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SHORT COMMUNICATION

INCIDENTAL LIMING: INDIGENOUS FARMERS' PRACTICES IN DANGE-SHUNI AREA OF SOKOTO STATE, NIGERIA

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Introduction

Agricultural activities in most part of Africa are still largely traditional. In most cases, some practices that have come to stay may have evolved from what could be described as mere coincidence and becomes indigenous knowledge which not only preserves the past, but can be vital to ensuring a sustainable future. Farmers in Dange-Shuni Local Government Area in Sokoto State, north-western Nigeria occasionally dig wells to obtain water for their household use and for irrigating their farmlands which are mostly uplands. In the process of digging these wells they often reach a layer of whitish material which has been confirmed to be calcium carbonate (Limestone) by visual examinations and later by laboratory analysis. Farmers in the area have observed overtime that where the heaps of these materials are deposited crops surrounding such heaps usual grow more luxuriantly and perform better. As a result of this many farmers in the area now apply this excavated material on the soils prior to planting. However, when asked as to why the application, the response was that the farmers apply the material because crops grow much better where it was applied.

Scientifically, limestone is known to be a key agronomic tool enabling farmers to balance soil pH variation and to produce high quality crops (Rell, 2009). From an agronomist's perspective, the reason for recommending limestone application is to change the soil pH to a level best suited to future cropping. Farmers apply agricultural lime on their fields to adjust the pH of the soil. Repeated cultivation and application of inorganic fertilizers lowers down the pH of the soil, thereby rendering the soil more acidic. When this condition happens many plant nutrients which are released through fertilizer application become fixed on the soil particles thus unavailable to the crops.

Liming in the case of Dange-Shuni may be described as the utilization of indigenous knowledge by the farmers. Indigenous knowledge is sometimes limited to the knowledge of indigenous peoples, and other times applied in a broader context, such as to farmers. Overall, indigenous knowledge can be understood as the local knowledge of a defined community that has developed over time and forms the basis for agriculture, food preparation, health care, education, conservation and a wide range of other activities that sustain a society and its environment (Sumner, 2006).

Limestone is available in large quantities in Dange-Shuni area being located in geologic material known as Dange Formation (Kogbe, 1976). This material, until recently, was only utilized by the cement company of northern Nigeria (CCNN) for cement manufacturing. With the identification of its potential as a liming material by the indigenous farmers its utilization in agriculture is likely to gain more prominence. This paper presents the results of analysis of the locally available natural limestone material used by farmers in Dange-Shuni local government area of Sokoto State and discusses the benefits of the practice.

Materials and Methods

The Study Area

Dange-Shuni Local Government area is located about 30km South-east of Sokoto, the state capital. The study area is located between latitude $12^o50'$ to 12^o $51'$N and Longitude $5^o20'$ to $5^o21'$E. Climatically, the area experiences a long dry (from October to May) and short rainy (from June to September) seasons. The dry season consists of a cold dry spell (Harmattan) roughly from November to January, followed by a hot dry spell from February to April (Singh and Babaji, 1989). Rainfall in the area is erratic in nature, small in quantity with an annual mean of 530 mm. The temperature during the year in Sokoto fluctuates roughly between 40^oC maximum and 15^oC minimum (Arnborg, 1988). The Dange Formation (of Paleocene age) is mainly known for its wealth of vertebrate remains including crocodiles. The Dange sediments contain gypsiferous shales and phosphate nodules (Kogbe 1972, 1976). The overlying Paleocene Kalambaina and Gamba Formations are dominated by limestones and laminated (‘paper’) shales. A horizon with phosphatic pellets within the Gamba Formation (Kogbe 1976) is probably equivalent to the phosphate-containing marine sequence in neighbouring Niger and Mali (Wright *et al.* 1985; Hanon, 1990). The soils are of different textures with sandy soil being more dominant (Agbu, 1982).

Soil Sample Collection and Analysis

Three (3) composite samples each of the untreated soils, soils treated with limestone and the limestone materials were collected from the study site for laboratory analyses. The untreated soil, treated soil and limestone material were air-dried and sieved using a 2mm sieve before analysis. Particle size analysis was performed using the Bouyoucos hydrometer method as described by Day (1956); the reaction (pH) was determined in 1:2 ratio of the suspension according to Peech’s method (Peech *et al.* 1962). Organic carbon was determined by Walkley-Black method (Walkley and Black, 1934); total nitrogen by macro-Kjeldahl method (Jackson, 1958). Cation exchange capacity (CEC) was determined in 1N NH_4OAc pH7.0 method (Peach *et al.,* 1947). Exchangeable bases (Ca and Mg) were determined by EDTA titration method (Mclean, 1965). Potassium (K) and sodium (Na) were determined by the use of Flame Photometer (Rich, 1965). Available Phosphorus was determined according to Bray 1 method (Bray and Kurtz, 1945).

Results and Discussion

The results of the analysis of some selected physical and chemical properties of the soils and the limestone material from Dange-Shuni area are presented in Table 1. The soils are generally sandy in texture with percentage sand content of 91.2%. The treated soils and the limestone had percentage sand of 60.8 and 59.8% respectively. The high amount of sand in the limestone material could be attributed to impurities associated with it. Even with the impuritiest the application of limestone has affected the texture of the soil by reducing the quantity of sand from 91.2% to 60.8% (Table 1).

Table 1: Some selected physical and chemical properties of the soil and limestone material from Dange-Shuni Area

Sample	pH 1:2 H_2O	Particle size Distribution %			Ava P mg/kg	Total N g/kg	Exchangeable Bases cmol kg^{-1}				CEC cmol kg^{-1}	Base Saturation %
		Sand	Silt	Clay			Ca	Mg	K	Na		
Normal Soil	6.5	91.2	3.90	4.9	4.73	0.32	0.70	0.70	3.2	1.7	7.2	87.5
Amended Soil	7.5	60.8	34.3	4.9	4.90	0.32	11.6	0.20	9.8	2.0	26.4	89.4
Limestone	8.1	59.8	29.4	10.8	4.85	0.07	29.3	1.50	2.2	2.0	37.8	92.6

The implication of this is the generally appreciable improvement in the water holding capacity of the soil. This could help greatly, given the erratic and scanty rainfall in the area. Similarly, the level of silt also increased in the soil from 4.9% to 34.3% after liming which could equally contribute in increasing the water holding capacity of the soils. The organic carbon content did also increase from 0.24% in the soil prior to liming to 0.76% after liming. Liming has been shown to increase the in situ mineralization of soil N over 3 years (Nyborg and Hoyt, 1978). Liming has also been shown to increase microbial activity and biomass Carbon (Edmeades *et al.*, 1981) and might promote N mineralization through increased microbial biomass C in reduced tillage systems. The nitrification process is usually restricted at low pH (Harmsen and van Schreven, 1955) and is promoted by liming (Nyborg and Hoyt, 1978; Haynes and Swift, 1988). Liming has been shown to reduce the total Carbon content after 2 years in direct drill systems whereas it had no significant effect under cultivation (Coventry *et al.* 1992). Total nitrogen was not affected by liming remaining the same (Table 1). The exchangeable bases were generally higher in the soil after limestone application except Magnesium which indicates that the lime material is not a dolomitic lime. The amount of Calcium in the soil increased from 0.70 $cmol_c$. kg^{-1} to 11.6 $cmol_c$. kg^{-1} after liming (Table 1). A similar trend was observed with respect to potassium and sodium which increased from 3.2 and 1.7 $cmol_c$. kg^{-1} prior to liming to 9.8 and 2.0 $cmol_c$. kg^{-1} respectively after liming (Table 1). The high amount of potassium in the soil could be due to repeated ash application by the farmers in the process of cultivating vegetables which is a common practice in the area.

The cation exchange capacity (CEC) of the soil increased from 7.2 $cmol_c$. kg^{-1} to 26.4 cmol kg^{-1} after liming. This is an appreciable positive CEC change which could substantially improve the productivity of the soil. The liming material had a CEC of 37.8 $cmol_c$. kg^{-1} (Table 1). This implies that it could improve the CEC of the soil upon application. The higher the CEC the more clay or organic matter present in the soil. This usually means that high CEC (clay) soils have a greater water holding capacity than low CEC (sandy) soils (Cornell University, 2007). The available phosphorus in the soil did not change considerably upon lime (from 4.73 mg kg^{-1} to 4.90 mg kg^{-1}) as expected since phosphorus is a major component of lime. The Percentage base saturation of the soil also increased from 87.5 to 89.4% after liming which could also help in justifying the favourable growth observed in crops growing where lime was heaped.

From the foregoing discussion it could be concluded that the concept of incidental liming which is purely an indigenous knowledge practiced more often by farmers of the Dange-Shuni area could greatly help in ensuring good soil management and resultant crop production in the area. The results of the laboratory analysis have shown the effects of liming in bringing about changes in the physical, chemical properties of the soils of the area. Farmers in the surrounding villages and beyond where soil conditions are similar could be encouraged to embrace this practice. Further research should also be conducted to determine the suitability of the liming material for use in the management of acidic soils and as a raw material in the manufacture of Calcium containing fertilizers such as calcium ammonium nitrate (CAN).

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