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ECONOMIC EFFICIENCY OF SMALL-HOLDER WHEAT FARMERS AROUND HADEJIA VALLEY IRRIGATION SCHEME IN JIGAWA STATE, NIGERIA

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ABSRACT

The study analyzed economic efficiency of small-holder wheat farmers around Hadejia Valley Irrigation scheme in Jigawa, State Nigeria. Multi-stages sampling procedure was used to select 346 wheat farmers from the study area. Data were collected with the aid of questionnaire. Both descriptive and inferential statistics were used to analyzed the data. The stochastic frontier analysis results indicated that a unit increase in the use of land, fertilizer, labour and herbicide contributed to wheat output by 0.577, 0.341, 0.078 and 0.174 respectively. The predicted technical, allocative and economic efficiencies were 0.76, 0.32 and 0.24 respectively. This implies that wheat farmers were not fully efficient and output could have been increased by 24% and about 68% of cost would have been saved. Furthermore, tobit regression results revealed that age of the farmers positively affected technical (0.0012, $p<0.10$), allocative (0.0025, $p<0.05$) and economic (0.0023, $p<0.01$) efficiencies of wheat farmers' production in the study area. The sex of the wheat farmers was significant (0.0472, $p<0.05$) and positively affecting wheat farmers technical efficiency. Education of the wheat farmers significantly ($p<0.10$) and negatively affected their technical (-0.0021) inefficiencies, access to extension service was influencing both technical (- 0.0223, $p<0.10$) and economic (- 0.0789, $p<0.10$) inefficiencies negatively. The study concluded that wheat farmers were not fully efficient and more output (24%) could be achieved with the same level of inputs as indicated by the increasing return to scale of 1.197. The study therefore, recommended that concerted efforts should be made towards training farmers on appropriate inputs combination by extension agents to improve and boost wheat production in the study area.

Keywords: Economic, Efficiency, Hadejia, Irrigation, Small-holders, Wheat.

INTRODUCTION

Wheat (*Triticum durum*) is the most widely grown crop in the world, on more than 218 million ha, and approximately 766 million tonnes global production. It world trade is greater than for all other crops combined (Giraldo *et al*., 2019). It is used for both human food (wheat flour) and animal feed (wheat bran) Andres and Saenz (2021). Wheat is one of the three most produced kind of cereals in the world, in addition to rice and corn. Andres and Saenz (2021), Leiva (2022) and Miller (2022). World Wheat production rose to 775.1 million tonnes in the year 2021, and the 2022/23 production season was estimated to be 796.6 million tonnes (FAOSTAT, 2023). The largest producers of wheat in the world in order of production magnitude are: China, India, United States and Russian respectively (FAOSTAT, 2023). Wheat is an important industrial crop, with bread, cake, biscuit, pasta, spaghetti, semolina, Macaroni containing reasonable amounts of wheat. The offal is used in compounding life stock feeds. Wheat is an essential livelihood crop for approximately 2.5 billion poor who daily live on less than 2 US Dollar in countries where wheat is among top three food crops.(FAOSTAT, 2020). In addition wheat also provides substantial amounts of components which are beneficial for health, notably protein, vitamins dietary fiber, and phyto-chemicals (Shewry & Hey, 2015).

The consumption of wheat is increasing globally, even in countries with climates unfavourable for wheat production in spite of low productivity Giraldo *et al*. (2019). Wheat is not a traditional crop in most sub-Saharan Africa (SSA) countries, and its proper cultivation is little known to most farmers, unlike other local crops such as maize, sorghum, millet, rice, cassava and others Tadesse *et al.* (2022). Nigeria is a huge importer of wheat and has depended on imported wheat to meet the growing demands of its large population of about 217 million people Balana *et al.* (2022) and SARCD-SC (2017). In the year 2020 it was reported that over $2.15 billion was spent on wheat importation NBS (2022). Nigeria's wheat production has been so dismal that for decades, the country only managed to produce about 2 % of the wheat consumed. According to Federal Ministry of Agriculture and Rural Development FMARD (2022) the national requirement for wheat is 5.7 million metric tonnes annually while the production is 420,000 metric tonnes. The wheat importation estimate for the 2022/23 marketing year

was put at 6.5 million metric tonnes a 5% increase on the previous year GAIN (2022).
According to GAIN (2022) Wheat consumption is expected to reach 6.06 million tonnes in 2022/23 production year while production was projected at 160,000 tonnes which means the demand deficit of 6.5 million tonnes will be met through importation. The Russia-Ukraine war is raising food prices worldwide, including in Nigeria. The war has disrupted the global food supply chain. NBS (2022) reported that price volatility continued from the beginning of the year and that food inflation stood at 22.02 % in July 2022, representing 1.42 % point increase as compared to 20.6% recorded in June, leading to increases in the prices of bread and cereals, food products, potatoes, yam and other tubers. Milling companies across Nigeria struggle to find alternative sources of imports GAIN (2022). As a result of this, the federal government of Nigeria has resolved its commitment to validate national wheat strategy policy to rejig production. Wheat production in Nigeria is experiencing renewed attention from the government, the African Development Bank, and researchers. The Central Bank of Nigeria through its Anchor Borrowers Program (ABP) is collaborating with the Wheat Farmers Association of Nigeria (WFAN) to extend wheat production from 5 states to 15 states GAIN (2022). In-spite of stakeholders' efforts towards increasing domestic production, while demand for wheat and its derivatives kept increasing, to cater for the shortage in domestic wheat production, two billion dollars is lost annually to wheat importation (NBS, 2022). In the past two decades, more than 70% of the increased cereal production in Sub-Saharan Africa (SSA) is estimated to have resulted from crop area expansion, whereas other regions have achieved 80% of their increased production via yield increases (World Bank, 2016).
Several reports have been put forward on the abysmal performance of the country's domestic wheat production in the midst of it overwhelming market demand for wheat. However, sufficient information on reasons why Nigeria has not been able to meet up her wheat requirement is still scanty. In addition, GAIN (2022) reported that most Nigerian flour mills buy cheaper wheat from Russia, Latvia, and Lithuania to reduce the domestic price of wheat flour and sustain profitability rather than buying home grown wheat. The reasons why imported wheat is cheaper than domestically produce wheat in Nigeria given the natural resources endowment has not been given due attention. Although series of reports have emerged on low yield status of wheat production in Nigeria, reports on economic efficiency of the wheat farmers are inadequate. In the light of the afore-mentioned problems, this study was carried out with the objectives of determining the economic efficiency of the wheat farmers and factors influencing their efficiency in the study Area.

Theoretical framework

Productivity and production efficiency

Production is the process of transforming inputs into outputs. While the term "productivity" refers to the efficiency with which production inputs are transformed to output in a production process. Productivity is a measure of performance (FAO, 2018) which can be expressed as the ratio of output to its inputs. Modern economic theory is based on the assumption of optimizing behavior, either from a producer or a consumer approach. Economic theory assumes that producers are rational and optimize both from a technical and economic perspective: From a technical perspective, producers optimize by not wasting productive resources, from an economic perspective producers optimize by solving allocation problem involving prices. Modern efficiency measurement begins with Farrell work which state that economic efficiency of a firm or a farm consists of two components.

Technical efficiency measures the ability of a farm to obtain maximal output from a given set of inputs (output-oriented measures); or use the minimum feasible amount of inputs to produce a given level of output (input-oriented measures) Nakana *et al.*(2021); Onuche *et* al.(2020); Gela *et al.*(2019)*;* Bhagavath (2009) and Coelli (1996).Allocative efficiency measures the ability of a farm to use inputs in optimal proportions given their respective prices and the production technology Adewuyi and Amurtiya (2021); Degefa *et al.*(2020); Konja *et al.* (2019); Coelli, (1996); Cooper *et al.* (2004). Allocative inefficiency arises when inputs of production are used in a proportion that does not minimise the costs of producing a given level of output (Coelli *et al.*, 2005) Economic efficiency is the product of technical efficiency and allocative efficiency. A firm that is both technical and allocative efficient is said to be an economically efficient firm. Efficiency measurements involve a comparison of actual performance with optimal performance located on relevant frontier.
The stochastic frontier analysis (SFA) model that was independently formulated by Aigner *et al.* (1977) and Meeusen & Van Den Broeck, (1977) Adopted by Konja *et al*, 2019; Kamau, 2019 and Akinbode *et al.* (2011) was adopted for this study. The model is formulated as follow: $Y_i = f(X_i;\beta) + \varepsilon_i$ … (1)

Where i= 1,2 …,n and, Y_i= ith farm output, X_i is the inputs vector for ith farm and β_i are values of unknown parameter of the production function. $\varepsilon_i = V_i + U_i$ represents error term composed of random error (V_i)

which has zero mean and variance $N(0;\sigma^2)$. V_i is associated with measurement errors and factors which a farmer does not have control over, U_i is the other component of ε_i and it is a random non-negative ($U_i \leq 0$)truncated half normal $N(0;\sigma^2)$ variable that hinders a certain farm from achieving maximum output because it is associated with farm factors (inefficiency). Technical efficiency ranges between 0 and 1 and thus expressed as follow:

$$TE_i = Y_i / Y_i^* \quad \ldots \quad (2)$$

Where $Y_i^* = f(X_i;\beta)$ is the highest predicted output from i[th] farm. The TE of the i[th] farm is expressed by the ratio of the observed production output to the highest predicted output (frontier output) Thus

$$TE= Exp(-u_i)= Y_i / Y_1^* = \frac{f(X_i;\beta)expV_i - U_i}{f(X_i;\beta)expV_i} \ldots \quad (3)$$

$$\text{Technical inefficiency} = 1 - TE \quad \ldots \quad (4)$$

The Stochastic frontier cost function model for estimating overall farm level economic efficiency is specified as $C_i = g(Y_{i,} P_{i;} \alpha) + \varepsilon_i \ldots$ (5)

Where i= 1,2,…n , C_i is the overall production cost of wheat per hectare, $Y_{i,}$represent wheat output, Pi represent cost of inputs, α represent a vector of unknown cost function parameters, ε_i is error term formulated as $\varepsilon_i = V_i + U_i$ Positive signs precede the error components because inefficiencies are known to raise production costs (Coelli *et al*.,1998). The farm specific economic efficiency (EE) is defined as the ratio of minimum observed total production cost (C*) to actual total production cost (C)

$$EE = \frac{C_i}{C_i^*} \quad (6)$$

Here EE takes values between 0 and 1.Hence a measure of farm specific allocative efficiency (AE) is obtained from technical and economic efficiencies estimated as:

$$AE = \frac{EE}{TE} \ldots \quad (7)$$

This means that $0 \leq AE \leq 1$

METHODOLOGY

Study Area

The study was carried out in Hadejia Valley irrigation Scheme in Jigawa State, Which is situated in the North Western part of Nigeria, between latitude 11^0N to 13^0N and Longitude 8^0E to 10.15^0E. The State is comprised of 27 Local Government Areas (LGAs) and shares borders with Kano and Katsina to the West, Bauchi State to the East, Yobe State to the North East and International border with Zinder region of the republic of Niger to the North. The state is blessed with large expanse of agricultural land, rivers and flood plains, suitable for crops, livestock and fish production. The major arable crops cultivated during the wet season include; millet, sorghum, cowpea, groundnuts, sesame, rice, maize, sweet potatoes, bambara nuts, water melon, cassava, cotton and okra. Under the dry season irrigation, crops such as tomatoes, pepper, onions, wheat, sugarcane, carrot, cabbage, lettuce, maize and a host of other leafy vegetables are grown (VLS, 2016). The Hadejia valley irrigation scheme is one of the projects under the Hadejia-Jamare River Basin Development Authority. It consist of a barrage with storage capacity of 11.4 million cubic meters of water with its input coming from the water released from the upstream Challawa and Tiga Dams into the river system with north and south main canal, which is completed and operational, it is about 7km long and covers 12500 hectares.

Sampling Procedure

The Population for the study constitutes wheat farmers around Hadejia Valley Irrigation Scheme (HVIS) in Jigawa State. Multi-stages sampling procedure was used to select sample representative wheat farmers for this Study. First stage involved purposive selection of twelve (12) sectors out of the Nineteen sectors under Hadejia Valley Irrigation Project due to concentration of wheat farmers in the sectors. The second stage involves random selection of wheat farmers from each of the sectors. The sectors selected are :Auyakayi, Akubushin, Yamidi, Auyo, Arbanau Hausa, Gamsarka, Zumoni and Adaha , Ganuwar Kuka, Aguza and Furawa. Sampling frame was developed based on information obtained from Hadejia valley irrigation scheme(HVIS) Sectors Site listing Survey of (2021), amounting to 2316 wheat farmers from the 12 selected sectors.

Yamane's formula for determining sample size at 5% error margin and 95% confidence interval was used to determine the sample size of the wheat farmers which is equal to 15% of the sample frame (2316), hence on the last stage 15 % of wheat farmers' in the 12 irrigation sectors were selected proportionately base on their population, which give a total sample size of 346 wheat farmers.

$$N = \frac{N}{1+N(e^2)} \quad (8)$$

where n= Sample size, N= Population of the Study e= error margin

Analytical techniques

Both descriptive and inferential statistics were used to analyzed the data for the study. Descriptive statistics were used to describe the Socio-economic

Characteristics of the wheat farmers and the constraints to wheat production.

The stochastic production frontier approach

The stochastic frontier analysis was used to analyzed data for estimation of technical, allocative and Economic efficiency of wheat farmers. The Cobb Douglas production form was used for this study because of its practicality and ease in the interpretation of its estimated coefficients. This functional form also meets the requirement of being self-dual that is, allowing an examination of economic efficiency following Bashir *et al.*(2023); Alemu *et al*. (2022) ;Senbata *et al*.(2022); Asfaw *et al.* (2019); Konja *et al*. (2019) ; Kamau, (2019); Gela *et al.*(2019) and Akinbode *et al.* (2011). It is specified as follow:

$$lnY_i = \beta_0 + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + .. + \beta_5 lnX_{5i} + \beta_6 lnX_{6i} + V_i - U_i \quad (9)$$

Where ln= Natural Logarithm

Y_i = wheat output (kg) of i[th] farmer per hectare

X_1= Farm land size (ha)

X_2 = seed quantity (kg)

X_3 = fertilizer (kg)

X_4 = herbicides (Litre)

X_5 = pesticides (Litre)

X_6 =Labour (mandays)

Vi = random variable which is assumed to be independently and identically distributed (iid) N(0,σv^2) and independent of U; U_i = non-negative random variable associated with technical inefficiency in production, and is assumed to be independently and identically distributed half normal (iid) N(0, σu^2) where the conditional mean μ is assumed to be related to farm and farmers related socioeconomic characteristics, In order to estimate the economic and allocative efficiency of wheat farmers, a Cobb-Douglas Cost function for wheat farms in Jigawa State is specified as:

$$lnC_i = \alpha_0 + \alpha_1 lnP_{1i} + \alpha_2 lnP_{2i} + \alpha_3 lnP_{3i} + \alpha_4 lnP_{4i} + . + \alpha_6 lnP_{6i} + V_i - U_i \quad (11)$$

where C is the total production cost per hectare ;P_1 is the rental value of land per hectare for the season; P_2 is the wage rate of labor per workday; P_3 is the price of wheat seed per kilogram; P_4 is the price of fertilizer per kilogram; P_5 is the price of pesticide per litre; αs are parameters. The frontier cost function was estimated using maximum likelihood methods. The cost efficiency estimate was generated using Computer software stata 15 and subsequently the allocative efficiency was obtained as inverse of Cost efficiency while the farm level economic efficiency was computed as the product of technical and allocative efficiency.

The factors influencing technical, allocative and economic efficiency of wheat farmers was achieved by analyzing data with Tobit regression analysis following Akinbode *et al.*, 2011; Mburu *et al.*, 2016; Hunde & Abera, 2019; Dessale, 2019 and Kamau, 2019. Tobit regression was used because the efficiency index derived from stochastic frontier analysis is bound to be value between 0 and 1 , thus it is suitable for use to identify the determinant of censured efficiency levels among farmers, the model was censored left for minimum value of efficiency and right censored for the maximum value. The model is thus specified as follow:

$$Y_i^* = \beta_0 + \beta_i w_1 + \beta_2 w_2 + \beta_3 w_3 + \beta_4 w_4 + \beta_5 w_5 + \cdots + \beta_9 w_{9+} \varepsilon_i \quad (12)$$

$Where\ Y_i^*$ = latent score of Technical, Allocative and Economic Efficiency

W_1= Age of farmer in years;

W_2= Sex of farmer (1 if male, 0 if otherwise);

W_3 = Educational level of farmer (number of years spent in school);

W_4= Household Size (Numbers);

W_5 = Years of wheat farming experience (years);

W_6 = Extension contact (1 if the farmer has extension contact, 0 if otherwise);

W_7= Land ownership type (rented =1, 0= not rented);

W_8 = cooperative membership (yes =1, no =0)

W_9 = irrigation method (1= surface irrigation,2= underground irrigation)

RESULTS AND DISCUSSION

The results presented in Table 1 showed that, the minimum and maximum age of the wheat farmers were 20 and 70years, respectively. The mean age of the farmers was 43years, which implies that averagely the farmers were young and capable of bearing the drudgery associated with farm work. This assertion is in tandem with the findings of Lelimo *et al*., (2021) , Getachew *et al*.,(2020) and Konja et al.,(2019) and Milkessa, *et al*., (2019). The results further Showed that 95.01% of the respondents were male while 4.09% were female. It can be deduced that majority (95.01%) of the wheat farmers were male. This is indicating that wheat production in the area is male dominated which may be linked to the socio-cultural and religious belief of the respondents. This assertion is in line with the reports of Getachew *et al*. (2020) ; Hunde and Abera (2019); Dessale (2019); Assefa *et al*.(2019); Tiruneh and Geta (2016). The average years of schooling of the wheat farmers was 6 years and the implication of this result is that, an average wheat farmer in the study area had at least primary education which can influence the attitudes and production decision of the farmers. This assertion is in line with the findings of Getachew *et al.* (2020); Asfaw *et al*.(2019) and Assefa *et al*.(2019).

Results further shows that 5.78% of the wheat farmers were single and have never marry before, 91.62% of the farmers were married, while only 2.60% of the farmers were widower.

Table 1: Distribution of Wheat Farmers by Socio-economic Characteristics (n=364)

Variables	Characteristics	Frequency	Percentage	Mean
Age	20-30	59	17.06	43years
	31-40	78	22.54	
	41-50	133	38.44	
	51-60	61	17.63	
	61-70	15	4.33	
Sex	Male	329	95.01	
	Female	17	4.09	
Education level	No formal education	79	22.83	6 years
	Primary education	171	49.42	
	Secondary education	89	25.72	
	Tertiary education	7	2.03	
Marital status	Single	20	5.78	
	Married	317	91.62	
	Widow	9	2.60	
Household size	1— 10	153	44.22	11 persons
	11—20	165	47.69	
	21—30	26	7.51	
	31—40	2	0.58	
Farm size(ha)	0.1- 0.5ha	249	71.97	0.59ha
	0.6- 1.0ha	74	21.38	
	1.1- 1.5ha	21	6.06	
	1.6- 2.0ha	2	0.59	
Yield per hectare (tons)	0.04-1.0	155	44.5	1.33tons
	1.01-2.0	156	45.1	
	2.01-3.0	29	8.4	
	3.01-4.0	4	1.2	
	4.01-5.0	3	0.8	

Source: Field Survey (2022).

The implication of this result is that majority of the farmers were married, and by extension they have social capital in terms of family support which can aid their productive activities and provide their family need. This assertion is in line with the position of Olutumise *et al*.(2018) ;Konja *et al*.(2019) ; Akinwole *et al*.(2019) and Toluwase *et al*.(2020) that married farmers are more likely to possess large family that can be of assistance in their productive activities. The average household size was 11 persons and the result suggests wheat farmers in the study area have large household size which is capable of supplying or complimenting the necessary labour requirements needed for wheat cultivation. This large family is unconnected to the polygamous nature of the farmers in the study area originating from cultural and religious belief. This view is in consonant with the findings of Kaoje *et al*. (2019) ; Osuafor *et al*.(2020); Kehinde and Efororuku (2020) that reported that large household size provides cheap family labour which reduce the cost of labour in production processes.

The results also shows that the minimum wheat farm size in the study area was 0.2ha and the maximum farm size was 2.0ha while the mean wheat farm size was 0.59ha.This suggests that wheat farmers in the study area were operating on a low scale level which by implication means wheat production is relatively low, thereby resulting to insufficient domestic wheat supply and by extension food insecurity. The finding of this study is in tandem with the report of other studies (Assefa *et al.*,2019; Tiruneh and Geta, 2016) who reported that average land holding for wheat to be 0.98ha

Moreover, the average yield was 1.33 tonnes per hectare. This can be considered as a good yield however, this is low compare to the average yield reported by other authors and studies from other wheat producing countries. For instance Tiruneh and Geta (2016) reported yield of 1.9 tons per hectare. Conversely another study titled analysis of levels and determinants of technical efficiency of wheat producing farmers in Ethiopia carried out by Kelemu and Negatu (2016) reported an average yield of 1.24 tons which is lower to the average yield 1.33tons reported in this study. Similarly, Asfaw *et al* (2019);Hunde and Abera (2019) also reported an average yield of 1.53 tons which is similar to the findings of this study. The reports of other studies indicates that average wheat yield in the study area was low and could be higher.

The result of the maximum likelihood estimates (MLE) presented in table 2. gave values of parameters estimation for frontier model and value of sigma square (σ^2) in addition to log likelihood. Estimates of the stochastic production frontiers model revealed that sigma square (σ^2) value was 0.232 and significant at 1% level of significance, this implies goodness of fit of the model and correctness of the specified assumption of the composite error term distribution (Hunde and Abera, 2019). The estimated value of gamma (γ) which measures the effect of technical efficiency variation in the observed output was 0.568 which indicated that 56.8% of total variation in wheat output was due to technical efficiency variation. It was observed all the coefficients of the variables estimated were positive. The positive coefficient of the variables implies that wheat output increases as these inputs increases. Land allocation (0.577), fertilizer (0.341) and labour (0.078) were found to be statistically significant at 1% level of significance while herbicide (0.174) was significant at 5% level of significance. This implies *ceteris paribus* a 1% increase in land, fertilizer, labour and herbicide will contribute to wheat output by 0.577, 0.341,0.078 and 0.174 percent respectively. This is in agreement with the results of Hunde and Abera(2019) and Dessale *et al* (2019). The result further shows wheat seed and pesticides exert no significant effect on wheat output as indicated by their T-ratio and by implication it means that increasing the use of wheat seed and pesticide will not increase wheat output in the study Area.

Table 2 Maximum Likelihood Estimate of Parameters for Cobb- Douglas Production Function

Variables	Parameter	Coefficients	Standard error
Constants	β_0	4.888***	0.336
Land	β_1	0.577***	0.058
Seed	β_2	0.013	0.045
Fertilizer	β_3	0.341***	0.057
Herbicide	β_4	0.174**	0.062
Pesticide	β_5	0.014	0.091
Labour	β_6	0.078***	0.024
Diagnostic statistics			
Lambda	(λ) $= \frac{\sigma_u}{\sigma_v}$	1.148***	
Sigma Square	(σ^2) $=\sigma u^2 + \sigma v^2$	0.232***	
Gamma	(γ) $= \frac{\sigma u^2}{\sigma 2}$	0.569	
Log Likelihood		-159.72	

Source: Field Survey (2022). *** = p< 0.01, **= p < 0.05 and *= p <0.1

In addition, the return to scale (RTS) analysis which serves as a measure of total resource productivity is presented in Table 3 The return to scale parameter (1.197) is obtained from the summation of the coefficients of the estimated inputs (elasticity) which implies wheat production is in the stage I of the production surface in the study Area. Stage I is the stage of increasing positive return to scale and by implication, this means wheat farmers should make more efforts to increase the scope of wheat production in order to actualized the full potential of production by employing more of the variable inputs to obtain more output where resource use and production are inefficient . In order words a 1% increase in all inputs proportionally would lead to increase in total wheat production by 1.197 %. This result is in tandem with the findings of Getachew *et al*. (2020) who estimated return to scale to be 1.112 in an efficiency study of wheat farmers in North Shewa zone of Ethiopia; Dessale *et al*.(2019) in a study titled technical efficiency of wheat farmers in Jamma district also in Ethiopia estimated RTS be 1.43. In addition to the report of Hunde and Abera (2019) in a study titled Technical Efficiency of Smallholder Farmers Wheat Production: The Case of Debra Libanos District, Oromia National Regional State, Ethiopia estimated return to scale to be 1.147.

Table 3 Production Elasticity and Return to Scale of Wheat Farmers Around Hadejia Valley Irrigation Scheme

Variables	Elasticity
Land	0.577
Seed	0.013
Fertilizer	0.341
Herbicides	0.174
Pesticide	0.014
Labour	0.078
Return to scale	1.197

Source: Field Survey (2022)

The estimates of the stochastic cost function were presented in Table 4. The result revealed that only land and labour have a positive coefficient in conformity with a priori expectation. This implies that as these factors increases so also the total production cost increases *ceteris paribus.* Other variables such as seed price, fertilizer, herbicide and pesticide all had negative coefficient contrary to a priori expectation. This means increasing the use of these inputs does not increase the total cost of production. Although this reality is unexpected, it could be attributed to subsidizing production inputs for farmers or delivery of farm inputs as donations from government functionary to the farmers and other constituents as a means of alleviating poverty. Increasing the usage of such donated inputs does not increase the total cost of production in as much as the farmer does not expend additional money. The T-ratio revealed that seed and land were statistically significant at 5% level of significance while fertilizer was significant at 1% level of significance.

Table 4 Stochastic Cost Function Estimation of Wheat Farmers Around Hadejia Valley Irrigation Scheme

Variables	Parameter	Coefficients	Standard error	T-ratio
Constant	α_0	14.397***	0.834	17.25
Seed price	α_1	-0.230**	0.114	2.01
Fertilizer price	α_2	-0.372***	0.044	-8.29
Herbicide price	α_3	-0.007	0.039	-0.20
Pesticide price	α_4	-0.030	0.019	-1.54
land price	α_5	0.067**	0.027	2.44
labour price	α_6	0.051	0.048	1.06
Sigma Square	$(\sigma^2) = \sigma u^2 + \sigma v^2$	0.396	0.066	5.95
Lambda	$(\lambda) = \frac{\sigma_u}{\sigma_v}$	1.646	0.121	13.50

Source: Field Survey (2022). *** = p<0.01 , **= p<0.05 and *= p<0.1

Efficiency analysis of wheat production revealed that technical inefficiency existed in wheat production in the study area as confirmed by the gamma value 0.569 that is significant at 1% level in Table 2 The gamma (γ) ratio indicate the relative magnitude of variance (σ^2) associated with technical inefficiency effect. The gamma value of 0.569 implies that about 56.9% variations

in output of wheat farms in the study area was due to differences in technical inefficiencies of wheat farmers and the remaining 43.1% was due to factors beyond the control of the farmers. The predicted technical efficiencies (TE) as revealed in Table 5 ranged between 0.47 to 0.90 with the mean technical efficiency 0.76, this result implies that, if the average wheat farmers in the study area was to achieve technical efficiency level of his most efficient counterpart, then the average farmers could achieve 15.5% increase in wheat output derived from (1-0.76/0.90)*100 by improving technical efficiency with the same inputs mix and level of technology.

Table 5 Distribution of Technical, Allocative and Economic Efficiency Levels among the Wheat Farmers

Distribution	Technical efficiency		Allocative efficiency		Economic Efficiency	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.01-0.29	0	0.0	196	56.65	245	70.81
0.30-0.49	4	1.16	104	30.06	93	26.88
0.50-0.69	56	14.74	46	13.29	8	2.31
0.70-0.89	281	82.94	0	0	0	0
0.90-1.00	4	1.16	0	0	0	0
Total	346	100	346	100	346	100
Mean	0.76		0.32		0.24	
Min	0.47		0.07		0.05	
Max	0.90		0.69		0.59	

Source: Field Survey (2022).

Factors affecting technical, allocative and economic efficiency levels of the wheat farmers

Tobit model was used to identify factors affecting technical, allocative and economic efficiencies of wheat farmers in this study. The result in table 6 shows that age of the farmers affected technical (0.0012, p<0.10), allocative (0.0025, p<0.05) and economic (0.0023, p<0.10) efficiencies of wheat farmers' production in the study area. This implies that older farmers were more efficient than younger farmers, probably as a result of their wealth experience in farm management. The predicted marginal effect result further showed that a year increase in the age of the wheat farmers increases the technical, allocative and economic efficiencies by 0.0012, 0.0025 and 0.0023 respectively. This is in line with the findings of Aswaf *et al* (2019); Assefa *et al* (2019); Tiruneh and Geta (2016) and in contrast with the findings of Mahgoub *et al* (2017). The sex of the wheat farmers was significant (0.0472, p<0.05) and positively affecting wheat farmers technical efficiency and this suggests that male wheat farmers were more technically efficient than their female counterparts. The result further revealed that sex of the wheat farmers increases technical efficiency by 0.0472. This result is in tandem with the reports of Seogo and Zahanogo (2021); Degefa *et al* (2020); Tiruneh and Geta (2016).

The result of Tobit regression also showed that education of the wheat farmers significantly (-0.0021, p<0.10) and negatively affected their technical inefficiencies. This shows the importance of education in better decision making and farm management process, it implies that the more educated the farmers are, the less inefficient they become. The marginal effect result further showed that a unit increase in the years of schooling reduces technical inefficiency by -0.0021. The report of other studies corroborates the findings of this study. Adewuyi and Amurtiya (2021) in a study carried out in Adamawa State reported that level of education reduces farmers' technical inefficiency. Onuche *et al.*(2020) in another study in Kogi State also reported that education had a negative influence on farmer technical inefficiency. In addition, Gela *et al.* (2019) also confirmed that education level of sesame farmers significantly influence their technical and allocative efficiencies positively. The coefficients of household size were found to be significantly influencing allocative (-

0.0036, p<0.05) and economic (-0.0031, p<0.01) inefficiencies of the wheat farmers, which implies that as the household size increases the allocative and the economic efficiencies also increases. It implies large farm household is a source of family labour which will reduces cost expended on hired labour. The marginal effect result showed that a unit increase of household size reduces allocative and economic inefficiencies by -0.0036 and -0.0031 respectively. This assertion corresponds with findings of Srinivas *et al*. (2017).

Years of farming experience was significantly affecting allocative (0.0051, p<0.01) and economic (0.0039, p<0.01) efficiencies of the farmers positively. The implication is that experienced farmers were more efficient both allocatively and economically than the inexperience farmers. Marginal effect result showed that as year of farming experience increase the allocative and economic efficiency increases by 0.0051 and 0.0039 respectively. This result is in line with the findings of previous studises; Senbeta *et al*.(2022); Adewuyi and Amurtiya, (2021); Degefa *et al*.(2020). The result further revealed that access to extension service was significantly influencing both technical (p<0.10) and economic (p<0.10) inefficiencies negatively. This implies that farmers with access to extension service were more efficient that those that have no access to extension service. Seogo and Zahanogo (2021); Adewuyi and Amurtiya (2021); Gela *et al.* (2019) all reported the same findings in previous studies. Marginal effect result showed that access to extension services reduces both technical and economic inefficiency by - 0.0223 and - 0.0789 respectively.

Table 6: Factors Affecting Technical, Allocative and Economic Efficiency of the Wheat Farmers

Variables	TE	AE	EE
Constants	0.7165	0.2132	0.1492
	(0.0564)***	(0.0786)***	(0.0638)**
Age	0.0012	0 .0025	0.0023
	(0.0007)*	(0.0010)**	(0.0008)***
Sex	0.0472	-0.0245	-0.0065
	(0.0220)**	(0.0307)	(0.0249)
Education	-0.0021	0.0026	0.0015
	(0.0011)*	(0.0016)	(0.0013)
Household size	-0.0012	-0.0036	-0.0031
	(0.0010)	(0.0014)**	(0.0012)***
Farming experience	- 0.0003	0.0051	0.0039
	(0.0008)	(0.0011)***	(0.0009)***
Cooperative membership	0.0200	0.0223	-0.0249
	(0.0271)	(0.0378)	(0.0307)
Extension service	-0.0223	-0.0895	-0.0789
	(0.0133)*	(0.0186)***	(0.0151)***
Land ownership	- 0.0201	- 0.0075	-0.0085
	(0.0252)	(0.0352)	(0.0285)
Irrigation method	0.0009	0.0046	0.0029
	(0.0075)	(0.0105)	(0.0085)
Prob>Chi^2	0.0799	0.000	0.000
LR TEST	15.43	80.82	83.51

Source: Field Survey(2022). Standard error in parenthesis, directly below coefficient
*** = 1%, ** = 5% * = 10% significance level

CONCLUSION

The study concluded that wheat farmers in the study area were not fully efficient and more output could be achieved with the same level of inputs combination as indicated by the increasing return to scale of 1.197. The prime factors influencing wheat farmers economic efficiency were; age, sex, education, farming experience, access to extension and land ownership and therefore recommended that farmers should be trained by extension agents on the appropriate inputs allocation to attain maximum wheat output potential and policy that will enable farmers to produce wheat on large scale should be formulated by policy makers in other to boost economic prospects in the wheat value chain.

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