ANALYSIS OF FACTORS INFLUENCING TECHNICAL EFFICIENCY OF ACHA (*Digitaria spp*) PRODUCTION IN BAUCHI STATE NIGERIA

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ABSTRACT

The need to attain food security status can best be achieved if effort is extended to crops that are indigenous to the nations communities. Acha is one of such crops whose awareness and consumption is on the increase. The study examined the determinants of technical efficiencies of acha production in Bauchi State, Nigeria. A sample of 384 acha farmers were randomly selected for the study. Data were collected through the use of questionnaire for 2021 cropping season. Descriptive statistics and stochastic frontier analysis were used to analyze the data. Socioeconomic characteristics of acha farmers showed a mean age of 42 years, household size of 8persons per household, mean farming experience of 10 years and a mean farm size of 0.6hectares devoted to acha production. Four factors were significant in determining technical efficiency of acha farmers; these were seed quantity (1.14), fertilizer (0.23), labour (-0.61) and farm size (0.36). The result for technical inefficiency showed that transportation had (-0.006), age (-0.002) and years of faming experience (0.002) were found to be significant. Constraints to acha production were found to include insufficient funds (83.1%), soil infertility (72.1%) and manual method of harvesting (65.4%). It was concluded that acha farmers were efficient in the combination of inputs and this was influenced by seed quantity, fertilizer, labour and farm size. It was therefore recommended that farmers should increase seed quantity and decrease units of labour while they maintain the rate of fertilizer application and farm size.

Keywords: Technical, Efficiency, Acha, Farmers, Bauchi

1.0 INTRODUCTION

To address the threatening situation of severe impact of global food crisis on food security in Africa, Countries in sub-Saharan Africa would have to look inwards to indigenous foods Especially those neglected due to influx of western foods into the continent (Jideani, 2012). Cereals output is up to 26.2 million tons as of 2018 (Ikem *et al.* 2023), and provides incomes as well as form the basis of many households' diets both in the rural and urban areas (Balami *et al*, 2011). Many West African countries have a large population of people classified as food insecure; malnutrition is rampant, energy and protein intakes, fall below the estimated minimum dietary requirements with micronutrients deficiency (International Plant Genetic Resources Institute, IPGRI, 2004).

Acha (*Digitaria spp*), also known with other names as *fonio*, *iburu*, *findi*, *fundi*, *pom*, and *kabug* in different West African countries, is the oldest cereal, since its cultivation is thought to date back to 7000 years ago (Cruz, 2004). There are two varieties of *acha* commonly called white *acha* (*Digitaria exilis*) and black *acha* (*Digitaria iburua*) that are the most widely cultivated. The varities are so named due to the colour of their seed coverings. It has been reported that certain *fonio* varieties mature more quickly that they are ready to be harvested long before other grains in the field, which may well place them as perhaps the world's fastest maturing cereal producing grain just 6 or 8 weeks after planting; while other *acha* varieties may mature more slowly-typically in 165-180 days after planting. Acha, because of its nutritional value could contribute to address these issues if it was well developed" alongside rice (IPGRI, 2004). The insufficiency experienced in terms of food production may not be unconnected to the total neglect of most of these African cereals (Philip and Itodo, 2006). The focus of this study on acha production is derived from the observation made by Jideani (2011) that, acha demand and consumption is on the increase due to increasing awareness of its nutritional value.

Acha production (which is an established staple in the study area) is seen not to enjoy the patronage other cereals such as rice and maize have. There has been some loss of interest in *acha* production in the study area due partly to what can be attributed to: 1) low yield per land area compared with other cereals grown in the study area. The average production of *acha* per hectare has remained low, ranging from 500-700kg/ha as against 1.48t/h (Umar, 2022); 2) the difficulty being experienced in obtaining labour for harvest at the time of maturity of the crop; most especially when the time of maturity coincides with that of rice; and 3) absence of improved technology for increased productivity of *acha*. This can be resolved through exploring the potentials of *acha* as well as the comparative advantage that may be derived in its production relative to those of foreign origin. Duniya (2014) observed that the measurement of efficiency has remained an area of important research both in the developing and developed countries. This is especially important in developing countries, where resources are meager and opportunities for developing and adopting better technologies are dwindling. Efficiency measures are important because it is a factor for productivity growth. Such studies benefit these economies by determining the extent to which it is possible to raise productivity by improving the neglected source of growth, that is, efficiency, with the existing resource base and available technology.

The study was therefore carried out to describe the socioeconomic characteristics of acha farmers, determine the factors affecting technical efficiencies and technical inefficiencies of acha production and to identify the constraints associated with acha production in the study area.

MATERIALS AND METHODS

The Study Area

Bauchi State occupies an area of 49, 119km^2 about 5.3% of the total land mass of the country and ranked 5th among 36 States. The State cuts across two distinct ecological zones; Sudan Savannah and Sahel Savannah, with the south west part of the State overlapping into guinea savannah. It is located between 9^{0}3$^/$ and 12^{0}3, north of the equator and between latitude 8^{0}50, and 11^0 east of Greenwich meridian. This study was carried out in three of the Local Government Areas in the western zone namely; Tafawa Balewa, Bogoro and Toro LGA's being the main *acha* producing areas of the State. The three local government areas occupy a total land area of 10, 341km^2 with a total projected population of 654, 607 people (NPC, 2006), at a growth rate of 3.6%. Separately, however the land area and population of Tafawa Balewa, Bogoro and Toro LGA's are 2,515^{2}km and 219, 988 people; 894^{2}km and 84,215 people and 6, 932^{2}km and 304, 203 respectively (NPC, 2006).

Sampling Procedure and Sample Size

A multi-stage sampling technique was employed in selecting acha farmers for this study. First stage was the random selection of 20% of wards in the three LGA's resulting in 2, 3 and 3 wards in Tafawa Balewa, Bogoro and Toro LGAs respectively. Second stage was the random selection of 5 communities from each of the selected wards; thus, a total of 40 communities were selected. Third stage, a simple census of acha farmers was conducted using trained enumerators, on the selected communities. Then a total of 384 farmers were randomly selected as sample for the study. Sample size determination for infinite population was applied to determine the sample size required for the study as follows (Smith, 2013)

$$NSS = [Z^2 \times SD(1-SD)]/ME^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

NSS= Necessary sample size

Z= Z value at determined level of significance

SD=Standard deviation

ME= Margin of error or confidence interval

$$NSS = [1.96^2 \times 0.5(1-0.50]/0.05^2$$
$$=3.8416 \times 0.25/0.0025$$
$$=0.9604/0.0025$$
$$=384.16$$
$$\sim 384 \text{ respondents needed}$$

Sample was assigned to the selected communities using the formula for assigning sample to strata when the population of acha and rice farmers in the selected communities were known from the simple census conducted (Berman, Undated):

$n_a = (N_a/N)*n$……..
(2)

Where:

n_a = the sample size for that community

N_a = the known population size of acha farmers for that community

N = the total population of acha and rice farmers for the selected communities

n = the determined necessary sample size.

Analytical Techniques

Descriptive statistics-frequencies, percentage, mean, and charts was used to describe the socioeconomic characteristics of acha farmers and to identify the constraints associated with acha production in the study area.

Stochastic frontier production function was employed to determine the factors influencing technical efficiencies and technical inefficiencies.

SFPF (Technical Efficiency)

$InY=In\beta 0+\beta_1 InX_1+\beta_2 InX_2+\beta_3 InX_3+\beta_4 InX_4+\beta_5 InX_5+\beta_6 inX_6+V_i-U$…..... (3)

Where;

In = natural logarithm to base e,

Y_i = output of acha (kilogrammes)

X_1 = farm size (hectares)

X_2 = quantity of seeds used (kilogrammes)

X_3 = quantity of fertilizer used (kilogrammes)

X_4 = labour used in the production (man-days)

X_5 = quantity of herbicides used (litres)

X_6 = quantity of pesticides used (grams)

β_0, β_1, β_2, β_3, β_4, β_5, β_6= parameters to be estimated

Vi = assume independently distributed random error or random shock having zero mean. It is associated with random factors such as measurement errors in production and weather which the farmer does not have control over.

SFPF (Technical Inefficiency)

$U_i=d_0+d_1Z_1+d_2Z_2+d_3Z_3+d_4Z_4+d_5Z_5+d_6Z_6+d_7Z_7+d_8Z_8$..... (4)

Where; Ui = technical inefficiency of the ith acha farmer; Z_1 = Age (years); Z_2 = Household size of acha farmer (number of people); Z_3 = Years of formal education of the farmer (years); Z_4 = Years of experience of acha farmer (years); Z_5 = Acha harvesting cost in naira (naira); Z_6= Acha Storage cost in naira (naira); Z_7= Transportation cost in naira (naira); Z_8= Distance to acha farm (km)

d_0, d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8 = parameters to be estimated

RESULTS AND DISCUSSION

Socioeconomic Characteristics of *Acha* Farmers

The result for socioeconomic characteristics of acha farmers is presented in Table 1. The mean age was 42years. This is an active age desirable for effective performance in any economic activity. Gidado (2012) reported that *acha* farmers studied were within the age bracket of 21-50 represented by 81% percent of the respondents. The implication is that *acha* farmers were within productive age that is likely to contribute in realizing greater output. A mean household size of 8 persons per household disagrees with Bamire, *et al.,* (2007) who reported a mean household size of 6 persons per household of rice farmers but agrees with the report Gidado *et al.* (2013) who reported a lead household size of 5-10 of *acha* farmers. This large household size of *acha* farmers may be said to have advantage of making use of family labour for their *acha* production and therefore save some costs that may otherwise have been expended in payment for hired labour. The finding on education disagrees with Philip and Itodo (2012) who reported that only 43% of the responding *acha* farmers had formal education. This identified level of literacy among *acha* farmers is expected to improve the adoption of new technologies and to appreciate extension services where available thereby resulting in improved productivity. The mean years of *acha* farming was 10 years. Ten years was enough to guarantee the acquisition of the necessary skills needed for effective performance in any agricultural enterprise. The result however was below 16 years of farming experience reported by Katanga *et al.* (2015). The mean farm size put under *acha* cultivation as studied was 0.6ha, implying that *acha* cultivation was at subsistent level This is in agreement with the finding of Abdulrahman *et al.* (2015) who reported a mean *acha* farm of 0.56ha. The result shows that 65.6% of *acha* farmers in the study area were female, while the remaining 34.4% were male. Interestingly, this agrees with the traditional believe that the production of *acha* is female dominated. The result, however, disagrees with the findings of Ayo and Nkama (2006) who showed that majority of *acha* producers were male represented by 90% of respondents. What this implies is that females may not have the capacity to operate at large scale hence limiting *acha* production to small farm size allocations. Marital status indicated that 80.7% of the respondents were married, while 10.9% were widowed. That majority were either married or widowed indicates a presence of responsibility that demands engagement in an economic activity to take care of dependents. Contact with extension agent by farmers however showed only 8.1%, as 91.9% of *acha* farmers in the study area claimed they never had contact with extension agents for the period under study. This indicated that even if there were relevant technologies with respect to *acha* production, it was not getting to the farmers as it was required. It also indicates a huge gab in communication between *acha* farmers and researchers which may have hindered the development of relevant technologies that will lead to improvement in *acha* production.

Table 1: Socioeconomic Characteristics of *Acha* Farmers

Variable	Min.	Max.	Mean	Std. Dev.
Age (years)	20	70	42	12.5
Household size (number)	1	30	8	5
Years of experience in *acha* production (years)	1	50	10	11
Farm size (hectares)	0.25	1.2	0.6	0.3
Frequency of extension visits (per season)	0	8	0.2	
	Frequency		**Percentage**	
Level of education				
None	62		16.2	
Adult education	28		7.3	
Primary education	61		16.0	
Secondary education	127		33.2	
NCE/Diploma	76		19.8	
HND/B.Sc.	25		6.5	
Sex				
Male	132		34.4	
Female	252		65.6	
Marital Status				
Single	31		8.1	
Married	310		80.7	
Divorced	1		0.3	
Widowed	42		10.9	

Source: Field Survey, 2021

Determinants of Technical Efficiency of Acha Farmers

Table 2 shows the estimated parameters of the production function. The estimates of the parameters of the stochastic frontier production model revealed that estimated coefficients (farm size (0.36), seed quantity (1.14), fertilizer (0.23), and insecticides (0.07) of the production function were positive while that of labour and herbicide (Herb) were negative. The positive coefficients implied that as the use of each of these variables is increased, *acha* output increased by the corresponding coefficient. While the negative coefficients of labour (--0.61) and herbicides (0.94) showed that as farmers increased the use of these inputs in the production, *acha* output decreased by their corresponding coefficients. The significant effect of these inputs is an indication that they determine to a large extend the yield of *acha*. Thus, it is imperative to determine how technically efficient are their usage in *acha* production. This result is however slightly different with Duniya (2014) who reported the technical efficiency of inputs used in *acha* production in Kaduna state for land size ($P < 0.01$), labour ($P < 0.01$), seeds ($P < 0.01$), fertilizer ($P < 0.01$) and herbicides (Ns). All the inputs examined had significant effect on *acha* production at 1% level, except herbicide. Gidado (2013), however reported negative coefficients (-0.2335) for farm size ($P < 0.01$) seeds (-0.1253) that was not significant, 0.2411 for family labour ($P < 0.1$), while 0.2411 for hired labour and 0.3277 for quantity of fertilizer used were both significant ($P < 0.01$); for *acha* production in Bogoro LGA of Bauchi State.

Again with all having coefficients of less than one, their use is in stage two of the production phase. Seed quantity, however, whose coefficient was greater than one show that it is in stage one of production and therefore need to be increased to achieve technical efficiency.

Table 2: Determinants of Technical Efficiency

Variable	Coefficient	Std Err.	Z	P
Constant	3.5014	0.8546	4.10	0.000***
lnFS	0.3617	0.1801	2.01	0.045*
lnSQ	1.1447	0.1087	10.53	0.000***
lnFert.	0.2339	0.0793	2.95	0.003**
lnLab.	-0.6112	0.2005	-3.05	0.002**
lnHerb.	-0.9425	0.1232	-0.76	0.444^{NS}
lnIns.	0.0708	0.0843	0.84	0.401
$Sigma^2$	-2.3406	0.4504	-5.20	0.000***
Gamma	4.6344	1.1634	3.98	0.000***
Mu	0.0258	0.1699	0.15	0.879

Source: Field Survey, 2021
***Significant at 1%, **Significant at 5%, *Significant at 10%
FS = Farm size; SQ = Seed quantity; Fert. = Fertiliizer; Lab. = Labour;
Herb. = Herbicide; Ins. = Insecticide

Determinants of Technical Inefficiency

The result for technical inefficiency as presented in Table 3shows that two factors, namely, age and transportation were found to have negative effect on farmer's technical inefficiency. This means that as age ($P<0.05$) and transportation ($P<0.01$) increased, farmer's technical efficiency also increases. Whereas only years of farming experience ($P<0.1$) was found to positively affect technical inefficiency of *acha* farmers, implying that any unit increase in this factor leads to decrease in technical efficiency. The result for technical inefficiency factors indicates that of all the factors examined only three were found to significantly affect farmer's inefficiency. These were age, years of farming experience and transportation. Transportation was found to have very high significant effect ($P<0.01$) on technical efficiency of *acha* farmers, while age and years of faming experience were found to be significant ($P<0.05$ and $P<0.1$) respectively.

Table 3: Determinants of Technical Inefficiency

Variable	Coefficient	Std Err.	Z	P
Constant	0.3094	0.0708	4.37	0.000***
Age	-0.0020	0.0008	-2.41	0.016**
Household Size	0.0004	0.0017	0.28	0.781^{NS}
Years of formal education	-0.0010	0.0013	-0.78	0.436^{NS}
Years of farming experience	0.0016	0.0009	1.79	0.074*
Harvesting cost	0.0057	0.0062	0.91	0.363^{NS}
Transportation cost	-0.0064	0.0064	-1.00	0.001***
Storage cost	-0.0002	0.0001	-3.42	0.316^{NS}
Farm distance	-0.0028	0.0027	-1.04	0.297^{NS}
Farm size	0.0355	0.0665	0.53	0.594^{NS}
/lnsigma v	-4.05414	0.0722	-56.14	0.000
/lnsigma u	-14.0592	166.0153	0.08	0.933

Source: Field Survey, 2021

***Significant at 1%, **Significant at 5%, *Significant at 10%, NS = Not significant

Constraints to *Acha* Production

The result for the constraints to *acha* production as presented in Table 4 revealed that the major constraints were insufficient funds (83.1%), soil infertility (72.1%) and manual method of harvesting (65.4%). Insufficient funds may have been a major challenge due to the fact that *acha* can be produced on zero tillage as in other crops. Also, elective herbicides are not common for use on *acha* farms, leaving the farmers with the only option of manual weeding. Soil infertility challenge may be attributable to the fact that there is unavailability of land and so *acha* has to be produced on land that has been put to use continually without bush fallowing. Manual harvesting has been a major challenge in *acha* production particularly when its harvest coincides with that of rice; women (who are the major participants in its harvest) prefer to go for rice harvest than *acha* harvest. Gidado (2012) however has the following ranking order for the constraints to *acha* production observed in his study; lack of technology, soil fertility depletion, processing problem, pests and disease, lack of loan, poor marketing, harvesting problem and lack of awareness of modern technology. Similarly, among constraints to *acha* production was that the method of production is that of subsistence, no modern technology is practiced from land preparation to harvesting (Jideani, 1999).

Table 4: Distribution of Farmers by Constraints to *Acha* Production

Category	Frequency	Percentage	Rank
Infertility of Soil	277	72.1	2nd
Insufficient Funds	319	83.1	1st
Scarcity of Labour	179	46.6	8th
Farm Distance	180	46.9	7th
High Cost of Labour	237	61.7	4th
Transportation Cost	191	49.7	6th
Pre-harvest Loss	166	43.2	9th
Pests	209	54.4	5th
Manual Harvest	251	65.4	3rd

Source: Field Survey, 2021

CONCLUSION AND RECOMMENDATION

Technical efficiency of *Acha* farmers was influenced by how best the combined inputs in its production. Inputs that significantly influence *acha* production were seed quantity, fertilizer quantity, labour and farm size, while those factors that determine technical inefficiency among *acha* farmers were age, years of farming experience and transportation. Major constraints to *acha* farming included insufficient funds, infertility of soil and manual method of harvest. It was, therefore, recommended that;

i. *Acha* farmers be encouraged to maintain their farm size and the use of fertilizer as the elasticity of production of these inputs were found to be within stage two of the production function.
ii. *Acha* farmers should however be advised to increase the use of seed quantity and decrease the use of labour.
iii. Deliberate effort should be made at making funds available to farmers to enable them boost their productivity.
iv. There is need for a machine to be designed and produced for the harvest of *acha* as is obtainable in other crops.

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