DE GRUYTER OPEN
DOI: 10.1515/ats-2016-0004 AGRICULTURA TROPICA ET SUBTROPICA, 49/1-4, 30-37, 2016

Original Research Paper

Climate Variability and Livestock Production in Nigeria: Lessons for Sustainable Livestock Production

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Abstract

The study examined the relationship between climate variability and livestock production and the lessons that can be drawn for achieving sustainable livestock production in Nigeria. The study employed time series data on annual rainfall and livestock production given by index of the aggregate livestock production over the period of 1970 to 2008. The data were obtained from various publications of the Central Bank of Nigeria and the Nigerian Meteorological Agency. The data were analyzed through the instrumentality of econometric tools such as Augmented Dickey Fuller (ADF) test, Vector auto regression (VAR) lag order selection test and Pairwise granger causality. The results of the data analysis revealed the existence of unidirectional causality from climate variability to livestock production in Nigeria and this implies that climate variability has been significant in influencing livestock production over the period under study. Based on the foregoing, it is recommended as a matter of urgency that government should continually sensitize farmers on the challenges of climate change and feasible adaptation measures that they can adhere to in order to avert the detrimental effects of climate change on sustainable livestock production. In other words, implementation of the policy thrust on climate smart agriculture should be pursued vigorously.

Keywords: Livestock production; climate variability; flood; drought.

Introduction

The global livestock sector is growing faster than any other agricultural sector; it is currently the single largest anthropogenic user of land, and the source of many environmental problems, including global warming and climate change (Keith, 2008).The switch in food consumption pattern from traditional cereals and root crops to wheat based processed foods, high protein and animal products has accentuated the demand for more livestock. The global meat and milk production is expected to be more than double in the next half century (Mongabay, 2006). FAO (2007) report showed that livestock contributes 37% of methane emission, 9% of carbon-dioxide output and utilizes 8% of the world water. .According to the United Nations Food and Agriculture Organization, animal production is presently responsible for 18% of all human-induced greenhouse gas emissions (Steinfeld, 2006). The threat that climate changes pose to agricultural production does not only cover the area of crop husbandry but also includes livestock and in fact the total agricultural sector. African farmers also depend on livestock for income, food and animal products (Nin et al. 2007). Climate can affect livestock both directly and indirectly (Adams et al. 1999; Manning and Nobrew, 2001). Direct effects of climate variables such as air, temperature, humidity, wind speed and other climate factors influence animal performance such as growth, milk production, wool production and reproduction. Climate can also affect the quantity and quality of feedstuffs such as pasture, forage, and grain and the severity and distribution of livestock diseases and parasite (Niggol and Mendelsohn, 2008). Hence, the totality of agricultural sector is considered by examining agricultural productivity.

Climate change is the most severe problem that the world is facing today (Ayindeet al., 2011). It has been identified that it is a more serious threat than global terrorism (King, 2004). Climate change affects food and water resources that are critical for livelihood in Africa where much of the population especially the poor, rely on local supply system that are sensitive to climate variation (Ayinde et al., 2011). Rainfall is by far the most important element of climate change in Nigeria and water resources potential in the country (Adejumo, 2004). Agriculture in Nigeria is mostly rain-fed, it follows therefore that any change in climate is bound to influence agricultural productivity and livestock production in particular and other socio-economic activities in the country (Ayinde et al., 2011). The issue of climate change has become more threatening not only to the sustainable development of socio-economic and agricultural activities of any nation but also to the totality of human existence (Adejuwon, 2004).

The nation's natural and agricultural ecosystems, including freshwater and coastal resources, are highly susceptible to the effects of climate change (NASPA-CCN, 2011). As climate becomes hotter or drier, goats and sheep will take precedence over cattle and chickens, because they are more sensitive to heat stress. The raising of chicken and dairy cows will then be restricted to highland area like the plateau state of Nigeria. However, if rainfall increases in these areas, goats and chicken may become options that are more attractive. In 2007, the UNEP suggested doubling the number of small ruminants in Africa. Goat rearing for instance is already gaining momentum in Ghana (SPORE, 2008).

It is worth noting that numerous empirical studies on different aspects of livestock production in Nigeria have been carried out (Akpa et al., 2004; Olowofeso et al., 2012; Orheruata, 2014; Omolaran et al., 2014; Rekwot et al., 2001; Taiwo et al., 2015; Odeyinka et al., 2008; Alphonsus et al., 216; Olawumi et al., 2008, Ajala et al., 2004; Adunni, 2008; Rekwot et al., 2015; Gwaza and Momoh, 2016). Despite the myriads of research in livestock, there exists a gap in livestock research with respect to livestock production and climate change nexus in Nigeria. Arising from the global trend in climate variability, it has become imperative for this study to be undertaken to gain insight into the relationship between livestock production and climate variability in Nigeria. Therefore, the purpose of this study was to investigate the relationships that exist between climate variability and livestock production in Nigeria over a period of 39 years and draw up relevant implication for sustainable livestock production in the light of climate change.

MATERIAL AND METHODS

Description of Data

This study employed time series data on mean annual rainfall and livestock production given by index of the aggregate livestock production over the period of 1970 to 2008. The data period was chosen based on the period during which reliable data are available. The data were collected from various issues of Central Bank of Nigeria statistical bulletin and annual reports and the Nigerian Meteorological Agency. The data were processed with the support of Eview 7.1 statistical package.

Analytical framework

Descriptive and inferential statistics were utilized to achieve the objectives of this study. Descriptive statistics was used to examine the trend of climate variability and livestock production over the data period. Inferential statistics such as Augmented Dickey Fuller (ADF) test, unrestricted vector auto regression (VAR) and pairwise Granger Causality Test were employed. The ADF test was used to ascertain the time series properties of all the variables so as to avoid spurious regression which results from the regression of two or more non-stationary time series data. Unrestricted VAR was employed to generate the criteria (likelihood ratio, final prediction error, Akaike information criterion and Schwarz information criterion) which formed the basis for selecting the optimal lag length used in the Granger Causality Test and finally, the pairwise Granger Causality Test was used to determine the causal links between climate variability, and livestock production in Nigeria. The Augmented Dickey Fuller Model (ADF) with the constant term and trend is as follows:

$$\Delta Y_t = a_1 + a_2 t + \beta Y_{t-1} + \sum_{i=1}^{n} \gamma_i \, \Delta Y_{t-1} + \varepsilon_t \qquad (1)$$

The null hypothesis () of the ADF test indicates that the series is not stationary and the alternative hypothesis ( ) indicates that the series is stationary. If the absolute value of calculated ADF statistic () is higher than the absolute value of the critical values, we reject the hypothesis which states that the series is stationary. However, if this value is lower than the critical values, the time series is not stationary (Gujarati, 2004). The Granger causality test assumes that the information relevant to the prediction of the respective variables, X and Y, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions:

$$X_t = \beta_0 + \sum_{i=1}^{p} \beta_i X_{t-i} + \sum_{j=1}^{p} \alpha_j Y_{t-j} + \mu_{1t} \qquad (2)$$

$$Y_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{j=1}^{p} \delta_j X_{t-j} + \mu_{2t} \qquad (3)$$

It is assumed that the disturbances and are uncorrelated. Thus there is unidirectional causality from to if = 0 and ≠ 0. Similarly, there is unidirectional causality from to if = 0 and ≠ 0. The causality is considered as mutual if ≠ 0 and ≠ 0. Finally, there is no link between and (independence) if = 0 and = 0.

Empirical model specification

The pairwise Granger Causality Test was modelled as a bivariate vector autoregressive (VAR) model as follows:

$$CV_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i CV_{t-1} + \sum_{j=1}^{p} \omega_j LP_{t-1} + \epsilon_{1t} \qquad (4)$$

$$LP_t = \beta_0 + \sum_{i=1}^{p} \beta_i LP_{t-1} + \sum_{j=1}^{p} \varphi_j CV_{t-1} + \epsilon_{2t} \qquad (5)$$

Where:

CVt = Climate Variabilitygiven by mean annual rainfall in mm;

LPt = livestock production given by index of aggregate livestock production;

α_0, β_0= Constant terms,
α_i, ϖ_j = Estimated coefficients;
ε_{1t}, ε_{2t} = Gaussian white noise error terms;
p = optimal lag length.

RESULTS AND DISCUSSION

Descriptive statistics of variables

It is important to examine the summary statistics of the variables under study (climate variability and livestock production). The basic features of livestock production and climate variability in this study are given in Table 1. Livestock production is positively skewed (most values are concentrated on left of the mean, with extreme values to the right), platykurtic (flatter than a normal distribution with a wider peak) and the probability value (0.08) of its Jarque-Bera statistic (4.99) denotes that its errors are normally distributed. Climate variability is positively skewed; platykurtic and its errors are normally distributed based on the Jarque-Bera statistic (14.99) which is significant at 1% probability level.

Table 1. Descriptive statistics of livestock production and rainfall in Nigeria (1970 – 2008)
Original printout

Mean	152.7995	573.0000
Median	117.8000	395.0000
Maximum	321.4000	1735.000
Minimum	73.60000	193.0000
Std. Dev.	80.17630	449.4793
Skewness	0.828852	1.491753
Kurtosis	2.429430	3.572739
Jarque-Bera	4.994492	14.99768
Probability	0.082311	0.000554
Sum	5959.180	22347.00
Sum Sq. Dev.	244273.1	7677204.
Observations	39	39

Augmented dickey fuller unit root test

The result of the unit root test from the augmented dickey fuller (ADF) test is presented in Table 2. lnCV and lnLP were found to be non-stationary at level form leading to the acceptance of the null hypothesis of the ADF test. The variables became stationary after first difference. The differencing was necessary so as to avoid spurious result when the variables are used in their non-stationary form.

Vector Autoregression (VAR) lag order selection criteria

The result presented Table 3 shows that VAR model was fitted to the time series data in order to find an appropriate lag structure for the granger causality test. This was necessitated by the sensitivity of granger causality to lag length structure (Foresti, 2006; Afzal, 2012; Oyinbo and Rekwot, 2014). The result on Table 3 indicates that the optimal lag length is one

Table 2. Summarized result of Augmented Dickey Fuller test

Variable	ADF Statistic	Test Critical value (5%)	Inference
Level			
LnRF0.3226		-3.6156Non-Stationary	
LnLP0.9044		-3.6156Non-stationary	
First difference			
ΔlnRF-6.7073		-3.6210	Stationary
ΔlnLP-4.8311		-3.6122	Stationary

NB: ln = natural logarithm
Δ = difference operator
Lag length selection was automatic based on Schwarz Information criterion (SIC)

Original printout
Null Hypothesis: RF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.322598	0.9765
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RF)
Method: Least Squares
Date: 11/03/14 Time: 18:57
Sample (adjusted): 1971 2008
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RF(-1)	0.021642	0.067087	0.322598	0.7489
C	26.68187	45.49010	0.586542	0.5612
R-squared	0.002882	Mean dependent var		38.42105
Adjusted R-squared	-0.024815	S.D. dependent var		166.2232
S.E. of regression	168.2730	Akaike info criterion		13.14025
Sum squared resid	1019368.	Schwarz criterion		13.22644
Log likelihood	-247.6647	Hannan-Quinn criter.		13.17091
F-statistic	0.104069	Durbin-Watson stat		2.290595

Null Hypothesis: D(LP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag = 9)

		t-Statistic
Augmented Dickey-Fuller test statistic		-6.707334
Test critical values:	1% level	-3.621023
	5% level	-2.943427
	10% level	-2.610263

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RF,2)
Method: Least Squares
Date: 11/03/14 Time: 19:02
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RF(-1))	-1.122178	0.167306	-6.707334	0.0000
C	40.68876	28.47593	1.428883	0.1619
R-squared	0.562436	Mean dependent var		-1.135135
Adjusted R-squared	0.549934	S.D. dependent var		251.9246
S.E. of regression	169.0085	Akaike info criterion		13.15031
Sum squared resid	999735.4	Schwarz criterion		13.23739
Log likelihood	-241.2808	Hannan-Quinn criter.		13.18101
F-statistic	44.98833	Durbin-Watson stat		1.966803
Prob(F-statistic)	0.000000			

based on Likelihood ratio (LR), Final prediction error (FPE) and Akaike information criterion (AIC).

Granger causality test

A pairwise granger causality test was carried out to examine the presence as well as the direction of causal link that exist between climate variability and livestock production and the result is given in Table 4. The f-statistic of 3.5526 was significant at 10% probability level and therefore, this indicates that there is unidirectional causality from climate variability to livestock production which indicates that the null hypothesis that climate variability does not granger cause (influence) livestock production is rejected and the alternative is accepted. The result implies

Null Hypothesis: LP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.904356	0.9945
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LP)
Method: Least Squares
Date: 11/03/14 Time: 19:01
Sample (adjusted): 1971 2008
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LP(-1)	0.023241	0.025699	0.904356	0.3718
C	2.430295	4.303165	0.564769	0.5757
R-squared	0.022214	Mean dependent var		5.892105
Adjusted R-squared	-0.004947	S.D. dependent var		12.08789
S.E. of regression	12.11775	Akaike info criterion		7.878415
Sum squared resid	5286.234	Schwarz criterion		7.964604
Log likelihood	-147.6899	Hannan-Quinn criter.		7.909081
F-statistic	0.817860	Durbin-Watson stat		1.711721
Prob(F-statistic)	0.371819			

Null Hypothesis: D(LP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.831111	0.0004
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

that climate variability has been significant in influencing the trend of livestock production over the period under study and this collaborates the findings of Adeolu and Adeyemo (2011) who noted that climate variability especially rainfall has a direct often adverse effects on the quantity and quality of agricultural production. Therefore, in the face of changing climate, which influences rainfall and drought, climate variability affects livestock production in Nigeria. Low rainfall (drought) induces environmental changes in temperature which results in heat stress especially in Nigeria which has a negative effect on the reproductive capacity of livestock. This is in consistent with Ayinde et al. (2011) who reported that high temperature depletes soil nutrient making it hard on livestock and agricultural production. Besides drought, high rainfall (flooding) has negative feeding and reproduction effect on livestock and it causes damage to pasture. In the words of Smith et al. (1996) climate change will affect animal production in four ways; the impact of changes on livestock feed-grain availability and price; the impact on livestock pastures and forage crop production

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LP,2)
Method: Least Squares
Date: 11/03/14 Time: 19:02
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LP(-1))	-0.869027	0.179881	-4.831111	0.0000
C	5.158555	2.346840	2.198086	0.0346
R-squared	0.400065	Mean dependent var		-0.585946
Adjusted R-squared	0.382924	S.D. dependent var		15.66729
S.E. of regression	12.30731	Akaike info criterion		7.910803
Sum squared resid	5301.448	Schwarz criterion		7.997879
Log likelihood	-144.3498	Hannan-Quinn criter.		7.941501
F-statistic	23.33963	Durbin-Watson stat		1.907087
Prob(F-statistic)	0.000027			

Table 3. VAR lag order selection result

Original printout

VAR Lag Order Selection Criteria
Endogenous variables: LP RF
Exogenous variables: C
Date: 11/03/14 Time: 19:14
Sample: 1970 2008
Included observations: 36

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-456.9612	NA	4.06e+08	25.49784	25.58582	25.52855
1	-366.2051	166.3861*	3279109.*	20.67806*	20.94198*	20.77018*
2	-364.5502	2.850190	3746011.	20.80834	21.24821	20.96187
3	-361.5507	4.832380	3985635.	20.86393	21.47974	21.07887

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 4. Result of P

Pairwise Granger Ccausality Test

Pairwise Granger Causality Tests
Date: 11/03/14 Time: 19:15
Sample: 1970 2008
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LP does not Granger Cause RF	38	1.18436	0.2839
RF does not Granger Cause LP		3.55261	0.0678

and quality; changes in livestock diseases and pests; and the direct effects of weather and extreme events on animal health, growth and reproduction.

Lessons for sustainable livestock production

This study has succeeded in establishing the significant influence of climate variability in enhancing livestock in

Nigeria. The results confirmed the findings of NRC (2002) who noted that lack of prior conditioning of livestock to weather events such as temperature and drought often result to catastrophic losses in the domestic livestock industry. Ambient temperature has the greatest influence on voluntary feed intake and this explain the poor performances of local herds in the supply of animal protein required in Nigeria. Also, Amogu (2009) noted that those unfavorable environmental situations hinder livestock production in Nigeria. Climate change will have far-reaching consequences for livestock production, especially in vulnerable parts of the country where it is vital for nutrition and livelihoods. The impact of climate change can heighten the vulnerability of livestock systems and exacerbate existing stress upon them, such as droughtthat affects livestock production. Hence, sustainability of livestock production in the face of climatic variation calls for adaptation measures to prevent its adverse effect on livestock production.

Implementation of climate smart agriculture (an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate) in Nigeria can guarantee sustainable livestock production in the face of climate change. The policy trust on climate smart agriculture contained in the agriculture promotion policy for the period of 2016 – 2020 (FMARD, 2016) will reduce the effects of climate change on agriculture (livestock inclusive) if properly implemented.

CONCLUSION

Using annual data on rainfall and index of livestock production in Nigeria over the period of 1970 to 2008, this study investigated the relationships that exist between climate variability and livestock production in Nigeria. The major finding of the study was that climate variability has been significant in influencing livestock production over the years. Climate variability resulting from climatic change poses a threat to livestock production in terms of their reproductive capacity and feeding habit of the animals. Based on the foregoing, it is recommended as a matter of urgency that government should continually sensitize farmers on the challenges of climate change and feasible adaptation measures that they can adhere to in order to avert the detrimental effects of climate change on livestock production. Essentially, the policy trust on climate smart agriculture put forward in the agriculture promotion policy (2016 – 2020) in Nigeria should be implemented accordingly.

REFERENCES

Adams R., McCarl B., Segerson K., Rosenzweig C., Bryant, K.J., Dixon, B. L., Conner R., Everson R.E., Ojima D. (1999): The economic effect of climate change on United States agriculture. In: R Mendelsohn, J Neuman (Eds.): The Impact of Climate Change on the United States Economy.: Cambridge University, pp. 18–54.

Adejuwon S.A. (2004): Impact of climate variability and climate change on crop yield in Nigeria. Contributed Paper to Stakeholders Workshop on Assessment of Impact and Adaptation to Climate Change (AIACC): 2–8

Adeolu B.A., Adeyemo V.A. (2011): Rainfall variability and food cropproduction: the case of maize in Osun state, Nigeria. In: Erahabor, P.O., Ada-Okungbowa, C.I., Emokaro, C.O. and Abiola, M.O. (Eds), From Farm to Table: Whither Nigeria? Proceeding of the 12th National Conference of the Nigerian Association of Agricultural Economists (NAAE), University of Benin, 13th – 16th November. pp. 524–533.

Adunni S.A. (2008): Animal traction: an underused low external input technology among farming communities in Kaduna state, Nigeria. Tropicultura 26 (1): 48–52.

Ajala M.K., Alli-Balogun J.K. (2004): Economics of rabbit production in Zaria, Kaduna State, Nigeria.Tropical Journals of Animal Science 7: 1–10.

Akpa, G.N., Jokthan, G.E., Ogunleye, K.O. Lakpini, C.A.M. (2004): Genetic and non-genetic sources of variation for litter size, gestation length and sex ratio in Nigerian goats. Journal of sustainable Tropical Agricultural Research 12: 66–70.

Alphonsus C., Akpa G. N., Nwagu B. I., Barje P. P., Sam I. M., Abdullahi I., Finangwai H. I., Achi N. P., Olobatoke R. Y., Olaiya O., Opoola E. (2016): Effect of Post-Partum Body Condition Score on Fertility and Milk Yield of Friesian X Bunaji Dairy Cows. Journal of Animal Science Advances 6 (2): 1537–1542.

Amogu U. (2009): Maximizing the animal production value addition chain in Nigeria. Invited presentation at Nigeria Institute of Animal science, Annual General Meeting, University of Calabar, July 28, 2009.

Ayinde O.E., Muchiea M., Olatunjib G.B. (2011): Effect of Climate Change on Agricultural Productivity in Nigeria: A Co-integration Model Approach Journal of Human Ecology 35(3): 189–194.

Food and Agriculture Organization (FAO), (2007): Managing livestock-environment interactions, a report to the FAO committee on Agriculture. In: CTA special issue- August 2008. http://spore.cta.int.

Federal Ministry of Agriculture & Rural Development (FMARD), (2016): The Agriculture Promotion Policy (2016 – 2020): Building on the Successes of the ATA, Closing Key Gaps. Policy and Strategy Document.

Gwaza, D.S., Momoh, O.M. (2016): Endangered indigenous cattle Breeds of Nigeria a case for their conservation and management. World Scientific News 30: 68–88.

Intergovernmental Panel on Climate Change (IPCC) (2007): Impacts, adaptation and vulnerability: The Working Group II Contribution to the Intergovernmental panel on climate change fourth assessment report. Cambridge University Press.

Keith R. (2008): Farm animal production and climate change. http://www.temasactuales.com.

Manning M., Nobrew C. (2001): Technical Summary Impact, Adaption and Vulnerability: A Report of Working Group II of the Intergovernmental Panel on Climate Change. In: J. McCarthy, O.F. Canziani, N.A. Leavy, J.D. Dekken, C. White Eds.): Climate Change: Impact, Adaption and Vulnerability. Cambridge: Cambridge University Press, pp. 44-65.

Mungabay C. (2006): Cattle produce more global warming gases than cow. http://newa.mongabay.com/2006/1130-un.html.

National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN) (2011): Prepared for the Federal Ministry of Environment special Climate Change unit by the Building Nigeria's Response to Climate Change (BNRCC) project.

Niggol S., Mendelsohn R. (2008): Animal Husbandry in Africa: Climate impacts and adaptations. African Association of Agricultural Economists 2(1): 66.

Nin A., Ehui S., Benin S. (2007): Livestock productivity in developing countries: An assessment. In: R. Evenson, P. Pingali (Eds.): Handbook of Agricultural Economics (3). North Holland, Oxford Press, pp. 2467–2532.

(NRC) National Research Council (2002): Abrupt climate change inevitable surprises. National Academy Ppress, Washington, D. C., National Academy Press.

Odeyinka S. M., Oyedele O. J., Adeleke T. O., Odedire J. A. (2008): Reproductive performance of rabbits fed *Moringa oleifera* as a replacement for *Centrosema pubescens*. 9th World Rabbit Congress Verona-Italy, June 10-13, pp. 411-416

Olowofeso, O., Adejuwon, A. J., Ademokoya V.A., Durosaro, S.O. (2012): Breeding and Productive Performance of Three Breeds of Rabbit in South-West Nigeria. Global Journal of Science Frontier Research Bio-Tech & Genetics 12(5):35–38.

Omolaran B. B., Odunayo J. O., Sunday A. I., Jimoh M., Micheal S., Afolabi., Musibau A. A., Suleiman, Y. A. (2014): Agro-nutritional variations of quality protein maize (*Zea mays*) in Nigeria. Journal of Agricultural Sciences 59 (2): 101–116.

Orheruata M. A. (2014): Animals with low productivity everywhere: increasing productivity, the breeder's task. Inaugural lecture Series 140, University of Benin.

Oyetade L. (2007): Desertification in Nigeria (African Agriculture).Text of a lecture delivered at the 38th interdisciplinary research discourse, postgraduate school, University of Ibadan, 11th December, 2007.

Olawunmi, O.O., Salako, A.E., Afuwape, A.A. (2008): Morphometric differentiation andassessment of function of the Fulani and Yoruba ecotype indigenous Chickens of Nigeria. International Journal Morphology 26(4): 975–980.

Oyinbo O., Emmanuel, Y.D. (2012): Empirical Assessment of the Growth Rate of Maize Production in the Pre – SAP, SAP and Post – SAP Periods in Nigeria, Russian Journal of Agricultural and Socio-economic Sciences 5 (5) : 23–27.

Oyinbo O., Rekwot G.Z. (2014): The Relationships of Inflationary Trend, Agricultural Productivity and Economic Growth in Nigeria, CBN Journal of Applied Statistics 5 (1): 35-47.

Rekwot P.I., Oguw D., Oyedipo E.O., Sekini V.O. (2001): The role of pheromones and biostimulation in animal reproduction. Animal Reproductive Science 30 (3-4):157–170.

Rekwot G. Z., Oyinbo O., Lasisi T.O. (2015): Adoption of IAR improved groundnut varieties for livestock production in Jigawa state, Nigeria. Biological and Environmental Sciences Journal for the Tropics 12(2): 790–794.

Smith B., McNabb D., Smithers J. (1996): Agricultural adaptation to climatic variation. Climate Change 43: 7-29.

Steinfeld H.,Gerber P., Wassenaar T., Castel V., Rosales M., de Haan C. (2006): 'Livestock's Long Shadow: Environmental Issues and Options, Food and Agricultural Organization' p. 21.

Spore (2008): Climate Change. Leplaideur M (ed.) SPORE Magazine, August, The Netherlands.

Taiwo B.B.A., Buvanendran V., Adu I.F. (2005): Effect of body condition score on the reproductive performance of Red Sokoto goats. Nigerian Journal of Animal Production 32 (1):1–6.

Received: October 14, 2015
Accepted after revisions: September 29, 2016

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