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Impact of Agro-Ecological Belts and Rainfall Distribution on Poultry Production in the Major Tropical Regions of Nigeria

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Abstract- This study investigated the factor responsible for poultry production in the Northern and Southern regions of Nigeria. Using Geographic Information System (GIS) and applying the FAO categories of poultry farm production for the Northern Nigeria: 55.6% of Household free-range (HHFR) farms (<200 birds) produced at 67.7%, 58.6% of Backyard commercial (BYC) farms (200-4,999) produced at 56%, 52.7% of Medium-scale commercial (MSC) farms (5,000-19,999) produced at 51.5% and 32.6% of Large-scale commercial (LSC) farms (with≥20,000 birds) produced at 23.7%. In the South: 44.4% of Household free-range (HHFR) farms (<200 birds) produced at 32.3%, 41.4% of Backyard commercial (BYC) farms (200-4,999) produced at 44%, 47.3% of Medium-scale commercial (MSC) farms (5,000-19,999) produced at 48.5% and 67.4% of Large-scale commercial (LSC) farms (with ≥20,000 birds) produced at 76.3%. Agro-ecological production distribution showed Arid/Semi-Arid (14.2%), Derived Savanna (38.7%), Humid Forest (28.5%), MidAltitude (9.9%), Northern Guinea Savanna (6.3%) and Southern Guinea Savanna (2.4%).

Keywords: *ADP, GPS, heat stress, poultry meat type, rainfall pattern.*

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Abstract- This study investigated the factor responsible for poultry production in the Northern and Southern regions of Nigeria. Using Geographic Information System (GIS) and applying the FAO categories of poultry farm production for the Northern Nigeria: 55.6% of Household free-range (HHFR) farms (<200 birds) produced at 67.7%, 58.6% of Backyard commercial (BYC) farms (200-4,999) produced at 56%, 52.7% of Medium-scale commercial (MSC) farms (5,000-19,999) produced at 51.5% and 32.6% of Large-scale commercial (LSC) farms (with≥20,0 00 birds) produced at 23.7%. In the South: 44.4% of Household free-range (HHFR) farms (<200 birds) produced at 32.3%, 41.4% of Backyard commercial (BYC) farms (200-4,999) produced at 44%, 47.3% of Medium-scale commercial (MSC) farms (5,000-19,999) produced at 48.5% and 67.4% of Large-scale commercial (LSC) farms (with ≥20,000 birds) produced at 76.3%. Agro-ecological production distribution showed Arid/Semi-Arid (14.2%), Derived Savanna (38.7%), Humid Forest (28.5%), MidAltitude (9.9%), Northern Guinea Savanna (6.3%) and Southern Guinea Savanna (2.4%).

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I. Introduction

The existing acute shortage of protein in Nigeria and the ever increasing demand for livestock products point to poultry meat and eggs as a quick means of bridging the protein deficiency gap Adegeye and Dittoh (1982). Production of food has not increased at the rate that can meet the increasing population in Nigeria. The evident disparity in rate of food production and demand for food in Nigeria has led to adverse increase in food importation and consequently resulting in high rates of increase in food prices. Agriculturists and Nutritionists generally agreed that developing the poultry industry of Nigeria is the fastest means of bridging the protein-deficiency gap presently prevailing in the country. The obtainable quality of poultry management system in Nigeria lacks modern techniques which require adequate funding. A report made by Omodele and Okere (2014) showed that the highest production of poultry is in Ogun State in the South-west geopolitical zone of Nigeria. This highest production of poultry is not only as a result of population but also due to availability of market in the neighbouring States and other zones in the country.

According to Udoh and Etim (2007), poultry is by far the largest livestock group, consisting mainly of chickens, ducks and turkey. The types of poultry that are of commercial or economic importance are chickens, guinea fowls and turkeys, amongst which chickens predominate. As a result of this, poultry farming is generically used to refer to chicken farming in Nigeria because it provides meat for delicacies and no tribe or religion in Nigeria forbids chicken meat. In communities where food shortages are uncommon, chickens are kept to supplement the meals or to honour a guest (Nwagu, 2002). Chickens comprise: Broilers, Breeders, Layers and Cockerels (Omodele and Okere 2014). The Layer bird and its products (eggs) are very rich source of protein. Estimates from consumption of poultry and demand surveys in Nigeria indicated that the consumption of poultry meat is gradually outstripping most other kinds of meat except beef.

Various factors in the bird's environment affect its well being and its levels of productivity (Smith, 2001). In tropical areas, the effect of the tropical environment varies from area to area. For example, humidity in the air is of more importance near the equator in the rain forest areas; high temperatures are important in the seasonally dry areas away from the equator and very important in hot desert areas. The sun is hotter in equatorial regions than in temperate regions, although this effect is modified in heavy rainfall areas by the presence of a thick cloud cover. The actual temperatures at the lower and upper extremes of the zone of thermal neutrality depend on insulation of the bird (feather cover) and its level of feeding. Below the zone of thermal neutrality food is used wastefully and above this zone the bird suffers heat stress (Smith, 2001). Birds are more cold tolerant than heat tolerant and they are much more likely to die from heat stress than cold stress. It should however be emphasized that under 'modern' systems of management poultry are normally intensively housed and therefore live in a modified microenvironment. The modern technology requires substantial funding which is not affordable by most farmers in the tropical regions of Nigeria.

FAO has divided the production system into 4 categories based primarily on scale of production and

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level of bio-security: sector 1: industrial integrated system with high bio-security systems; sector 2: commercial poultry production system with moderate to high bio-security; sector 3: commercial poultry production system with low to minimal bio-security; and sector 4: village or backyard production system with minimal bio-security (Adene and Oguntade 2006). Researchers simulated farm locations and animal populations by randomly locating the farms within restrained areas determined by several geographic factors, such as roads and water bodies (Geter, 2006; Miller *et al*., 2007). Although promising, this approach resulted in local farm densities that were too high as well as an unreasonably large spatial distribution.

The use of GIS in qualitative livestock production is needed to collect data, store, manage, analyze and produce useful information from production stage to decision making stage. Unlike any other type of information handling tool, GIS can understand the concept of location and will help poultry producers with optimal and cost-effective poultry management. A report made by Omodele and Okere (2014) showed that GIS capability in poultry management is achievable in land type description, feed cost monitoring, disease spread analysis and monitoring credit facility sources. This study was undertaken to technically assess the poultry production in the two major regions of Nigeria and to help the decision makers in creating a competitive environment where poultry production is optimized in order to meet the rising demands of the increasing population in the regions and also knowing the geographic boundaries or areas where rescue operations are essential.

II. Materials and Methods

a) Survey of poultry farms

An intensive survey was carried out in 2010 for the creation of an accurate spatial dataset of poultry farms contributing to the development of the poultry sector in the Northern and Southern geographical regions of Nigeria (Figure 1). This determination of positions of the poultry farms required the use of Global Positioning System (GPS) for the purpose of assessing and evaluating the development of the poultry sector in their respective localities (Figure 2). Through interview sessions conducted by Agricultural Development Programme (ADP) Officers, a set of questionnaire were also administered to obtain information on the characteristics of the sampled farms.

Figure 1 : Map of the study area

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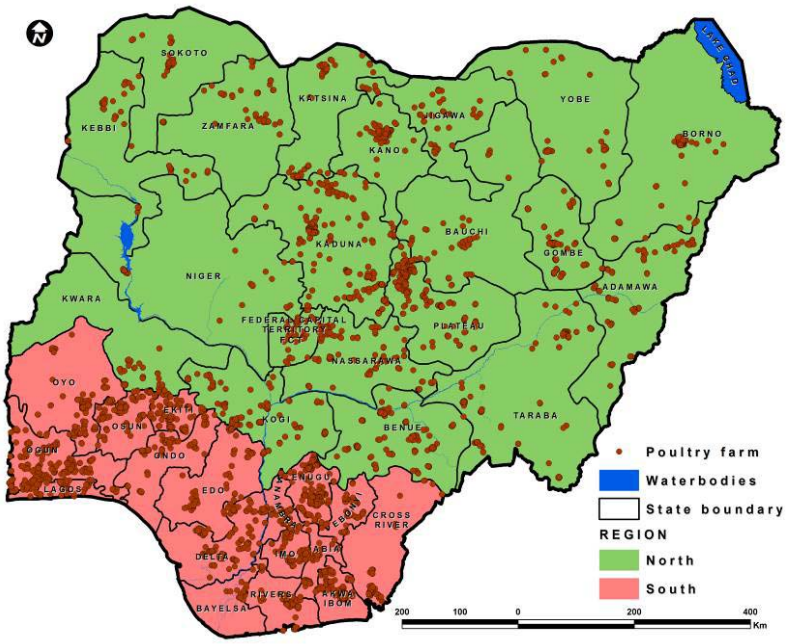

Figure 2 : Spatial distribution of poultry farms in the Northern and Southern Nigeria

b) Integration of spatial and attribute data of poultry farms

Integrating the logically structured spatial and attribute data of the surveyed poultry farms using ArcGIS 10.1® capabilities, the obtained data of the poultry farms within the study area were logically queried and analyzed. The geographical spreads of the farms with respect to their locations were determined for an easy determination of the poultry production capabilities of the regions as displayed in Table 1. The regional identification of all farms was geographically defined based on the centroid of each poultry farm. The adopted GIS mapping procedure is shown in Figure 3 (*Source: Omodele and Okere (2014)*).

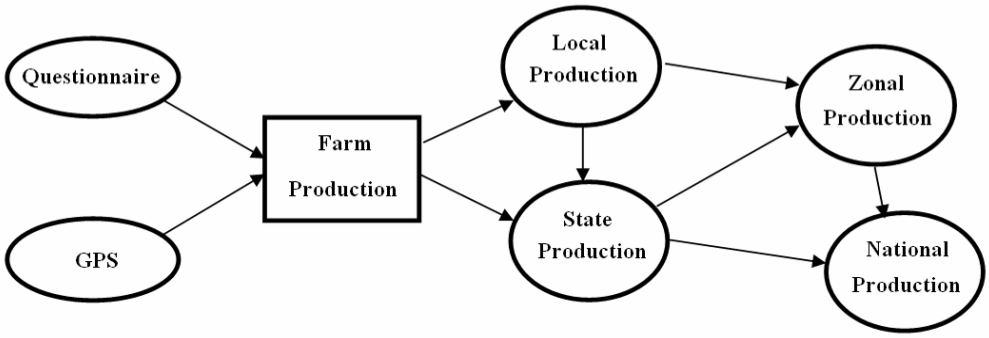

Figure 3 : Mapping procedure for poultry production in a GIS environment

III. Results and Discussion

a) Landmass and farms proportion

According to Figure 2, the Northern land mass of 720,782.1 SqKm contained 3,452 poultry farms while the Southern land mass of 188,678.6 SqKm contained 2,629 poultry farms. From these results, it is presumed that the Northern part of Nigeria should emerge as the higher producer of poultry products especially with the advantage of larger available space (land) and proportion of contributors (farms) in Nigeria. Agriculture and poultry in particular thrives with the availability of conducive space (land).

b) Northern and Southern disparity in poultry production

Table 1 shows the poultry meat types and their production in the North and South regions while Figure 4 displays the percentage production profile of the surveyed poultry meat types between the regions. With the expectation of the North to outstrip the South in production, it was revealed that the Southern region produced more than the Northern region except in Breeders production where the North dominated. This is a clear indication that the high number or proportion of poultry farms in an area does not guarantee a high production in such a locality as reported by Omodele *et. al.* (2014a). Assessing the non-producing farms in

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Nigeria, 51.3% and 48.7% of farms in the North and South respectively are not producing. The non-production percentages by these farms was considered negligible for the assessment because of their closeness.

Table 1 : Year 2010 regional poultry meat production in Nigeria (birds)

Region	Broilers	Breeders	Layers	Cockerels	Total
North	708836	469995	3916344	119251	5214426
South	1163479	378650	5506864	210608	7259601
Total	1872315	848645	9423208	329859	12474027

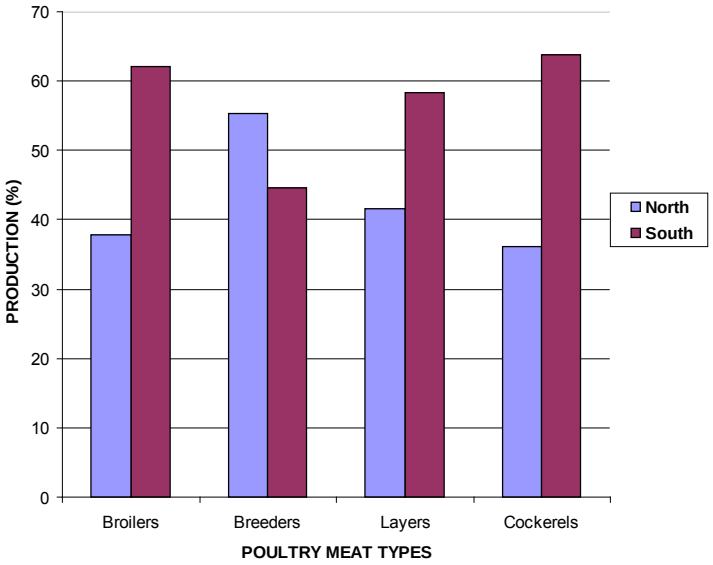

Figure 4 : North and South Percentage production of poultry meat types

c) Farms proportion and production

As stated in Table 2 and displayed in Figure 5: In the North, 56.8% of farms produced 41.8% of poultry products and in the South, 43.2% of farms produced 58.2%. This implies that despite the lower percentage of poultry farms in the South, the Southern region still emerged the higher producer of poultry products in Nigeria. Hence, this requires further investigation.

Table 2 : Poultry farms proportion and production in the Northern and Southern Nigeria

Region	No of farms	Production (birds)
North	3452	5171919
South	2629	7210962

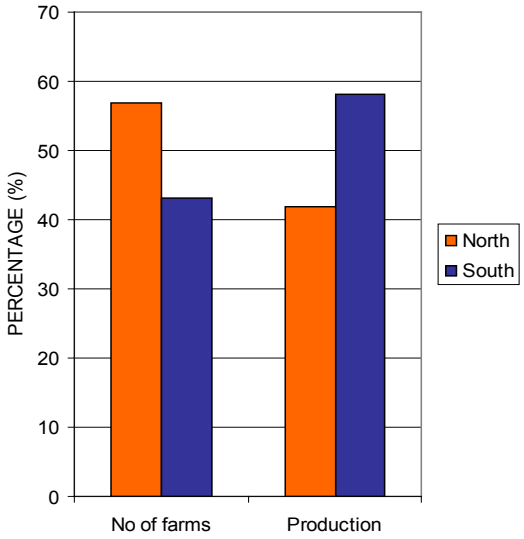

Figure 5: Percentages of disparity in farms proportion and production in the Northern and Southern parts of Nigeria

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d) Application of FAO categories of poultry farms

Applying the FAO categories and adopting the classes of poultry farms production applied by Omodele *et. al.* (2014a): Household free-range (HHFR) farm (<200 birds), Backyard commercial (BYC) farm (200-4,999), Medium-scale commercial (MSC) farm (5,000-19,999), Large-scale commercial (LSC) farm (with ≥20,000 birds) made the farm production capacity assessment achievable. However, because farm size is not necessarily directly related to level of bio-security, these four categories were proposed for the benefit of this assessment. According to the classes, regional justification of poultry farms performance was applied. Figure 6 displays the spatial distribution of the poultry farms according to FAO categories of production while Table 3 shows the applied classes of production in the Northern and Southern regions of Nigeria. As in Figure 7, the Northern region outstrips the Southern region in the Household free-range (HHFR), Backyard commercial (BYC) and Medium-scale commercial (MSC) farms categories which was as a result of the North having more farms contributing in these 3 categories than the south. The Southern region recorded a higher number of farms in the Large-scale commercial (LSC) category which is the highest production class. As a result, the South had a higher production than the North. This position of production connotes that there is an appreciable production of poultry meat in the South due to higher number of farms in the highest production category (LSC). This qualitative analysis has given the agriculturists and decision makers' broader perception of the overall performance of all farms across the regions.

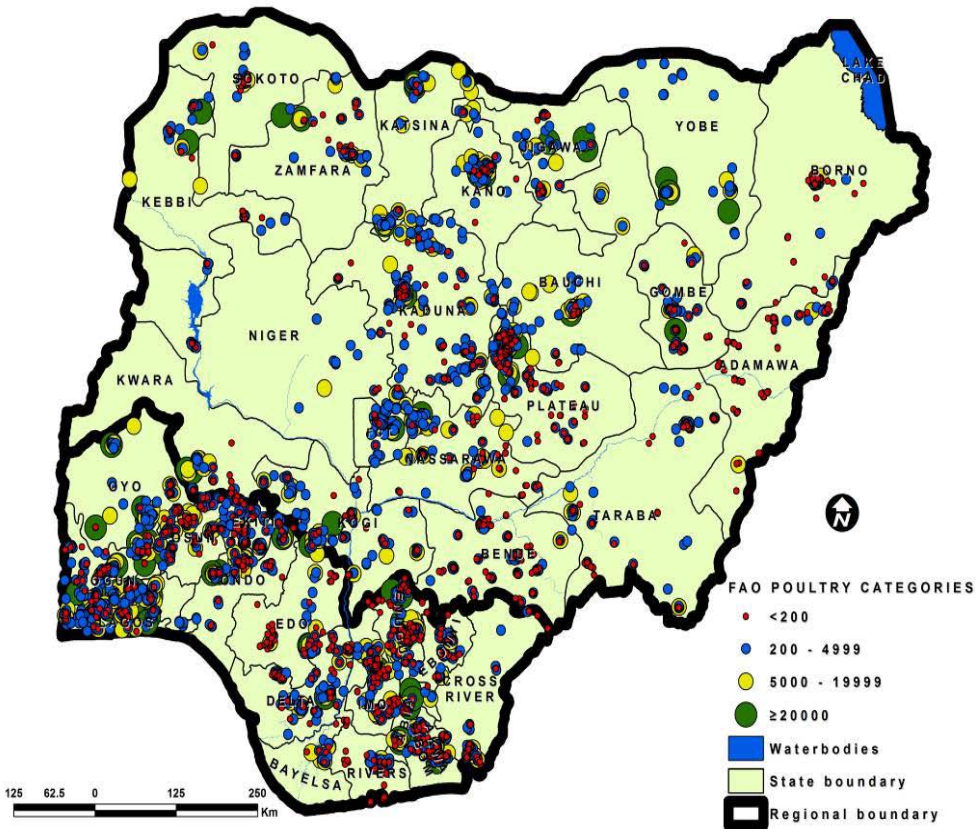

Figure 6 : Northern and Southern distribution of poultry farms according to FAO categories

Table 3 : Categories of poultry farms in the Northern and Southern Nigeria

Class	No of farms (North)	Northern Production (birds)	No of farms (South)	Southern Production (birds)
<200 (HHFR)	1183	40228	946	19192
200-4999 (BYC)	2024	2212258	1429	1741489
5000 – 19999 (MSC)	216	1729811	194	1630458
≥20000 (LSC)	29	1189622	60	3819823

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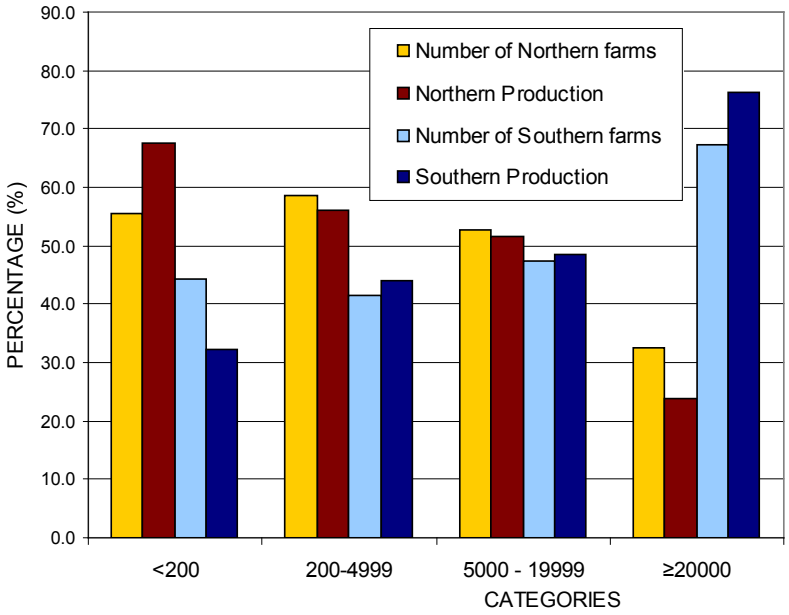

Figure 7 : FAO categories comparison of percentages of farms and their percentage production in the Northern and Southern parts of Nigeria

e) Market availability

Availability of market is one of the most important determining factors of poultry production. As stated by Omodele *et. al.* (2014b), population attracts increase in consumption of poultry products (meat and eggs) and that high population connotes more of commercial activities as agricultural products have ready markets. As confirmed that market access plays an important role in the development of the poultry industry in Delta State, Omodele *et. al.* (2014b) stated further that human population attracts increase in production and consumption of poultry products in the Niger Delta area. Therefore in the same perspective, Table 4 shows the human population distribution in the Northern and Southern regions which were 53.6% and 46.4% respectively. The higher population in the North did not guarantee a higher production as confirmed in the South. It could be stated that the purchasing power of the Southern region is higher than that of the Northern region. The poverty level in the North is also presumed to be higher. This implies that human population does not always determine poultry production in the wide regions of the North and South of Nigeria.

Table 4 : The Northern and Southern human population

Region	Human Population
North	75269722
South	65162068

f) Agro-ecological distribution of production

Poultry production distribution was assessed across the various agro-ecological zones in Nigeria. In order of the six identifiable zones displayed in Figure 8, the quantities of birds produced across the zones are listed in Table 5. As shown in Figure 9, agro-ecological distribution of poultry production was Arid/Semi-Arid (14.2%), Derived Savanna (38.7%), Humid Forest (28.5%), Mid Altitude (9.9%), Northern Guinea Savanna (6.3%) and Southern Guinea Savanna (2.4%). The differential production output across the agroecological zones is the fact that all the commercial birds either for egg or meat type are bred or selected under temperate conditions. Expectedly, they perform below their potentials in accordance to the severity of the heat stress elicited by their production system in the tropical regions. Since the Southern region is where rainforest agro-ecological zone and a part of the derived savanna is domicile, there existed an appreciable production of birds in the region (Figure 9). The derived savanna belt which spreads across the Northern and Southern regions recorded the highest production while the Mid Altitude zone which experiences a cool climate produced remarkably as compared with the vast land areas of the Northern and Southern Guinea Savannas of the North.

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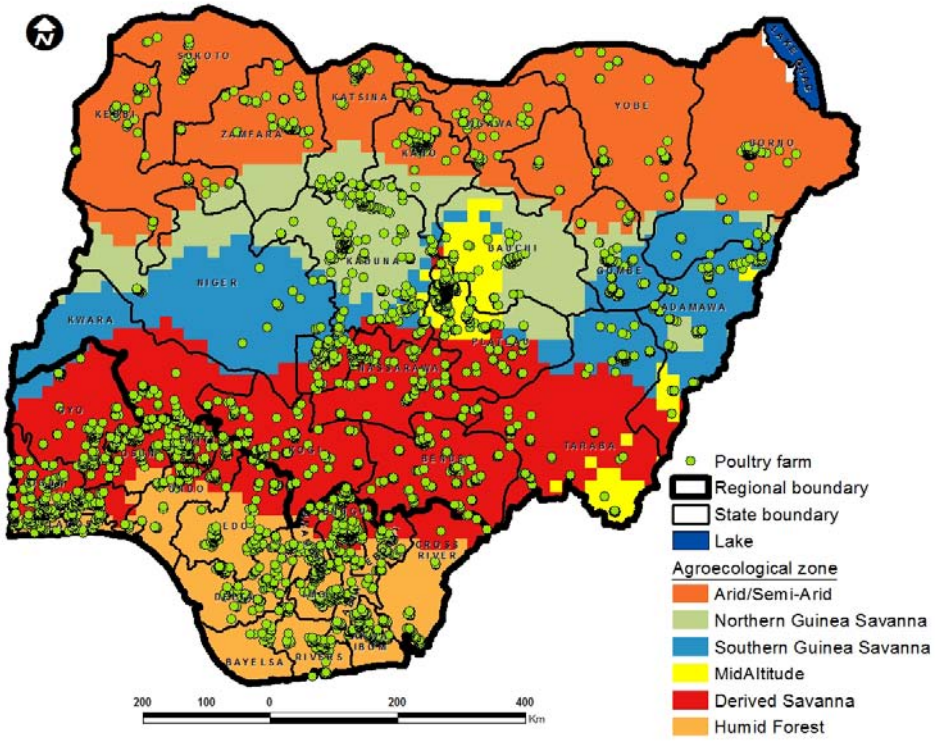

Figure 8 : Spatial distribution of poultry farms across agro-ecological zones

Table 5 : Agro-ecological distribution of poultry production

S/N	Agro-ecological zone	Land area (SqKm)	Total production (birds)
1	Arid/Semi-Arid	271974.1	1763008
2	Derived Savanna	249834.4	4797111
3	Humid Forest	109262.4	3524441
4	MidAltitude	31423.4	1223440
5	Northern Guinea Savanna	114203.6	783450
6	Southern Guinea Savanna	132782.7	291431

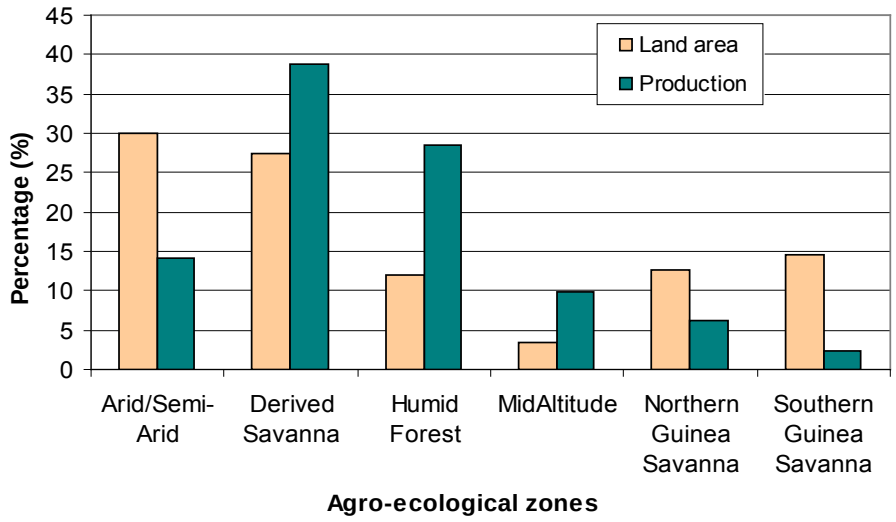

Figure 9 : Percentage production of poultry birds across agro-ecological zones

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g) Regional division of the derived savanna

For the purpose of comparing the production of the two major regions, the derived savanna was sub-divided using the regional boundary. Figure 10 shows the distribution of the farms across the savanna while Table 6 shows the proportions of farms and their production across the derived savanna (Northern and Southern Guinea Savanna). As displayed by Figure 11, their existed a higher production of birds in the Southern derived savanna than the Northern derived savanna. It was reconfirmed that the Southern tropical region of Nigeria had an intensified production of poultry. The Southern derived savanna is also believed to experience a lower heat stress as a result of its closeness to the humid agro-ecological zone. Omodele and Okere (2014) had revealed that the highest production of poultry was from the South-Western Nigeria where Ogun State took the lead.

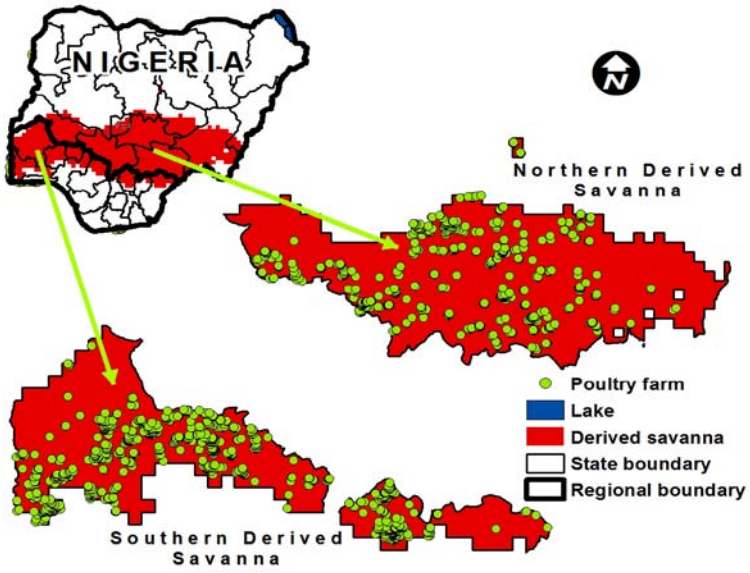

Figure 10 : Spatial distribution of farms across the Northern and Southern derived savanna

Table 6 : Derived savanna belt farms proportions and their production

S/N	Derived Savanna	No of farms	Production (birds)
1	North	938	1159640
2	South	1185	3636871

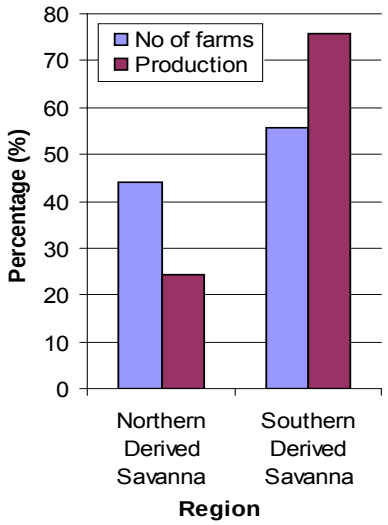

Figure 11 : Percentage production of poultry birds across the Northern and Southern derived savanna

h) Climatic precipitation

Poultry birds are much more likely to die from heat stress than cold stress. It has already been reported that food intake by laying birds declines exponentially as environmental temperature is increased. Consequently a reduction occurs in the number of eggs produced by laying hens. The revelation made by Omodele and Okere (2014) showed that most poultry farm operations in Nigeria are into Layers production. The major production of Layers is due to the derivation of meat and eggs. The most obvious constraint on poultry production in these regions is the climate. High temperature, especially when coupled with high humidity, imposes severe stress on birds and leads to reduced performance (Daghir, 2008). Using the rainfall pattern assessment as displayed in Figure 12, it was observed that the Southern region of Nigeria experiences a higher magnitude of annual rainfall while the Northern region experiences a warmer climate. In Nigeria, most production of poultry is done under open-sided housing system which relies mostly on natural ventilation. Heat stress had been observed as one of the major factors determining turn-over in the poultry industry. Expectedly, poultry farmers are encouraged into more production as production turnover are to be well favoured in the cooler Southern region of Nigeria. Most highly productive poultry are kept in temperate zones where the effect of cold stress is likely to be more

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important than the effect of high ambient temperatures. The hot regions of the world have probably the greatest potential for further growth since the level of consumption is still very low (Daghir, 2008).

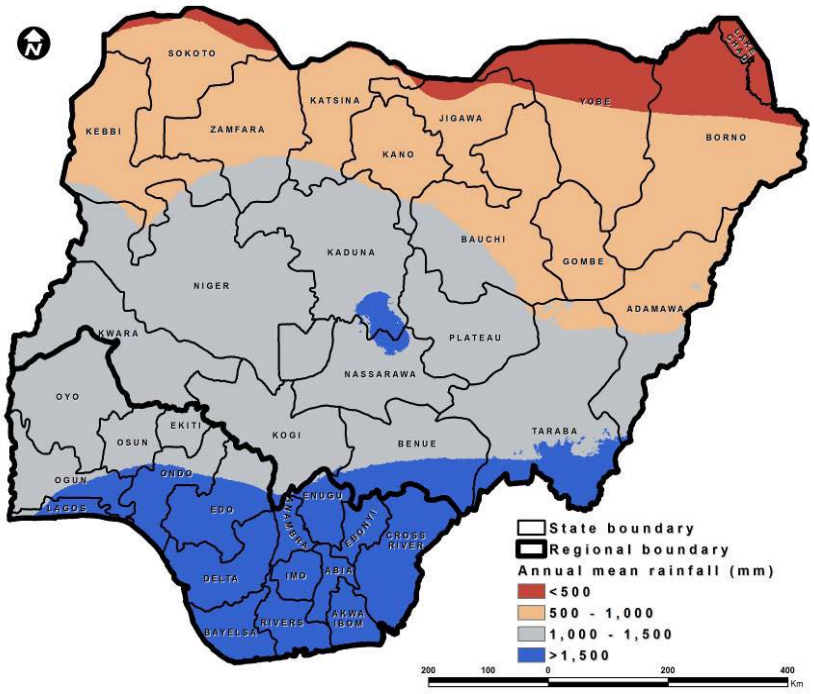

Figure 12 : Northern and Southern annual mean rainfall distribution

IV. Conclusion and Recommendation

In conclusion, this technical study revealed that landmass is not directly proportional to poultry production in Nigeria; it does not guarantee high production of animal especially in the poultry sector. A high number or proportion of poultry farms in an area does not also guarantee a high production in that locality. An appreciable number of Large-scale commercial farms in the Southern region were responsible for the higher production of poultry meat in the region while the higher human population in the Northern region did not guarantee a higher production of poultry products in the region. Poultry production is well favoured in the cooler Southern region of Nigeria due to its higher rainfall pattern as compared with the Northern region. Higher production is realized when heat stress is reduced in poultry birds and this encourages farmers into more production in the South. Provision of substantial funding for construction of modified microenvironment would control heat stress in poultry in the tropical regions especially in the northern part of Nigeria. The GIS approach to the study of poultry development has assisted in assessing the development of the sector in the Northern and Southern regions of Nigeria and has provided a database of the areas where developmental strategies are essential in poultry production in Nigeria. Therefore, GIS techniques could strengthen monitoring and assessment of poultry production from local to the regional level.

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