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EFFECTS OF RISK ATTITUDE ON THE TECHNICAL EFFICIENCY OF SMALL-HOLDER RICE FARMERS IN OGUN STATE, NIGERIA

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Abstract. The growth and development of the agricultural sector in developing countries is largely dependent on technological enhancements, because merely expanding the area of farm cultivation is no longer sufficient to meet the increasing food needs of growing populations. This study examined the effects of risk attitudes on the technical efficiency of small-holder rice farmers in Ogun State, Nigeria. Primary data were collected for the study using a multi-stage sampling technique, and 180 rice farmers were selected from the study area. The data were analyzed with descriptive statistics, stochastic frontier analysis and a simple lottery-choice experiment. The findings revealed that 36.1% of the farmers were between the ages of 31 and 40. Farmers who were 41 years and over were seen to be more risk averse than their younger counterparts. In this age group, 76.66% of rice farmers were risk averse, while 23.34% were risk tolerant. The result of the maximum likelihood estimate (MLE) of the parameters of the stochastic frontier analysis revealed that farm size positively and significantly influenced rice output ($\beta = 0.16$, $p < 0.1$), as did quantity of seed ($\beta = 0.74$, $p < 0.01$) and use of chemicals ($\beta = 0.26$, $p < 0.01$). Years of farming had a negative effect on technical efficiency ($\beta = 0.64$, $p < 0.01$), as did severe risk aversion ($\beta = 0.57$, $p < 0.1$). The study concludes that small-holder farmers are generally risk averse, negatively influencing technical efficiency in the study area. The study recommends that the design of government programs should incorporate farmers' risk attitudes as an important variable.

Keywords: Risk attitude, technical efficiency, stochastic frontier, rice

INTRODUCTION

The world population is predicted to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100 (United Nations, 2017). The world needs more food than ever before to sustain the increasing number of people living in poverty and extreme hunger, especially in Africa. The capacity of many developing countries to escape poverty traps will depend on the growth and development of the agricultural sector (Osabohien et al., 2019). Agricultural growth and development are not possible without yield-enhancing technologies, because merely expanding the area under cultivation to meet the increasing food needs of growing populations is no longer sufficient (Pawlak and Kołodziejczak, 2020). Increasing production and productivity is critical to achieving sustainable development goals (SDGs). However, given limited agricultural resources like arable land, it will be difficult to increase production. Thus, the yields of major staple crops such as rice need to be improved to ensure better food security.

Risk plays an important role in almost every production process, especially in agricultural production, affecting both input use decisions and the production of outputs (Kumbhakar, 2002). In the context of agriculture, a risk can be defined as a situation where producers cannot predict with certainty the output their production process will yield due to external factors such as

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weather, pests, and diseases (World Bank, 2005). Risk can also be defined as the imperfect knowledge where the probabilities of the possible outcomes are known (Hardaker et al., 2004). To understand farmer's risk behavior, it is important to understand their attitudes towards and perceptions of risk. A farmer's risk attitude is a unique reflection of their personality, usually influenced by socio-economic factors and life experiences, and risk attitude influences how a farmer manages a farm business (Bard and Berry, 2000). Farmers can be classified as risk averse, i.e., those farmers who try to avoid taking risks, risk tolerant, i.e., those who are open to taking risks or risk neutral, i.e., those who are neither risk averse nor risk tolerant (FAO, 2008).

Rice is becoming one of the most important food crops on the African continent (CARI, 2018). According to the USDA (2016), the annual consumption of rice in Nigeria was about 5 million metric tons, while the quantity supplied was 2.7 million metric tons, with a demand-supply gap of about 2.3 million metric tons, which is currently filled by imports (Obih and Baiyegunhi, 2017). The low productivity of rice farmers in Nigeria is caused by the use of technologically limited agricultural equipment which does not support large-scale production. For instance, Fasoyiro and Taiwo (2012) observed that in Nigeria, rice is mainly produced by small-holder farmers whose production is characterized by low output resulting from production inefficiency, an aging farming population, low technological know-how, and other factors.

Most countries in Africa are yet to meet the criteria for a successful agricultural revolution, and factor productivity lags far behind the rest of the world (Babatunde et al., 2010). Given limited agricultural resources like arable land, it will be difficult to increase production, so the situation calls for an improvement in the yields of major staple crops to ensure better food security. One issue to be considered is that most government programs are designed without consideration of farmers' characteristics – for example, their risk preferences (Olarinde et al., 2007). Agricultural production is characterized by risks ranging from adverse weather to pests and disease, which can in turn lead to price uncertainty (Ayinde et al., 2008). For these reasons, farmers' risk attitudes are imperative in understanding their adoption of new technology and their managerial decisions (Ayinde et al., 2008). For example, the more risk averse a farmer, the more likely they are to make managerial decisions that emphasize the goal of reducing variation in income rather than the goal of maximizing income; the converse is also true (FAO, 2008).

Numerous studies (Obwona, 2006; Ogundele and Okoruwa, 2006; Tijani, 2006; Alhassan, 2008; Nwaru and Iheke, 2010; Onoja and Achike, 2010) have attempted to determine the technical efficiency of farmers in developing countries including Nigeria, because determining the efficiency of farmers is important for policy purposes. Binam et al. (2004), Tan et al. (2010), Akongo (2016) and Tong et al. (2018) have examined the effects of climate-smart agricultural practices and risk attitudes on the technical efficiency of farmers in some parts of Asia and Africa. However, very few studies have taken into account the effects of risk attitude on technical efficiency. In this study, rice farmers' attitudes towards risk-taking are assumed to be an important factor that will influence their efficiency.

THEORETICAL REVIEW

The principal theory that is used to guide decision-making under risk is subjective expected utility theory (SEU). The chances of bad or good outcomes can only be evaluated and compared if the decision maker's relative preferences for such outcomes are known. According to the subjective expected utility (SEU) hypothesis, the decision maker's utility function reflects his or her attitude towards risk (Anderson et al., 1977). Although expected utility theory has come under criticism (Rabin and Thaler, 2001; Allais, 1984; Rabin, 2000), the SEU hypothesis nevertheless remains the most appropriate theory for the prescriptive assessment of risky choices (Hardaker et al., 2004; Meyer, 2001). SEU was selected for this study based on the fact that the theory is more appropriate for the assessment of risk choices.

In terms of utility frameworks, risk aversion can be measured by partial risk aversion, which is fixed regardless of the level of payoff (Menezes and Hanson, 1970; Zeckhauser and Keeler, 1970). Let W stand for final wealth which consist of initial wealth (ϕ) and the certainty equivalent of the prospect of new wealth M,

$$W = \phi + M \tag{1}$$

An individual's utility function is given by, $U(W) = U(\phi + M)$.

From the utility function, relative risk aversion (RRA) can be defined. Relative risk aversion traces the behaviour of an individual in relation to both their initial wealth ϕ and the size of the prospect *M* (Binswanger, 1981). The measure of relative risk aversion is expressed as:

$$RRA = -W\frac{U''}{U'} = WQ \qquad (2)$$

where *Q* represents absolute risk aversion (Pratt, 1964). *U*' and *U*'' are the first and second derivatives of the utility function.

Evaluating RRA at the point (ϕ + *M)*, this becomes:

$$RRA = (\phi + M)\,Q \qquad (3)$$

The partial relative risk aversion (PRRA) was proposed by Menezes and Hanson (1970) and Zeckhauser and Keeler (1970), following RRA. Partial risk aversion (PRA) traces the behaviour of an individual when the scale of the prospect *M* changes by a certain factor but their wealth ϕ remains the same (Binswanger, 1981). Partial risk aversion, *S*, is given by:

$$S(W+M) = -M\,\frac{U''(W+M)}{U'(W+M)} \qquad (4)$$

where *W* is certain wealth and *M* is the certainty equivalent of a new prospect. A risk-averse individual would have increasing partial risk aversion for increases in the prospect *M* (Menezes and Hanson, 1970; Miyata, 2003). For the game used in this study, each risk aversion category corresponds to an interval of partial risk aversion (*S*). The wealth (*W*) and the certainty equivalent of a new prospect (*M*) were provided (Jirgi et al., 2016).

METHODOLOGY

Study area

The study was carried out in Ogun State, which has been identified as one of the states of Nigeria with a comparative advantage in rice production (FMAWR, 2008). Other states include Anambra, Bayelsa, Benue, Delta, Ebonyi, Edo, Kebbi, Kogi, Kwara, Niger, Rivers and Taraba. Ogun State is bounded to the West by the Republic of Benin, to the South by Lagos State and the Atlantic Ocean, to the North by Oyo and Osun States, and to the East by Ondo State. It lies within latitudes 6°N and 8°N and longitudes 3°E and 5°E. Ogun State, with 20 LGAs, is divided into 4 agricultural zones, namely Egba, Yewa, Ijebu and Remo zones, under the three existing Senatorial zones of Ogun West, Ogun Central and Ogun East. Ogun State has a large expanse of arable land where food crops such as rice, cassava, yam, cocoyam and maize are cultivated. It has a tropical climate with a rainy season from March to November and a dry season from December to February. The temperature range is 27°C to 32°C and the average temperature is about 31°C. The humidity is about 95% and the average annual rainfall is 192mm. Obafemi Owode ranks highest among the three major rice-producing Local Government Areas (LGAs) in Ogun State, with a high tonnage of cultivated rice. It specializes in a variety popularly known as Ofada rice, which is largely consumed in many households in Ogun State and its environs. The two other rice-producing LGAs, in order of production capacity, are Ogun Waterside and Yewa North (Ologbon et al., 2018).

Sampling technique and sample size

For the cross-sectional survey of rice farmers, this study made use of the Ogun State Agricultural Development Programme (OGADEP) division of Ogun State to sample respondent farmers. The OGADEP divides Ogun State into four agricultural zones, namely Abeokuta, Ijebu-Ode, Ilaro and Ikenne, as seen in Figure 1. The various zones are divided into blocks, while the blocks are further divided into cells (Afolami, 2002). A multi-stage sampling technique was used in this study to select 180 rice farmers; the first stage involved the purposive selection of two (2) zones among the OGADEP zones due to high levels of rice production in these areas. The zones selected were Ilaro and Ikenne. The second stage involved the random selection of three blocks from each of the two zones, making a total of six blocks selected. The third stage involved the random selection of three cells from each of the six selected blocks, making a total of eighteen cells. The fourth stage involved the random selection of two villages from each of the eighteen selected cells, making a total of thirty-six villages. The last stage involved the random selection of five farmers from each of the thirty-six randomly selected villages, making a total of 180 respondent farmers.

Analytical techniques

Simple lottery-choice experiment

A simple lottery-choice experiment approach that allowed the measurement of the degree of risk aversion over a wide range of payoffs was used in this study. The

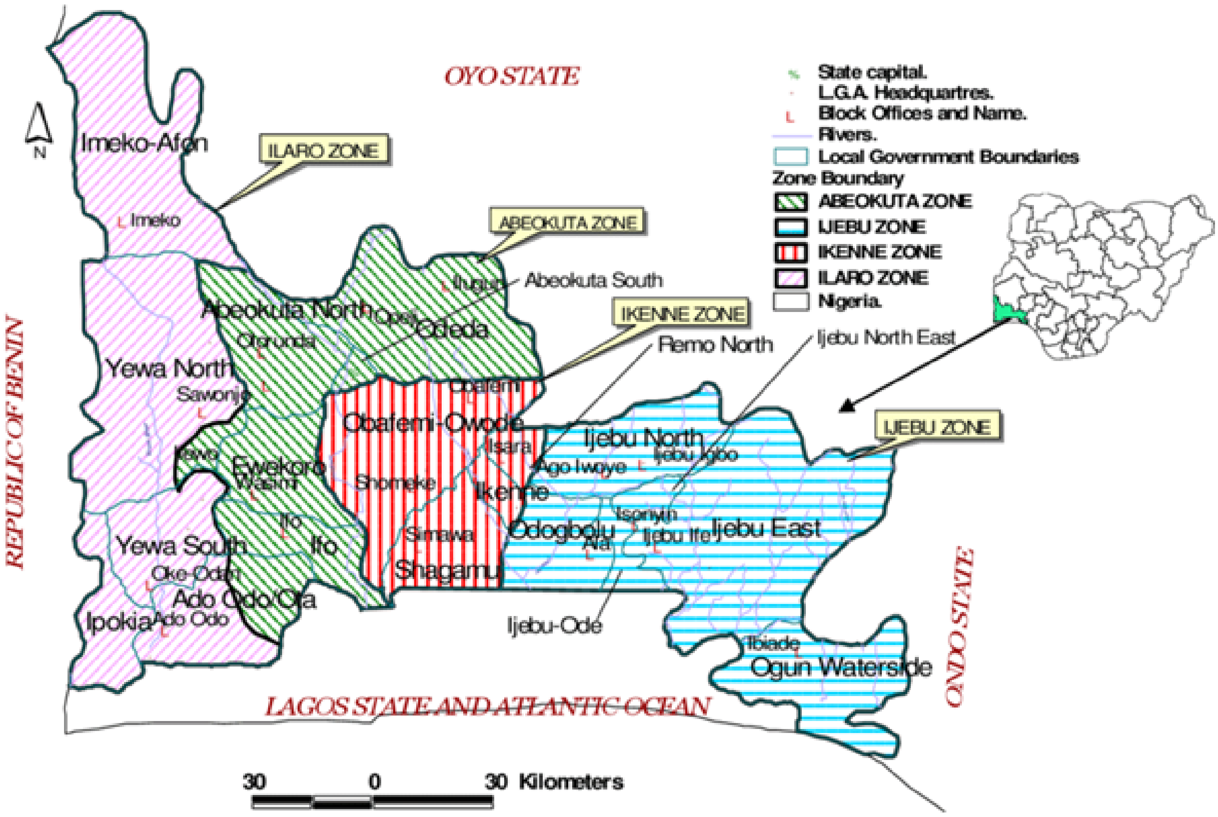

Fig. 1. Map of Ogun State showing the Ogun State Agricultural Development Programme (OGADEP) zones and blocks
Source: Olaoye et al., 2011.

approach is similar to that used to collect lottery-choice data in a field experiment by Binswanger (1980). The lottery-choice procedure was used by Yesuf (2007), Kouamé (2010), and Miyata (2011) and more recently by Jirgi et al. (2016). In the experiments, respondents were presented with a set of alternative prospects involving hypothetical payments.

The payoffs varied from very low levels to high levels. It was, however, believed that the payoffs would provide an incentive for respondents to reveal their true preferences. The respondents' choices between the given alternative prospects were taken as an indication or sign of their degree of risk aversion. This experiment was administered as part of the questionnaire undertaken by the sampled farmers in the study area. In this experiment, each subject was offered a series of choices from sets of alternative risky prospects, such as the set presented in Table 1. The game listed six prospects, each with a 50% probability of winning. Each respondent was asked to choose his or her preferred alternative from the six prospects: A, B, C, D, E or F. The risk aversion coefficients of the respondents were calculated using a constant partial risk aversion (CPR)

Table 1. Hypothetical money payment table (₦)

	Amounts to be won if	
game 1	heads	tail
A	5,000	5,000
B	4,500	9,500
C	3,000	12,000
D	2,000	15,000
E	1,000	19,000
F	0	20,000

Source: Jirgi et al., 2016.

Table 2. Classification of risk aversion coefficients of respondents

Choices	Bad outcome “Heads” (₦)	Good outcome “Tails” (₦)	Expected gain (₦)	Standard deviation or spread	S = Approximate partial risk aversion coefficient	Risk classification
A	5,000	5,000	5,000	0	∞ to 7.51	extreme
B	4,500	9,500	7,000	3 535.534	7.51 to 1.77	severe
C	3,000	12,000	8,000	5 656.854	1.77 to 0.84	intermediate
D	2,000	15,000	9,000	8 485.281	0.84 to 0	moderate
E	1,000	19,000	10,000	12 727.92		inefficient
F	0	20,000	10,000	14 142.14	0 to –∞	neutral to preferring

Source: Binswanger, 1980; Jirgi et al., 2016.

utility function of the form $U = (S – 1) M^{1-S}$, where S is the coefficient of risk aversion, and M is the certainty equivalent of a prospect. The partial risk aversion coefficients were computed for each indifference point (CE) at each game scale, as shown in Table 2.

From Table 2, it can be seen that alternative A was the safest alternative in this game. An individual who chose alternative A would simply get ₦5000, whether he got heads or tails with the flip of a coin, i.e., participation in the game would result in an automatic and certain increase in wealth of ₦5000. If the individual chose alternative B instead of A, his or her expected gain would increase by ₦2000, but bad luck (heads) would give him or her ₦500 less than the person who had chosen the safe alternative A. This means that if the respondent chose B instead of A, the standard deviation in gain increased from 0 to ₦3,535.534. The same explanation holds for the successive alternatives, B to C, C to D, and D to E: the expected gain increases, and so does the spread between the two outcomes. Alternatives E and F had the same expected gain, but alternative F had a larger spread.

According to Kouamé (2010), when risk is viewed in terms of uncertainty in gains, income or wealth, as in utility-based choice theories, the alternatives involve more risk the further down you go in the table above (Jirgi et al., 2016). The degree of concavity of an individual’s utility function determines the choice the individual will make. The classification of the different prospects, from extreme risk aversion (alternative A) to neutrality to high risk tolerance (alternative F), is the same as the one used by Binswanger (1980), Miyata (2011) and Jirgi et al. (2016). The intervals of the partial risk aversion (S) derived above correspond to the risk aversion class, and the risk aversion classes were used as explanatory variables in the technical efficiency model.

Stochastic frontier analysis

Technical efficiency (TE) is defined as a firm’s ability to produce maximum output given a set of inputs and technology, or alternatively, technical inefficiency reflects a failure to attain the highest possible level of output with a given set of inputs and technology (Funaab Raaf Pasanao, 2017). The Stochastic Production Function was used to determine the technical efficiency of rice farmers in the study area. This was used to specify the relationship between the output and input level of the rice farmers using two error terms. One error term was the traditional error term in which the mean is zero and the variance is constant; the other represented technical inefficiency. The stochastic frontier production function assumes the presence of technical inefficiency of production (Battese and Coelli, 1995). Thus, for this study the stochastic frontier production function was employed. It was adapted from Salau et al. (2012) and Lema and Tessema (2017). Hence, the function was defined as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_1 – U_1 \quad (5)$$

where:

ln – natural logarithm,

Y – total rice yield of the farmer (kg/ha),

β_s – the parameters to be estimated,

X_1 – farm size (hectares),
X_2 – labor used per hectare (man-days),
X_3 – quantity of seeds planted (kg),
X_4 – quantity of inorganic fertilizer applied (kg),
X_5 – chemicals (pesticides and herbicides) in litres,
V_i – random errors which are assumed to be independently and identically distributed,
U_i – non negative random variable associated with technical inefficiency of production.

The inefficiency of production was modelled in terms of the factors that are assumed to affect the efficiency of the rice farmers. Such factors are assumed to be independently distributed such that U_1 is obtained by truncation (at zero) of the normal distribution with variance σ^2 and mean u where the mean is defined by

$$U_1 = \sigma_0 + \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 + \sigma_4 Z_4 + \sigma_5 Z_5 + \sigma_6 Z_6 + \sigma_7 Z_7 \ldots + \sigma_{13} Z_{13} + e \quad (6)$$

where:
U_1 – technical inefficiency,
σ – a vector of unknown parameters to be estimated,
e – error term,
Z_1 – age of farmers in years,
Z_2 – education level (number of years spent in school),
Z_3 – household size (number of members living together in a house),
Z_4 – number of years of farming experience in rice production,
Z_5 – membership of coop society (1, if farmer is a member, 0 otherwise),
Z_6 – access to credit (1 if yes, 0 otherwise),
Z_7 – extension contact (1 if yes, 0 otherwise),
Z_8 – planting system (1, if upland, 0 otherwise),
Z_9 – severely risk averse (1, if farmer picks and 0, if otherwise),
Z_{10} – very risk averse (1, if farmer picks and 0, if otherwise),
Z_{11} – moderately risk averse (1, if farmer picks and 0, if otherwise),
Z_{12} – neutral to preferring risk averse (1, if farmer picks and 0, if otherwise),
Z_{13} – risk loving (1, if farmer picks and 0, if otherwise).

The extremely risk averse variable was used as the base variable to avoid the dummy trap, hence it was dropped from the analysis.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

The description of the socio-economic characteristics of the respondent rice farmers in the study area is presented in Table 3. The results reveal that farming was the main

Table 3. Socio-economic characteristics of respondents

Variable	Frequency	Relative frequency (percentage)	Mean	Standard deviation
Main economic activity				
Farming	127	70.56		
Trading	32	17.78		
Civil-servant	14	7.78		
Artisan	6	3.33		
Others	1	0.56		
Total	180	100.00		
Age range (years)				
≤30	33	18.33	41.78	12.00
31–40	65	36.11		
41–50	41	22.78		
51–60	28	15.56		
>61	13	7.22		
Total	180	100.00		
Farming experience (years)				
≤10	116	64.44	13.98	13.52
11–20	21	11.67		
21–30	19	10.56		
31–40	12	6.67		
>40	12	6.67		
Total	180	100.00		
Area cultivated (ha)				
≤3	124	68.89	3.12	2.90
3.1–6	43	23.89		
6.1–10	11	6.11		
>10	2	1.11		
Total	180	100.00		

economic activity of the majority (70.6%) of the rice farmers, 36.11% of the rice farmers were between the ages of 31 and 40 years, 64.44% of the rice farmers had less than 10 years' farming experience, and 68.89% of the rice farmers cultivated between 0 and 3 hectares of land.

Risk attitude classification of small-holder rice farmers

The risk attitude classification for rice farmers in Table 4 reveals that 26.7% of the rice farmers were extremely risk averse, 28.3% were severely risk averse, 12.2% were very risk averse, 9.4% were moderately risk averse, 13.3% were slightly to neutrally risk averse and 10.0% were neutral to risk tolerant or risk tolerant. Overall, 76.7% of the rice farmers were risk averse while 23.3% were risk tolerant. These results agree with those of previous studies, such as Jin et al. (2015), Jirgi et al. (2016) and Tong et al. (2018), that found more than a quarter of farmers to be highly or extremely risk averse. Tong et al. (2018) asserted that most farmers were generally risk averse and this is a result of many factors. For example, Cassio et al. (2010) demonstrated that lower cognitive ability is associated with greater risk aversion. Furthermore, a number of studies have revealed the relationship between risk attitude and age, education, subjective beliefs, or even behavioral context (Harrison et al., 2007; Menapace et al., 2012).

The classification of risk attitude by age range is shown in table 5. 24.2% of the farmers ≤30 years were severely risk averse, while 6% were very risk averse. For the age range 31–40 years, 21.5% of the farmers were severely risk averse and 21.5% were risk tolerant, while 3% were moderately risk averse. In the age range 41–50 years, 26.8% of the farmers were extremely risk averse while a mere 2.4% (representing just 1 respondent in that age range) were risk tolerant. For the age range 51–60 years, 39.2% of the farmers were moderately risk averse while 0% were risk tolerant and 10.7% were slightly to neutrally risk averse (representing just 3 farmers). And finally, for the age range >61 years, 46.1% (representing just 6 farmers) were severely risk averse while 7.7% (representing 1 farmer) were risk tolerant.

Table 4. Risk attitude classification by age range of small-holder rice farmers

Risk aversion class	Frequency	Relative frequency (%)
Extremely risk averse	48	26.67
Severely risk averse	51	28.33
Intermediately risk averse	22	12.22
Moderately risk averse	17	9.44
Risk averse total	138	76.66
Slight to neutrally risk averse	24	13.33
Neutral to preferring risk averse or risk loving	18	10
Risk loving total	42	23.34
Grand total	180	100

Factors influencing rice production in the study area

The results of the Maximum Likelihood Estimates (MLE) of the parameters of the Cobb-Douglas Stochastic Frontier

Table 5. Risk attitude classification of small-holder rice farmers by age range

Age range	Extremely risk averse	Severely risk averse	Intermediately risk averse	Moderately risk averse	Slight to neutrally risk averse	Risk loving	Total
≤30	6(18.1)	8(24.2)	2(6.0)	4(12.1)	8(24.2)	5(15.1)	33(18.3)
31–40	13(20.0)	14(21.5)	9(13.8)	2(3.0)	13(20.0)	14(21.5)	65(36.1)
41–50	11(26.8)	13(31.7)	9(21.9)	3(7.3)	4(9.7)	1(2.4)	41(22.8)
51–60	5(17.8)	6(21.4)	3(10.7)	11(39.2)	3(10.7)	0(0)	28(15.6)
>61	3(23.0)	6(46.1)	0(0)	3(23.0)	0(0)	1(7.7)	13(7.2)
							180(100)

Figures in parenthesis are percentages.

Production Function (SFPF) and the inefficiency model of rice farmers are presented in Table 6. The variance parameters, sigma-square (σ^2) and lambda (λ) were estimated at 0.753 and 3.725, respectively. The sigma-square attests to the goodness of fit and correctness of the distributional form assumed for the composite error term, while the lambda indicates that variations in yield are mainly due to differences in the production practices of farmers and not random variations. The parameter estimates of the production function of rice farmers revealed that farm size β = 0.16, ($p < 0.5$), seed β = 0.75 ($p < 0.01$) and chemicals β = 0.26 ($p < 0.01$) positively influenced rice output, while labor and fertilizer had a negative but insignificant influence on rice output.

Table 6. Determinants of rice production in the study area

Variable	Parameter	Coefficient	*t*-value
Constant	X_0	6.8535***	24.160
Farm size	X_1	0.1643*	1.840
Labour	X_2	–0.0751	–1.160
Seed	X_3	0.7484***	10.450
Fertilizer	X_4	–0.0299	–1.370
Chemicals	X_5	0.2580***	3.480
Inefficiency model			
Constant	Z_0	–3.1165	–1.600
Age	Z_1	0.2988	0.520
Education level	Z_2	–0.9379*	–1.780
Household size	Z_3	0.6175	1.120
Years of farming	Z_4	0.6388***	3.250
Membership of coop society	Z_5	0.2967	1.040
Access to credit	Z_6	–0.2089	–0.710
Extension contact	Z_7	0.6195*	1.740
Planting system	Z_8	–0.5098*	–1.790
Severely risk averse	Z_9	0.5671*	1.670
Intermediately risk averse	Z_{10}	0.0317	0.070
Moderately risk averse	Z_{11}	0.5731	1.170
Neutrally risk averse	Z_{12}	–0.0189	–0.050
Risk loving	Z_{13}	–1.1374*	–1.900
Diagnostic statistics			
Sigma square	δ^2	0.7536	
lambda	λ	3.7250	
Log-likelihood		–114.0847	

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

The inefficiency model of the rice farmers incorporated their personal characteristics, namely: age, level of education, household size, years of farming experience, membership of cooperative society, access to credit, extension contact, planting system and the various risk attitudes. The signs of the coefficients of these variables have important policy implications as a positive sign implies a negative effect on efficiency while a negative sign signifies a positive effect on efficiency. Education level had a negative and significant coefficient, β = –0.93 ($p < 0.1$), implying a positive effect on the efficiency of rice farmers in the study area. This could mean that the number of years spent in school increases the technical efficiency of the rice farmers. Education increases the capacity to adopt new technologies; hence it enables rice farmers to increase their technical efficiency. Years of farming had a positive and significant coefficient, β = 0.63 ($p < 0.01$), implying a negative effect on the technical efficiency of farmers. The more years of farming experience they had, the less efficient they were. This could be because experienced farmers in the study area are risk averse and may not want to try out the new technologies required to enhance rice production.

Severe risk aversion had a positive and significant coefficient, β = 0.57 ($p < 0.1$), indicating that risk aversion reduced technical efficiency. This result is in line with Tong et al. (2019), who also found that risk aversion decreases rice farmers' technical efficiency. The risk tolerance coefficient was negative and significant β = –1.14 ($p < 0.1$). This implies that high risk tolerance increases the technical efficiency of rice production in the study area. This is also in line with Tong et al. (2019), who found that farmers who are risk neutral or risk tolerant are more likely to have higher technical efficiency in rice production than farmers who are risk averse. He further asserted that this may be because risk-averse farmers invest fewer managerial resources in rice production per se and more in producing other foods to mitigate risk. At the same time, they may turn to alternative sources of income to avoid agricultural risks, resulting in less focus on rice production and lower efficiency.

These result differ from those of Dhungana et al. (2004), who found that higher risk aversion reduced allocative efficiency but had no significant effect on technical efficiency. Since farmers' risk attitude is an important determinant for farming decisions, including investment in inputs (Ramaswami, 1992), the significant correlation between farmers' risk attitudes and efficiency is not surprising, because any measure, adjustment, operation or arrangement to reduce risk may have an effect on the procedure, portfolio and outcome of production. In this context, Llewelyn and Williams (1996) argued that higher fertilizer use, regarded as a risk-reducing strategy, is associated with the least efficient farms. Thus, it could be inferred that in the face of large production risks and weather shocks, risk-averse farmers tend to cope with these potential situations by expanding agricultural investment to make up for possible losses, thus reducing efficiency. This idea was also supported by Rosenzweig and Binswanger (1992).

Technical efficiency of rice farmers

The distribution of rice farmers in the study area given their technical efficiency is shown in Table 7. Almost half (37.2%) of rice farmers operated below 50% of full technical efficiency. 6.7% attained an efficiency level ranging between 0.51 and 0.60. 10.6% had technical efficiencies between 0.61 and 0.70. 20.0% had technical efficiencies ranging between 0.71 and 0.80. 21.0% had technical efficiencies ranging between 0.81 and 0.90, while 3.9% had technical efficiencies ranging between 0.91 and 1.0. The mean technical efficiency among the sampled farmers was 59.0%, with a minimum of 11.0% and a maximum of 94.0%. This implies that farmers could increase their output by 41% if the efficiency of input usage was increased.

Table 7. Distribution of rice farmers by technical efficiency

Efficiency index	Frequency	Relative frequency (%)
≤0.50	67	37.22
0.51–0.60	12	6.67
0.61–0.70	19	
0.71–0.80	36	10.56
0.81–0.90	39	21.67
0.91–1.0	7	3.89
Mean	0.5973	
Minimum	0.1146	
Maximum	0.9468	
Total	180	100.00

CONCLUSION

This study was carried out to investigate the relationship between the risk attitudes and technical efficiency of small-holder rice farmers in Ogun State, Nigeria. The findings revealed that 36.1% of the farmers were between ages 31–40 years. Farmers 41 years and above were seen to be more risk averse than their younger counterparts. 76.66% of rice farmers were risk averse, while 23.34% were risk tolerant, and risk tolerance had a positive effect on technical efficiency, while risk aversion had a negative effect, decreasing technical efficiency. The study concludes that small-holder rice farmers are generally risk averse, negatively influencing their technical efficiency.

This implies that it is important to place emphasis on the risk attitudes of farmers as they have a significant impact on technical efficiency.

Farmers' risk attitudes should be taken into account in the design of government programs. Policy makers and other risk management information providers may be better able to tailor their programs based on the information in this study.

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