RESEARCH ARTICLE **(Open Access)**

Economic Analysis of the Effect of Flooding on Cassava-Based Production in Delta State, Nigeria

GRACE O. ALUFOHAI, JOSEPH AHMADU*, STEPHEN G. ISIBOR AND DAN E. OYOBOH

Department of Agricultural Economics and Extension Services, Faculty of Agriculture, University of Benin, P.M.B. 1154, Benin City, Nigeria

Abstract

The study analysed the economic effect of flooding on cassava-based production in Delta State of Nigeria. A three-stage sampling procedure was used to sample 240 cassava-based farmers in the study area. Data were collected from the respondents using structured questionnaire. A total of 238 correctly completed questionnaires were used for analysis. Data were analysed using both descriptive statistics and quantitative techniques. The results showed that majority (96%) of the respondents had their farmland (2.87 hectares) affected by flood with about 2281.29kg/ha of cassava yield lost to the flood. The average cost of direct damage to cassava by flood was ₦1,595,773.30 while the average estimated total cost of losses due to flood was ₦931,025.33. Four variables, including cost of damage to farmers' house, clean-up cost, value of expected yield lost to flood and total cost of damage to farmland had significant positive effect on the total cost of losses due to the flood. The major significant strategy employed by the respondents to guide against the effect of flood was adjustment of planting date, while the strategy of quick harvesting of the crop before flood was not significant. It was recommended that the cassava farmers should cultivate fast growing and quick yielding cassava varieties that would be planted and quickly harvested before flood.

Keywords: Analysis, Effect, Flooding, Cassava, Production, Nigeria

1. Introduction

1.1 Background of the study

Cassava is one of the key staple food crops consumed by Nigerians. However, its production is continually being threatened by flood disaster [2, 5, 6]. Cassava production is an all year round activity and it does well in a warm, moist climate [13, 19]. It is very tolerant and has the ability to grow on marginal land where other food crops cannot grow well because of its high yield and productivity under moderate climatic condition [4]. Cassava is not just important as a food crop but also as a major source of income and food security for rural households, raw materials for industries, and revenue for the nation from the exportation of cassava and its products.

In view of the importance of cassava, various measures have been taken by the Nigerian Government over the years to boost its production. According to the Nigerian Presidential Initiative on cassava in July 2002, the cropped area of cultivation of cassava was proposed to be increased to 5 million heçtares by the end of 2010 with a projected annual yield of 150 million tonnes resulting in annual export earnings of five billion USD. In 1999, Nigeria produced 33 million tones [17], while a decade later; it produced approximately 45 million tonnes, which is almost 19% of production in the world [1]. A welcomed innovation was the introduction of vitamin A rich cassava varieties to improve food nutrition [2].

Therefore, extreme weather conditions such as excessive amount of rainfall which leads to flood that may be detrimental to cassava output needs to be checked. Flooding may occur as an overflow of water from water bodies such as a river or lake in which the water overtops or breaks levee, resulting in some of that water escaping its usual boundaries [15] or it may occur due to an accumulation of rain water on saturated ground. Flooding is the most common of all environmental hazards across the globe posing tremendous danger to arable lands, crops, people's lives and properties [12]. It is a major natural disaster which accounts for about 34% of all natural disasters and more than 50% of those affected by natural disaster are victims of flooding [7].

*Corresponding author: Joseph Ahmadu; E-mail: joseph.ahmadu@uniben.edu
(Accepted for publication December 11, 2019)
***ISSN**: 2218-2020, © Agricultural University of Tirana*

In several parts of Delta State, most cassava-based farmers lament the devastation of their farmlands as a result of flooding. Flood has inundated several farmlands across the State, caused premature harvest, submerged and/or destroyed the produce. The loss of agricultural productive farmland, crops and displacement of farmers from their source of livelihood affect their income as well as cause them huge economic losses [5]. There is therefore the need for good management of flooding in the area especially to guide against its effect on cassava production but such strategies would rely on adequate empirical data effect of flooding on cassava production.

1.2 Objectives of the study

The main objective of the study was to analyse the economic effect of flooding on cassava-based production in Delta State of Nigeria. The specific objectives were to;

i. examine the effects of flooding on cassava-based farmland and yield;
ii. estimate the cost of direct damage to cassava and total cost of losses to the farmers due to flood;
iii. determine the contribution of each cost component to the total cost of losses;
iv. identify the strategies employed by affected farmers to guide against the effect of flood.

2. Methodology

The study was carried out in Delta State of Nigeria and covered the flood disaster experienced in the year 2012. The study employed a three-stage sampling procedure to select respondents for the study based on the list of flood affected areas obtained from the State Ministry of Environment.

Stage 1 involved a purposive selection of two Local Government Areas (LGAs) from each of the Agricultural zones of the State where flooding was frequently experienced to give a total of six LGAs. In stage 2, four most affected communities were purposively selected from each of the six LGAs making a total of 24 communities. In the third stage, 10 cassava-based flood affected farmers were randomly sampled from each community to give a total sample size of 240 respondents; out of which 238 respondents correctly completed their questionnaires which were used for the study (one questionnaire each from Delta South and Central were wrongly completed). Primary data were collected using structured questionnaire, complimented with interview schedules for non-literate farmers.

Data collected were analyzed using descriptive statistics and quantitative techniques (agricultural flood damage model and regression analysis). The agricultural flood damage model was used to estimate the cost of direct damage to cassava. The model as employed by AGDAM [3] is given as:

$$D_{ij} = IC_{ti} + NR_i + OC_{ij} \quad (1)$$

where: i = specified crop (cassava), t = flood date, j = event (flood), D_{ij} = Cost of direct damage to cassava by flood (₦), IC_{ti} = Investment costs at time-of-year (t) for cassava (₦), NR_i = Net Revenue or income from cassava lost to flood (₦); and OC_{ij} = Cost of correcting the damage related to land and infrastructure as a result of flood (₦) .

The multiple regression analysis was used to determine the contribution of each cost component to the total cost of losses due to flood. The regression model is implicitly specified as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, e_i) \quad (2)$$

Where: Y = estimated cost of damage (₦), X_1 = cost of damage to farmers house (₦), X_2 = total cost of damaged farm implement (₦), X_3 = cost of evacuation (₦), X_4= clean-up cost (₦), X_5 = total cost of damage to planting material (₦), X_6= total cost of damage to farm land (₦), X_7= value of expected yield lost to flood (kg), b_0 = constant, b_1– b_7 = regression coefficient and e_i = error term

Four functional forms of the regression equation including linear, semi-log, exponential and double-log models were specified for the analysis. The double-log function gave the results with the best fit and was selected. The Cobb-Douglas function is explicitly specified in the log-linear form as:

$$\log Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + e_i \quad (3)$$

Where all variables are as earlier defined.

Dollar-Naira Exchange Rate

In 2015, the average Dollar-Naira exchange rate by Inter-bank Foreign Exchange Market (IFEM) is US$1.00 = N196.99 [11]. This is for the purpose of any conversion of Naira to Dollar in the study.

3. Results and Discussion

3.1 Effect of flood on cassava-based farmland

Table 1 shows the distribution of farmers in the study area whose farmlands were affected and those not affected by 2012 flood disaster. According to the results, almost all (96.64%) the respondents had their

farmlands affected by flood. In Delta North the whole of the respondents (100%) had their farmlands affected by flood while 94.94% of cassava-based farmlands in Delta South and Central were affected by flood.

Table 1: Frequency distribution of cassava-based farmers whose farmlands were affected by 2012 flood in the study area

Agricultural Zones	Farmers with affected farmland		Farmers not affected	
	Freq.	%	Freq.	%
Delta South	75	94.94	4	5.06
Delta North	80	100	0	0
Delta Central	75	94.94	4	5.06
Pooled Data	230	96.64	8	3.36

Source: Field Survey, 2015

Table 2 shows the average farmlands affected by flood. Across the study area, a mean area of 3.27 ha of cassava-based farmland was owned per respondent before the flood while a mean value of 2.87 hectares was affected by flood. Assessing by agricultural zones, Delta Central had the largest mean area of cassava farmland affected by the flood (3.18 ha), followed by Delta North (2.95 hectares) while Delta South had 2.49 hectares affected.

Table 2: Average cassava farm size affected by 2012 flood incidence

Agricultural Zones	Farm size before flood (ha)	Farm size affected (ha)
Delta South	2.69	2.49
Delta North	2.99	2.95
Delta Central	4.13	3.18
Total (Pooled mean)	**3.27**	**2.87**

Source: Field Survey, 2015

3.2 Effect of flooding on cassava yield in the study area

Across the study area (Table 3) a mean value of 4589.90kg/ha of cassava yield was obtained before the flood. This dropped to a yield of 2308.61kg/ha after the flood with 2281.29kg/ha cassava yield lost to the flood. Ranking according to agricultural zones, Delta South had the highest yield loss to flood ($\bar{X}$=2890.52kg/ha), followed by Delta North ($\bar{X}$= 1982.58kg/ha) and Delta central (1970.78kg/ha). This is in line with the findings of [13] that about 60 percent of damage and losses to the crop subsector are caused by floods.

Table 3: Cassava yield before and after flood and yield lost to flood per hectare

Agricultural Zones	Mean yield before flood (kg) Yield/ha	Mean yield after flood (kg) Yield/ha	Mean yield loss in kg Yield loss/ha
Delta South	6755.87	3865.35	2890.52
Delta North	3679.39	1696.81	1982.58
Delta Central	3334.45	1363.67	1970.78
Pooled Mean	**4589.90**	**2308.61**	**2281.29**

Source: Field Survey, 2015

3.3 Costs of damage to cassava and losses due to flooding

3.3.1 Cost of direct damage to cassava due to flood

Table 4 shows that across the study area the average cost of direct damage to cassava due to flood which included the cost of investment i.e. production cost (₦209, 779.50), net revenue of cassava lost (₦656, 543.80) and cost of correcting the damage related to land and infrastructure (₦729, 450.10) amounted to about ₦1, 595,773. In Delta Central, the mean cost of direct damage to cassava was reported to be ₦1,731,096.30.00. in Delta North ₦1,673.927.70 and Delta South ₦1,382,296. This is in line with the findings of [13] that the total cost of damage and losses to the crop subsector amount to about 13 billion USD.

Table 4: Estimated cost of direct damage to cassava by flood per respondent

Variables	Agricultural Zones [Mean per respondent (₦)]			
	Delta South	Delta North	Delta Central	Pooled Mean
Investment costs (IC_{ti})	215,369.40	222,400.60	191,568.40	209,779.50
Net revenue for cassava lost to flood (NR_i)	547,984.90	584,174.20	837,472.30	656,543.80
Cost of correcting the damage related to land or infrastructure (OC_{ij})	618,941.70	867,352.90	702,055.60	729,450.10
Cost of direct damage to cassava by flood (Dij)	**1,382,296.00**	**1,673,927.70**	**1,731,096.30**	**1,595,773.30**

Source: Field Survey, 2015

3.3.2 Estimated total cost of losses due to flooding

The results presented in Table 5 show that on the whole the average cost of loss per respondent was ₦931, 025.33. Delta North Agricultural zone had the highest mean loss value of ₦983,493.45, followed by Delta Central with a mean value of ₦964, 879.76 and Delta South with ₦844,346.03. This was as a result of the different topographical settlement of the respondents, type of house and proximity to flood plains. This corroborates the findings of [9] that the average cost of flood damage is about two hundred USD per household per year which approximately 20 percent of average household income.

Table 5: Estimated total cost of losses due to flooding per respondent

	Mean (₦)			
Variable	Delta South	Delta North	Delta Central	Pooled Mean
Value of expected yield lost to flood	547,984.90	584,174.20	837,472.30	656,543.80
Total cost of damage to farmland	29,235.00	31781.25	20069.68	27057.76
Total cost of damage to planting materials	43,181.25	45,425.00	25996.27	38251.90
Clean-up costs	59,715.00	64,415.00	47,630.13	57,293.64
Cost of evacuation	6,237.73	9,500.04	3709.62	6,481.44
Total cost of damage farm implement	6,773.01	8,724.04	612.15	5,369.73
Damage to farmers' house	151,219.14	239,473.92	29,389.61	140,027.56
Total cost of loss	**844,346.03**	**983,493.45**	**964,879.76**	**931,025.33**

Source: Field Survey, 2015

3.3.3 Contribution of the cost components to total cost of losses

The results of the regression analysis on the contribution of the individual cost component to the total cost of losses (Table 6) indicated that 98.83% (R^2 = 0.9883) of the total variation in the total cost of losses was accounted by the various cost components.

The model was of good fit as evidenced by the F-statistics (79.44) that was significant at 1% level. The cost of damage to farmers' house, clean-up cost, total cost of damage to farmland and value of expected yield lost to flood all had positive and significant effects on the total cost of losses due to flood in the study area. This corroborates the findings of [15] that flood has an inverse effect on cassava productivity.

3.4 Strategies employed to guide against the effect of flooding

The results of the study (Table 7) showed that the major (97.06%) significant
(mean score = 3.62) strategy employed by the respondents to guide against the effect offlood in the study area was adjustment of planting date.

This was followed by quick harvesting of crop before flood (47.06%) and quick return to farm to salvage what was left after flood (35.29%), though not significant.

Table 6: Contribution of cost components to total cost of losses due to flood: estimated Cobb-Douglas regression result

Variables	Coefficient	Standard error	t-value
Constant	1.43***	0.09	16.81
Cost of damage to farmers house	0.04***	0.003	14.59
Total cost of damage farm implement	-0.0038	0.003	-1.11
Cost of evacuation	0.003	0.004	0.63
Clean-up costs	0.19***	0.03	6.55
Total cost of damage to planting materials	0.02	0.03	0.63
Total cost of damage to farmland	0.05**	0.02	2.21
Value of expected yield lost to flood	0.69***	0.01	46.86
R^2	0.9883		
Adjusted R^2	0.9880		
Fcal	79.44***		

** Significant at 5%, *** Significant at 1%

Source: Field Survey, 2015

The least adopted strategy was the application of manure or fertilizer to replenish the soil after flood (17.65%). Only adjustment of planting date was the most effective strategy which might be as a result of the limitations associated with the other strategies, inadequate information received and insufficient fund. This is in line with previous findings on climate change [8, 14, 18].

Table 7: Strategies employed by respondents to guide against the effect of flooding

Strategies employed	Frequency*	Percent*	Mean score
Adjust planting date	131	97.06	3.62**
Quickly harvest cassava before the flood	114	47.06	2.41
Quickly return to farm to salvage what was left after flood	82	35.29	2.02
Proper drainage after flood	57	23.95	1.75
Creation of channels for flood to flow from farm site during flood	55	23.11	1.70
Construction of temporary dwelling places close to the farm to give close attention to surviving crops	34	14.28	1.49
Application of manure/ fertilizer to replenish the soil after flood	42	17.65	1.35
No strategy employed	2	0.84	0.03

Note: Mean of mean scores = 2.5

** Significant mean score

*Multiple response exist

Source: Field Survey, 2015

4. Conclusions and Recommendation

The study has established that the economic effect of flood on cassava-based production in the study area was high. Flood negatively affected size of farmlands and cassava yield, causing high economic losses. The major strategy employed by the respondents to guide against the effect of the flood was adjustment of planting date. Based on the findings of the study, it is hereby recommended that the cassava farmers should cultivate
fast growing and quick yielding cassava varieties that would be planted and quickly harvested
before flood.

5. References

1. Adekanye TA, Ogunjimi SI, Ajala AO: **An assessment of cassava processing plants in Irepodun Local Government Area, Kwara State, Nigeria.** World Journal of Agricultural Research 2013, 1(1): 14-17.
2. Adesina AA: **Minister of agriculture launches pro-vitamin A cassava in Nigeria.** Harvest Plus (Challenge Program of the CGIAR), 2011.
3. AGDAM: **Agricultural flood damage analysis, user manual.** US Army Corps of Engineers, Hydrologic Engineering Center (HEC), Davis, CA, 1985, pp9.
4. Akanbi WB, Olabode OS, Olaniyi JO, Ojo AO: **Introduction to tropical crops.** Published by Raflink Compter Eleyele, Ibadan, 2004, pp33.
5. Alufohai GO: **Natural Disaster Management Strategies in the Niger Delta Region of Nigeria.** A report of the baseline study submitted to African Network for Environment and Economic Justice (ANEEJ), 2014.
6. Apata TG: **Effects of global climate change on Nigerian agriculture: an empirical analysis.** CBN Jounal of Apllied Statistics 2011, 29(1):31-50.
7. Beckmann M: **An assessment of methodologies to evaluate flood losses and impacts.** Flood site project report, HR Wallingford, UK, 2008, pp26.
8. Bradshaw B, Dolan H, Smith B: **Farm-level adaptation to climate variability and change: Crop diversification in the Canadian Prairies.** Climate change 2004, 67: 119-141.
9. Brouwer R, Akter S, Brander L, Haque E: **Socio-economic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh.** Risk analysis: An official publication of the society for risk analysis 2007, 27(2): 313.
10. Central Bank of Nigeria (CBN): **Monthly average exchange rates of the naira per unit of foreign currency,** 2017. Access at: https://www.cbn.gov.ng/rates/ exrate. asp? year= 2017 &months=2.
11. Coker AA, Adebayo CO, Odoemena BC, Akogun EO, Ezinne CG: **Flood and cassava productivity in Kogi State, Nigeria: A quantitative analysis using cross-sectional data.** Ethiopian Journal of Environmental Studies & Management 2014, 7(6): 599 – 608.
12. Etuonovbe AK: **The Devastating Effect of Flooding in Nigeria.** Hydrography and the Environment. FIG Working Week, Marrakech, Morocco, 2011.
13. Ezekiel AA, Olawuyi S0, Ganiyu MO, Ojedokun IK, Adeyemo SA: **Effects of climate change on cassava productivity in Ilesa - East Local Government Area, Osun State, Nigeria.** *British Journal of Arts and Social Sciences* 2012, 10(2): 153-162.
14. Food and Agriculture Organization (FAO): **The impact of natural hazards and disasters on agriculture and food security and nutrition: A call for actions to build resilient livelihoods.** Rome, Italy, 2015, Pp6.
15. Harriet F, Cindy C, Hal S, Dan W, Ben S, Kathrine N: **The prevalence and cost of urban flooding: A case study of Cook County, IL.** Center for Neighborhood Technology, Chicago, 2013.
16. Hassan R, Nhemachena: **Determinants of African farmers' strategies for adapting to climate change; multinomial choice analysis.** African Journal of Agricultural and resource Economics 2008, 2 (1), 83-104.
17. International Institute for Tropical Agriculture (IITA): **Overview.** IITA, 2013. Retrieved 25th September, 2013 from: http://old.iita.org/ cms/details/cassava_project_details. aspx?zoneid=63&articleid=267
18. Ike PC, Ezeafulukwe LC: **Analysis of coping strategies adopted against climate change by small scale farmers in Delta State, Nigeria.** Journal of Natural Sciences Research 2015, 5(4): 15-23.
19. World Bank: **World Development Indicators**. World Bank, New York, 20l0.