

Poultry Waste Management Techniques, The Implication On Environment And Agricultural Productivity In Afijo Local Government Area, Oyo State, Nigeria¹Ezekiel, A.A, ²Adeyanju, J.A and ¹Oladeebo, J.O

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ABSTRACT

Poultry wastes are giving serious environmental pollution in Africa, it causes severe odours that entice fly and rodent infestation in Nigeria. Farmers disposed poultry wastes through heaping, burning and dumping in their farm to generate soil fertility. This study analyzed the impact of poultry waste utilization on crop yield and income of the farmers' in Afijio Local Government Area of Oyo State, Nigeria. A random sampling technique was used to select 104 respondents using structured questionnaire and interviewed schedule to obtain information from the respondents. Descriptive statistics, Gross Margin analysis and cobb-Douglas production function were used to analyze the data collected. The results of the analysis revealed that an average poultry farmer in the enterprise were between 41-50 years which means most of the farmers were in their active age, 96.6% of the poultry farmers had formal education, while 3.8% of the farmers had non-formal education, this implies that majority of farmers were literate. The following variables had significant relationship with poultry waste: interval of waste removal day significant at 5% level but had a negative relationship with poultry waste impact, this implies that as the period for waste removal extends, there was a negative impact on the environment and performance on the poultry birds thus resulting to low output. The purpose of rearing birds, years of experience and ingredient that increase/decrease waste smell are all significant at 1% level of significance respectively. It was recommended that farmers should be encouraged to increase hygiene by undertaking frequent sanitation so as to reduce the chances of disease infestation.

Keywords: poultry waste; management techniques; environment; agriculture; productivity

INTRODUCTION

Poultry by-products are potential pollutants to water and air quality concerns, and in some cases on soil quality (FAO, 2008; and Nahm, 2004; Williams, Barker and Sims, 1999). Poultry production adversely affects the environment in numerous ways; through poor management of manure and litter,

waste streams from processing plants (blood, bones, feathers, etc), birds' carcasses, dust, insects, odour, etc. Furthermore, intensive poultry production is held responsible for the emission of greenhouse gasses, acidification, and eutrophication. The environmental impact of

poultry production depends on numerous factors, among which are farm size, production system, diet composition, type of bedding used (Akanni *et al.*, 2014). It is well known that, if properly managed, waste generated in the poultry can be source of soil fertility. According to Williams *et al.*, 2006; Organic fertilizers including farmyard manure and sheep manure may be used for crop production as a substitute to chemical fertilizers because the importance of the organic manures cannot be overlooked. Worldwide, there is growing interest in the use of organic manure due to depletion in the soil fertility. Economic premiums for certified organic grains have been driving

Theoretical Framework

Management and Techniques of using Poultry Waste

Poultry waste materials must be properly managed to make it usable to stop pollution effects on the environment and human health.

Poultry wastes can be managed in the following ways by:

Converting poultry litter into bio-fuel:

Efforts towards safe disposal of poultry wastes resulted into a recent technology that converted poultry litter to valuable bio-oil, usable gas and crop fertilizers (Anonymous, 2007). Broiler and turkey litters can be converted to bio-oils with application of modern technology (Anonymous, 2007). There are currently several electrical generating plants within the UK and US that are utilizing poultry and turkey litter as their primary fuel (Anonymous, 2007).

Composting of poultry litter: Composting of poultry litter and dead carcasses are considered to extend value chain and marketplace for poultry litter readily needed in crop and vegetable farms, homes, lawns and golf courses (Forbes, 2006). Composting may be a simple natural

many transition decisions related to the organic farming (Delate and Camberdella, 2004). Continuous use of fertilizers creates potential polluting effect in the environment (Oad *et al.*, 2004). Synthesis of chemical fertilizers consumes a large amount of energy and money. However, organic farming with or without chemical fertilizers seems to be a possible solution for these situations (Oyebanjo, *et al.*, 2011). Organic sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards (Ahmad *et al.*, 1996).

biological phenomenon that renders poultry litter odourless, stable, consistent and soil-like that's unable to wreck crops and surface waters. It is a controlled decomposing natural breakdown process of organic materials (Anne, 2007). The process utilizes aerobic microorganisms within the poultry litter within the presence of oxygen and water to vary the chemical and physical nature of poultry litter to make a humus-like material referred to as compost (Forbes, 2006). Composting reduces litter weight to as much as 50-70% (Anne, 2007) and compost has been reported to air condition soils and improve soil quality by adding organic matter, nutrients and beneficial microbes thereby increasing soil porosity, density, water and nutrient holding capacity (Forbes, 2006). It is important to notice that the main nutrients of poultry litter include carbon, nitrogen, phosphorus, potassium etc. needed for plant and microorganism's growth and reproduction (Embury, 2004), it is mentioned as a superb soil amendment (Anne, 2007). Composted broiler litter for instance has a pH of 5.5-6.5 and is weed free making it suitable fertilizer for seedlings, shrubs, roses and fruit trees and is rich in Vitamin B12 (Embury, 2004; Anne, 2007).

Storage of poultry litter: The demand for poultry litter like another seasonally demanding good appears to be sporadic and thus requiring temporary holding until an appropriate application time even though fresh poultry litter has the very best nitrogen content making it of greater fertilizer value (Embury, 2004). Proper storage of poultry litter will make sure the most benefit use of valuable fertilizer nutrients and can prevent contamination of surface waters on poultry farms (Dan *et al.*, 2009). The most valuable nitrogen in poultry litter is gradually lost to the atmosphere as ammonium over a prolonged period (Doye *et al.*, 2009). Covered stockpiles; involves stockpiles of litter that is covered using plastic sheets anchored to the earth or other devices to protect against rain and atmospheric losses. Stockpiles with ground liners; this involves the use of good plastic as liner to ground or concrete slabs to primarily prevent nutrient leaching to ground water (Dan *et al.*, 2009). Permanent storage structures with sufficient roofs and concrete floors appear to be best but associated with high risk of spontaneous

STATEMENT OF THE PROBLEM

Despite an increase intensive chicken keeping in early 1980's, the withdrawal of subsidy by government on the prices of day-old chicks and feed ingredients led to a general decline in the number of poultry birds particularly under commercial production in the country (Zhang *et al.*, 2013). The ever-increasing cost of feeds and management forced many commercial poultry establishments to fold-up. Most poultry manure and litter are applied to land near poultry production farms. With few exceptions, this is the preferred practice in developing countries and elsewhere. Such land management of poultry by-products brings the risk of surface and groundwater contamination from potential pollutants

combustion and fire outbreaks (Dan *et al.*, 2009).

Applying poultry litter to crops: Certain considerations are put in order before litter are often effectively and safely applied on farms (Dan *et al.*, 2009). Poultry manure should not be applied to very steep lands, lands in close proximity to surface waters, drainage ditches and wells. Avoid application prior to heavy rains and to crops best apply at the time of nutrient needs. Litter should generally be applied to as close to planting time as possible and should be mechanically incorporated to plants as soon as possible after application (Forbes, 2006). This approach will minimize loss due to ammonia volatilization and nutrient loss by wind and water erosion. Application of litter well ahead of planting will lead to denitrification and leaching (Forbes, 2006). A trial of bioactive compost on crops indicated that compost containing poultry litter gave plant maximum levels of nutrients required, growth promoting effects and price benefit (Kavitha and Subramanian, 2007).

contained in the manure and litter. Air quality can be affected by aerial emissions of pollutants from poultry production facilities. Ammonia emitted into the atmosphere is arguably the most environmentally significant aerial pollutant associated with poultry production (Wiebe van der sluis, 2007) sport and fate of ammonia once it is emitted into the atmosphere are not well understood, but its presence in high concentration can trigger environmental effects that have impacts on local ecosystems and human health. Based on the previous discussions on waste management, this study intends to answer the following questions: What are the socio-economic differentials of poultry waste users on the management pattern of poultry waste in the study area? What are the

poultry waste management and utilization techniques and their determinants in Afijio Local government area of Oyo State, Nigeria? What is the impact of poultry waste utilization on yield and revenue of the respondents in the study area? Specifically, this study assessed the economic impact of poultry waste on the environmental and agricultural productivity.

RESEARCH METHODOLOGY

This study was conducted in Afijio local government Area of Oyo State, Nigeria. Its headquarters is Jobele. It has an area of 722km² and a population of 134,173 at the 2006 census. The postal code area is 21, which comprises of eleven (11) wards such as Ilora 1, Ilora 11, Ilora 111, Fiditi 1, Fiditi 11, Fiditi 111, Awe 1, Awe 11, Akinmori Jobele, Iware, and Imini. The local government is governed by an elected chairman and 10 councilors elected from each ward. Town under Afijio Local Government are (Awe, Akinmori, Fiditi, Ilora, Jobele, Iware, Imini, Ore lope).

Methods of data collection

Both primary and secondary data were collected using structured questionnaires. Random sampling technique was used to select 104 respondents for the purpose of this study.

Measurement of variables

The variable consists of both dependent and independent variables. The dependent variable is environment and agricultural productivity measured with Cobb–Douglas production function. While independent variables were the socio-economic characteristic of the respondents. In its most standard form for production of a single good with two factors, the function is:

$$Y = AL^{\beta}K^{\alpha} \quad (\text{display Style } Y = AL^{\beta}K^{\alpha}) \dots\dots\dots (1)$$

where:

- Y = total production (the real value of all goods produced in a year or 365.25 days)
- L = Labour input (the total number of person-hours worked in a year or 365.25 days)
- K = Capital input (a measure of all machinery, equipment, and buildings; the value of capital input divided by the price of capital)
- A = A total factor productivity.
- α and β are the output elasticities of capital and labor, respectively. These values are constants determined by available technology.

Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production, *ceteris paribus*. For example, if $\alpha = 0.45$, a 1% increase in capital usage would lead to approximately a 0.45% increase in output. Sometimes the term has a more restricted meaning, requiring that the function display constant return to scale, meaning that doubling the usage of capital K and labor L will also double output Y . This holds if

$$\alpha + \beta = 1, \quad \dots\dots\dots (2)$$

If

$$\alpha + \beta < 1, \quad \dots\dots\dots (3)$$

returns to scale are decreasing, and if

$$\alpha + \beta > 1, \quad \dots\dots\dots (4)$$

returns to scale are increasing. Assuming perfect competition and $\alpha + \beta = 1$, α and β

In its generalized form, the Cobb–Douglas function models more than two goods. The Cobb–Douglas Production function may be written as:

$$F(x) = A \prod_{i=1}^L x_i^{\lambda_i}, \quad x = (x_1, \dots, x_L) \quad (6)$$

Cobb-Douglas production function was employed to determine the productivity of the farm. While Gross margin analysis

1.5 Gross margin analysis is given by equation:

$$GM = TR - TVC \dots \dots \dots (7)$$

Where

The performance and economic worth of the respondents can be determined by the use of the following Profitability ratios:

- Benefit Cost Ratio BCR = TR/TC
- Expense Structure Ratio ESR = FC/VC

$$Q = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, e_i) \dots \dots \dots (8)$$

Where

Q = Total Revenue (N)

X_1 = Distance of poultry farm to residential households (Meters)

X_2 = Number of poultry birds (Units)

X_3 = Frequency of visit of poultry sanitation officials (per month)

X_4 = Age of poultry farm manager (Years)

X_5 = Quantities of water used (Litres)

X_6 = Number of farms labour (Family and Hired) (Man- day)

X_7 = Poultry farming experience of the farm manager (Years)

can be shown to be capital's and labor's shares of output.

where:

- A is an efficiency parameter
- L is the total number of goods
- $x_1, \dots, x_L$ is the (non-negative) quantities of good consumed, produced, etc.
- λ_i is an elasticity parameter for good i

and profitability ratio were used to examine the costs and returns of poultry farming in the study area.

GM = Gross Margin (N)

TR = Total Revenue (N)

TVC = Total Variable Cost (N)

- Rate of Return ROR = NR/TC
- Gross ratio GR = TC/TR

The Cobb-Douglas production function analysis explanation postulated for poultry farmers in the study area is implicitly presented as:

X_8 = System of operation of the farm (Deep Litter = 1, others = 0)

X_9 = Quantity of faecal materials generated (Kg)

X_{10} = Number of dead chicks/chicken (Numbers)

X_{11} = Frequency of waste clearance (per month)

X_{12} = Number of cracked/stale eggs (Number)

e_i = Random (stochastic) factor external to the model

The Semilog, Antilog and Cobb-Douglas production functions were evaluated using ordinary least square method.

RESULTS AND DISCUSSION

Table 1 showed that 52.9% of the respondents were male, while 47.1% were female. This implies that the percentage of male household head was slightly more than the female household heads. The result shows that the respondents within the age range of 20-30 years were 9.6% while those within the age range of 41-50 years were 25.0%, 34.6% of the respondents were in the age group of between 31- 40 years, while only 5.8% were above 60 years of age. This implies that majority of the respondents were actively involved in farming. This finding tells that the higher the age of the household head, the more unstable the economy of the farm household. 9.6% of the respondents were single, 53.8% were married; 3.8% were divorced; while 32.7% were widow. The highest number of the respondents were married, it is a clue that they have a number of dependents which affect their food security status. Results revealed that 3.8% of the respondents have no formal education, 10.6% had primary education, 21.2% had secondary education while 64.4% attended an adult learning program. The results showed that the lowest percentage

of the respondents were non-literates. 57.7% of the respondents were Christians, 41.3% were Muslims while the rest 1.0% were traditional worshippers. This implies that most of the respondents were Christians. Results showed the years of experience of the respondents, 73.2% of the respondents had range of 1-5 years of experience, 23.1% had 6-10 years of experience, while the rest 3.9% had 11-15 years of experience. This implies that most

of the respondents had good years of experience in poultry waste management.

The results showed that 40.4% of the respondent's reared layers, broilers were being reared by 32.7% of the respondents, while 26.9% of the respondents were rearing cockerels. It was revealed that out of all the respondents 21.2% dispose poultry waste by pouring them into the river, 45.2% of the respondents' disposal method is by burying them while the other 33.7% respondents run their waste into soak away. 75% of the respondents agreed that some ingredients increase or decreases the smell of waste, 23.1% of the respondents says that no ingredients contribute to waste smell while 1.9% of the respondents says they were not sure. 62.5% of the respondents remove their waste between 2-3 days, while 37.5% of the respondents remove the waste in between 5-7 days. Results shows that, 21.2% of the respondents got complaints from people about the smell of their poultry waste while the rest 78.8% respondents don't receive any complaint from people around. This implies that greater percentage of the respondents managed their poultry well or their poultry farm is situated in a non-residential area.

The results showed the production cycle of the respondents yearly in that, 51.0% of the respondents said they undergo 1 production cycle per year, 31.7% undergo 2 production cycle per year, 9.6% said they undergo 4 production cycle per year while 7.7% of the respondents undergo above 4 production cycle per year. 47.1% of the respondents had range of 500 to 10,000 birds in a single cycle, 39.4% reared 4000 birds in a cycle,

1.9% of the respondents reared 3000 birds per cycle while 11.5% of the respondent reared 4000 birds per cycle. It was revealed that out of all the respondents, 7.7% of them rear for the purpose of feeding themselves and their families (subsistence), while 92.3% of the respondents' rear for commercial purposes. 78.8% of the respondents formulate their feed for the birds themselves, while the rest 21.1% do not formulate the feed by themselves. The ratio of feed used by the respondents, 76.0% of the respondents have 70/30 feed overall maintenance while 24.0% have 80/20 feed overall maintenance.

The result shows that all respondents had a kg of starter or finisher that weighs 2 - 3 kg per each bird, the information on the table below showed that 1.0% of the respondents' kg starter/finisher have 1-2kg per bird, while 99.0% of the respondent's kg of starter/finisher have 4-5 kg per bird. 83.7% of the respondents use local finishers to feed their birds while 16.3% of the respondents were not using local finisher to feed their birds. 80.8% of the respondents' use N868 to rear each bird, that is the feed, drugs and maintenance, 11.5% of the respondent used N760 to rear each bird, while 7.7% of the respondents used 782 amounts to rear each bird. 41.3% of the respondents sell at the price of 1,200 for each bird, 15.4% of the respondents sell between the price range of 1,300-1,500 for each bird, 20.2% of the respondent sells at the price range of 1,600 - 2,000 for each bird, while 23.1% sells at the price range of 2,100.00 - 2,500 on each bird. 83.7% of the respondents sell their poultry wastes to the farmers, 10.6% of the respondents do not sell their poultry waste, while 5.8% of respondents sometimes sell and sometimes do not sell. 58.7% of them have other wastes apart from poultry litter while 41.3% do not have any other waste

apart from poultry wastes. 45.2% of the respondents said that poultry farmers buy the waste from them, 6.7% of the respondents said that the waste were bought by pig farmers, 6.7% of the respondents sell the waste to other industries, 35.6% of the respondents says the wastes were bought by crop farmers.

The result shows that 6.7% of the respondents had 70,000 as their annual returns, 24.0% of the respondents make 200,000 as their annual returns, 1% of the respondents made 360,000 as their annual returns, 7.7% makes 400,000 as their annual return, 2.9% of the respondents made 500,000 as their annual returns, 1.9% of the respondents had an annual returns of 750,000. 20.2% made 800,000 as their annual returns, 24% of the respondents made 100,000,000 annual returns, 1.9% made an annual return of 200,000,000 while 9.6% of the respondents made 440,000,000 as their annual returns.

The results showed that all the respondents are substituting poultry waste for fertilizer. 27.9% of the respondents use poultry waste to substitute NPK, 8.7% of the respondent's substitute poultry waste with urea while 63.5% of the respondents' substitute poultry waste with both NPK and urea. 18.3% of the respondents said that they were using poultry waste to yield soil fertility for cassava planting. 68.3% used poultry waste for planting maize, while the rest 13.5% of the respondents used poultry waste for cultivating vegetables. 45.2% of the respondents buy it at the rate of 5500 while 54.8% of the respondents buy it at the rate of 6000. 86.5% of all the respondents experienced the same effectiveness when using poultry wastes, while only 13.5% of the respondents says poultry wastes has more effectiveness on crops. The results revealed that 90.4% of the respondents agreed that it serves the same purpose with

fertilizer substitute while 9.6% of the respondents disagreed that it does not serve the same purpose with fertilizer.

The result of multiple regression analysis is presented on table 2, from the result, an adjusted R-squared value of 0.8154 revealed that 81.54 percent of the explained Variation poultry waste impact of respondents were captured by the estimated independent variables specified in the model, while the rest 18.46 percent of the unexplained variation in poultry waste impact of respondents may be due to certain variables of interest not specified in the model but resident in the error term. F-value is 5.74 and significant at 1%. The variables that have significant relationship with poultry waste impact of respondents include;

Waste remover day interval, significant at 5% level, but had a negative relationship with poultry waste impact, this implies that as the period for waste remover extends, there was a negative impact on the environment and performance of the poultry birds thus, resulting to low output. Purpose of rearing birds, years of experience and ingredient that increases/decrease waste smell were all significant at 1% level of significance respectively. Purpose of rearing birds had a negative and inverse relationship with poultry waste impact. Years of experience and ingredient that increases/decrease waste had a positive and direct relationship with the impact of poultry waste on the environment and productivity of the farmer by implication, increase in the years of experience and ingredient that increases/decrease waste, brings about positive increase in agricultural productivity.

Table 1: Socio-Economic characteristics of Respondents

Sex	Frequency	Percentage
Male	55	52.9
Female	49	47.1
Total	104	100.00
Age range (years)	Frequency	Percentage
20-30	10	9.6
30-40	36	34.6
41-50	26	25.0
51-60	26	25.0
Above 60	6	5.8
Total	104	100.00
Marital status	Frequency	Percentage
Single	10	9.6
Married	56	53.8
Divorced	4	3.8
Widow	34	32.7
Total	104	100.00
Educational level	Frequency	Percentage
Non-formal	4	3.8
Primary	11	10.6
Secondary	22	21.2
Adult learning	67	64.4
Total	104	100.00
Religion	Frequency	Percentage
Christianity	60	57.7
Islam	43	41.3
Traditional	1	1.0
Total	104	100.00
Year of experience	Frequency	Percentage
1-5	76	73.2

6-10	24	23.1
11-15	4	3.9
Total	104	100.00
Type of birds	Frequency	Percentage
Broiler	34	32.7
Layers	42	40.4
Cockerels	28	26.9
Total	104	100.00
Waste disposal method	Frequency	Percentage
Into river	22	21.2
Burying	47	45.2
Into soak away	35	33.7
Total	104	100.00
Ingredient / increase/decreases waste smell		Percentage
Yes	78	75.0
No	24	23.1
Not sure	2	1.9
Total	104	100.00
Waste interval day	Frequency	Percentage
2-3	65	62.5
5-7	39	37.5
Total	104	100.00
Complaints from people	Frequency	Percentage
Yes	22	21.2
No	82	78.8
Total	104	100.00
Number of production cycle	Frequency	Percentage
1	53	51.00

2	33	31.70
4	10	9.60
Above 4	8	7.70
Total	104	100.00
Waste disposal method	Frequency	Percentage
500-100.00	49	47.1
2000	41	39.4
3000	2	1.9
4000	12	11.5
Total	104	100.00
Purpose of rearing	Frequency	Percentage
Subsistence	8	7.7
Commercial	96	92.3
Total	104	100.00
Formulate feed	Frequency	Percentage
Yes	82	78.8
No	22	21.2
Total	104	100.00
Overall maintenance	Frequency	Percentage
70/30	79	76.0
80/20	25	24.0
Total	104	100.00
Kg of starter/finisher 2-3kg	Frequency	Percentage
2-3 kg per bird	104	100.000
Total	104	100.00
If yes what is it	Frequency	Percentage
1-2 kg per bird	1	1.0
4-5 kg per bird	103	99.0
Total	104	100.00
Use local finisher feed	Frequency	Percentage

Yes	87	83.7
No	17	16.3
Total	104	100.00
Amount used to rear each bird	Frequency	Percentage
868	84	80.8
760	12	11.5
782	8	7.7
Total	104	100.00
Price of each birds	Frequency	Percentage
1200	43	41.3
1300-1500	16	15.4
1600-2000	21	20.2
2100-2500	24	23.1
Total	104	100.00
Do you sell waste	Frequency	Percentage
Yes	87	83.7
No	11	10.6
Sometimes sell & not sell	6	5.8
Total	104	100.00
Other wastes	Frequency	Percentage
Yes	61	58.7
No	43	41.3
Total	104	100.00
Who buys them	Frequency	Percentage
Poultry	47	45.2
Pig farmers	7	6.7
Other industries	37	35.6
Crop farmer	13	12.5
Total	104	100.00
Annual returns	Frequency	Percentage

70000	7	6.7
200000	25	24.0
360000	1	1.0
400000	8	7.7
500000	3	2.9
750000	2	1.9
800000	21	20.2
100,000000	25	24.0
200,0000,000	2	1.9
440,000,000	10	9.6
Total	104	100.00
Waste substitute fertilizer	Frequency	Percentage
Yes	104	100.00
Total	104	100.00
If yes what	Frequency	Percentage
NPK	29	27.9
Urea	9	8.7
Both	66	63.5
Total	104	100.00
Crop best used for	Frequency	Percentage
Cassava	19	18.3
Maize	71	68.3
Vegetables	14	13.5
Total	104	100.00
Price	Frequency	Percentage
5500	47	45.2
6000	57	54.8
Total	104	100.00
How effective	Frequency	Percentage
More	14	13.5
Same	90	86.5

Total	104	100.00
Same purpose with fertilizer substitute	Frequency	Percentage
Yes	94	90.4
No	10	9.6
Total	104	100.00

Source: Field Survey, 2017.

Table 2: Results of Multiple Regression.

Variable	Co-efficient	T	p>t
Waste removal day interval	-0.142	-1.09	0.018**
Purpose of rearing birds	-1.030	-0.60	0.000*
Years of experience	0.402	3.97	0.000*
Ingredient that incre/decre.	0.665	8.71	0.000*
Waste			
Annual return	3.670	0.69	0.493
Constant	3.714	6.83	0.000

Source: Field Survey, 2017.

*, **, *** Significant at 1%, 5% and 10% respectively.

CONCLUSION AND RECOMMENDATION

Based on the result of the findings, the study showed that respondents in the study area were above their active and economic age, and were married. Average household size was 8 members. The following was recommended: Farmers should be encouraged to increase hygiene by doing frequent sanitation so as to reduce the chances of disease infestation. Community-based surveillance of pathogens on poultry products should be intensified to ensure the success of programs undertaken. The farmers should be advised to attend waste management and health program to support year of experience. The government should assist through research institute, make available feed ingredient that will reduce waste without causing a detrimental effect on the poultry animal.

REFERENCES

- Akanni K.A.*, Benson O.B. (2014). Poultry Wastes Management Strategies and Environmental Implications on Human Health in Ogun State of Nigeria, 11:14-15
- Abdelhamid, M.T., Horiuchi, T., Oba, S. (2004) Composting of rice straw with oilseed rape cake and poultry manure and its effect on faba bean (*Vicia faba* L.) growth and soil properties, *Bioresource Technology*, 93: 183-189.
- Anne, F. (2007). Poultry house management for alternative production. <http://www.poultryinternational.digital.com>.
- Anonymous, (2006). Better utilization of locally available feed resources. What Local Supplements Are Available to Feed Dairy Cows and How to Use Them?, <http://www.fao.org/ag/againfo/themes/documents/PUB6/P621.htm>.
- Dan, L.C., W.R. Casey and C.M. William, (2009). Best management practices for storing and applying poultry litter. The University of Georgia Cooperative Extension, pp: 1-12.
- Doye, D., B. Freking, J. Payen and S. Ferrell, (2009). Broiler production: Considerations for potential growers. Oklahoma Cooperative Extension Fact Sheet, Oklahoma State University, <http://pods.dasnr.okstate.edu/docshare/dsweb/Get/Document-3099/AGEC-202web.pdf>.
- Embury, I.S. (2004). Alternative litter materials for poultry. Poultry Division of Animal Production, NSW Agriculture, http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/134446/Alternative-litter-materials-for-poultry.pdf.
- Forbes, W. (2006). On-farm composting of poultry litter. Agricultural Extension Service Unit, The University of Tennessee Institute of Agriculture, pp: 1-9.
- Kavitha, R. and P. Subramanian, 2007. Bioactive compost-a value added compost with microbial inoculants and organic additives. *J. Applied Sci.*, 7: 2514-2518. [CrossRef](#) | [Direct Link](#) |

- Nahm K.H. (2000): A strategy to solve environmental concerns caused by poultry production. *World's Poultry Science Journal*, 56, 379-388.
- Oyebanjo Olumayowa¹ and O. Otunaiya Abiodun (2011). Profit Efficiency and Waste Management in Poultry Farming: The Case of Egba Division, Ogun State, Nigeria
- Wiebe van der sluis (2007): Intensive poultry production better for globalwarming. *World Poultry*, 23, 12, 28-31. www.worldpoultry.net
- 8380.
- Williams, A.G., Audsley E., Sandars D.L. (2006): Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Defra Research Project IS0205. Bedford: Cranfield University, 5:12-13
- Zhang, W.-F.; Dou, Z.-X.; He, P.; Ju, X.-T.; Powlson, D.; Chadwick, D.; Norse, D.; Lu, Y.-L.; Zhang, Y.; Wu, L.; *et al*, (2013) New technologies reduce greenhouse gas emissions from nitrogenous fertilizer in China. *Proc, Natl. Acad. Sci. USA* **2013**, *110*, 8375-

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ABSTRACT

A 56- day feeding trial was conducted to investigate the effects of dietary raw and Ammonium hydroxide treated *Moringa oleifera* seed cake (AHMOSC) on performance, serum and haematological characteristics, and nutrient retention of broiler chickens. One hundred and fifty day- old Arbor acre chickens were used in this experiment. They were fed five different diets as follows; Diet 1-the control devoid of *Moringa oleifera* seed cake (MOSC), diet 2-raw MOSC, diets 3, 4, and 5 –MOSC soaked in 10, 20, and 30% Ammonium hydroxide solution. Broilers fed graded level of AHMOSC had similar ($p < 0.05$) DWG, FI and FCR with the control (61.73 to 61.99 vs. 59.99; 103.75 to 104.74 vs. 102.51 g/bird/day and 1.67 to 1.69 vs. 1.71, respectively, and were significantly ($p > 0.05$) better than value for raw MOSC. The haematological indices and serum chemistry of chickens fed treated MOSC were poorer than the control but significantly ($p < 0.05$) better than those of raw MOSC. In conclusion, treatment of MOSC with Ammonium hydroxide was effective in reducing its anti-nutritional contents and can be used as protein supplement in poultry diet. This study recommends the use of 20% ammonium hydroxide in treatment of MOSC for improvement of its nutritive value.

Key words: Moringa seed cake, broiler chickens, performance, biochemical and haematological indices

INTRODUCTION

Feeding in livestock production is majorly a source of nutrient to the livestock and the importance of the feed can be seen from the point of view that feed accounts for 55-75% of cost of producing chickens, 45-65% of the cost of producing dairy cattle, 40-60 % of the cost of producing sheep and goats and about 70% of the cost of raising rabbits (Atteh, 2002). The biggest constraint to poultry production in Nigeria is cost of feed, which accounts for about 60 to 80% of the recurrent expenditure in intensive poultry production (Oluyemi and Roberts, 2000). This is because feedstuffs

used in formulating and compounding diets for poultry are also in high demand for human consumption and industrial uses (Anike and Okeke, 2003) thus, alternative feeding stuff must be sourced to prevent competition between man and animal. Plant proteins are cheaper and therefore their use in large quantity ensures less expenditure as compared to animal Proteins. Some nutrients chemicals however, possess well known toxic properties if consumed in excessive amounts or without adequate preparation. The toxic chemicals in feeds when consumed by animals can cause a variety

of actions in the body or can react in some adverse ways between the nutrients and toxins *in vivo*. For instance, some feed chemical toxins exert their action by interfering with nutrients retention, availability and some are known to adversely affect the utilization of nutrients while others have been reported to influence negatively the metabolism of nutrients, all these chemicals which influence the metabolism negatively are called anti-nutritional factors, the anti-nutritional factors present in these feeds include trypsin, chymotrypsin and amylase inhibitors, aflatoxins and polyphenolic compounds which tend to inhibit and obstruct the activity of digestive enzymes thereby causing digestive losses (Singh, 1988). To find ways of reducing feed cost there have been numerous efforts by researchers, nutritionists and producers to find alternatives by considering novel feedstuffs which are safer, cheaper, locally available and nutritionally adequate and majorly that contain lesser toxin in which case their method of detoxification will be cheaper as feed ingredients. Overwhelmed by the numerous economic benefits of *Moringa oleifera* tree in the tropical world where the plant is considered a miracle tree due to its industrial, medicinal and nutritional attributes, the area of its anti-nutritional or toxic factors remains to be fully dealt with. However, there is no information on the use of ammonium hydroxide for the processing of *Moringa oleifera* seedcake in nutrition of poultry. The constrain in the use of this present novel feed resources attributed to the ANFs present in MOSC could be ameliorated using aqueous ammonium hydroxide for the removal of condensed tannin (Griffiths, 1991).

MATERIALS AND METHODS

20kg of *Moringa oleifera* seed cake used for this work was obtained from Moringa processing plant at Afe Babalola University, Ado-Ekiti, Nigeria. Raw (unprocessed) *Moringa oleifera* seed cake was divided into four equal portions of 3Kg each. A portion was left untreated, while each of the other three portions was treated by soaking in 5Litres of 10, 20 and 30% ammonium hydroxide solution respectively for 24hours. The seed cake was later removed from solution and properly dried in the sun to a constant weight and milled for replacing soyabean in the diets

Five experimental diets were formulated to meet NRC (1994) requirement for day old broiler chicks. A corn-soybean reference diet (diet 1) is devoid of *Moringa oleifera* seed cake (MOSC), diet 2 contained raw MOSC, while the other three diets contained processed *Moringa oleifera* seed cake using ammonium hydroxide before inclusion in the diet at the same 5% level of inclusion corresponding to diets 1, 2, 3, 4 and 5 respectively. One hundred and fifty day-old Arbor acre breed of broiler birds used for this experiment were obtained from Novic Farms, Ibadan, Oyo State Nigeria. The experiment was designed as a complete randomized design. The dietary treatments contained three replicates with 10 chicks per replicate. All the birds were raised under similar management practices throughout the eight week experimental period. The birds were given feed and water *ad-libitum* and weighed weekly. The composition of the experimental diets for the broilers on as fed basis is presented on Table 1.

Table 1: Composition of the experimental diets on as fed basis (%)

Ingredients (%)	Inclusion doses of treated MOSC (%)				
	0 (control)	0 (Raw)	10	30	50
Maize	52.00	52.00	52.00	52.00	52.00
AHMOSC	0.00	3.10	3.10	3.10	3.10
Wheat offal	10.00	10.00	10.00	10.00	10.00
Soya bean meal	31.00	27.90	27.90	27.90	27.90
Palm oil	1.50	1.50	1.50	1.50	1.50
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.25	0.25	0.25	0.25	0.25
Bone meal	1.15	1.15	1.15	1.15	1.15
Oystershell	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Fish meal	2.00	2.00	2.00	2.00	2.00
*Vit/Min premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

The proximate composition of the treated *Moringa oleifera* seed cake diet is presented on Table 2

Table 2: Analysed nutrient content of Ammonium hydroxide MOSC diets for broilers

Parameters	Inclusion levels of MOSC (%)				
	0(control)	0(untreated)	10	30	50
Dry matter	86.69	92.71	93.25	94.31	93.58
Crude protein	22.20	22.60	21.70	20.65	24.12
Ether extract	3.64	3.84	3.43	3.98	2.89
Crude fibre	8.73	8.71	8.68	8.50	8.74
Ash	7.44	7.47	7.50	7.54	7.48

At the end of the experiment, one broiler per replicate in all the treatments was taken at random and blood collected by decapitation. Blood for biochemical indices was collected in bottles without EDTA for the analysis of the biochemical parameters of total protein albumin, globulin, urea, transaminase activities-AST, ALT ALP etc. The blood samples for haematological parameters were

pretreated with ethylene diamine tetra-acetic acid (EDTA). Haematological indices examined include WBC, RBC, PCV, and Hb. MCV, MCH and MCHC were calculated from the values of the RBC, PCV and Hb respectively.

Statistical Analysis

Data collected on the response criteria were subjected to analysis of variance

according to the completely randomized design model and differences between treatment means were separated using the Duncan's multiple range test (Steel and Torrie, 1980).

RESULTS

Table 3 presents data on performance characteristic of broilers fed ammonium hydroxide treated *Moringa oleifera* seed cake (MOSC) diet. Except for birds on raw diet (treatment 2), the average daily weight gains, the feed intake values and the feed conversion ratio of the birds were not significantly ($p > 0.05$) affected. Table 4 presents the biochemical indices of the broiler chickens given dietary ammonium hydroxide treated MOSC diet. There was a significant ($p < 0.05$) increase in the total protein levels with the inclusion of ammonium hydroxide treated *Moringa oleifera* seed cake (MOSC) in the diet of the birds. The albumin levels revealed a decrease in the trend with the inclusion of ammonium hydroxide treated *Moringa oleifera* seed cake (MOSC) in the diet of the birds. ALT and ALP levels of the birds significantly ($p < 0.05$) decreased linearly except treatment 2 with the inclusion of ammonium hydroxide treated *Moringa oleifera* seed cake (MOSC) in the diet of

the birds. The hematology indices of the birds fed with graded level of ammonium hydroxide treated *Moringa oleifera* seed cake diet is presented on Table 5. RBC, PCV, MCH and MCHC were significantly ($p < 0.05$) affected with an irregular pattern in the values with the inclusion of graded level of ammonium hydroxide treated MOSC in the diet of the birds. The mean cell volume, haemoglobin and white blood cell of the birds were not statistically ($p \geq 0.05$) different by the inclusion of the graded level of ammonium hydroxide treated *Moringa oleifera* seed cake in the diet of the birds. Table 6 presents the nutrient retention of broilers fed with graded level of ammonium hydroxide treated MOSC diet. The nutrient retention of crude protein, fat and fibre of birds on control diet and the ammonium hydroxide treated groups were not significantly ($p > 0.05$) different with the inclusion of graded level of ammonium hydroxide treated MOSC in the diet of the birds. The trend in the crude protein, fat and fibre retention revealed that the birds on 30% ammonium hydroxide treatment (diet 5) had the best nutrient retention compared with its counterparts, the raw and the control diet.

Table 3: Performance characteristics of broiler birds fed ammonium hydroxide treated *Moringa oleifera* seed cake diet

Parameters	0(control)	0(Raw)	10	20	30	SEM
Daily weight gains (g/bird/day)	59.993 ^a	42.340 ^b	61.763 ^a	61.873 ^a	61.993 ^a	1.366
Feed intake (g/bird/day)	102.507 ^a	92.307 ^b	104.477 ^a	103.747 ^a	104.737 ^a	3.972
Feed conversion ratio	1.707 ^b	2.180 ^a	1.693 ^b	1.677 ^b	1.687 ^b	0.045

SEM= Standard error of mean*= $P < 0.05$ Means with different superscript along the same rows are significantly ($P < 0.05$), MOSC=*Moringa oleifera* seed cake

Table 4: Serum biochemical indices of broiler birds fed ammonium hydroxide treated *Moringa oleifera* seed cake diet

Parameters	Inclusion doses of treated MOSC (%)					SEM
	0(control)	0(Raw)	10	30	50	
Urea (mmol/l)	4.657 ^b	8.070 ^a	4.707 ^b	4.520 ^b	4.657 ^b	0.127
Total protein (g/l)	13.927 ^c	24.230 ^a	5.817 ^b	15.620 ^b	14.060 ^c	0.230
Albumin (g/l)	2.727 ^b	6.163 ^a	2.307 ^{bc}	2.020 ^c	2.157 ^c	0.261
Aspartate Amino transaminase(U/L)	70.000 ^b	90.030 ^a	64.210 ^{bc}	54.737 ^c	61.053 ^{bc}	6.894
Alanine Amino transaminase(U/L)	19.480 ^c	30.443 ^a	20.827 ^c	24.480 ^b	10.830 ^d	1.136
Alkaline phosphatase (U/L)	35.680 ^a	36.287 ^a	25.020 ^b	23.580 ^b	22.960 ^b	3.948

SEM= Standard error of mean*=P<0.05 Means with different superscript along the same rows are significantly (P<0.05); NS=Non Significant (P>0.05); .MOSC=Moringa oleifera seed cake.

Table 5: Blood composition of broiler birds fed ammonium hydroxide treated *Moringa oleifera* seed cake diet.

Parameters	Inclusion doses of treated MOSC (%)					SEM
	1 0(control)	2 0(Raw)	3 10	4 20	5 30	
Red Blood Cell (x 10 ¹² /l)	2.360 ^{ab}	2.520 ^a	2.215 ^b	2.355 ^{ab}	2.180 ^b	0.148
Haemoglobin (g/dl)	8.750 ^a	9.300 ^a	9.000 ^a	8.950 ^a	8.650 ^a	0.397
Packed Cell Volume (%)	31.200 ^a	32.600 ^a	30.250 ^{ab}	31.400 ^{ab}	29.800 ^b	1.412
Mean Cell Volume (fl)	132.250 ^a	129.600 ^b	136.550 ^a	133.350 ^a	137.500 ^a	4.048
Mean Cell Haemoglobin (pg)	37.150 ^c	36.950 ^c	40.600 ^a	38.050 ^{bc}	39.950 ^{ab}	1.264
Mean Cell Hae. Conc (g/dl)	28.050 ^c	28.550 ^{bc}	29.750 ^a	28.500 ^{bc}	29.050 ^{ab}	0.4147
White Blood Cell (x 10 ⁹ /l)	231.000 ^a	233.850 ^a	234.750 ^a	238.900 ^a	232.500 ^a	4.482

SEM= Standard error of mean=P<0.05; Means with different superscript along the same rows are significantly (P<0.05); Mean Cell Hae. Conc= Mean Cell Haemoglobin Concentration, .MOSC=Moringa oleifera seed cake.

Table 6: Nutrient retention of broiler birds fed ammonium hydroxide treated *Moringa oleifera* seed cake diet

Parameters(%)	Inclusion doses of treated MOSC (%)					SEM
	1 0(control)	2 0(Raw)	3 10	4 20	5 30	
Crude protein	76.870 ^a	55.300 ^b	76.107 ^a	75.440 ^a	76.007 ^a	1.432
Crude fibre	68.993 ^a	48.690 ^b	71.023 ^a	71.153 ^a	71.293 ^a	1.571
Fats	65.997 ^a	46.570 ^b	67.937 ^a	68.057 ^a	68.197 ^a	1.503

SEM= Standard error of mean;p<.05;**^c Means with different superscript along the same rows are significant (P<0.05), .MOSC=Moringa oleifera seed cake.

DISCUSSION

Growth performance characteristics: The observed improved growth performance of birds with the inclusion of graded level of ammonium hydroxide in the diets of the birds indicate the efficiency of the processing method to reduce the various anti-nutrients inherent in MOSC thereby enhancing its better utilization by the birds. This present study agrees with the findings of Barlett (1998) that found reduction in toxicity in mustard meal after alkali heating in broilers.

The significant increase in the feed intake of the animals fed ammonium hydroxide treated MOSC diet compared to those on the raw MOSC may be an indication of reduction in the level of tannins in the treated feed sample. Tannins are known to cause reduction in feed intake (probably by irritating the gut) due to their astringency or bitter taste, thereby reducing the palatability of the feed (Reed, 1995). Ferreira *et al.*, (2008) reported that higher levels of 7.5 and 100 g/kg moringa seed meal supplementation depressed intake, growth rate and live weights of the chickens. Also, the significant improvement observed in the feed conversion ratio of the birds placed on ammonium hydroxide treated MOSC based diet, when compared with those on the raw MOSC diet, is indicative of a better utilization of the feed.. It showed that the animals, reared on the feed, gained more weight with little amount of the feed consumed. There was an indication that birds fed the control diet and the treated groups had better feed conversion ratios. The best FCR observed in birds on the control diet and the treated groups was due

to the absence of anti-nutritional factors (ANFs) in the control diet and subsequent reduction in the ANFs present in MOSC by the adopted processed method.

This result confirms earlier findings of Emiola *et al.*, (2003) that reduced ANFs as a result of improved processing techniques enhanced birds' performance. Absence of mortality in this study is an indication that most of the anti-nutrients in the treated MOSC diets have been eliminated or significantly reduced. Some of these anti-nutrients are known to cause death in animals. The observed non-significant ($p>0.05$) difference in serum urea between the control and the treated groups is in agreement with the findings of Eggum (1970); Esonu *et al.*; (2001); Iyayi and Taiwo (2003) who reported that serum urea and total protein contents depend on both the quantity and quality of the protein supplied in the diet. The significant ($p<0.05$) increase in serum urea observed in raw diet (treatment 2) is an indication that, the more the test feed was included in the diet of broilers, the more the birds survive at the expense of their body response. The observed significant ($p<0.05$) increase in total protein, and albumin with the inclusion of graded level of ammonium hydroxide in the diets of the birds attest to the nutritional adequacy of treated MOSC in meeting the protein needs of the birds. Onifade and Tewe (1993) had earlier reported that serum protein, albumins and globulins are generally influenced by total protein intake. ALP, AST and ALT decreased with the inclusion of graded level of ammonium hydroxide in the diets of the birds. The increase in ALT values in birds in treatments 2, compared with the control and treated group suggest that there may be

a likelihood of liver damage by the raw MOSC. Haematological parameters such as Packed Cell Volume (PCV), Haemoglobin (Hb) and Total Protein (TP) were observed to be better for the control diet than for the MOSC diets.

CONCLUSION

From this study, broilers fed treated MOSC diet performed better than those fed raw MOSC diet while those fed the control diet performed significantly better than those fed raw and treated MOSC diet respectively. The adopted treatment method in this study

In this study, the nutrient retention of the birds fed the treated MOSC was better than those fed with raw MOSC diet and the better nutrient retention of the birds fed with the graded level of ammonium hydroxide treated MOSC implies the effectiveness of the processing of raw MOSC for broilers.

was not sufficient to totally detoxify the anti-nutrients present in MOSC. The best result obtained from replacing soyabean with treated *Moringa oleifera* seed cake diet was 30% Ammonium hydroxide treatment at 5% inclusion level.

REFERENCES

- AOAC (1990). Official method of Analysis, 15th Edition. Association of Analytical Chemists. Washington D. C.
- Anike, A. O. and G. C. Okeke (2003). The substitution of pigeon pea (*Cajanus cajan*) seed meal for soya bean in broiler finisher rations. Proceedings of the 8th Annual Conference of the Animal Science Association of Nigeria (ASAN), Sept. 16th – 18 th, Federal university of Technology, Minna, Nigeria. P 10-12.
- Atteh, J. O. (2002). Principles and Practice of Livestock Feed Manufacturing. Adlek printers, Ilorin p.137.
- Barlett J. E., Klopfenstein C. F., Leipold H. W. (1998): Alkaline heating of canola and mustard meals reduces toxicity for chicks. Plant Foods for Human Nutrition 52, 9-15.
- Duncan, D.B., (1980). Multiple Range and Multiple F- Test. Biometrics, 11: 1-42
- Emiola, I.A., A.D. Ologhobo, J. Akinlade, O.S. Adedeji and O.M. Bamigbade, (2003). Effect of inclusion of differently processed mucuna seed meal on performance characteristics of broilers. Trop. Anim. Prod. Invest., 6: 13-21.
- Fuglie L.J (1999). The Miracle Tree; *Moringa oleifera* ; Natural nutrition for the Tropics. Church World Service, Dakar, 68 pp; revised 2001 and published as The Miracle Tree; The Multiple Attributes of Moringa, 172pp.
- Iyayi, E.A. and Taiwo V.O. (2003). The effects of diets incorporating *Mucuna pruriens* seed meal on the performance of laying hens and broilers .*Tropical and Subtropical Agro-ecosystem*, 1:239-246.
- Makkar H.P.S. and K. Becker. (1996a). Nutritional Value and anti-nutritional Components of whole and ethanol extracted *Moring oleifera* Leaves. Anim. Feed Sci. Technol; 63, 211 – 228

- Morton J.F (1991). The Horseradish tree, *Moringa pterygosperma* (Moringaceae) a boon to arid lands? *Econ. Bot*; 45, 318 – 333.
- National Research Council (1994). Nutrient Requirements of Domestic Animals. In: Nutrient Requirement of Poultry (9th edition). National Academic of Science, Washington. D.C., USA. pp 71-73.
- Prabhu, T.M., Deva Kumar C., Sastry V.R.B., Agarawa D.K. (2002). Quantification of Karanjin using high performance liquid chromatography in raw and detoxified karanj (*Pongamia glabra* vent) seed cake. *Asian-Australasian Journal of Animal Sciences* 15:416-240
- Steel, R.G.D., and Torrie, J.H. (1980). Principles and procedures of statistics: A biometric approach, 2nd Edition, New York McGraw Hill Kugakusha, USA.

Food Safety And Hygiene Practices Among Street Food Vendors In Ibadan Metropolis Of Oyo State, Nigeria

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ABSTRACT

More than half of all illnesses and death among children and even adults are often caused by germs that enter their mouths through dirty hands or contaminated foods and water. This research work was conducted to ascertain the food safety and hygiene practices among food vendors in Ibadan metropolis of Oyo State, Nigeria. The study used interview schedule approach and structured questionnaire for data collection. One hundred and twenty street food vendors were selected using multi-stage sampling technique. Frequencies, percentages and Tobit regression analysis were used to describe and analyze the variables such as socio-economic characteristics of the respondents, perception of food safety knowledge and practices, status of food safety practices, socio-economic consequences of unsafe foods and constraints to compliance to safe food practices. The practice of covering of foods for sale to prevent flies and washing of fruits and vegetables before eating were the practices that had the highest ranking among the food safety practices. Also, the practice of covering foods for sale to prevent flies before selling and checking food stuffs before selling were the variables that had the highest ranking based on the perception of the respondents to the food safety practices. Also, lack of portable water and electricity supply constituted the major constraints to food safety practices while the consequences of unsafe food hygiene practices will lead to illnesses which includes dysentery and typhoid among others. Tobit regression analysis revealed that there was a significant relationship between educational level, sex, health condition, total income and the respondents' food safety practices. Therefore, the study concluded that food safety practices of these areas is poor and recommended inclusion of food safety practices in school curriculum, mounting public campaigns in urban and rural areas on food safety practices and evolving effective monitoring strategy by agricultural extension agents and the other stakeholders in order to achieve healthy households

Keyword: Food safety, Food vendor, Hygiene practices, Street and Metropolis.

INTRODUCTION

Food is a necessity for all living creatures, and it can be in liquid, solid or gaseous form. As such, it should be handled and prepared in the safest way possible to meet all consumer needs (Jones *et al*, 2006). Food is said to be safe when it is wholesome, balanced, and health giving in nature, a food that is devoid of constituents that are dangerous or inimical to continuous existence of the consumer (Taiwo, 2002). Therefore, measures adopted to ensure and protect the cleanliness and wholesomeness of food is referred to as Food Safety practices. Unclean food is indicated by the presence of contaminants. However, contaminants are unwanted elements or “foreign bodies” that have contact with food, thereby causing food contamination. This may be through insects, pesticide residue, metal fragments and glass sphincter from mechanical processing or storage conditions (Akinyele, 1992). The term “street food” refers to a wide variety of ready – to – eat foods and beverages sold and sometimes prepared in public places. It may be consumed where it was purchased or can be taken away and eaten elsewhere (WHO, 1996). Street food satisfies a vital need of the urban population, because it is reasonably priced and conveniently available, and sometimes some segment of the population depends entirely on it for survival (Jones *et al*, 2006).

Food safety is a major concern with street food, as this food is generally prepared and sold under unhygienic conditions with limited access to safe water, sanitary services or garbage disposal facilities (Isara, *et al*, 2009). A street vendor is broadly defined as a person who offers goods for

sale to the public without having a permanent built up structure but with a temporary static structure or mobile stall (or head load). Street vendor may be stationary by occupying space on the pavements or other public or private area or may be mobile in the sense that they move from place to place carrying their wares on push carts or in cycles or baskets on their heads, or may sell their wares in moving trains, buses etc (National policy on urban street vendors, 2004). Street food vending is a prevailing and distinctive part of a large informal sector. It is commonly seen in public places, particularly in the cities and it is distinctive in the sense that it provides a basic need to the urban inhabitants (Muzaffar, *et al*, 2009). Women are often owners or employees of street food businesses. According to FAO study, 70% - 90% vendor are women and they sell food in the street primarily to improve food security of their family and for a degree of financial independence (FAO, 1997)

More than half of all illnesses and death among young children are often caused by germs that enter their mouth through dirty hand or contaminated food or water. WHO (1992) found that in 1989 alone, 2.2 million children died of diarrhea. A large number of these causes were caused by contaminated foods and unclean water due to lack of adequate community sanitation (Meludu, 2003). Street food is a public health concern, since safe food hygiene can be difficult to practice at street level in settings where resources are scarce and the surroundings are of low environmental and sanitary standards. Diarrhea diseases due to contaminated and unhygienic food are among the leading causes of illness and death in low income countries, and several

outbreaks of diseases have been attributed to the consumption of street food (Okpaala, *et al.*, 2003). Several foods borne disease outbreaks have been reported to be associated with poor personal hygiene of food stuff handlers. Diarrheal diseases, mostly caused by food borne microbial pathogens are the leading causes of illness and deaths in the developing countries, killing an estimated 1.9 million percent annually at the global level (Schlundt, *et al.*, 2004). Street food vending in urban areas, especially in metropolitan cities has become an integral part of the urban lives and culture. It is also recognized that despite of good taste and easy availability, street food vendors are often poor, uneducated and lack hygiene practices. So street food are perceived to be a major public health risk (WHO, 2002). Food handling personnel play important role in ensuring food safety throughout the chain of food production and storage. This research was therefore designed to examine the food safety knowledge, attitude and hygiene practices among the street food vendors in Ibadan metropolis.

METHODOLOGY

This study was conducted in Ibadan metropolis. Ibadan, is the capital city of Oyo state, Nigeria, located on seven hills (average elevation 700 feet (200 meters) 100 miles (160 km) from the Atlantic coast with the coordinates of 7°23'47"N 3°55'0"E. It is one of the most populous cities in the country and the third largest metropolitan area, by population, in Nigeria, after Lagos and Kano, with a population of 2,628,000 according to 2007 census. The city ranges in elevation from 150m in the valley area, to 275m above sea level on the major north-

south ridge which crosses the central part of the city. The city's total area is 1,190 sq. mi (3,080 km). Ibadan has a tropical wet and dry climate, with a lengthy wet season and relatively constant temperatures throughout the course of the year. Although the city's farming population has declined, it is still large for an urban area. Ibadan is an important commercial Centre. Virtually every street and corner in the traditional core and the inner suburbs of the city is a market square consisting of both male and female street vendors.

Sampling procedure and Sample size

A multi-stage sampling technique was used to select one hundred and twenty food vendors operating in the major streets and open market in Ibadan metropolis. About 60% of the food vendors were local/street vendors and 40% of the sampled vendors were the conventional eateries and or restaurants were randomly selected from each of the major streets and open market within Ibadan metropolis. The study basically utilizes primary which was obtained through observations of procedures and practices employed by food caterers that produce food, while interview schedule and questionnaire was used to elicit the needed food safety information from caterers or vendors. The data collected was subjected to descriptive statistics with the aid of frequency table and percentages while Tobit regression model was used to analyze variables such as personal characteristics, status of food safety practices in the area, socio- economic consequences of unsafe foods, perception on government policy on food safety practices and constraints militating against food safety and hygiene practices.

Model specification

Tobit regression model

This was used to analyze the determinants of knowledge, attitude and practice of food safety among street food vendors. The model can be stated as

$$y^* = \beta z + e$$

$$y = y^*(\beta z + e) \text{ If } y^* > 0$$

$$y = 0 \text{ If } y^* \leq 0$$

y_i = Food safety index (the index was computed through the food safety and hygiene practices)

X = vector of explanatory variables

β = vector of unknown variables

e = independently and normally distributed random error terms

X_1 = Age (Years)

X_2 = Sex (male=1, female=0)

X_3 = Marital status (married=1, others =0)

X_4 = Educational level (years spend in school)

X_5 = Ethnic group (Yoruba=1, others=0)

X_6 = Health condition of the vendor (healthy=1, others =0)

X_7 = Total income (naira)

X_8 = Customers

RESULTS AND DISCUSSIONS

Socio- economic characteristics of the respondents

One hundred and twenty (120) street food vendors were interviewed for the study. The modal category of the respondent's age was 41-50 years, representing 40.8 percent of the population while the average age of the respondents is 45 years. 25% of the respondents had their ages between 51-60 years, 22.5 percent of them were between 31-40 years, and 6.7 percent of them were 30 years and below while 5 percent represents those that were above 60 years. This indicated that majority of the respondents were in their active years and were likely to engage in food handling or vending and thus, would be concerned with food hygiene and safety practices.

Also, the distribution by Sex showed that majority of the respondents (97.5%) were females and very few (2.5%) were males. This implies that more female headed were found engaging in vending food. This low involvement by males is supported by WHO (1992) assertion that women are recognized to constitute a major category of food handlers in most regions of the world. This phenomenon indicates that food safety decision-making and implementation largely rests on women.

The educational background of the respondents showed that about 39.2 percent of the food vendors had only basic primary education, 30 percent never had any form of educational experience, not more than 25.8 percent had attended secondary school while just 5 percent got post-secondary or tertiary education. This low literacy level is expected to contribute greatly to the problem of non- observation of food safety practices in the study area.

The distribution of respondents by health problem showed that majority (75%) of the

respondents' experienced one health problem or the other, while few (25%) are healthy.

Table 1 further reveals that 17.5% of the respondents had a monthly income ranging from 1 – 50,000 naira, 22.5% earned within the range of 51,000 – 100,000 naira, 16.7% also earned within the range of 101,000 – 150,000 naira, 14.2% earned within 151,000

– 200,000 naira, 8.3% makes between 201,000 – 250,000 naira, 10.8% makes between 251,000 – 300,000 naira, 6.3% makes between 301,000 – 350,000 naira while about 3.3% of them makes above 350,000 naira as their monthly income which implies that high income level can as well encourage a food vendor to abide by the rules governing food safety and hygiene practice.

Table 1: Socio- economics characteristics of respondents.

Variables	Frequency	Percentage
Age (years)		
<30	8	6.7
31-40	27	22.5
41-50	49	40.8
51-60	30	25.0
<60	6	5.0
Total	120	100
Sex		
Male	3	2.5
Female	117	97.5
Total	120	100
Educational Level		
None	36	30.0

Primary	47	39.2
Secondary	31	25.8
Tertiary	6	5.0
Total	120	100
Health Problem		
Yes	90	75.0
No	30	25.0
Total	120	100
Total Income (Naira)		
1 – 50,000	21	17.5
51,000 -100,000	27	22.5
101,000 – 150,000	20	16.7
151,000 – 200,000	17	14.2
201,000 – 250,000	10	8.3
251,000 – 300,000	13	10.8
301,000 – 350,000	8	6.7
Above 350,000	4	3.3
Total	120	100

Source: Field Survey, 2018

Food Safety Practices of the Respondents

The distribution of the respondents by food safety practices was presented on Table 2. It was measured on a 3-scale of highly practiced, occasionally practiced and rarely practiced. The practice of covering food for sale to prevent flies and washing of fruit and vegetables very well before eating had the highest ranking of 1st with the weighted mean score (WMS) of 2.92, the practice of serving food immediately after they are cooked and checking foodstuff before selling had the joint 3rd ranking with the WMS of 2.76, while the practice of serving food in clean and contaminant free environment ranked 3rd with the WMS of

2.73, Also, the practice of washing of hands with soap before food preparation ranked 6th with the WMS of 2.44, while the practice of disposing your waste away from homestead or selling place was ranked 7th with WMS of 2.31, the practice of washing hands with soap after toilet usage before handling foods ranked 8th with the WMS of 2.12 while the use of cutleries for eating and serving food ranked 9th with the WMS of 1.92. Also, the practice of refrigerating and warming left over foods after a meal is eaten is ranked 10th with the WMS of 1.23 while the practice of storing and preparing frozen foods according to label instruction had the least ranking of 11th with the WMS of 1.17.

Table 2: Distribution of the Respondents by Food safety Practices

Food Safety Practices	Rarely practiced	Occasionally practiced	Highly practiced	WMS	Ranking
Cover foods for sale to prevent flies	2(1.7)	6(5.0)	112(93.3)	2.92	1 st
Wash fruits and vegetables very well before eating	2(1.7)	6(5.0)	112(93.3)	2.92	1 st
Serve food immediately after they are cooked	6(5.0)	17(14.2)	93(80.8)	2.76	3 rd
Check foodstuff before selling	4(3.3)	19(15.8)	97(80.8)	2.76	4 th
Serve food in clean and contaminant free environment	5(4.2)	22(18.3)	93(77.3)	2.73	5 th
Wash your hand with soap before food preparation	3(2.5)	61(50.8)	56(46.7)	2.44	6 th
Dispose your waste away from homestead or selling place	5(4.2)	56(46.7)	59(49.2)	2.31	7 th
Wash your hand with soap after toilet usage	4(3.3)	98(81.7)	18(15.0)	2.12	8 th
Use cutleries for eating and serving food	43(35.8)	44(36.7)	33(27.5)	1.92	9 th

Refrigerate and warm left- over food after a meal is eaten	96(80.0)	21(17.5)	3(2.5)	1.23	10 th
Store and prepare frozen foods according to the label instruction	104(86.7)	15(12.5)	1(0.8)	1.17	th

Source: Field Survey, 2018

Perception of the respondents by food safety practices

The result on Table 3 shows the perception of the respondents on food safety practices and this was measured on a 3-scale item of strongly agreed, agreed and undecided. Based on the ranking, the practices of covering food for sale to prevent flies before selling was ranked 1st with the weighted mean score (WMS) of 2.69, checking the foodstuff before selling ranked second with the WMS of 2.63 while washing fruits and vegetables very well before eating and serving food in clean and contaminant free environment ranked joint 3rd with the WMS of 2.58. Also, the practice of food immediately after they are cooked and

washing of hands with soap before food preparations ranked joined 5th with the WMS of 2.57, the practice of disposing waste away from the homestead or selling place ranked fifth (7th) with the WMS of 2.47, the practice of washing of hand with soap after toilet usage before handling food ranked sixth(8th) with WMS of 2.36 while the practice of the use the cutleries for eating and serving foods ranked 9th with the WMS of 2.33. The practice of storing and preparing frozen foods according to label instruction ranked 10th with the WMS of 1.92. The implication of these findings is that the practice of covering of food for sale to prevent flies and checking of foodstuff before selling had the highest ranking and were the practices that the respondents,

Table 3: Distribution of Respondent by Perception to Food Safety Practices

Food safety practices	Strongly agree	Agree	Disagree	WMS	Rank
Cover food for sale to prevent flies	83(69.2)	37(30.8)	-	2.69	1 st
Check foodstuff before selling	76(63.3)	44(36.7)	-	2.63	2 nd
Wash fruits and vegetables well before eating	70(58.3)	50(41.7)	-	2.58	3 rd
Serve food in clan and contaminant free environment	70(58.3)	50(41.7)	-	2.58	3 rd
Serve food immediately after they are cooked	72(60.0)	44(36.7)	4(3.3)	2.57	5 th
Wash your hands with soap before food preparation	68(56.7)	52(43.3)	-	2.57	5 th
Dispose your waste away from homestead and selling place	56(46.7)	64(53.3)	-	2.47	7 th
Wash hands with soap after toilet usage before handling food	43(35.8)	77(64.2)	-	2.36	8 th

Use cutleries for eating and serving foods	40(33.3)	61(50.8)	19(15.8)	2.33	9 th
Store and prepare frozen food according to label instruction	11(9.2)	93(77.5)	16(13.3)	1.92	10 th
Refrigerate and warm left-over foods after a meal is eaten	14(11.7)	81(67.5)	25(20.8)	1.91	11 th

Source: Field Survey, 2018, percentages in parenthesis; WMS – weighted mean score

Constraints to Food Safety Practices

The constraints to food safety practice was presented on Table 4 and this was measured on a 3-scale of major constraints, minor constraint and not a constraint. Of all the constraints mentioned by the respondents, lack of clean water ranked 1st with the weighted mean score (WMS) of 2.96, followed by lack of electricity which ranked 2nd with the WMS of 2.77 while illiteracy on the part of respondents ranked 3rd with WMS of 2.58. Also, poor storage facilities ranked 4th with WMS of 2.26, poor

processing facilities ranked 5th with the WMS of 1.79, inadequate extension services ranked 6th with the WMS of 1.64 while poor transportation system ranked 7th with the WMS of 1.29, uncommitted health workers ranked 9th with the WMS of 1.08 while culture, natural disaster and inappropriate agricultural practices had joint 10th ranking with the WMS of 1.03 and inadequate funding for safety programmes had least ranking with WMS of 1.02. The implication of these findings is that lack of portable and pure water and lack of electricity constituted most troubling constraints to respondents.

Table 4: Distribution of Respondents by Constraints to Food Safety

Factors	Not a constraint	Minor constraint	Major constraint	WMS	Ranking
Lack of clean water	1(0.8)	3(2.5)	116(96.7)	2.96	1 st
Lack of electricity	7(5.8)	14(11.7)	99(82.5)	2.77	2 nd
Illiteracy	1(0.8)	49(40.8)	70(58.3)	2.58	3 rd
Poor storage facilities	4(3.3)	71(59.2)	45(37.5)	2.26	4 th
Poor processing facilities	24(20.0)	73(60.8)	23(19.1)	1.79	5 th
Inadequate extension services	50(41.7)	63(52.5)	7(5.8)	1.64	6 th
Poor transportation system	51(42.5)	41(34.2)	28(23.3)	1.63	7 th
Inaccessibility of rural areas	84(70.0)	35(29.2)	1(0.8)	1.29	8 th
Uncommitted health worker	110(91.7)	10(8.3)	-	1.08	9 th
Culture	116(96.7)	4(3.3)	-	1.03	10 th
Natural disaster	117(97.5)	3(2.5)	-	1.03	10 th
Inappropriate agricultural practices	37(30.8)	81(67.8)	-	1.03	10 th
Inadequate finding for safety programmes	33(27.5)	86(71.7)	1(0.8)	1.02	13 th

Source: Field Survey, 2018

Common Food borne Diseases

Of all the food borne diseases identified by the respondents, more people (40.8%) respondents named dysentery as the most

troubling disease, 28.3% of the respondents named typhoid, 19.2% of the respondents indicated diarrhea while cholera was found to be the least common (11.7%) among the food borne diseases.

Table 5: Distribution of the Respondents by Common Food borne Diseases

Food borne diseases	Frequency	Percentage (%)
Cholera	14	11.7
Typhoid	34	28.3
Dysentery	49	40.8
Diarrhea	23	19.2
Total	120	100

Source: Field Survey, 2018

Determinants of food safety and hygiene practices

The result of the analysis of determinants of food safety practices shows that the model is significant at 1 percent ($P < 0.01$) as the sigma was 294.453 with a t – value of 15.492 as seen in Table 6, four independent variables were significant in determining the food safety practices of the respondents in the area. Among the four significant variables out of eight included variables were Educational level, Sex, Health condition and Total income. As shown in Table 6, Tobit model analysis revealed that educational level has a positive coefficient and it is significant 5%, this implies that the educated people considered food safety and hygiene practices very important and thus practice them more than the less educated ones. This could be due to the knowledge

gained in their course of study. Sex has a negative coefficient and thus significant at 1%, which implies that the female respondents mostly participate in food handling and preparation thus tend to practice food safety and hygiene practices more than their male counterparts.

Health condition has a negative coefficient and the significance level is at 10%, which implies that respondents with poor health condition will be discouraged from been able to practice the appropriate food safety and hygiene practices that are expected of them. Total income is also a very prominent variable with a positive coefficient and a significance level at 1%, this implies that increase in total income of a respondent will encourage the willingness to practice appropriate food safety and hygiene practices. It is assumed that respondents

with higher income will be able to afford quality food items and as well care more

about the wellbeing of the consumers than those earning lesser income.

Table 6: Determinants of food safety and hygiene practices among street food vendors in Ibadan Metropolis.

Variables	Coefficient	t-value	Prob/t/
Constant	26.167	16.072***	0.0000
Age	-0.402	-1.313	0.1893
Sex	-1.518	-3.570***	0.0004
Marital Status	-0.265	-0.910	0.3628
Educational Level	0.379	2.359**	0.0340
Ethnic Group	-0.208	-1.179	0.2386
Health Condition	-0.895	-1.879*	0.0603
Total Income	0.694	2.881***	0.0040
Customers	2.166	0.783	0.4338
Sigma	294.452	15.492***	0.0000

Source: Field Survey, 2018

CONCLUSIONS AND RECOMMENDATIONS

Food borne diseases resulting from unsafe foods was found to be evident in the study area causing illnesses like dysentery and typhoid which could reduce productivity of the urban dwellers. The major food safety practices observe in the area includes covering foods for sale to prevent flies and Wash fruits and vegetables very well before eating. The four major factors that determine food safety and hygiene practices in the study area includes Educational level, Sex of the responded, Health condition and Total income.

Therefore, the following recommendations were made

- 1) Since shortage of infrastructural amenities poses a very difficult challenge to the compliance to food safety practices among the respondents, then the government should provide more pipe borne water and constant electricity supply to avert problems of unclean food preparation as well as food preservation in the study area.
- 2) The problem of illiteracy can be reduced by training which can be imparted through mass literacy campaigns on food safety practices just like in the case of HIV/AIDs to induce voluntary behavioral changes in the respondents' low instincts for dirty habit and poor food handling.

REFERENCES

- Akinyele, I.O. (1992): Street Foods in Nigeria. In: Report of the Food and Agricultural Organization (FAO), Rome, Italy. Pp 15-34.
- Food and Agriculture Organization. (FAO) (1997). Street Food: Small Entrepreneurs, Big Business. [Hhttp://www.fao.org/english/newsroom/highlights/1997/970408-e.htm](http://www.fao.org/english/newsroom/highlights/1997/970408-e.htm) (Accessed 14 December 2010)
- Isara A.R, Isah E.C and Aino B.G. (2009) Knowledge and practice of food hygiene and safety among food handlers in fast food restaurants in Benin City. *Edo-State Post graduate Medical Journal*; 16(3)207-12.
- Jones T.F, Angulo F.H, and Bernard O.D. (2006) Eating in restaurants, a risk factor for food borne disease? *Clinical infectious disease*; 43; 1324-8.
- Meludu, N.T. (2003): Community Sanitation. In Extension Community Education. External Studies Programme Centre. University of Ibadan, Ibadan, Nigeria. Pg 6
- Muzaffar, A. T., Huq., I., and Mallik, B. A. (2009). Entrepreneurs of the street: An Analytical Work on the Street Food Vendors of Dhaka City. *International Journal of Business and Management*, 4(2): 80-88.

- National Policy on Urban Street Vendors, (2004). Department of Urban Employment & Poverty Alleviation, Ministry of Urban Development & Poverty Alleviation, Government of India, 2004
(http://www.nasvinet.org/nasvi.php?Page_code_no=33, accessed on 20th, February, 2011).
- Okpaala I.A, Osbert F.C, Wilfred D.C, (2003) Survey of the incidence of intestinal parasites among school children. *West African Medical Journal*; 10(1): 143-57.
- Schlundt, J., Toyofuku, H., Jansen, J., & Herbst, S. A. 2004. Emerging Food–Borne Zoonoses. *Review of Science and Technology*, 23, pp 513-515.
- Taiwo, V.O. (2002): “Global Security and Food Safety” Paper presented at a Symposium on Marketing the Worlds’ Veterinary Day Organised by the Nigerian Veterinary Medical Association. Oyo State Branch held at Conference Centre. Pg 9-10
- WHO (1992): Report of inter country workshop on Street Foods in Africa. Accra, Ghana
- WHO (1996). *Essential safety requirements for street vended foods*. Food Safety Unit, Division of Food and Nutrition, WHO/FNU/FOS/96.7.
- World health Organization (WHO, 2002). Nutrition and food safety. Retrieved October 9, 2004 from www.who.int

Demand And Nutritional Contribution Of Locally Produced Rice In Lagos State: A Case Study Of Lake Rice

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ABSTRACT

This study examined the determinants of household consumption of Lake Rice, the most important attribute consumers consider when purchasing Lake rice and its nutritional contribution, in Lagos State Nigeria. Data was collected from 110 respondents. Ordinary least square regression model was used to analyze the determinants of household consumption of Lake rice. The key variables influencing household demand for Lake rice are; household size, age of household head, household monthly income and distance to sales center. Likert-type scale was used to determine the most important attributes consumers consider when purchasing Lake Rice. The result of the analysis showed price, taste, grain size and cleanliness as the most important attributes consumers consider when purchasing Lake rice and about 18% of respondents agreed that lake rice give them nutritional requirement they needed. The constraints to the consumption of Lake rice in the study area were largely due to unawareness, inaccessibility and unavailability of the product. The study therefore recommends that efforts to increase the demand for the locally produced Lake rice must take these important attributes of Lake rice into consideration. Also efforts should be made in ensuring the product is available every time of the year. There is also the need for an increase in the awareness of the product as this poses a major problem to the consumption of the product.

Key Words: Lake-Rice, Demand, Perception, Consumption

INTRODUCTION

Rice is an increasingly important crop globally. As a cereal grain, rice is the most widely consumed staple food for a large part of the world's human population (Muthayya *et al* 2014). Two species have emerged as the most popularly cultivated rice; *Oryza sativa*

(Asian rice) and *Oryza glaberrima* (African rice). Of these two species, the more widely produced is *Oryza sativa* (Ajala & Gana, 2015). Rice is, according to the United Nations Food and Agricultural Organization's Corporate Statistical Database, the agricultural commodity with the third-highest

worldwide production with a total of 741.5 million tonnes in 2014 after sugarcane which had 1.9 billion tonnes and maize with 1.0 billion tonnes (Food and Agricultural Organization Corporate Statistical Database, 2017). Odusina (2008), discovered that rice, having emerged as a festive food, provides about 20% of the world's energy supply.

Rice, when compared with other world leading crops (maize and wheat), has the highest rate of human consumption. In 2009, the hectares of land harvested for wheat exceeds that of rice but human consumption accounted for 78% of the total production for rice compared with the 64% of wheat (Akoni and Olowoopejo, 2016). This implies that rice, despite not being the crop with the largest land allocated for its cultivation, still enjoys the highest consumption rate. Rice is a staple food in many countries of Africa and constitutes a major part of the diet in many other continents. In third world countries, the demand for rice exceeds its supply. This is evident in the Nigeria situation (Ajala & Gana 2015).

The largest nutritional problems occurring both globally and in rice-consuming countries are protein-energy malnutrition and iron, iodine and vitamin A deficiencies (Della Lucia *et al.* 2016). Millions of children are affected by malnutrition, which contributes to half of the 10 million annual deaths in children

under five years of age (Shrimpton *et al.*, 2001). Globally, there are 3.5 billion people with iron deficiency, 2 billion at risk of iodine deficiency and millions with clinical manifestations of vitamin A deficiency (ACC/SCN, 2000). The highest prevalence of anaemia and vitamin A deficiency occurs in South Asia (Tian & Della, 2001). This can probably be attributed to a combination of lack of dietary diversity, the strict vegetarian diet of a proportion of the population and unfavourable socio-economic conditions, particularly for women. Poor diets and micronutrient deficiencies are evident across many low-income settings. Micronutrient deficiencies have detrimental effects across the life course, such as impaired fetal growth, low birth weight, poor nutritional status of children, low productivity, intellectual growth impairment and poor growth and development (Muthayya *et al* 2014).

Public health programs introduced to address micronutrient deficiencies in Nigeria include the vitamin A supplementation program for under-fives, iron-folic acid supplementation for pregnant and lactating women (and more recently for adolescent girls), deworming of children and pregnant women, zinc supplementation in combination with oral rehydration salts for treatment of childhood diarrhea, flour fortification at roller mills, and universal iodine fortification of salt, yet malnutrition continues to be a major

driver of death and disability. Prevalence of stunting, underweight and wasting among children under-five is be 36%, 27% and 10% respectively. Similarly, anemia among children and women increased over the recent years to 53% and 41% respectively (Beinner 2010).

One of the immediate causes of micronutrient deficiency is inadequate intake of micronutrient-rich foods. Most people in Lagos state consume large portions of rice in their regular diet with inadequate portions of micronutrient rich foods (Muthayya *et al* 2014). Fortification of food, especially staples that are consumed by a large population, has potential to address micronutrient deficiencies. For Lagosian, rice is the most appropriate staple to fortify, as the national average per capita rice consumption is 359g/day, which is higher than the minimum level of consumption of 100g/day for rice fortification to be worth the investment. (Della *et al* 2016).

Also, as observed by Falola *et al.* (2014), several moves have been made by the government to increase indigenous rice production; successive governments have put in place several measures to ensure Nigeria is self-sufficient in rice production. These measures include Federal Rice Research Station (FRRS) in 1970, the National Cereal Research Institute (NCRI) in 1974, National Seed Service (NSS) in 1975, Operation Feed the Nation (OFN) in 1976, River Basin

Development Authority (RBDA) 1975, the National Grain Production Programmes (NGPP), the Presidential Initiative on Increased Rice Production, Processing and Export in 2003.

Consequent to the persistently increasing demand for rice in Nigeria, the collaborative effort of Lagos state and Kebbi state government in cushioning the gap between the quantity of rice demanded and supplied has resulted to the production of 'Lake Rice'. Prior to the production of Lake Rice, several states have embarked on the production of indigenous rice in Nigeria. According to Bashorun (2008), these states include (Kano state: Umzarice, Gombe state: Mas rice, Niger state: Mama happy rice, Kebbi state: Labana rice, Ebonyi state: Ebonyi rice, Anambra state: Anambra rice, Nasarawa state: Olam rice, Ogun state: Ofada rice, Osun state: Erin-Oke rice, Ekiti state: Igbemo rice.

The "Lake" , a fraction of the brand name "Lake Rice" is coined from the first two letters of the names of the two states involved in its production "La" and "Ke" from Lagos and Kebbi respectively. This nomenclature is a substantial proof indicating the mutual collaborative efforts of the two states involved. It also underscores the bid to create a local brand capable of competing with other imported products. The lake rice is cultivated in Kebbi state

and thereafter processed and packed in Imota Rice mill in Lagos state.

The rice, although sold generally at several markets in Lagos state is available for sale at the following government outlets in Lagos state: Lagos East, Lagos West, and Lagos Central local government areas (Molina *et al*, 2011). The production of the new variety of rice ("Lake Rice") in Nigeria seems to have been orchestrated majorly by the unbaiting increase in consumer demand and the amount of money spent on rice importation. Hence, self-sufficiency is the precedence of the Nigerian food policy program.

Interestingly, Nigeria is the world's second and Africa's largest importer of rice. Over the years, the country has depended so much on imports to fill the local supply gap due to the inability of local producers to meet the consumers' demand (Olga, 2002). Abutu (2014), submitted on the total area of land allocated to rice production: Hectares of land cultivated to rice, still appears small. In 2000, out of about 25 million hectares of land cultivated to various food crops, only 6.37% was cultivated to rice.

In the same vein, the unstable Dollar-Naira exchange, which affects imported goods and other import activities, has resulted in the increased demand for locally produced goods and

commodities. One of such products that have received good attention from Nigerians is the locally produced rice as the prices of imported rice have increased significantly. Several factors might have stimulated the structural increase in the demand for indigenously cultivated rice species in Nigeria (Rohman *et al*, 2014). These factors might have been informed by, but not restricted to, the cost of such products, increase in consumer's income and population growth. The increasing demand for rice and the resultant effect on the amount of money spent on food importation might have orchestrated the production of Lake rice. In order to study the demand for such locally produced rice species as Lake Rice, it is germane to examine the factors influencing consumer demand for such commodities. The specific objectives are to: identify the factors that influence household consumption of Lake rice, determine the most important attribute consumers consider when purchasing Lake rice, describe the perceptions of consumers towards the Lake rice, determine the nutritional contribution of Lake Rice and determine the constraint to the consumption of the Lake rice;

RESEARCH METHODOLOGY

Study area

The study was conducted in Lagos state. Lagos State is located between latitudes

6°22'N and 6°52'N longitude 2°42'E and 3 ° 42'E. The state is located in the south-western part of Nigeria, covering a total area of 3,577 sq km of which 22% of this area are lagoons and creeks, the state has a total projected population of 12,239,206. The state borders the Atlantic Ocean to the South, Ogun State to the North and East then stretches over 180km along the Guinea Coast of the Bight of Benin on the Atlantic Ocean. Generally, the climate conditions of Lagos State vary considerably according to month and seasons. (Nayar, 2014).

Sampling technique

A two stage sampling was used. The first stage was a purposive selection of two (2) authorized government outlets where Lake rice is being sold (LTV Agidingbi and LAISA Ojo) and Daleko market in Lagos state. The second stage was a systematic random sampling of 40 respondents from each of the two government outlets and 30 respondents from the rice market (Daleko) to make a total of 110 respondents.

Analytical tools

Datae collected was analyzed using the following tools of analysis: Descriptive statistics, Ordinary least square regression and Likert-type scale.

RESULTS AND DISCUSSION

The socio-economic characteristics of the respondents considered in the study area include; age of household head, gender of household head, marital status, household size, household monthly income and level of education.

The table 1 revealed that about 76% of the Household head were male while about 24% were female. This is in line with *a priori* expectation that men in most African homes are the dictators of the affairs at home (Guleria & Parmar, 2015).

The table 1 below also revealed that majority of respondents are between the ages 45 and 54 years (31.8%), the mean age of the respondents was 46.7 years which indicate that most of the respondents were in active age. This finding is in consonance with Ruel, Minot and Smith (2005), who found that the age bracket of 40 years and above show greater appetite for grains in the sub-Saharan Africa.

The table also revealed that most of the respondents had household income ranging between ₦50000- ₦100000 (42.73%), The mean of the household income is ₦119990.9.

On the average, the sampled households' size revealed that majority (53.64%) of the respondents had households size less than five (5). The moderate family size

may be due to the fact that most of the respondents had tertiary education and it follows that “the higher the level of a woman’s educational attainment, the fewer children she will likely bear (Pradhan, 2015).

The table 1 also revealed on educational level of the respondents’ shows that a high percentage of the respondents had tertiary education. The high level of literacy among the respondents is likely due to the fact that the study area is an urban area and it is more likely to be inhabited by people with high level of

education. This corroborates with the findings of Akoni and Olowoopejo, (2016), which explains that peasants in rural areas were less literate than inhabitants of urban areas.

The result of marital status in the table 1 also revealed that 60.91% of the respondents is married. The result on occupational distribution of household head reveals that 26.23% of the respondents are civil servants, (42.73%) are artisans despite the high literacy level among the respondents in the study area.

Table 1: Respondents’ socio-economic characteristics

Variable	Frequency	Percentage (%)
Age of Household Head		
25 – 34	16	14.54
35 – 44	30	27.27
45 – 54	35	31.80
55 – 64	21	19.09
65 – 74	6	5.45
>74	2	1.81
Total	110	100
Mean	46.7	

Household income

≤ ~~N~~ 50000	16	14.54
~~N~~ 50001– ~~N~~ 100000	47	42.72
~~N~~ 100001– ~~N~~ 150000	27	24.55
~~N~~ 150001– ~~N~~ 200000	9	8.18
Above ~~N~~ 200000	11	10.00
Total	110	100.0
Mean	~~N~~ 119990.9	

Household size

≤5	59	53.64
6-10	45	40.91
Above 10	6	5.45
Total	110	100.0
Mean	5.3	

Educational level of Household Head

Non-formal	9	8.18
Primary	5	4.54
Secondary	45	40.90
Tertiary	51	46.36
Total	110	100

Gender of Household Head

Male	86	76.36
Female	26	23.64

Total	110	100
Marital status		
Single	18	16.36
Married	67	60.91
Separated	9	8.18
Widowed	16	14.55
Major Occupation of Household head		
Civil servant	29	26.36
Artisan	46	41.81
Professionals	21	19.09
Others	14	12.73
Total	110	100

Source: Field Survey, 2019

Table 2: Consumption information on Lake rice

Variable	Frequency	Percentage (%)
Frequency of consumption		
Every day	42	38.18
2 – 5 days	61	55.45
Once a week	5	4.55
Once a month	2	1.82
Total	110	100.00
Quantity purchased (kg)		
10	11	10.00
25	45	40.90
50	44	40.00
>50	10	9.09
‘kk’		

Source: Field Survey, 2019

The result in table 2 shows that a high percentage of the respondents (55.45%) consume the product between 2-5 times in a week and about 38% of the respondents consume the product every day. The frequency of consumption as indicated in the table shows that rice has

become a staple food in the study area. This conforms to the findings of Bamide *et al* (2010), which explains that rice is rapidly becoming the preferred staple food in the urban areas. The table also shows the quantity purchased.

Table 3: Determinants of household consumption of Lake rice in the study area.

Variables	Coefficients	Std. Err.	t	P> t
Age	0.0079769*	0.004307	1.85	0.067
Educational level	0.0123793	0.0110976	1.15	0.267
Gender	-0.0050053	0.1141095	-0.04	0.965
Household size	0.0820807***	0.0196473	4.18	0.000
Major occupation	-0.0510959	0.0493119	-1.04	0.303
Proximity to point of purchase	-0.0081183*	0.00435	-1.87	0.062
Household income	0.00000185 ***	0.000000586	3.16	0.002
Constant	7.795099	0.2877185	27.09	0.000
R-squared	0.6371			
Adjusted R-squared	0.5595			

Source: Field Survey, 2019

*** Significant at 1%, ** Significant at 5%, *Significant at 10%

Four functional forms: Exponential, Semi-log, Linear and Double log were fitted for the collected data. The Semi-log was chosen as the lead equation based on econometrics and statistical criteria such as coefficient of determination (R^2), the number of estimators that are statistically significant, the least value of standard error and appropriateness of the signs of the explanatory variables. The data obtained were tested based on the assumption of normality.

The result shows the adjusted R^2 of 55.95% which indicated that about 56% change in household monthly expenditure on Lake Rice (a proxy for the demand/consumption of lake rice) is explained by the independent variables included in the model.

The coefficient of age, household size and income of the respondents were positive and statistically significant in the model. The coefficient of proximity

to sales Centre shows a negative sign and it is statistically significant.

Analysis of the result shows that the Age of the household head is positively significant at 10%. This implies that an increase in age will lead to an increase in the demand/consumption of Lake rice in the study area by 0.79%. This conforms with *a priori* expectation that *ceteris Paribus*, an increase in the age of the household head will lead to an increase in the overall age of the household and thus results to an increase in food consumption.

The coefficient of household size is significant at 1% and positively related to the demand of Lake rice. This implies that an increase in household size will lead to an increase in the demand for Lake rice. This is in consonance with

Bamidele and Abayomi (2010) who reported that large households tend to consumer more of local rice than small households. The coefficient of proximity to sales center shows a negative sign and it is statistically significant at 10%. Corroborating with the *a priori* expectation, the result indicates that an increase in the distance to sales centre of Lake rice will reduce the demand for the product in the study area. This is due to the fact that transportation costs add to the cost of purchasing the product.

The coefficient of household income was significant at 1% and positively related to the demand of Lake rice. It corroborates with *a priori* expectation that an increase in consumers' income will lead to an increase in the quantity of commodity demanded *ceteris paribus*.

Table 4: Important attribute consumers consider when purchasing Lake Rice

Variables	8 th	7 th	6 th	5 th	4 th	3 rd	2 nd	1 st	Weighted score	Mean score
Taste	0 (0.00)	2 (1.82)	0 (0.00)	6 (5.45)	14 (12.73)	13 (11.82)	50 (45.45)	25 (22.73)	264 (6.67)	2.4
Price	0 (0.00)	0 (0.00)	0 (0.00)	2 (1.82)	5 (4.55)	12 (10.91)	20 (18.18)	71 (64.55)	177 (4.47)	1.61
Aroma	9 (8.18)	30 (27.27)	43 (39.09)	12 (10.91)	7 (6.36)	7 (6.36)	2 (1.82)	0 (0.00)	653 (16.49)	5.94
Grain size	0 (0.00)	9 (8.18)	10 (9.09)	23 (20.91)	21 (19.09)	26 (23.64)	12 (10.91)	9 (8.18)	433 (10.94)	3.94
Cleanliness	3 (2.73)	0 (0.00)	6 (5.45)	19 (17.27)	31 (28.18)	32 (29.09)	18 (16.36)	1 (0.91)	412 (10.41)	3.75
Color	30 (27.27)	39 (35.45)	20 (18.18)	9 (8.18)	5 (4.55)	4 (3.64)	3 (2.73)	0 (0.00)	716 (18.08)	6.51
Packaging	47 (42.73)	23 (20.91)	20 (18.18)	10 (9.09)	5 (4.55)	3 (2.73)	0 (0.00)	2 (1.82)	738 (18.64)	6.71
Time of cooking	29 (26.36)	7 (6.36)	11 (10.00)	29 (26.36)	21 (19.09)	14 (12.73)	5 (4.55)	2 (1.82)	566 (14.30)	5.15

Source: Field Survey, 2019 (Percentage in parenthesis)

The attributes consumers consider when purchasing Lake rice include; taste, price, aroma, color, grain size, cleanliness, packaging and time of cooking. The result as presented in Table 4 reveals how the respondents ranked these attributes on an eight (8) point scale. The table also shows the weighted score and the mean score of each attribute. The result however indicated that price is the most important attribute most consumers consider when purchasing Lake rice, taste was ranked as the second important attribute consumers consider when purchasing Lake rice. Cleanliness was ranked the third important attribute, grain size was ranked fourth. Time of cooking, aroma,

colour and packaging was ranked fifth, sixth, seventh and eighth important attribute respectively. Therefore, price, taste, grain size and cleanliness as the most important attribute consumers of lake rice considered in purchasing the product in the study area because they were lower than the mean score (4.5). Time of cooking, although not as important as (price, taste, grain size and cleanliness) with a mean score of (5.15) is also an important attribute consumers consider when purchasing. Aroma, colour and packaging are regarded as attributes that are unimportant to consumers purchasing Lake rice because their mean score was higher than (4.5).

Table 5: Consumers perception towards Lake Rice production

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree	Weighted score
Lake rice production is an important development on the part of the government.	40 (36.36)	63 (57.27)	6 (5.45)	1 (0.91)	362
Lake rice production, if improved upon, can help reduce the amount of money spent on food importation yearly.	43 (39.09)	57 (51.82)	8 (7.27)	2 (1.82)	361
The government should stop the subsidy it pays on Lake rice. Rather, Imported rice should be subsidized and Lake rice production should be stopped.	19 (17.27)	27 (24.55)	53 (48.18)	11 (10.00)	274
Lake rice production is a total waste of resources.	4 (3.64)	11 (10.00)	72 (65.45)	23 (20.91)	216
There is still the need for improvement on the production of Lake rice.	48 (43.64)	55 (50.00)	4 (3.64)	3 (2.73)	368
Lake rice is better than other locally produced rice	7 (6.36)	28 (25.45)	50 (45.45)	25 (22.73)	237
At the same price with imported rice, I will still buy Lake rice.	5 (4.55)	15 (13.64)	43 (39.09)	47 (42.73)	198

Source: Field Survey, 2019 (Percentage in parenthesis)

Table 5 reveals that 93.63% of the respondents agreed that Lake rice production is an important development on the part of the government. This means that Lake rice production is a highly welcomed idea and this is backed by the percentage of respondents that regarded it as an important development in the study area. Also more than 90% of the respondents posited that lake rice production, if improved upon can help reduce the amount of money spent on food importation yearly. The result further shows that 58.18% of the

respondents disagree to the statement of government stopping the subsidy it pays on Lake rice. 86.36% of the respondents disagree with the fact that Lake rice production is a total waste of resources while only 13.64% agreed to the statement. About 93% agreed that there is still the need for improvement on the production of Lake rice. About 68% disagree that Lake rice is better than other locally produced rice only 25.45% agreed to the assertion. 81.82% disagree of purchasing lake rice even if it has the same price with imported rice.

Table 6: Attributes of Lake rice that should be improved on

Attributes	Taste	Aroma	Grain size	Cleanliness	Colour	Packaging	Time of cooking
Frequency							
Improved	82	42	80	98	30	34	60
Not Improved	28	68	30	12	80	76	50
Total	110	110	110	110	110	110	110
Percentage							
Improved	74.55	38.18	72.73	89.09	27.27	30.91	54.55
Not Improved	24.45	61.82	27.27	10.91	72.73	69.09	45.45
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Field Survey, 2019

Table 6 shows the attributes of Lake rice. 89% of the respondents suggested that there is still a need for improvement on the cleanliness of Lake rice. 75% of the respondents feel the taste of the rice still needs to be improved upon. 73% of the respondents emphasized on the need for an improvement on the grain size of the rice. Therefore, taste, grain size and

time of cooking of lake rice need to be improved on. However, as suggested by the respondents, aroma, colour and packaging don't need to be improved on. This is because these attributes are of no significant importance to the consumers of Lake rice and an improvement on them might be a waste of resources on the part of the government.

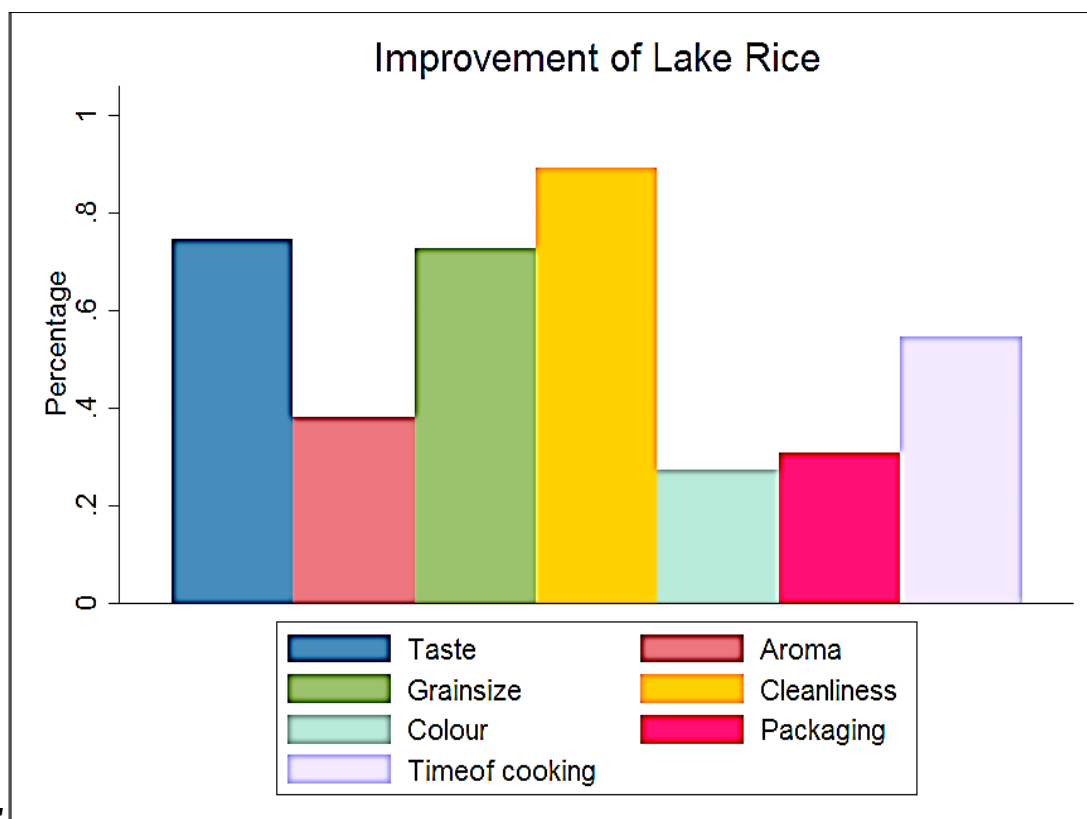


Figure 1: Representation of consumers' responses for lake rice improvement.

Table 7: Nutritional contribution of LAKE RICE

Statements	Agree	Disagree	Neutral	Total
Does Lake rice palatable?	60 (54.54)	20 (18.18)	30 (27.27)	110 (100)
Does it contribute to nutritional requirement needed?	20 (18.18)	40 (36.37)	50 (45.45)	110 (100)
Do you perceive lake consumption improve your health condition?	40 (36.37)	10 (9.09)	60 (54.54)	110 (100)
Do you eat more than you should because of its nutritional content?	50 (45.45)	20 (18.18)	40 (36.37)	110 (100)
.Do you perceive that lake rice consumption can alleviate micronutrient malnutrition in the body?	70 (63.63)	25 (22.73)	15 (13.64)	110 (100)

Source: Field Survey, 2019 (Percentage in parenthesis)

The table 7 shows that more than 54% of the respondents indicated that lake rice is palatable, while 27% of respondents are neutral; they are neither agreed nor disagreed. Also, most of respondents did not know if they met their nutritional requirement from consuming lake rice, but about 18% of respondents agreed that lake rice give them nutritional requirement they needed. This was in line with the findings of Tomlins *et al* (2005) who found out that locally produced rice provided micronutrients to the children and adults. It also shows that some respondents (36.37%)

perceived that lake rice contribute to their health condition. And almost half of respondents (45.45%) eat more than what they should eat because of its nutritional content. Over (60%) of respondents accept that lake rice consumption can alleviate micronutrient malnutrition in the body. This corroborates with the finding of Rohman *etal* (2014), in their study on “Rice in health and nutrition” where most of the respondents were agreed that rice alleviate micronutrient malnutrition from the body.

Table 8: Constraints to the consumption of the locally produced Lake rice

Variables/Statement	Very severe	Severe	Not severe	Not a problem	Weighted score	Mean score
Unavailability	33 (30.00)	43 (43.64)	23 (20.91)	6 (5.45)	328	2.98
Inaccessibility	34 (30.91)	44 (40.00)	20 (18.18)	12 (10.91)	320	2.91
High price (compared to some locally produced rice)	13 (11.82)	15 (13.64)	44 (40.00)	38 (34.55)	223	2.02
Presence of stones and other contaminants.	10 (9.09)	23 (20.91)	47 (42.73)	30 (27.27)	233	2.11
Unawareness	23 (20.91)	64 (58.18)	16 (14.55)	7 (6.36)	323	2.93
Favouritism	3 (2.73)	17 (15.45)	65 (59.09)	25 (22.73)	218	1.98

Source: Field Survey, 2019 (Percentage in parenthesis)

The table shows that more than 70% of the respondents indicated that unavailability and inaccessibility of lake rice in the study area poses a serious threat to the consumption of the product. About 40% posited that high price attached to the product does not necessarily constitute any problem to the consumption of the product. The presence of stone and other contaminants were not a serious problem for the consumers of lake rice in the study area. Most of the respondents agreed that unawareness is a major constraint to consumption of Lake Rice in the study area and large number of the respondents disagree to the fact that favoritisms is a constraint in demand and consumption of Lake Rice in the study area. The table also showed the weighted

score of each attitude and the mean score. Any constraint faced by consumers with a mean score greater or equal to 2.5 will be regarded to as severe and a mean less than 2.5 will be regarded to as not severe. Therefore, unavailability of the product, inaccessibility of the available product and lack of adequate awareness are the major constraints of demand and consumption of Lake Rice in the study area as indicated by their mean scores.

Conclusion

Based on the findings of the study, it was concluded that the demand for Lake rice is influenced by the socio-economic factors of households that consume Lake rice and some attributes of Lake rice. Thus an attempt to increase the

consumption of Lake rice should take these factors and attributes into consideration.

Unavailability, unawareness and inaccessibility of the product is a major constraint to the consumption of the product in the study area.

Recommendation

Based on the findings of the study, the following recommendations were made;

- There is a need to increase the production of Lake rice in order to meet the increasing demand of consumers for the product.
- There is the need to increase the number of sales center in the

Price, taste, grain size and cleanliness remains strong bait that attracts the demand for Lake rice in the study area.

study area as this will help reduce the unnecessary queues at the few available centers.

- The awareness of Lake rice should be increased as this will increase the demand for the product.
- There is still room for improving the quality, and cleanliness of the product as this will bring the product to more acceptable platform not only in the country alone but also in the international market.

REFERENCES

Abutu, P.O (2014). Challenges of agriculture in Nigerian economy: A bane to food security. In IOSR Journal of Agriculture and Veterinary Sciences 5, 7, 18-21.

ACC/SCN. (2000). Fourth report on the world nutrition situation. Geneva, United Nations Administrative Committee on Coordination/Sub-Committee on Nutrition (ACC/SCN) in collaboration with the International Food Policy

Research Institute (IFPRI), Washington, DC.

Ajala, S. & Gana, A.(2015). Analysis of challenges facing rice processing in Nigeria. Journal of Food Processing Volume 2015, Article ID 893673, 6 pages. Available online at <http://dx.soi.org/10.1155/2015/893673>

Akoni, O & Olowoopejo, M. (2016). Lake rice. Available at www.vanguard.com/2016/12/ambode-bagudu-launch-lake-rice-lagos-2/ pp 12- 14

- Bamidele, F.S, Abayomi, O.O & Esther, O.A. (2010). Economic Analysis of Rice Consumption Patterns In Nigeria. *J. Agr. Sci. Tech.* 12(1): 1-11
- Bashorun, J.O (2008). Analysis of the Relationships of Factors Affecting Rice Consumption in a Targeted Region in Ekiti-State, Nigeria. *Journal of Applied Quantitative Methods* 4(2): 145-153
- Beinner MA, Velasquez-Mele´ndez G, Pessoa MC, Greiner T (2010). Iron-Fortified Rice Is As Efficacious As Supplemental Iron Drops in Infants and Young Children. *The Journal of Nutrition.*;140(1):49–53.
<https://doi.org/10.3945/jn.109.112623> PMID: 19889805
- Della Lucia CM, Rodrigues KCC, Rodrigues VCC, Santos LLM, Cardoso LM, Martino HSD. (2016) Diet Quality and Adequacy of Nutrients in Preschool Children: Should Rice Fortified with Micronutrients Be Included in School Meals? *Nutrients.*; 8(5):296.
- Falola, A. Jubril, O. Animashaun, Oluwasogo, D. Olorunfemi. (2014). Determinants of commercial production of Rice in rice producing areas of Kwara state, Nigeria.
- FAOSTAT database online and AQUASTAT database online, as of September 2017.
- Molina, J.; Sikora, M.; Garud, N.; Flowers, J. M.; Rupotential S.; Reynolds, A.; Huang,P.; , S.; Schaal, B. A.; Bustamante, C. D.; Boyko, A. R.; Purugganan, M. D. (2011). "Molecular evidence for a single evolutionary origin of domesticated rice" *Proceedings of the National Academy of Sciences* . 108 (20): 8351.
- Muthayya S, Sugimoto JD, Montgomery S, Maberly GF . (2014). An overview of global rice production, supply, trade, and consumption. *Annals of the new york Academy of Sciences*; 1324(1):7–14.
- Nayar, N. M. (2014). African rice: An overview. Available at <https://www.sciencedirect.com/topics/food-science/african-rice>
- National Bureau of statistics (2015).
- Odusina, O.A. (2008). Urban rice demand analysis. A case study of Ijebu ode towns. *Res* 3 (2) 62-66.

- Olga, F. Linares (2002). African rice (*Oryza glaberrima*) : History and future potential. Proceedings of the National Academy of Sciences of the United States of America. Vol. 99, No. 25 (Dec.10, 2002), pp. 16360-16365
- Pradhan, E. (2015). Female Education and Childbearing: a closer look at the data. The world Bank group. Pp 25- 32
- Rohman, A., Siti Helmiyati, Mirza Hapsari and Dwi Larasati Setyaningrum (2014) “Rice in health and nutrition” International Food Research Journal 21(1):13-24 Journal homepage: <http://www.ifrj.upm.edu.my>
- Ruel, T.M., Minot N., & Smith L.(2005). Patterns and Determinants of Fruit
- Tomlins, K., Manful, J. T., Larwer, P.and Hammond, L. (2005). “Urban consumer preferences and sensory evaluation of locally produced and imported rice in West Africa. “Food quality and preference 16: 79-80.
- Rijswijk, W.V. & Fewer, L.J. (2008). Consumer Perceptions of Food Quality and Safety and Their Relation To Traceability. British Food Journal, 110(10): 1034-1046.
- Tian, L. & DellaPenna, D. (2001). The promise of agricultural biotechnology for human health. *British Food Journal*, 103 (11): 777–771
- Rijswijk, W.V. & Fewer, L.J. (2008). Consumer Perceptions of Food Quality and Safety and Their Relation To Traceability. British Food Journal, 110(10): 1034-1046.
- Shrimpton, R., Victoria, C., de Onis, M., Lima, R., Blossner, M. & Clugston, G. (2001). Worldwide timing of growth faltering: implications for nutritional interventions. *Pediatrics*, 107

CLIMATE VARIABILITY AND LIVESTOCK PRODUCTION IN NIGERIA: BOON OR BANE

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ABSTRACT

Adequate knowledge is vital to avert the adverse impacts of climate change that are inherent on livestock production, ensure adequate returns to farmers' investment and stimulate expansion and food production thereby bolster the pursuit for food security in Nigeria. This study examines the effect of climate variability on livestock productivity in Nigeria. The study employed Co-integration analysis and unit root test to analyze the time-series data between 1977 and 2017, sourced from Central Bank of Nigeria statistical bulletin, International Financial Statistics and National Bureau of Statistics (NBS). The results show that there was variation in trend of annual rainfall, annual temperature, and livestock production. The Augmented Dickey-Fuller test shows that annual rainfall, temperature, and livestock production were non-stationary at level but became stationary at first difference. The Co-integration test indicates that there is a long-run dynamic equilibrium relationship between the variables. It is recommended that government should continually sensitize farmers on the challenges of climate change and possible coping strategies that they can adhere to in order to avert the detrimental effects of climate change on livestock production. Also, government policy should be geared towards smart techniques and develop technology that are not only sustainable but also increase productivity.

Keywords: Climate, Climate variability, Livestock, Causality, Co-integration, Stationary

INTRODUCTION

The global livestock sector is growing faster than any other agricultural sector; it is currently the single largest user of land (Keith, 2008), covering about 45% of the Earth's land surface, and much of it in harsh and variable environments that are unsuitable for other purposes (Sejian et al., 2012). Livestock products are important agricultural commodity for global food security because they provide 17% of global kilocalorie consumption and 33% of global protein consumption (Rosegrant et al.,

2009). The livestock sector contributes to the livelihoods of over one billion of the poorest population in the world and employs close to 1.1 billion people (Hurst *et al.*, 2005). There is a growing demand for livestock products, and its rapid growth in developing countries has been deemed the "livestock revolution" (Thornton, 2010; Wright et al., 2012). Integrating the crop-livestock mechanism as a system of farming tends to allow nutrients to be recycled more efficiently on the farm and in turn increase crop yield. Under such a system, livestock can be fed on crop residues like straw,

damaged fruits, grains, and other products that would have posed a major waste disposal problem (Fakoya, 2007).

However, diverse irregularities have been identified to be militating against the productivity of all sectors of agriculture across the globe. Some of the reasons identified in Nigeria by previous studies include inconsistent production pattern, overdependence on petroleum as the major source of foreign exchange, disease incidence small farm holdings, pest attack, low yield, and climate change (Wood, 1985; Villalobos, 1989; Wright, 1993; Obatolu *et al.*, 2003; Oluyole and Sanusi, 2009). The relevance of favourable climate in livestock production cannot be overemphasized. Climate is an important factor of agricultural productivity and climate change is expected to severely impact livestock production systems (Sejian *et al.*, 2012). Livestock productivity may be lower by 50% in 2050s compared to without climate change scenario. Climate change may increase the number of people looking for food aid by 30% (World Bank, 2010), increase drought expenses by 72% in 2050s (FDRE, 2015). Increasing temperatures and decreasing rainfall reduce yields of rangelands and contribute to their degradation.

Intergovernmental Panel for Climate Change (IPCC) (2007) posit that climate change refers to statistically significant variation in either mean state of climate or in its variability, persisting for an extended period which could be in decades or more. It was added that climate change involves a shift of climatic condition to a new equilibrium position with values of climate elements changing significantly. Climate variability is one of the most severe problem that the

world is facing today (Ayinde *et al.*, 2011). It affects growth, wool production, milk production, and reproduction. Among factors which influence livestock production, climate and location are undoubtedly the most significant. In fact, climatology characteristics such as ambient temperature and rainfall patterns have great influence on pasture and food resources availability cycle throughout the year among animal populations.

The continuous dynamism and adverse effect of climate change on agricultural productivity of which the livestock subsector is not an exemption forms the thrust of this study. Thus, this study examines the effect of climate change variability on livestock subsector in Nigeria. The specific objectives of the study are to: examine the variability in temperature, precipitation and livestock production, identify factors that affect livestock production and identify the direction of causality of variables in the study area.

METHODOLOGY

Nigeria is located in West Africa. The country features 36 states and its federal capital territory which is Abuja. As of 2018 the estimated population of the country is about 200.96 million. Nigeria lies between 14⁰ and 15⁰N and thus contains a wide variety of bioclimatic zones. These extend in parallel belts ranging from the northern which is semi arid to the most southern where annual rainfall surpasses 2000mm. The wide variety of bioclimatic conditions means that most crops found in the tropics are grown in Nigeria: cereals, tubers, oil plants, cocoa, cotton, rubber, and coffee are all produced.

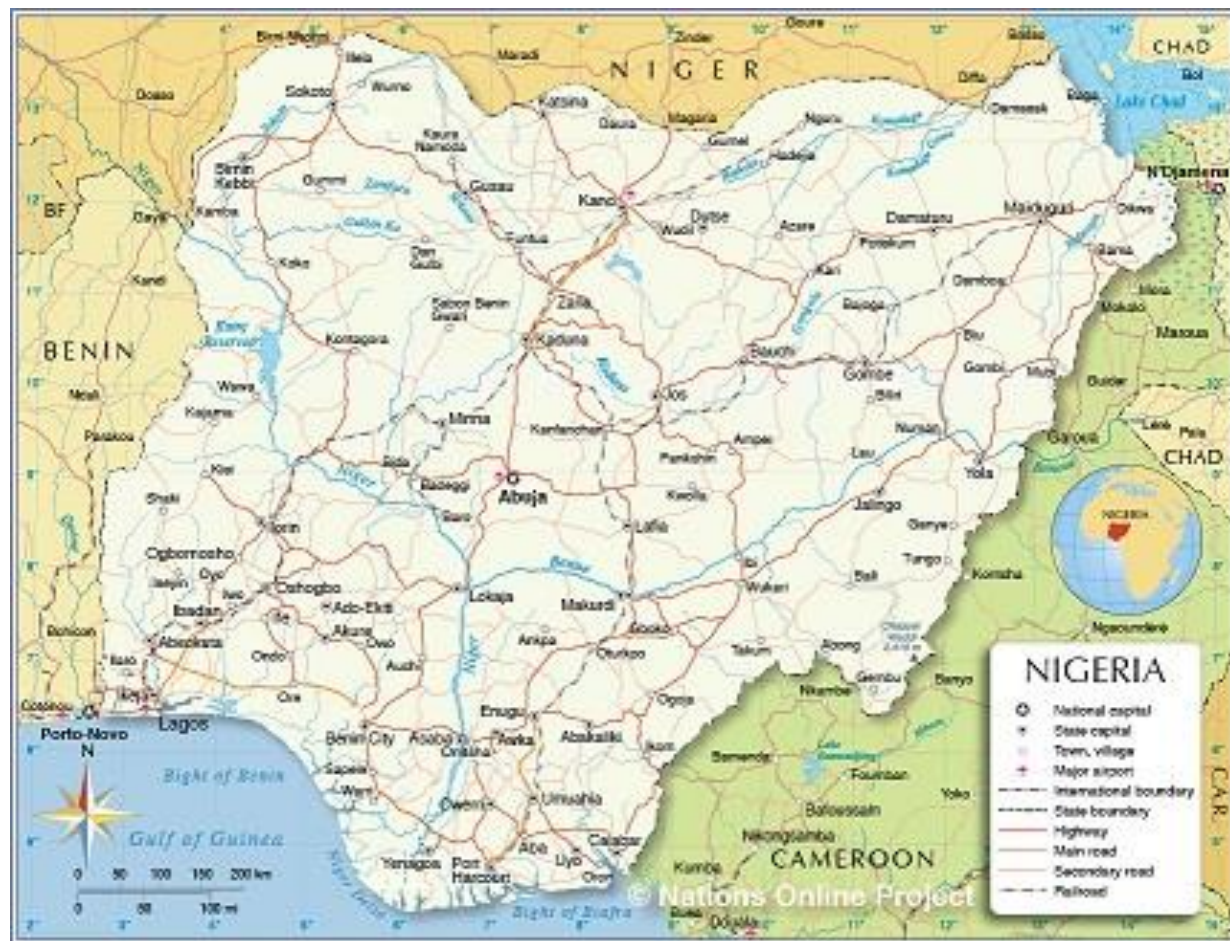


Fig 1: Map of Nigeria. (source: www.researchgate.net)

Type and sources of data

The data used for this study is exclusively from secondary sources. The data comprises of annual time series spanning from 1977 to 2017. The data set was sourced from Central Bank of Nigeria statistical bulletin edition, International Financial Statistics and National Bureau of Statistics (NBS).

Analytical techniques

Inferential statistics was adopted in the analysis of data, and also testing of scientific hypotheses. The Vector Error Correction

Model (VECM) model was employed using Econometric View (E-view) software package for the data analysis. Prior to the regression analysis, diagnostic tests were carried out to ensure the validity of data. The test for stationary was carried out using the Augmented Dickey-Fuller (ADF) unit root test, while the test for the long run equilibrium adjustment was accomplished using Johansen co-integration test.

Trend Analysis

A number of techniques have been developed for the analysis of rainfall and temperature, which generally fall into

variability and trend analysis categories. Variability analysis involves the use of Coefficient of Variation (CV), percentage departure from the mean (Anomalies), Precipitation Concentration Index (PCI) and moving average. Trend detection and analysis are performed through parametric and non-parametric tests only for consistent data.

Test for stationary

Prior to the test of co-integration between climate outputs and the individual climate variables under consideration, average annual rainfall, annual temperature, interest rate, inflation rate, livestock import, exchange rate and annual livestock production output were all tested for stationary as follows:

$$Y_t = pY_{t-1} + U_t$$

$$-1 \leq p \leq 1$$

Where Y_t is the time series variable, Y_{t-1} is one period lag of the time series variable, p is the coefficient and U_t is the white noise error. If Y_t is regressed on its lagged value of Y_{t-1} and the estimated p is statistically equal to 1, then Y_t is non-stationary that is, it exhibits unit root [I(1)]. On the other hand, if the estimated value of p is not statistically equal to 1, the Y_t is stationary that is, has no unit root [I(0)].

RESULTS AND DISCUSSION

Trend of Temperature Variation in Nigeria 1977-2017

The Augmented Dickey Fuller (ADF) test was used to test for stationarity of the data.

The test consists of the following regression:

$$\Delta Y_\tau = \beta_1 + \beta_2 \tau + \delta Y_{\tau-1} \alpha \sum_{\tau=1}^n \Delta Y_\tau + \varepsilon_\tau$$

Where;

$$E_t = \Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3}).$$

Co-integration (Johansen) test

The Johansen co-integrated model is given as:

$$Y_t = f(X_{1t}, X_{2t}, U_t) \dots \dots \dots (1)$$

Where;

Y is a dependent variable and

X is an independent variable

Where Y = livestock production

X_1 = annual temperature (0c)

X_2 = Annual rainfall (mm)

t = time variable

Granger causality test determine the causal links between climate variability and livestock production in Nigeria.

The statistical records of temperature data for Nigeria between 1977 and 2017 showed an increasing trend. The highest average annual temperature of 27.86°C was experienced in the year 2010 as shown in figure 2.

Fig 2: Yearly trend of Rainfall data for Nigeria 1977-2017

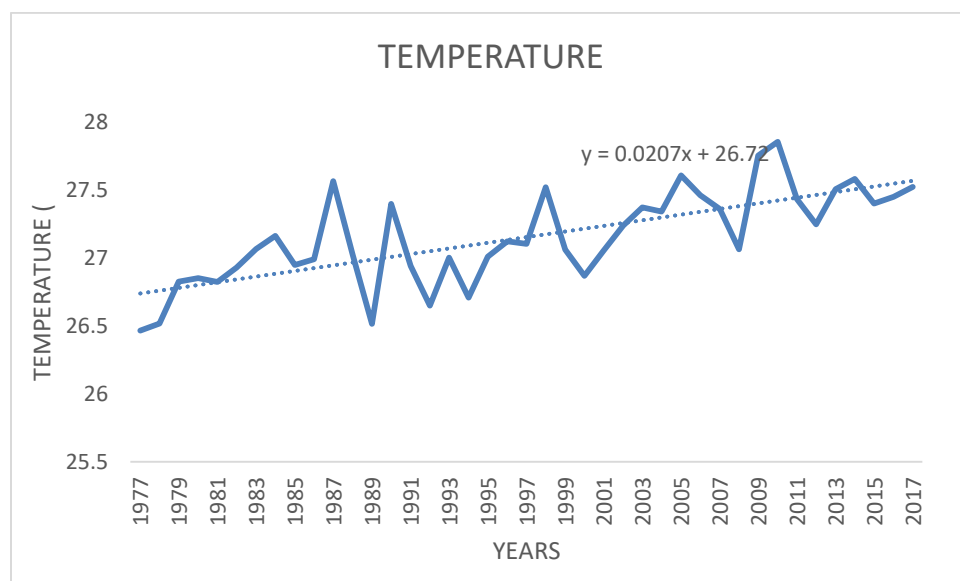


Table 1: Annual temperature 1977-2017

Temperature	Yearly
Mean °C	27.14
Total change calculated from the trend (°C in 39 years)	0.94

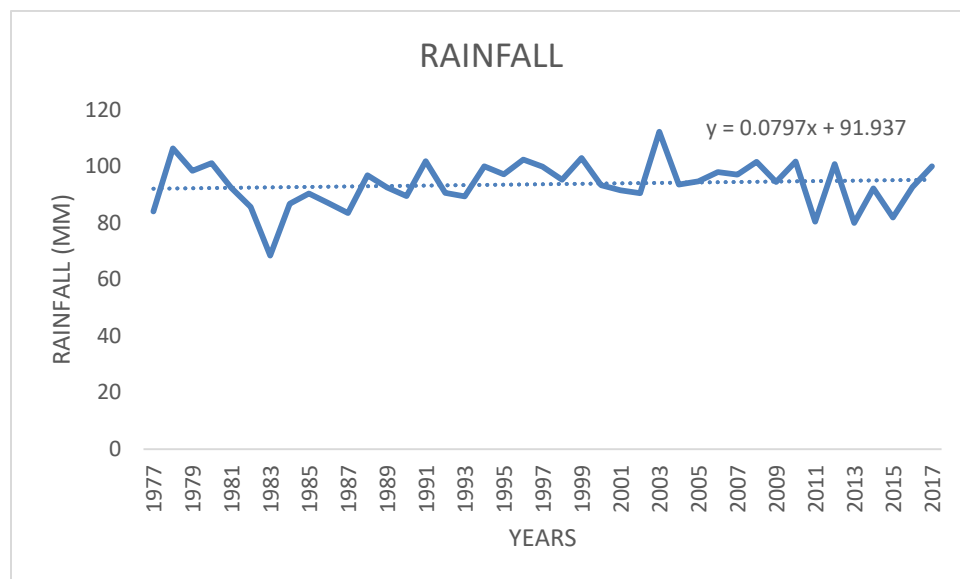
Source: Authors Computation, 2019

*Total change is the difference between the trend line value of the last and first year. During the period of 40 years under review, temperature had risen by about 0.94°C. The average temperature recorded for Nigeria during this period was 27.14°C with an

equation of $y=0.021x+26.71$. However there are variations over the years (Figure 5), which shows climate variability. Figure 2 shows the variation in the average temperature of Nigeria, which depicts a warming trend.

Trend of rainfall Variations in Nigeria 1977-2017

Fig 3: Yearly trend of Rainfall data for Nigeria 1977-2017



Source: Author's Computation, 2019

Table 2: Analysis of rainfall data from 1977-2017

Rainfall	Yearly
Mean (mm)	112.25
Total change calculated from the trend (mm/40 years)	-2.92

Source: Data Analysis, 2019

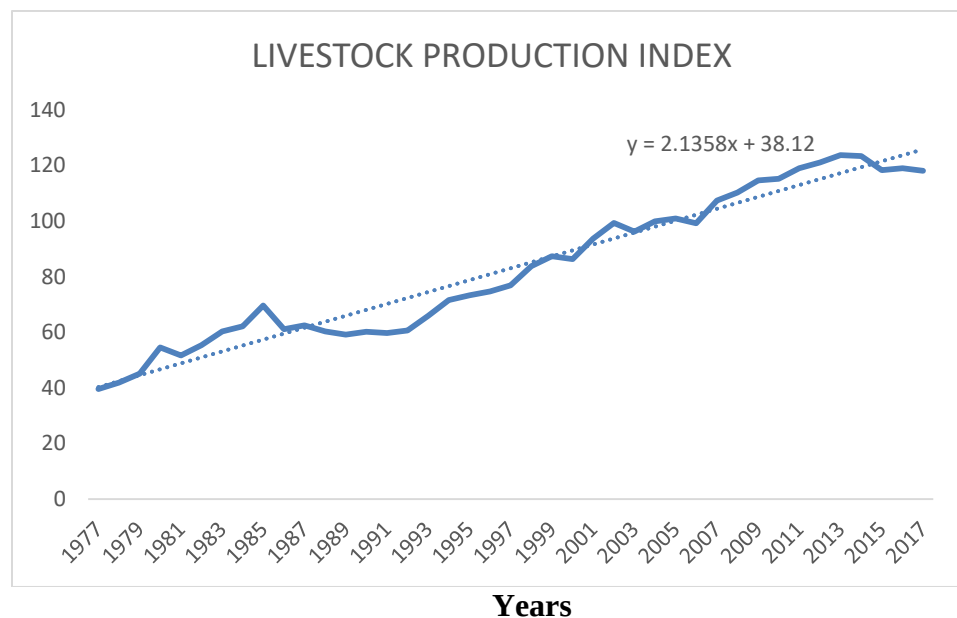
*Total change is the difference between the trend line value of the last and first year.

The record showed an increasing trend in average annual rain fall with year 2003 recording an average of 112.25mm regarded as the highest amount of rainfall during the period with a stated equation of $Y=0.069x+92.08$. The average amount of

rainfall recorded during this period was 93.55mm as shown in table. Also, during the period of 40 years, the rainfall volume has decreased by around 2.92mm. The decrease and irregularity in rainfall pattern from these records points is a clear indication of climate variability and will definitely have a consequence on livestock production.

Trend of Livestock Variation in Nigeria 1977-2017

Fig 4: Yearly trend of livestock production data for Nigeria 1977-2017



Source: Authors Computation, 2019

Table 3: Analysis of livestock production data (1977 to 2017)

Livestock production	Yearly
Mean production (index)	82.10
Total change calculated from the trend(index/40 years)	78.72

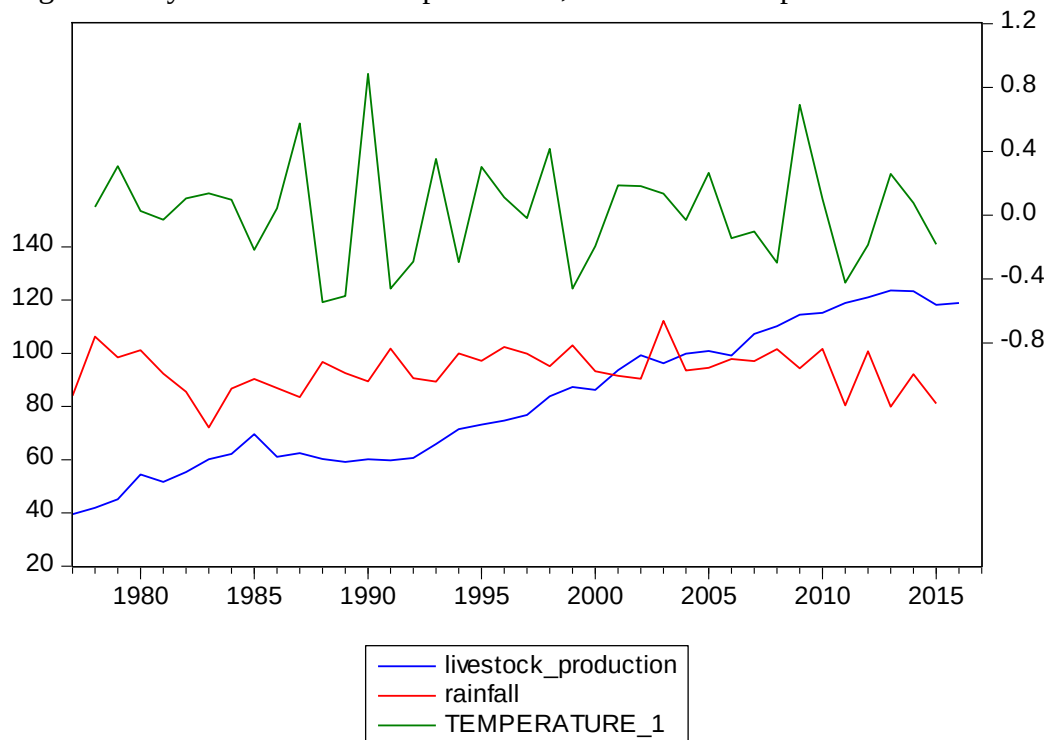
Author's Computation, 2019

The trend of livestock production variation in Nigeria is as shown in figure 4. It shows there has been an increase in livestock production in Nigeria over the years 1977-2015. The average production index recorded during this period was 82.10 as shown in table 3. Also, during the period under consideration, the livestock production index increased from 39.54 in 1977 to 118.26 in 2015, reaching an all-time high of 123.65 in the year 2013 with a stated

equation of $y = 2.165x + 37.70$. The difference between the highest and lowest livestock production index recorded is 84.11. This implies a great variability in livestock production index. The increase and irregularity in livestock production from these records points to a clear indication of variability in livestock production perhaps in response to observed variability in climate variables in the study area.

Trend of livestock production, temperature and rainfall from 1977 to 2017

Fig 5: Yearly trend of livestock production, rainfall and temperature



The record showed that there was an increasing trend in livestock production, temperature and rainfall at the same time. Livestock production and rainfall intercepted during the year 2002 to 2005 which shows that rainfall and livestock

production had equal trend and practically affect each other. The graph showed that between the years 2005 to 2015, as rainfall was decreasing during the years, livestock production was increasing.

Analysis of long run relationship between climate variability factors and livestock production index

Table 4: Analysis of Augmented Dickey Fuller test

At level

Variables	ADF Statistic	ADF Critical value	Remarks	ADF Statistic	ADF Critical value	Remarks
LP	-0.844804	-2.938987	Unit root	-6.788161	-2.941145	No unit root
Rainfall	-2.678452	-2.943427	Unit root	-12.45988	-2.943427	No unit root
Temperature	-1.826118	-2.945842	Unit root	-9.158385	-2.945842	No unit root
Interest rate	-4.629099	-2.936942	No unit root			
Inflation rate	-5.905768	-2.936942	No unit root			
Livestock import	-5.729897	-2.936942	No unit root			
Exchange rate	1.303847	-2.938987	No unit root			

Source: Data Analysis, 2019

Unit Root Hypothesis is stated as follows:

H_0 : There is unit root

H_1 : There is no unit root

Presence of unit root implies that the time series under investigation is non-stationary, while the absence of a unit root shows that it is stationary (Brooks, 2008). The short-run of the Augmented Dickey Fuller test statistics employed at 5% of significance for the unit root test is presented in Table 4.

Note: The H_0 is that the series is non-stationary (presence of unit root) against alternative hypothesis H_1 of a series being stationary (No unit root). The rejection of H_0 for the ADF test is based on the MacKinnon critical values. Lag length were determined in accordance with the SIC.

The time series behavior of each of the series under consideration using the ADF is

presented in table. The result shows that all the variables except Temperature, rainfall and Livestock production index (LP) were non-stationary at level but became stationary at first difference. Therefore, co-integration test is required to verify if long run relationship exist between the variables.

Johansen Co-integration Test

Table 5: Unrestricted Co integration rank test

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.729569	84.71777	29.79707	0.0000
At most 1 *	0.480419	37.63920	15.49471	0.0000
At most 2 *	0.323485	14.06883	3.841466	0.0002

Source: Data Analysis, 2019

Trace test indicates 3 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table 6: Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max- Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.729569	47.07856	21.13162	0.0000
At most 1 *	0.480419	23.57037	14.26460	0.0013
At most 2 *	0.323485	14.06883	3.841466	0.0002

Source: Data Analysis, 2019

Max-eigenvalue test indicates 3 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

The result of the Johansen's co-integrating test reveals that the null hypothesis of no co-integration is rejected by both tests. Both the trace test and maximum-Eigen test indicates three co-integrating equations at 5% level. This indicated that three variables are co-integrated. Only one of the co-integrating equations was chosen. The co-integrating equation chosen was based on the consistency of the coefficients with economic theory and its statistical significance. From the equation, all the independent variables considered significantly affects livestock production in Nigeria during the studied years.

It is deduced that there is a stable long run relationship between the series. The existence of co-integrating relationships among the variables implies that the determinants of livestock production in Nigeria can be efficiently modeled with an error correction specification.

Vector Error Correction Model (VECM)

The existence of stationarity and the presence of co-integration between variables suggest a stable long run relationship among the variables under consideration. Therefore, the VECM can be applied. The long run relationship between livestock production, rainfall and temperature for the significant co-integration equation for Nigeria in the period 1977-2015 is presented below

$$LP = -1.633828 + 0.832905^{***} \text{Rainfall} - 20.88337^{***} \text{Temperature}$$

The equation shows that there is a long run negative relationship between livestock production and temperature

Estimated Short Run Coefficients

The short run dynamics coefficients associated with the long run co-integration relationships was obtained from the estimation of error correction model. The

result of the ECM equation above represents the coefficients of the short run relationships among the variables in the model. The error correction term (ECT) is the speed of adjustment or the adjustment parameter because it measures the speed at which the target variable or dependent variable (LP) returns to equilibrium after a change in the independent variable. The ECT has a significant negative sign meaning that the series are co-integrated and move towards a long term equilibrium. The negative sign shows that in each period, a portion of the deviation from the long term equilibrium is compensated. Specifically, from VECM the previous period deviation from long run equilibrium is corrected at an adjustment speed of 30.7%.

A percentage change in rainfall is associated with a 0.25% increase in livestock production on average *ceteris paribus* in the short run.

A percentage change in temperature is associated with a 5.03% decrease in livestock production on average *ceteris paribus* in the short run.

CONCLUSION AND RECOMMENDATION

Conclusion

It can be inferred from the study that climate variability has significant effect on livestock production in Nigeria. It also shows that climate variability resulting from climate change poses a great threat to livestock production in terms of their reproductive capacity and feeding habit of animals.

Recommendation

It is recommended that government and non-governmental organizations should continually sensitize farmers on the

challenges of climate change and possible coping strategies that they can adhere to in order to avert the detrimental effects of climate change on livestock production. Also, government policy should be geared towards best practices, smart techniques and develop technology that are not only sustainable but also increase productivity.

REFERENCES

- Ayinde, O.E, Muchie M. and Olatunji G.B (2011). Effect of climate change on Agricultural productivity in Nigeria: *a co-integration approach journal of human ecology (Delhi, India)* 35(3):189-194
- Brooks, C., 2nd Edition, (2008), Introductory Econometrics for Finance, Cambridge University
- Fakoya, E.O. (2007). Utilization of Crop – Livestock Production Systems for Sustainable Agriculture in Oyo State, Nigeria. *Journal of Social Sciences*, 15(1): 31-33.
- Federal Democratic Republic of Ethiopia (FDRE), (2011). *Climate Resilient Green Economy: Mission Statement*. FDRE, Addis Ababa.
- Hurst, P., Termine, P., Karl, M. (2005). Agricultural workers and their contribution to sustainable agriculture and rural development. FAO, Rome.
<ftp://ftp.fao.org/docrep/fao/008/af164e/af164e00.pdf>.
- IPCC (2007). Summary for policymakers. In: *Climate Change 2007: the Physical Science Basis*, edited by Solomon S, Qin D, Manning M, Chen Z and others. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press) Cambridge.
- Keith R. (2008): Farm animal production and climate change.
<http://www.temasactuales.com>
- Nuru, S. (1986). Livestock systems research in Nigeria's subhumid zone. Proceedings of the second ILCA/NPRI symposium in Kaduna, Nigeria
- Obatolu, C. R., Fashina, A. B. and Olaiya, A. O. (2003) Effects of Climatic changes on Cocoa Production in Nigeria. *Proceedings of African Crop Science Conference, Lagos, Nigeria*, 5:957 959.
- Oluyole, K.A. and R.A. Sanusi. (2009) Socioeconomic Variables and Cocoa Production in Cross River State, Nigeria. *Journal of Human Ecology*. 25(1): 5 – 8.
- Rosegrant, M.W., Fernandez, M., Sinha, A., 2009. Looking into the future for agriculture and AKST. In: McIntyre, B.D., Herren, H.R., Wakhungu, J., Watson, R.T. (Eds.), *International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD)*. Agriculture at a crossroads, Island Press, Washington, DC, pp. 307–376.

- Thornton, P.K., 2010. Livestock production: recent trends, future prospects. *Philos. Trans. Roy. Soc. B* 365, 2853–2867.
- Sejian V, Naqvi, SMK, Ezeii, T., Lakritz, J., Lal, R (eds.) (2012). Environmental Stress and Amelioration in Livestock Production, DOI: 10.1007/978-3-642-29205-7_15, *Springer-Verlag Berlin Heidelberg* 413-468
- Villalobos, V. M. (1989). Advances in Tissue Culture Methods Applied to Coffee and Cocoa Plant Biotechnology for Developing Countries. United Kingdom. CTA/FAO, Chayce Publication Services.
- Wood, G.A.R (1985). Cocoa 4th (edition) Longman group UK Ltd. Pp 620.
- World Bank, (2010). The social dimensions of adaptation to climate change in Ethiopia. Development and climate change discussion papers No. 14. Washington, DC. USA
- Wright, I.A., Tarawali, S., Blummel, M., Gerard, B., Teufel, N., and Herrero, M., (2012). Integrating crops and livestock in subtropical agricultural systems. *J. Sci. Food Agric.* 92, 1010–1015.
- Wright, J. C. (1993). Banana and plantain, AB International Wallongfood.

INCIDENCE AND SEVERITY OF SUGARCANE RED ROT DISEASE IN SELECTED SUGARCANE GROWING AREAS OF KWARA STATE, NIGERIA

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ABSTRACT

Red rot disease caused by *Collectotrichum falcatum* is a major constraint of sugarcane production in Nigeria. A study was carried out in some sugarcane growing areas of Kwara state namely Tsaragi, Bacita, Shonga, Patigi, Lafiagi, Lade, Oke-Ero and Ilorin to determine the incidence and severity of the disease. The study was conducted between January and July 2019.

Farms were purposively selected from the eight sugarcane growing areas. Leaf and stem samples with the disease symptoms were taken to the laboratory for isolation using the agar plate technique and the isolated fungi were identified using morphological and microscopic features of the red rot pathogen. Confirmation of identity of the pathogen was carried out at the pathology laboratory of the International Institute for Tropical Agriculture (IITA) Ibadan, Oyo State, Nigeria. Data on the incidence and severity of the disease was analyzed using SPSS software version 21 and significantly different means were separated using LSD test at 5% probability level. The results showed that red rot disease incidence was highest in Shonga (36.10 %) and lowest in Ilorin (14.10%). The disease was rated as severe in Tsaragi (47.20%), moderately severe in Bacita, Egosi, Ilorin, Patigi and Shonga (31.25% - 40.70%) and mild in Lade (26.75%). The study revealed that red rot disease of sugarcane is prevalent in all the sugarcane growing regions of Kwara State and this shows the need to create awareness among sugarcane farmers on the importance of the disease and its management for increased sugarcane productivity.

Key words: Incidence; Severity; Red rot; Sugarcane.

INTRODUCTION

Sugarcane, *Saccharum officinarum* L., is a crop which provides sugar, biofuel, fibre, fertilizer, bagasse and molasses (National Sugar Development Council, 2003; Busari, 2004). The crop is also a strong contender in the current worldwide theme on biofuel campaign. Sugarcane is a member of the

Family *Poaceae*, tribe *Andropogoneae* and native to warm temperate to tropical regions of the old world (Wada et al, 2017). It has stout, jointed and fibrous stalks that are extensively rich in sugar. Varieties of sugarcane are highly heterogeneous and generally multiply vegetatively by stem cuttings (Richard, 2009). Matured cane may have green, yellow, purplish or reddish

colour and are considered ripe when sugar content is at its maximum (Onwueme and Sinha, 2003).

Sugarcane is vegetatively propagated with cuttings of 2-3 buds from mature stalks and subsequently from ratoon crops for some years as well as from true seed which is only used for breeding of new cultivars.

There are four Sugar Cane estates prominent in Nigeria:- Bacita, Numan, Sunti and Lafiagi. These estates grow sugarcane in relatively large scale while the majority of the small holder farmers grow soft sugar cane called Chewing Cane (Agboire et al., 2002). The area put under cultivation is progressively increasing from 24,000 ha in 2000 to 49,000 ha in 2007 (FAO, 2008) largely due to the privatization of the sugar estates.

Today, sugar production is showing a downward trend as a result of reduced yield of sugarcane which should be considered serious in view of the transformation of the sugar industry into energy industry. Many factors are responsible for this, which include the increased incidence of phytopathogens of which fungi are an important group.

Red rot is the most common disease of sugarcane in Nigeria, caused by the fungus *Colletotrichum falcatum*. The fungus causes severe loss in yield and quality of the susceptible cultivars available (Satyavir, 2003; Duttamajumder, 2008). It can reduce

cane weight by up to 29% and loss in sugar recovery by 31% (Hussnain and Afghan, 2006). Red rot pathogen hydrolyzes the stored sucrose by producing the enzyme invertase which breaks the sucrose molecule into glucose and fructose. As a result the quantity of molasses increases (Sehtiya et al., 2003). Information on the occurrence and distribution of the disease is paramount for adequate planning of improved and sustainable sugarcane production. The current study is therefore aimed at determining the incidence and severity of red rot disease in sugarcane growing areas of Kwara State with the view to providing information necessary for improved production of the crop.

MATERIALS AND METHODS

Selection of Study sites

Four Local Government Areas with history of sugarcane production in Kwara State were purposively selected for the determination of incidence and severity of red rot disease in the 2018/2019 growing season. The sampling was done on each farm based on one hundred sugarcane plants. This was achieved by walking across a 'Z' shaped path in a field with plants spaced at equal distance from each other. The sampled study locations are presented in Figure 1.

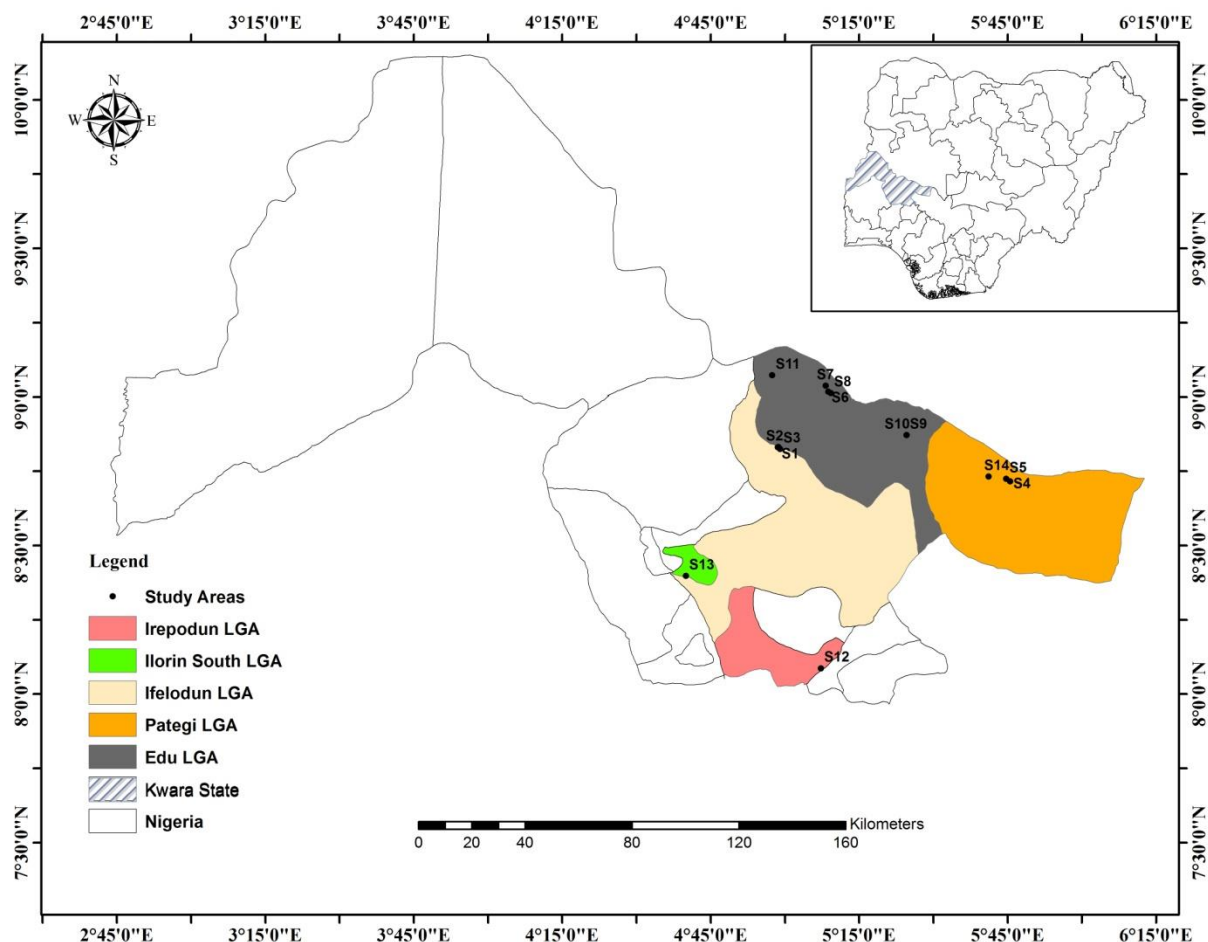


Figure 1: Map of Kwara State showing the selected study areas

Determination of Disease Incidence and Severity

The disease incidence and severity were calculated in Accordance with Allen *et al.*, (1983) formula;

$$\% \text{ Incidence} = \frac{\text{Number of infected (symptomatic) plants}}{\text{One hundred plants sampled}} \times 100\%$$

Red rot disease severity was determined by taking ten plants randomly from the population of plants showing the disease symptoms. Severity was scored on a developed scale of 1-10 based on number of symptomatic leaves relative to the total number of leaves per plant and expressed as a percentage.

$$\% \text{ Severity} = \frac{\text{Number of infected leaves on a plant}}{\text{Total no of leaves}} \times 100\%$$

on the plant sampled

- 1 = 1- 10% (very mild)
- 2 = 11- 20% (moderately mild)
- 3 = 21-30% (mild)
- 4 = 31-40% (moderately severe)
- 5 = 41-50% (severe)
- 6 = 51 - 60% (very severe)
- 7 = 61- 70% (highly severe)
- 8 = 71 – 80% (Extremely severe)
- 9 = 81 -90 (almost dead)
- 10 = 91- 100% (totally dead)

Sample collection

Sugarcane plants were assessed visually for disease symptoms (spindle leaves, displaying drying and at later stage, stalks become discoloured and hollow) and leaf samples were collected from symptomatic plants. The leaf samples that were taken from each farm were placed in sample tube containing silica gel wrapped in paper and labeled. All samples were stored in an ice crest cooler for onward transportation to the laboratory of the Department of Crop Protection Faculty of Agriculture University of Ilorin where isolation and identification of the responsible pathogen was done.

Isolation and identification of Red rot fungus

The culture medium (Potato Dextrose Agar) used was prepared by dissolving 39g in 1 litre of distilled water in a 2 litre flask. Streptomycin (1g/litre) was also added to prevent the growth of bacteria. The mixture

was then sterilized in an autoclave at 121 °C and 15psi pressure for 15 minutes. Leaves and stem samples with symptoms were cut into smaller pieces (1cm²), surface sterilized using sodium hypochlorite (0.5%) and rinsed in several changes of sterile water. The plant parts were then plated on solidified medium in 9cm diameter petri dishes and incubated for 7 days at 25⁰ C ± 2⁰C (modified ISTA 1996 procedure). Morphological characteristics of the fungal isolates on plates were observed using hand lens and under low power microscope. Temporary slides were prepared for the isolates. The slides were then observed under a compound microscope for the purpose of identification. The morphological and microscopic characteristics were matched with those described in standard reference (Barnett and Hunter, 1972). Samples of the fungal isolates were sent to the pathology laboratory of the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria for confirmation of identity.

Results

The results in Table 2 shows that all the sugarcane fields sampled were affected by the disease. There was significant difference ($p < 0.05$) in the percentage incidence of the disease in the different sampled sugarcane farms. The values ranged from 14.1 in Ilorin sugar research farm which was the least affected area to 36.1 in Shonga which was the place with the highest percentage incidence.

Table 1: % Incidence of red rot disease of sugarcane

Location	Number of farms	Mean % Incidence $\pm$ SD
Tsaragi	2	27.7 a $\pm$ 0.6
Shonga	2	36.1 b $\pm$ 0.8
Patigi	2	32.6 c $\pm$ 0.1
Lafiagi	2	15.1 d $\pm$ 0.1
Bacita	2	20.0 e $\pm$ 0.0
Egosi	2	18.5 e $\pm$ 0.0
Ilorin	2	14.1 d $\pm$ 0.1
Lade	2	15.0 d $\pm$ 0.0

Mean values in the same column not sharing the same letter are significantly different at $p = 0.05$. There was no significant difference ($p > 0.05$) in the percentage severity of red rot disease in all the sampled farms.

The results in Table 3 however showed that the disease was severe in Tsaragi (47.2%),

moderately severe in Ilorin, Egosi, Bacita, Shonga and Patigi with percentage severity ranging from 31.25 – 40.70. The disease was only mild in Lade with severity percentage of 26.75.

Table 3: Severity % and scaling of red rot disease of sugarcane

Location	Mean Severity% $\pm$ SD	Severity rating
Tsaragi	47.20 a $\pm$ 3.96	Severe
Shonga	40.40 a $\pm$ 5.66	Moderately Severe
Patigi	40.70 a $\pm$ 3.11	Moderately Severe
Lafiagi	18.75 a $\pm$ 8.84	Moderately Mild
Bacita	33.00 a $\pm$ 6.36	Moderately Severe
Egosi	31.25 a $\pm$ 8.84	Moderately Severe
Ilorin sugar research farm	31.25 a $\pm$ 8.84	Moderately Severe
Lade	26.75 a $\pm$ 2.47	Mild

Mean values in the same column not sharing the same letter are Significantly different at $p=0.05$

With respect to the causal organism of the disease, two morphologically different *C. falcatum* were isolated on PDA from the diseased sugarcane plants obtained from the fields surveyed during the study. The identity of both isolates was confirmed in

IITA Ibadan, Nigeria. The description of the colony morphology of the isolates are shown in Table 4. The colony morphology were those of ten-day-old cultures of the isolated organisms.

Table 4: Morphological description of the isolated *C. falcatum*

Isolates	Colony characteristics				
	Colony colour	Substrate colour	Margin	Colony Topography	Colony Diameter (average)
1	Greyish white	Black	Smooth	Raised cottony	88.5mm
2	White	White	Smooth	Raised cottony	86.7mm

DISCUSSION

Red rot disease of sugarcane occurred in all the sampled study areas. The percentage incidence and severity however differed. The difference might be due to the fact that the farmers plants different sugarcane varieties. Information from the growers confirmed the fact that the farmers plant different varieties of sugarcane. This observation is therefore in line with the report of Vikash and Shukla (2017) that disease incidence depends partly upon the crop varieties but also partly upon localities as well as favourable environmental factors. Another possible reason for variability in the disease severity might be attributed to

differences in the strains of the isolated pathogens. The result implicated two morphologically different *C. falcatum* from all the sampled farms. This is in line with the finding of Abbas et al. (2010) who found remarkable morphological diversity among four isolates of *C. falcatum*. According to Bharti et al, (2014) variability in cultural and morphological characters as well as virulence of *C. falcatum* might be as a result of hybridization, mutation conidial and hyphal fusions. Other factors that might have caused differences in incidence and severity of the disease could be the differences in the agronomic practices of spacing and use of

fertilizers. Legard et al, (2000) showed that higher plant density in the farm can encourage splash dispersal of fungal conidia thereby helping quicker and more effective dispersal of the disease. The use of fertilizers is believed to encourage vigorous vegetative growth of plants and boost the ability of the plant to withstand and resist disease development. Lack of fertilizer usage makes plants weak and hence more susceptible (Khatun et al, 2011).

REFERENCES

- Abbas, H., Anwar, S. A., Javed, N., Iqbal, M. A., & Abid, N. (2010) Morphological Variability among isolates of *Colletotrichum falcatum* Went. Infecting four cultivars of sugarcane. ***Pakistan Journal of Phytopathology*** 22: 101-104.
- Agboire, S., Wada, A. C. & Ishaq, M. N (2002) Evaluation and Characterization of Sugarcane Germplasm/Accessions for their Breeding values in Nigeria. ***The Journal of Food Technology in Africa*** 7: 33-35.
- Allen, R.N., Plumb, R.T. & Thresh, J.M. (1983). Spread of banana bunchy top and other plant virus diseases in time and space. In: Plant Virus Epidemiology: The Spread and

CONCLUSION AND RECOMMENDATIONS

The study shows that red rot disease of sugarcane is prevalent in Kwara State. The incidence and severity varied from one sampled farm to another. The disease is particularly severe in Tsaragi. It is recommended that awareness on the existence of sugarcane red rot disease be raised among the farmers as well as the consequences of the disease on general productivity of the crop so as to help the farmers imbibe the practices of preventing its spread.

Control of Insect-Borne Viruses pp: 51–59.

- Bharti, Y. P., Kumar, A. , Sharma, D. D. K. , Singh, S. K and Shukla, D. N (2014) Morphological, physiological and pathological variations among isolates of *Colletotrichum falcatum* that cause red rot of sugarcane. ***African Journal of Microbiology Research***. 8(10):1040-1049 DOI: 10.5897/AJMR2012.2469
- Busari, A. D. (2004). *Sugar-cane and Sugar industry in Nigeria: The bitter-sweet lessons*. Spectrum Books. 302pp.
- Duttamajumder S. k (2008) Red Rot of Sugarcane. Indian Institute of Sugarcane Research Lucknow, India
- Food and Agriculture Organization of the United Nations, (2008). The state of Food and Agriculture BIOFUELS:

- prospects, risks and opportunities, Rome.
- Burgess Publishing Company, Minneapolis, 241pp.
- Hussnain Z, Afghan S (2006) Impact of Major Cane Diseases on Sugarcane Yield and Sugar Recovery. Annual Report, Shakarganj Sugar Research Institute, Jhang, Pakistan.
- ISTA (1996): International Rules for Seed Testing, International Seed Testing Association (ISTA). Seed Science and Technology 24 (Supplement). Zurich, Switzerland.
- Khan Hmwa, Awais M, Raza W, Zia A (2011) Identification of Sugarcane Lines With Resistance To Red Rot. ***Pakistan Journal of Phytopathology*** 23: 98-102.
- Khatun, F., Alam, M., Hossain, M., Alam, S., and Malaker, P. "Effect of NPK on the incidence of Alternaria Leaf Blight of Mustard," ***Bangladesh J. Agril. Res.***, vol. 36, no. 3, pp. 407-413, 2011.
- Legard, D. E., Xiao, C. L., Mertely, J. C., and Chandler, C. K. "Effects of plant spacing and cultivar on incidence of Botrytis fruit rot in annual strawberry," ***Plant Dis.***, vol. 84, pp. 531-538, 2000.
- NSDC (2003). National Sugar Policy. Nigeria Sugar Development Council (NSDC), Abuja.19pp
- Barnett, H. L. and Hunter, B. (1972). Illustrated Genera of imperfect fungi.
- Richard C (2009). A Simple Description of the Long Term Potential for Biotechnology in Sugar Crops. *S J Sugar Journal* 6-9.
- Roach, B. T. (2009) Origin and improvement of the genetic base of sugarcane. In "*Proceedings of Australian Society of Sugarcane Technologists*", 11.
- Satyavir (2003) Red Rot of Sugarcane - Current Scenario. ***Indian Phytopathology*** 56: 245-254.
- Sehtiya Hl, Phawan AK, Virk KS, Dendsay J (2003) Carbohydrate Metabolism In Relation To *Colletotrichum Falcatum* In Resistant and Susceptible Sugarcane Cultivars. ***Indian Phytopathology*** 46: 83-85.
- Ogolla, F. O., Onyango, B. O., Muraya, M. M., and Mulambula, S. "Morphological Characterization of Sorghum E. turcicum Isolate from Different Areas of Tharaka Nithi County, Kenya," ***Journal of Scientific and Engineering Research***, vol. 5, no. 12, pp. 218-226, 2018.
- Onwueme IC, Shina TD (2003). CTA – Field Crop Production in Tropical Africa. CTA, Wageningen, Netherlands; 401–414 Ouagadougou, Burkina Faso

Vikash Pandey and D.N. Shukla (2017) Morphological Studies on Red Rot of Sugarcane from Hardoi District of Uttar Pradesh. ***International Journal of Agriculture Innovations and Research*** 6(2): 2319-1473

Wada, A. C., Abo-Elwafa, A., Salaudeen M. T., Bello L. Y. and Kwon-Ndung E. H.(2017). Sugar cane production problems in Nigeria and some Northern African countries – a review. ***Direct Research Journal of Agriculture and Food Science*** 5(3): 141-160.