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Agricultural Risk Management and Production Efficiency among Peasant Farmers in Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study analysed relationship between agricultural risk management strategies and production efficiency among peasant farmers in Benue State, Nigeria. Data for the study were collected from randomly sampled 130 peasant farmers in Benue State using a structured questionnaire. Descriptive statistics and inferential statistics were used to analyse data collected. The study showed that majority of the respondents (45.54%) operated within a technical efficiency range of 0.50 and less than 0.90. Majority of the respondents (35.27%) operated within an allocative efficiency range of 0.0001 and less than 0.001. Majority of the respondents (37.50%) operated within an economic efficiency range of 0.0001 and less than 0.001. Technical efficiency among the respondents varied substantially ranging between 0.292 and 1.00, with a mean technical efficiency of 0.778. Allocative efficiency among the respondents varied widely ranging between 0.0001 and 0.869, with a mean allocative efficiency of 0.148. Economic efficiency among the respondents varied substantially ranging between 0.0001 and 0.869, with a mean economic efficiency of 0.127. There was a significant positive correlation between respondents' predicted efficiencies and agricultural risk management strategies adopted by the respondents. Policy should be conscious of the need to ensure the combination of job creation and improvement of overall economic efficiency of the peasant farmers in

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order to enhance their productivity and income generation. There is the need to offer farmers more extension services in their critical areas of needs. This will help the farmers adopt risk mitigating measures that would further reduce or out rightly avert the negative effects of agricultural risks, thereby increasing their agricultural productivity and income. In addition, more rural farmers should be encouraged to join cooperative associations as this can increase their chances of mitigating the negative effects of agricultural risks due to the comparative advantages associated with membership of co-operative societies.

Keywords: Peasant farmers; agriculture; risks; risk management; production efficiency.

1. INTRODUCTION

The world as a whole has been making progress towards improved food security and nutrition. This is clear from the substantial increase in per capita output food supplies achieved globally and for a large proportion of the population of the developing world [1].

Risk among agribusiness investments has become increasingly popular in recent years. The Nigerian agribusiness environment is full of risks and uncertainties arising from several factors. This is obvious considering that agribusiness investment depends on vagaries of the environment and nature. The recent flooding in most part of Nigeria in 2012 especially in Benue State posed a great threat to food security in the state and the nation in general. This is obvious considering that Benue State which is the "food basket of the nation" experienced the most devastating flood as most crops grown in water prone areas were completely wiped out. Yet, a whole variety of methods, tools and practices are not attuned to the fact that the future is uncertain and that risks are all around us. Hence, there has been skepticism about the realization of Millennium Development Goals (MDGs) most especially, cutting of people living under food insecurity by half in 2015 [2,3,4,5,6].

Nigeria being prone to a lot of environmental inconsistencies requires high degree of risk aversion strategy to break the cycle of poverty which engulfed over 70% of its population and also to achieve increased food production to meet 3.18% population growth [7,8,9,10].

Risk which investment economists describe as the variation from expected outcomes due to imperfect knowledge of investor in decision making is inherent in every form of enterprise but is more intensive in input – output relation among agribusiness productions [5,11]. [10] Opined that a situation of imperfect knowledge is more common in agribusiness enterprises. Hence, investors (farmers) face the danger that what they expect ex-ante may not be realized ex-post [12]. For instance each time an investor borrows money for investment in agribusiness enterprise, there is the possibility that return on investment is less than cost of borrowed fund. Also, in this era of global climate change, an investor cannot predict with certainty the degree of fluctuation in prices of input and output.

Obviously, agricultural activities are exposed to greater risk. In fact, agricultural activities are more susceptible to the physical and natural uncertainties than other enterprises. Agricultural activities entail extensive, direct and continuous contact with the forces of nature and in this part of the world where scientific methods are less developed; predicting nature can be less accurate thus, making the primary role of agriculture as the supplier of food and raw materials to the agro-industrial processing and manufacturing sector ineffective. The effectiveness of this primary role of agriculture with less risk can facilitate the other traditional

roles of agriculture as a provider of employment opportunities and income generation and a contributor to foreign exchange earnings through exports. In Nigeria, the rate of achievement of the linkage between agriculture and industrial sector has remained very tardy as a result of risks. This is why [13] and [14] maintained that there is a need for research work to fortify the concept of risk management.

In spite of the growing urbanization and increased revenue from the oil sector, agriculture is the main stream of the Nigerian economy. Nigeria is pronominally rural in population with about 75 percent of the population directly or indirectly dependent on agriculture [6]. The land area is much diversified reflecting various ecological types. Most farmers are smallholders (peasant farmers) with outdated technology; consequently their production level is low. In the past, the peasant farmers have been able to feed the country but in recent times their outputs have been insufficient to satisfy levels of demand generated by the rapidly growing population, increases in real per capita income and rapid urbanization. The nation's decades-long aspiration of realizing self-sufficiency in food production has thus become a failed dream, indeed a mirage. However, despite risk management entering the agenda some decades ago, it has introduced risks on its own that the future is uncertain and that risks are all around us [15].

The Nigerian agribusiness environment is full of risks and uncertainties arising from several factors and these risks affect the efficient conversion of input to output [16,17]. According to [5], risk which investment economists describe as the variation from expected outcomes due to imperfect knowledge of investor in decision making is inherent in every form of enterprise but is more intensive in input – output relation among agribusiness productions. The arrays of hazards in Nigerian agriculture result in low productivity and output instability. Human and economic factors added to the situation making agriculture a high-risk undertaking. Benue State which is the "food basket of the nation" is in the centre stage of the devastating effects of risk factors associated with agricultural production. For example, most crops grown in water prone areas were completely wiped out in the recent flood disaster in Nigeria in 2012. This obviously has necessitated the need to examine the issue of risk management in agricultural production as it concerns the peasant farmers, as this has implication for food security in Nigeria. It is important therefore, to give optimum attention to the peasant farmers, especially in the area of management of risk on their farms since they make up a large portion of the population and as their farms represents an important part of the nation's assets. In this regard, pertinent questions arise. For example, what agricultural risks do these peasant farmers face? What risk management strategies are being adopted to mitigate agricultural risks faced? How are these risk management strategies related to efficient conversion of inputs into output? Therefore, the goal of this study is to analyse the relationship between agricultural risk management strategies adopted by peasant farmers and production efficiency among peasant farmers in Benue State, Nigeria. The null hypothesis that there is no significant relationship between production efficiency and agricultural risk management strategies among peasant farmers in Benue State, Nigeria was tested.

2. LITERATURE REVIEW

2.1 Decision Making Under Risk

The existence of risk and uncertainty adds complexity to many problems and to the decision making process. However, decision must still be made and the manager is faced with

making the best given the uncertainty associated with the available information [18]. Understanding, identifying and assessing the risks based on probability of occurrence and severity of impact is a starting point to develop effective risk management strategies [19].

Agricultural risk management process starts with identification of the risks and ends with risk mitigation through the risk response development [20]. However, three key risk management decisions in the farms are keeping debt low, producing at the lowest cost and good liquidity condition. [21] Maintained that decision for managing risk starts with identifying the most crucial risk you face, understanding the potential impacts and likelihood of desirable outcomes and identifying and taking possible steps to mitigate or lessen the impacts.

[22] Stated that risk management and mitigation can be done at the farmer level or at the community level as a whole. This can be done either with the help of self-insurances for the crop. Risk pooling and mutual insurance at the community level can serve as a method of risk management strategy.

[23,24,22,15] identified the decisions for managing risks, mitigate its impact or to increase the business's ability to survive unfavourable consequences. These decisions are:

i. **Choice of reliable enterprise:** varieties of crops and livestock maybe chosen in preference to the one with variable yields even when the other gives a higher return on average [24].
ii. **Insurance**: The choice between profit maximization and security is particularly obvious where it is possible to insure against risks. By such insurance a private company or state organization guarantees to pay a substantial sum in the event of a major catastrophe in return for a relatively small annual premium. Insurance may cover major risks such as the death of the farmer or some members of his family or it may be used for sickness and accidents which disable the farmer, and for fires or other hazards which can destroy capital items such as buildings, breeding and fattening stock, cars, lorries and other machines. Crops may also be insured against drought. Risk mitigation can be done by the farmers either with the help of self-insurances for crops or risk pooling and mutual insurance at the community level [22].
iii. **Discount for risk:** This means producing less than the economic optimum level of output every year in order to reduce losses in bad seasons. This means that in bad years the farmer makes losses but these are counter-balanced by larger than average profits in good years. The alternative left to farmers is to choose a level of input somewhere between that which minimize losses in bad years.
iv. **Food reserves:** This also provides some security against risk of crop failure, but stored foods are liable to deterioration and losses. Cassava has the particular advantage that it can be left in the ground for up to two years without deterioration; indeed it continues growing. This makes cassava a particular famine reserve in many parts of Africa. This is one of the National Economic Empowerment and Development Strategy (NEEDS). It is an embracing strategy targeted towards poverty reduction, food security and increased industrial capacity utilizations. One of its principal roles is to vigorously increase strategy on the production of cassava. Under this strategy, Nigeria hopes to increase very much on her agricultural export earnings by the year 2015 [7].
v. **Maintaining flexibility:** This refers to the ability to make adjustments in the farm operation in response to changing conditions in order to reduce disruption and fluctuation in income [21]. This is because agricultural risk management is a

proactive approach rather than reactive approach [20]. The farmer does not have to make firm plan at the start of growing season and stick to it rigidity. Thus, if an early planted stable food crops fail, he may re-plant with more drought-resistant variety. If he feels none will be successful he increase the area of famine reserve crop.

vi. **Contracting price in advance:** this is another method of guarding against uncertainty of price fluctuation of agricultural products by farmers. It is an arrangement between a processor, contractor, manufacturer and farmer or farmers group to produce a specified grade and quantity of agricultural products at an agreed price to agribusiness firm at a stipulated future date. Contract of this nature has a lot of advantages [21]. Apart from helping to reduce the variability in prices, the farmer could give precise information about his needs and thus, the producer could more efficiently mobilize his resources which guarantee him of efficient market. The assurance of market enables the manufacturer to take advantage of economies of scale of production which lower the unit cost of production and consequently of the products to the farmer. Usually 60 percent of the sale income is invested for the procurement of materials. As a result, farmers should utilize their internal network more efficiently to manage the purchase related risks [14,25].

vii. **Use of improved technology:** It has been found that technological changes disrupt the suppliers stand in the supply chain [26]. This technological failure affects the efficient conversion of input to output [16]. So the farmers face the danger that what they expect exactly may not be realized as output [12]. For this reason, the use of improved technology such as tractors, spraying machines for weed control, pesticide, storage and processing facilities as well as improved transportation, irrigation etc would guard against the risk of poor harvest, spoilage and unnecessary crop failure. Change of parochial attitudes and ethnocentrism by rural farmers in adopting these innovations will ensure speedy agricultural growth and development and make agriculture a less risky enterprise.

viii. **Information collection:** A farmer can reduce risk and uncertainty by collecting information about the costs and returns for the alternatives open to him and about market prices. A farmer who keeps record of market prices is more likely to be able to predict future price trends and cycles than his less well informed neighbor [23]. The asymmetric “information” between the supplier and the manufacturer could lead to supply chain disruption and finally leads to market failure [27].

Better risk management can be done through improved information technology [28]. Other examples of information needed by the farmers are:

- Crop production and animal performance records;
- On farm fertilizer and variety trials;
- Reliable sources of market outlook;
- Current financial records comparing actual with projected cash flow in order to anticipate difficulties;
- Current regulations and interpretation of compliance requirement;
- Research report to anticipate technological changes.

2.2 Risk Attitudes

Attitudes toward risks are major determinants of the rate of diffusion of new technologies among peasant farmers and of the outcomes of rural development programmes. If they are going to be effective, new technologies and rural development programmes need to be tailored to the attitudes toward risks of particular categories of smallholders. However, [29]

held that attitudes of farmers to risk vary from person to person and from one enterprise to another depending on time and the prevailing climatic, ecological and economic conditions.

According to the work of [30], risk attitudes are divided into three categories namely:

i. Risk averters or risk avoiders: these are characterized as more cautious individuals with preferences for less risky sources of income and investments. [31] defined a risk averter as one who starting from a position of certainty is unwilling to take a bet which is actually fair. Nigeria being prone to a lot of environmental inconsistencies (risks) requires high degree of risk aversion strategy to break the cycle of poverty and also to achieve increased food production [7,8].
ii. Risk preferrers or risk takers: these are more adventuresome with a preference for more risky business alternatives. They are sometimes referred to as "risk lovers".
iii. Risk neutral: this is the limiting case between risk averse and risk preferring. The risk neutral individual chooses the decision with the highest expected returns, regardless of the probabilities associated with alternative level of gains and losses. He essentially ignores risk when making a decision. After all we are talking about food – and everyone eats [32].

2.3 Sources of Risk in Agriculture

The Nigerian agribusiness environment is full of risk and uncertainties arising from several factors. Some of these constraints which compound the practice of agriculture are variability, instability and unpredictability of climate, biological constraint and soil degradation, high cost of inputs, inefficient channel of technology transfer, poor extension services, lack of suitable credit facilities, general man power shortage, land tenure problems which make land acquisition for large scale farming difficult, poor inter and intra-state food trade, political interference in the execution of projects and marketing services. These risks affect the efficient conversion of input to output [16,17].

According to [33,6,34,35], risk sources to agribusiness enterprise can be grouped into social, market, political, financial, production and foreign exchange risks. Social risk is suggestive that the risk or hazard has their origin from man. The risk could be due to fire outbreak, burglary or theft, kidnapping of investors/workers for ransom, embezzlement, strike, civic commotion and changes in social structure, for example, divorce and dissolution of partnership which can lead to unexpected decline in efficient operation of enterprise. Market risk arises due to fluctuation in input and output prices. Political risk is due to changes in government machineries and polices. The use of debt in financing agribusiness investment exposes the firm to financial risk. Foreign exchange risk is borne out of the firm's dependence on foreign currency. Production risk occurs because agribusiness enterprise is affected by many uncontrollable events that are often related to weather, drought, physical hazard to the factory site and technological failure of the firm. This risk affects the efficient conversion of input to output [16,17].

According to [10], the most important sources of risk are technical – drought, market and financial risk. [35] Maintained that the most important risk sources among agribusiness marketing firms in central and eastern Europe are currency and del credere in that order.

[28] Identified the various types of risks for fruits and vegetables to be investment, socio-economic, environmental, production and market risks. Price and production risks are the most vital risks in this case. [21] Opined that as you think about managing risk to stabilize

farm income, there are five basic sources of agricultural risk that you should consider – production, marketing, financial, legal and human resources management risks.

2.4 Peasant Farmers in Agricultural Production

Peasant farmers (small-scale farmers) are part of a large scale system and therefore, their economic behaviour as agricultural producers depends on how the larger system works for them. Their average production ranges from 0.10 – 5.99 hectares. Thousands of Nigerian peasant farmers can be relied upon as a driving force for the transformation of Nigeria's agriculture because they are willing to accept new crops and management practices and are more responsive to price and income incentives.

The government has rightly focused its current agricultural development policy on peasant farmers. Priority must be given to peasant farmers because they constitute about 95% of farm households in Nigeria and produce most of the food crops and livestock consumed in the country [6]. Although medium-scale and large-scale farmers are gradually emerging, Nigeria will continue to depend largely on the smallholder farmers for food supply and economic stability for many years to come.

2.5 Risk and Uncertainty in Agricultural Production

Risk and uncertainty, though used interchangeably in various studies, are not the same. In case of risk the probability is known, it is not known for uncertainty. But both incur losses to the supply chain [24]. The problems pertaining to financial instability, capacity constraints, quality related risks and the technological changes are the major variables found disrupting the suppliers' stand in the supply chain [26].

All agricultural production are exposed to greater risk, since cost has to be incurred in advance of the final output which may turn out to be more or less than was expected. Crops and livestock are highly affected by many uncontrollable events that are often related to weather, drought, physical hazard and technological failure. This risk affects the efficient conversion of input to output [17]. Yet a whole variety of methods, tools and practices are not attuned to the fact that the future is uncertain and that risks are all around us [15]. Rains may arrive early or late or there may be too much or little rain for normal plant growth. In period of drought, the restricted plant growth means that livestock fodder supplies and hence livestock production may also be limited. Then again outbreaks of animals or insects pest and diseases can cause major losses. There is a need for research to fortify the concept of risk [13,14]. Apart from the risk of crop failure or losses of livestock production, there are also risks of sickness, injury or death of family members.

2.6 Types of Risk in Agriculture and Management Strategies

Generally, farmers take some precaution against risk, which may limit their total output or increase their total cost over a period of years. [21] Maintained that there are different tools and strategies to manage agricultural risks with reference to five particular types of risks as follows:

i. **Production Risks**: these relate to weather, drought, physical hazard to factory site and technological failure of firm.

Tools and management strategies:

- Follow recommended production practices.
- Diversify enterprises by growing different crops and varieties.
- Expand production or plant excess acreage.
- Purchase multi-peril crop insurance coverage to stabilize income.
- Adopt appropriate technology such as drip irrigation, tile drainage, or resistant varieties.
- Consider site selection – use or rent acreage less susceptible to specific pests or frosts.
- Maintain equipment and keep facilities in good working condition.

ii. **Marketing/price risks:** these are related to the possibility that you will loss the market for your products or that the price received will be less than expected. This also include lower prices due to increased supply or decreased consumer demand, loss of market access due to relocation or closing of a processor or other buyer, and lack of marketing power due to the small size of farm sellers relative to others in the market.

Tools and management strategies:

- Develop a marketing plan with realistic sales forecasts and target price.
- Form or join a market co-operative to enhance prices and guarantee a market.
- Increase direct marketing efforts to capture a higher price.
- Market through multiple channels or outlets to reduce reliance on a single market.
- Enter into sales or price contracts with buyers.
- Spread harvest and sales over the season by scheduling planting and considering storage options.
- Conduct basic market research-survey of your customers.

iii. **Financial risks:** these relate to the possibility of having insufficient cash to meet expected obligations, lower than expected profits, and loss of network. In addition, financial risk may be caused by increases in interest rates, excessive borrowing, lack of adequate cash or credit reserves and changes in exchange rates.

Tools and management strategies:

- Develop a comprehensive business plan identifying mission, objectives and goals.
- Monitor financial ratios and bench marks related to liquidity, solvency and profitability.
- Control key farm expenses.
- Conduct a trend analysis to assess what is happening with farm income and network over time.
- Purchase whole farm revenue insurance to provide a safety net.
- Communicate with suppliers and lenders to review and renegotiate contracts and loan terms.
- Consider leasing and rental options rather than purchasing machinery, equipment or land.
- Evaluate the possibility of business expansion (getting larger) or contraction (reduce size).

- Control or defer unnecessary family and household expenditures.
- Find off-farm employment for a family member, preferably a job with benefits such as health insurance, group life insurance and a retirement programs.
- Use non-farm investments such as mutual funds to diversify your asset portfolio.

iv. Legal and environment risks: legal risk relate to fulfilling business agreements and contracts. Another source of legal risk is tort liability which means causing injury to another person or property due to negligence. Legal risk is also related to environmental liability and concerns about water quality, erosion and pesticide use.

Tools and management strategies:

- Review business insurance policies and be certain to carry sufficient liability coverage.
- Evaluate your choice of business legal structure.
- Understand business contracts and agreements; ask questions if you are unsure.
- Take time to develop good relationships with neighbour and address their concerns.
- Use good agricultural practices to limit environmental risk.
- Know and follow state and federal regulations relating to your farming operation.

v. Human resources management risks: human resources risks pertain to risks associated with individuals and their relationships to each other, their families and the farm business. Sources of human resource risk include divorce, death or disability of a business owner, manager employee or family member. It also includes risks arising from poor communications and people management practices.

Tools and management strategies:

- Develop and practice good “people skill” for family as well as employees.
- Evaluate alternative sources of labour.
- Provide adequate training for employees; formalized programs may help your safety record as well as improve performance.
- Communicate with employees and family members.
- Review estate and business transfer plans to help insure the farm continuously.
- Consider long-term care and life insurance needs.

3. METHODOLOGY

3.1 The Study Area

Benue State is one of the 36 states of Nigeria located in the North-Central part of Nigeria. The State has 23 Local Government Areas, and its Headquarters is Makurdi. Located between Longitudes 60 35’E and 100E and between Latitudes 60 30’N and 80 10’N. The State has abundant land estimated to be 5.09 million hectares. This represents 5.4 percent of the national land mass. Arable land in the State is estimated to be 3.8 million hectares [36]. This State is predominantly rural with an estimated 75 percent of the population engaged in rain-fed subsistence agriculture. The state is made up of 413,159 farm families [37] and a population of 4,219,244 people [38]. These farm families are mainly rural.

Farming is the major occupation of Benue State indigenes. Popularly known as the “Food Basket” of the Nation, the State has a lot of land resources. For example cereal crops like rice, sorghum and millet are produced in abundance. Roots and tubers produced include yams, cassava, cocoyam and sweet potato. Oil seed crops include pigeon pea, soybeans and groundnuts, while tree crops include citrus, mango, oil palm, guava, cashew, cocoa and *Avengia spp*.

3.2 Sampling Technique

The population for this study is the entire peasant farmers in Benue State. Since it was impractical to study the entire population, a sample of the population was taken for the study. All 13 council wards in Otukpo Local Government Area of Benue State were selected for the study. From each of the council wards, one community was selected using a random sampling technique. Finally, from each community, 10 households were drawn for the study using a random sampling technique. A total of 130 peasant farmers were selected for the study using the randomized sampling design.

3.3 Data Collection

Data for this study were obtained mainly from primary sources. Primary source of information were obtained using a structured questionnaire, copies of which were administered to the 130 peasant farmers selected for the study.

3.4 Analytical Technique

Data for the study was analyzed using both descriptive and inferential statistics. Data Envelopment Analysis was used to analyse production efficiency among the farmers. Spearman’s rank Correlation was used to analyse the relationship between efficiency and risk management strategies among the peasant farmers. The null hypothesis was tested using the Spearman’s rank Correlation permutation test result.

3.5 Model Specification

3.5.1 Data envelopment analysis (DEA) model

In order to predict respondents’ efficiency in the conversion of input to output, the Variable Returns to Scale (VRS) Data Envelopment Analysis (DEA) model specification suggested by [39], which has been the most commonly used specification [40] was used as specified below:

$$\begin{aligned} &\min_{\theta,\lambda}\theta, \\ &\text{st} \quad -y_i + Y\lambda \geq 0, \\ &\theta x_i - X\lambda \geq 0, \\ &N1'\lambda = 1 \\ &\lambda \geq 0, \end{aligned} \qquad (1)$$

where θ is a scalar and λ is an N x1 vector of constants, whereas N1 is an Nx1 vector of ones. The value of θ obtained will be the efficiency score of the i-th Decision Making Unit (DMU). It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU, according to [41] definition.

One would then run the following cost minimization Data Envelopment Analysis:

$$\begin{aligned} &\text{Min}_{\lambda,xi*}\ w_i'x_i^* \\ &\text{st} \quad -y_i + Y\lambda \geq 0, \\ &x_i^* - X\lambda \geq 0, \\ &N1'\lambda=1 \\ &\lambda \geq 0, \end{aligned} \quad \ldots\ldots\ldots\ldots(2)$$

where w_i is a vector of input prices for the i-th DMU and x_i^* (which is calculated by the LP) is the cost minimizing vector of input quantities for the i-th DMU, given the input prices w_i and the output levels y_i. The total cost efficiency (CE) or economic efficiency of the i-th DMU would be calculated as:

$$CE = w_i'x_i^*/w_i'x_i \quad \ldots\ldots\ldots\ldots (3)$$

That is, the ratio of minimum cost to observed cost. One can then calculate the allocative efficiency residually as:

$$AE = CE/TE \quad \ldots\ldots\ldots\ldots (4)$$

Note that the product of technical efficiency and allocative efficiency provides the overall economic efficiency. Note that all three measures are bound by zero and one.

The choice of the DEA model (the non-parametric approach) over the stochastic frontier model (the parametric approach) for the determination of resource use efficiency of the respondents in this study was because DEA offers a flexible approach with considerable scope for the use of diverse data (real and monetary) [42]. DEAP estimates the three efficiency measures (technical efficiency, allocative efficiency and economic efficiency) simultaneously. Furthermore, DEA is deterministic and permits the choice between the constant return to scale (CRS) specifications and the variable return to scale (VRS) specifications depending on whether all decision making units (DMU's) are operating at the optimal scale and otherwise respectively. The DEA approach avoids parametric specification of technology as well as the distributional assumption for the inefficiency [43].

The CRS assumption is only appropriate when all DMU's are operating at an optimal scale. Imperfect competition, constraints on finance, etc. may cause a DMU not to be operating at optimal scale. [39] suggested an extension of the CRS DEA model to account for variable returns to scale (VRS) situations. The use of the CRS specification when not all DMU's are operating at the optimal scale will result in measures of TE which are confounded by scale efficiencies (SE). The use of the VRS specification will permit the calculation of TE devoid of these SE effects.

Many studies have decomposed the technical efficiency (TE) scores obtained from a CRS DEA into two components, one due to scale inefficiency and one due to "pure" technical inefficiency. This may be done by conducting both a CRS and a VRS DEA upon the same data. If there is difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency (SE), and that the scale inefficiency can be calculated from the difference between the VRS TE score and the CRS TE score. Thus, $TE_{I,\ CRS} = TE_{I,\ VRS} \times SE_I$.

3.5.2 Spearman's rank correlation

The Spearman's rank correlation coefficient is defined as the Pearson correlation coefficient between the ranked variables [44]. For a sample of size *n*, the *n* raw scores are converted to ranks x_i, y_i, and ρ is computed from these:

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}.$$

Tied values are assigned a rank equal to the average of their positions in the ascending order of the values. In applications where ties are known to be absent, a simpler procedure can be used to calculate ρ [44,45]. Differences $d_i = x_i - y_i$ between the ranks of each observation on the two variables are calculated, and ρ is given by:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}.$$

The sign of the Spearman correlation indicates the direction of association between *X* (the independent variable) and *Y* (the dependent variable). If *Y* tends to increase when *X* increases, the Spearman correlation coefficient is positive. If *Y* tends to decrease when *X* increases, the Spearman correlation coefficient is negative. A Spearman correlation of zero indicates that there is no tendency for *Y* to either increase or decrease when *X* increases. The Spearman correlation increases in magnitude as *X* and *Y* become closer to being perfect monotone functions of each other. When *X* and *Y* are perfectly monotonically related, the Spearman correlation coefficient becomes 1. A perfect monotone increasing relationship implies that for any two pairs of data values X_i, Y_i and X_j, Y_j, that $X_i - X_j$ and $Y_i - Y_j$ always have the same sign. A perfect monotone decreasing relationship implies that these differences always have opposite signs.

The Spearman correlation coefficient is often described as being "nonparametric." This can have two meanings. First, the fact that a perfect Spearman correlation results when *X* and *Y* are related by any monotonic function can be contrasted with the Pearson correlation, which only gives a perfect value when *X* and *Y* are related by a linear function. The other sense in which the Spearman correlation is non-parametric in that its exact sampling distribution can be obtained without requiring knowledge (*i.e.*, knowing the parameters) of the joint probability distribution of *X* and *Y*.

3.5.2.1 Determining significance

One approach to testing whether an observed value of ρ is significantly different from zero (*r* will always maintain $1 \geq r \geq -1$) is to calculate the probability that it would be greater than or equal to the observed *r*, given the null hypothesis, by using a permutation test. An advantage of this approach is that it automatically takes into account the number of tied data values there are in the sample, and the way they are treated in computing the rank correlation.

In order to determine the relationship between efficient conversion of input to output and agricultural risk management strategies adopted by the respondents, the Spearman's rank correlation coefficient was used. Agricultural risks affect the efficient conversion of input to

output [16,17]. However, three key risk management decisions in the farms are keeping debt low, producing at the lowest cost and good liquidity condition.

Generally, farmers take some precaution against risk, which may limit their total output or increase their total cost over a period of years [21]. Maintained that there are different tools and strategies to manage agricultural risks with reference to five particular types of risks as follows: production risks management strategies, marketing/price risks management strategies, financial risk management strategies, legal and environment risk management strategies and human resources management risks.

In this study, risk management strategies adopted by the respondents were classified into five major groups based on the risk faced. Any farmer who adopted a strategy from any of the five risk management strategies listed above was scored 1 while a farmer who did not adopt a strategy from any of the five risk management strategies was scored 0. The total score was then obtained for each respondent. The total risk management strategies scores were then correlated with the corresponding (DEA) predicted efficiencies of the respondents using the Spearman correlation.

4. RESULTS AND DISCUSSION

4.1 Efficiency Predictions from the Data Envelopment Analysis

The result in Table 1 shows that majority of the respondents (30.77%) operated within a technical efficiency range of 0.01 and less than 0.10. Majority of the respondents (34.62%) operated within an allocative efficiency range of 0.0001 and less than 0.001. Majority of the respondents (37.69%) operated within an economic efficiency range of 0.0001 and less than 0.001. Majority of the respondents (31.54%) operated within a scale efficiency range of 0.0001 and less than 0.001.

The implication of these results is that majority of the respondents were not efficient – technically, allocatively and economically – in the conversion of input to output. Furthermore, the farmers were scale inefficient (did not operate at optimal scale). This finding validates the assertion of [46] that in reality, small-scale producers are not always efficient. This can result to low productivity and low income.

Furthermore, technical efficiency among the respondents varied substantially ranging between 0.292 and 1.00, with a mean technical efficiency of 0.778 (Table 1). This result suggests that the farmers were not converting input to output efficiently, indicating that they were not obtaining maximum output from their given quantum of inputs. In other words, technical efficiency among the respondents could be increased by 22.2% through better use of available production resources, given the current state of technology. This would enable the farmers obtain maximum output from their given quantum of inputs, and hence increase their farm incomes.

Allocative efficiency among the respondents varied widely ranging between 0.0001 and 0.869, with a mean allocative efficiency of 0.148 (Table 1). This result suggests that the farmers were not able to equate the marginal value product (MVP) of the factor to the factor price (P) as they allocate the factors of production for production, indicating that they were utilizing the inputs in the wrong proportions, given input prices. In order words, 85.2% of resources were inefficiently allocated relative to the best-practice farms producing the same

output and facing the same technology in the study area. This implies that allocative efficiency among the respondents could be increased by 85.2% in the study area through better utilization of resources in optimal proportions given their respective prices and given the current state of technology. This would enable the farmers equate the marginal revenue product (MRP) of input to the marginal cost of the input thereby improving farm income.

Table 1. Percentage distribution of the respondents by efficiency estimates

Efficiency estimate	Frequency				Percentage			
	Z_1	Z_2	Z_3	Z_4	Z_1	Z_2	Z_3	Z_4
0.0001<0.001	20	45	49	41	15.38	34.62	37.69	31.54
0.001<0.01	35	39	31	37	26.92	30.00	23.85	28.46
0.01<0.10	40	18	15	20	30.77	13.85	11.54	15.38
0.10<0.50	25	22	23	24	19.23	16.92	17.69	18.46
0.50<0.90	10	6	12	8	7.69	4.62	9.23	6.15
≥ 0.90	0	0	0	0	0.00	0.00	0.00	0.00
Minimum efficiency	0.292	0.0001	0.0001	0.0003				
Maximum efficiency	0.934	0.869	0.869	0.843				
Mean efficiency	0.778	0.148	0.127	0.7024				

Source: Field Survey, 2012

Where:

Z_1 = Technical efficiency
Z_2 = Allocative efficiency
Z_3 = Economic efficiency
Z_4 = Scale efficiency

In addition, economic efficiency among the respondents varied widely ranging between 0.0001 and 0.869, with a mean economic efficiency of 0.127 (Table 1). This result suggests that the farmers in the study area were not able to minimize the cost of production. In other words, 87.3% of production costs were wasted relative to the best-practiced farms producing the same output and facing the same technology in the study area. The implication is that overall (total) economic efficiency among the respondents could be increased by 87.3% in the study area through the reduction in production costs that would occur if production were to occur at the allocatively and technically efficient point given the current state of technology. This would enable the farmers to minimize production costs, and hence maximize income and profit.

Scale efficiency among the respondents varied widely ranging between 0.0003 and 0.127, with a mean scale efficiency of 0.7024 (Table 1). This result suggests that the farmers were operating in less than optimal scale size. In other words, scale efficiency among the respondents could be increased by 29.76 percent by operating in optimal scale size, given the current state of technology. This would enable the farmers operate in optimal scale size, and hence increase their farm productivity and incomes.

The result of a t-test shows that there was a significant difference between the two groups (CRTS specifications and VRTS specifications) of efficiency scores at 5% level of significance (Table 2). This indicates that some of the decision-making units had scale

inefficiency, suggesting that the decision-making units were not all operating at the optimal scale.

Table 2. T-test of no significant difference between the CRTS and VRTS efficiency scores among the farmers

	VRTS	CRTS
Mean	0.955357	0.933036
Hypothesized mean difference	0	
Degree of Freedom	258	
t statistics	6.85	
t critical	2.576*	
Decision	Reject H_0	

Source: Field Survey, 2012.
**Critical value is significant at 1% level of significance (two-tail).*

4.2 Relationship between Efficiency and Agricultural Risk Management Strategies among the Peasant Farmers

The result in Table 3 shows that the null hypothesis that there is no significant relationship between production efficiency and agricultural risk management strategies among peasant farmers in Benue State, Nigeria is rejected at 5% level of significance. The result shows that there was a significant positive correlation between respondents' predicted efficiencies and agricultural risk management strategies adopted among the respondents, suggesting that predicted efficiency and agricultural risk management strategies adopted tend to rise or fall together among the respondents. The results further indicate that while there was a strong positive correlation between agricultural risk management strategies adopted and respondents' predicted technical efficiency, the correlation with agricultural risk management strategies adopted was relatively lower with respect to allocative efficiency and economic efficiency. Nevertheless, the implication of these results is that as efforts to mitigate agricultural risks increases efficient conversion of input to output among the respondents increases and vice versa.

The results showed that there was a significant positive correlation between mitigation of agricultural risk and technical efficiency among the respondents, suggesting a direct relationship between mitigation of risk and technical efficiency among the respondents. The implication is that as effective risk management strategies were adopted to mitigate agricultural risks, technical efficiency among the farmers increase (and this means that the ratio of total output to total inputs for a farm was increasing). This implies that as effective risk management strategies were adopted to mitigate agricultural risks, average productivity increased, suggesting that output was being maximized from a given quantum of inputs.

Furthermore, the results showed that there was a significant positive correlation between mitigation of risk and allocative efficiency among the respondents, suggesting a direct relationship between mitigation of risk and allocative efficiency among the respondents. The implication is that as effective risk management strategies were adopted to mitigate agricultural risks, allocative efficiency among the farmers increased (and this means that the ratio between total cost of producing one unit of output using actual factor proportions in a technically efficient manner and total cost of producing one unit of output using optimal factor proportions in technically efficient manner was decreasing). This implies that as effective risk

management strategies were adopted to mitigate agricultural risks, the cost of technical efficiency decreased, suggesting that production cost was being minimized.

Similarly, the results also showed that there was a significant positive correlation between mitigation of risk and economic efficiency among the respondents, suggesting a direct relationship between mitigation of risk and economic efficiency among the respondents. The implication is that as effective risk management strategies were adopted to mitigate agricultural risks, economic efficiency among the farmers increased (and this means that the costs per unit of output for a farm was decreasing). This implies that as effective risk management strategies were adopted to mitigate agricultural risks, the cost of maximizing output decreased, suggesting that profit was being maximized.

The results further indicate that technical efficiency was more strongly correlated with production risks mitigation; allocative efficiency was more strongly correlated with financial risks mitigation; economic efficiency was more strongly correlated with Marketing/price risks mitigation.

Table 3. Correlation analysis of efficiency and agricultural risk management strategies adopted by respondents

	Z_1	Z_2	Z_3	X_1	X_2	X_3	X_4	X_5
Z_1	1.00							
Z_2	0.332*	1.00						
Z_3	0.894**	0.706**	1.00					
X_1	0.893**	0.194**	0.175**	1.00				
X_2	0.861**	0.255**	0.229**	0.131**	1.00			
X_3	0.854**	0.872**	0.173**	0.161*	0.125*	1.00		
X_4	0.864**	0.870**	0.173**	0.162*	0.123*	0.102*	1.00	
X_5	0.867**	0.250**	0.226**	0.137*	0.103*	0.203**	0.180**	1.00

Source: Field Survey, 2012

** Correlation coefficient (r) is significant at 5% level (2-tailed).*

***Correlation coefficient (r) is significant at 1% level (2-tailed).*

Where:

X_1 = Production risks management strategies.
X_2 = Marketing/price risks management strategies.
X_3 = Financial risk management strategies.
X_4 = Legal and environment Risk management strategies.
X_5 = Human resources management Risks management strategies.
Z_1 = Technical efficiency.
Z_2 = Allocative efficiency.
Z_3 = Economic efficiency.

5. CONCLUSION

The study showed that majority of the respondents was not efficient – technically, allocatively and economically – in the conversion of input to output. Furthermore, majority of the respondents were not operating at optimal scale.

The study also showed that there was a significant positive correlation between respondents' predicted efficiencies and agricultural risk management strategies adopted among the

respondents, suggesting that predicted efficiency and agricultural risk management strategies adopted tend to rise or fall together among the respondents. The results further indicate that while there was a strong positive correlation between agricultural risk management strategies adopted and respondents' predicted technical efficiency, the correlation with agricultural risk management strategies adopted was relatively lower with respect to allocative efficiency and economic efficiency. Nevertheless, the implication of these results is that as efforts to mitigate agricultural risks increases efficient conversion of input to output among the respondents increases and vice versa.

6. RECOMMENDATIONS

Policies should be conscious of the need to ensure the combination of job creation and improvement of overall economic efficiency of the peasant farmers in order to enhance their productivity and income generation. The multiplier effect of this will lead to a quantum leap in agricultural output in Benue State in particular and Nigeria at large.

Sufficient number of extension agents should be deployed to the rural areas so that more peasant farmers can be reached by extension agents and be offered extension services in their critical areas of needs. This will help the farmers adopt risk mitigating measures that would further reduce or out rightly avert the negative effects of agricultural risks, thereby increasing their agricultural productivity and income.

In addition, more rural farmers should be encouraged to join cooperative associations as this can increase their chances of mitigating the negative effects of agricultural risks due to the comparative advantages associated with membership of cooperative societies.

COMPETING INTERESTS

Authors declare that no competing interests exist.

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