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EDITED BY
Henry Bikwibili Tantoh,
University of South Africa, South Africa

REVIEWED BY
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Kwara State University Malete, Nigeria
Olufemi Adesope,
University of Port Harcourt, Nigeria

*CORRESPONDENCE
Sidiqat Aderinoye-Abdulwahab
✉ aderinoye.as@unilorin.edu.ng

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Determinants of food security in Nigeria: Empirical evidence from beneficiaries and non-beneficiaries rice farmers of the Kano River Irrigation Project

Abdulazeez Hudu Wudil[1], Asghar Ali[1], Sidiqat Aderinoye-Abdulwahab[2]*, Hafiz Ali Raza[3], Hafiz Zahid Mehmood[4] and Andrew Borboh Sannoh[1]

[1]Institute of Agricultural and Resource Economics, Faculty of Social Sciences, University of Agriculture, Faisalabad, Pakistan, [2]Department of Agricultural Extension and Rural Development, Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria, [3]Institute of Agricultural Extension, Education and Rural Development, University of Agriculture, Faisalabad, Pakistan, [4]Department of Agribusiness and Applied Economics, University of Agriculture, Multan, Pakistan

Introduction: While the prevalence of hunger decreased globally, it has risen in sub-Saharan Africa in recent years mainly due to rapid population growth, low agricultural productivity, and economic downturns. This study was conducted to examine food security determinants at the household levels among the beneficiaries and non-beneficiaries rice farmers of the Kano river irrigation project in Nigeria.

Methods: Cross-sectional data were used for the analysis while multi-stage sampling technique was used to obtain data from 382 respondents, out of which 217 were project beneficiaries and 165 non-beneficiaries; using a semi-structured questionnaire. Data were analyzed using Household food security index and Logit regression model.

Results and discussion: The results showed that 72.6% of the beneficiaries' households were food secure, against the non-beneficiaries, who had 65.4% food secure households. The findings also revealed that the beneficiaries have 11 and 4% food insecurity depth and severity respectively. Non-beneficiaries, on the other hand, had 17 and 8% food insecurity depth and severity, respectively. Extension contact, farm size, rice output, and educational attainment were the positive determinants of food security. Similarly, determinants that could increase food insecurity identified were; credit constraints and household size. It is recommended that the design of a food security strategy should be multi-dimensional and should encompass social, institutional and economic transformation of small scale farmers. Addressing the identified determinants is also crucial for enhancing the food security status in the study area.

KEYWORDS

agricultural productivity, food security index, unemployment, population explosion, irrigation

1. Introduction

There are four global threats that have significant implications for food security viz; population explosions, global warming, loss of biodiversity and globalization of injustice (Matuschke, 2009). The continent of Africa is not yet on the path to eliminate hunger by 2030 while the prevalence of malnutrition in Africa has risen from 17.6% in 2014 to 19.1% in 2019 (FAO, 2019). Over the years, the question of appropriate food security has remained a critical subject for consideration by many government administrations in Nigeria (Ejikeme, 2017; Osabohien et al., 2020a,b). Small-scale

farmers in Nigeria constituted 90% of Nigeria's agricultural output (Ayinde et al., 2020) while the majority of such farmers are not able to feed themselves and other relatives. The low productivity is mainly as a result of fragmented land holding, over reliance on rain-fed agriculture, climate change, low access to input and poor economic base. Some interventions were developed in Nigeria since independence in 1960 to increase crop productivity, generate employment, and ensure food security. Notable among the interventions were: The Green Revolution, Lower Niger River Basin Development Authority (LNRBDA), Operation Feed the Nation (OFN), and regulatory bodies such as the Directorate of Foods, Roads, and Rural Infrastructure (DFRRI) and National Agricultural and Land Development Authority (NALDA). However, many of these programs failed due to weak institutional foundation, corruption, and poor implementation (Aderinoye-Abdulwahab, 2020).

The alarming rise of food insecurity in Nigeria necessitates prompt action. As much as 21.4% of Nigerian families were experiencing acute food scarcity in 2020 (Osabohien et al., 2020a). Similarly, Erokhin and Gao (2020) reported that 50% of the Nigerian population are living below poverty line of 1.9 USD. The Global Food Security Index (GFSI) rating shows that Nigeria ranked 94th out of 113 nations in 2019 with a 48.4/100 score, which puts the country below Ethiopia, Niger, and Cameroon (Ayinde et al., 2020). In addition, Nigeria has overtaken India as the world's most impoverished country (Ayinde et al., 2020). Otekunrin et al. (2019) and Amzat and Aminu (2020) reported that food insecurity in the country is aggravated by rapid population growth; they predicted that Nigeria's population would grow to 400 million people by 2050. The country therefore needs to check her population growth if food security is to be improved.

The Kano River Irrigation Project (KRIP) is one of the pioneer projects established by the Federal government of Nigeria in 1970 (Ahmad, 2018). The project aimed at increasing food production and productivity, improve the beneficiaries' income, provide employment opportunities and reduce food insecurity (Yusuf et al., 2020). The study purposively used rice farmers for the study because rice is cultivated in more than 70% of the cropped area (Wudil et al., 2021). The crop is also one of the most consumed staples in Nigeria (Uduma et al., 2016; Fawole and Aderinoye-Abdulwahab, 2021) while available statistics showed that Nigerians consume more than seven million metric tons of rice in 2020 (Ihedioha et al., 2021). In recent decades however, insufficient local rice production to meet the local consumption has emerged as a significant food security issue (Seck et al., 2012; Matemilola, 2017). Historically over dependence on rain-fed agriculture coupled with low investments in irrigated rice production, makes the country to rely heavily on rice imports to meet growing demand (Uduma et al., 2016). Previous studies have looked at food security from various angles, including government engagement, climate change, and the demand for food and associated resources for human consumption (Ayinde et al., 2020). This study is thus the first attempt at investigating the project beneficiaries' food security situation in order to ascertain the extent to which Kano River Irrigation Project (KRIP) has achieved its set objectives for ensuring food security when compared with non-beneficiaries. The study therefore attempted to answer the following research questions:

1. What is the food security status of both beneficiaries and non-beneficiaries rice farmers of the Kano River Irrigation Project in the study area?
2. What are the determinants of food security situation of beneficiaries and non- beneficiaries rice farmers in the study area?
3. What is the average Kcal of major food items consumed per beneficiaries and non-beneficiaries rice farmers' households in the study area?

2. Literature review

Subsistent farmers who live in rural environments are rather poor and are not able to meet their basic daily needs for sufficient food in developing countries (Akukwe, 2020). Consequently, Nigeria has been listed among the 55 Low Income Food Deficit (LIFD) countries due to the high prevalence of undernourished people living within agricultural households (Ambali et al., 2015). Food security indices have been measured globally using various indicators such as: per capita expenditure on food, food insecurity access scale, food consumption score, per capita food consumption, share of dietary intake and coping strategy index (Ogundari, 2017). Notwithstanding the extensive studies on food security indicators, there is still not a consensus on the core parameters that are needed to adequately measure household food security situations at both the micro and macro levels around the world (Akukwe, 2020).

Food security and insecurity are two opposing terms used to describe how much access or lack of access to sufficient and nutritious food are available to a population. Food security involves food access, availability, use and sustainability (FAO, 2017); hence, people can be said to be food secured when they are able to get adequate, safe and nutritious diets all year round. Although, majority of the food in-secured are domiciled in developing countries, food security has become an issue of top priority for both developing and developed countries (Mohammed et al., 2021). This is because household food insecurity is responsible for a huge proportion of malnutrition and deaths in developing worlds (Drammeh et al., 2019); hence the emphasis on food security in the sustainable development goals (SDGs). Moreover, evidence has shown that food insecurity is closely related to socio-economic characteristics such as: poverty, low income, employment status, age, household size, level of education among others (Drammeh et al., 2019; Mohammed et al., 2021; Fikire and Zegeye, 2022). In addition, it has been established that an increased level of education can translate into higher level of food security (Mohammed et al., 2021).

The poorest countries of the world are found in Africa while they face chronic poverty and food insecurity (Farzana et al., 2017). In the same vein, these countries are heavily dependent on rain-fed agriculture and this predisposes the region to environmental hazards such as droughts, desertification, erosion and many others. Consequently, countries have had to develop a range of coping mechanisms to either cushion the effect or strengthen their resilience to household food insecurity. Literature has identified diverse coping strategies applied at the household level amongst population affected by natural calamity such as droughts and erosion (Farzana et al., 2017; Drammeh et al., 2019; Mohammed et al., 2021). Of particular reference is the construction of several dam projects to alleviate issues

of droughts and erosion in typical rain-fed agriculture areas of sub-Saharan Africa. Understanding the coping measures that have been put in place at household level in each location is a critical strategy to formulating and implementing appropriate policies that would strengthen food security in those areas.

More farming households would experience severe food insecurity due to the negative impact of the COVID-19 pandemic as enormous challenges are still faced by people with less wealth, lower and more unstable incomes and poorer access to critical basic services (FAO, 2021). The African continent has witnessed the most severe food insecurity while regions such as the Latin America and the Caribbean have not been excluded from the impacts; albeit at a slower pace. The prevalence of food insecurity slightly reduced in Asia between 2020 and 2021. Nonetheless, the pandemic has further amplified the uncertainty characterizing the estimates of the number of people who are affected by food insecurity (Aderinoye-Abdulwahab and Abdulbaki, 2021).

The determinants of food insecurity can be broadly categorized into social, economic, environmental, political and physical factors. Countries have become more food insecure as a result of factors such as: droughts, land degradation, population explosion, lack of productive resources, insufficient assets, poverty and deprivation (Fikire and Zegeye, 2022). Food insecurity has been and remained a public health threat that needs to be addressed in order to reduce environmental hazards and problems of malnutrition, dietary diversity needs and psychological dysfunction (Drammeh et al., 2019). Studies on determinants of food security have been conducted across the world and they range from socio-economic, institutional, environmental, and safety-related perspectives. In focusing on a more precise approach, this study concentrates more on the socio-economic determinants at the household level and economic indicators at the macro level to uncover the determinants of food security among the beneficiaries of KRIP. Whilst Cheema and Abbas (2016) identified that off-farm income significantly impacts household food security positively, Karki et al. (2021) reported that assets possession is an important determinant of food security. In a similar vein, Firdaus et al. (2020) showed a positive association between household food security and socio-economic indices such as: family size, land size and land quality while Fikire and Zegeye (2022) also noted that age is a significant socio-economic consideration in food security index. This is because the older a farmer becomes, the more experience they must have acquired in farm operations and planning; and this will make it easier for them to attain food security. Gundersen and Garasky (2012) had previously asserted that a positive correlation exists between age of household head and food security while food security also increases with increasing income.

Obayelu (2012) in his study on food security situation in northern Nigeria found that only 16% of the households were food secure (FS), 36% food insecure without hunger, 28% FS with moderate hunger and 21% food insecure with severe hunger. His result further revealed that geographical location, food dietary diversity, level of education, occupation of household head, household dependency ratio, social capital and agricultural land-holding size significantly affect households' food security status. Ajayi and Olutumise (2018) found that 43% of their respondents in Ondo State, Nigeria were food secured. The shortfall and surplus indices were found to be 0.13 and 0.20 respectively. Their findings further revealed that experience, education, access to credit, access to extension agent, distance to farm and farm size were the factors that influenced food security in the study area. Akukwe (2020) analyzed food security in agrarian community of south eastern Nigeria where it was shown that majority (53.5%) of the households were food insecure while 46.5% were food secured. The regression coefficients revealed that households headed by unmarried persons with higher level of education and monthly income as well as with fewer dependents were more food secure; while food security decreased with increasing distance to market in southeastern Nigeria. Abdelhedi and Zouari (2020) argued that family farming play a crucial role in the fight against food insecurity in developing countries. They observed that this type of agriculture helps to meet the subsistence needs and generate income for the poor and, on the other hand, contributes to a healthy and balanced diet. Abdelhedi and Zouari (2020) further showed that agricultural value addition positively and significantly impact on food security. Martin-Shields and Stojetz (2019) in their review on the nexus between food security and conflict opined that conflict is the most significant driver of food insecurity in many parts of Africa. Several studies outlined negative correlation between increase in temperature and reduction in rainfall on food security in Africa (Durodola, 2019; Leisner, 2020; Dino Abdula, 2021; Kogo et al., 2021). Climate adaptation strategies such as sustainable watershed management activities, crop diversification, planting of early maturing variety and irrigated agriculture were recommended to assuage the negative impact of weather events on food security (Dino Abdula, 2021).

Household food insecurity has been linked, with a considerable negative correlation, to education level of the households' head, lack of physical assets and absence of female-headed families in Kolkata, India (Maitra and Rao, 2014). Oke (2015) in his study found a negative correlation between food security and population growth in Nigeria. It was also found that increase in productivity; either in terms of a rise in production or expansion of cultivated lands, will positively influence food security at the macro-level (Pieters et al., 2013). Moreover, foreign direct investment in agriculture sector equally has positive impact on food security (Slimane et al., 2016) while it was also observed that the unemployed are 8% and more likely to be food insecure when compared to employed persons.

3. Methods

This section highlights the study area, methods of data collection and the analytical techniques used for data analysis.

3.1. Study area

Kano State is located between latitude 12° 00' 0.43" North of the equator and longitude 8° 31' 0.19" East of Greenwich (Figure 1). The state has about nine million people with 4,957,952 men and 4,453,336 women (National Population Commission (NPC), 2006). Annual growth rate is estimated at 2.27% (Raimi et al., 2020) and this puts the population of the state in 2020 at 13,895,103 people. The project area is situated in a vast area of over 25 km south of Kano city and is one of the functional irrigation schemes in the country. It is designed to provide irrigation facilities to about 22,000 hectares of land utilizing water release from the Tiga dam through the Ruwan Kanya reservoir (Wudil et al., 2021). The scheme operates in three local government areas: Kura, Garum Mallam, and Bunkure. Data for this study were collected from all the three local governments'

areas (LGAs). Due to the lack of baseline data and the limitation of "before and after" approach of not incorporating the counterfactual effect, the study used the "with and without" approach to capture the counterfactual effect.

3.2. Sampling procedure and sample size

The study's respondents included both irrigation project beneficiaries and non-beneficiaries who lived in the same catchment in the study area. Private irrigation schemes that are owned by individuals who can afford were used as non-beneficiaries. With this category of irrigation scheme, farmers use tube-wells and they allow other farmers to use it at a cost. Multi-stage Sampling Procedure (MSP) was employed in assembling data. In the first stage, all three LGAs where the beneficiaries are located were purposively selected due to the presence of irrigated agriculture and high rice production. The second stage of the sampling technique took place at the village level. A visit to the villages in the three project areas-Kura, Bunkure, and Garum Mallam LGAs, was made in order to get a comprehensive picture of the prevailing situation regarding irrigation in the study area. Twenty-four villages were purposively selected for the study, 12 from the irrigation command area and 12 from the non-command site. The 24 villages were purposively selected because of high populations of rice farmers and massive production of rice too. The areas were selected also to ensure an even representation of all towns in the location. The third stage was a proportionate random sampling of rice farmers' beneficiaries (217) and non-beneficiaries (165). Thus, 382 beneficiaries and non-beneficiaries were interviewed as the study's sample size (Table 1). However, out of the 382 interview schedule conducted, only 208 from beneficiaries and 152 from non-beneficiaries were meaningful and were therefore processed for analysis.

3.3. Model specification

3.3.1. Household food security index

The study used the Food Security Index (FSI) and simple statistical techniques. The instrument has been used in Nigeria (Ahungwa et al., 2013); in Ghana (Kuwornu et al., 2013) and in Pakistan (Bashir et al., 2012). It was demonstrated that data on the caloric content of commonly consumed foods were collected using parameters that convert edible portions into calories. The food security indices were constructed and the caloric acceptability was calculated by dividing the calorie supply for the household by the family size adjusted for adult equivalent (Runge-Metzger, 1993). The SPSS Statistical software; version 21 was used to calculate the frequency, mean, standard deviation and other food security metrics (Ahungwa et al., 2013).

$$Z_i = \frac{Household's\ daily\ per\ capita\ calorie\ avaibility\ (A)}{Household's\ daily\ per\ capita\ \ calorie\ requirement\ (R)} \quad (1)$$

Where Z_i denotes the status of ith household food security (Z ≥1 food secure and Z<1 food insecure).

A household is considered a collection of persons living together and consuming from the same pot. The study used the FAO recommended daily caloric intake of 2,700 kcal for an adult aged man (30–60 years) as a benchmark for developing nations (Kidane et al., 2005) and as a criterion for food security status. Using the shortfall/surplus index, P, numerous food security indices were computed based on Z:

$$\mathbf{P_i} = \frac{\mathbf{1}}{\mathbf{M}} \sum_{\mathbf{i=1}}^{\mathbf{M}} \mathbf{GK_i}. \quad (2)$$

Where $\mathbf{P_i}$ denotes the shortfall or surplus index for the ith household,

$\mathbf{GK} = \frac{\mathbf{X_{ki}-I}}{\mathbf{I}}$ = shortage or excess encountered by ith household,

X_{ki} = Mean everyday caloric accessible to the i^{th} household.

M = the magnitude of households that are food secure (excess index) or food insecure (deficit index).

I = the food security line (2,700 kcal/capita/day).

$$\text{The Headcount ratio (H) is given as } H = \frac{\mathbf{1}}{\mathbf{M}}. \quad (3)$$

Where M = the number of food secure or insecure members of the sampled population

N = total population under study.

With this approach, the individuals or households were aggregated into food secure and food insecure populations. Thus, food poverty was regarded as a condition where an individual's or household's consumption falls below an *ex-ante* identified food security line, in this case (2,700 kcal/capita/day).

3.3.2. Logit regression model for determinants of food security

The binary logistic regression methodology has been employed in several agricultural, economic and extension studies that call for the research and prediction of a dichotomous outcome such as fertilizer use or non-use, adoption and non-adoption, participant and non-participant. The logistic probability model (Bogale and Shimelis, 2009) is expressed implicitly as thus;

$$P_i\left(Y = \frac{1}{X_i}\right) = f(Z_i) = \frac{1}{1 + ^{-(\alpha + \beta_i X_i + \varepsilon_i)}} \quad (4)$$

Where

P_i = *probability that a household is food secure in the face of exogenous variables* (X_i) *and* P_i *ranges between 0 and 1*

e = *natural logarithm base*

X_i = *a vector of predictor variables*

α *and* β_i = *the regression factors to be predicted, and*

ε_i = *Random error term*

The model is transcribed in expressions of odds and log of odds for simplicity of presentation of the coefficients. As a result, the odds ratio is the ratio of the likelihood of a home being food secure (Pi) to the likelihood of a household not being food secure (1-Pi).

Thus,

$$e^{z_i} = \frac{P_i}{1 - P_i} \quad (5)$$

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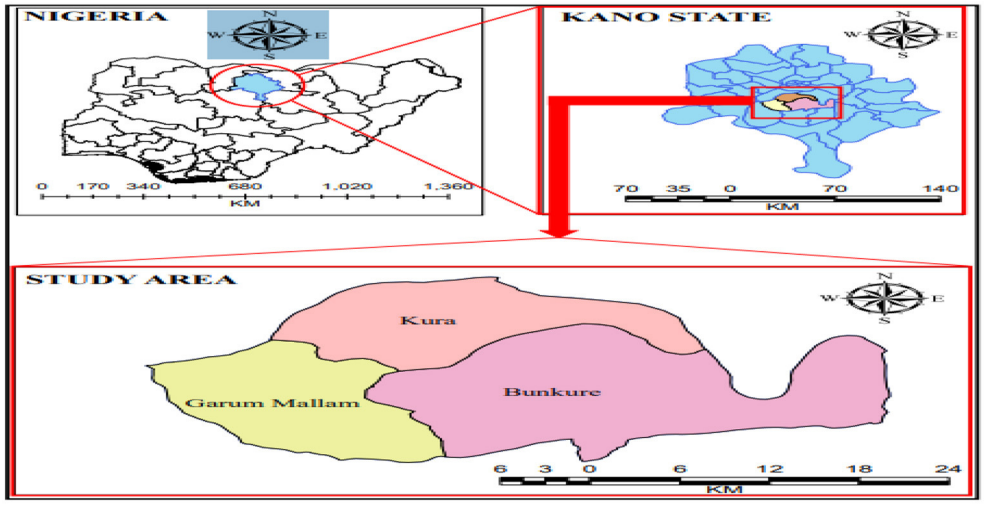

FIGURE 1
Map of the study area. Source: Authors' computation, 2020.

TABLE 1 Sample procedure and sample size.

Local government Area (LGA)	Beneficiaries villages	Sample frame	Sample size (5%)	Non-beneficiaries villages	Sample frame	Sample size 5%
Kura	Karfi	650	28	Gundutse	342	15
	Kura	840	36	Danhassan	397	17
	Bugau	280	12	Kudani	420	18
	Kosawa	590	26	Kosawa	384	17
Garun Mallam	Mudawa	274	12	G/Mallam	164	7
	Chiromawa	337	15	Kwarin bototo	592	26
	Yada kwari	196	8	Garin Babba	174	8
	Kadawa	207	9	Kwanar Gafan	269	11
Bunkure	Bunkure	724	31	Barkun	369	16
	Lautaye	323	14	Kumurya/Daba	228	10
	Gafan	404	17	Karwan Kwari	324	14
	Turba	209	9	Luran	149	6
Total		5,034	217		3,812	165

Source: Authors' computation, 2020.

$$\ln\left(\frac{P_i}{1-p_i}\right) = z_i \tag{6}$$

$$Z_i = \alpha + \sum_{1=0}^{n} \beta_i X_i + \varepsilon_i \tag{7}$$

By introduction of a dichotomous response variable, $Y_i, Y_i = \begin{cases} 1 \text{ if } Y^* > 0 \\ 0 \text{ otherwise} \end{cases}$

Where $1 =$ *food secure*

$0 =$ *food insecure*

$i =$ *number of respondents*

Solving for the probability that $Y = 1$,

Equation (5) can be modified as:

$$\left(\frac{P_i}{1-P_i}\right) = e^{z_i} \tag{8}$$

$$\text{Then, } P_i = \frac{e^{z_i}}{1+e^{z}} \tag{9}$$

4. Results

This section presents the findings of the research objectives under the listed sub-headings.

4.1. Household food security of beneficiaries and non-beneficiaries

The summarized data and food security indices amongst the sampled beneficiaries are presented in Table 2. The results showed that 72.6% of the household beneficiaries were food secure, while 27.4% were food insecure based on the necessary daily calorie intake of 2,700 kcal. The data also revealed that beneficiaries' average per capita calorie intake was 2,274.93 and this is lower than the recommended average of 2,700 Kcal. Food secure households consumed 3,607.63 Kcal on average, which was greater than the recommended mean. Beneficiaries' food insecure households consumed 1,625.81 calories per day which translates to 60% of the recommended national average. The food insecurity gap/surplus Index (P), which evaluates the degree to which families deviate from the food security line, revealed that the secure food home surpassed the necessary average Kcal by 34%. In comparison, the food insecure household fell short by roughly 40%. However, the average household size (adult equivalent) for the project was 10 people while it was about 6–7 persons for the food secured households among them and around 13–14 for those who were food in-secured (Table 2). This further showed that the households that were food in-secure had more dependents to their detriment.

On the food insecurity depth and severity, the project beneficiaries had indexes of 0.11 and 0.04, respectively, meaning that there was 11 and 4% chances of food insecurity occurrence and severity among the beneficiaries (Table 2). The food security indices among the sampled non-beneficiaries showed that 65.36% were food secure while 34.64% were food insecure. The data also revealed that the non-beneficiaries' average per capita calorie intake was 2,697.44 Kcal which is slightly lower than the recommended national average of 2,700 Kcal. The average calorie consumption of food secure households was 3,982.69 Kcal; a value that is greater than the national recommendation. Food insecure households consumed 1,323.72 Kcal, which was only 49% of the recommended national average. The food insecurity gap/surplus Index (P), which evaluates the degree to which families drifted from the food security line revealed that non-beneficiary households were short of food security by a margin of 51%. However, the average number of dependents for the food secured among the non-beneficiaries of the project was 7.96 while that of the food-insecure households was 13.98; bringing the overall average of total dependents of sampled households to 10 dependents.

On the food insecurity depth and severity, the non-beneficiaries had indexes that included 0.17 and 0.08; translating into 17 and 8% chances of food insecurity occurrence and severity respectively. Figure 2 presents a graph of the food insecurity index of the beneficiaries and non-beneficiaries. The chart depicted that all the indexes of the beneficiaries were lower than those of the non-beneficiaries.

4.2. Determinants of household food security status of beneficiaries and non-beneficiaries

The study investigated the factors that influence food security in the study area. The dummy variable (food security status) of rice farmers in the project and non-project areas was taken as the dependent variable. The independent variables used were age, agricultural experience, access to credit, educational status, household size, farming output, extension contact, and annual income. The factors of food security status of KRIP beneficiaries are detailed in Table 3.

The estimated logistic regression model indicated that the statistical parameters that express the goodness of fit of the model for the study were highly significant at 1% probability level. The chi-square (X^2) 115.223 and 108.36 for beneficiaries and non-beneficiaries, respectively, indicated support for the model and implied that the model, including the intercept and the explanatory variables, were within the acceptance region. The Cox and Neglekerke estimate (Table 3) of beneficiaries showed that the model's differences between 42 and 61% variance were attributed to the independent variables' contribution in the analysis. For the non-beneficiaries, the estimated Cox and Neglekerke suggested that between 52 and 69% variance observed in the model attributed to the independent variable included in the model. The 2log-likelihood of 129.706 and 98.5 for the beneficiaries and non-beneficiaries, respectively, further confirmed the validity and reliability of the estimated Cox and Neglekerke indicated that model in explaining the statistical influence of the selected variables.

The variables that were positively related to beneficiaries' household food security status were; extension contact (1.1407), farm size (1.263), farming output (1.145) and educational attainment (1.099) (Table 3). The Exp. (β) in parentheses indicated that 1% increase in each of the variables increases the probability of the household to be food secure by the respective Exp (β) coefficient. The age of the head of the household, household size, and credit constraints had negative coefficients which imply that an increase in any of these will result in a decrease in the level of food security. Furthermore, household size also had a negative significant coefficient of 0.452 and Exp (β) of 0.637.

For the non-beneficiary households, farming experience, farm size and educational attainment were positively and significantly related to food security status. Farm size has Exp (β) of 1.712 while the coefficient of educational status of the respondents was positive and significant at 5% level of probability with Exp (β) of 1.13. Credit constraint (−1.093) and household size (−0.452) were negatively significant at 1%.

4.3. Average Kcal of major food items consumed per household per day

The food security index was calculated based on detailed food items consumed by the households within the week. Food items identified for the estimation were cereals (rice, maize, sorghum, millet, and wheat), root and tubers (cassava, yam, and potato), legumes (cowpea, soybeans), poultry,

TABLE 2 Summary of the food security indices for project beneficiaries and non-beneficiaries.

Food security indices	Project beneficiaries			Project non-beneficiaries		
	Food secure	Food insecure	All	Food secure	Food insecure	All
Percentage of households	72.6	27.4	100	65.36	34.64	100
Number of household	151	57	208	99	53	152
Household size (Adult equivalent)	6.78	13.92	10.35	7.96	14.19	11.08
Food security index (z)						
Mean	1.79	0.72	1.18	2.32	0.61	1.70
Per capita daily calorie availability	3,607.63	1,625.81	2,274.93	3,982.69	1,376.28	2,697.44
Food insecurity gap/Surplus index	+0.34	−0.40			0.49	
Head count ratio	0.73	0.27			0.35	
Food insecurity depth	-	0.11			0.17	
Severity of food insecurity		0.04			0.08	

Source: Field survey, 2020.
FIGR, Food Insecurity Gap Ratio; FID, Food Insecurity Depth.
FIGR, multiplying the head count ratio by the square of the food insecurity gap; FID, multiplying the food insecurity gap by head count ratio.

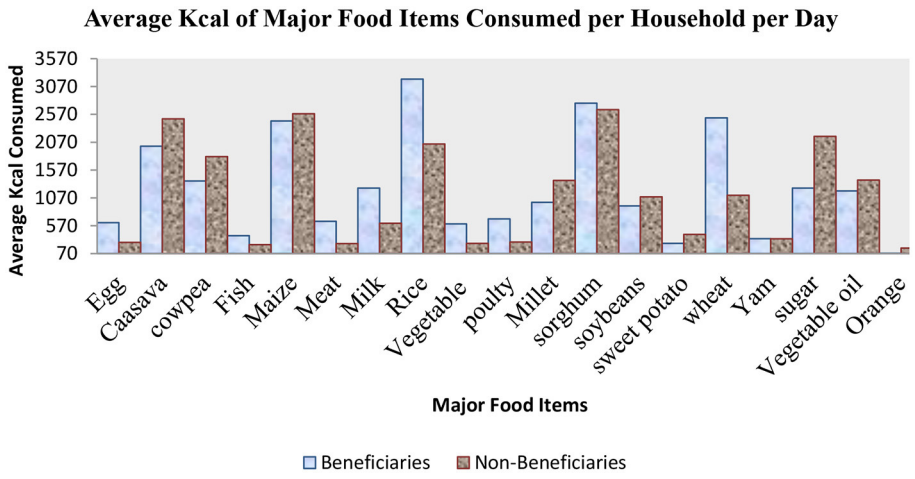

FIGURE 2
Average Kcal of major food item consumed per household per day between beneficiaries and non-beneficiaries. Source, Authors' computation, 2020.

meat, sugar, cooking oil and vegetables. Figure 2 provided information on the major food items consumed by the beneficiaries and non-beneficiaries with the mean Kcal consumed per day.

Figure 2 shows different food groups for households, along with their average Kcal consumption score in the study area. Evidence, as depicted in Figure 2, showed that rice is consumed the most given the amount of kcal consumption per household per day among the beneficiaries. This is followed by sorghum, wheat, and maize respectively; unlike millet which has the lowest amount of kcal consumption and is the least consumed. Among root and tubers, cassava was the highest consumed while the non-beneficiaries consumed sorghum more than other food items as results showed that it had the highest calorie consumption with a mean of 2,654.61 kcal per household. This is followed by maize, cassava, sugar, and rice in terms of consumption pattern of the non-beneficiaries.

5. Discussion

5.1. Household food security of beneficiaries and non-beneficiaries

The finding which indicated a positive relationship between food security and household size is consistent with many empirical studies that affirmed a positive correlation between food insecurity and household size (Jabo et al., 2017). On food insecurity depth and severity, results showed that both beneficiaries and non-beneficiaries were food secured although the project beneficiaries fared relatively better. These results are consistent with other studies where it was reported that 44, 37, and 34% of the households in Lagos, the North Central region and Borno States of Nigeria were food secured (Ahmed and Naphtali, 2014). Similar to these findings, Omotesho et al. (2016) reported that about 67% of households were food secure in Kwara State, Nigeria. Mannaf and Uddin (2012) in their research

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TABLE 3 Determinants of food security status of project beneficiaries and non-beneficiaries.

	Beneficiaries					Non-beneficiaries				
Variables	B	S.E	Wald	Sign	Exp (B)	B	S.E	Wald	Sig	Exp (B)
Constant	1.895	1.724	1.208	0.272	6.651	5.919	2.510	5.560	0.018***	371.995
Age of the farmers	−0.028	0.038	0.549	0.459	0.972	−0.042	0.029	2.039	0.153	0.959
Educational status	0.095	0.048	3.891	0.049**	1.099	0.124	0.050	6.188	0.013***	1.132
Farming experience	0.070	0.034	4.151	0.042**	1.073	0.068	0.032	4.575	0.032**	1.070
Household size	−0.452	0.073	38.483	0.000***	0.637	−1.867	0.541	11.886	0.001***	0.155
Credit constraints	−1.093	0.529	4.263	0.039**	0.335	−1.742	0.630	7.654	0.006***	0.175
Annual income	0.000	0.000	0.380	0.538	1.000	0.000	0.000	2.020	0.155	1.000
Rice output	0.135	0.046	8.502	0.004***	1.145	0.043	0.037	1.305	0.253	1.044
Extension contact	0.342	0.592	0.333	0.564	1.407	0.302	0.690	0.191	0.662	1.352
Farm size	0.234	0.137	2.917	0.088*	1.263	0.537	0.250	4.624	0.032**	1.712
Model statistics										
−2loglikelihood	129.706					98.573				
Cox and snell estimate	0.424					0.512				
Neglekerke estimate	0.614					0.686				
Model chi-square	115.223					108.361				

Source: Field survey, 2020. ***Significant at 1%; **ignificant at 5%; *Significant at 10%.

conducted in the Bogra District, Bangladesh reported that 66.67% of the respondents were equally food secured.

5.2. Determinants of household food security status of beneficiaries and non-beneficiaries

Extension contact, farm size, farming output and educational attainment showed positive inclination to household food security. These findings are consistent with that of Ahmed et al. (2017) who reported that outputs and educational attainments were important productivity variables that played essential role in improving household food security. Ogundari (2017) also reported that farm size plays a vital role in agricultural production, poverty alleviation and food security. The age of the head of the household, household size, and credit constraints had negative coefficients. For example, as credit constraints increases, food security will also decrease. The result further indicated that age has a negative correlation with food security. The negative co-efficient was in line with the a-priori expectation that as the number of dependents in the household increase, food requirements will also increase, and more pressure will be on the already scarce resources. A large household with many dependents has more people to cater for and would be more likely to be food insecure. It has been similarly reported that farmers who struggled to access credits equally found it harder to pay back; these set of farmers were necessarily more prone to being food insecure (Amanullah et al., 2019).

For the non-beneficiary households, farming experience, farm size and educational attainment were positively and significantly related to food security status. This indicates that a 1% increase in the farm size could increase the probability of the household being food secured. This implies that an increase in the level of education can increase the food security status of the farming households. This result was in line with a priori expectation that education has a positive correlation with food security, and this corresponds with the finding of Mohammed et al. (2021) who opined that education was an insulator against food insecurity. Years of farming experience was also positive and statistically significant, indicating that the probability of food security for farming households increases with farming experience.

Credit constraint and household size were negatively significant. This means that food insecurity increases with an increase in any of these variables given their corresponding coefficients; as similarly reported that Pakistan's food insecurity is exacerbated by low production due to credit constraints, lack of financial resources and low incomes (Khan, 2021). The finding was also consistent with the assumption that large sized households will be more prone to food insecurity than small sized ones.

5.3. Average Kcal of major food items consumed per household per day

That rice is the most consumed is not surprising as people in developing countries favor consumption of cereals such as wheat and rice over more coarse cereals like millet. It therefore means that there is an urgent need to increase production of the preferred cereals in order to meet domestic demands. The protein-rich crops like beans and soybeans has higher kcal consumption than meat, fish, eggs, and poultry; probably because they were relatively cheaper since farmers typically produce them on their farms. Among root and tubers, cassava was the highest consumed and this could be

attributed to its simplicity in preparation as it can be boiled and consumed with grinded groundnut cake. This finding is consistent with that of Lawson (2015) who reported that families in Nigeria greatly depend primarily on products from grains and root/tuber crops. The author further claimed that grain provides calories (46%) and proteins (52%) when consumed while root crops/tubers only offer 20% of calories and around 8% of proteins. On the other hand, non-beneficiaries consumed sorghum more than other food items; but this is closely followed by maize, cassava, sugar, and rice in terms of consumption pattern. The high consumption of sugar and cooking oil by both the beneficiaries and non-beneficiaries may probably be due to culture of the people of northern Nigeria or increased incomes or both.

6. Conclusion and recommendations

This study assessed the food security situation of rice farmers in the KRIP with the aim of exploring the determinants of food security among beneficiaries and non-beneficiaries in the project area. Findings showed that 73% of beneficiaries were food secure when compared to 65% of non-beneficiaries. The beneficiaries' food insecurity headcounts, depth, and severity were 0.27, 0.11, and 0.04, respectively, meaning that 27% of the beneficiaries fall below the 2,700 Kcal per person per day food security adult criterion. The chances of food insecurity incidence and severity were 11 and 4%, respectively. For non-beneficiaries, the food insecurity headcount, depth, and severity index were 0.35, 0.17, and 0.8, respectively. The determinants of household food security at the household level were; extension contact, farm size, rice output, educational attainment, credit constraints and household size. Similarly, at the country level, the result showed that unemployment and population increase had an increasing effect on the prevalence of hunger as well as a decreasing effect on the GDP.

The government should emphasize on creation of awareness and motivation for rice farmers to increase their production so that food security can be further enhanced. This is critical to reduction of poverty and food insecurity. Social networking and collaboration among smallholder farmers is also essential so that they can team up to produce a formidable voice to make demands from authorities. Similarly, to eradicate hunger and food insecurity in Nigeria, government and other stakeholders should emphasize on education and training and provision of enabling environment for investors. All of these will reduce unemployment rate and enhance productivity. Findings from this study might serve as a benchmark for future comparisons with other similar projects targeted at attaining food security.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

Ethics statement

The studies involving human participants were reviewed and approved by Faculty of Agriculture Ethics Review Committee, University of Ilorin, Nigeria. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AW and SA-A were responsible for the Introduction and Literature Review sections while AA, HM, and HR handled the methodology and results segments. In addition to producing the manuscript, AS and SA-A proof read the article while SA-A prepared it for submission. All authors collectively worked to produce this manuscript and contributed to the discussion of the findings. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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