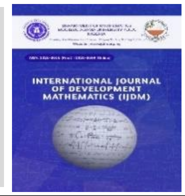
INTERNATIONAL JOURNAL OF DEVELOPMENT MATHEMATICS

ISSN: 3026-8656 (Print) | 3026-8699 (Online)

journal homepage: https://ijdm.org.ng/index.php/Journals



Optimization of Rice Production: A Case Study of Rabba in Mokwa Local Government Area of Nigeria

Tajudeen. O Aliu[a,*], Yisa Elisha[a], Adediran. D. Adeshola[a], Rasheed. O. Ayinla[a]

[a]Department of Mathematics and Statistics, Kwara State University, Malete, Kwara State, Nigeria

ARTICLE INFO

Article history:
Received 04 September 2005
Received in revised form 08 February 2026
Accepted 20 February 2026

Keywords:
Optimization, Linear programming, maximum yield and Rice Production

MSC 2020 Subject classification:
65K10, 90C08

ABSTRACT

This research work aimed at optimizing rice production in Nigeria using linear programming approach. Data were collected from Rabba farm in Mokwa Local Government Area of Niger State. Five varieties of rice namely; Gwali (R_1), FARO 44, FARO 68, FARO 61 and Ebangichi commonly grown by the farmers in the community were selected for the work. The computation of results to identify the variety of rice with high and low yield was done with the use of MATLAB. The results revealed that both Gwali (R_1) and Faro 68 have the tendency of producing higher yield, followed by FARO 61 and Ebangichi, while FARO 44 produced relatively low yield. The maximum profit attained was #14,510,580.89. Sensitivity analysis was carried out to investigate the impact of change in parameter value (price) on the profit of the variety with lower yield (faro 44). The sensitivity analysis revealed also that faro 44 still has the tendency of producing lower yield, with Faro 68 and Gwali (R_1) having the tendency to produce higher yield with no significant change in the profit of the farmers. Sequel to this analysis, farmers in the area are encouraged to grow varieties with tendency of higher yield to enhance maximum production with a view to satisfying the demand for rice in the area, and the country at large.

1. Introduction

Rice is one of the major staple foods in Nigeria; it is the third most popular staple food after cassava and maize, consumed across all geographical zones and social-economic classes Dzarm et al (2024). Rice plays a central role in household food consumption in many Nigerian home. It has the advantage of easy preparation by young and old. According to United State Department of Agriculture (USDA), rice production in Nigeria slowed to 5.23 metric tonnes in 2024, down from 5.61 metric tonnes in 2023 and 5.41 metric tonnes in 2022. It was further reported that rice consumption in Nigeria annually surpasses seven (7) million metric tonnes over the past five years. Approximately 7.6 metric tonnes of rice was said to be consumed in 2024, a rise from 7.55 metric tonnes in 2023 and 7.5 metric tonnes in 2022. Yet, only about half of this demand is met domestically Premium Time (2025).
Russon (2019) reported that Nigeria is the country with the highest consumption of rice in the continent, one of the largest producer of rice in Africa and the largest rice importers in the world.
The country's overdependence on rice importation was noticed as far back as 2017, when just about 3.7 million metric tonnes was produced locally Imolehin et al (2018). It is however worth noting that many states in the country now grow rice in large quantities. Among these are, Niger, Kebbi, Kano, Kaduna, Benue, Ebonyi, Kogi, Jigawa, Cross Rivers, Ogun, and Ekiti state. Currently, most of the farmers producing rice predominantly use traditional methods, which often result in low and poor yields. To enhance productivity of rice in Nigeria, Dzarm et al (2024) observed that adopting improved varieties of rice and having good knowledge of the rice economy is of paramount importance. Availability of quality and adequate farm input is another impetus towards improving production level of rice. Daniel and Afofum (2019) identified the basic cost inputs in the cultivation of rice as: the cost for fertilizer, pesticide, insecticide, herbicide, irrigation, hired labor, seed and seedling. Scarcity of resources to acquire necessary inputs

* Corresponding author. Tel.:+2348055825778
E-mail address: xxx@gmail.com (Aliu, T. O.)
https://doi.org/10.62054/ijdm0301.18

according toBrechenmacher (2019) is a major contributor topoor rice yield. Despite several efforts put by researchers, rice production in Nigeria still fail to meet the country's demand. Ajiboye et al(2021) used the Johansen error correction model to investigate rice yield response in Nigeria. Putri*et al* (2018) made use of crop health and soil fertility to develop a prediction model for rice production using multiple regression analysis. Abiola et al (2016) carried out modification on the Cobb-Douglas production function to determine rice yield in Mada, Malaysia. Their model however failed to consider the effect of constraints. Chikezie et al (2020) was able to predict farm-level technical efficiency using the Cobb-Douglas production function model. Yahya et al (2024) identified several factors as responsible for preventing attainment of optimal rice production level; among these are: environmental variability, land use inefficiency and rising cost of production. Using the multivariate linear regression (MLR) method, input variables such as rainfall, temperature, humidity, land area used and production cost are responsible to variation in optimal rice yield in the country. Sambu and Malik (2025) stated that despite the noble position of India as the second largest producer of rice in the World after china, the country still records a low growth rate in productivity of rice. Their findings identified over reliance on monsoon rains, regional concentration and climatic shocks as key factors; thus recommending the Promotion of drought-resistant and flood-resistant rice varieties. Shikh et al (2016) estimated the parameters of the Neo-Classical and Cobb-Douglas production function using Ordinary Least Squre (OLS) method to examine determinants of rice production in Jaffarabad district in Balochiston (Pakistan). Their investigation revealed that, explanatory factors; capital, labor, education, availability of credit loan and farm size have positive effect on rice output, while farmer's experience and cost of input do not.

Ingio et al (2024) adopted the Multilinear Regression (MLR) coupled with Recursive Future Elimination (RFE) to predict rice yield in Adamawa and Cross River states of Nigeria. Despite the significant contributions from these studies, rice production in Nigeria remains insufficient to meet the demand.

Linear programming kind of optimization model has been found useful in several arears of human endearvour. Aliu et al (2024) employed linear programming to determine efficiency level for power distribution in Ilorin metropolis. The same programming method was carried out to minimize the cost of pig feeds in Nigeria. Aliu et al (2023). Siddharth et al (2025) used linear programming model to increase profit at Sunshel Textiles, a garment manufacturing company in Gujarat, India. Linear Programming model was also developed for optimization of product mix and profit maximization by Kalwaret al (2022). The research was conducted at ABC Leather Footwear Company of Lahore, Pakistan. Their findings revealed that a 25% reduction in production lead to 39% additional profit to the company, when linear programming method was used.

Thus, the development of a comprehensive rice yield model that incorporates rice input variables and production constraints could significantly enhance rice productivity in the country. The aim of this research is to construct linear programming model for rice production with a view to identify high and low yielding varieties and varieties with low cost of production in the study area.

2 MATERALS AND METHODS

2.1 Study Area

This study was conducted at Rabba Community in Mokwa local government area of Niger state, Nigeria. The community is on Latitude $9^0 17^I 0N$, $5^0 3^I$ 0E. Rainfall is steady and evenly distributed, usually between May and November, varying from 1,100mm to 1,600mm. Its maximum temperature is normally 37^oC which is recorded between March and June, while minimum temperature is around 21^0C recorded between December and January.

2.2 Materials

Single sample technique was used in the study. Five (5) varieties of both local and improved rice namely; Gwali (R_1), FARO 44, FARO 68, FARO 61, and Ebangichi were used, with rice farmers selected based on the variety of rice produced and thesize of their farms.

2.3 Data collection

Fifteen (15) farmers were engaged in oral interview individually and separately to get information on the cost involved in the rice production from the process of land preparation, cost of seed/seedling, cost of fertilizer and application, cost of chemicals and application, cost of Irrigation, harvesting and the profit made from the sales.

2.4 Data analysis

Collected data was subjected to analysis using Linear Programming Model developed to identify the most yielding variety for optimum production.

2.5 DATA DESCRIPTION

Data on the optimization of rice production in Nigeria was collected for use in this study. Linear programming technique was employed to determine varieties of rice that farmers in the study area can rely on for customer satisfaction and profit making.

Fig1: Map of the Study Area

2.6 LINEAR PROGRAMMING MODEL FOR OPTIMIZATION OF RICE PRODUCTION

The linear programming model states as follows:
Optimize

$$Z = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5$$

Subject to:

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 + a_{15}x_5 \leq b_1$$
$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + a_{24}x_4 + a_{55}x_5 \leq b_2$$
$$a_{31}x_1 + a_{13}x_2 + a_{33}x_3 + a_{34}x_4 + a_{35}x_5 \leq b_3$$
$$a_{41}x_1 + a_{42}x_2 + a_{43}x_3 + a_{44}x_4 + a_{45}x_5 \leq b_4$$
$$a_{51}x_1 + a_{52}x_2 + a_{53}x_3 + a_{54}x_4 + a_{55}x_5 \leq b_5$$
$$x_i \geq 0;\ i = 1(1)5$$

Where

x_i =Tendency that type i rice gives higher profit.

c_j =Profit realized from the sale of type jrice.

a_{1j} = Cost of fertilizer used to grow type j rice.

a_{2j} =Cost of chemical used to control insects and pests affecting type j rice grown.

a_{3j} = Cost of irrigation to grow type j rice.
a_{4j} = Transportation cost on type j rice growing.
a_{5j} = Cost of harvesting type j rice.
a_{6j} =Cost of Land preparation to grow type j rice.
a_{7j} = Cost of seed/seedling for type j rice grown.
a_{8j} =Cost of fertilizer application for growing type j rice.
b_j =Total average cost for each identified eight areas of facilitating growth and production of the five varieties of rice in the study area.

2.6 SIMPLEX METHOD

The Simplex Method: This is a computational approach for solving linear programming problem consisting of many variables.
Using this method, the following algorithm will be adopted.

i. If the problem is of minimization, we convert it to maximization problem by multiplying the objective function Z by (−1);

ii. Ensure that all $b_j s$are positive;

iii. Convert all inequalities to equalities by adding slack variables or subtracting surplus variables;

iv. Find the starting basic feasible solution;
Construct the starting simplex table as follows.

BV	CV	X_1	X_2	X_3	...	X_n	X_{n+1}	X_{n+2}	,,			X_b
X_{n+1}	0	a_{11}	a_{12}	a_{13}	...	a_{1n}	1	0				b_1
X_{n+2}	0	a_{21}	a_{22}	a_{23}	...	a_{2n}	0	1				b_2
X_{n+3}	0	a_{31}	a_{32}	a_{33}	...	a_{3n}	0	0	1	0		b_3

.														
.														
X_{n+m}	0	a_{m1}	a_{m2}	a_{m3}	...	a_{mn}	0	0	0	0	0	1		b_m
Z_j		0	0	0	...	0	0	0	0	0	0	0	0	
C_j		c_1	c_2	c_3	...	-	-	-	-	-	-	-	C_n	
$Z_j - C_j$		$-c_1$	$-c_2$	$-c_3$	...	-	-	-	-	-	-	-	- - C_n	

v. Test for the optimality of the Basic Feasible Solution (BFS) by computing $Z_j - C_j$, if $Z_j - C_j \geq 0$, then the solution is optimal. Otherwise go to step vii.

vi. Improve on the BFS' by identifying the incoming and outgoing vectors. The incoming vector is the variable which corresponds to the greatest minimum value of $Z_j - C_j$, while the outgoing vector is the variable which corresponds to the smallest ratio $\frac{b_j}{a_{ij}}$ for all a_{ij} >0 along the incoming vector row.

vii. Ensure that the pivotal element becomes a unity, with all other elements along the pivotal column zero. We obtain the next table by using row reduced operation.

viii. Test for the optimality, if not optimal, go back to step vii.

3 RESULTS AND DISCUSSION

The result on table 1 shows that Ebangichi has the highest cost of production, followed closely by Gwail (Ri), FARO 61, FARO 68 and FARO 44. The Constraints, Fertilizer had the highest cost across the varieties while its application had the least cost of ₦34,500 across the varieties.

Table1: Data on the cost of production of the selected varieties of rice

Constraints	Varieties of Rice					Total Cost
	Gwali(R_1)	Faro 44	Faro 68	Faro 61	Ebangichi	
Fertilizer cost	134,000	100,000	134,000	133,000	122,000	623,000
Chemical cost	21,600	7,900	12,000	17,000	24,000	82,500
Irrigation cost	25,000	17,000	15,000	18,000	28,000	103,000
Transportation cost	22,400	-	-	25,600	20,000	68,000
Harvesting cost	20,000	35,000	45,000	40,000	38,000	178,000
Land preparation cost	55,000	33,000	35,000	36,000	40,000	199,000
Cost of seed/seedlings	44,000	22,000	33,000	33,000	66,000	198,000
Cost of fertilizer App	6,500	5,000	8,500	8,000	6,500	34,500
Total cost	328,500	216,900	282,500	310,600	344,500	

Table 2: Proceed from the sale of each category of rice harvested

Rice Categories	Number of bag produced	Price per bag	Total sales
Gwali(R_1)	45	76,000	3,420,000
FARO 44	35	50,000	1,750,000
FARO 68	43	80,000	3,440,000
FARO 61	48	74,625	3,582,000
Ebangichi	52	65,000	3,380,000

‘

Table 3 depicts the selling price, cost price, and profit realized from sales of produce. Higher profit was recorded from the sales of FARO 61 (₦3,271,400), followed by FARO 68 (₦3,157,500) while FARO 44 gave the least profit of (₦1,533,100).

Table 3 Profit for each variety of rice

Name	Selling Price	Cost price	Profit
Gwali (R_1)	3,420,000	328,500	3,091,500
FARO 44	1,750,000	216,900	1,533,100
FARO 68	3,440,000	282,500	3,157,500
FARO 61	3,582,000	310,600	3,271,400
Ebangichi	3,380,000	344,500	3,035,500

Table 3 shows the profit realized from each variety of rice produced.

The Linear Programming Model depicts as follows:

$$Max\ Z_p = 3,091,500x_1 + 1,533,100\ x_2 + 3,157,500\ x_3 + 3,271,400x_4 + 3,035,500x_5 \quad (2)$$

Subjectto

$$134,000\ x_1 + 100,000\ x_2 + 134,000\ x_3 + 133,000\ x_4 + 122,000x_5 \leq 623,000 \quad (3)$$

$$21,600x_1 + 7,900\ x_2 + 12,000\ x_3 + 17,000x_4 + 24,000\ x_5 \leq 825,000 \quad (4)$$

$$25,000\ x_1 + 17,000\ x_2 + 15,000\ x_3 + 18,000\ x_4 + 28,000\ x_5 \leq 103,000 \quad (5)$$

$$22,400\ x_1 + 0x_2 + 0x_3 + 25,600\ x_4 + 20,000x_5 \leq 68,000 \quad (6)$$

$$20,000x_1 + 35,000\ x_2 + 45,000x_3 + 40,000\ x_4 + 38,000\ x_5 \leq 178,000 \quad (7)$$

$$55,000x_1 + 33,000\ x_2 + 35,000\ x_3 + 36,000\ x_4 + 40,000\ x_5 \leq 196,000 \quad (8)$$

44,000 x_1+ 22,000x_2+ 33,000 x_3+ 33,000x_4+ 66,000 x_5≤ 198,000 (9)

6,500x_1+ 5,000 x_2+ 8,500 x_3+ 8,000x_4+ 6,500 x_5≤ 34,500 10)

$x_i \geq 0$, i = 1(1)5

Introducingslack variables, we obtain
Max Z_p= 3,091,500 x_1 + 1,533,100 x_2 + 3,157,500 x_3 + 3,271,400 x_4 + 3,035,500 x_5(11)
Subject to
134,000 x_1 + 100,000 x_2 + 134,000 x_3 + 133,000 x_4 + 122,000 x_5 + x_6 = 623,000(12)
21,600x_1 + 7,900 x_2 + 12,000 x_3 + 17,000 x_4 + 24,000 x_5 + x_7 = 825,000(13)
25,000 x_1 + 17,000 x_2 + 15,000 x_3 + 18,000 x_4 + 28,000 x_5 + x_8 = 103,000 (14)
22,400 x_1 + 0 x_2 + 0 x_3 + 25,600 x_4 + 20,000 x_5 + x_9 = 68,000(15)
20,000 x_1 + 35,000 x_2 + 45,000 x_3 + 40,000 x_4 + 38,000 x_5 + x_{10} = 178,000 (16)
55,000 x_1 + 33,000 x_2 + 35,000 x_3 + 36,000 x_4 + 40,000 x_5 + x_{11} = 196,000 (17)
44,000 x_1 + 22,000 x_2 + 33,000 x_3 + 33,000 x_4 + 66,000 x_5 + x_{12} = 198,000 (18)
6,500 x_1 + 5,000 x_2 + 8,500 x_3 + 8,000 x_4 + 6,500 x_5 + x_{13} = 34,500 (19)
$x_i \geq 0$, i = 1(1)13

INITIAL SIMPLEX TABLE

BV CV	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_B
X_6 0	134000	100000	134000	133000	122000	1	0	0	0	0	0	0	0	623000
X_7 0	21600	7900	12000	17000	24000	0	1	0	0	0	0	0	0	825,000
$X_8$0	25000	17000	15000	18000	28000	0	0	1	0		0	0	0	103,000
X_9 0	22400	0	0	25600	20000	0	0	0	1	0	0	0	0	68,000
X_{10} 0	20000	35000	45000	40000	38000	0	0	0	0	1	0	0	0	178,000
X_{11} 0	55000	33000	35000	36000	40000	0	0	0	0	0	1	0	0	196,000
X_{12} 0	44000	22000	33000	33000	66000	0	0	0	0	0	0	1	0	198,000
X_{13} 0	6500	5000	8500	8000	6500	0	0	0	0	0	0	0	0	34,500
Zj	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cj	3091500	1533100	3157500	3271400	3035500	0	0	0	0	0	0	0	0	
Zj-Cj	-3091500	-153310	-3157500	-3271400	-3035500	0	0	0	0	0	0	0	0	

Figure 3.1: Initial Simplex Tableau

The Solution is not optimal, Hence x_9 leaves the basis while x_4 enters. The pivot element is 25,600

The first iteration table in the linear programming optimization process was carefully computed and tested for optimality of the basic feasible solution (BFS) by computing $\delta_j = Z_j - C_j$. Since $\delta_j$is not positive, shows that the solution is not optimal. We further compute the result using MATLAB. The software indicted that the optimal solution is attained at the 8th iteration with the following results:

$$x_1 = 1.479737545371131$$
$$x_2 = 0.000000000000004$$

$x_3 = 1.624183319373078$
x_4 =0.785509154002506
x_5 =0.737242232061000
Z_P =#14,510,580.89

4 SENSITIVITY ANALYSIS

Sensitivity analysis was carried out to determine the impact of change in parameter values in the objective function and or the constraints on linear programming model. It is a technique used to examine how change in input parameters or variables affects the output of a model or system.
We consider an increase in the price of FARO 44 rice variety from #50,000 to #60,000 leaving prices of other varieties unchanged. The effect of this change can be found on table 4.

Table 4: Effect of change in price of Rice variety

Rice Categories	Number of bag produced	Price per bag	Total sale	Total profit
Gwali(R_1)	45	76,000	3,420,000	3,091,500
Faro 44	35	60,000	2,100,000	1,883,100
Faro 68	43	80,000	3,440,000	3,157,500
Faro 61	48	74,625	3,582,000	3,271,400
Ebangichi	52	65,000	3,380,000	3,035,500

The new objective function reads:

$$\text{Max } Z_p = 3{,}091{,}500x_1 + 1{,}883{,}100\ x_2 + 3{,}157{,}500\ x_3 + 3{,}271{,}400x_4 + 3{,}035{,}500x_5$$

.
While the MATLAB result indicates as follows:

$$x_1 = 1.479737545009269$$
$$x_2 = 0.000000014293694$$

$x_3 = 1.624183316108073$

$$x_4 = 0.785509159500268$$
$$x_5 = 0.737242218181165$$

$$Z_P = \#14510580.89$$

5 DISCUSSION

In this study, five varieties of rice commonly grown by farmers in Rabba area of Mokwa Local Government Area of

Niger State were considered, with a view to identify the highly producing ones that maximizes the profit margin of the farmers. The cost involved from planting stage to marketing of the product was identified for all the varieties of rice in the study area. Total profit after sales was determined for each variety. The data was modelled in linear programming, consisting of both the objective functions and the constraints. The model was subjected to analysis using MATLAB solver. The result revealed that, FARO 44 has the tendency of producing lower yields compared to others. Faro 68 followed by Gwali (R_1) have positive contribution to the profit of the farmers, approximated to #14,510,580.89. The sensitivity Analysis further indicated that FARO 68 and Gwali (R_1) surperssed others in contributing to the objective function. While FARO 44 was still at the base of contribution to the farmer's profit.

6 CONCLUSION

This study aimed at developing an optimization model to identity the variety of rice with higher yield and lower yield respectively. The adoption of MATLAB software to solve the linear programming problem formation using data collected from rice producing farmers in Rabba area of Mokwa local government, Niger state, enhanced easy identification of the research objective.

Sequel to the results obtained in the analysis, it becomes highly relevant to state that:

FARO 68 Rice out performs other varieties in terms of yield, with an increase yield of about 34% compared to others.

Farmers are advised to consentrate on the growing of Rice varieties with higher tendency for better yield. If they must engage in production of low yielding varieties, there should be an upward review of the selling price.

It could therefore be concluded that farmers should be encourage to cultivate FARO 68 variety due to its higher yielding potential.

REFERENCES

Abiola, O. A., Mad, N., Alias, R., & Ismail, A. (2016). "Resource use and allocative efficiency of paddy rice production in mada, Malaysia". *Journal of Agriculture* 7(1). 49 – 55.

Ajiboye, A., Aturamu, O. A., Amao, S. A., and Farayola, C. O. (2021). "Yeild response of Nigeria rice agriculture.. (19720-017)." *Jounal of Agriculture*. 6(3), 98-104. Doi:10.31248/JASP 2021.278.

Aliu, T. O., Gbolagade, M. G., and Adeshola, A. D. (2023). "Application of linear programming on cost minimization of Pig Feed (A case study of MOV farm Ilorin)" *Earth line Journal of mathematical science,* 13,(1), 267-289. DOI: https://doi.org/10.34198/ejms.13123.267289.

Aliu, T.O., Issa, S.F., Issa, K . -. And Owolabi, Y.T. (2024). "Optimization of Electric Power Distribution in Ilorin Metropolis". *Journal of Research and Innovation in Applied Science (IJRIAS)*. 9(15) pg 474 - 485.). DOI: https://doi.org/10.51584/IJRIAS.2024.905042.

Brechenmacher, S. (2019).Stabilizing Northeast Nigeria after Boko haram. *Carnegie endowment for international peace.working paper.*

Chikezie, C., Benchendo, G., Ibeagwa, O., Oshaji, I., and Onuzulu, O. (2020). "Analysis of technical efficiency among rice farmers in Ebonyi State of Nigeria" .*A stochastic frontier approach.Journal of agriculture and food science,* 18(1), 40-49.

Daniel E. J. and Afofum A. A. (2019). "Econometric Analysis of Efficiency of Rice input-output Relationship in Yobe State". *International Journalof Innovative Finance and Economic Research.* 7(4), 101-109.

Dzarma, E. D., Nyor, N. &Degla,G. (2024). "Modeling and optimization of rice production in Nigeria:bibliometric analysis and future research. *International Jouner of Physical Sciece*. 19(1), 47-57.

Imolehin, E. D & Wada, A. C. (2018). "Meeting the rice production and consumption demand of Nigeria with improved Technologies". *National cereal Research Institute, Baddaggi, Niger State, Nigeria,* 1-11.

Ingio, A. S., Nsang, and Iorciam. (2024) "Optimizing Rice Production Forcasting Through Integrating Mutltiple Linear Regression with Recursive Feature Elimination", *J. Fut. Artif. Intell. Tech*. 1(2), 96-108.

Kalwar, M. A., Khan, M. A., Shahzad, M. F., Wadho, M. H., Marri, H. B. (2022) "Development of Linear Programming Model for Optimization of Product Mix and Maximization of Profit: Case of Leather Industry". *J. App/Res Eng. Technol. and Engineering* 3(1), 67-78. https://doi.org/10.4995/jarte.2022.16391.

Putri, R., Yahaya, A., Adam, N., and Abdul-aziz, S. (2018). "Rice yield prediction model with respect to crop healthiness and soil fertility". *Food and Agricultural Organization of United Nation. FAO AGRIC – International System for agricultural Scienceand Technology*. 3(2), 171-176. ISSN 2550-2166.

Russon (2019). "Boosting Rice Production in Nigeria". https://www.bbc.com/news/businss-47858725.

Sambu, S. and Malik, D. P. (2025). "Growth and Instability of Rice Production in India: A Zone wise study". *Archives of crrent Research International* 25(9): 94-109. https://doi.org/10.9734/acri/2025v25i91479.

Shaikh, S. A., Hongbing, O., Khan, K., & Ahmed M.. (2016). Determinants of rice productivity: Analysis of Jaffarabad District-Balochistan (Pakistan). *European Scientific Journ*al, 12(13), 41-50. http://dx.doi.org/10.19044/esj.2016.v12n13p41-50.

Siddarth, G., Tanishaa, G., Harsh, S., Purvi, S., andDebashmita, M. (2025). "Enhancing Profitability and Product Mix Optimization Through Linear Programming Problem: A case on the Indian Garment Industry". *Journal of Engineering, Management and Information Technology*. 3(4) 285-294. Doi:10.61552/JEMIT.2025.04.006 - htt://jemit.aspur.rs

Yahaya, A. A., Hakimi, D., Shehu, M. D., and Daniya, E. (2024). "Development of Mathematical Model for Optimal Rice Production in Niger State" *FUDMA Journal of Sciences*. 8(6), 450-454. https://doi.org/10.33003/fis - 2024 - 0806 – 2990.

APPENDIX

MATLAB RESULT
Optimization terminated.

x =

1.479737545371131
0.000000000000004
1.624183319373078
0.785509154002506
0.737242232061000
fval =

-1.451058089426032e+007

exitflag =

1

output =

iterations: 8
algorithm: 'large-scale: interior point'
cgiterations: 0
message: 'Optimization terminated.'
constrviolation: 2.619344741106033e-010

>>

MATLAB CODE FOR THE MAIN RESULT

```
formatlong
symsabxf
f=[-3091500 -1533100 -3157500 -3271400 -3035500];
a=[134000 100000 134000 133000 122000; 21600 7900 12000 17000 24000; 25000
17000 15000 18000 28000; 22400 0 0 25600 20000; 20000 35000 45000 40000 38000;
55000 33000 35000 36000 40000; 44000 22000 33000 33000 66000; 6500 5000 8500
8000 6500; -1 0 0 0 0; 0 -1 0 0 0; 0 0 -1 0 0; 0 0 0 -1 0; 0 0 0 0 -1];
b=[623000;82500;103000;68000;178000;196000;198000;34500;0;0;0;0;0];
lb=[0 0 0 0 0];
[xfvalexitflag output]=linprog(f,a,b,[],[],lb)
```

NEW 2
MATLAB RESULT FOR SENSITIVITY ANALYSIS
Optimization terminated.

x =

```
   1.479737545009269
   0.000000014293694
   1.624183316108073
   0.785509159500268
   0.737242218181165


fval =

   -1.451058088560195e+007


exitflag =

     1


output =

iterations: 7
algorithm: 'large-scale: interior point'
cgiterations: 0
message: 'Optimization terminated.'
constrviolation: 0

>>
```

MATLAB CODE FOR THE SENSITIVITY ANALYSIS

```
formatlong
symsabxf
f=[-3091500 -1883100 -3157500 -3271400 -3035500];
a=[134000 100000 134000 133000 122000; 21600 7900 12000 17000 24000; 25000
17000 15000 18000 28000; 22400 0 0 25600 20000; 20000 35000 45000 40000 38000;
55000 33000 35000 36000 40000; 44000 22000 33000 33000 66000; 6500 5000 8500
8000 6500; -1 0 0 0 0; 0 -1 0 0 0; 0 0 -1 0 0; 0 0 0 -1 0; 0 0 0 0 -1];
b=[623000;82500;103000;68000;178000;196000;198000;34500;0;0;0;0;0];
lb=[0 0 0 0 0];
[xfvalexitflag output]=linprog(f,a,b,[],[],lb)
```