e-ISSN 3050-9602
p-ISSN 2795-4340

Check for updates

10.5281/zenodo.17019121
Vol. 08 Issue 07 July - 2025
Manuscript ID: #02067

RESOURCE USE EFFICIENCY OF ACHA (*Digitaria specie*) PRODUCTION IN SOUTHERN BAUCHI, BAUCHI STATE NIGERIA

By:

Bulus, G., Audu, I. A. & Osayi, C. P.

Department of Agricultural Economics and Extension, Federal University Wukari, Taraba State, Nigeria

Abstract:

The study examined resource use efficiency in *acha* production in Southern Bauchi, Bauchi State, Nigeria. A multistage random sampling technique was employed which led to a sample of 384 *acha* farmers randomly selected for the study. Data were collected through the use of structured questionnaire. Descriptive statistics and multiple regression analysis were used to analyze the data. Socioeconomic characteristics of *acha* farmers showed a mean age of 42 years, household size of 8 persons, mean farming experience of 10 years and a mean farm size of 0.6hectares devoted to *acha* production. Four factors were significant in determining resource use efficiency of *acha* farmers; these were seed quantity at ($P \leq 0.01$), fertilizer and labour ($P \leq 0.05$) and farm size ($P \leq 0.1$). The rate of technical substitution (RTS) of 0.88 indicates that *acha* production operates in Stage II of the production function, characterized by decreasing positive returns to scale. The resource use efficiency ratios indicated that seed, insecticide, and farm size were under-utilized, as their ratios were greater than one; while the ratio for fertilizer was less than one. 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 use of resources but not without opportunity for adjustment of input use to optimize production. Providing farmers with training on optimal input use and resource management can help in adjusting their practices according to the efficiency ratios was recommended, among others.

Keywords:

Technical, Efficiency, Acha, Farmers, Bauchi

How to cite: Bulus, G., Audu, I. A. & Osayi, C. P. (2025). RESOURCE USE EFFICIENCY OF ACHA (Digitaria specie) PRODUCTION IN SOUTHERN BAUCHI, BAUCHI STATE NIGERIA. *GPH-International Journal of Agriculture and Research*, 8(7), 42-52. https://doi.org/10.5281/zenodo.17019121

This work is licensed under Creative Commons Attribution 4.0 License.

1.0 INTRODUCTION

Acha (Digitaria exilis), a nutrient-rich cereal crop, is an essential staple food in many parts of West Africa, including Nigeria. As the most populous country in the region, Nigeria's demand for *acha* is high, particularly in the northern regions where it is a dominant crop. Southern Bauchi, Bauchi State, is one of the major *acha*-producing areas in Nigeria, with many smallholder farmers engaged in its production. However, *acha* production in this region faces challenges related to resource use efficiency, which can impact productivity, sustainability, and farmers' livelihoods.

Availability of resources is a desirable phenomenon whether for agricultural production or other forms of production. The presence of resources is not in itself an indication of optimum production until the resources are harnessed efficiently in the production process. Resource use is a concept to designate the allocation of resources such as land, labor, capital and management in their various forms between competing alternatives (Olayide and Heady, 1982 as cited by Abiola *et al.,* 2016). *Acha*rya *et al.* (2020) pointed out that efficient use of resources and adoption of new technologies are the major areas to be emphasized in an effort to increase agricultural production thereby leading a country to be self-sufficient in food production.

This study aims to investigate the resource use efficiency of *acha* production in Southern Bauchi, Bauchi State, Nigeria. Specifically, it seeks to examine the productivity and efficiency of resource use (land, labor, and inputs) among *acha* farmers in the area, identify the factors influencing resource use efficiency, and provide recommendations for improving productivity and sustainability in *acha* production. The findings of this study will contribute to the development of targeted interventions and policies to support smallholder farmers in improving the efficiency and sustainability of *acha* production, ultimately enhancing food security and the well-being of local communities.

2.0 MATERIALS AND METHODS

2.1 The Study Area

Bauchi State is made up of 20 local government areas which have been divided into three agricultural zones, namely; Northern Zone (Zaki, Gamawa, Jama'are, Itas-Gadau, Shira, Giade, Katagum, Misau and Dambam LGA's), Central Zone (Ningi, Warji, Darazo and Ganjuwa LGAs) and Western Zone (Alkaleri, Kirfi, Bauchi, Dass, Tafawa Balewa, Bogoro and Toro LGAs), Agricultural Development Programme (ADP). The 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. Rainfall amount varies between the northern and southern parts of the state with 700mm and 1300mm, respectively. The major climatic factor affecting cropping pattern and practices in the area is the length of rainfall and growing season that spans between an estimated 110 days to 220 days between the north and the south-western part of the State (Abulrahman *et al.*, 2015). This study was carried out in three of the Local

Government Areas in the western zone namely; Tafawa Balewa, Bogoro and Toro LGA's (which are the main *acha* producing areas in southern part of the state) 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). Prominent among the tribes inhabiting these LGAs are the Jarawa, Sayawa (Zaar), Ribina, Fulani, Hausawa and Angasawa. However, the Sayawa, Jarawa and Ribina are specifically associated with the cultivation of *Acha* and it has formed part of their material culture. Even though other prominent tribes are engaged in the cultivation of the crop, the Sayawa, Jarawa and Ribina seem to be the traditional producers of this valuable crop (Abdulrahman *et al*, 2015).

2.2 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. Since the actual population of *acha* farmers in the study area was not known, sample size determination for infinite population was applied to determine the sample size required for the study as follows (Smith, 2013)

$$NSS = [Z^2 \text{ x } SD(1-SD)]/ME^2 \quad (1)$$

Where:

NSS= Necessary sample size

Z= Z value at determined level of significance

SD=Standard deviation

ME= Margin of error or confidence interval

$$NSS = [1.96^2 \text{x } 0.5(1-0.50)]/0.05^2$$

$$=3.8416 \text{ x } 0.25/0.0025$$

$$=0.9604/0.0025$$

$$=384.16$$

~384 respondents needed

Sample was assigned to the selected communities using the formula for assigning sample to strata when the population of *acha* 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* farmers for the selected communities

n = the determined necessary sample size.

2.3 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. Multiple regression analysis was employed to determine the factors influencing resource use efficiency.

2.3.1 Multiple regression analysis

$Y=\beta 0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+e$ (3)

Where;

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)
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$= parameters to be estimated

2.4 Resource use efficiency

$$r = \frac{MVP}{MFC} \quad (4)$$

Where;
r = Allocative efficiency ratio
MVP = Marginal value product of the variable input used in *acha* production
MFC = Marginal factor cost (price of unit input) of *acha* production
The value of *MVP* was estimated as follows:

$MVP = (bi \times Py)$ (5)

Where;
bi = regression coefficient
Py = Price of a unit of output

And *Py* was obtained as follows:

$$P_y = \frac{Average\ Revenue/ha}{Average\ Output/ha} \quad (6)$$

$$MFC = Px_1 \quad (7)$$

Where;

Px_1 = additional cost resulting from using an extra unit of input

3.0 RESULTS AND DISCUSSION

3.1 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 between 5-10 of *acha* farmers. The implication is that, given this large household size of *acha* farmers, they 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. Of the total respondents, only 16.2% indicated they never attained any formal education; thus 93.8% of the total respondents had one level of formal education or the other. This 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, represented by 68.57% of the *acha* farmers studied.

Given the mean farm size for *acha* farmers in the study area, therefore, the decision to adopt new technology, if any, will be negatively affected. 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	1	50	10	11
(years)	0.25	1.2	0.6	0.3
Farm size (hectares)	0	8	0.2	
Frequency of extension visits (per season)				
	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, 2022

3.2 Determinants of resource use efficiency

Table 2 shows the estimated parameters of the production function. The positive coefficients implied that as the use of each of these variables is increased, *acha* output increased. While the negative coefficients of labour and herbicides showed that as farmers increased the use of these inputs in the production, *acha* output decreased i.e. an inverse relationship. The result also showed that the effect of seed quantity on output was highly significant (P<0.01), while that of fertilizer and labour were very significant (P<0.01). Farm size, on the other hand, was significant (P<0.05). 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 resource use efficient farmers are in *acha* production. This result is however slightly different with Duniya (2014) who reported the 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. The result therefore shows that all the inputs except seed quantity have significant effect on resource use efficiency of *acha* farmers. 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 the production and therefore need to be increased to achieve greater resource use efficiency.

Table 2: Determinants of resource use efficiency in *acha* production

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
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, 2022

***Significant at 1%, **Significant at 5%, *Significant at 10%

FS = Farm size; SQ = Seed quantity; Fert. = Fertiliizer; Lab. = Labour;

Herb. = Herbicide; Ins. = Insecticide

3.3 Elasticity and Return to Scale of the Parameters

The result for rate of technical substitution (RTS) shows that yield has the highest responsiveness to seed quantity followed by fertilizer and insecticide. The rate of technical substitution (RTS) 0.88 was obtained from the summation of the coefficients of the inputs (elasticity) which indicates that *acha* production in the study area was in stage II of the classical production surface. Stage II is the stage of decreasing positive return-to-scale, where resources used are believed to be efficient. Kumar (undated) had stated that if the product has any value at all, input use once begun, should be continued until Stage II is reached. That is because physical efficiency of variable resources, measured by APP, increases throughout stage –I. Hence, *acha* production as demonstrated by the result is at feasible region. This is however lower compared with that reported by Ogundari and Ojo (2006), who had a rate of technical substitution of 0.84, and Duniya (2014) who reported technical substitution of 1.42 indicating that *acha* production in her study was at stage 1 of production. The efficiency ratios of three positively signed variables (seed, $X_{2;}$ fertilizer, $X_{3;}$ and insecticide, X_6) inputs used in *acha* production were estimated to determine the efficiency of the use of such inputs. The result is as presented in Table 3.

Table 3: Elasticity and Return to Scale of the Parameters

Variable	Elasticity
Farm Size	0.36
Seed Quantity	1.14
Fertilizer	0.23
Labour	-0.61
Herbicide	-0.94
Insecticide	0.70
RTS	**0.88**

Source: Field Survey, 2022

3.4 Resource use Efficiency Ratios

The result shows that while seed, insecticide and farm size were under-utilized with ratios greater than one, fertilizer was over utilized with a less than one ratio. This therefore implies that farmers need to increase the use of seed, insecticide and farm size while, on the other hand, fertilizer use should be decreased. The over utilization of fertilizer is similar to the findings of Gidado *et al.* (2013) which had a ratio of 0.5.

Table 4: Resource use Efficiency Ratios

Resource	MPP	MVP	MFC	R(MVP/MFC
Seed	1.14	216	201	1.07
Fertilizer	0.23	43	160	0.27
Insecticide	0.07	13.3	0.86	15.47
Farm Size	0.36	68.4	6.3	10.86

Source: Field Survey, 2022

3.5 Constraints to *acha* production

Constraints to *acha* production refer to the challenges faced by farmers in the course of *acha* production. The constraints considered were infertility of soil, insufficient funds, scarcity of labour, farm distance, high cost of labour, transportation cost, preharvest loss, pests' incidence and manual harvest. The result is as presented in Table 47.

The result for the constraints to *acha* production revealed that insufficient funds was the major constraint to *acha* farming as indicated by 83.1% of the respondents, followed by soil infertility, 72.1% and manual method of harvesting 65.4%. 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. This may be attributable to the fact that *acha* production is labour intensive, particularly weeding and harvesting which are done manually, at least for now that weeding operation cannot be done chemically or mechanically and harvesting of the crop has not been mechanized as in other cereal crops such as rice, maize and sorghum. Consequently, high cost of labour ranked fourth among the constraints associated with *acha* production represented by 61.7%. 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 5: 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, 2022

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the research, it was concluded that;

Variables such as seeds, fertilizer, and farm size have positive coefficients, indicating that increasing their use can lead to an increase in *acha* output. The negative coefficients for labour and herbicides suggest that increasing their use actually decreases *acha* output. This could be due to overutilization or inefficient use of these inputs.

Highly significant ($P<0.01$) positive impact on output, indicating that quality and quantity of seeds are crucial for *acha* production, fertilizer use is critical for increasing yield, larger farm sizes can lead to higher outputs, though the level of significance is less compared to seeds and fertilizer; while, negative impact indicated that potential overemployment or inefficiency in labour use.

The yield of *acha* is most responsive to seed quantity, followed by fertilizer and insecticide, indicating these inputs are crucial for increasing output. The rate of technical substitution (RTS) of 0.88 indicates that *acha* production operates in Stage II of the production function, characterized by decreasing positive returns to scale. This suggests efficient use of resources.

The resource use efficiency ratios indicate that seed, insecticide, and farm size are under-utilized, as their ratios are greater than one. This suggests that increasing the use of these inputs could lead to higher productivity. The ratio for fertilizer is less than one, indicating over-utilization. This implies that the current level of fertilizer use is not efficient, and reducing its use could optimize production.

Based on the results it was recommended that;

1. Given the highly significant positive effect of seed quantity on output, farmers should focus on using high-quality seeds in optimal quantities. Agricultural extension services could provide training on seed selection and treatment.
2. Since fertilizer has a significant positive impact, its judicious use should be promoted. Training on the right dosage and application timing could enhance efficiency.
3. Given the negative impact of labour, strategies to improve labour productivity should be explored. This could include mechanization where feasible and training on efficient farming practices to reduce waste and enhance output.
4. While larger farm sizes contribute to higher outputs, the relatively lower significance compared to seeds and fertilizer suggests that merely increasing farm size without focusing on input quality and efficiency might not yield proportional increases in output.
5. Providing farmers with training on optimal input use and resource management can help in adjusting their practices according to the efficiency ratios. This could include workshops on soil health, pest management, and efficient use of farm inputs.
6. Given the differences in findings compared to previous studies (e.g., Duniya, 2014), further research could be beneficial to understand the dynamics of *acha* production in different regions and to validate these findings.

REFERENCES

Abdulrahman, S., Nasiru, M., Iliyasu, A. G., Ja,afar-Furo, & M. R., Baidu, M. (2015). Economics of *Acha* Production in Bauchi State, Nigeria. *Researchjournali's Journal of Agriculture*, 2:12.

Ayo, J. A & Nkama I. (2006). A survey of the production, processing and Consumption of *acha*. *International journal of food and Agricultural Research* **3(**1):

Bamire, B. S., Oluwasola, O. & Adesiyan A. J. (2007). Land Use and Socio-Economic Determinants of Technical Efficiency of Rice Farms in Osun State, Nigeria, in : Haruna, U., Jubril, A., Mancha, Y. P and Nasir, M. (eds)proceeding of the Nigerian Association of Agriculture Economics (NAAE), pp.27-35.

Duniya, K. P. (2014). Analysis of Technical Efficiency and Determinants of *Acha* (*Digitaria exilis*) Production in Kaduna State, Nigeria. Unpublished M. Sc. Thesis. ABU, Zaria 97pp

Gidado E.H. (2012). Resource-use efficiency in *acha* production: A case study of Bogoro Local Government Area of Bauchi State Nigeria. Unpublished M.Sc. Thesis. Federal University of Technology, Yola. 69pp.

Gidado E. H., Adebayo, E, F., Daniel J. D., & Alama M. K. (2013). Resource-use efficiency in *acha* production: A case study of Bogoro Local Government Area of Bauchi State Nigeria. *International Journal of Management and Social Science Research (IJMSSR).* **2**(6):8-12.

Jideani, I. A. (1999). Traditional and Possiible Technological Uses of *Digitaria exilis* (*Acha*) and *Digitaria iburua. A review of Plants Food. Human Nutrition,* **5**(4):363-374.

Katanga, Y.N., Nasiru, A., Hudu, A.H., & Bose, A.A. (2015). Economics of Cassava Production and Marketing in Jigawa State, Nigeria. **In:** Haruna, U, Izge, A.U., Abdulhamid, A., Iliyasu, Y., Abdulrahman, S. L. and Katanga, Y.N.(eds). **Agriculture: a renewed focus for economic development in Nigeria.** A proceeding of the 29th annual conference of the Farm Manament Association of Nigeria, Faculty of Agriculture, Federal University Dutse, Jigawa State Nigeria. 23rd -26th November, pp. 224-228.

NPC. (2006). National Population Communication. Abuja, Nigeria.