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26- RESOURCE PRODUCTIVITY ANALYSIS OF SMALL SCALE ROOT AND TUBER CROP FARMERS IN NIGER STATE, NIGERIA

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ABSTRACT

The study examined resource productivity analysis of small scale root and tuber crop farmers in Niger State, Nigeria. Data used for the study were obtained from primary source using a multi-stage sampling technique with structured questionnaires administered to 150 randomly selected root and tuber crop farmers from the study area. Descriptive statistics such as means, standard deviations, frequency distribution table and percentages were used to summarize the variables used in the analysis while data envelopment analysis was used to empirically determine the resource productivity in the study area. The DEA result on the overall technical efficiency of the farmers showed that 6% of the sampled root and tuber crop farmers in the study area were operating at frontier and optimum level of production with mean technical efficiency of 1.00. Decomposition of technical efficiency also showed mean efficiency scores of 0.25 and 0.32 for overall technical efficiency and scale efficiency respectively meaning that, on average, the sampled farms were more scale efficient than they are technically efficient. The study further revealed that most of the farms could reduce total expenditures on the farm land, labour, planting material, agrochemical, fertilizer and capital inputs by 8.17%, 5.17%, 29.53%, 23.71%, 0.09% and 10.08%, respectively without reducing their current level of production. The study therefore recommended that root and tuber crop farmers in the study area should form cooperative societies so as to enable them have access to productive inputs that will enable them expand. This will as well increase efficiency of resource utilization. Also, since few farms were robustly efficient, the farmers in the study area, enhanced research, extension delivery and farm advisory services should be put in place for farmers to learn the best farm practices carried out on the robustly efficient farms. This will go a long way to increase the efficiency level of the farmers in the study area

KEYWORDS: Resource productivity, scale technical efficiency, root and tuber crop.

INTRODUCTION

Roots and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates. The terms refer to any growing plant that stores edible material in subterranean root, corm or tuber (FAO, 1990). Historically, very little attention has been paid to root crops by policy-makers and researchers as most of their efforts have been concentrated on cash crops or the more familiar grains. Root crops were regarded as food mainly for the poor, and have played a very minor role in international trade. This misconception has lingered for so long because of the lack of appreciation of the number of people who depend on these root crops, and the number of lives that have been saved during famine or disasters by root crops (FAO, 1990). According to FAO (1990), yam, cassava and potato of various varieties are the common roots and tubers in Africa. Cassava is commercially processed into *gari*, a staple food in parts of Nigeria, and into *kokonte* in

Ghana. According to FAO, (2004), Nigeria is the largest producer of cassava in the world. Its production put at least at 34million metric ton a year. Total area cultivated of the crop (cassava) in 2001 was 3.125 million hectares with an average yield of 10.83metric ton per hectare.

IFPRI (2010) reported that cereals, roots, and tubers dominated Nigerian crop production, and Nigeria is the world's leading producer of cassava, yams and cowpea. However, productivity is below potential yields with the farmer yields of most crops less than half of yield potential. Hence, the role of increased efficiency and productivity of root and tuber crop farms is no longer debatable but a great necessity in order to reverse the low technical, economic and allocative efficiency of small holder farms in Nigeria, since root and tuber crops (e.g. cassava and yam) have the potential for bridging the food gap, as they have been discovered from research that famine rarely occur where these crops are widely grown (Nweke *et al.*, 2002). Given the fact that a number of root and tuber crop development programmes such as varietal improvement, seed development, multiplications and distribution have been implemented to boost the root and tuber crop sector in Nigeria, there is no comprehensive and up-to-date information as regards the level of resource productivities of the root and tuber crop farmers. The few available ones are either system based or location specific. Also most of these studies focused mainly on the profitability of the enterprise without in depth enquiry into productivity of farmers. The main focus of this study is to determine the levels of resource productivity of these farmers in the study area.

Analytical Framework

The terms productivity and efficiency are often used interchangeably but these are not precisely the same things. Productivity is an absolute concept and is measured by the ratio of outputs to inputs while efficiency is a relative concept and is measured by comparing the actual ratio of outputs to inputs with the optimal ratio of outputs to inputs. Productivity could be measured in terms of marginal physical product (MPP) in which case, the interest is in the addition to total product resulting exclusively from a unit increase in the use of that input i.e., total factor productivity (TFP) growth, which is measured using the frontier and non-frontier approaches. It therefore suffices to say that productivity can only be measured and ascertained from farm-level efficiency (Udoh and Falake, 2006). According to Arthur Ha *et al.*, (2001), an important concept of productivity analysis is technical efficiency. Productivity is generally measured in terms of the efficiency with which factor inputs, such as land, labour, fertilizer, herbicides,

tools, seeds and equipment etc are converted to output within the production process (Umoh and Yusuf, 1999).

Estimation of total technical, pure technical and scale efficiencies

Generally, there are two approaches to measure efficiency estimates of a firm i.e. parametric approach and non-parametric approach. Parametric approach involves the use of stochastic frontier analysis (SFA) while non-parametric approach involves the use of data envelopment analysis (DEA). DEA approach was preferred over parametric approach for the estimation of efficiency in this study because it provides means of decomposing total technical efficiency into pure technical and scale efficiency (SE). Technical efficiency scores can be obtained by running a constant returns to scale DEA model or variable returns to scale (VRS) DEA model. Technical efficiency scores obtained from constant returns to scale (CRS) DEA model are called total technical efficiency and from variable returns to scale DEA model as pure technical efficiency. Total technical efficiency of a firm can be decomposed into pure technical and scale efficiency. Pure technical efficiency relates to management practices while scale efficiency relates to the residuals. This would enable better understanding of the nature of technical efficiency of farms and would assess the possibilities for productivity gains by improving the efficiency of farmers in the study area.

The key construct of a DEA model is the envelopment surface and the efficient projection path to the envelopment surface (Charnes *et al*., 1978). The envelopment surface will differ depending on the scale assumptions that underline the model. The efficiency projection path to the envelopment/surface will differ depending on if the model is output-oriented or input oriented. The choice of model depends upon optimization production process characterizing the firm. Input oriented DEA determines how much the mix for a firm would have to change to achieve the output level that coincides with the best practice frontier. Output-oriented DEA is used to determine a firm's potential output given its inputs mix if operated as efficiently as firms along the best practice frontier. For this study input-oriented DEA 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. For this study, technical efficiency was used to estimate the resource productivity of the farmers in the study area. Measurement of technical efficiency is important because it is a success indicator of performance measure by which production units are evaluated (Ajibefun, 2008).

DEA is a relative measure of efficiency where the general problem is given as:

$$\text{Max TE} = \frac{\sum_{r=1}^{s} \alpha_r Y_{ro}}{\sum_{r=1}^{m} \beta_i X_{i0}} = \frac{q}{q^*} \qquad (1)$$

Subject to :

$$\frac{\sum_{r=1}^{s} \alpha_r Y_{rj}}{\sum_{r=1}^{m} \beta_i X_{ij}} \leq 1, j = 1,\ldots\ldots,n \qquad (2)$$

$\alpha_r, \beta_i \geq 0$; r = 1, -----, s; i = 1, …., m

Where X_{ij} and Y_{ij} respectively are quantities of the i^{th} input and *rth* output of the j^{th} firm and α_r, $\beta_i \geq 0$ are the variable weights to be determined by the solution to this problem

Scale efficiency can be obtained residually from CRS and VRS technical efficiency scores as follow:

SE= TECRS/TEVRS

SE= 1 indicates scale efficiency or constant return to scale (CRS) and SE <1 indicates scale inefficiency. Scale inefficiencies arise due to the presence of either increasing returns to scale or decreasing return to scale.

METHODOLOGY

Study Area: The study was conducted in Niger State of Nigeria. Niger State is located between latitudes 8o11′N and 11° 20′ N and longitude 4° 30′E and 7° 20′E. It is bordered on the north-east by Kaduna state and on the South-east by the Federal Capital Territory, Abuja. It is also bordered on the North, West, South West and South by Zamfara, Kebbi, Kogi and Kwara States respectively (see figures 3.1 and 3.2). It shares a foreign border with the Republic of Benin in the North West. The state covers an estimated land area of 76,363 square kilometers and a population of 4,082,558 people (Wikipedia, 2011). The state is agrarian and well suited for production of arable crops such as cassava, cowpea, yam, and maize because of favourable climatic conditions. The annual rainfall is between 1100mm – 1600mm with average monthly temperature ranges from 23oC and 37oC (Wikipedia, 2010). Kaduna state and Federal Capital Territory (Abuja) are her borders to the North-East and South-East respectively; Zamfara state borders the North, Kebbi State in North-West, Kogi

state in South and Kwara state in South-West. The vegetation consists mainly of short grasses, shrubs and scattered trees.

Sampling technique and sample size

The data mainly from primary sources were collected using a multi-stage sampling technique. The first stage involved the random selection of 3 Local Government Areas (LGAs) in the State which include Shiroro, Lapai and Gurara. Cassava and yam were purposively selected for this research work because they are the prevalent tuber and root crops produced in the study area as confirmed by IITA, (2004). The second stage involved a simple random selection of five villages in each LGA and ten yam and cassava farmers in each village totalling 150 farmers sampled for this study.

Method of data collection

A limited cost-route approach method was used in data collection for this study. The data were collected with the use of structured questionnaire designed in line with the objectives of the study. Data collected included total output produced per annum in tonnes, while the inputs included the size of farm land in hectare, quantity of seeds as planting materials in kg; quantity of fertilizer used in kg; quantity of herbicides used in litres and total labour in man-days which include family and hired labour utilised pre and post planting operations and harvesting; prices of yam and cassava in naira; total production cost per year; average wage rate per man days of labour, price per kg of planting materials, average price of agrochemicals, average price of fertilizer and average price of farm tools. Also, data collected include the farmer's socio-economic variables such as farmer's age, years of schooling, household size, number of contact with extension agents, accessibility to credit etc.

Empirical Model specification

The output variable used for estimating efficiency scores was total farm output (tons) (Y). Total farm output included outputs of yam and cassava in tons which were aggregated using wheat grain equivalent table.

The inputs used included farm size (ha), labour (man-day), planting materials (kg) agrochemical (herbicides and pesticides) (₦), fertilizer (kg) and capital Input (₦).

RESULTS AND DISCUSSION

The summary statistics of the variables for the data envelopment analysis (DEA) for yam and cassava production in Niger State presented in Table 1. They include the sample mean and the standard deviation for each of the variables. The results from Table 1 show that the mean of

1.83 tons of outputs per annum was obtained from the data analysis in the study area. Analysis of the inputs also revealed an average farm size of 2.84ha per farmer, an indication that the study covered small scale family managed farm units. The average labour of 140.70 man-day showed that yam and cassava farmers in the study area relied heavily on human labour to do most of the farming operations. The analysis of other input variables showed the mean values of 181.29kg, ₦5902.13, 597.07kg and ₦1192.56 for fertilizer, cost of agrochemical, planting materials and capital input cost respectively. All these findings point to the characteristic nature of subsistence farming which dominates agricultural production in Nigeria.

Table1: Summary statistics of the variables in data envelopment analysis for root and tuber crop production in Niger State.

Variables	Mean	Standard Deviation	Minimum	Maximum
Total Output (tons)	1.83	2.51	0.05	25.60
Total farm size (ha)	2.84	1.74	0.53	9.00
Labour	140.70	48.73	20.00	210.00
Total Planting Material	597.07	691.26	15.00	3000.00
Agrochemical (₦)	5902.13	7666.88	250.00	54000.00
Total Fertilizer(kg)	181.29	74.20	0.50	500.00
Capital input cost (₦)	1192.56	727.52	350.00	5292.00

Source: Data Analysis, 2012

The total technical, pure technical and scale efficiency scores of root and tuber crop production in the study area are presented in Table2. Results of study indicate that the mean total technical efficiency of the sample farms is 0.25 implying that the farmers would have to reduce the level of inputs by 75% if they were operating at the frontier. . Decomposition of technical efficiency shows that, on average, the sample farms are more scale efficient than they are technically efficient. The mean pure technical efficiency of the sample farms is 0.76 with a lowest of 0.36 and a highest of 1.0. The mean scale efficiency of the sample farms is 0.32. Results in Table3 also depicts that only 6 percent farms are scale efficient while remaining 94 percent farms are scale inefficient. All the scale inefficient farms operate in an area of increasing returns to scale, implying that they could achieve higher efficiency level by decreasing the production scale. The high pure technical efficiency in comparison with scale efficiency shows that total technical inefficiency is mainly due to inefficient management practices.

Table 2: Summary statistics of efficiency estimates in root and tuber crop production in the study area.

Efficiency Estimates	Mean	Standard Deviation	Minimum	Maximum
CRS technical efficiency	0.25	0.25	0.01	1.00
VRS technical efficiency	0.76	0.19	0.36	1.00
Scale efficiency	0.32	0.26	0.02	1.00

Data Analysis, 2012

Table 3: Share of farms under CRS (scale efficient), IRS (increasing returns to scale) and DRS (decreasing returns to scale) in root and tuber production in the study area.

Efficiency Estimates	Frequency	Percentage
Scale efficient farms	9	6.00
Farms under increase returns to scale	141	94.00
Farms under decrease returns to scale	0	0.00

Data Analysis, 2012

Farms and Their Counts Appearing as Peers for Other Farms in the Study Area

Table 4 reports the number of counts a farm appeared as a peer for other farm(s) in the study area. Farms appearing more frequently as a peer for other farms are termed robustly efficient. They are robustly efficient because their production practices are such that these farms were frequently used to form the efficient frontier for the inefficient farms in the data. As observed from table4, farms 27, 115 and 124 with peer count of 66, 64, and 88 farms respectively were identified as robustly efficient farms in the study area. Other root and tuber crop farms could learn more of better production practices from these farms.

Table 4: Farms and Their Counts Appearing as Peers for Other Farms in Niger State

Farm	Peer count:	Farm	Peer count:
4	28	38	8
11	28	39	30
12	5	44	15
15	30	46	7
16	4	70	23
18	19	110	41
25	14	115	64
27	66	122	24
30	1	124	88
33	1	134	11
34	22	139	2

Data Analysis, 2012

Table 5 shows slack inputs for root and tuber crop farms in the study area. A slack variable represents the amount of excess expenditure on an input, i.e., the amount by which the expenditure on a particular input could be reduced without altering the production level. It is

evident that 42 farms together could reduce total expenditures on the farm land by 8.17% without reducing their current level of production. Similarly, excess expenditures on labour, planting material, agrochemical, fertilizer and capital inputs are estimated at 5.17%, 29.53%, 23.71%, 0.09% and 10.08%, involving 43, 87, 47, 3 and 36 farms, respectively.

Table5. Input slacks and number of root and tuber crop farms using excess inputs in and Niger State

Input	Number of farms	Mean Slack	Mean input Used	Excess Input use (%)
Total farm size (ha)	42	0.23	2.84	8.17
Labour	43	7.27	140.70	5.17
Total Planting Material	87	176.31	597.07	29.53
Agrochemical (₦)	47	1399.48	5902.13	23.71
Total Fertilizer(kg)	3	0.17	181.29	0.09
Total Depreciation	36	120.23	1192.56	10.08

Data Analysis, 2012

CONCLUSION AND RECOMMENDATIONS

The empirical study is resource productivity analysis of small scale root and tuber crop farmers in Niger State, Nigeria. The DEA result on the overall technical efficiency of the farmers showed that 6% of the sampled root and tuber crop farmers in the study area were operating at frontier and optimum level of production with mean technical efficiency of 1.00. This shows that 94% of the root and tuber crop farmers in the study area can still improve on their level of efficiency through better utilization of available resources, given the current state of technology. Decomposition of technical efficiency also showed that, on average, the sample farms were more scale efficient than they were technically efficient. The findings in the study also indicated that most of the farms could reduce total expenditures on the farm land, labour, planting material, agrochemical, fertilizer and capital inputs by 8.17%, 5.17%, 29.53%, 23.71%, 0.09% and 10.08%, respectively without reducing their current level of production. In view of the above findings, it is therefore recommended that root and tuber crop farmers in the study area should form cooperative societies so as to enable them have access to productive inputs that will enable them expand. This will as well increase efficiency of resource utilization. Also, since few farms were robustly efficient, the farmers in the study area, enhanced research, extension delivery and farm advisory services should be put in place for farmers to learn the best farm practices carried out on the robustly efficient farms. This will go a long way to increase the efficiency level of the farmers in the study area.

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