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TECHNICAL EFFICIENCY AMONG WOMEN FARMERS IN KWARA STATE: DATA ENVELOPMENT ANALYSIS APPROACH

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ABSTRACT

There is food crisis in the country. Food supply can no longer meet up with food demand. This study explored the potential for improving food productivity through Technical Efficiency (TE) of Women Food Crops Farmers in Kwara State. Primary data were collected from these women using multi-stage random sampling technique. Two ADP geopolitical Zones were randomly selected from the four in the state. Following this was a random selection of four extension blocks, two from each zone from which four groups of women in Agriculture (WIA) were selected per block. In the final stage 100 respondents were randomly selected from the selected groups on the basis of probability proportionate to size. Data were analysed using Descriptive statistics, Data Envelopment Analysis (DEA), and Ordinary least squares regression (OLS) method.

The mean age and farming experience of the women farmers were 47.6 ± 9.5 and 20.4 ± 12.3 years respectively. Their mean farm size and number of plots cultivated were 1.8 ± 1.18 acres and 2.0 ± 0.84 respectively. Factors found contributing to technical efficiency of women farmers include; years of education, membership of farmers association, years of farming and extension visits. One percent increase in years of education and membership of farmers association would increase TE by 8.8% ($p < 0.01$) and 1.0% ($p < 0.1$) respectively, while one percent increase in years of farming and extension visits would reduce TE by 0.69% and 4.0% at ($p < 0.05$) respectively.

Technical inefficiency among women food crop farmers leads to low food productivity. Therefore, education and awareness (extension and farmers associations) are the vital variables to be considered by the policy makers to increase food productivity in Kwara state.

Key Words: Women farmers, Data Envelopment Analysis (DEA), Technical Efficiency (TE) and Regression Analysis.

INTRODUCTION

The population census figures for 2006 clearly indicated that women accounted for 49.7 per cent of the Nigerian population. Population from the classical economics perspective is a veritable factor in national development. The high number of Nigerian women is a potential source for the supply of requisite labour for a virile and dynamic growth process, as well as for increased food production.

The role of women in Agricultural development process has been well documented. Everywhere in the world, women have been actively involved in farming, food processing and preservation. In a study carried out by the Economic Commission for Africa (ECA) to review and appraise the achievements of the UN Decade for Women, it was observed that African women do between 60 to 80 per cent of the agricultural work, including animal husbandry, gardening, food processing, marketing and distribution. A similar study by the Food and Agricultural Organization (FAO, 2005) reveals that women farmers make up more than 40 percent of the developing world's agricultural labour force and grow at least half of the world's food supply. In Nigeria, empirical evidence shows that in response to the increase in male migration to urban centers, women are managing an increasingly larger proportion of the country's small holdings, as well as providing the bulk of the labour force. (Awoyinka et al., 2006, Awoyemi and Adekanye 2005 and Ajani 2002). They are involved in land clearing, crop planting and spraying, as well as in post harvest management of agricultural produce. The extent of their involvement in each of these agricultural activities varies depending on the season, culture, economic system and socio economic milieu (Bogunjoko 1999).

Despite the enormous contributions of women to the development process, their economic role has been grossly underestimated, undervalued, rarely acknowledged and marginalized. In the words of the United Nations (1993), "while women constitute over 60 percent of labour force in agriculture and produce 80 percent of the food supply, they earn less than 10 percent of the world's income and own less than one percent of the world's assets". A similar study carried out by Awoyemi and Adekanye, (2005) in Nigeria also showed that, women are seriously disadvantaged in terms of equal access to health care, education, financial and agricultural extension services. These scenarios have significant influence on the productivity of women farmers, and the effects may have translated to the current problem of food shortage in the country. As part of the contribution to the way forward, this study is out to empirically determine the opportunities for increasing food output by examining the technical efficiency of women farmers in the derived savannah zone of Nigeria. The study will therefore address the following research questions; Are women farmers in the derived savannah zone efficient in the use of farm resources? What are the factors affecting their technical efficiency? What is the possibility of improving food productivity in the area? The result of the study will help to provide information for the formulation of appropriate policies.

The Problem

Agricultural contribution to GDP declined from about 90% before independence to about 41% between 2001 and 2005 (CBN, 2003 and 2005). The low agricultural output has led to the poor performance of the food sub-sector. Food supply is currently below food demand. This scenario has induced tremendous increase in the country's import bills from about N8 billion in 1996 to over N183 billion in 2005 (CBN 2005). It has also increased the prices of major food staples over the years.

Government has made several efforts to raise and return agriculture to its past enviable position but, all to no avail because there is still high cost of food, increasing food import bills and the problem of food insecurity in the country. The reason may be probably due to a wrong approach to solving the problem. In the literature, it has been discovered that agricultural productivity could be improved through two major ways, namely: (i) Improved Technology i.e. introducing new technology and (ii) Improved Technique i.e. improving the techniques of input applications for a given technology (Mario, 2006). However, most efforts in Nigeria focus extensively on the first method while less attention is paid to the latter approach. Whereas, unless the potential of an existing technology is fully exploited, benefits from new technologies may not be realized. In fact, the whole issue of the appropriate balance in emphasis between efficient uses of the chosen technology has received little policy attention in Nigeria. This should not be the case. Thus, from a policy viewpoint it is imperative to examine how efficiently farmers in the country are using existing technology (Technical efficiency) at the farm level and what factors constrain them from operating at the frontier of the existing technology. Such information can then be used in designing policies that will enable farmers to first realize the potential output from a given technology before resorting to the more expensive alternatives of introducing advanced technologies. With this contextual problem statement, this study aims to examine the technical efficiency of women farmers in Kwara state, due to the fact that Kwara State is a major agricultural state, with a high concentration of women farmers according to the information provided by the extension agents of the state ADP. The study will therefore address the following research questions.

*Are women farmers in Kwara state efficient?

*What are the factors affecting technical efficiency of these women?

*What is the possibility of increasing food productivity in the state through technical efficiency of women food crop farmers?

The rest of the paper is structured as follows. Section 2 provides the theoretical framework for the study while, section 3 is on the methodology. Section 4 focuses on results and discussion and the last section concludes the paper.

The main purpose of the study is to analyze empirically, sources of technical efficiency among women farmers. The specific objectives are to:

Determine the level of technical efficiency in the use of the existing technology among the women farmers.

Identify factors affecting technical efficiency of the farmers; and proffer some policy recommendation based on the findings of this investigation.

The study of efficiency is a significant area of research especially in developing economies like Nigeria where resources are meager and opportunities for developing and adopting better technology are dwindling (Ali et al., 1993 and Udoh, 2000). Measurement of efficient use of technology otherwise called technical efficiency is very important for productivity growth. Such studies ascertain the extent to which it is possible to increase productivity by improving efficiency with the present resource base and the available technology. Thus, by doing so, they could also resolve whether to improve efficiency first or develop a new technology in the short run.

Various studies lend credence to the fact that there are shortfalls in the resource use efficiency in this country (Ogundari and Ojo, 2007; Oredipe and Akinwumi, 2000 and Federal Ministry of Agriculture 1995). This means that output can be increased without new technology. There is therefore, the need to determine the magnitude of the efficiency shortfall so as to determine the magnitude of the gains that could be obtained by improving performance in agricultural production with a given technology.

The current food demand supply gap in the country demands for an increasing need to improve and expand local food production. To do this, it is necessary to investigate the socio-economic factors of the female farmers (the major food producers) that affect the efficiency of food production and determine the opportunities for increasing farm output.

Most studies on technical efficiency often concentrate on male farmers (Ogundari and Ojo, 2007; Ojo, 2004; Adewuyi, 2002;) or compare technical efficiency between male and female farmers (Odi, 1996; Awoyemi and Adekanye, 2005; Awoyinka et al 2006) basing their evaluation on the assumption that both male and female farmers face the same input and output markets as well as the same level of technology and risks. This assumption tends to limit the findings of such studies because according to Adesina and Djatto (1997) female farmers may not necessarily face identical price, technology and risks. Hence, this study is expected to fill the knowledge gap in the literature by considering agricultural activities of women farmers only.

THE CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Technical efficiency according to Fare et al, (1985) and Farrell (1957) is a major component of productivity which itself is a measure of performance. It indicates whether a farm uses the best available technology. It also reflects the ability of a farm to obtain maximum output from a given set of inputs (Coelli et al, 2005). A technical efficient farm operates on the production frontier. A technically inefficient farm operates below the frontier. He could operate on the frontier either by increasing output with the same input bundle or using less input to produce the same output. The closer a farm gets to the frontier, the more technically efficient it becomes.

Several approaches, which fall under the two broad groups of parametric and non-parametric methods, have been used in empirical studies of farm technical efficiency. Of these, the parametric stochastic frontier production function approach (Aigner et al., 1977; Meeusen and Vanden Broeck, 1977, Udoh, and. Oluwatoyin 2006, Seidu, . 2008) and the non-parametric mathematical programming approach, commonly referred to as data envelopment analysis (DEA) (Charnes et al, 1978, Fare et al, 1985, 1994, Ajibefun 1998, Adenegan 2006) are the two most popular techniques. This study uses DEA approach to analyze technical efficiency among women farmers in Kwara state of Nigeria. Data envelopment analysis is a non-parametric method of measuring efficiency. It uses mathematical programming rather than regression. It circumvents the problem of specifying an explicit form of the production function and makes only a minimum number of assumptions about the underlying technology. Charnes et al, (1981) introduced DEA to address the problem of efficiency measurement for Decision Making Units (DMUs) with multiple inputs and multiple outputs in the absence of market prices. A DMU is regarded as a firm. DEA studies producers' behaviour by the efficiency frontier and the distance between a DMU and the frontier. It provides a comprehensive analysis of relative efficiency by evaluating each DMU and measuring its performance relative to an envelopment surface composed of other DMUs. Units that lie on the surface are deemed efficient. Units that do not lie on the surface are termed inefficient and the analysis provides a measure of their relative efficiency. In the Data Envelopment Analysis, the envelopment surface and the efficient projection path depend on the type of model specified which could be input or output oriented. The choice of the model depends upon optimization production process characterizing the firm, input oriented DEA determines how much of the inputs mix for a firm would have to change to achieve the output level that coincides with the best practice frontier. Output oriented DEA on the other hand is used to determine a firm's potential output given its inputs mix if operated as efficiently as firms along the best practice frontier. The envelopment surface will also differ depending on the scale assumptions that underline the model. This could either be constant return to scale (CRS) or variable return to scale (VRS). For the purpose of this study, input oriented DEA at constant return to scale was used to determine how much input mix the farmers would have to change to achieve the output level that coincides with the best practice frontier.

RESEARCH METHODS

The study was conducted in Kwara state. The coordinates of the state are 7°45'N and 6°40'E. It has a total population of 2,701,056 comprising of 1,550,548 males and 1,150,508 females (NPC 2006). The study area is basically an agrarian state. 80 percent of the population reside in the rural areas 90 percent of this rural population are farmers with more than 50 percent being women (Adeoti, 2001: Ayedun 1994: Ogunfowora et al, 1974). The state covers an area of 3,682,000 hectares out of which about 214,153

farming households cultivate 270,060 hectares, thus giving an average of about 1.26 hectares of arable land per farming household (KWADP 1998).

The sample frame comprises of independent women food crop farmers under Women in Agriculture (WIA) in Kwara ADP. Kwara state Agricultural Development Project (ADP) is stratified into four geopolitical zones. Each zone has eight extension blocks and each block has different numbers of WIA groups ranging between 16 and 32 with many contact farmers. The selection of respondents followed the ADP stratification, it was therefore multi-stage. The first stage was a random selection of two ADP geopolitical zones from the four ADP strata in the state. The second stage involved random selection of two extension blocks from each selected ADP stratum. The third stage of sampling was a random selection of four groups of Women in Agriculture (WIA) from each extension block from which 100 respondents were drawn on the basis of probability proportionate to size.

Both primary and secondary data were used. Structured questionnaires, personal interview and direct observation methods were used for primary data. Data were collected on socio-economic characteristics as well as on the quantities and prices of farm inputs of interest. These were analyzed using combinations of analytical tools including; Descriptive statistics, Data Envelopment Analysis (DEA), input slacks analysis and OLS Regression Analysis.

Odels Specification

Data Envelopment Analysis (DEA Model)

Technical efficiency was estimated in this study using DEA model of Charnes et al, (1978) and Fare et al. (1985, 1994).

The technical efficiency (TE) measure is obtained by solving the following DEA model:

$$\begin{aligned} \text{Min } & \theta_i^{CRS} \\ \text{Subject to } & Y_i = \theta Y \\ & \theta_i^{CRS} \geq X \\ & \theta_i^{CRS} \geq 0 \end{aligned} \quad (\text{Eq 1.0})$$

where

θ_i^{CRS} Is a TE measure of each woman farmer under CRS

Y_i = is the vector of outputs produced (measured in grain equivalent) by each woman farmer

X_i = is the vector of inputs used

= is an $n \times 1$ vector of weights attached to each of the efficient woman farmer.

A separate linear programming (LP) problem is solved to obtain the TE score for each of the 100 women farmers in the sample.

If $CRS = 1$, the farmer is on the frontier and she is considered technically efficient. If $CRS < 1$, then the farmer lies below the frontier and is considered technically inefficient.

The variables of DEA model include:-

- Y_{ij} = Vector of output including yams, cassava and cowpea
- X_{ijs} = Vector of inputs - these include:-
- X_1 = Farm size (Ha)
- X_2 = Family labour (days)
- X_3 = Hired labour (days)
- X_4 = Planting materials (Kg)
- X_5 = Fertilizer (kg)

Regression Analysis

Farmers' specific characteristics including; Years of schooling, farming experience, family size, number of plots, Membership of an Organization (MBO) and extension visits were modeled as determinants of efficiency to understand how these characteristics influence the level of efficiency of the women farmers. The Regression model used is as follows:-

$$\mu = f(Z_1, Z_2, Z_3, Z_4, Z_5).$$

Where

- μ = TE (derived from DEA model)
- Z_1 = Years of schooling
- Z_2 = Membership of organization
- Z_3 = Farming experience (Years)
- Z_4 = Access to credit (Dummy Variable Yes = 1 otherwise = 0)
- Z_5 = Contact with extension agent (Dummy variable Yes = 1 Otherwise = 0)

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Women Farmers

The summary of the socio-economic characteristics is presented in Table 1. The table reveals the average household size of 7 persons consisting 4 adult members and 3 children. It further shows that women farmers in the study area are experienced farmers with an average farming experience of 20 years. Analysis also shows that they had an average of 4.5 years of formal education, and a number of farm plots raging between

1 and 5. The result further showed that 78 percent were married, 10 percent were widowed while 12 percent were single. They had mean extension visits of 14 and belonged to one or two agricultural association.

Table 1: Descriptive Statistics for Selected Socio-economic characteristics of Women Farmers

Variable	Min	Max	Mean	Std. Dev.
Farming Experience (Years)	1	50	20.42	12.26
Years of schooling	0	14	3.72	1.58
Family Size (No)	2	20	7.80	4.72
Adult Members (No)	1	17	4.6	2.98
Children (= 15 years) (No)	0	10	3.06	2.43
No of plot	1	5	2	0.84
Extension visit	0	48	14	12.23

Membership of association = 65%

Access to credit = 45%

Marital status; married 78.1%, single 9.5%, widowed 10% and; divorced 2.4%

Analysis of Technical Efficiency

The distribution of the efficiency scores among the farms is as shown in Table 3. The efficiency scores ranged between 100 percent and less than 10 percent while the mean technical efficiency is 54 percent. The result shows that an average woman farmer in Kwara state is 54 percent efficient in the use of farm resources. This implies that, there is room for improvement. If an average woman farmer could adopt the efficient practices of the efficient farms on the frontier, food productivity in kwara state could be increased by 46 percent. Thereby increasing rural income and reducing the problem of food insecurity in the state.

Table 2: Technical Efficiency Scores

Class internal of efficiency indices	Frequency	Percentage
< 0.1	3	3
0.1 0.19	11	11
0.2 0.29	09	09
0.3 0.39	16	16
0.4 0.49	10	10
0.5 0.59	11	11
0.6 0.69	14	14
0.7 0.79	05	05
0.8 0.89	01	01
0.9 1.0	20	20
Total	100	100

Source: Field Data 2007

Mean efficiency = 54%

Minimum value = 0.03

Maximum value = 100

Factors Affecting Technical Efficiency of the Women Farmers

To determine sources of technical efficiency among women farmers the contribution of some selected farmers' personal characteristics were studied. These include level of education, farming experience, access to credit, membership of association and visit of extension agents. The result of the technical efficiency model shows that four of the five variables have significant impact on the farmer's efficiency. The coefficients of years of education and membership of farmers association are positively signed and significant as expected. However, contrary to expectation, the coefficients of farming experience and extension visits though significant are negatively signed. The implication of the positive coefficients of years of education and membership of association is that women farmers with more years of education and membership of an association tend to be more efficient in food crop production presumably due to their enhanced ability to acquire technical knowledge through education and (or) sharing information in crop husbandry, marketing channels and other useful information at association level which also tend to improve their technical know-how on food production. This finding agrees with Seyoun et al (1998) and Yusuf and Malomo (2007) on education Binma et al (2004) and Chirwa (2007) on Membership of association.

It is however surprising that extension visits to women farmers had negative impact on efficiency. This could be explained by the fact that extension services in

Nigeria in general has not been effective, especially after the withdrawal of World Bank funding from the Agricultural Development Project (ADP) which is the main agency responsible for extension services. Given the problem of inadequate funding of the extension outfit, dissemination of agricultural innovation to farmers are sparingly done. This finding corroborates the findings of Seyoun et al (1998) who reported negative influence of extension contact on efficiency in their study of technical efficiency and productivity of maize farmers in Eastern Ethiopia.

Farming experience, contrary to expectation also has negative coefficient implying that the more the years of experience the less the technical efficiency of women farms. This result can be explained on the fact that majority of the women farmers are married (78%), as they grow older they tend to have more responsibility in terms of their children education and upkeep, as such, are likely to be more conservative and, therefore, less willing to adopt new practices, thus leading to low efficiencies in production. In addition, older women who had stopped child bearing /rearing may no longer be as agile as they used to be and as such less efficient. Parikh et al (1995) reported a negative relationship between farming experience of farmers and technical efficiency of farmers in Pakistan and Ethiopia respectively. The coefficient of access to credit though positive is not significant suggesting that it does not contribute to technical efficiency of women farmers.

The outcome of this analysis suggests that education and awareness (extension and associations) are the major determinants of technical efficiency of women farmers in Kwara state and should be considered by the policy makers.

Table 3; Determinants of Women Farmers Technical Efficiency in Food Crop Production

Variable	Double log	t-value
Constant	-0.5360	-4.61***
Education (Z^1)	0.8872	3.68***
MBO (Z^2)	0.1061	1.99*
Access to credit (Z^3)	0.0492	0.46
Year of farming (Z^4)	-.0069	-2.03**
Extension (Z^5)	-0.4092	-5.172***

Source: Field Data 2007

*** Significant at 1%

** Significant at 5%

* Significant at 10%

CONCLUSIONS

This paper has explored the factors undermining technical efficiency of food crop production by women farmers in Kwara state. Two important findings emerged. First, women farms in Kwara state are averagely efficient. They had 54% level of technical efficiency. The implication of this finding is that there is ample opportunity to increase food output, rural income and reduce the problem of food insecurity in Kwara state in particular and Nigeria in general if the less efficient farms adopt the efficient practices of farms on the frontier. Secondly, the analysis of efficiency effects revealed that personal characteristics of the women farmers such as level of education, membership of association, extension visits to women farmers and farming experience are the determinants of technical efficiency of women farms in Kwara state. However, while level of education and membership of association improve level of technical efficiency, extension visits and farming experience tend to increase inefficiency of women farms. Increased inefficiency with extension visits may be explained by the fact that the extension unit is poorly funded in Nigeria. This may had influence effective dissemination of agricultural innovation to farmers. The reason for increased inefficiency with years of farming may be adduced from the fact that, as married women farmers grow older, their responsibility tend to increase in respect of children education and upkeep while elderly women who are no longer bearing/raising children are no longer agile as they use to be.

Recommendations

To increase food productivity and farm income that will enhance food security in Kwara state, the following recommendations are considered imperative:

- inefficient women food crop producers should adopt the efficient practices of their counterparts on the frontier;
- National Centre for Agricultural Mechanization (NCAM) need to design time and labour saving devices specifically for women to reap the potentials of the young mothers in food crop production;
- cooperative societies and other farm organizations should intensify efforts on technical education and training of women farmers on the effective and efficient management of farm resources; and
- for the purpose of improving technical and economic knowledge of women farmers, there is need for improvement and intensification of extension service in Kwara state.

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