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Research Article

Determinants of Welfare Status and Net Farm Income Among Smallholder Sorghum Farmers in North West, Nigeria

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Abstract

This study focused on the determinants of welfare status and net farm income among smallholder sorghum farmers in North West, Nigeria. A multi-stage sampling method was employed to select 140 smallholder sorghum farmers. Primary data were used. The data were analyzed using descriptive and inferential statistics. The results show that the mean age of smallholder sorghum farmers was 47 years. The smallholder sorghum farmers were literate with approximate of 11 years of school education. Approximate 75% of smallholder sorghum farmers were members of cooperative organizations. Averagely, the farm size was estimated at 1.5 hectares, this means they are small-scale farmers. The gross margin and net farm income were calculated at 557 175.35 and 518022.45 Naira per hectare, respectively. This shows that sorghum production is profitable. The total income and expenditure were estimated at 12192714.72 and 476439.76 Naira, respectively. The sorghum farmer household income exchange was calculated at 2.56. Approximate 97 which amounted to 69.29% of smallholder farmers had increased in welfare status from sorghum farming. The age of farmers, level of education, household size, farm experience, farm size, and amount of credit accessed were significantly different from zero in influencing the welfare status of smallholder sorghum farmers. The farm size and labour were significantly different from zero in influencing the net farm income of smallholder sorghum farmers. The study recommends mechanized farming utilizing improved seeds and new farm technologies to increase productivity, income and welfare status.

Keywords: Welfare Status, Net Farm Income, Tobit Regression Model, Sorghum Farmers, North West, Nigeria.

Kuzey Batı, Nijerya'daki Küçük Toprak Sahibi Sorgum Çiftçileri Arasında Refah Durumunun ve Net Çiftlik Gelirinin Belirleyicileri

Öz

Bu çalışma, Kuzey Batı Nijerya'daki küçük sorgum çiftçileri arasındaki refah durumuna ve net çiftlik geliri belirleyicilerine odaklanmıştır. Çok aşamalı bir örnekleme yöntemi kullanılarak 140 küçük ölçekli sorgum çiftçisi ile anket yapılmıştır. Veriler tanımlayıcı ve çıkarımsal istatistikler kullanılar analiz edilmiştir. Sonuçlar, küçük ölçekli sorgum çiftçilerinin yaş ortalamasının 47 olduğunu göstermektedir. Sorgum çiftçileri oku-yazar olup yaklaşık 11 yıl okul eğitimi almışlardır. Küçük sorgum çiftçilerinin yaklaşık %75'I kooperatif kuruluşlarının üyesidir. Ortalama olarak çiftlik büyüklüğünün 1,5 hektar olduğu tahmin edilmiştir, bu durum da işletme ölçeğinin küçük olduğunu göstermektedir. Brüt kar marjı ve net çiftlik geliri hektar başına sırasıyla 557175,35 ve 518022,45 Naira olarak hesaplanmıştır. Bu da sorgum üretiminin karlı olduğunu göstermektedir. Toplam gelir ve giderin sırasıyla 12192714,72 ve 476439,76 Naira olduğu tahmin edilmiştir. Sorgum çiftçisinin hane geliri değişimi 2,56 olarak hesaplanmıştır. Küçük çiftçilerin %69,29'unu oluşturan yaklaşık 97 kişinin sorgum üretimi sayesinde refah durumu arttığı görülmüştür. Çiftçilerin yaşı, eğitim düzeyi, hane büyüklüğü,

çiftlik deneyimi, çiftlik büyüklüğü ve erişilen kredi miktarı, küçük ölçekli sorgum çiftçilerinin refah durumunu etkileme açısından sıfırdan önemli ölçüde farklı bulunmuştur. Çiftlik büyüklüğü ve işgücü, küçük ölçekli sorgum çiftçilerinin net çiftlik gelirini etkileme açısından sıfırdan önemli ölçüde farklı bulunmuştur. Çalışma, üretkenliği, geliri ve refah durumunu artırmak için gelişmiş tohumlardan ve yeni tarım teknolojilerinden yararlanan tarımsal mekanizasyonu önermektedir.
Anahtar Kelimeler: Refah Durumu, Net Çiftlik Geliri, Tobit Regresyon Modeli, Sorgum Çiftçileri, Kuzey Batı, Nijerya

Introduction

Sorghum (*Sorghum bicolor*) ranked fifth as the world major cereal crops after maize wheat, rice, and barley (Naik et al., 2016). Nigeria is the leading producer of sorghum in Africa with 34% followed by Sudan with 21% (Mitaru et al., 2012). Averagely, sorghum constitutes 20% of total cereals produced in Africa (Dube et al., 2014). According to FAO (2024), the output of sorghum in 2021 and 2022 approximates 6.7 million tons and 6.8 million tons, respectively (Figure 1). Similarly, the world output of sorghum in 2021 and 2022 approximates 62.1 million tons and 57.5 million tons, respectively (Figure 2). Also, in Nigeria the sorghum area in 2021 and 2022 approximates 5.9 million hectares and 5.7 million hectares, respectively (Figure 2). Similarly, the world area of sorghum in 2021 and 2022 approximates 41. 6 million hectares and 40.7 million hectares, respectively (FAO, 2024) (Figure 2). Nigeria is the largest producer of sorghum in West Africa accounting for approximately 71 percent of the total regional sorghum output and ranks the second largest producer of sorghum in the world (Tugga et al.,2023). Globally, sorghum serves as staple food for more than 500 million people living in semi-arid, arid lands of Asia and Africa (Teferi,2013). Sorghum is very important industrial crop for brewing alcoholic and non-acoholic drinks, it is also used in baking and confectionary industry. The leaves and grain of sorghum are used for feeding livestock and the stalks are used for thatching houses and making fences (Onuk et al., 2020). Sorghum plays an important role in providing food security in the face of climate change (Mundia et al., 2019). Despite the potentials of sorghum in driving sub-Saharan Africa towards sustainable increase its food reserve, sorghum is under-utilized and the production is still low (Grovermann et al., 2018). Sorghum is one of the drought tolerant cereal crops presently under cultivation and it offers the smallholder farmers the ability to reduce costs on other farm expenses and irrigation (Aduba et al., 2013). It is a crop grown by resource poor farmers in predominantly low rainfall and the crop Is typically produced under harsh conditions such as marginal land and low input use (Alemu and Haji, 2016). The research gap is that sorghum productivity is low, the largest percentage of farming population are small-scale subsistence producers with minimal access to production inputs such as pesticides, fertilizers, improved seeds and inadequate technical know-how (Tugga et al., 2023). According to Baiyegunhi and Fraser (2009), who reported that the Nigerian small-scale producers are characterized with the use of unimproved inputs and traditional production tools that are capable of generating only low level of income. The low income of producers leads to low level of savings and investment, the welfare status and living conditions of farmers is generally low which leads to low productivity and low income. The economic potentials of sorghum have not been fully harnessed in Nigeria and sub-Saharan Africa countries due to a number of production and productivity constraints (Yahaya et al., 2022). According to Ndjeunga et al. (2015) who reported that only 20% of total sorghum production area is planted with improved cultivars in Nigeria. Also, Mundia et al. (2019) documented that the small-scale producers in Africa, Nigeria inclusive use landraces because of poor access to seed of improved cultivars, production technologies and a lack of financial support (Ajeigbe et al., 2018). This study differs from the current and previous study conducted by Tugga et al. (2023) on profitability analysis of sorghum small-scale farmers in selected local governement areas of Gombe State, Nigeria, the gross margin of 187758 Naira was realized per hectare of sorgum farming, the constraints encountered were cost of fertilizer, inadequate capital, cost of labour, inadequate improved seeds, pest and diseases, weed infestation, and inadequate extension workers. The current research study conducted by Yahaya et al. (2022) on sorghum production in Nigeria, opportunities, constraints, and recommendations reported that the farmer percieved constraints to sorghum production across the study zones of Northern Nigeria include, lack of access to production inputs, drought stress, striga infestation, bird damage, lack of access to credit, stem borer pest, and limited agricultural lands. This research study fills the gap that none of the

previous literatures examined determinants of welfare status and net farm income among smallholder sorghum farmers in North West, Nigeria.

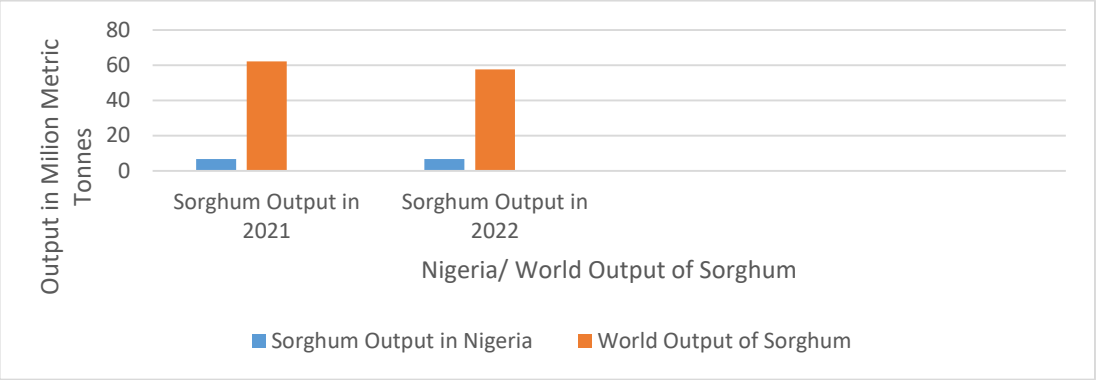

Figure 1. Sorghum Output in Nigeria and the World

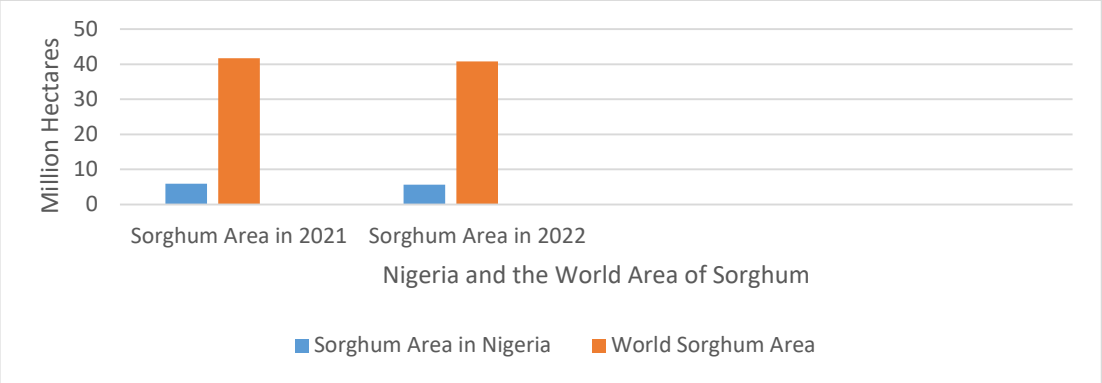

Figure 2: Sorghum Area in Nigeria and the World

Objectives of the Study

The main aim of the study is to evaluate factors influencing the welfare and net farm income among smallholder sorghum farmers in North West, Nigeria. The specific objectives include:

(i) determine the summary information of smallholder sorghum farmers,
(ii)estimate the welfare status and net farm income of sorghum farmers,
(iii)evaluate the predictors influencing welfare status of sorghum farmers, and
(iv)evaluate the predictors influencing net farm income of sorghum farmers.

Materials and Methods

This study was carried out in Kano and Kaduna States, Nigeria. Sorghum (Sorghum bicolor) is widely cultivated in the three agro-ecological zones (Guinea Savanna, Sudan Savanna, and Sahel Savanna) and approximately in the North-Western, North- Central and North East geopolitical zones of Nigeria.For the purpose of this research study, our focus or target location is North West, with an area of 317.5 thousand hectares and production average of 604675 metric tonnes (FMARD, 2018).The North-West is a geopolitical zone that contributes approximately 48% of the Nigeria sorghum production, Kaduna and Kano states are predominantly known for sorghum farming in the North West region (FMARD, 2018). This work utilized the use of a multi-stage sampling method. The multi-stage sampling design was used for a variety of reasons, time efficiency, cost reduction, flexibility, and increase reliability. The multi-stage sampling design is used when you have a large, geographically spread samples and you can obtain a probability sample without a complete list of sample respondents, and obtain a more reliable estimate of population parameters like the mean or proportion, you draw a sample from a population using smaller and smaller groups (units) at each stage. In the first stage, two states were purposively selected. In the second stage, two local government areas in each state were randonmly selected. In the third stage, two villages in each local governement area were randonmly

selected. The sample frame of sorghum producers approximately 215 respondents. In the fourth and final stage, the total sample number of sorghum producers was proportionately and randomly selected which approximately 140 respondents comprising of 70 smallholder sorghum producers each from Kano and Kaduna States, respectively. Primary sources of data were used based on a well-structured questionnaire that was made susceptible to reliability and validity test. This sample number was calculated following the estimated formula of Yamane (1967) as follows:

$$n = \frac{N}{1+N(e^2)} = \frac{215}{1+215(0.05)^2} = 140 \quad (1)$$

Where,
n = The Sample Number
N = The Total Number of Smallholder Sorghum Producers (Number for the 2 States)
e = 5%
The data obtained were analyzed using both inferential and descriptive statistics:

Farm Household Income Exchange

The welfare of smallholder sorghum farmers was estimated following Kuswanto (2019). The income of sorghum farmers comes from sorghum farming and other farming and non-farming agricultural businesses. Mathematically the formula stated is as:

$$Y = Y_{sf} + Y_{of} + Y_{nfa} \quad (2)$$

Where,
Y= Farmers Income (Naira),
Y_{sf}= Income Sorghum Farming Businesses (Naira),
Y_{of}= Income from Other Farming Businesses (Naira), and
Y_{nfa}= Income from Non-Farming Agricultural Businesses (Naira).

The expenditure of the smallholder sorghum farmers can be classified into agricultural expenditure, non-agricultural expenditure and expenditure for consumption in the household.

$$E = E_{sf} + E_{of} + E_{nfa} \quad (3)$$

Where,
E= Farmers Expenditure (Naira),
E_{sf}= Expenditure Sorghum Farming Businesses (Naira),
E_{of}= Expenditure from Other Farming Businesses (Naira), and
E_{nfa}= Expenditure from Non-Farming Agricultural Businesses (Naira).

By comparing the total income received by the smallholder sorghum farmers with the total household expenditure, FHIE was generated as a measure of the level of welfare of sorghum farmers as:

$$FHIE = P_i^* = \frac{Y}{E} \quad (4)$$

Where,
FHIE = Farmer Household Income Exchange (Units),
Y = Total Income (Naira), and
E = Total Expenditure (Naira).
P_i^* = Welfare Index
If FHIE>1 shows that the farmer's household have prospered. However, if FHIE< 1 shows that the farmer's household is not yet prosperous. Thus, farmers FHIE >1 are more likely to meet their consumption and business needs.

Farm Budgetary Technique

Gross Margin Analysis is one of the budgetary technique and it can be defined as the difference between the gross farm income (GFI) and Total Variable Cost (TVC):

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{i=1}^{n} P_j X_j \quad (5)$$

$$GM = TR - TVC \quad (6)$$

Where,
GM = Gross Margin (₦)

TR = Total Revenue (₦)
TVC =Total Variable Cost (₦)
NFI = Gross Margin (GM) – Total Fixed Cost (TFC)

$$NFI = \sum_{i=1}^{n} P_i Q_i - \sum_{i=1}^{n} P_j X_j - K \quad (7)$$

Where
NFI = Net Farm Income (Naira)
GM= Gross Margin (Naira)
P_i = Price of Sorghum Output ith ₦/Kg
Q_i = Quantity of Sorghum Output ith (Kg)
P_j = Price of Input jth (₦/Kg)
X_j = Quantity of Input jth used (Kg/ha)
K = Total Fixed Cost (TFC)

Depreciation of Assets

The straight line depreciation method is specified as:

$$D = \frac{P - S}{N} \quad (8)$$

D= Depreciation of Farm Production Assets (Naira)
P= Purchase Cost of Farm Asset (Naira)
S= Salvage Value of Farm Asset (Naira)
N= Number of Years of the life span of the Farm Asset (Years)

Financial Analysis

The formula of Gross Margin Ratio (GMR) is stated as:

$$GMR = \frac{Gross\ Margin}{Total\ Revenue} = \frac{GM}{TR} \quad (9)$$

The operating ratio (OR) is stated thus:

$$OR = \frac{TVC}{GI} \quad (10)$$

Where, OR= Operating Ratio (Units); TVC= Total Variable Cost (Naira); GI= Gross Income (Naira).
The rate of return invested per naira is stated thus;

$$RORI = \frac{NI}{TC} \quad (11)$$

Where, RORI= Rate of Return per Naira Invested (Units); NI= Net income from Sorghum Production (Naira); TC= Total Cost (Naira).

Tobit Dichotomous Regression Model (TDRM)

The model is explicitly stated as:

$$Y_i = P_i^* = \alpha_0 + \sum_{i=1}^{5} \alpha_i Z_i + \cdots \alpha_n Z_n + \mu_i$$

$$Y_i = P_i^* = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \mu_i \quad (12)$$

$$Y_i = \begin{cases} P_i^*, & if \quad P_i^* > 0 \\ 0, & if \ P_i^* \leq 0 \end{cases}$$

Where,
Y_i = The Dependent Variable, it is Discrete when the households have Higher Welfare Status (Prospered), and Continuous when they have Lower Welfare Status (Not Prospered).
P_i^* = Welfare Index
α_0 = Constant Term
α_1 - α_6 = Regression Coefficients
Z_1 = Age (Years)
Z_2 = Level of Education in Years
Z_3 = Household Size (Number)
Z_4 = Farm Experience (Years)

Z_5 = Farm Size (Ha)
Z_6 = Amount of Credit Accessed (Naira)
μ_i= Noise Term

Multiple Regression Model (MRM)

The multiple regression model (Lead Equation) is stated as:

$$Y_i = \beta_0 + \sum_{i=1}^{5} \beta_i X_i + \cdots \beta_n X_n + \varepsilon_i \quad (13)$$

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_i \quad (14)$$

Where,

$Y_i =$ Net Farm Income (Naira), X_1= Farm Size (Ha), X_2 = Seed Planted (Kg), X_3 = Fertilizer Usage (Kg), X_4 = Labour (Mandays), X_5 = Agrochemicals (Litres), $\beta_0 =$ Constant Term, $\beta_1 - \beta_5 =$ Regression Coefficients, ε_i = Noise Term

Results and Discussion

Summary Details of Smallholder Sorghum Farmers

The summary details of smallholder sorghum farmers are presented in Table 1. The mean age of smallholder sorghum farmers is 47 years. This means that they are young, strong, energetic and resourceful. Averagely, the smallholder farmers had 12 years' experience in sorghum farming. This result agrees with Tugga et al. (2023) who reported that farmers with more years of farming experience have been observed to have higher farm output than those with lesser years of farming experience. The household sizes were large with an average of 7 people per household. They are small-scale farmers who cultivated an average farm size of 1.5 hectares of sorghum farms. Approximate 75% of smallholder sorghum farmers belongs to cooperative organization, while 25% of the respondents do not belong to any cooperative organizations. Membership of cooperatives enables the smallholder sorghum farmers share ideas, information, access credit and sell in bulk the sorghum produce. Furthermore, 85% of smallholder sorghum farmers were male, while 25% of the respondents were female. Approximate 90% (SD = 0.51) of smallholder sorghum farmers were married, while 10% of the respondents were not married. The smallholder sorghum farmers had formal education were literate with an average of 11 years of school education. This means they will be able to adopt innovation and farm technologies to increase productivity, income and welfare. This finding is line with outcomes of Tugga et al. (2023) who reported that 74% of sorghum farmers in Gombe State, Nigeria were members of cooperative organizations.

Table 1. Summary Details of Smallholder Sorghum Farmers

Variables	Unit of Measurement	$\bar{X}_i$	SD
Age	Years	47	12.17
Farming Experience	Years	12	5.21
Household Size	Number	7	2.13
Farm Size	Hectare	1.5	0.56
Member of Cooperatives	1, Member; 0, Otherwise	0.75	0.41
Sex	1, Male; 0, Otherwise	0.85	0.45
Marital Status	1, Married; 0,Otherwise	0.90	0.51
Formal Education	Years	11	3.18

Source: Field Survey (2024)

Analysis of Cost and Returns in Sorghum Production

Analysis of cost and returns in sorghum production is presented in Table 2. The various costs involved and revenue obtained in sorghum production was based on the current market survey. The total variable cost was estimated at 100979.82 Naira (97.09 USD) per hectare and this accounted for 72.06% of total cost. The total fixed cost was estimated at 39152.75 Naira (37.65 USD) per hectare, and this accounted for 27.94% of total cost. The total cost is the addition of total variable cost (TVC) and total fixed cost (TFC), and this was estimated at 140132.57 Naira (134.74 USD) per hectare. The

gross margin and net farm income were evaluated at 557175.35 Naira (535.75 USD) and 518022.45 Naira (498.09 USD), respectively. This means that sorghum production in the area was profitable. The gross margin ratio and rate of return on investment was calculated at 0.846 and 3.69, respectively. The gross margin ratio of 0.846 implies that for every one Naira invested in sorghum production, 85 Kobo covered profits, interest, depreciation, and other expenses (marketing and administrative cost). This can be further explained to mean that the smallholder sorghum farmers retained 85.6% after accounting for the production cost. That implies that 85.6% of each Naira earned contributes to covering other expenses and generating net profit. The rate of return on investment or return per Naira invested in sorghum production was estimated at 3.69. This implies that for every one Naira invested into sorghum production, approximate 3.69 Naira is made as revenue, that is 2.69 Naira is realized as profit. This finding is in line with result of Aduba et al. (2013) who obtained the rate of return on investment of 1.89 among sorghum farmers in Kwara State, Nigeria.

Table 2. The Estimation of Costs and Returns in Sorghum Production

Items	Value (Naira)	Value (USD)	Percentage
Total Variable Cost (TVC)	100 979.82	97.09	72.06
Total Fixed Cost (TFC)	39152.75	37.65	27.94
Total Cost (TFC + TVC)	140132.57	134.74	100.00
Consumed (C) and Gift (G)	138202.78	132.89	
Quantity Sold (QS)	519 952.39	499.95	
Gross Income (QS+C+G)	658155.17	632.84	
Gross Margin	557175.35	535.75	
Net Farm Income	518022.45	498.09	
Gross Margin Ratio	0.846		
Operating Ratio	0.15		
Rate of Return on Investment	3.69		

Source: Field Survey (2024) USD = 1040 Naira

Sorghum Farmer Household Income Exchange (SFHIE) and Welfare of Sorghum Farmers

Results in Table 3 shows that the average income of sorghum farmers from non-farming agricultural businesses amounted to 287538.15 Naira (276.48 USD). Also, the income from other farming businesses were 413714.12 Naira (397.80 USD). The income from sorghum farming businesses was calculated at 518022.45 Naira (498.09 USD). Similarly, the expenditure on non-farming agricultural businesses amounted to 253048.55 Naira (243.31 USD). Furthermore, expenditure on other farming businesses approximate 83258.64 Naira (80.06 USD). The expenditure on sorghum farming businesses approximate 140132.57 Naira (134.74 USD). The total income of sorghum farmers approximates 1219274.72 Naira (1172.38 USD). The total expenditure of sorghum farmers was calculated at 476439.76 Naira (458.12 USD). The farmer household income exchange was 2.56. This outcome is in line with the findings of Mustapha *et al.* (2018).

Table 3. Sorghum Farmer Household Income Exchange (SFHIE)

Description	Value (Naira)	Value (USD)
Income from Non-Farming Agricultural Business	287538.15	276.48
Income from other Farming Business	413714.12	397.80
Income from Sorghum Farming Business	518022.45	498.09
Expenditure on Non-Farming Agricultural Business	253048.55	243.31
Expenditure on Other Farming Business	83258.64	80.06
Expenditure on Sorghum Farming Business	140132.57	134.74
Total Income	1219274.72	1172.38
Total Expenditure	476439.76	458.12

Farmer Household Income Exchange	2.56	

Source: Field Survey (2024) USD = 1040 Naira

Classification of Welfare of Sorghum Farmers

The classifications of welfare of sorghum farmers was presented in Table 4. The classification was done to identify the farming households that have prospered from the sorghum production and the households that were yet to prosper. The result shows that 69% of the smallholder farmers have higher welfare status from the production of sorghum, while only 31% of the sorghum farmers have lower welfare status. This implies that approximate 7 out of every ten-farming household have higher welfare status, while approximate 3 out of every ten-farming household have lower welfare status. This means that sorghum production was a viable enterprise, judging by the percentage of farming households that have prospered with higher welfare status from the cultivation of sorghum.

Table 4. Classification of Welfare of Sorghum Farmers

Description	Frequency	Percentage
Number of Sorghum Farmers Households that have Higher Welfare	97	69.29
Number of Sorghum Farmers Household that have Lower Welfare	43	30.71
Total	140	100.00

Source: Field Survey (2024)

Factors Influencing the Welfare Status of Smallholder Sorghum Farmers

The results of maximum likelihood estimates using Tobit regression model of predictors influencing the welfare status of smallholder sorghum farmers was presented in Table 5. The dependent variable is the welfare status which was categorized as discrete when the households have higher welfare and have prospered, and continuous when they have lower welfare status and were not prospered. Approximate six predictors were significantly different from zero in influencing welfare status of smallholder sorghum farmers. The six significant predictors include age, level of education, household size, farm experience, farm size, and amount of credit accessed. All the coefficients of variables included in the model except household size had positive signs with welfare status of smallholder farmers, and this is in line with a priori expectations. The coefficient of age was measured at 0.2902 which was significantly different from zero at 1% level of probability. The marginal effect was estimated at 0.3817, this means that a 1 unit increase in age of smallholder sorghum farmers, while holding other factors constant would increase welfare by 0.3817 times. The coefficient of level of education was evaluated at 0.2159 and was significantly different from zero at 5% level of probability, while the marginal effect was evaluated at 0.1506, this implies that a 1 unit increase in the level of education of smallholder sorghum farmers, while keeping all other variables constant would increase the welfare status by 0.1506 times. The coefficient of household size was estimated at -0.2401, which was significant at 10% level of probability, the marginal effect was evaluated at -0.3225, this signifies that a 1 unit increase in household size of smallholder sorghum farmers would decrease welfare status by 0.2401 times. In addition, the coefficient of farm expereince was calculated at 0.2319 and was siginifantly different from zero at 5% level of probability. The marginal effect was estimated at 0.2718, this shows that a 1 unit increase in farm expereince of smallholder sorghum farmers, while keeping all other factors constant would increase the welfare status by 0.2718 times. Similarly, the coefficient of farm size was evaluated at 0.2108 and was significantly different from zero at 1% probability level, while the marginal effect was calculated at 0.3914, this means a 1 unit increase in the farm size of smallholder sorghum farmers, while keeping all other variables constant would increase welfare status by 0.3914 times. The coefficient of the amount of credit assessed was estimated at 0.1208 and was significant at 5% level of probability. The marginal effect was evaluated at 0.4209, this means that a 1 unit increase of the amount of credit accessed by smallholder sorghum farmers, while keeping all other factors constant would increase the welfare status by 0.4209 times. The Pseudo R square value was evaluated at 0.8407, this connotes that 84.07% of the welfare status was explained by the stimuli entered in the model. The LLF (The Likelihood Function) (-159.37) is

different significantly from zero at 1% probability level. This implies that the model and data is of good fit.

Table 5. The MLEs (Maximum Likelihood Estimates) of the Tobit Regression Model

Variables	Parameters	Coefficient	Standard Error	t-Value	ME
Constant	α_0	0.4205***	0.1209	3.48	0.0427
Age	α_1	0.2902***	0.0467	6.21	0.3817
Level of Education	α_2	0.2159**	0.0875	2.47	0.1506
Household Size	α_3	-0.2401*	0.1279	-1.88	-0.3255
Farm Experience	α_4	0.2319**	0.1046	2.21	0.2718
Farm Size	α_5	0.2108***	0.0462	4.56	0.3914
Amount of Credit Accessed	α_6	0.1208**	0.0479	2.52	0.4209
Diagnostic Statistics					
Sigma	0.27543				
LR_{χ^2} (6)	94.67***				
Pseudo R^2	0.8407				
LLF (Log Likelihood)	-159.37				
Prob $>_{\chi^2}$	0.00000***				

Source: Field Survey (2024), ME=Marginal Effect
*Significant at ($P < 0.10$)., **Significant at ($P < 0.05$), ***Significant at ($P < 0.01$).

Factors Influencing Net Farm Income of Smallholder Sorghum Farmers

Table 6 presents the factors influencing net farm income of smallholder sorghum farmers. The dependent variable is a continuous variable of net farm income of sorghum farmers measured in Naira. Two predictors were significantly different from zero in influencing net farm income of smallholder sorghum farmers. The two significant predictors include farm size, and labour. All the predictors had positive coefficients. The coefficient of farm size was evaluated at 0.654, and was significantly different from zero at 5% probability level. A 1 unit increase in farm size of smallholder sorghum farmers, while keeping all other variables constant would increase the welfare status (net farm income) by 0.654 times. Similarly, the coefficient of labour is 0.447 and was significantly different from zero at 5% probability level. A 1 unit increase in labour usage, while keeping all other variables constant would increase the welfare status (net farm income) of smallholder sorghum farmers by 0.447 times. The coefficient of multiple determinations (R^2) was evaluated at 0.94, this signifies that 94% of variations in the welfare status was explained by the independent predictors included in the model. The F-value of 432.76 was significantly different from zero at 1 percent probability level. This means that the model is of good fit. This finding is in line with result of Okeyo et al. (2020) who obtained that land size labour, farm gate price, and seed variety were significant predictors influencing output of sorghum in Siaya County Kenya.

Table 6. Multiple Regression Result of Factors Influencing Net Farm Income of Sorghum Farmers

Variables	Parameters	Coefficient	Standard Error	t-Value
Constant	β_0	1.798**	0.659	2.73
Farm Size	β_1	0.654**	0.258	2.53
Seeds	β_2	0.136	0.145	0.94
Fertilizer Usage	β_3	0.327	0.269	1.22
Labour	β_4	0.447**	0.193	2.32
Agrochemicals	β_5	0.135	0.145	0.93
R^2	0.94			
Adjusted R^2	0.92			
F-Value	432.76***			

Source: Field Survey (2024),
*Significant at ($P < 0.10$)., **Significant at ($P < 0.05$), ***Significant at ($P < 0.01$).

Conclusion

This study focused on the determinants of welfare status and net farm income among smallholder sorghum farmers in North West, Nigeria. A multi-stage sampling technique was employed to select 140 smallholder sorghum farmers from total sample frame of 215 respondents. Primary data

were utilized through the use of a well-designed questionnaire. The data were analyzed using descriptive and inferential statistics. The result shows that the average age of smallholder sorghum farmers was 47 years. This implies that they are young, strong, and energetic and can easily adopt innovations and new farm technologies. The average farm size was 1.5 hectares. Approximate 75% of smallholder sorghum farmers belong to cooperative organizations. Also, 90% of smallholder sorghum farmers were married. The average number of years' smallholder sorghum farmers' spent in school education was 11 years. The total variable cost of 100979.82 Naira per hectare accounted for 72.06% of total cost in sorghum production. Similarly, the total fixed cost of 39152.75 Naira accounted for 27.94% of the total cost. The gross margin and net farm income were estimated at 557 175.35 and 518022.45 Naira per hectare, respectively. This means that sorghum production is profitable in the area. The total income and expenditure of smallholder were calculated at 1219274.72 and 476439.76 Naira, respectively. The sorghum farmer household income exchange was estimated at 2.56. Approximate 97 which accounted for 69.29% of smallholder sorghum farmers have higher welfare status and have prospered, while approximate 43 which accounted for 30.71% of smallholder sorghum farmers have lower welfare status and have not prospered. The age of farmers, level of education, household size, farm experience, farm size, and amount of credit accessed were significantly different from zero in influencing the welfare status of smallholder sorghum farmers. Also, the farm size and labour were significantly different from zero in influencing the net farm income of smallholder sorghum farmers. Based on the findings the study suggest that:

(i) Based on the significant variable of farm size, the mechanized farming should be implemented using new farm technologies, also, the improved seed varieties should be given to smallholder sorghum farmers, this will increase productivity, income and welfare

(ii) The amount of credit acessed was significant, this suggets that the government and private organizations should provide credit to smallholder sorghum at low interest rate devoid of cumbersome administrative procedures

(iii) Farm inputs such as agrochemicals, fertilizers, at subsidized price should be provided to smallholder sorghum farmers.

(iv) Extension services should be employed to disseminate new research findings and innovations to farmers.

(v) The level of education was a significant variable in the model, this suggest that the persistent issue of neglecting education could lead to adverse effects on agricultural productivity, hence the welfare of smallholder sorghum farmers. Therefore, it is imperative to increase the investment in education in order to broaden educational opportunities including access to classes, capacity buldings, and traning through agricultural extesnion services. Demonstrating the positive impact of education on agricultural output can significantly enhance the quality and yield of agriculture.

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