

COMPARATIVE ANALYSIS ON DEMOGRAPHIC MATHEMATICAL PROJECTION MODEL ON LIVESTOCK POPULATION IN NIGERIA

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Abstract - This Research is carried out to assess the livestock's population in Nigeria from 1961 to 2010. Data were collected on the livestock's population (Grazing livestock: cattle, sheep, goat and buffalo) from 1961 to 2010 in Nigeria. However, mathematical population projection models that is linear and logistics models are use to determine the rate of population growth..Each of the model are used to estimate the livestock's population and comparison was done between estimate from each model with actual livestock's population to find the model that produce the closest values(estimated values) to the actual livestock's population. The model that produces the closest estimated livestock's population is linear model and it is use to project the livestock's population in Nigeria from 2011 to 2030. Base on this livestock's population projection Government should come with a policy that will place a restriction on people from keeping animals in urban area to avoid competition of man and animal on limited land space.

INTRODUCTION

[Nigeria](#) is a country in [West Africa](#). Nigeria shares land [borders](#) with the Republic of [Benin](#) in the west, [Chad](#) and [Cameroon](#) in the east, and [Niger](#) in the north. Its coast lies on the [Gulf of Guinea](#) in the south and it borders [Lake Chad](#) to the northeast. Noted geographical features in Nigeria include the [Adamawa highlands](#), [Mambilla Plateau](#), [Jos Plateau](#), [Obudu Plateau](#), the [Niger River](#), [River Benue](#) and [Niger Delta](#).

Nigeria is found in the [Tropics](#), where the climate is seasonally damp and very humid. Nigeria is affected by four [climate types](#); these climate types are distinguishable, as one moves from the [southern part of Nigeria](#) to the [northern part of Nigeria](#) through Nigeria's [middle belt](#). Numerous ancient African civilizations settled in the region that is today Nigeria, such as the [Benin Empire](#), the [Kingdom of Nri](#) and the [Oyo Empire](#). Islam reached Nigeria through the [Hausa States](#) during the 11th century, while Christianity came to Nigeria in the 15th century through Augustinian and Capuchin monks from Portugal. The [Songhai Empire](#) also occupied part of the region. [Lagos](#) was captured by [British](#) forces in 1851 and formally annexed in 1861. Nigeria became a British protectorate in 1901. Colonization lasted until 1960, when an independence movement succeeded in gaining Nigeria its independence.

Nigeria first became a [republic](#) in 1963, but succumbed to military rule in 1966 after a bloody coup d'état. A separatist

movement later formed the Republic of Biafra in 1967, leading to the three-year [Nigerian Civil War](#). Nigeria became a [republic](#) once again after a new constitution was written in 1979. However, the republic was short-lived, when the military led by Major General [Muhammadu Buhari](#) seized power again four years later. Buhari was overthrown and a [new republic](#) was founded in August 1993, but was dissolved once again by General [Sani Abacha](#) in November that same year. Abacha died in 1998 and a [fourth republic](#) was later established the following year, ending three decades of intermittent military rule.

STATEMENT OF THE PROBLEM

Decades ago number of census of human population have been conducted for numerous purposes, significantly, to determine the size, growth and development that would allow government to come out with justifiable planning policy. Unfortunately, this is not the case in livestock. Official livestock data are indirectly derived from various administrative sources that are inaccurate, out of date and incomplete which yielded population estimate that considerably uncertainty. Therefore, the need for an impartial, objective and comprehensive assessment of Nigeria's livestock population is very crucial to be able to determine the rate of growth and to forecast for the future population

SIGNIFICANCE OF THE STUDY

This research work will help to obtain more reliable, up-to-date information about Nigeria livestock population in order to establish a sound foundation for livestock development planning and more effective targeting initiatives in the future

IMPORTANCE OF LIVESTOCKS

1. Livestock as a source of income
2. Livestock as a generator of employment
3. Livestock as a source of energy
4. Livestock as a source of fertilizer and soil conditioner
5. Livestock as weed control
6. Livestock for investment and savings

RESEARCH METHODOLOGY

DATA PRESENTATION

METHOD OF DATA ANALYSIS

The method of data analysis used in this work is mathematical projection models:

LINEAR/ARITHMETIC MODEL

This models based on the assumption that the absolute change in the population is the same every year and the number of individuals in the population change by a fixed rate per unit of time is independent of the population size. This model has advantages over others in a situation where a population is divided into a subpopulation and estimates are required for every subpopulation as well as for the entire population. It gives a quick but crude measure of population change.

The model is given as:

$$P_t = P_o(1 + rt)$$

Where $r = \frac{P_t - P_o}{P_o t}$

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

r = growth rate

LOGISTICS MODEL

Logistics model

$$P_t = \frac{a/b}{1 + \left(\frac{a/b}{P_o} - 1 \right) e^{-at}}$$

Where; $a/b = \frac{P_1(P_0P_1 - 2P_oP_1 + P_1P_2)}{P_1^2 - P_oP_e}$

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

a = growth rate

a/b = population capacity

$$e^{-a} = \frac{P_o(P_2 - P_1)}{P_2(P_1 - P_o)}$$

YEAR	LIVESTOCK POPULATION(Millions)
1961	7.7
1962	8.2
1963	8.9
1964	9.6
1965	10.3
1966	11.1
1967	12
1968	13
1969	14.2
1970	15.3
1971	16.5
1972	17.9
1973	19.4
1974	20.8
1975	22.3
1976	24.3
1977	26.0
1978	27.8
1979	29.7
1980	31.5
1981	33.0
1982	35.0
1983	36.8
1984	38.5
1985	40.2
1986	43.0
1987	44.9
YEAR	LIVESTOCK POPULATION
1988	46.9
1989	49.4
1990	49.7
1991	50.5
1992	51.6
1993	53.8
1994	57.4
1995	61
1996	64.6
1997	69.6
1998	74.1
1999	79.1
2000	83.6

2001	89.1
2002	90.9
2003	92.8
2004	95.2
2005	97.4
2006	99.6
2007	101.7
2008	104
2009	106.3
2010	108.6

$$t_o = 2000$$

$$t = t_t - t_o = 2010 - 2000 = 10$$

$$r = \frac{108.6 - 83.6}{83.6(10)} = 0.0299$$

$$P_t = 83.6 (1 + 0.0299 t) \quad \text{Model (Arithmetic)}$$

Comment: This implies that the predicted rate of Nigeria livestock population growth is approximately 2.99% with the linear/arithmetic growth model

LOGISTICS MODEL

Logistic model

$$P_t = \frac{a/b}{1 + \left(\frac{a/b}{P_o} - 1 \right) e^{-at}}$$

$$\text{Where; } a/b = \frac{P_1(P_o P_2 - 2P_o P_1 + P_1 P_2)}{P_1^2 - P_o P_2}$$

$$P_o = P_{2000} = 83.6$$

$$P_1 = P_{2001} = 89.1$$

$$P_2 = P_{2002} = 90.9$$

Grazing livestock include cattle, sheep, goats and buffalo

CONSTRUCTION OF PROJECTION MODEL

ARITHMETIC/LINEAR MODEL

$$P_t = P_o (1 + rt)$$

$$\text{Where } r = \frac{P_t - P_o}{P_o t}$$

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

$$P_o = P_{2000} = 83.6 \text{ (million)}$$

$$P_t = P_{2010} = 108.6 \text{ (million)}$$

	<u>YEAR</u>	<u>ACTUAL POPULATION</u>	<u>LIEAR MODEL</u>	<u>LOGISTICS MODEL</u>
$a/b = \frac{89.1[83.6(89.1) - 2(83.6 \times 89.1) + 89.1(90.9)]}{(89.1)^2 - 83.6(90.9)}$	1961	7.7	7.9	9.3
	1962	8.2	8.4	9.9
	1963	8.9	9.2	10.7
	1964	9.6	9.9	11.5
$a/b = \frac{89.1[7,448.76 - 14,897.52 + 8,099.19]}{7938.81 - 7599.24}$	1965	10.3	10.6	12.4
	1966	11.1	11.4	13.4
	1967	12	12.4	14.4
$a/b = \frac{57,953.313}{339.57} = 170.667$	1968	13	13.4	15.6
	1969	14.2	14.6	17.1
$e^{-a} = \frac{P_0(P_2 - P_1)}{P_2(P_1 - P_0)} = \frac{83.6(90.9 - 89.1)}{90.9(89.1 - 83.6)} = 0.300$	1970	15.3	15.8	18.4
	1971	16.5	16.9	19.9
	1972	17.9	18.4	21.5
	1973	19.4	19.9	23.3
	1974	20.8	21.4	25.0
$e^{-a} = 0.3$	1975	22.3	22.9	26.8
	1976	24.3	25.0	29.2
$a = -\ln(0.3) = 1.2039$	1977	26	26.7	31.3
	1978	27.8	28.6	33.5
$a =$ Growth rate	1979	29.7	30.6	35.7
	1980	31.5	32.4	37.9
	1981	33	33.9	39.7
$P_t = \frac{170.667}{1 + (1.0415)e^{-at}}$	1982	35	36.0	42.1
	1983	36.8	37.9	44.3
	1984	38.5	39.6	46.3
	1985	40.2	41.4	48.4
Comment: The predicted rate of Nigeria Livestock population growth is approximately 1.2039 (120.39%) with the logistics growth model	1986	43	44.3	51.8
	1987	44.9	46.2	54.1
	1988	46.9	48.3	56.5
	1989	49.4	50.9	59.5
	1990	49.7	51.1	59.8
LIVESTOCK POPULATION ESTIMATE (MILLIONS)	1991	50.5	52.0	60.8
	1992	51.6	53.1	62.1
	1993	53.8	55.4	64.8
	1994	57.4	59.1	69.1
	1995	61	62.8	73.4
	1996	64.6	66.5	77.8
	1997	69.6	71.6	83.8
	1998	74.1	76.3	89.2
	1999	79.1	81.5	95.2
	2000	83.6	83.6	83.6
	2001	89.1	86.1	130.0
	2002	90.9	88.6	156.0
	2003	92.8	91.1	165.0
	2004	95.2	93.6	169.2
	2005	97.4	96.1	170.2
	2006	99.6	98.6	170.5
	2007	101.7	101.1	170.63
	2008	104	103.6	170.65
	2009	106.3	106.1	170.6
	2010	108.6	108.6	170.7

4.5 COMPARISON OF MODELS

Comparing the population estimate of each model: linear and logistics, it is the linear model that its estimated value is very close to the actual value of the livestock's population. This is done by comparing the estimated population value of each model with the actual population values from the base year (2000) to the current year (2010)

SELECTION OF THE BEST MODEL

Since the LINEAR model is the one that provides the closest value to the actual value, therefore, it is considered as the best model as this research work is concerned. And it is appropriate for livestock's population projection

PROJECTED LIVESTOCK POPULATION (MILLIONS) USING LINEAR MODEL

The livestock's population projection from 2011 to 2060 is shown below

2011	111.1
2012	113.6
2013	116.1
2014	118.6
2015	121.1
2016	123.6
2017	126.1
2018	128.6
2019	131.1
2020	133.6
2021	136.1
2022	138.6
2023	141.1
2024	143.6
2025	146.1
2026	148.6
2027	151.1
2028	153.6
2029	156.1
2030	158.6

SUMMARY

The data were collected on the livestock's population in Nigeria from 1961 to 2010. Analysis was done on the data collected using mathematical population projection model. The estimated population of the livestock obtained from each model was compared with the actual livestock's population to detect which of this model is the best. Using

linear and logistics model, the livestock population growth rate is 0.0299 and 1.2039 respectively

CONCLUSION

Base on the analysis and comparison of the model estimate with actual livestock population. The model that its estimate is very close to the actual livestock's population is the linear model and is therefore considered as the best model to project the livestock population from 2011 to 2030.

RECOMMENDATION

With continued growth of the livestock's population, competition for limited land resources has steadily increased over the years and there has been a progressive expansion of settlement and agriculture. There is need for proper management of these livestock's since their significance on economy and importance to human cannot be over-emphasized.

Therefore, in lieu of this, we thereby recommend the following to the Government and other stakeholders

1. Government should come with a policy that will place a restriction on people from keeping animals in urban area to avoid competition of man and animal on limited land space
2. Establishment of veterinary hospitals where animals can receive proper caring
3. Training of more veterinary Doctors that will take of these animals health
4. Sowing of grass to feed grazing livestock to check the rate of nomadic farming system
5. Government should also take effective steps to control slaughtering in the country.

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