Comparative Analysis Of Linear/Arithmetic and Geometric Model on Livestock Population in Nigeria.

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Abstract— **This research is carried out to compare the linear/arithmetic and geometric model on 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 geometric models were applied to determine the rate of population growth and to construct the model. Each of the model were 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 considered to be the best model. The best model is linear and is therefore used to predict the livestock's population in Nigeria from 2011 to 2060. Base on this livestock's population forecast, recommendation was made to the government and other stakeholders that there is need for proper management of these livestocks since their significance on economy and importance to human cannot be over-emphasized.**

Index Terms—**Linear, Arithmetic, Geomertic Model, Pollution.**

I. INTRODUCTION BACKGROUND TO THE STUDY AREA

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.

II. 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

III. RESEARCH METHODOLOGY

LINEAR/ARITHMETIC MODEL

This model s 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:

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

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

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

r= growth rate

GEOMETRIC MODEL

This model is based on the assumption that the number of individual in the population changes during a unit of time by constant multiple of the population size at the beginning of the interval. It recognizes that the change in population size is dependent of that population.

Geometric model is given:

$$P_t = P_o (1+r)^t$$

$$r = \left[\left(\frac{P_t}{P_o} \right)^{1/t} - 1 \right]$$

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

r= growth rate

IV. DATA PRESENTATION AND DATA ANALYSIS

DATA PRESENTATION

Year	Livestock population (millions)	Year	Livestock population (millions)
1961	7.7	1988	46.9
1962	8.2	1989	49.4
1963	8.9	1990	49.7
1964	9.6	1991	50.5
1965	10.3	1992	51.6
1966	11.1	1993	53.8
1967	12	1994	57.4
1968	13	1995	61
1969	14.2	1996	64.6
1970	15.3	1997	69.6
1971	16.5	1998	74.1
1972	17.9	1999	79.1
1973	19.4	2000	83.6
1974	20.8	2001	89.1
1975	22.3	2002	90.9
1976	24.3	2003	92.8
1977	26	2004	95.2
1978	27.8	2005	97.4
1979	29.7	2006	99.6
1980	31.5	2007	101.7
1981	33	2008	104
1982	35	2009	106.3
1983	36.8	2010	108.6
1984	38.5		
1985	40.2		
1986	43		
1987	44.9		

Source;

YEAR	ACTUAL POPULATION	LIEAR MODEL	GEOMETRIC MODEL
1961	7.7	7.9	7.9
1962	8.2	8.4	8.4
1963	8.9	9.2	9.1
1964	9.6	9.9	9.8
1965	10.3	10.6	10.6
1966	11.1	11.4	11.4
1967	12	12.4	12.3
1968	13	13.4	13.3
1969	14.2	14.6	14.6
1970	15.3	15.8	15.7
1971	16.5	16.9	16.9
1972	17.9	18.4	18.4
1973	19.4	19.9	19.9
1974	20.8	21.4	21.3
1975	22.3	22.9	22.9
1976	24.3	25	24.9
1977	26	26.7	26.7
1978	27.8	28.6	28.5
1979	29.7	30.6	30.4
1980	31.5	32.4	32.3
1981	33	33.9	33.8
1982	35	36	35.9
1983	36.8	37.9	37.7
1984	38.5	39.6	39.5
1985	40.2	41.4	41.3
1986	43	44.3	44.1
1987	44.9	46.2	46
1988	46.9	48.3	48.1
1989	49.4	50.9	50.7
1990	49.7	51.1	51
1991	50.5	52	51.8
1992	51.6	53.1	52.9
1993	53.8	55.4	55.2
1994	57.4	59.1	58.9
1995	61	62.8	62.6
1996	64.6	66.5	66.3
1997	69.6	71.6	71.4
1998	74.1	76.3	76.1
1999	79.1	81.5	81.2
2000	83.6	83.6	83.6
2001	89.1	86.1	85.8
2002	90.9	88.6	88.1
2003	92.8	91.1	90.4
2004	95.2	93.6	92.8
2005	97.4	96.1	95.3
2006	99.6	98.6	97.8
2007	101.7	101.1	100.4
2008	104	103.6	103.1
2009	106.3	106.1	105.8
2010	108.6	108.6	108.6

CONSTRUCTION OF PROJECTION MODEL

ARITHMETIC/LINEAR MODEL

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

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

P_o = Population of base year

P_t = Population of current year

t = Difference between current and base year

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

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

$t_o = 2000$

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

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

$P_t = 83.6 (1 + 0.0299 t)$ Model (Arithmetic)

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

GEOMETRIC MODEL

Geometric model

$$P_t = P_o(1 + r)^t$$

$$r = \left[\left(\frac{P_t}{P_o} \right)^{1/t} - 1 \right]$$

$$r = \left[\left(\frac{108.6}{83.6} \right)^{1/10} - 1 \right]$$

$$r = (1.2990)^{0.1} - 1$$

$r = 1.0265 - 1$

$r = 0.0265$

$P_t = 83.6 (1 + 0.0265)^t$

$= 83.6 (1.0265)^t$ Geometric model

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

V. COMPARISON OF MODELS

Comparing the population estimate of each mode: linear, geometric, exponential 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)

VI. 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 project 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

Year	Population
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
2031	161.1
2032	163.6
2033	166.1
2034	168.6
2035	171.1
2036	173.6
2037	176.1
2038	178.6
2039	181.1
2040	183.6
2041	186.1
2042	188.6
2043	191.1
2044	193.6
2045	196.1
2046	198.6
2047	201.1
2048	203.6
2049	206.1
2050	208.6
2051	211.1
2052	213.6
2053	216.1
2054	218.6
2055	221.1
2056	223.6
2057	226.1
2058	228.6
2059	231.1
2060	233.6

VII. SUMMARY AND CONCLUSION

The data were collected on the livestocks 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 were compared with the actual livestock's population to detect which of these model is the best. Using linear model, the livestock population growth rate is 0.0299, and 0.0265 respectively.   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 predict for the livestock population from 2011 to 2060.

RECOMMENDATION

With continued growth of the livestocks 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 livestocks since their significance on economy and importance to human cannot   be over-emphasized.

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