

Note: Figures in superscripts denote the rank of revenue / cost share in an average poultry farms cost/return structure

SOURCE: Computed from field survey data

Table 8: Costs and Returns Structure per 1000birds of an average poultry (egg) farm in the sample by extent of vertical integration adopted

Description	EXTENT OF INTEGRATION					
	Non-integrated		Partially integrated		Fully integrated	
	Amount (N)	Share(%)	Amount (N)	Share(%)	Amount (N)	Share(%)
Revenue						
• Egg	2822140.5	85.83[1]	2639911.50	85.84[1]	2447532.10	84.92[1]
• Spent Layers	466032.04	14.17[2]	435316.52	14.16[2]	434546.05	15.08[2]
Gross Revenue	**3288172.6**		**3075228.00**		**2882078.20**	
Costs						
• Birds Stocked	479846.86	18.18[2]	357401.81	16.89[2]	277056.85	13.45[2]
• Feed	1641762.1	62.20[1]	1362613.9	64.40[1]	144181.50	70.12[1]
• Veterinary services	31897.206	1.20[6]	24449.734	1.16[5]	21954.53	1.07[5]
• Labour	169303.64	6.41[3]	98870.881	4.67[3]	81239.70	3.94[3]
• Water	24260.353	0.92[7]	18941.484	0.90[7]	15409.90	0.61[6]
• Energy	34040.685	1.29[5]	24332.188	1.15[6]	9116.31	0.44[8]
• Transportation	35335.774	1.33[4]	25106.995	1.19[4]	11536.69	0.56[7]
• Others variable cost	6460.3897	0.24[8]	3614.9205	0.17[8]	2606.72	1.27[4]

Total Variable Cost	**2422907.0**	**91.79**	**1915332.0**	**90.53**	**1863102.20**	**90.46**
Gross Margin	**865265.61**		**1159896.0**		**1018975.90**	
Less: Fixed Cost	216730.52	8.21	200422.00	9.47	196599.07	9.54
Net Farm Income	**648535.09**		**959474.04**		**822376.87**	
Profitability Indicators						
• Value Added/Sale Ratio	0.26		0.35		0.33	
• Rate of returns on investment	26.10		43.04		39.37	
• Rate of returns on fixed cost	400.76		553.68		507.32	

Note: Figures in superscripts denote the rank of revenue / cost share in an average poultry farms cost/return structure

SOURCE: Computed from field survey data

Table 9 Costs and Returns Structure per1000birds of an average poultry (broiler production enterprise) farm in the sample by extent of vertical integration adopted

Description	Non-integrated		Partially integrated	
	Amount (N)	Share(%)	Amount (N)	Share(%)
Revenue				
Broiler	716666.67	100	850000.0	100
Gross Revenue	**716666.67**		**850000.0**	
Costs				
• Birds Stocked	123334.62	19.48[2]	120048.00	14.72[2]
• Feed	193528.39	30.57[1]	246173.78	30.19[1]
• Veterinary services	19913.978	3.15[5]	36000.000	4.42[6]
• Labour	87806.452	13.87[3]	120000.00	14.72[3]
• Water	22358.070	3.53[4]	31183.187	3.82[7]
• Energy	12064.730	1.91[6]	49313.53	6.05[4]
• Transportation	5870.9677	0.93[7]	41459.504	5.09[5]
• Others variable cost	1146.2366	0.18[8]	4122.0989	0.51[8]
Total Variable Cost	**466023.45**	**73.62**	**648300.09**	**79.52**
Gross Margin	**250643.22**		**201699.91**	
Less: Fixed Cost	167000.00	26.38	167000.00	20.48
Net Farm Income	**83643.216**		**34699.910**	
Profitability Indicators				
• Value Added/Sale Ratio	0.35		0.24	
• Rate of returns on investment	13.23		4.26	
• Rate of returns on fixed cost	150.09		120.78	

Note: Figures in superscripts denote the rank of revenue / cost share in an average poultry farms cost/return structure
Computed from field survey data

Table 10: Costs and Returns Structure per 1000birds of an average poultry (egg and broiler) farm in the sample by extent of vertical integration adopted

Description	EXTENT OF INTEGRATION					
	Non-integrated		Partially integrated (N= 1527)		Fully integrated (N=8713)	
	Amount (N)	Share(%)	Amount	Share(%)	Amount	Share(%)
Revenue						
• Egg	1033420.60	66.36[1]	1835591.50	76.55[1]	1765093.40	77.20
• Spent Layers	175760.62	11.29[3]	299941.36	12.51[2]	267443.48	11.70
• Broilers	348079.92	22.35[2]	262418.83	10.94[3]	253863.86	11.10
Gross Revenue	**1557261.14**		**2401951.20**		**2286399.90**	
Costs						
• Birds Stocked	296861.60	21.59[2]	403661.57	19.84[2]	233781.05	16.99[2]
• Feed	822116.96	57.05[1]	1134834.90	55.79[1]	907145.58	65.40[1]
• Veterinary services	17660.82	1.23[5]	20415.92	1.00[5]	9452.95	0.69[4]
• Labour	48959.06	3.40[3]	218352.08	10.73[3]	15870.89	2.31[3]
• Water	17428.24	0.99[6]	22370.32	1.10[4]	5033.26	0.37[5]
• Energy	14202.32	1.15[7]	14428.95	0.71[7]	3630.85	0.26[7]
• Transportation	14059.80	1.50[4]	17596.43	0.87[6]	4262.85	0.31[6]
• Others variable cost	2975.25	0.21[8]	3375.53	0.17[8]	830.55	0.06[8]
Total Variable Cost	**1238495.90**	**85.94**	**1835035.70**	**90.31**	**1195883.60**	**86.39**
Gross Margin	**318765.19**		**566915.53**		**1090516.10**	
Less: Fixed Cost	164528.27	14.06	199209.58	9.69	184682.03	13.61
Net Farm Income	**154236.93**		**367705.95**		**905834.12**	
Profitability Indicators						
• Value Added/Sale Ratio	0.20		0.23		0.45	
• Rate of returns on investment	9.94		17.52		69.69	
• Rate of returns on fixed cost	192.10		277.11		551.27	

Note: Figures in superscripts denote the rank of revenue / cost share in an average poultry farms cost/return structur
Computed from field survey data

Table 11: Cost and return Structure per 1000birds of an average poultry (egg, broiler and cock/cockrel) farm by extent of vertical integration adopted

Description	EXTENT OF INTEGRATION					
	Non-integrated		Partially integrated		Fully integrated	
	Amount (N)	Share(%)	Amount (N)	Share(%)	Amount (N)	Share(%)
Revenue						
• Egg	1241396.00	71.03[1]	1217596.2	64.99[1]	1138284.9	66.37[1]
• Spent Layers	221581.03	12.68[3]	183467.47	9.79[4]	158054.79	9.22[4]
• Broilers	59881.42	3.43[4]	191582.36	10.22[3]	186741.62	10.89[3]
• Cockerels	224911.07	12.87[2]	280957.09	15.00[2]	231989.43	13.53[2]
Gross Revenue	**1747769.60**		**1873603.1**		**1715070.7**	
Costs						
• Birds Stocked	251561.26	15.76[2]	137137.86	10.51[2]	142683.22	11.22[2]
• Feed	1113504.5	69.78[1]	861984.75	66.09[1]	872644.13	68.60[1]
• Veterinary services	16681.82	1.05[4]	14164.83	1.09[5]	14791.20	1.16[4]
• Labour	36656.13	2.30[3]	71277.10	5.46[3]	33296.06	2.62[3]
• Water	1750.27	0.11[7]	15111.41	1.16[4]	12287.72	0.97[6]
• Energy	2924.90	0.18[6]	7100.87	0.54[7]	6812.40	0.54[7]
• Transportation	5401.07	0.34[5]	10757.62	0.82[6]	13595.02	1.07[5]
• Others variable cost	747.04	0.05[8]	1734.71	0.13[8]	1802.79	0.14[8]
Total Variable Cost	**1429226.9**	**89.56**	**1119269.20**	**85.82**	**1097912.50**	**86.31**
Gross Margin	**318542.62**		**754333.93**		**617158.20**	
Less: Fixed Cost	166541.50	10.44	184981.53		174095.37	13.69
Net Farm Income	**152001.12**		**569352.39**		**443062.83**	
Profitability Indicators						
• Value Added/Sale Ratio	0.20		0.40		0.35	
• Rate of returns on investment	10.90		44.85		33.65	
• Rate of returns on fixed cost	194.98		403.08		346.34	

5.2.3 Vertical integration and Production Efficiency

In a study on the effects of vertical integration on technical efficiency in poultry production, it was discovered that flock size and quantity of feed significantly increased the output (trays of eggs) in both vertically integrated and non-integrated poultry farms (Bamiro *et al,* 2006). The sign of the coefficient of feed is contrary to apriori expectation, however, this result might be due to excessive usage of feed because the vertically integrated poultry farms mill their feeds unlike the non-integrated poultry farms that utilized commercial feeds and are therefore conscious of the quantity that must be used each day. The coefficient of the veterinary cost is negative and not significant even at 10 percent probability level. In conclusion therefore, vertical integration with respect to flock size increases the output of poultry (eggs) farms while it reduces the trays of eggs produced with respect to feed and labour (See Table 12)

The frequency distribution of the Technical efficiency of the estimate obtained is presented in Table 13. Predicted technical efficiencies range between 65% and 97%. The results show that about 49% of the sampled poultry farms have technical efficiencies greater than 90% operating close to the technology frontier. About 36% of the sampled poultry farms have technical efficiencies that is equal to 80% but less than 90%. About 15% of the sampled poultry farms have technical efficiencies that is below 80%. The mean technical efficiency of the entire sample was estimated at 88% indicating substantial efficiencies in poultry production. This signifies that there exists a 12% potential for poultry farmers to increase their production vis-a-vis their income at the existing level of resources and technology. This suggests that by operating at full technical efficiency level poultry producers can increase their production by an average of

12% with the available farm resources and technology.

5.2.4 Determinants of technical efficiency in integrated poultry farms

The determinants of the technical efficiency of the poultry farms are presented in Table 12. The Table reveals that age of the decision maker and flock size are significant at 1% level. The value added sales ratio, which was used as a measure of the extent of integration also have a significant effect on the technical efficiency of the poultry farms in Ogun and Oyo States. The feedtype, which stands as a proxy to the use of private feed, which is a measure of a form of integration is significant at 5% level. The second major factor, which has significant positive influence on the technical efficiency of poultry farms in the study area, is the extent of vertical integration proxy by value added-sales ratio. The positive effect of the extent of vertical integration implies that the greater the level of integration, the higher the level of technical efficiency in the poultry (egg) farms. In comparison, Bamiro et al, (2006) reported that the technical efficiency in partially integrated poultry farms is higher than technical efficiency in fully integrated poultry farms which is in turn greater than that of non-integrated poultry farms. They further opined that the technical efficiency of fully integrated poultry farms being lower than that of partially integrated poultry farms is due to unbalanced throughput.

Table 12 Estimates of Stochastic Production Frontier by Ordinary Least Square (OLS) and Maximum Likelihood Estimators (MLE) and Inefficiency Function

Explanatory Variables	Ordinary Least Square (OLS) Estimates	Maximum Likelihood Estimates (MLE)
Production Function		
Constant	2.222*	0.225*
	(19.911)	(12.61)
Ln Flock Size	0.701*	0.750*
	(5.73)	(11.72)
Ln Feed	0.320*	0.242*
	(2.63)	(4.03)
Ln Labour	-0.52**	- 0.012
	(-2.05)	(0.066)
Ln Vet Cost	-0.0117	-0.059
	(-0.939)	(-0.303)
Dln flock size	0.515*	-0.026
	(2.85)	(-0.075)
Dln Feed	-0.528*	0.0019
	(-3.06)	(0.0057)
Dln Labour	0.090*	0.344
	(2.82)	(0.23)
Inefficiency Function		
δ0 constant		0.155*
		(3.03)
δ1 (ln Age)		-0.322*
		(-2.23)
δ2 (ln Education)		-0.144*
		(-2.23)
δ3 (ln Experience)		0.029
		(0.87)
δ4 (ln Flocksize)		0.0632*
		(2.74)
δ5 (D1)		-0.0186*
		(-6.73)
δ6 (D2)		0.202*
		(3.23)
δ7 (lnValue added-Sales ratio		-0.0317
		(-0.395)

Diagnosis Statistics		
Sigma –square ($\delta 2 = \delta u2 + \delta v2$)	0.0139	0.0305* (5.162)
Gamma ($\gamma = \delta 2U / \delta 2U + \delta 2V$)		0.99
Log of likelihood function	107.826	156.00
LR test		109.47

Computed from field survey Figures in parenthesis are t values
*Significant at 1% level

Table 13 Frequency Distribution of Technical Efficiency Estimates and Extent of Vertical Integration for Sampled Poultry Farmers

Description	Category of farms						ENTIRE SAMPLE	
	Non-integrated		Partially integrated		Fully integrated			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Level of Efficiency (%)								
Less than 70	14	16.67	0	0.00	0	0.00	13	9.02
70-79	26	30.95	6	18.75	10	35.71	40	27.78
80-89	30	35.71	14	43.75	13	46.43	58	40.28
90 and above	14	16.67	12	37.50	5	17.86	33	22.92

Source: Computed from field survey (2004)
Minimum = 65% Mean = 85% Maximum = 99%

5.2.5 Vertical Integration and Cost Behaviour

One major motive of adopting vertical integration in agriculture and agribusiness enterprises is profit maximization, which is sine qua non to cost minimization. Value added–sales ratio was used as a measure of the extent of vertical integration in a study on vertical integration and cost behaviour in poultry industry in Ogun and Oyo States by Bamiro and Shittu (2011). The coefficients of the value added–sales ratio are significant at 5% level in all the share equations with the exception of other operating expenses equation. The coefficients are positive in all the share equations with the exception of labor equation. The implication is that vertical integration (measured by value added-sales ratio) is feed using, veterinary services using and labor saving. (See Table 14).

This means that the greater the extent of integration the higher the shares of feed and veterinary costs. This was attributed to the large flock size in vertically integrated poultry farms, a situation in which overcrowding cannot be ruled out and thus render the birds susceptible to diseases and pests attack.

The negative sign of the coefficient of value added-sales ratio in labor equation implies that **share of labor cost or wages decreases with the extent of vertical integration.** This was due to combination of two or more stages of production and marketing under a single ownership, the same set of workers that work in the poultry farms were also used in the feed mills and for other farm activities, hence the reduction in the labor cost. In the layers' output, broiler's output and cock/cockerel output equations, the value added–sales ratio, (the measure of extent of vertical integration) coefficients have the expected positive signs, with a significant effect on output. This implies that the more vertically integrated a farm is the greater the level of output

Table 14 Factors and Revenue Share Estimates of the Coefficient of Translog Cost Function Computed from field survey data

Share Equation for	EXPLANATORY VARIABLES											
	Prices/Unit Cost of						Output of			Other variable		
	Constant	Vet	Feed	Labour	Others	Stock	Eggs	Broilers	Cock	VAS	Stocktype	Feedtype
Vet. Services	0.0664	0.0104	-0.0057	-0.0010	-0.0009	0.0028	-0.0020	0.0009	-0.0002	0.0087	0.0005	-0.0010
$R^2 = 0.77$	(12.46)	(17.44)	(-3.24)	(-1.22)	(-1.75)		(-10.40)	(5.66)	(-0.93)	(2.08)	(0.22)	(-0.96)
Feed	0.3478	-0.0057	0.1611	-0.0336	-0.0159	0.1059	0.0313	-0.0041	-0.0081	0.0983	0.0107	-0.0159
$R^2 = 0.82$	(10.27)	(-3.24)	(13.38)	(-4.93)	(-5.80)		(21.8)	(-3.61)	(-1.26)	(3.14)	(0.78)	(-2.00)
Wages	0.1800	-0.0010	-0.0336	0.0335	0.0054	0.0043	-0.0185	-0.0062	0.0005	-0.2098	-0.0267	0.0268
$R^2 = 0.60$	(6.01)	(-1.22)	(-4.93)	(5.42)	(2.93)		(-13.91)	(-6.14)	(0.41)	(-7.30)	(-3.01)	(3.65)
Other Operating	0.0588	-0.0009	-0.0159	0.0054	0.0186	0.0072	-0.0008	0.0006	0.0011	0.0085	0.0029	-0.0032
Expenses	(6.01)	(-1.75)	(-5.80)	(2.93)	(15.26)		(-1.75)	(1.61)	(2.58)	(0.83)	(0.81)	(-1.24)
$R^2 = 0.63$												
Stock	0.3470	0.0028	0.1059	0.0043	0.0072	-0.1202	-0.01	0.0088	0.0004	0.0943	0.0126	-0.00701
Layers" Output	0.1787	-0.0020	0.0313	-0.0185	-0.0008		0.0683	-0.0557	-0.0049	1.8161	0.0594	0.0622
$R^2 = 0.86$	(3.99)	(-10.40)	(21.80)	(-13.91)	(-1.75)	-0.0100	(21.23)	(26.10)	(-3.83)	(19.78)	(2.41)	(2.67)
Broilers" Output	0.6357	0.0009	-0.0041	-0.0062	0.0006	0.0088	-0.0557	0.0503	-0.0044	0.2648	-0.0802	-0.0683
$R^2 = 0.82$	(16.03)	(5.66)	(-3.61)	(-6.14)	(1.61)		(-26.10)	(21.42)	(-4.59)	(2.98)	(-3.36)	(-3.02)
Cock/Cockerel	0.0780	-0.0002	-0.0018	0.0005	0.0011	0.0004	-0.0049	-0.0044	0.0282	0.0598	0.0050	0.0143
Output	(4.71)	(-0.93)	(-1.25)	(0.41)	(2.58)		(-3.83)	(-4.59)	(20.52)	(1.98)	(0.60)	(1.83)
$R^2 = 0.76$												

in the poultry industry.

6.0 Conclusion and Recommendations

6.1 Conclusion

Increase in food production in Nigeria over the years was due to increase in hectrage of farms cultivated and not due to yield per hectare. This form of increase cannot solve the problem of food security in Nigeria. Therefore, effort has to be geared towards increase in yield of all food crops. The two roadmaps or route to Canaan-food security discovered are efficiency in agricultural production and adoption of vertical integration in all agribusiness enterprises. Apart from food security that will be attained, vertical integration will solve the herdsmen and farmer clashes and mitigate against risks.

6.2 Recommendations

Vertical Integration and Efficiency in Agrarian Mandate of Landmark University:

Observations and Recommendations

Landmark University is the only private institution with agrarian revolution and an institution in which both the Commercial and Teaching and Research farms are integrated.

(1) Vertical integration is indeed in place in both Landmark University Teaching and Research Farm and Landmark University Commercial Farm, but unbalanced throughout, which is scale and scope incompatibility, is a major limitation to reaping the profitability and efficiency benefits of vertical integration. It is therefore necessary for the operators of both farms to ensure full forward and backward integration.

(2) Non-use of slaughter slab in the Teaching and Research

Farm does not only render the facility redundant and promotes its decay, it also inhibits forward vertical integration. It is therefore recommended that the slaughter slab be put into efficient and profitable use by slaughtering cattle (bull or cow) and pigs on a specific day of the week for both Landmark University community and its environ's consumption.

(3) Vertical integration in LMU context is Partial. This form of integration is a bottleneck that has limited the success of our agrarian revolution. A situation in which the commercial and teaching and research farms have to buy maize in the open market to feed the feed mills is an indication of incomplete integration.

(4) While cost minimization is of necessity for profit maximization, inadequate labour for each unit/stage of agribusiness will reduce the efficiency of staff / casual workers vis-à-vis the profitability. Adequate number of work force especially casual workers should be employed.

(5) Administrative bureaucracy associated with the purchase of farm inputs and the maintenance of farm machineries and implements is another limitation to the realization of optimal output from vertical and horizontal integration in the pursuit of LMU agrarian mandate. Agribusiness enterprise especially the production sector is time bound, therefore, bureaucracy should be eliminated from the supply of inputs.

6.3 Recommendations to Government

The government must stop paying lip service to agricultural

revolution by doing the following:

(1) Returning to the age of providing strategic public support for land development – bush clearing and tractorization which condition is precedent for farmers to maintain the optimum farm size of four hectares that could leverage the farmers enjoy economies of scale in their production decisions. This will further help to reduce drudgery in agriculture and thus increase technical, allocative and economic efficiency in food crop production.

(2) Government should go further to increase its investment in agriculture in terms of provision of dams, irrigation facilities, constituting the Social Overhead Capital (SOC), and thereby encourage Direct Production Activities (DPA) by the private, large scale farmers and agricultural companies that are highly desirable for sustainable food security in Nigeria.

(3) Farmer's inefficiency is very high due to lack of agricultural education and sustained extension service delivery. Therefore scholarship should be granted to candidates who are willing to study agriculture in private and public universities.

(4) Another limiting factor to efficiency is access to credit; hence, efficiency of farmers will receive a boost if government formulates policies that will compel financial institutions to lend to farmers at a low interest rate.

(5) Vertical integration should be encouraged in both crop production and animal husbandry by making importation of agricultural equipment import duty free.

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