ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

Game Theory–Driven Optimization of Agri-Business Value Chain Interventions for Sustainable Agricultural Systems in the Niger Delta

Eme Luke Chika[1]; Moluno Anthony Ndidi[2]

[1]Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria.
[2]Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria.

Publication Date: 2025/07/07

Abstract: This research is aimed at Applying Game decision model in Agribusiness value chain intervention project for sustainable Agriculture in Niger Delta. The aim is to improve decision making processes in selection of agribusiness commodity value chain to enhamce profitability and sustainability. The methodology applied involves data which were collected from the beneficiaries (Incubators and Incubatess) in selected beneficiaries of LIFE-ND agribusiness cluster across the 98 selected local government across the Nine states, Nine LIFE-ND mandate State Offices of Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, Rivers, and the National Coordinating Office in Port Harcourt and Federal Ministry of Agriculture and Rural Development. The methods used in the experiments for the Agri-business intervention projects were as follows: estimating the performance of economic efficiency of the multipurpose projects, estimating performance of the net benefits of the interaction between multi-purpose and the multi-objective, assembling the total net benefits of the interaction between multipurpose and the multi-objective, analyzing the data obtained as the total net benefits to ascertain the reliability and validation of the sources of data by using: Contingency coefficient and association, Pearson moment correlation coefficient and T- distribution test. The results indicate that Nutrition Production & Processing is the optimal solution, achieving an optimal function value of 25/462.This suggests that, given the constraints and the evaluation criteria, Nutrition Processing provides the best balance among the economic and social factors.While Poultry Production & Processing has the highest EMV (8.16) and Economic Efficiency (15.1), it was not selected as optimal.Nutrition Production & Processing may have been chosen due to a balance across various socio-economic factors rather than pure monetary benefits.The model likely places greater weight on federal redistribution (18.48) and social well-being, making Nutrition Processing more favorable.The paper concludes that Nutrition Production & Processing as the optimal economic activity based on a multi-criteria evaluation.This selection likely prioritizes federal economic redistribution, social well-being, and environmental impact, despite its lower economic efficiency compared to other alternatives.

Keywords: *Agri-Business,Value-Chain, Modeling, Game Theory.*

How to Cite: Eme Luke Chika; Moluno Anthony Ndidi (2025) Game Theory–Driven Optimization of Agri-Business Value Chain Interventions for Sustainable Agricultural Systems in the Niger Delta. *International Journal of Innovative Science and Research Technology,* 10(6), 2753-2761. https://doi.org/10.38124/ijisrt/25jun1406

I. INTRODUCTION

Game decision theory provides a structured framework for analyzing strategic decision-making processes involving multiple alternatives and constraints. In this study, game decision theory modeling is applied to evaluate different agribusiness commodity value-chain activities, including poultry production, crop processing, fish production, nutrition processing, retail, fabrication, and marketing. The objective is to identify the optimal decision choice based on economic efficiency, federal and state economic redistribution, social well-being, environmental improvement, gender equality, and youth employment security.

The decision model incorporates prior probabilities and expected monetary values (EMV) to assess the viability of each agribusiness commodity value-chain activity. Through optimization techniques, the study identifies Nutrition Production & Processing as the optimal solution, balancing economic and sociolect-environmental considerations. This introduction provides an overview of the decision-making process, the criteria used for evaluation, and the implications of selecting the optimal alternative. The insights derived from

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

this study can inform policymakers and stakeholders in designing strategies that align with economic and social priorities.

The integration of Game Theory, Linear Programming, in Agribusiness commodity value chain (production, processing and marketing) offers a new vista and promising approach to addressing the complexities associated with decision-making in this domain. This study emphasizes the application of these tools not only within specific geographical contexts, such as Nigeria, but also on a global scale, recognizing the interconnected nature of Agribusiness activities and the imperative for sustainable management practices across borders (Mukand S.B. et al 2012)[1].

The primary objective of this study is to improve and promote decision-making processes related to Agribusiness commodity value chain activities through the implementation of an optimized approach. The utilization of Game Theory introduces strategic considerations, Linear Programming facilitates quantitative analysis, and provides a valuable criterion for determining whether the optimization solution should be maximized or minimized.

➢ *Background*

Agricultural production plays an important role in economic development, food security, and rural livelihoods, particularly in regions with vast agricultural potential such as the Niger Delta of Nigeria. The area, known for its rich natural resources and favourable climatic conditions, has a diverse agricultural sector producing key crops like cassava, rice, cocoa, plantain, and oil palm. However, despite its potential, the efficiency and profitability of agricultural production in the Niger Delta remain largely under explored, with challenges related to resource misallocation, productivity constraints, and market inefficiencies. Understanding these dynamics is crucial for formulating effective policies that can enhance agricultural sustainability and economic growth (Moluno A.N, Eme L.C)(2025)[2] .This paper looks at an in-depth assessment of Agribusiness commodity value-chain project management optimization, using Game Theory, Linear Programming approach Beginning with an introduction that establishes the important role of Agribusiness commodity value chain management and the challenges associated with production, processing and marketing activities, the paper provides clarity on its primary objective—to enhance decision-making related to Agribusiness commodity value chain activities using optimization methods. The review of existing literature, identifies gaps in understanding the trade-offs and synergies between maximizing overall agribusiness commodity value chain enterprises/system profits and minimizing losses. The methodology section provides insights on data collection, payoff table formulation, and step-by-step processes involving Game Theory-Linear Programming . The theoretical foundations, including equations and optimization concepts, are presented. The subsequent simulation and analysis section clearly examines results obtained through maximizing options. The conclusion provides a summary, key findings, and strategic recommendations, ensuring that stakeholders can make informed decisions in line with their specific objectives. The article concludes with a comprehensive list of reference materials used that provided a solid foundation of the study in established literature.

➢ *Objectives*

The primary objective of this study is to ascertain the optimal solution for Agribusiness agricultural commodity value-chain through a comprehensive integration of Game Theory, Linear Programming. The key focus lies in enhancing decision- making processes associated with the management of agribusiness commodity value-chain enterprises by employing a sophisticated methodology. This entails not only the selection of the most viable agribusiness commodity value-chain among alternative courses of action or multipurpose options but also the optimization of resource allocation within the system. To attain this primary objective, one sub-objective must be accomplished:

- Determine Optimal Solutions through System Maximization: Execute a simulation to maximize outcomes by utilizing Game Theory-Linear Programming, employing a Linear solver (Michael .M. (2011)[3]

II. LITERATURE REVIEW

The paper applied Game theory using the Linear programming approach to provide ideas in effective decision making in Agribusiness commodity value-chain intervention project in the Niger Delta for efficiency and sustainability.Previous studies have extensively examined agricultural efficiency and profitability across different regions(Moluno A.N, Eme L.C.)(2025)[2], there remains a lack of comprehensive analysis across the Agribusiness commodity value-chain in the Niger Delta. The region presents unique agricultural and economic conditions, including smallholder-dominated farming, varying levels of mechanization, and challenges such as land degradation, poor infrastructure, and fluctuating market prices. Existing research has primarily focused on individual crops or employed limited methodological approaches. However, a holistic approach of looking at the Agricultural/ Agribusiness commodity value chain (production, processing and marketing) provide a more global understanding of efficiency drivers and profitability trends across multiple crops and associated value-chains.

Recently, focus has shifted to employing advanced modeling options to improve decision making process in multipurpose and multi-objective projects like the Agribusiness commodity value-chain intervention project in the Niger Delta[4]. The present literature is limited to the application of Game theory using linear programming approach to optimizing Agribusiness commodity value chain project to ensure sustainability.

A study to evaluate the efficiency and profitability analysis of agro production in the Niger Delta using Data Envelopment Analysis (DEA) and Tobit regression modelling. The findings highlighted substantial variations in farm productivity, cost structures, and profitability across different crops, with Plantain and Rice emerging as the most

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

profitable, while Cassava and Oil Palm exhibit inefficiencies that limit their economic benefits. The study established that production costs negatively impact efficiency, whereas productivity enhances efficiency, reinforcing the importance of cost-effective and productivity-enhancing strategies in agricultural practices (Moluno A.N, Eme L.C.)(2025)[2]

A study applied game theory-based models to analyze and resolve apparent conflicts concerning fund allocation for multi-purpose and multi-objectives in the Benin- Owena River Basin. This study covers the dynamics between five river basin purposes and five river objectives, exploring how the relationship between the two can be optimized using a game theory model for the benefit of the basin's inhabitants (Eme L.C. and Ohaji, E 2019)[5].

The literature gap lies in the application of Game theory to explore the interaction and interrelation across commodity line and across agribusiness commodity value chain to enhance informed decision options for sustained Agri-preneurial activities in the Niger Delta. The motivation for the current study is to look at bridging this gap by evaluating the efficiency and profitability of agro-production and agri-business enterprise in the Niger Delta using Game theory approach. This study is expected to contribute to evidence-based policy making aimed at improving agri-business enterprise sustainability, resource allocation, and farmer profitability in the Niger Delta by integrating advanced decision making techniques with practical agricultural insights.

III. METHODOLOGY

An indispensable area of this research involves the gathering of data from Agribusiness commodity value chain intervention project in Niger Delta.The methodology applied involves data which were collected from the beneficiaries (Incubators and Incubatess) in selected beneficiaries of LIFE-ND agribusiness cluster across the 98 selected local government across the Nine states , Nine LIFE-ND mandate State Offices of Abia, Bayelsa, Cross River, Akwa Ibom, Edo, Delta, Rivers, Ondo, Imo, and the National Coordinating Office in Port Harcourt and Federal Ministry of Agriculture and Rural Development. The methods used in the experiments for the Agri-business intervention projects were as follows: estimating the performance of economic efficiency of the multipurpose projects, estimating performance of the net benefits of the interaction between multi-purpose and the multi-objective, assembling the total net benefits of the interaction between multipurpose and the multi-objective, analyzing the data obtained as the total net benefits to ascertain the reliability and validation of the sources of data by using: Contingency coefficient and association, Pearson moment correlation coefficient and T-distribution test.

- *Game Theory- Linear Programming (L.P.)*

Linear Programming Method[6]: Game theory bears some relationship with linear programming. Two-person zero-sum games can also be solved by linear programming technique. It has an additional advantage of being able to solve mixed strategy games of larger dimension payoff matrix. To illustrate the transformation of a game problem to a linear programming problem, consider a payoff matrix of m x n size, the elements in the ith row and jth column of the game payout matrix are represented by A, while the probability of m strategies are represented by pi. (i=1,2,...,m) for player A. Then the expected gains for player A, for each of B's strategies will be. The aim of player A is to select a set of strategies with probability pi (i= 1,2,..., m) on any play of game such that he can maximize his minimum expected gains. To obtain values of probability pi, the value of the game to player A for all strategies by player B must be at least equal to V. Thus to maximize the minimum expected gains, it is necessary that player A, for each of B's strategies will be.

$$j = 1,2,\dots,n \qquad (1)$$

The aim of player A is to select a set of strategies with probability pi (i= 1, 2,..., m) on any play of game such that he can maximize his minimum expected gains. To obtain values of probability pi, the value of the game to player A for all strategies by player B must be at least equal to V.

Thus to maximize the minimum expected gains, it is necessary that

$$\left.\begin{aligned} a_{11}p_1 + a_{12}p_2 + \dots a_{m1}p_m &\geq V \\ a_{12}p_1 + a_{22}p_2 + \dots a_{m2}p_m &\geq V \\ a_{1n}p_1 + a_{1n}p_2 + \dots a_{mn}p_m &\geq V \end{aligned}\right\} \dots(2)$$

Where $p_1 + p_2 + \dots + p_m = 1$; $p_i \geq 0$ for all i

Dividing both sides of the m inequalities and equation by V, division is valid as long as V > 0, the direction of the inequality constraints must be reversed. But if V=0, division would be meaningless. In this case, a constant can be added to all entries of the matrix ensuring that the value of the game (V) for the revised matrix become more than zero. After optimal solution is obtained, the true value of the game is obtained by subtracting the same constant value. Let $pi/V = x, (\geq 0)$.

Then we have

$$\left.\begin{aligned} a_{11}p_1/V + a_{12}p_2/V + \dots a_{m1}p_m/V &\geq 1 \\ a_{12}p_1/V + a_{22}p_2/V + \dots a_{m2}p_m/V &\geq 1 \\ a_{1n}p_1/V + a_{1n}p_2/V + \dots a_{mn}p_m/V &\geq 1 \\ p_1/V + p_2/V + \dots + p_m/V &= 1 \end{aligned}\right\} \dots..(3)$$

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

Since the objective of player A is to maximize the value of the game, V which is equivalent to minimizing 1/V, the resulting linear programming problem can be stated as Minimize $Zp(= I/V) = x_1 + x_2 + \cdots + x_m$

Subject to the constraints

$$\left.\begin{array}{l} a_{11}x_1 + a_{12}x_2 + \ldots a_{m1}x_m \geq 1 \\ a_{12}p_1 + a_{22}x_2 + \ldots a_{m2}x_m \geq 1 \\ a_{1n}x_1 + a_{1n}x_2 + \ldots a_{mn}x_m \geq 1 \\ x_i, x_2, x_m \geq 0 \end{array}\right\} \ldots\ldots..(4)$$

$xi, = pi/V \geq 0;\ I = 1,2,\ldots,m$. Similarly, player B has a similar problem with the inequalities of the constraints reversed, i.e. minimize the expected loss. Since minimizing of V is equivalent to maximizing I/V, therefore, the resulting linear programming problem can be stated as:

$$\left.\begin{array}{l} a_{11}y_1 + a_{12}y_2 + \ldots a_{n1}y_n \geq 1 \\ a_{12}p_1 + a_{22}y_2 + \ldots a_{n2}y_n \geq 1 \\ a_{1n}y_1 + a_{1n}y_2 + \ldots a_{mn}y_n \geq 1 \\ y_i, y_2, y_n \geq 0 \end{array}\right\} \ldots\ldots(5)$$

$$y_j, = pi/V \geq 0;\ j = 1,2,\ldots,n$$

It may be noted that the LP problem of player B is the dual of LP problem for player A and vice versa. Therefore, solution of the dual problem can be obtained from the primal simplex table. Since for both players $Zp = Zq$, the expected gain to player A in the game will be exactly equal to expected loss to player B.

It should be noted that linear programming technique requires all variables to be non- negative and therefore to obtain a non-negative of value V of the game, the data of the problem, i.e. a, I the payoff table should all be non-negative. If there are some negative elements in the payoff table, a constant to every element in the payoff table must be added so as to make the smallest element zero; the solution to this new game will give an optimal mixed strategy for the original game. The value of the original game then equals the value of the new game minus the constant.

➢ *Game Decision Theory Modelling - Analyses, Interpretation and Insights*

Utilizing Payoff Table 1, one basic analysis was conducted which aligned with one distinct objective:

- *Identification of the Optimal Solution: Maximize Simulation using Game Theory Linear Programming.*

The Decision variables utilized in the model simulation for system analysis include the Multipurpose (alternatively referred to as the alternative course of action, denoted as i) and the Multi-objectives or State of Nature (denoted as j). The comprehensive representation of this arrangement is termed the Payoff Table, as illustrated in Table 1.

Table 1 Net Benefits of Agribusiness Commodity Value Chain Intervention Project in Niger Delta

	Alternatives[i]						
	Poultry prod. & process.	**Crop prod. & process.**	**Fish prod. & process.**	**Nutrition prod.& processing**	**Retail & Wholesale**	**Fabrication**	**Marketing**
[j]	**Prior Probability**						
Prior	**0.190000108**	**0.119999869**	**0.019999978**	**0.179999994**	**0.059999998**	**0.215000053**	**0.214999999**
Economic Efficiency	15.1	14.15	14.15	12.27	12.27	13.2	13.21
Federal Econ. Redistr.	22.86	21.43	21.43	18.48	18.48	19.9	19.9
State Econ. Redistr.	0.5	0.47	0.47	0.41	0.41	0.44	0.44
Social Welbeing	0.5	0.47	0.47	0.41	0.41	0.44	0.44
Environmental Improvement	1.64	1.54	1.54	1.34	1.34	1.44	1.44
Gender Equality	2.36	2.21	2.21	1.92	1.92	2.07	2.07
Youth Employment and security	0.24	0.22	0.22	0.19	0.19	0.21	0.21
EMV	**8.162404653**	4.832394715	0.805399119	6.2693998	2.089799933	**8.060351989**	**8.062499978**

- *Simulation for Maximization in Agribusiness Commodity Value-Chain*

The simulation for maximization in Agribusiness commodity vale-chain is achieved by putting the coefficient of the objective function and the constrains into programme solver as shown in table 2.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

Table 2 Maximization Pay off Table

LiPS Model4

	X1	X2	X3	X4	X5	X6	X7		RHS
Objective	1	1	1	1	1	1	1	->	MAX
Constraint1	15.1	14.15	14.15	12.27	12.27	13.2	13.21	<=	1
Constraint2	22.86	21.43	21.43	18.48	18.48	19.9	19.9	<=	1
Constraint3	0.5	0.47	0.47	0.41	0.41	0.44	0.44	<=	1
Constraint4	0.5	0.47	0.47	0.41	0.41	0.44	0.44	<=	1
Constraint5	1.64	1.54	1.54	1.34	1.34	1.44	1.44	<=	1
Constraint6	2.36	2.21	2.21	1.92	1.92	2.07	2.07	<=	1
Constraint7	0.24	0.22	0.22	0.19	0.19	0.21	0.21	<=	1
Integer	NO	NO	NO	NO	NO	NO	NO		

>> Optimal Solution FOUND
>> Maximum = 25/462

The outcomes of the maximization simulation, encompassed results corresponding to the variables and constrains such as (i)Value, (ii) Object Cost, (iii) Reduced Cost, (iv) Slack, and (v) Dual Prices, are presented in Table 3. Summing up all the numbers under the Value column equals to the Optimal Solution, where the maximization value is recorded as 25/462.

Table 3 Maximized Results

*** RESULTS ***

Variable	Value	Obj. Cost	Reduced Cost
X1	0	1	73/308
X2	0	1	295/1848
X3	0	1	295/1848
X4	25/462	1	0
X5	0	1	0
X6	0	1	71/924
X7	0	1	71/924

Constraint	RHS	Slack	Dual Price
Constraint1	1	207/616	0
Constraint2	1	0	25/462
Constraint3	1	0.977814	0
Constraint4	1	0.977814	0
Constraint5	1	857/924	0
Constraint6	1	69/77	0
Constraint7	1	0.989719	0

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

Nutrition prod.& processing, has the OPTIMAL solution o f(I/V) = 25/462

Where V = 18.48

- *Analysis, Interpretation, and Insights on Game Decision Theory Modeling*

✓ *Understanding the Alternatives and Decision Context*

The decision problem involves choosing among seven economic activities:

- Poultry Production & Processing
- Crop Production & Processing
- Fish Production & Processing
- Nutrition Production & Processing
- Retail & Wholesale
- Fabrication
- Marketing

Each alternative is evaluated based on multiple criteria:

- Economic Efficiency
- Federal Economic Redistribution
- State Economic Redistribution
- Social Well-being
- Environmental Improvement
- Gender Equality
- Youth Employment & Security
- Expected Monetary Value (EMV)

Each of these criteria contributes to the overall decision-making process in determining the best economic activity.

IV. INTERPRETATION OF THE RESULTS

➢ *Optimal Decision Choice*

The results indicate that **Nutrition Production & Processing** is the optimal solution, achieving an optimal function value of **25/462**.

This suggests that, given the constraints and the evaluation criteria, Nutrition Processing provides the best balance among the economic and social factors.

➢ *Breakdown of the Decision Variables*

- The **decision variable X4** (corresponding to Nutrition Production & Processing) is the only one with a positive value (**25/462**), meaning it is the selected optimal choice.
- All other alternatives (X1, X2, X3, X5, X6, X7) have values of zero, implying they are not included in the final decision.

➢ *Economic and Social Performance Metrics*

- Nutrition Processing has relatively lower economic efficiency (12.27) compared to other options like Poultry (15.1) and Crop Production (14.15).
- However, it still performs reasonably well across other criteria such as federal economic redistribution (18.48), environmental improvement (1.34), gender equality (1.92), and youth employment security (0.19).
- The **Expected Monetary Value (EMV)** for Nutrition Processing is **6.2694**, which is neither the highest nor the lowest among the alternatives.

V. DISCUSSION

➢ *Trade-Offs in the Decision*

- While **Poultry Production & Processing** has the highest **EMV (8.16)** and Economic Efficiency (15.1), it was not selected as optimal.
- **Nutrition Production & Processing** may have been chosen due to a balance across various socio-economic factors rather than pure monetary benefits.
- The model likely places greater weight on **federal redistribution (18.48)** and social well-being, making Nutrition Processing more favorable.

➢ *Impact of Constraints*

- The **binding constraint (Constraint2)** has a dual price of **25/462**, indicating that this constraint plays a crucial role in determining the optimal solution.
- Other constraints have slack values greater than zero, implying they are not actively restricting the decision space.

➢ *Sensitivity Analysis*

- The **Reduced Cost** values suggest that some alternatives (like Poultry, Crop, and Fish Production) would require substantial improvements in their objective function contribution to become optimal.
- If the weight on Economic Efficiency or EMV were increased, Poultry or Fabrication might become more favorable.

➢ *Graphical Insights*

To provide a graphical insight into the **Game Theory Model Analysis**, the following visualizations were generated:

- **Comparison of Alternative Sectors** – A bar chart comparing the contributions of different production and processing sectors across various criteria.
- **Optimal Solution Representation** – A pie chart showing the allocation of resources based on the optimal solution.
- **Constraint Contributions** – A Heatmap showing how different sectors contribute to the constraints.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

➢ *Depicted Below are Visualizations:*

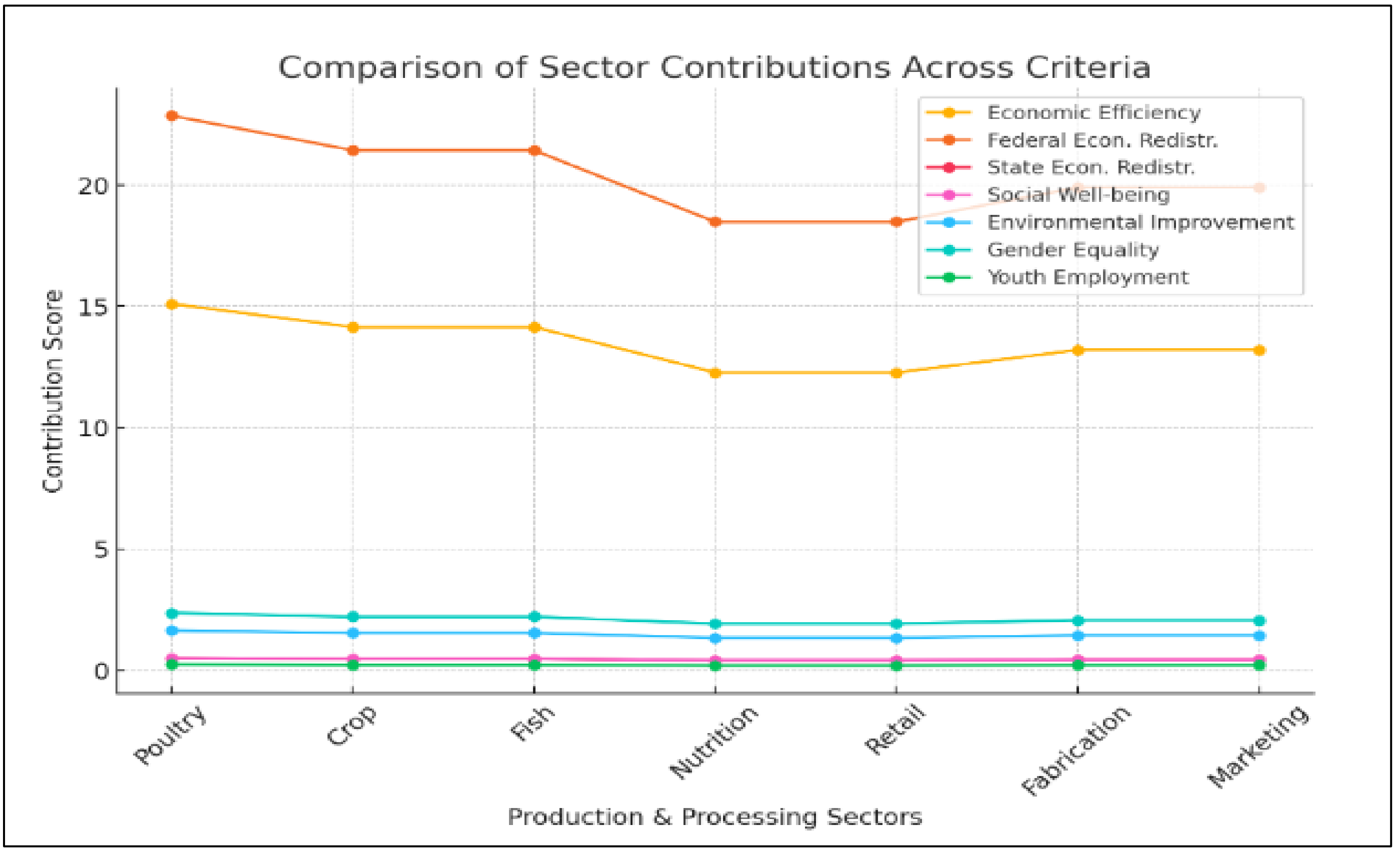

Fig 1 Comparison of Sector Contribution Across Criteria

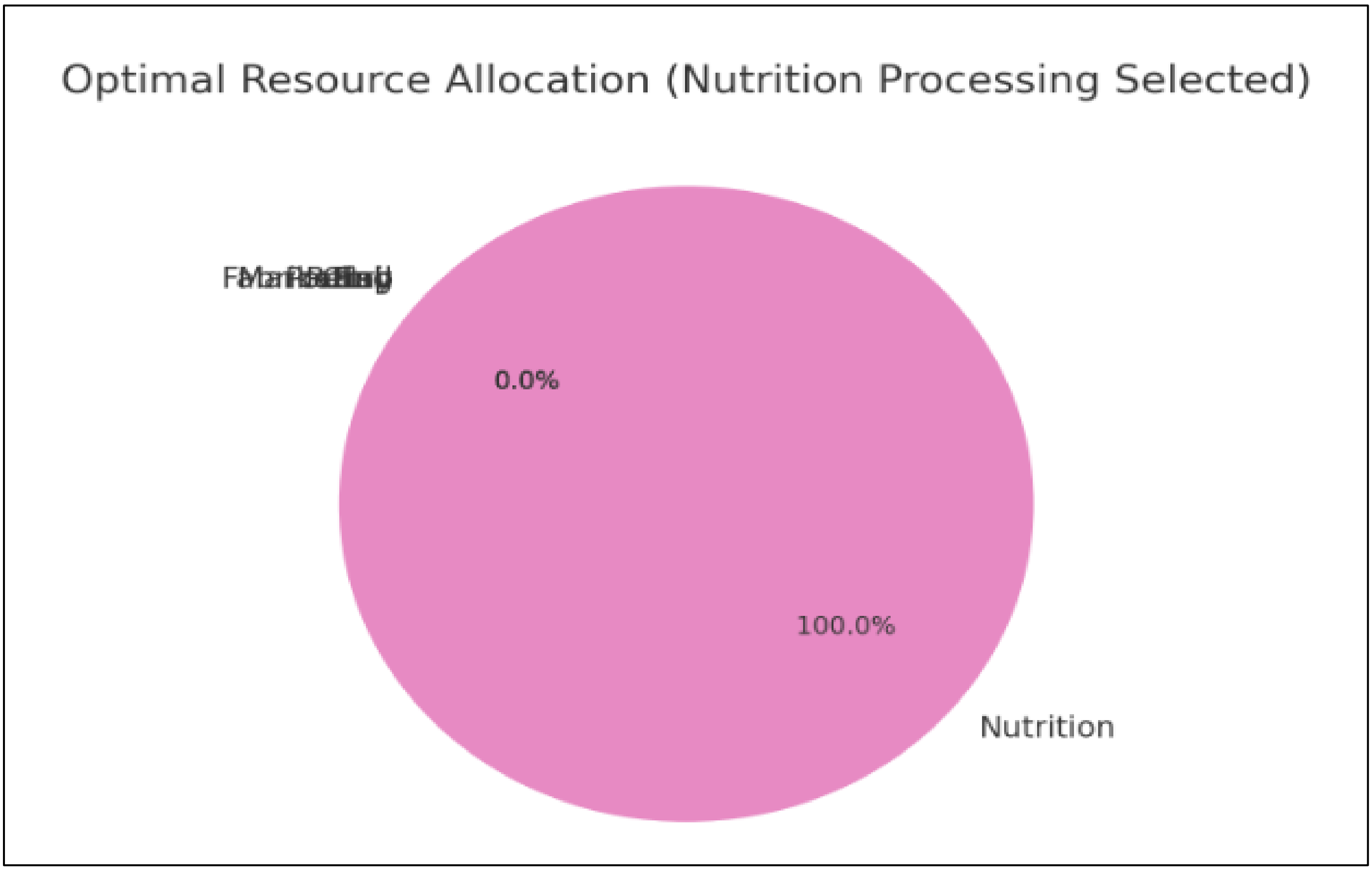

Fig 2 Optimal Resources Allocation (Nutrition Processing Selected)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1406

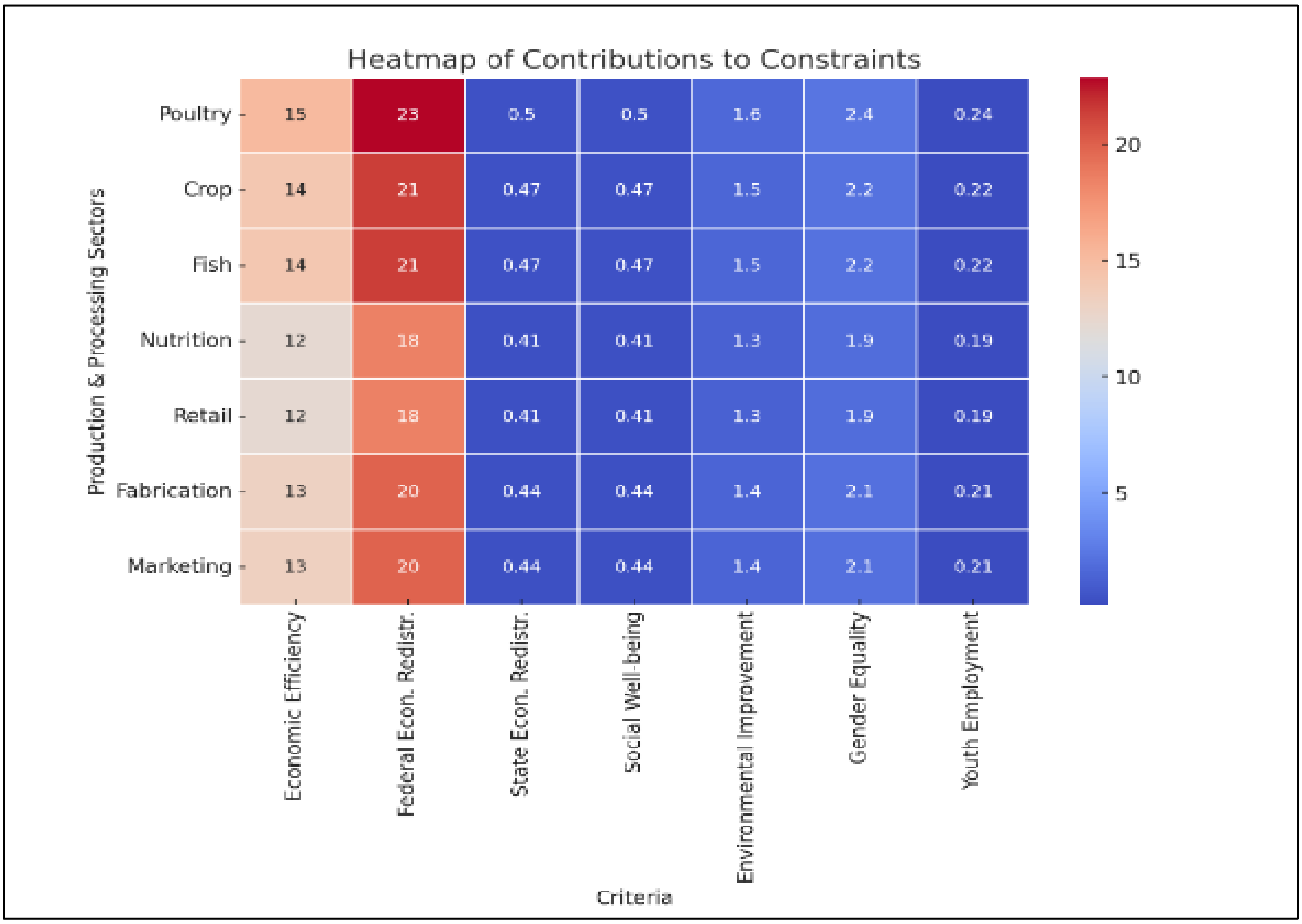

Fig 3 Heatmap of Contribution to Constraints

VI. CONCLUSION

The application of game decision theory modeling in this study has effectively demonstrated the importance of balancing economic efficiency with social and environmental factors in decision-making. The model's results indicate that Nutrition Production & Processing is the optimal choice, achieving the best overall performance across the evaluated criteria. This selection suggests that factors such as federal economic redistribution, social well-being, and environmental considerations played a significant role in determining the most favorable alternative.

The study highlights key trade-offs between economic and social priorities, emphasizing the need for policymakers to reassess weight allocations in decision models. If economic efficiency were the sole focus, alternatives like Poultry or Fabrication might be preferred. However, the model underscores the necessity of a holistic approach that considers multiple dimensions of sustainability and equity.

Moving forward, further analysis through sensitivity testing and scenario adjustments can refine decision-making processes and provide more adaptable strategies. The insights from this study contribute to a deeper understanding of strategic economic planning and the application of game theory in optimizing complex decision frameworks.

REFERENCES

[1]. Mukand S. B. et al (2012) River Basins: A global Analysis of River Basins science and transboundary management. Report number: ISBN 92-808-6022-4 Affiliation: United Nations University Institute for Water, Environment and Health. [Link](https://www.researchgate.net/publication/295073861).

[2]. Moluno A.N, Eme L.C (2025)Efficiency and Profitability Analysis of Agro-production in the Niger Delta: A data Envelopment and Tobit Regression Approach. Malaysian Journal of Sustainable Agriculture (MJSA) 9(2) (2025) 115-120

[3]. Moluno Anthony Ndidi; Eme Luke Chika; Nwanneka C. Mmuonwuba; Ohaji Evans; (2025) Harnessing Agro-Waste for Electricity Generation: A Pathway to Environmental Sustainability and Energy Poverty Reduction in The Niger Delta. *International Journal of Innovative Science and Research Technology*, 10(6), 20-27. https://doi.org/10.38124/ijisrt/25jun019

[4]. Michael .M. (2011) Linear Program Solver (Lips V.1.1.4) Department of Operation Research, State University of Management, Moscow, Russia.

[5]. Ohaji E.C, Mahmud H (2024) Optimizing Watershed Management: An Integrated Approach with Game Theory-Linear Programming, and Dominance

Property.https://www.researchgate.net/publication/381108022

[6]. Eme L.C. and Ohaji, E (2019). Bayesian Decision Modeling in Watershed Management – Cross River Basin, Nigeria *The International Institute for Science, Technology and Education (IISTE), Journal of Civil Engineering and Environmental Research*,Vol.11, No. 2, Pg 105-120,www.iiste.orgISSN (Paper) 2224-5790, ISSN (Online) 2225-0514.DOI of the journal: 10.7176/CER http://www.crossref.org/01company/17crossref_members.html

[7]. Madani, K. (2010). Game theory and water resources. Journal of Hydrology, 381(3–4), 225–238. https://doi.org/10.1016/j.jhydrol.2009.11.045