

A Mathematical model for the Sustainable Production of Igbemo Rice in Ekiti State Nigeria

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Abstract: *This paper presents a mathematical model for the sustainable production of Igbemo Rice. The study reveals that the key to unlocking the potential of Igbemo Rice lies in Science and technology and empowerment of the producers, marketer and consumers to take advantage of what research offers. Factors considered to enhance Igbemo rice production in Igbemo Ekiti include Land, Improved seed, Agrochemical, credit facilities, processing machine, improved packaging, Extension agents, Regulated market, Research capacity building. The study employed the multiple linear regression models for data analysis.*

Of all the factors considered Credit facilities appeared to be more significant with an indication that if more fund is pumped into the production, poverty will be alleviated to the minimum. It is on this note that the paper presents a mathematical model of sustainable production of Igbemo rice in South West Nigeria.

Keywords: *Igbemo Rice, Investment, Sustainability, Food security, Ekiti- State, Mathematical model.*

1. INTRODUCTION

Agriculture is the largest sector of Nigerian economy, it provides about two-third of the nation's workforce. In spite of this, Nigeria faces acute shortage of food as a result of its low agricultural productivity [1]. Among the foods that Nigerians have food deficit is rice. Rice is a staple crop widely consumed by both rich and poor.

[2] reported that Nigeria import above 5.3 metric tons of rice annually, an equivalent of 260 million US dollars. However, Nigeria has high potential for producing local rice (Igbemo rice) which is mostly found at Igbemo Ekiti and his environment. Igbemo rice is of high nutritional value than the polished imported rice. The local rice competes favorably with imported rice in the market. This is shown by the two types of rice being sold at the same price, in some markets, the local rice commands higher prices than the imported rice.

This is a reflection of the fact that if enhanced, Igbemo rice has the potential of reducing the incidence of food insecurity and alleviates poverty in Nigeria. However, its production suffered from poor investment and low productivity. It is believed that with accelerated investment in Igbemo rice production, food insecurity and poverty will be reduced. So also rice importation and thus improving the Countries GDP.



Figure 1. *Igbemo Rice Farm*

The models provide for the fundamental abstraction of the key concepts and parameters necessary for sustainable development to occur within the concepts of the earth systems. Rice has high contribution to income and food security. It has high cultural value especially in traditional marriages in Nigeria.

However, Igbemo rice is under-researched due to low funding and this has limited the potential of the crop for alleviating poverty. If we attract more investment to advance Igbemo rice production globally, the anticipated benefits and impacts will be quite enormous. Rice production is unexploited in several aspects; actual yield is lower than the potential utilization.

Rice production in South West Nigeria can be enhanced by increasing funding for research and development on Igbemo rice production will help unleash the potential of the crop which will improve livelihoods, create jobs and enhance food security in Nigeria, crop protection, and mitigation of risks due to pests, diseases and climatic change, conservation of genetics resources, prevention of post-harvest losses, improving seed systems, rice diversification, enhancing industrial potential of rice production and improving market access. Increase in investments will pay off and a demonstration of Rice greater potential will come out than what is being realized.

Rice is widely cultivated with high production in South-East Asia, the United States (the largest exporter of rice in the world) and Southern Europe regions [3]. It is a staple diet in Japan and India - where annual rice productions exceed 40 million metric tons [1]. Thailand and Vietnam depend on rice production as the mainstay of their economies [4]. In sub-Saharan Africa, West Africa is the leading producer and consumer of rice, widely produced in Cote d'Ivoire, the Gambia, Guinea, Guinea Bissau, Liberia, Burkina Faso, Senegal and Sierra Leone [3]. According to [5], the mangrove rice cultivation - a highly specific type of lowland rice production is favored in the region which accounts for one-tenth of total rice production in Africa.

Rice is cultivated in virtually all the agro-ecological zones in Nigeria [6]. Cultivation of rice in appreciable scale and dimension commenced in Nigeria during the Second World War due to a halt in the importation from the far East [7]. From the mid-1970s, rice consumption in the country rose significantly as a result of accelerating population growth rate of 2.8% per annum [8]. No doubt, rice production has also expanded as a result of vast increase in land area put under cultivation, "but this was still considered insufficient to match the consumption increase" [9].

Nigeria is Africa's second largest economy, with 75 million people living in poverty [10]. It has a federal structure of 36 states – Ekiti State inclusive. In South-Western Nigeria, Ekiti State is the least-developed in social and economic terms. Rice farming is a primary activity among the farmers in the state where 70 percent are actively engaged in its production [10]. Most Nigerians prefer local rice varieties because of their taste and smell. However, unhygienic processing has hindered our local rice from competing favorably with imported rice [3]. It is becoming increasingly clear that, Igbemo-Ekiti is acquiring national and international reputation for producing rice.



Figure 2. *A Section of Igbemo Rice*

1.1 Objectives of the study

Sustaining rice production seeks to balance three long term goals, growth in economy, friendliness to environment and acceptance of people. The right blend of the goals is greatly indispensable for food security.

1.2 Roles of mathematical model

A model is a concept or an object that represents something else, it is often like the real object but in a compact form. A mathematical model is a model whose concepts are mathematical.

Mathematical modeling is the process of creating a mathematical representation of some phenomenon in order to gain a better understanding of that phenomenon. It is a process that attempts to match observation with symbolic statements. During the process of building a mathematical model, the modeler will decide what factors are relevant to the problem and what factors can be de-emphasized. Once a model has been developed and used to answer questions, it should be critically examined and often modified to obtain a more accurate reflection of the observed reality of that phenomenon. In this way, mathematical modeling is an evolving process; as new insight is gained, the process begins again as additional factors are considered. Generally the success of a model depends on how easily it can be used and how accurate are its predictions.

One can think of mathematical modeling as an activity that allows a mathematician to be a chemist, an ecologist, an economist, a physiologist etc instead of undertaking experiments on mathematical representations of the real-world. Also, mathematical modeling is the use of mathematics to describe the real-world phenomena, investigate important questions about the observed world, explain real world phenomenon, test ideas and make predictions about the real-world. The real-world refers to engineering, physics, physiology, ecology, wild-life, management, chemistry, economics, etc.

Definition 1.0

Mathematical Model is the representation of the essential aspects of an existing system (or a system to be constructed) which presents knowledge of that system in usable form.

It usually describes a system by a set of variables and a set of equations that establish relationships between the variables. The values of the variables can be practically anything; real or integer numbers, Boolean values or strings, for example. The variables represent some properties of the system, system outputs can be measured in the form of signals, timing data, counters, event occurrence (yes/no). The actual model is the set of functions that describe the relationships between the different variables.

Mathematical models are basically a simplified description of a system built to help us understand the operation of a real system and the interactions of its main and relevant components.

2. METHODS

For a better result, two hundred and fifty Igbemo rice farmers were selected from the town through random sampling technique. The study employed the use of a multiple linear regression model. This is applicable when the data are multivariate. It relates a **response** variable y to **more** than one explanatory variable x .

The model is given by

$$\left. \begin{aligned} y_i &= \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_k x_{ki} + \varepsilon_i, \\ i &= 1, 2, \dots, n. \end{aligned} \right\} \quad (1)$$

Where

y Is the output of the rice production in Igbemo Ekiti,

β_0 Is the intercept of the model,

x_{1i}, \dots, x_{ki} Is the number of explanatory variables

$\beta_0, \beta_1, \dots, \beta_k$ Are the parameters of the model and

ε_i Is the error term.

The above model (1) can be used to assess the relationship between the output of rice production in Igbemo Ekiti and some selected factors inputs such as

Land (x_1),

Improved seeds of Igbemo rice (x_2),

Agrochemicals (x_3),

Credit Facilities (x_4),

Processing machines (x_5),

Improved packaging x_6 ,

Extension agents (x_7),

Research capacity building (x_8)

(1) Yields

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_8 x_{8i} + \varepsilon_i, \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \end{array} \right\} \quad (2)$$

$i = 1, 2, \dots, n.$

If the regression is not significant, then y does not depend on the x 's [11] Then the hypotheses may be written as:

$$H_0 : \beta_1 = \beta_2 = \dots = \beta_8 = 0$$

(y does not depend on x's) model: $y_i = \beta_0 + \varepsilon_i$

$$H_1 : \text{at least one of the } \beta_i \neq 0$$

model: $y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_8 x_{8i} + \varepsilon_i$

3. RESULTS AND DISCUSSION

$$\text{Test Statistic } F = \frac{MS(\text{regression})}{MS(\text{residual})}$$

This concludes that y depends on x. Out of all the variables considered, credit facilities, x_4 is more significant than $x_1, x_2, x_3, x_5, x_6, x_7, x_8$ which shows that if more funds is released into the production of Igbemo rice, all other variables will be affected positively i. e. an increase in x_4 leads to increase in all other factors. From the rank coefficient, r of (2), we have that

$r > 0 \Rightarrow$ There exists correlation between y and the selected factors.

$$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8$$

Sustaining and enhancing funding support for rice research and development backed by political will are needed to unlock the crop's full potential

Increasing funding for research and development on rice will help unleash the potential of the crop, improve livelihoods, create jobs and enhance food security in Africa because of its contribution to incomes and food security, rice also has high cultural value especially in traditional marriages in Africa. However, the crop is under-researched due to low funding and this has limited the potential of the crop for alleviating poverty

4. CONCLUSION

The study reveals that high investment into the production of Igbemo rice would lead to increase in all these variables Land (x_1), improved seeds of Igbemo rice (x_2), agrochemicals (x_3), credit facilities (x_4), processing (x_3), credit facilities (x_4), processing machines (x_5), improved packaging x_6 , extension agents (x_7), research capacity building (x_8). The study recommends that more funds should be injected into Igbemo rice production to boost the productivity and sustainability of Nigeria economy. Agricultural should be established to give loans to farmers at a low interest rate. Establishment of Agro-allied industries should be encouraged to create job opportunities and sustainable use of natural resources in the region. "If we attract more investments to advance and expand rice research globally, the anticipated benefits and impacts will be quite enormous,"

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I got a Ph.D. in Mathematics (Numerical Analysis) 2010, M.Sc. in Mathematics 2004, and B.Sc. in Mathematics 1999. I have been actively involved in research and teaching for over fourteen years and I have published numerous articles in highly rated journals. I am a member of various local and international societies. I have also served and still serving as a member of several committees at the departmental, faculty and university levels.