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Original Research

Sustainable Food Production through Systematic Soil Analysis and Appropriate Fertilizer Recommendations in some Parts of Kebbi State, Nigeria

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ABSTRACT: A field study was conducted across some selected local government areas of Kebbi State to evaluate both some fertility and productivity indices in the study areas so as to come up with a better fertilizer and other agricultural practices that will ensure sustainable food production and reduces the cost of agricultural production through appropriate fertilizer recommendations. The finding of this work indicates that in most of the areas studied there were observed low basic plant's nutrients (NP and K) as well as moisture and higher temperature which are not favorable for the productions of some certain crops for example tomato, wheat and some other vegetables. In some cases, farmers within these farming communities were faced with a problem of a soil with low fertility status, which in their attempt to increase productivity of such soil over applied fertilizers, which contains mainly those basic plat's nutrients. In this paper we gave farmers appropriate fertilizer recommendations for some principal crops grown in the area.

Keywords: Fertilizer recommendation, sustainable agriculture, soil nutrients, soil analysis, soil temperature, soil moisture
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INTRODUCTION

Agriculture plays a crucial role in sustainable development and in hunger and poverty eradication. The challenges faced by agriculture in sustainable development is in working out ways of bringing about a society that is materially sufficient, socially equitable, and ecologically sustainable and one that is not obsessed by growth only, but motivated by satisfying human needs and equity in resource allocation and use. Sustainable agriculture must meet economic, social and ecological challenges. All these challenges are closely related. These features of sustainable agriculture should be considered as a package, and no single feature should predominate over the others. Sustainable agriculture needs to protect the natural resource base, prevent the degradation of soil and water; conserve biodiversity; contribute to the economic and social well-being of all; ensure a safe and high-quality supply of agricultural products; and safeguard the livelihood and well-being of agricultural workers and their families. The main tools towards sustainable agriculture are policy and agrarian reform, participation, income diversification, land conservation and improved management of inputs. The Nigerian government's policies have always emphasized food grain self-sufficiency, which has not necessarily coincided with agricultural sustainability. The growth of agricultural production and productivity, which had risen significantly during 1970s and 1980s, declined during 1990s. These slowdowns have worsened since 2000;

both overall agricultural production and food grains production have shown negative growth rates in 2000-01 to 2002-03 periods. Decline in the growth rates of agricultural production and productivity is a serious issue considering the questions of food security, livelihood, and environment. As such, a critical examination of the approaches for sustainable agricultural development is necessary.

The sustainable agriculture may be defined as any set of agronomic practices that are economically viable, environmentally safe, and socially acceptable (Thakur, 2021). If a cropping system requires large inputs of fertilizer that leak from the system to pollute ground water, drinking supplies and distant coastal fisheries, the system may be sustainable economically as the long-term supply of fertilizer is stable and the economic cost of fertilizer is easily borne by larger grain production but it is not sustainable environmentally or socially, since it does not cover the cost of environmental damage or social costs (Spoor, 2000). The organic agriculture focuses on "living soil", on optimizing the use of biological processes and on avoiding the use of synthetic chemicals and fertilizers (Adepetu, 1986).

Soil fertility is the capacity of a soil to provide adequate and balanced amounts of nutrients for the growth of plants (Sekhar, 2014). Other necessary factors must be favorable for adequate nutrients uptake. Some of these are soil moisture and temperature, aeration, water-holding capacity, a pH that should be near neutral, without hard pans that would inhibit root growth, and have adequate organic matter as well as conditions that promote the growth of soil microorganisms (Brady and Weil, 1999).

Soil analyses can provide information that is important for maximizing nutrient use efficiency and agricultural productivity. A historical record of soil properties provided by long-term soil testing is useful for determining the effectiveness of fertilizer management strategies in maintaining soil fertility and sustainable agricultural productivity.

Despite the relative importance of soil analysis in achieving sustainable agricultural production, only very few farmers in Kebbi State care to find the fertility status of their farms which led to blanket fertilizer application that did more harm to the soil and unnecessary increases production cost. The research seeks to bridge the gaps that exist of soil nutrient status and the appropriate fertilizer quantity to apply for sustainable agricultural production.

METHODOLOGY

Experimental sites

For the purpose of this research, the two agro-climatic zones that are in Kebbi State that is Sudan savanna and Northern guinea savanna serve as a sampling area, and within each sampling area some selected local government will be earmarked as a sub-sampling area. In the Sudan savanna, Kalgo, Bunza, Argungun and Birnin Kebbi were selected, while in the Northern guinea savanna, Yauri, Bagudo and Danko Wasagu Local Government areas were selected to serve as our sampling units.

Analysis of data

Data to be generated from the research were compared with the world standard for a proper fertilizer recommendations based on the principles of site specific nutrients management (SSNM).

RESULTS AND DISCUSSION

As can be seen in (Tables 2-7), in almost all the site sample the amount of NP and K are found to be very medium as compared to the expected values of those elements in a fertile soil in Nigeria (Table 9), this could be attributed to continuous cultivation of the land without adequate compensation of additional nutrient source (nutrient mining) which is very common within the area. Land fragmentation and unsupportive agricultural system by government in most cases contributed immensely to that which could have been averted through agricultural subsidy and opening of more arable lands to be allocated to farmers so as to boost their production capacity.

Both moisture and temperature of the studied area were found to be high as shown in (Tables 2-7), though moisture content was low compared to temperature, high temperature could be associated to many factors one of which is the current global warming due to certain poor environmental management and a farmer's attitude of removing all the crop remnants from the farm which expose the soil to direct sunlight. In the soil both high and low temperature and moisture have their detrimental effect especially on the decomposition of organic matter which are the carriers of most of the basic essential nutrient elements.

The major nutrients (NPK) in the study area were found to be within the minimum value as shown in the respective tables across the areas sampled and when compared with the values using fertility classes for Nigerian soils as shown in (Table 8). However, some little variations were observed within the soil sampled from Yauri and Zuru areas, this could be due to the differences in the climatological conditions within the State as those areas (Yauri and Zuru) falls under the Northern Guinea Savannah which is characteristically different from the other parts of the State that falls under the Sudan Savannah region.

Table 1: Some soil characteristics of Kalgo Local Government Area

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	0.1	0	1	7	8.8	17.1	10
30 – 60cm	0.4	5	13	6.6	9.5	20.4	81
60 – 90cm	0.8	12	28	7	10.1	28.1	168

Table 2: Some soil characteristics of Bunza Local Government Area

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	0.1	6	1	7.0	8.8	17.1	10
30 – 60cm	0.4	5	13	6.64	9.6	20.4	81
60 – 90cm	0.8	12	28	7.0		28.1	168

Table 3: Some soil characteristics of Argungu Local Government Area.

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	2	27	64	9	9.2	26.1 us/cm	350 us/cm
30 – 60cm	32	44	103	7	8.8	44.5	66.2
60 – 90cm	4.2	58	135	7	9.0	36.4	805

Table 4: Some soil characteristics of Birnin Kebbi Local Government Area.

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	6.4	5	13	6.31	14.2	30.4	82
30 – 60cm	0.8	11	26	6.82	18.5	28.8	157
60 – 90cm	0.4	6	15	6.8	11.8	89	38.9

Table 5: Some soil characteristics of Bagudo Local Government Area.

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	0.1	2	5	6.73	9.2	26	31
30 – 60cm	0.2	2	6	6.5	0.8	30.7	39
60 – 90cm	Effective Depth	Effective Depth	Effective Depth	Effective Depth	Effective Depth	Effective Depth	Effective Depth

Table 6: Some soil characteristics of Yauri Local Government Area.

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	0	0	1	7.71	9	16.6	11
30 – 60cm	1.3	4	9	7.21	9.4	20.9	54
60 – 90cm	3.2	4.3	101	7.02	8.1	46.3	611

Table 8: Some soil characteristics of Danko Wasagu Local Government Area.

Sampling Depth	N	P	K	PH	Temp	MC	EC
0 – 30cm	1.2	17	39	7.70	7.1	24.1	238
30 – 60cm	0.1	1	3	7.64	6.3	19.6	22
60 – 90cm	0.3	5	11	7.0	7.5	19.0	70

Table 8: Interpretation of soil test values using fertility classes for Nigerian soils.

Fertility Class	Expected relative yield Without fertilize (%)	Available (extractable) nutrients		
		% N	P (mg kg^{-1})	K (me/100g)
Low	50	<0.10	<10	<0.15
Medium	50-100	0.10-0.15	10-20	0.15-0.25
High	100	>0.15	>20	>0.25

Nevertheless, productivity of the soils within those selected sites can be improved to meet the required targeted yield results if fertilizer at a recommended rate could supply.

Table 9: Fertilizer recommendation for some selected major crops based on soil test results as shown in Tables 2-7 in Kebbi State Nigeria.

Crops	Nutrient	Fertility Class	Nutrient rates/ha
Maize	N	Medium	60 Kg N
	P	Medium	30 Kg P_2O_5
	K	Medium	30 Kg K_2O
Sorghum	N	Medium	32 Kg N
	P	Medium	16 Kg P_2O_5
	K	Medium	15 Kg K_2O
Millet	N	Medium	30 Kg N
	P	Medium	30 Kg P_2O_5
	K	Medium	15 Kg K_2O
Soybeans/Cowpea	N	Medium	10 Kg N
	P	Medium	20 Kg P_2O_5
	K	Medium	10 Kg K_2O

Table 9 provides a comprehensive fertilizer recommendation for the major crops based on the soil test results as shown in (Tables 2-7). However, areas with low content of this nutrient studied the rate can be increase if targeted yield need to be achieve which could be identify if appropriate soil test has been conducted.

Conclusion

Soils constitute a natural reservoir of nutrients, but they are mostly present in forms not immediately available to plants, e.g. absorbed into or as constituents of soil minerals particles, or in soil organic matter. This research identified the most vital (primary) nutrients in the soil that are in control of most agricultural productivity in some parts of Kebbi State to be medium in most of parts and we can rightly conclude that, therefore, application of fertilizer must be based on the results of soil analysis and a complimentary organic manure in addition to certain conservation practices such minimum tillage, protection of the soil against wind and water erosion etc.

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