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Profit Maximization Modeling of Bori-Ogoni Multi-purpose/Multi-Objective Diesel Spill Land Reclamation Project

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ABSTRACT
This research is aimed at developing a profit maximization model for Bori-Ogoni multi-purpose/multi-objective diesel spill land reclamation project with objectives which include determination of accrued benefits of cultivating yam, maize, cassava, oil palm and rearing of fishes on five different hectares of diesel spill reclaimed land in Bori and the development of profit maximization model for the cultivation of multi-purpose/multi-objective project on reclaimed diesel spilled land in Bori. The problems of oil spill contaminations include soil and groundwater pollution, extinction of some plants and animals, chronic mutagenic and cancerous effects on humans and global warming. Profit maximization model of accrued benefits obtained in cultivating on reclaimed diesel spilled hectares of land was developed using 5 x 5 payoff matrix. Optimization model for profit maximization of the benefit accrued from the multi-purpose/multi-objective project development using game theory showed that player B best maximized profit at strategy $0.01_{x1}+0.04_{x2}+0.01_{x3}+0.03_{x4}+0.01_{x5}$ to obtain optimal scores of ₦75,826,000,000 with a game value of 0.04. The federal Ministry of Agriculture, Environment, NOSDRA, and the Niger Delta Development Commission (NDDC) should subscribe to the adoption of the developed optimization model.

KEYWORD: Game value, profit maximization model, saddle point, optimum strategy, accrued benefit

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I. INTRODUCTION

Bori-Ogoni is an industrial hub where numerous oil spills have ravaged (Olaifa and Osuagwu, 2017). It is located at latitude 4°40′34″N and longitude7°21′54″E. Its elevation above sea level is 18m(59ft). It is a town in Khana Local Government Area of Rivers State in the Niger Delta region of Nigeria. Coming with its goodies, petroleum products also have their negative effects on the environment during their extraction, production and transportation processes (Ite, Udo, Ite, and Petters,2013). Crude oil exploration in the Niger Delta has caused serious environmental impact in virtually all its environmental aspects (Kola-Olusanya and Mekuleyi,2018).The work of Laffon, Pásaro and Valdiglesias (2016) and UNEP report, 2011 has shown that plants and animals are now going into extinction. Soil and groundwater have been thoroughly contaminated (Chukwuemeka, 2016); livelihoods of the Niger Deltans are now greatly threatened (Aniefiok, Thomas, Clement, Ekpedeme and Iniemem, 2018); and unacceptably below poverty level (Zock, 2017).

Oil spill reclamation of the affected area is not the panacea. It is important that the cost of cultivating on reclaimed land be recovered. To achieve this feat, multi-purpose/multi-objective projects are the best approaches required to yield optimum return on investment on reclaimed oil spill land (Archetti, 2013). Optimal decision is required to maximize profit (Wei, 2019). Malley and Vesselinov, (2015) describe a general approach to making decisions on challenging problems such as this in the presence of severe uncertainties that combine probabilistic and non-probabilistic methods.

Therefore, an optimization model for profit maximization on investing in a multi-purpose/multi-objective project was considered in this research. The benefits of investing on different farm produce

such as cassava, maize, yam, oil palm and fishery were obtained. Game theory was used to develop the optimization model used to generate enough funds that would consequently recover the cost of reclaiming the land and rehabilitate the affected persons in the oil spill area. Profit maximization model of the 5 x 5 matrix of the benefits was developed.

II. METHODOLOGY

Cost benefit analysis was done to obtain the benfits of carrying out the multi-puporse/multi-objective reclaimed diesel spill land project. Game decision theory of a 5 x 5 payoff matrx was developed from the accued benefits of cultivating five different crops on five different portions of reclaimed diesel spill land. Two players A and B would be invloved in strategising to hit an optimum strategy. The strategy that achieve optimal profit is selected as the profit maximization model for the multi-purpose/multi-objective project development.

2.1 COST MINIMIZATION AND PROFIT MAXIMIZATION MODEL

Game theory was used to develop an optimization model.

2.2 Model Assumptions

i. The game has mixed strategies (Player A and Player B)
ii. Player A is the minimizer with an objective function of minimizing the cost of cultivating and nurturing maize, yam, cassava, palm fruit and fish.
iii. Player B is the maximizer with an objective function of maximizing profit from the five hectares of reclaimed diesel spilled land in Bori.
iv. The payoff matrix is obtained from the accrued benefits of cultivating maize, cassava, yam, oil palm and rearing of fishes on five hectares of reclaimed diesel spilled land in Bori.
v. Diesel spill occurred on 10%, 32%, 10%, 23% and 25% of land on hectares A,B,C,D,E and F respectively of Bori.

Table 1. Payoff Matrix of Accrued Benefit from Farm Produce on Reclaimed Diesel Spill on Five Hectares of Land in Bori

Player A

	Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	149,550,000	229,550,000	526,550,000	529,100,000	440,100,000
Hectare B	149,550,000	229,550,000	526,550,000	529,100,000	440,100,000
Hectare C	149,550,000	229,550,000	526,550,000	529,100,000	440,100,000
Hectare D	149,550,000	229,550,000	526,550,000	529,100,000	440,100,000
Hectare E	149,550,000	229,550,000	526,550,000	529,100,000	440,100,000

Player B

Table 2 Payoff Matrix of Accrued Benefits from Farm Produce on Five Different Farm Types Per 100 Hectares of Reclaimed Diesel Spilled Land in Bori Each (in billion naira).

Player A

Player B		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A	0.1	0.2	0.5	0.5	4.4
	Hectare B	0.1	0.2	0.5	0.5	4.4
	Hectare C	0.1	0.2	0.5	0.5	4.4
	Hectare D	0.1	0.2	0.5	0.5	4.4
	Hectare E	0.1	0.2	0.5	0.5	4.4

Since diesel spill occurred on 10%, 32%, 10%, 23% and 25% of land in hectares A, B, C, D, E and F of Bori respectively. The new payoff matrix becomes.

Table 3. Payoff matrix of diesel spill on 10%, 32%, 10%, 23% and 25% of land in hectares A, B, C, D, E and F of Bori respectively.

		Player A				
		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A 10%	0.01	0.02	0.05	0.05	0.44
	Hectare B 32%	0.04	0.07	0.16	0.16	1.32
Player B	Hectare C 10%	0.01	0.02	0.05	0.05	0.44
	Hectare D 23%	0.03	0.05	0.11	0.11	0.88
	Hectare E 25%	0.01	0.02	0.05	0.05	0.44

From the new payoff matrix, using game theory, the saddle point is determined. In determining the saddle point we have,

Table 4. Determining the saddle point

		Player A					
		Maize	Cassava	Yam	Oil Palm	Fishery	
	Hectare A	0.01	0.02	0.05	0.05	0.44	0.01
	Hectare B	0.04	0.07	0.16	0.16	1.32	(0.04)
Player B	Hectare C	0.01	0.02	0.05	0.05	0.44	0.01
	Hectare D	0.03	0.05	0.11	0.11	0.88	0.03
	Hectare E	0.01	0.02	0.05	0.05	0.44	0.01
		(0.04)	0.07	0.16	0.16	1.32	

Therefore, since saddle points exist. The players have pure strategies at Saddle point:(2,1).
Player B can maximize profit at $Z_{min}=0.01x_1+0.04x_2+0.01x_3+0.03x_4+0.01x_5$ and the game value is 0.04 where the saddle point exists.

III. RESULTS AND DISCUSSIONS

Table 5. Payoff Matrix of Accrued Benefits from Farm Produce on Five Hectares of Reclaimed Diesel Spill on Five hectares of Land in Bori in billion naira

		Player A				
		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A 10%	0.01	0.02	0.05	0.05	0.44
	Hectare B 32%	0.04	0.07	0.16	0.16	1.32
Player B	Hectare C 10%	0.01	0.02	0.05	0.05	0.44
	Hectare D 23%	0.03	0.05	0.11	0.11	0.88
	Hectare E 25%	0.01	0.02	0.05	0.05	0.44

Discussion of the result in table 5

i. Figure 5 shows the payoff matrix of diesel spill that affected 10%, 32%, 10%, 23% and 25% of land in hectares A,B,C,D,E and F of Bori respectively.

ii. Player A plays his strategy to minimize costs of cultivating maize, cassava, yam oil palm and fishery while player B plays his strategy to maximize profits on hectares A, B, C, D and E.

iii. The value in the payoff matrix is the accrued benefit in billion naira of a multi-purpose/multi-objective project.

Table6. Determination of the Game

		Player A					
		Maize	Cassava	Yam	Oil Palm	Fishery	
Player B	Hectare A	0.01	0.02	0.05	0.05	0.44	0.01
	Hectare B	0.04	0.07	0.16	0.16	1.32	(0.04)
	Hectare C	0.01	0.02	0.05	0.05	0.44	0.01
	Hectare D	0.03	0.05	0.11	0.11	0.88	0.03
	Hectare E	0.01	0.02	0.05	0.05	0.44	0.01
		(0.04)	0.07	0.16	0.16	1.32	

Discussion of the result in table 6

i. In table 6, saddle points exist, therefore the players have pure strategies at Saddle point:(2,1).

ii. Player B can maximize profit at $Z_{max}=0.01x_1+0.04x_2+0.01x_3+0.03x_4+0.01x_5$ on hectare B and the game value is 0.04 at saddle point.

Table 7. Cost of Production and Benefit

FARM TYPE	**PRODUCTION COST(₦)**	**PROFIT(₦)**
Maze	930,450,000	149,550,000
Cassava	940,450,000	229,550,000
Yam	885,450,000	526,550,000
Oil Palm	1,345,900,000	529,100,000
Fishery	3,849,000,000	4,401,000,000
Total	**7,951,250,000**	**5,835,750,000**

Discussion of the result in table 7

i. The total profit (benefit) of cultivating maize, cassava, yam, oil palm and fishery on five different portion (hectares A, B, C, D and E) of reclaimed diesel spilled land is ₦5,835,750,000.

ii. Player B maximizes profit cultivating maize using strategy $Z_{max}=0.01x_1+0.04x_2+0.01x_3+0.03x_4+0.01x_5$ to score ₦75,826,000,000.

iii. The game value is 0.04 for Z_{max} and it agrees with the thoughts of Gupta and Hira (2014).

IV. CONCLUSION

The accrued benefits per hectare of land per year are ₦149,550,000; ₦229,550,000; ₦526,550,000; ₦529,100,000 and ₦ 4,401,000,000. The net benefit of all the hectares of land per year is ₦5,835,750,000.

Figure 5 shows the payoff matrix of diesel spill that affected 10%, 32%, 10%, 23% and 25% of land in hectares A,B,C,D,E and F of Bori respectively.

Player A plays his strategy to minimize the costs of cultivating maize, cassava, yam oil palm and fishery while player B plays his strategy to maximize the profits on hectares A, B, C, D and E.

Saddle point exists. Therefore, the players have pure strategies at saddle point:(2,1). Player B can maximize profit at $Z_{max}=0.01x_1+0.04x_2+0.01x_3+0.03x_4+0.01x_5$ on hectare B with game value of 0.04 where the saddle point exists and this agrees with the work of Gupta and Hira(2014).

RECOMMENDATIONS

The following are recommended:

The Niger Delta Development Commission should financially support local famers in large scale farming on reclaimed diesel spilled land.

The Niger Delta Development Commission, Ministry of Environment, Khana Local Government Council of Rivers state in Nigeria and National Oil Spill Detection Regulation Agency(NOSDRA) should financially support and implement the developed diesel optimization model as this will help to optimally maximize profit at minimized cost.

CONTRIBUTION TO KNOWLEDGE

This research work agrees with the implementation of Environmental Management Systemas per clause 5, 6,7, 8,9 and 10 of ISO14001:2015.

The profit maximization strategy will help increase Nigeria's GDP in the current economic crises caused by COVID-19 pandemic.

REFERENCES

[1]. Aniefiok E. I., Thomas A. H., Clement O. O., Ekpedeme R. A.&Iniemem J. I. (2018) Petroleum Hydrocarbons Contamination of Surface Water and Groundwater in The Niger Delta Region of Nigeria, *Journal of Environment Pollution and Human Health***.** 6(2), 51-61. DOI: 10.12691/jephh-6-2-2.

[2]. Archetti, M. (2013). Evolutionary game theory of growth factor production: implications for tumor heterogeneity and resistance to therapies, *British Journal Of Cancer*, vol. 109 https://doi.org/10.1038/bjc.2013.336

[3]. Chukwuemeka P. U. (2016). Development of Model For Bioremediation of Crude Oil Using Moringa Extract, *Chemistry International* 2(1) 19-28 . http://www.bosaljournals/chemint/.

[4]. Ite, A. Udo I., Ite, M. and Petters W. S. (2013)Petroleum Exploration and Production: Past and Present Environmental Issues in the Nigeria's Niger Delta, *American Journal of Environmental Protection,* (1)78-90. DO - 10.12691/env-1-4-2

[5]. Kola-Olusanya A. and Mekuleyi G. O.(2018). The Eco-Economics of Crude Oil Exploration in Nigeria, The Political Ecology of Oil and Gas Activities in the Nigerian Aquatic Ecosystem,*Science direct*, .https://www.sciencedirect.com/topics/earth-and-planetary-sciences/crude-oil.

[6]. Laffon, B., Pásaro, E. and Valdiglesias, V. (2016). Effects of Exposure to Oil Spills on Human Health: Updated Review. *Journal of Toxicology and Environmental Health*, Part B. 19.1-24. 10.1080/10937404.2016.1168730.

[7]. Malley D. O. and Vesselinov V. V. (2015). Bayesian-information-gap decision theory with an application to CO2 sequestration, *Water Resour. Res*., 51, 7080–7089, doi:10.1002/ 2015WR017413. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2015WR017413

[8]. Olaifa, E. and Osuagwu, E. (2017) Effects of Oil Spills on Fish Production in the Niger Delta of Nigeria.In: CUCEN 2017,*Covenant University*, Ota. http://eprints.covenantuniversity.edu.ng/id/eprint/10339.

[9]. UNEP (2011). UNEP Ogoniland oil assessment reveals reveals extent of environmental contamination and threat to human lives. https://www.unenvironment.org/news-and-stories/story/unep-ogoniland-oil-assessment-reveals-extent-environmental-contamination

[10]. Wei J. M. (2019). Bayesian Decision Models: A Primer *NeuronJournal* (1) 104 P164-175, DOI:https://doi.org/10.1016/j.neuron.2019.09.037

[11]. Zock J. P. (2017). Some clues for studying long-term health effects of oil spills, *Journal of occupational and environmental medicine.*75, (3). http://dx.doi.org/10.1136/oemed-2017-104687.