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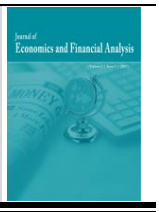

Decision-making under Rice Contract and Non-Contract Farming Arrangements in Ekiti State, Nigeria: A Game Theory Approach.

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Abstract

Farmers face considerable challenges in negotiating contracts, determining production levels, and fulfilling contractual obligations due to the inherent uncertainties associated with agricultural activities, including fluctuations in weather conditions, pest infestations, and crop diseases. Thus, this research delves into the decision-making processes within the rice farming sector in Nigeria, specifically examining the comparative profitability between contract and non-contract farming systems through Gross Margin analysis and the Maximax and Minima criteria.

Utilizing Ordinary Least Squares (OLS) technique on a randomly selected sample of 126 rice farmers from Ekiti State, Southwest Nigeria, our analysis reveals that rice farming in the region is economically viable, with contract farming demonstrating greater profitability compared to non-contract farming. The profitability of paddy rice cultivation is notably influenced by several factors, including farming experience, participation in cooperative associations, age, access to extension services, and agricultural training. Specifically, we observe that years of farming experience, membership in the association, and access to extension service positively influence profitability of paddy rice production of contracted farmers; while farmer age and formal training positively influence profitability of paddy rice production of non-contracted farmers.

Moreover, our study indicates that optimistic farmers are inclined towards adopting the contract farming model, while pessimistic farmers tend to favor non-contract arrangements. Thus, we recommend that optimistic farmers consider engaging in contract farming, while a non-contract approach is advisable for pessimistic rice farmers.

Keywords: *Profitability; Rice Farming; Optimist; Pessimist; Maximax; Minima.*

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1. Introduction & Literature

The availability of inputs and other necessary materials influences the decisions made by rural farmers about their output, among other considerations. With the farmers' requirements and objectives in mind, various factors are involved. A farmer's decision-making is influenced by a number of factors, including past experiences, a variety of cognitive biases, an escalation of commitment and sunk outcomes, individual differences, such as age and socioeconomic status, and a belief in personal relevance (Marsh & Hanlon, 2007; Nestler et al, 2008; Stanovich & West, 2008, de Bruin, Parker, & Fischoff, 2007; Finucane et al., 2005). Contract farming is a term used to describe an alternate market in which grower(s) and firm(s) (exporters, processors, retail outlets, or movers, for example) establish a written or informal arrangement to produce and provide agricultural commodities under the forward agreement. Predetermined price, quality, quantity, acreage (maximum and minimum), and time are all essentially included in the agreement (Swain, 2008). It is a system whereby farmers offer agricultural products to recognized buyers under advance contracts that specify the commodity's price, timing, and quantity (Singh, 2005). A pre-harvest agreement is what buyers and farmers have agreed to. It is widely acknowledged as an effective instrument for lessening smallholder farmers' risks and mitigating common market failures (Bellemare & Lim, 2018). It has been identified as an effective method for advancing rural advancement, an asset to advance productivity, cause development, make off-farm employment, and advance social incorporation. It likewise has multiplier impacts of connecting agriculture to agribusiness in creating employment opportunities and plays a crucial role in relaying consumer demands to farmers. Globally, contract farming has tremendously improved the gains from agricultural production, especially for smallholder farming households. In Europe, contract farming has resulted in a 19% net profit than in Turkey, a 21% net profit in Nepal, a 13% income per hectare in Vietnam, an 11% increase in revenue and a 50% higher profit margin than a non-contract farm in Taiwan (Tatlidil & Akturk, 2004; Mishra et al., 2018; Hoang, 2021; Ching-Cheng et al., 2006). In Africa, contract farming had a 12.5 % return on capital invested in Zimbabwe and 45% net income in Ethiopia (Mafuse et al., 2012; Tefera & Bijman, 2021). It has helped give independent work employment opportunities with variable capital, marked-down hazards and guaranteed costs, which further helps the farmers and agricultural workers expand their income and standard of living (Kakade et al., 2012). Nevertheless, one serious problem has been impeding the development of contract farming for a long time: the need for more trust between farmers and buyers.

One of the primary crops grown and eaten in Nigeria is rice, Oryza Sativa. Nearly all of Nigeria's agroecological zones support its cultivation. Like most

developing nations, Nigeria has a sizable rural population that relies on agriculture as a lucrative industry to raise their standard of living (Lagakos & Waugh, 2013). Through chain operations from production to consumption, rice production accounts for more employment in rural areas and contributes to the nation's Gross Domestic Product (GDP). Africa's largest rice producer is Nigeria, which will produce 4 million tons of rice annually in 2019[1]. Contract rice production is essential because of its profitability, greater employment creation, and expansion of rural markets, among other factors. Because they are the owners and managers of their farms, rice farmers are more likely to possess specific expertise, and they must grasp decision-making techniques and methods for growing rice. For instance, choosing whether or not to engage in contract farming, choosing the plant varieties to use, applying fertilizer, allocating labour, and selling agricultural products. Hirschleifer (1984) states that a market describes an equilibrium between supply and demand. Both internal and external factors have an impact on how well farming operations perform. One of the internal issues is a lack of capital, while the external factor is excessive rainfall related to climate change. Given how closely these issues connect to price fluctuations in crop growing, they should be considered farming hazards that must be addressed.

Game theory provides a theoretical framework for picturing competing individuals in social contexts. According to Turocy and Stengel (2003), it is a formal description of a strategic scenario and a study of decision-making in which many actors must make choices that could affect the interests of the other participants. Rasmusen (2006) notes that it is an effective tool for planning under uncertainty. Game theory can be considered the science of strategy, or at the very least, as the optimal approach for competing, autonomous individuals to choose their course of action in a strategic situation. A theoretical framework for examining the social interactions between competing players is provided by game theory. It seeks to facilitate the most effective strategic decision-making between competing and autonomous players. Game theory can be used to predict the results of real-world scenarios for events like pricing competition and product releases, among many other things. Examples of such situations are the dictator game and the prisoner's dilemma. The different types of game theory include sequential and simultaneous games, zero-sum and non-zero-sum games, and cooperative and non-cooperative games.

This study uses game theory methodologies to ascertain whether contract farming is profitable for rice producers, identifies the determinants of paddy rice profitability among contract and non-contract farmers, and evaluates the benefits

[1] FAO, (2020). Rice production in Africa: current situation and issues available at https://www.fao.org/3/x2243t/x2243t05.htm

and drawbacks of each agricultural structure and the strategic interactions between the many players in the two systems. Like most other economic models, game theory's fundamental flaw is based on the erroneous premise that individuals are irrational actors acting in their best interests (Ogu, 2013). Because we are social creatures, we often collaborate at personal cost. Game theory cannot explain why, depending on the social setting and the participants, we occasionally enter a Nash equilibrium and occasionally do not. Moreover, game theory usually fails to consider human traits like empathy, honesty, or loyalty. Statistical and quantitative calculations may determine the best course of action, but humans may react differently to complex and unpredictable situations, such as manipulation or sacrifice. While it can analyze behaviours, game theory cannot predict attitudes.

1.1. Definitions of Some Useful Terms in Game Theory

The following are the definitions of some few words that are frequently used in game theory research:

- **Game:** Any situation in which the course of events depends on the choices made by two or more participants.
- **Players:** A tactical decision-maker in the game's setting
- **Strategy:** A player's whole course of action depends on the conditions during the game.
- **Payoff:** The amount of money a player wins when a specific result is reached. (The payment might be measured in terms of money or usefulness.)
- **Information Set:** The data accessible during a specific game moment. (The phrase "information set" is typically used for a game's sequential component.)
- **Equilibrium:** A state in which both players have made decisions and reached a conclusion.
- **The Nash Equilibrium:** Once attained, the Nash Equilibrium indicates that no actor may unilaterally alter decisions to increase payoff. It can also be referred to as "no regrets" since, after making a choice, the player will not look back on it, even after considering the repercussions. In most circumstances, the Nash equilibrium is reached over time. The Nash equilibrium will not be altered after attaining it, though. Examine the effects of a unilateral action after determining the Nash equilibrium. Does that even make sense? Because it should not, the Nash equilibrium is called having "no regrets." In general, a game can have more than one equilibrium.

However, this typically occurs in games with more complex elements than only two-player modes. Repetitive simultaneous games eventually lead to one of these several equilibria. This scenario of making numerous decisions until equilibrium is most commonly seen when two businesses settle on prices for highly interchangeable products, such as plane trips or soft drinks (Moorthy, 1993). Game theory can be used in various areas of rice contract farming to assist players in understanding market dynamics and making strategic decisions. Contract farming for rice entails agreements between rice buyers, processors, and producers, whereby farmers commit to growing rice by predetermined guidelines and quality criteria. Game theory offers a useful framework for analyzing and optimizing several facets of rice contract farming. This framework assists parties in reaching mutually beneficial agreements, minimizing conflicts, and making well-informed decisions. It can also be modified to particular contexts and market situations to address rice production and distribution issues. The following are the applications of Game theory in Rice Contract Farming;

i) **Contract Negotiation:** Game theory can help farmers and processors understand the bargaining power they hold in contract negotiations. By modelling the negotiation process as a game, parties can strategically assess their options and make informed decisions regarding contract terms, including pricing, quality standards, and delivery schedules.
ii) **Quality Control:** Maintaining consistent quality is crucial in rice contract farming. Game theory can be used to model situations where farmers may have incentives to deviate from quality standards. By analyzing potential deviations and penalties for non-compliance, contracts can be designed to align the interests of both parties and ensure quality control.
iii) **Risk Management:** Rice production is subject to various risks, such as weather fluctuations, pests, and market price volatility. Game theory can help stakeholders develop risk-sharing mechanisms within contracts. For example, farmers and processors can negotiate risk-sharing agreements that allocate responsibilities and rewards based on actual outcomes, such as yield or price variations.
iv) **Monitoring and Enforcement:** Game theory can be applied to assess the costs and benefits of monitoring and enforcing contract compliance. Farmers and processors can use game theory to determine optimal strategies for monitoring activities and addressing potential breaches of contracts, which can reduce opportunistic behaviour and enhance trust between the parties.
v) **Market Dynamics:** Game theory can be used to model the competitive dynamics among rice processors and their interactions with farmers. This

can help processors make strategic decisions regarding procurement and pricing strategies in a competitive rice market.

vi) **Long-term Contracts:** When parties enter into long-term contracts, game theory can be employed to analyze the evolution of their strategies over time. This can be particularly useful in understanding how contract terms must adapt to changing market conditions or unforeseen events.

vii) **Information Sharing:** Game theory can be applied to assess the benefits and risks of sharing information between farmers and processors. Sharing information about market conditions, production techniques, or crop yields can lead to more efficient contracts and better decision-making for both parties.

viii) **Cooperative Farming:** Farmers sometimes form cooperatives to negotiate contracts collectively. Game theory can help these cooperatives devise strategies for collective bargaining and ensure that individual members' interests are adequately represented.

2. Literature Review

Game theory has been applied to model decision-making among farmers, considering factors such as crop choices, investment decisions, and adoption of new technologies. Studies have explored cooperative game models to analyze farmers' collaborations, emphasizing the importance of collective actions in optimizing agricultural outcomes. The reputation effect of moral hazard on the growth of the contract farming market was investigated by Olounlade et al. (2019) by applying game theory to rice farmers in Benin. According to the findings, a rice farmer using contract farming methods is motivated to uphold his reputation to increase future earnings. This explains why, to maintain a longer farmer-buyer connection, rice farmers will make greater investments to raise the quality of their customer service, considering both the final contractor customers' feedback and the product's quality. Contract farming can be grown in Benin with remarkable success since the rice farmer is motivated to uphold his reputation to earn greater earnings in the future. Using primary data from 127 smallholder contracts and 127 non-contract rice farmers, Yusuf (2018) investigated the profitability of rice production between smallholder contracts and non-contract irrigated rice farmers in the Kano River Irrigation Project. According to the outcome, the contract group's gross income from selling paddy rice was N523667/ha, while the non-contract group was N 462,300/ha. Oluyole et al. (2013) investigate the cocoa production management system that maximizes farmers' income under risk by applying game theory. The games were created based on the pay per hectare of the three management systems, using the maxima and maximin criteria. According to the Maximax criterion, the shared-crop approach was cocoa growers' most effective management strategy. On the other hand, the Maximin results indicated that the owner management

system (with an income per hectare of N92,463) was the best management method. Cabrera Garcia et al (2012) examined how an agricultural corporation could use game theory with perfect knowledge. The investigation confirmed that the parameters required to perform various linear programming issues will be considered in this game, along with production results for multiple crops. When all four players in the game have perfect information and a hierarchical structure (a management centre and three production units), a Nash equilibrium point is reached because, once the other players' strategies are known, any of them that choose a different course of action from the one suggested will see a decrease in earnings. Game theory was applied to horticultural crops in southwest Nigeria by Adeoye et al. (2012). The games were designed with the net profit from every fruit and vegetable in mind. The analysis used the game theory criteria for maxima, maximin, regret, utility, and Laplace. Based on the Maximax and Laplace criteria, farmers of the most profitable fruits and vegetables grew pineapples (net profit of ₦1398,200/ha) and tomatoes (net profit of ₦526,000/ha). According to the Maximum and Utility criterion results, the highest-performing alternatives were Amaranthus (net profit of ₦272,920) and Pineapple (net profit of ₦1398,200/ha). Plantains (net profit of ₦1348,625.8/ha) and pepper (net profit of ₦490,000/ha) were the farmers' best options when considering the regret criterion.

Table 1. Strategies of players which represent production conditions

Strategies	**Production Conditions Characteristics**
Contract Farming arrangement	• There is a formal agreement or contract between farmers and agribusiness firms or buyers that outlines the terms and conditions under which the farmer will produce. • It involves predetermined with a focus on rice crop production. • Input provision (seeds, fertilizers, pesticides, etc.) is often provided or financed by the contracting company as part of the contract, and the farmers may receive technical support and training. • Contract farming agreements usually specify the price at which the farmer will sell their produce. This can provide price stability and market access, reducing price risks for the farmer. • The risks are often shared between the farmer and the contracting company. The company may guarantee a minimum price or purchase quantity, providing some risk mitigation for the farmer. • Contract farming often involves strict quality and production

	standards that farmers must adhere to, as specified in the contract. • Contract farming arrangements can be long-term partnerships, with contracts spanning multiple seasons or years.
Non-Contract Farming arrangement	• No formal agreement. • Non-contractable farmers can choose the crops or livestock they want to produce based on market conditions, personal preferences, and other factors. • Input provision is typically the farmer's responsibility. They must secure their inputs and manage their production process independently. • Market forces determine prices in non-contract arrangements, and farmers may face greater price volatility. They must find their markets and negotiate prices independently. • Farmers in non-contract arrangements bear most production and price risks, as they are not guaranteed a market or price for their produce. • Quality standards may still be important for market access in non-contract farming; they are typically not as rigidly enforced as in contract arrangements. • Non-contract arrangements may vary in duration, and farmers can change crops or practices from one season to the next.

3. Data and Methodology

3.1. Study Area

The study was conducted in Nigeria, where Ekiti State was the study area. This state is located in the southwestern part of Nigeria. Established on October 1, 1996, the state is located in the tropics and comprises sixteen Local Government Areas (LGAs). The total land area of Ekiti State is roughly 8,6028km. Ekiti State is mostly an agricultural region with oil palm, cocoa, kola nuts, and timber as its principal revenue crops. Grain crops, including maize, rice, and food crops like cassava, yam, and cocoyam, are farmed. The rainy and dry seasons are the two main seasons in the state. With an estimated 500MT of production, Ekiti is well-known for producing native Igbemo rice (NBS, 2010). The state is included in the agricultural transformation plan and part of the staple crops processing zones (SCPZ)

(Agricultural Transformation Agenda (ATA), 2011-2014[2]; Federal Ministry of Agriculture and Rural Development, 2016[3]).

3.2. Data Source

This research made use of primary data. Well-designed questionnaires were used to get information from the respondents. The data collected encompassed socio-economic and demographic attributes of the participants, such as gender, age, marital status, educational attainment, family size, primary school, credit availability, cooperative association membership and extension access, distance to farm/market, awareness, and participation in contract farming among others. Other information collected from the farmers includes rice yield variable inputs such as quantity and cost of fertilizer, insecticides, and pesticides.

3.3. Sampling Techniques

The study adopted a multi-stage sampling technique to select respondents. In the first stage, Ekiti State was purposively selected from among the list of rice-producing states in Nigeria. The second stage involved the purposive sampling of three major rice-producing local governments from the state. The selected local governments are Irepodun-Ifelodun, Ado, and Gbonyin Local government areas. This was followed by randomly selecting two communities from each local government. The communities selected are Igbemo Ekiti and Afao Ekiti. They Are Ekiti from Irepodun/Ifelodun, Igirigiri, Farm Settlement, and Ago Aduloju from Ado Ekiti LG, while Ijan Ekiti, Iluomoba Ekiti, and Aisegba Ekiti were all selected from Gbonyin LG area. In the final stage, 15 rice farmers were randomly chosen from each community, making 50 respondents from each LGA. Thus, in the end, 150 respondents were surveyed for the study. Only 126 rice farmers' information, comprised of 63 contract farming participants and 63 non-contract farming participants, was helpful in this study. The respondents were rice farmers, those participating, and those not participating in contract farming.

[2] ATA. Agricultural Transformation Agenda: Action Plan for Cassava Transformation in Nigeria: Working Document, 1-10.

[3] FMARD (2016). The Agriculture Promotion Policy (2016-2020). Building on the successes of the ATA, Closing Key Gaps, Policy and Strategy Document.

3.4. Model

The dependant variable profitability of the paddy rice production is proxied by Gross Margin. Following Olajide and Omonona (2019), Farm profit is measured in terms of Gross Margin (GM), which equals the difference between the Total Revenue (TR) and Total Variable Cost (TVC) but not fixed costs as they remain fixed whether or not production has taken place, and to what scale production has been.

The gross profit of a business is estimated as the difference between the total sales and the variable cost incurred.

$$GM = TR - TVC \quad (1)$$

Where TR is considered as value of output (amount realized from rice sales).

Subsequently, we structure our Ordinary Least Square (OLS) Regression model in order to examine determinants of profitability of paddy rice production among contract and non-contract farmers by following Fakayode et al. (2008), Ashagidigbi et al (2011), and Obayelu et al (2014).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots\dots + \beta_n X_n + \varepsilon_i \quad (2)$$

Where *Y* is profitablity of paddy rice production and *X* are explanatory variables such as:

X_1 = Age (Years)

X_2 = Gender Dummy (Male = 1, Female = 0)

X_3 = Marital Status Dummy (Married= 0, Not Married = 1)

X_4 = Education Dummy (Educated=0, No Education = 1)

X_5 = Household Size (Number)

X_6 = Years of Farming Experience (Years)

X_7 = Farm Size Cultivated (acres)

X_8 = Access Credit Dummy (Yes = 1, No = 0)

X_9 = Years of being a Cooperative Member (number)

X_{10} = Access to Extension Dummy (Yes =1, No = 0)

X_{11} = Total income (Naira)

X_{12} = Herbicide cost (Naira)

X_{13} = Labour cost (Naira)

X_{14} = Fertilizer cost (Naira)

X_{15} = Rice seed cost (Naira)

ε_i = Error term

3.5. Decision Criteria or Types of Game Theory Strategies

Game theory criteria such as Maximax, Maximin, Laplace, Regrets, and Utility were used to evaluate the best options for decision-making under the contract and non-contract arrangement. For rice farmers, the selected criteria determine their risk behaviour, and the unknown quantity and emergence probability of a given condition often influence their decisions. Strategies involving price, quantity, quality standards, insurance contracts, or risk-sharing agreements are made between farmers and buyers and impact the profitability of both parties. Farming decision-making involves known payoffs with unknown probabilities (Fishburn, 2001). Examples include choosing a commodity type, combining inputs, allocating cash, and making other decisions. Factors such as dry and rainy seasons are considered. Farmers are classified as using contract farming as a pure strategy or anything else, and the players include the rice farmer and the contract farming manager who make decisions regarding price, quantity, quality standards, insurance contracts, or risk-sharing agreements between farmers and buyers. The optimal timing for planting, harvesting, and delivering rice also affects the profitability of both parties (Pazek & Rozman, 2009).

3.5.1. The Maximax (Optimist)

A maximax strategy involves no hedging. According to the maximax criterion, the decision-maker must select the alternative that maximizes the maximum value of the result. This positive strategy suggests that the decision-maker should assume the best-case scenario. This criterion explains that farmers are risk-averse and are willing to take any dangers associated with farming. After considering the options ' maximum payoffs, the decision-maker will choose the option that will produce the best outcome. Decision-makers who prefer the most significant rewards and do not hesitate to take risks will be satisfied with the outcomes of these criteria (Pazek & Rozman, 2009).

3.5.2. Wald's Criterion or Maximin (Pessimist)

When making decisions, it is essential to consider all possible outcomes. One strategy for doing so is the maximin or Wald's criterion. This approach involves

choosing the option with the most minor possible reward to prepare for the worst-case scenario. While this may mean sacrificing some potential payoff, it protects against the worst possible outcome. By acting as though the worst will happen, one can make decisions that offer the greatest possible reward, even in the face of uncertainty. This approach especially appeals to decision-makers who want to be sure they will get some reward, even if it is small. Ultimately, Wald's criterion is selecting a course of action to generate income while minimizing risk.

Following (Ulansky and Raza, 2012; Wu and Wang, 2011), mathematically, If the number of nature states in a decision problem is n, the probability will be in order as $P_1 \geq P_2 \geq P_3 \geq P_4 \geq \cdots \geq P_n$. If x_j stands for a decision result of a certain scheme probability of which P_j is the expected value for this scheme will be

$$E(\theta) = \sum_{j=1}^{n} P_j x_j \tag{3}$$

Therefore, solving the maximum and minimum expected value is to solve the following linear programming problem:

$$\max(min)\, E(\theta) = \max(min) \sum_{j=1}^{n} P_j x_j \tag{4}$$

3.5.3. Laplace Criterion

When many chances of an event are unknown, their probability should be considered equal, and the various actions should be assessed based on the average of their rewards across all natural states. According to Laplace, the likelihood of the payout received was presumed to be the same because no information was available. Therefore, the chance of each payment is 1/n if there are no payoffs. According to this technique, the decision-maker determines the expected payout for each alternative strategy and chooses the one with the highest value.

3.5.4. Regret or Savage Criterion

The consideration of all potential outcomes is essential when making decisions. Savage's criterion, which is conservative and considers the worst-case scenario like Wald's, is one way to do this. This criterion looks to reduce losses, opportunity costs, and regrets that might result from certain events after choosing the course of action that minimizes the highest regret's worth.

Compared to other workable possibilities, the selected option offers a lower payout. The difference between the value of a given outcome and the greatest value of all possible possibilities, considering the particular random event, is the regret of that particular occurrence. When applying this strategy, selecting the option that will leave you with the fewest regrets is crucial. The difference between the maximum payout and the reward for particular choices is used to compute this regret value (Adeoye et al., 2012; Pazek & Rozman, 2009). The best decision by the Hurwicz criterion satisfies the following condition (Ulansky and Raza, 2021).

$$\varphi_v^{opt} \Rightarrow \frac{min}{i=1,m}\left[\frac{\alpha min}{j=1,n} C_{ij} + (1-\alpha)\frac{min}{j=1,n} C_{ij}\right] \quad (5)$$

At *α=0*, Hurwitz's criterion coincides with the Wald criterion. For *α=1*, the choice of DM decision is subject to the least of all possible payoffs (*min* C_{ij}).

For the risk matrix R, the Hurwicz criterion of pessimism-optimism has the following form:

$$\varphi_v^{opt} \Rightarrow \frac{min}{i=1,m}\left[\frac{\alpha min}{j=1,n} R_{ij} + (1-\alpha)\frac{min}{j=1,n} R_{ij}\right] \quad (6)$$

For *α=0*, the decision choice is carried out according to the Savage minimax risk criterion; when *α=1*, by the condition of the least of all possible risks (*min* C_{ij}).

3.5.5. Utility Criterion

The farmer is a risk-averse person, according to the utility criterion approach. Risk avoiders prefer an alternative that offers an equal return but is riskier over a more specific return.

4. Results and Analysis

4.1. Socioeconomic Characteristics of the Contract and Non-contract Rice Farmers

The socioeconomic characteristics of the farmers are presented in Table 2. The table showed that a larger percentage of contract and non-contract farmers' 88.89% and 74.60%, are male, while just a few are female. This implies that most farmers sampled are male. This agrees with (Oloyede et al., 2020), where a larger percentage of rice farmers in their study were male. The mean age of the contract farmers' participants and non-participants was 39 and 38 years, respectively. Under the contract farming arrangement, 41.27% of the farmers are between 30 and 39 years old, while 50.79% are between 40 and 49 years under the non-

contract farming arrangement. About 85.71% of contract and 77.78% of non-contract farmers are married (Afolami et al., 2012). The proportion of single non-contract farmers is higher at 7.94% than contract farming at 1.59%. Also, 42.86% of the contract farmers had secondary education, compared to 36.51% of non-contract farmers, and 25.40% of the contract farmers had tertiary education, with 19.05% from non-contract farming, with 12.7% of contract farmers had no formal education, while 22.81% of non-contract farmers had no education. This shows that a large percentage of the contract farming households had education compared to the non-contracting farmers. Also, the distribution of respondents by household size shows that the mean household size of contract farmers is six and that of non-contract farmers is five. The majority of respondents who are contract farmers, 50.79%, have 0–5 persons in their household, while 57.14% of non-contract farmers have 0–5 persons in their household, indicating a moderate household size.

The study further revealed that the mean farm size for contract and non-contract farmers was 3.96 and 3.84 acres, respectively. Most contract farmers (34.92%) cultivate 4.1 to 6 acres of land; however, most non-contract farmers (39.68%) cultivate 2.1 to 4 acres. The small size of the farms cultivated by contract and non-contract farmers in the study area implies that they are mainly small-scale farmers. A more significant percentage, 65.08% of contract farmers, did not have access to formal agricultural training, while 34.92% had access to formal agricultural training. Similarly, 79.37%, a larger percentage of non-contract farmers, do not have access to formal agricultural training, while a smaller percentage of non-contract farmers, 20.63%, have access to formal agricultural training. A larger proportion of the contract farmers, 47.62%, have farming as their primary occupation, with 12.70% civil servants, while 68.25% of non-contract farmers have farming as their primary occupation and 3.17% are civil servants. The study revealed that the mean rice income of contract and non-contract farmers was N100 000.00 and N50,000.00, respectively. Most contract farmers, 38.10%, earn 0-200,000.00 annually from their rice farmers, while 53.97% of the farmers earn the same amount. The small size of the income by both contract and non-contract farmers in the study area implies that they are mainly small-scale farmers. Most contract farmers, 50.79%, produce rice commercially, while 49.21% practice small-scale rice production. Conversely, 55.46% of non-contract farmers produce rice on a small scale, while 44.44% practice commercial rice production. This implies that more contract farmers produce rice on a large scale than non-contract farmers. A larger percentage of the contract farmers, 82.54%, have access to credit, while 17.46% of them do not have access to credit. Also, 84.13% of the non-contract farmers have access to credit, and 15.87% of them do not have access to credit. This implies that more non-contract farmers have access to

credit than contract farmers. The distribution of the farmers by the sources of credit shows that 40.00% of the non-contract farmers obtained their credit from money lenders, while 27.27% of the contracting farmers obtained their credit from money lenders and friends/families. Other sources of credit identified by the farmers include government, cooperative and society associations, and microfinance banks, respectively. The study further shows that 44.44% of contract farmers use their land for rice farming, 23.21% rent/lease land for rice farming, and 22.22% inherited the land used for rice farming, while 6.35% purchased the land for their rice farming activities. However, 36.51% of non-contract farmers use their land for rice farming, 25.40% inherited the land, 26.98% rent/lease the land for rice farming activities, and 6.35% of non-contract farmers purchased land for rice farming. This shows that most farmers (both contract and non-contract) acquired their land for rice farming personally. The distribution by members of the cooperative association shows that 76.19% of contract farmers are non-members, while 23.81% belong to one cooperative association and others. Also, 90.48% of non-contract farmers are non-members of cooperatives, while 9.52% are cooperative association members. This shows that cooperative association membership could be better among the farmers in the study area. Also, 12.70% of contract farmers have access to extensions, 87.30% do not have access to extensions, 4.76% of non-contract farmers have access to extensions, and 95.24% do not have access to extensions. About 47.62% of the contract farmers sell their rice in the rural market, 23.81% sell at the farm gate, and 14.29% sell at the urban markets, while under the non-contract farming arrangement, 50.79% of the farmers sell in the rural market, 39.68% sell in the urban market, and 6.35% sell at the farm gate. This finding shows that, despite the contract farming arrangement among the farmers, the bulk of their produce still goes to the rural market. Also, around 71% of contract farmers sell to wholesalers, 21% to retailers, and 1.79% to agro-processors and off-takers. While 68% of non-contract farmers sell to wholesalers, 20% to retailers, 1.61% to agro-processors, and 0.8% sell to off-takers. About 62.5% of contract farmers supplied their inputs by wholesalers, 14.29% had their inputs provided by retailers, off-takers supplied 7.14%, and 5.35% got their inputs supplied by agro-processors. Also, 59.68% of non-contract farmers have their inputs provided by wholesalers, 26.79% by retailers, 5.65% by agro-processors, and 1.61% by off-takers.

Table 2. Socioeconomic Characteristics of Rice Contract & Non-contract Farmers

Variables	Contracts farmers		Non-contracts farmers	
Gender	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Male	56	88.89	47	74.60
Female	07	11.11	16	25.40
Age	**39**		**38**	
20-29	13	20.63	01	1.59
30-39	26	41.27	12	19.05
40-49	18	28.57	32	50.79
50-59	04	6.35	13	20.63
60-69	01	1.59	04	6.35
70-79	01	1.59	01	1.59
Marital Status				
Not married	05	7.94	07	11.11
Single	01	1.59	05	7.94
Married	54	85.71	49	77.78
Separated	02	3.17	01	1.59
Widowed	01	1.59	01	1.59
Educational Level				
No formal education	08	12.70	15	22.81
Adult literacy	01	1.79	02	3.17
Religious education	00	0.00	01	1.79
Primary education	11	17.46	10	15.87
Secondary education	27	42.86	23	36.51
Tertiary	16	25.40	12	19.05
Household size	**6**		**5**	
0-5	29	46.03	36	57.14
6-10	32	50.79	23	36.51
11-15	02	3.17	04	6.35
Farm size (acre)	**3.96**		**3.84**	
0.1-2	15	23.81	13	20.63
2.1-4	21	33.33	25	39.68
4.1-6	22	34.92	19	30.16
6.1-8	04	6.34	03	4.76
8.1-10	01	1.59	03	4.76
Agricultural Training				
No	41	65.08	50	79.37
Yes	22	34.92	13	20.63
Production Modality				
Smallholding	31	49.21	28	44.44
Commercial/industry	32	50.79	35	55.56

Access to Credit				
No	52	82.54	53	84.13
Yes	11	17.46	10	15.87
Source of Credit				
Money lender	03	27.27	04	40.00
Friends/ Families	03	27.27	03	30.00
Microfinance Bank	02	18.18	02	20.00
Cooperative Society	01	9.09	01	10.00
Government	02	18.18	00	0.00
Source of Land				
Personal land	28	44.44	23	36.51
Inherited	14	22.22	16	25.40
Rented/leased	15	23.21	17	26.98
Purchased	04	6.35	04	6.35
Others	02	3.17	03	4.76
Rice Income	**335000**		**315396**	
≤ 200000	24	38.10	34	53.97
200001-400000	24	38.10	13	20.63
400001-600000	10	15.87	10	15.87
600001-800000	04	6.35	06	9.52
800001-1000000	01	3.17	00	00
Member of Cooperative Associations				
No	48	76.19	57	90.48
Yes	15	23.81	06	9.52
Access to Extension				
No	55	87.30	60	95.24
Yes	08	12.70	03	4.76
Where do you sell your rice?				
Rural market	30	47.62	32	50.79
Farm gate	15	23.81	25	39.68
Urban market	09	14.29	04	6.35
Others	09	14.29	02	3.17
Who do you sell your rice?				
Wholesalers	34	53.97	41	70.69
Retailers	12	19,05	15	25.86
Agro-processors	01	1.79	00	0.00
Contracted off-takers	01	1.79	01	1.72
Others	00	3.57	01	1.72
Total	63	100	63	100

4.2. Profitability of Paddy Rice Production of Contract & Non-Contract Farmers

Table 3 shows the gross margin analysis and the profitability of rice farmers under contract and non-contract arrangements in Ekiti State, Nigeria. The table shows that the Total variable costs of the farmers under contract and non-contract farmers were ₦1,002,130.00 and ₦773,180.00, respectively. The total revenue from each arrangement was ₦12,360,000 and ₦10,200,000, respectively. The Gross Margin of rice farmers under contract and non-contract farming are ₦12 360,000 and ₦10, 200,000 respectively. This shows that rice farming is profitable in the Ekiti state but is more profitable under contract farming. The rice farmer's profit is calculated from the difference between the Total Variable Cost and Total Revenue, with the Total Variable Cost under contract and non-contract farming standing at ₦349,000.00 and ₦123,000.00; the rice farmers' profit is ₦11,008,870 and ₦9,303, 820 under contract and non-contract farmers arrangement.

$$Average\ Profit\ per\ Farmer\ per\ Season = \frac{Farm\ Profit}{Total\ No\ of\ Farmers}$$

For contract farmers, average profit per farmer per season is ₦174,744 (₦11,008,870 / 63). For non-contract farmers, average rice profit per season is ₦147,678.68 (₦9,303,820 / 63).

Table 3. Profitability of Contract and Non-Contract Rice Farmers

Variable Cost	Contract Farmers	Non-Contract Farmers
Herbicides	100,200.00	75,680.00
Pesticides	55,450.00	47,450.00
Fertilizers	250,000.00	180,670.00
Insecticides	20,780. 00	15,680.00
Rice Seed	75,500.00	60,400.00
Transportation	74,000.00	37,500.00
Milling	15,000.00	25,000.00
Irrigation	0.00	0.00
Harvesting	85,700.00	65,300.00
Labour cost	75,500.00	55, 500.00
Other costs	250,000.00	210, 000.00
Total Variable cost (TVC)	1,002,130.00	773,180.00
Total Fixed Cost (TFC)	349,000.00	123, 000.00
Total Cost TC (TVC+TFC)	1,351,130.00	896,180
Total output	1030 kg/ha	850 kg
Price per unit of output (₦)	12,000	12,000
Total Revenue (₦)	12,360,000	10,200,000
Gross Margin GM(TR-TVC) (₦)	11,002,130	9,426, 820
Profit (TR-TC) (₦)	11,008,870	9,303, 820

4.3. Determinants of Profitability of Paddy Rice Production among Contract and Non-Contract Farmers

The determinants of paddy rice production profitability among contract and non-contract farmers in the study area were analysed using the Ordinary Least Square Regression model. Table 4 presents results using four functional forms (Linear, semi-log, double log and exponential). Following Gujarati (2004), the criteria for choosing the best model are based on the model with the lowest mean square error, a better R-square, F statistics and many significant variables. For these reasons, the result was interpreted from exponential regression in both scenarios (contract and non-contract farming). The exponential form has the lowest mean square error of 0.50575 and 0.37491 in contract and non-contract farming, respectively. The R-square of 0.1326 and 0.1801 implies that 13% and 18% of the total variation in the profitability of rice is explained by a combination of fifteen explanatory variables. A positive and negative coefficient implies a direct and indirect relationship between regressors and the endogenous variables.

Under contract farming, years of experience, membership in the association, and access to extension service positively and significantly influenced the profitability of paddy rice production. Years of farming experience were found to be positive and significant at 5%, implying that a year increase in farming experience increased the profitability of paddy rice production among contract farmers by 66.7%. This follows the findings of Ume et al. (2021) that experience in agricultural production increases profitability. Membership in the association was positive and significant at 1%, increasing rice profitability by 2.3% among contract farmers. This is in line with the findings of Ume et al. (2021). Farmers' associations or organizations help bulk purchase agricultural inputs, enabling them to take advantage of reduced costs and efficient production (Olagunju et al., 2021). Also, an assemblage of harvested farm produce and sales by association encourages and promotes market access or linkage to industries. Access to extension service positively increased the profitability of paddy rice production at a 5% significance level among contract farmers.

Under non-contract farming, farmer age and formal training positively and significantly influenced paddy rice production. A year increase in age increased profitability by 98% at a 5% significance level. This shows that the non-contract rice farmers were actively involved in rice activities, as their mean age was found to be 38 years. Also, formal training received by non-contract farmers positively increased profitability by 22.6% at a 5% significance level. This is in line with the findings of Anang and Awuni (2018) that training on smallholder rice farmers had a significant effect on production. Training can also increase the number of group

memberships, credit access, and specialization levels in rice production (Anang and Awuni, 2018).

Table 4. OLS Model Results

Variables	CONCTRACTED FARMERS				NON-CONCTRACTED FARMERS			
	Linear	**Semi log**	**Double Log**	**Exponential**	**Linear**	**Semi log**	**Double Log**	**Exponential**
Age	0.394	-0.03	2.704***	0.849	0.870**	0.050	0.642	0.976***
	(0.658)	(0.01)	(0.603)	(0.008)	(0.435)	(0.038)	(0.588)	(0.497)
Sex	0.300	-0.484	-0.009*	0.866	0.230	0.011	-0.313	-0.137
	(0.700)	(0.306)	(1.018)	(0.191)	(0.190)	(0.542)	(0.485)	(0.142)
Marital status	-0.170	0.147**	0.182	-0.028	0.300	0.412**	0.281	-0.093
	(0.700)	(0.272)	(1.261)	(0.171)	(0.540)	(0.662)	(0.634)	(0.182)
Agricultural Training	0.010	-0.041	-0.164	0.143	0.400	0.899	1.048***	0.054***
	(0.160)	(0.267)	(0.787)	(0.161)	(0.500)	(0.671)	(0.638)	(0.154)
Household size	0.090	0.020	-0.150	-0.417	-0.850	-0.059*	-0.091	-0.286
	(0.300)	(0.039)	(1.504)	(0.424)	(0.770)	(0.084)	(0.921)	(0.326)
Farming experience	0.433	0.008***	0.604*	0.667***	0.613	0.010	0.814***	0.443
	(0.991)	(0.011)	(0.660)	(0.451)	(0.798)	(0.038)	(1.009)	(0.459)
Farm size	0.440	0.154	-0.095	0.210	0.650**	0.135	0.024	-0.027
	(0.102)	(0.255)	(0.731)	(0.289)	(0.300)	(0.493)	(0.612)	(0.238)
Access to credit	0.451**	0.394	0.449	0.116	0.280	0.031***	0.382	0.066
	(0.490)	(0.248)	(0.966)	(0.201)	(0.590)	(0.668)	(0.577)	(0.174)
Cooperative Association	0.690	0.000**	0.140	0.023***	0.162	-0.329*	-0.206	0.063
	(0.800)	(0.000)	(0.467)	(0.164)	(0.550)	(0.610)	(0.780)	(0.174)
Access to extension	0.128	-0.029	-0.309	0.191***	0.040	-0.000	0.525***	0.061
	(0.155)	(0.027)	(0.27)	(0.173)	(0.041)	(0.000)	(0.781)	(0.156)
Income	-0.668	-0.012**	0.076	0.500	0.003	0.204	0.280	0.110
	(0.135)	(0.037)	(0.289)	(0.680)	(0.154)	(0.214)	(0.201)	(0.114)
Herbicide cost	0.797	0.000	0.040	-0.939**	0.771*	0.000	0.547	-0.199**
	(0.930)	(0.000)	(0.475)	(0.463)	(0.077)	(0.000)	(0.765)	(0.148)
Labour cost	-0.786	0.000	-0.136	-0.453**	-0.724	0.000	-0.160	-0.006
	(1.079)	(0.000)	(0.243)	(0.867)	(1.421)	(0.000)	(0.218)	(0.125)
Fertilizer cost	-0.290	0.000	0.008	-0.179	-0.865*	0.000	-0.343*	-0.027***
	(1.706)	(0.000)	(0.159)	(0.397)	(0.092)	(0.000)	(0.149)	(0.149)
Rice seed cost	2.523**	0.000	0.476**	-0.019**	0.307	0.000*	1.218	0.058
	(2.451)	(0.000)	(0.072)	(0.197)	(0.903)	(0.000)	(1.246)	(0.151)
Constant	0.720	0.000	0.505	-0.019	0.700	0.000	-0.493	-0.314
	(0.840)	(0.000)	(0.390)	(0.537)	(0.720)	(0.000)	(0.318)	(0.389)
R-Squared	*0.3079*	*0.1587*	*0.0688*	*0.1326*	*0.3985*	*0.2545*	*0.2486*	*0.1801*
Adjusted R-sq	*0.0671*	*-0.1339*	*-0.2285*	*-0.1951*	*0.1713*	*-0.0271*	*0.0088*	*0.1297*
Prob F	*0.2509*	*0.5905*	*0.9983*	*0.9774*	*0.0673*	*0.5738*	*0.4374*	*0.8881*
Root MSE	*2.2e+05*	*1.8341*	*1.9091*	*0.50575*	*1.9e+05*	*1.5202*	*1.2935*	*0.37491*

Notes: The *, ***, ** and * indicate a 1%, 5% and 10% significance level, respectively.

Some important production variables were also found to influence paddy rice production. These include the cost of rice seeds, the cost of fertilizer, and the cost of herbicides. A percentage increase in the cost of rice seeds increased profitability by 47.6% at a 5% significance level among contract farming. This finding aligns with the work of Nguyen (2017), who found that an increase in seed cost increased rice profitability. Similarly, studies, such as Tatlidil and Akturk (2004) and Vande Velde and Maertns (2015), found that the cost of production under contract farming is higher than non-contract farming due to improved technologies or hybrids. An increase in fertiliser cost by one percent increases profitability by 34.3% among non-contract farmers. This result aligns with the works of Ume et al. (2021) and Salam et al. (2019), who found that fertiliser cost is positively associated with profitability. A good reason for this could be that non-contract farmers' involvement in association and training could help purchase high-value fertilizers for production. The cost of herbicides is positively associated with increased rice profitability at a 10% significance level among non-contract farmers. A unit increase in the cost of herbicides by one naira increased the profitability of paddy rice by 77.1%.

4.1. Decision Criteria - Game Decision

Different criteria can be used in game theory to make decisions. According to Burhan and Handan (2001), a few are the Maximax, maximin (Wald's), Laplace, Hurwicz, and salvage regret criteria. Different approaches are needed for each requirement. Nonetheless, the Maximax criterion and the Maximin (Wald's) criterion were considered in this study.

Maximax Criterion

In game theory, specifically in decision analysis, the Maximax criterion determines the optimal course of action when the decision-maker seeks to maximize the maximum potential reward. The rice farmer is optimistic about productivity, input availability, labour, land, insurance, and pricing conditions while considering the Maximax criterion. An optimistic farmer will use contract farming. Contract farming adopters have the highest profit, with a Gross Margin of ₦11,002,130.00, as indicated in Table 4. The optimists prefer adopting contract farming due to its benefits and support inherence in it. Under the contract farming arrangement, the contractual company provides the inputs and other necessary support needed for the farmer.

Maximin (Wald's) Criterion

The player, in this example, a farmer, attempts to select the best among the poorest according to Wald's criterion. Table 4 demonstrates that the owner management system with ₦9,426,820 produces the maximum income per acre under adverse conditions. Based on this standard, the farmer is thought to be pessimistic. The rice farmer chooses the management strategy that will maximize his minimum profit, in other words. The plan offers the farmer the highest level of security.

Table 4. Game Theory Result for Rice Contract Farming

Criteria	Gross Margin	Preferred Contract Arrangement
Maximax	₦11,002,130	Participating (Contracted)
Minimax	₦9,426,820	Non-participating (Non-contracted)

5. Conclusion

This study examines profitability between contract and non-contract rice farming and clarifies the complexity of decision-making in Nigeria's contract farming system for rice using a game theory method. Gross Margin analysis and Maximax and Minimax decision criteria were applied in this investigation. These were utilized for the optimistic and pessimistic farmers to select the rice farmers who were under contract and those who were not. Findings from the study reveal that more male rice farmers, most of whom are married, are under contract and non-contract farming. Also, under the contract and non-contract arrangement, the farmers had a low percentage of credit access, extension service access, agricultural training and membership in the cooperative associations. Household sizes were not large, so the farmers had a fairly large farm size and largely produced on a small scale. The gross margin and profitability analysis show that rice farming is profitable in the Ekiti state but is more profitable under contract farming arrangements than non-contract farming. Also, the results indicate that the optimist farmer will prefer the contract farming system, while the pessimistic farmer will decide against it. This is because contract farming arrangements are more profitable than non-contract farming systems, and optimistic farmers are not risk-averse, whereas pessimistic farmers are. Using Ordinary Least Square regression, under the contract farming arrangement, years of experience, membership of cooperative association, and access to extension service positively and significantly influenced profitability of paddy rice production while under the non-contract farming arrangement, age of the farmers and formal training positively and significantly influenced paddy rice production. The study thus recommends that optimistic farmers practice a contract farming system, while a non-contract arrangement is recommended for

pessimistic rice farmers. Also, government, policymakers and non-governmental organizations should create more awareness on the benefits and importance of contract farming by strengthening extension activities.

References

Adeoye, I.B., Yusuf, S.A., Balogun, O.S. and Alabuja, F. (2012). Application of Game Theory to Horticultural Crops in South-West Nigeria. *ARPN Journal of Agricultural and Biological Science*, 7(5).

Afolami, C.A. Obayelu, C.A., Agbonlahor, M.U. & Lawal-Adebowale, O.A. (2012). Socioeconomic Analysis of Rice Farmers and Effects of Group Formation on Rice Production in Ekiti and Ogun States of South-West Nigeria. *Journal of Agricultural Science*, 4(4). DOI: 10.5539/Jas.V4n4p233

Anang, B.T. and Awuni, J.A. (2018). Effect of training on small-scale rice production in Northern Ghana. *Applied Studies in Agribusiness and Commerce*, 12(3), 13-20.

Ashagidigbi, W.M., Abiodun, O.F. & Samson, O.A. (2011). The Rffects of Rural Infrastructure Development on Crop Farmer's Productivity in Osun state. *World Rural Observations*, 3(1), 48-58.

Bellemare, M.F. and Lim, S. (2018). In all shapes and colours: Varieties of contract farming. *Applied Economic Perspectives and Policy*, 40, 379-401.

de Bruin, W.B. & Parker, A.M. & Baruch, F. (2007). Individual Differences in Adult Decision-Making Competence. *Journal of Personality and Social Psychology*, 92(5), 938-956. DOI:10.1037/0022-3514.92.5.938.

Ching-Cheng, C., Chi-Chung, C., Min-Ching, C. and Wei-Chun, T. (2006). Is Contract Farming More Profitable and Efficient Than Non-Contract Farming: A Survey Study of Rice Farms in Taiwan. Selected paper prepared for presentation at the *American Agricultural Economics Association Annual Meeting*, Long Beach, California, July 23-26, 2006.

Finucane, M.L. & Lees, N.B. (2005). Decision-making competence of older adults: Models and methods. Paper presented at the *National Research Council Workshop on Decision Making* by Older Adults, Washington, DC

Fishburn, P. (2001). Measurement Theory: Conjoint. *International Encyclopaedia of the Social & Behavioural*. DOI: 10.1016/B0-08-043076-7/00594-5

Cabrera Garcia, S., Imbert Tamayo, J.E., Carbonell-Olivares, J., & Pacheco Cabrera, Y. (2013). Application of the Game Theory with Perfect Information to an

agricultural company. *Agricultural Economics*, 59(1), 1-7. DOI: 10.17221/1/2012-AGRICECON

Gujarati, D.N. (2004). *Basic Econometrics*. 4th Edition, McGraw-Hill Companies.

Hoang, V. (2021). Impact of Contract Farming on Farmers' Income in the Food Value Chain: A Theoretical Analysis and Empirical Study in Vietnam. *Agriculture*, 11(8), 797. DOI: 10.3390/agriculture11080797

Kakade, V.B, Suryavanshi, S.S and Shikalgar A.A. (2012). Employment and Income Generation under Contract Farming: A Case Study of Poultry in India. *Conference: 54th Annual Conference The Indian Society of Labour Economics.*

Lagakos, D. & Waugh, M.E. (2013). Selection, Agriculture, and Cross-Country Productivity Differences. *American Economic Review*, 103(2), 948-980.

Mafuse, N., Munyati, V., Mataruse, E., Manyumwa, D., and Chimvuramahwe, J. (2012). A Comparative Analysis of Profitability of Cotton Production under Contract and Non-Contract Farming. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences*, 12(10).

Marsh, D. & Hanlon, T. (2007). Seeing What We Want to See: Confirmation Bias in Animal Behavior Research. *Ethology*, 113, 1089-1098. DOI: 10.1111/j.1439-0310.2007.01406.x.

Mishra, A.K., Kumar, A., Joshi, P.K. & D'Souza, A. (2018). Impact of contract farming on yield, costs and profitability in low-value crop: evidence from a low-income country. *Australian Journal of Agricultural and Resource Economics*, 62:589–607.

Moorthy, K.S. (1993). Competitive Marketing Strategies: Game-Theoretic Models. In Nemhauser, G.L., A.H.G. Rinnooy Kan, J. Eliashberg, and G.L. Lilien (eds.), *Handbooks in Operations Research and Management Science: Marketing*, Vol. 5, Amsterdam, North-Holland.

Nestler, S., Blank, H., & von Collani, G. (2008). Hindsight bias and causal attribution: A causal model theory of creeping determinism. *Social Psychology*, 39(3), 182–188. DOI: 10.1027/1864-9335.39.3.182

Nguyen, H.D. (2017). Profitability and Profit Efficiency of Rice Farming in Tra Vinh Province, Vietnam. *Review of Integrative Business and Economics Research*, 6(1), 191–201.

Obayelu, A.E, Olarewaju, T.O. and Oyelami, N.L. (2014). Effect of Rural Infrastructure on Profitability and Productivity of Cassava-Based Farms in Odogbolu Local Government Area, Ogun State, Nigeria. *Journal of Agricultural Sciences*, 59(2), 187-200.

Olounlade, O.A., Gu-Cheng, L., Traora, L., Ouattara, N., Dossouhoui, F.V., & Biaou, G. (2019). Reputation effect of the moral hazard on contract farming market development: Game theory application on rice farmers in Benin. *African Journal of Agricultural Research*, 14(13), 666-671. DOI:10.5897/AJAR2019.13930

Ogu, M.I. (2013). Rational Choice Theory: Assumptions, Strengths, and Greatest Weaknesses in Application Outside the Western Milieu Context. *Arabian Journal of Business and Management Review*, 1(3).

Olagunju, F.I., Ayinde, O.E., Adewumi, M.O. & Adesiji, G.B. (2012). Effect of rural roads and marketing infrastructure on the income of farming households in Osun state: Implications for sustainable development. *World Rural Observations*, 4(2), 20–30.

Oloyede, W.O., Muhammad-Lawal, A., Amolegbe, K. B., Olaghere, I.L. & Joseph, I.A (2020). Comparative Analysis of the Profitability of Rice Production Systems in Kwara State, Nigeria. *Agrosearch*, 20(2), 82-101

Oluyole, K.A., Yusuf, S.A. & Alao, T.K. (2013). Application of Game Theory to Cocoa Production Management Systems in Ondo State, Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary*, 13(12).

Pazek, K. & Rozman, C. (2009). Decision Making Under Conditions of Uncertainty in Agriculture: A Case Study of Oil Crops. *Poljoprivreda*, 15(1), 45-50.

Rasmusen, E. (2006). *Games and Information: An Introduction to Game Theory*. 4th Edition. Wiley-Blackwell.

Stanovich, K.E. & West, R.F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioural and Brain Sciences*, 23, 645–726.

Swain, B.B, (2008). The Role of Contract Farming for Agricultural Development in Globalize World: An Institutional Economics Analysis. Centre for Development Studies. *MPRA* Paper No. 18683

Tatlidil, F.F. & Akturk, D. (2004). Comparative analysis of contract and non-contract farming models in tomato production. *Journal of Agronomy*, 3(4), 305-310.

Tefera, D.A. & Bijman, J. (2021). Economics of contracts in African food systems: evidence from the malt barley sector in Ethiopia. *Agricultural and Food Economics*, 9. DOI: 10.1186/s40100-021-00198-0

Ulansky, V. & Raza A. (2021) Generalization of minimax and maximin criteria in a game against nature for the case of a partial a priori uncertainty. *Heylion*. DOI: 10.1016/j.heliyon.2021.e07498

Ume, S., Ebeniro, L.A., Azuine, U.A. and Uche, F.O. (2021). Profit Function Analysis of Aquaculture Farmers from Selected States in South East, Nigeria using Cobb-Douglas Stochastic Production Frontier Function. *International Journal of Research and Revi*ew, 8(2), 464-481.

Velde, K.V. and Maertens, M. (2015). Contract-farming in staple food chains: the case of rice in Benin. In 2015 Conference, August 9-14, 2015, Milan, Italy (No. 212205). *International Association of Agricultural Economists*.

Turocy, T.L. & Stengel, B. (2003). Game Theory. In Hossein Bidgoli (ed.), *Encyclopedia of Information Systems*. pp. 403-420. Elsevier. DOI: 10.1016/B0-12-227240-4/00076-9.

Wu, X. & Wang, Q. (2011) Study on the Wald-W Method of Uncertain Decision-Making. Procedia Engineering, 15(2011), 4527-4531.

Yusuf, M. (2018). Comparative Analysis of Profitability between Smallholder Contract and Non-Contract Irrigated Rice Farmers in Kano River Irrigation Project (KRIP), Kano State, Nigeria. *Nigerian Journal of Agricultural Extension*, 19(3), 35–41.