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Comparative Analysis of Economic Efficiency between Low and High External Input Technology Agriculture in a Harsh Macroeconomic Environment of Imo State, Nigeria

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Abstract

The study compared economic efficiency among smallholder farmers who practiced low external input technology [LEIT] and high external input technology [HEIT] agriculture in a harsh macroeconomic environment typified by inadequate fertilizer subsidy in Imo State, Nigeria. Cross sectional data generated from 160 smallholder farmers randomly selected from 2 out of the 3 agricultural zones in Imo State were used. Profit function was used in analyzing the data. Results showed that the LEIT farmers achieved higher level of economic efficiency relative to their HEIT counterparts, although the difference is statistically non significant. It is therefore recommended that in the face of escalating costs of fertilizer, organic manure could be used. Appropriate policies should be put in place by the government to encourage livestock rearing so as to effectively utilize their bye product-organic manure. Household refuse or bio-degradable from the cities could be channeled to farms to serve as organic manure.

Keywords:
Economic Efficiency, Low External Input Technology, High External Input Technology, Macroeconomic Environment.

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INTRODUCTION

The importance of the agricultural sector in the Nigerian economy is generally well known but its productivity has not grown sufficiently because of under-investment in new technology, slow adoption of existing improved technologies, constraints associated with the investment climate and lagging infrastructure [Ugwu, 2009]. The contribution of agriculture to economic growth and sustained rural development remains to be fully exploited [FMARD, 2006], due to inconsistencies in governmental policy thrust induced by frequent changes in the leadership of the country.

Harsch (2004) noted that higher output will directly reduce hunger and bring down the cost of food imports as well as have wider economic benefits, stimulating rural incomes and provide raw materials for African industries. The main thrust of Nigeria's agricultural development efforts, therefore has been to enhance and sustain the capacity of the sector to play this assigned role, with particular emphasis on the attainment of sustainable level in the production of basic food commodities, especially those in which the country has comparative advantage. It also involve developing the capability to increase the production of agricultural raw materials to meet the growing needs of an expanding industrial sector, as well as the production and processing of exportable cash crops to boost the nation's non oil foreign exchange earning capacity. This process of transformation from a predominantly subsistence agriculture to a highly mechanized farming to enhance agricultural production as well as ensure its sustainability has been undermined by the disincentives induced by the macroeconomic environment (CBN, 2003). The potential of high external input technologies [HEIT] (e.g. inorganic fertilizer, agrochemicals, pesticides tractors etc.) in improving agricultural productivity and economic efficiency in Nigeria in general is not in doubt. But the small-holder farmers' dilemma, on the appropriate methodology to be adopted in increasing his economic efficiency in the face of harsh macroeconomic environment stems from the apparent scarcity and expensiveness of the high external input agricultural technologies especially inorganic fertilizer. This makes the search for cost effective and readily accessible alternatives, a desideratum.

Low External Input Technology (LEIT) Agriculture

LEIT are agricultural technologies using low levels of external inputs readily available either on-farm or from nearby off-farm sources and which are seen by some experts as more appropriate and sustainable (Pretty, 1995). This approach often referred to as low external input agriculture (LEIT), emphasizes the use of techniques that integrate natural processes such as nutrient cycling, biological nitrogen fixation, soil regeneration and natural enemies of pests into food production process (Pieri, 1995, Snapp *et al.,* 1998). Efforts are also made to minimize losses from the system, such as by leaching or removal of crop residues. The use of non renewable inputs such as pesticides and fertilizers that can damage the environment or harm the health of farmers and consumers is also minimized, and more emphasis is placed on the use of such techniques as, for example intercropping, agro forestry, cover-crops, or animal manure.

In many cases, LEIT are not new but are variations of those practiced by farmers for generations, who have sought to make use of resources such as vegetation or animal manure that have always been ready to hand (Graves *et al.,* 2004). Thus the heart of the debate is not about whether either approaches work as clearly both do and have done, under the appropriate conditions and according to their own criteria. Rather, the central question concerns which approach can best address the future demand for food pro-

duction while protecting the environment as much as possible. More specific questions relate to whether LEIT really have the capability to maintain or increase productivity per unit area above current levels in Imo state. Certainly there is evidence to suggest that the relative rate of increase in crop yields through the use of HEIT is slowing down (Mann, 1997), although Crosson and Anderson (2002) argue that this is more likely due to the practice of quoting annual percentage increases of a constantly increasing baseline rather than absolute annual growth. Proponents of LEIT often claim that the reliance on local sources of inputs is more sustainable but the analysis of De Jager *et al.,* (2001) suggests there is little difference between the two approaches in this respect, with both mining similar quantities of soil nutrients to generate farm income.

High external inputs are often convenient to use but the consequences of their use are difficult to predict. That may have accounted for the reservation expressed by Smill (2000) that the historic brevity of modern intensive agriculture should make us cautious when assessing its long term capacities. According to him, such regions as China's Huang Valley or Iraq's Tigris-Euphrates alluvium have been farmed continuously by traditional methods for more than 7000 years. Furthermore, as an illustration of the changes which high external inputs technology (HEIT) occasioned in Asia, Pretty (2002), describes the impact on the Ballinese irrigated rice system. According to him "soil fertility was maintained by the use of ash, organic matter and manures; rotations and staggered planting of crops controlled pests and diseases; and bamboo poles, wind-driven noise-makers, flags and streamers scared birds. Rice was harvested in groups; stored in barns and traded only as needs arose. The system was sustainable for more than 1000 years. Yet, in the blink of an eye, rice modernization during the 1960s and 1970s shattered these social and ecological relationships by substituting pesticides for predators, fertilizers for cattle and traditional land management, tractors for local labour groups, and government decisions for local ones". Although it has been shown elsewhere that HEIT achieved higher levels of aggregate agricultural productivity (Anyanwu and Obasi 2010) and were technically more efficient (Anyanwu, 2010) than their LEIT counterparts, it therefore becomes compelling for us to compare low external input technology (LEIT) and high external input technology (HEIT) agriculture to determine if there is any statistically significant difference in their levels of economic efficiency in a harsh macroeconomic environment of Nigeria..

High External Input Technology [HEIT] Agriculture

As the name implies, high external input agricultural technology (HEIT) are agricultural technologies that utilize high external inputs such as inorganic or chemical fertilizers to augment nutrient depletion from the soil, pesticides to control pests, herbicides to control weeds and irrigation facilities for water management in the farms. These inputs are often beyond the financial reach of the small – holder farmers (CBN, 2002; 2003; Imahe *et al.,* 2005; Tripp, 2006a; Obasi, 1995; Ohajianya *et al.,* 2004; Reardon *et al.,* 1997, Graves *et al.,* 2004). Adoption of the researcher developed high external input technology in sub-Saharan Africa according to De Jager *et al.,* (1998) has been very disappointing for a variety of reasons. Two factors according to him have played crucial roles; farmers were involved only in the final stages of technology development while the technologies were assessed at the crop or livestock activity level only, which does not match with the complex and multiple goals of a farm house-

hold at farm level. The role of fertilizer in increasing agricultural productivity has become a surprisingly controversial topic. It seems self evident to say that fertilizer increases productivity. Yet there have been many attempts to remove fertilizer from the list of key productivity – enhancing options worthy of government and donor policy support. Among the reasons given for down grading its importance in Africa according to Reardon *et al.,* (1997) are its riskiness under conditions of low or erratic rainfall, its relatively low yields response when compared to results in Asia and Latin America, as well as its high distributive costs in a context of low effective demand and poor storage facilities and roads.

Harsh Macroeconomic Environment of Nigeria

The frequency with which policies geared towards agricultural development are changed midstream has become worrisome. The upward trend in fertilizer consumption in the early 1980's in Nigeria continued into the 1990 and peaked in 1993 with total consumption reaching 1590 thousand metric tones. Thereafter fertilizer consumption declined consistently from 1010 thousand tones in 1994 to the lowest level of 357.8 thousand tones in Nigeria in 2001. The sharp increase in fertilizer utilization in the early 1990's was sustained by subsidy which was sometimes as high as 75% of the total cost per bag, but the level of subsidy gradually fell to between 50 and 25% as reflected in the sharp decline in fertilizer use from 80kg/ha to 23kg/ha in 1996 and 2000 respectively, compared with the minimum of 200kg/ha internationally recommended standard (CBN, 2003).The Food and Agricultural Organization (FAO) contends that for Africa to achieve 3% annual growth in agricultural output, it is required to adopt a 6-fold increase in fertilizer use over the next 20 years (WDR, 2003).

Graves *et al.,* (2004) insists that despite the continuing debate on the relative performance of LEIT and HEIT, there are few studies that compare yields and production under the same soil and climatic conditions and over wide areas. Both Tripp (2006a) and Graves *et al.,* (2004) argued that there is little in the literature on the issues that need to be faced in scaling up production in LEIT. Apart from the arguments of Graves *et al.,* (2004) and Tripp (2006a), previous studies among LEIT small-holder farmers in the study area (Anyanwu, 2009f; Anyanwu and Ibekwe 2010; Anyanwu, and Obasi 2010a; Anyanwu and Obasi 2010b; Anyanwu and Adesope 2010a; Anyanwu and Adesope, 2010b) appear to have been deficient on the comparative analysis of economic efficiency between LEIT and HEIT in Imo State, Nigeria. In addition, the harsh macroeconomic environment (such as inadequate subsidy on fertilizer or HEIT) under which the smallholder farmers are operating makes a comparative analysis of the economic efficiency of LEIT and HEIT in a harsh macroeconomic environment, urgent and compelling in order to sharpen governmental policy.

MATERIALS AND METHODS

The study was carried out in Imo state of Nigeria. Imo State is located in the south eastern part of Nigeria. The State lies between longitude 6° 4' East of the Greenwich Meridian and latitude 4° 4' and 8° 15' north and is located in the tropical rain forest belt of Nigeria. According to the National Population Commission (NPC, 2006), Imo state has a population of 3,934,899 people with an annual growth rate of 3.2 per cent. Low external input agricultural technologies, especially intercropping, animal manuring, alley cropping are predominant, while high external input agricultural technologies such as inorganic fertilizer application, irrigation facilities, use of herbicides are not predominant due to their scarcity and high prices.

Sample Selection

The multi-stage random sampling technique was used in selecting the sample. This technique was used in order to enable the researcher capture a significant portion of the resource characteristics of the farmers at different stages and to ensure a good spread of the data. Two agricultural zones (Owerri and Okigwe) were randomly selected from Owerri, Okigwe and Orlu that make up the state. From these two agricultural zones, two local government areas (LGA) were purposively selected from the list of LGAs in each zone, making a total of 4 LGAs. These 4 LGAs are Ohaji- Egbema, Ahiazu-Mbaise, Ihitte-Uboma, and Isiala-Mbano. The basis for the purposive selection of these LGAs is where the usage of organic manure, poultry droppings and inorganic fertilizer are more predominant. From each of these LGAs two communities were randomly selected from the list of communities in the LGAs collected from the LGA headquarters. The communities selected include Umuokanne, Mgbuishii, Obohia, Amuzi, Amainyi-Ukwu, Umuezegwu, Umuelemai and Isiama. The list of farmers that use high external input technology (HEIT) and low external input technology (LEIT) in the communities were compiled with the assistance of the extension agents. This list formed the sampling frame. From this sampling frame, 10 farmers that used the HEIT and another 10 farmers that used the LEIT were randomly selected from each of the 8 communities making a sample size of 160 farmers (made up of 80 HEIT and 80 LEIT) users.

Data used for the study were collected using structured questionnaire and interview schedule. Practical field measurement of plots was undertaken using global positioning system (GPS). Data were collected on socio- economic characteristics of the farmers such as age, years of farming experience, years spent in school, farm size, input prices, expenditures on fertilizer and organic manure, expenditures on agro- chemicals, seeds, labour input (including contract sum in case of farm operations contracted out) wage rate, income sources, number of crop species (in a mixture) planted per plot per year, household size, capital inputs used, farm output and output prices, value of produce (in Naira) consumed, stored and sold.

Data Analysis

Data was analyzed using the Unit Output Price (UOP) profit function developed by Lau and Yotopoulos (1971, 1972). The form of this model used is as adapted from Onyenweaku and Fabiyi (1991). The statistical test of relative economic efficiency used here involve the estimation of profit function and employing a dummy variable to

differentiate the two farm types in order to test the statistical significance of the value of its coefficient. The UOP model used is specified thus;

$$\text{Ln } \Pi = bo + b1D + b2\text{LnWr} + b3\text{LnFs} + b4\text{LnKv} + e \ldots \text{eqn. (1)}$$

Where

Ln = natural logarithm

Π = profit per farmer in naira (defined as total value of output less total cost) The total wage bill for each farmer were calculated to include wages paid to hired labour and imputed values of family and exchange labour based on the prevailing wage at the time of interview.

D = Dummy variable distinguishing farm type (1, for HEIT and zero otherwise)

Wr = money wage rate (Naira) per man day of an adult farm worker

Fs = Farm size (Ha)

Kv = Capital input (Naira) per farmer. This consists of fixed capital inputs in terms of depreciation on tools and equipment and working capital such as the costs of seeds, planting ma-

terials, fertilizer, agro – chemicals, etc.
e = the disturbance term.

While bo, b1, … b4 are parameter estimates.

If the coefficient of the dummy variable for HEIT farm is positive and significant it implies a larger intercept term of that farm type than the alternative farm type suggestive of higher level of economic efficiency and higher profit, and vice versa.

For a given level of technology and a given endowment of fixed factors of production, the profit function expresses the maximized profit of a farm as a function of the prices of output and variable input and the quantities of the fixed factors of production. According to Lau and Yotopoulos (1972) the assumptions employed in the formulation of the profit function are; (a) Firms are profit maximizing. (b) Firms are price takers in both output and variable input markets and (c) The production function is concave in the variable input.

RESULTS AND DISCUSSION

Data collected for LEIT and HEIT Farms were pooled and the profit function fitted to the data using the ordinary least square regression technique. Table 1 shows the results of the estimated function.

The included variables – farm size and capital were found to be statistically significant at 1 percent level. This indicates that these variables play significant roles in the determination of the maximized profit of the farm firm. The coefficient of multiple determination (R^2) is 0.236. This suggests that about 24 percent of the variations in profit are accounted for by the independent variables. The coefficient of the dummy variable was negative and not statistically significant at 5 percent level. This implies that the profit function of HEIT farms has a lower intercept term than that of the LEIT farms. This is suggestive of a higher level of economic efficiency in the low external input technology farms and a lower level of economic efficiency in the high external input technology farms, although, the difference is statistically non significant.

CONCLUSION AND RECOMMENDATION

The profit function of LEIT farms had a higher intercept term, than that of the HEIT farms. However, the difference between the two farms in their level of economic efficiency is statistically non significant. This shows that in a harsh macroeconomic environment, LEIT farms are as profitable as HEIT farms.

Therefore, in the face of the apparent scarcity, expensiveness and environmental hazards often associated with inorganic fertilizer usage, organic manure could be used. Appropriate policies should be put in place by the government to encourage livestock rearing so as to effectively utilize their bye product-organic manure. Household refuse or bio-degradable from the cities

Table 1: Estimated Profit Function for LEIT and HEIT Farms in Imo State

Explanatory Variables	Regression Coefficient	t – Ratios
Dummy variable (D)	-0.155	-0.507
Wage rate (Wr)	-1.591	-1.616
Farm size (Fs)	0.601	3.820***
Capital input (Kv)	0.633	2.960**
Constant term	17.484	2.790***
R^2	0.236	
F – Ratio	8.587***	
N	160	

** = significant at 5%, *** = Significant at 1%
Figures in parenthesis are t-ratios
Source: Survey data, 2008.

could be channeled to farms to serve as organic manure. Further research should be carried out on ways and means of making organic manure usage more cost effective.

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