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Competencies Required by Farmers in Revamping Acidic and Alkaline-sodic Soil for Sustainable Crop Production in North-central States of Nigeria.

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Abstract

The study investigates competencies required by farmers in revamping acidic and alkaline sodic soil for sustainable crop production in North-Central States of Nigeria. The Study was carried out in Nasarawa, Kogi and Taraba States in Nigeria. The study adopted descriptive survey research design. Four research questions guided the study. The population of the study was 186 made up of 145 farmers drawn from the areas of study (farm land largely acidic, alkaline-sodic in nature) and 41 extension agents were all used as respondents for data collection, hence, there was no sampling. A 24 items questionnaire on acidic, alkaline-sodic soil tagged (AASSQ) was developed from literature and used for data collection. Cronbach Alpha reliability method was used to determine internal consistency of the instruments and a reliability coefficient of 0.75 was obtained. Finding from the study revealed that respondents rated 5 out of the 6 item skills as required on good qualities of liming materials used for correcting acidic soil in the area. All the 4 item skills on neutralizing materials for soil acidity were rated as required by farmers, all the 7 item skills on management procedures for acidic, alkaline- sodic soil were rated required and all the 7 item skills were rated required by farmers in order to confront the challenges associated with salt affected soil. It was recommended amongst others that extension agents should make available good quality liming materials that would improve soil structure and organize workshop where farmers could be trained on management procedure for acidic, alkaline- sodic soil.

Keywords: *Acidic soil; Alkaline –Sodic soil; farmers and crop production*

Introduction

Organic matter decomposition process is a natural microbial process, and the rate of decomposition depends on soil environmental conditions and the nature of the organic materials. Good soil aeration, a near neutral soil PH, promotes rapid decomposition of organic matter in the soil (Ekele, 2018). However, acidity occurs in soil when there is build -up of acid in the soil which is often indicated as the soil PH. Adepetu, Adetunji and Ige (2014) states that soil PH is the negative logarithm of hydrogen ion concentration in the soil solution. The higher the hydrogen concentration in the soil, the more acid the soil. Soils developed from acidic parents materials such as granites and sandstones are more acid in nature than soil developed from basic rocks like limestones and Shales. Soil acidity reduces crop production options since only acid tolerant crops can grow well under acidic conditions. Unfortunately, few acid tolerant crops are grown in the study area.

In Nasarawa, Kogi and Taraba States where sometimes rainfall is heavy, water leaches through the soil and carries the basic cations such as calcium ion and potassium ion which are replaced by acidic cations like hydrogen ion and Aluminium ion. Adepetu., *et al*. (2014) maintained that soil acidity is often treated by the addition of acid neutralizing materials. Alkaline soil on the other hand, is quite different from acidic soil in their characteristics. As explained by Adekayode (2014), soil alkalinity is expressed by a PH higher than 7.0. Soil alkalinity results from the presence of sodium carbonate minerals or the presence of soil minerals that produce sodium carbonates upon weathering. Although, sodium carbonate is soluble and could readily be washed off the soil, Adekoyade and Akomalafe (2011) reported that the low rate of precipitation in the semi -arid and arid region results in the accumulation of this mineral in the soil.

High potential rate of evapotranspiration as obtained in some parts of Taraba and Nasarawa states also increases the salt concentration. Consequently, dissolved salt solution gets to the surface either by seepage or capillary flow, upon evaporation; it leaves a deposit of salt at or near the soil surface. Alkaline soils generally have poor soil structure and low infiltration capacity and are not suitable for crop production. Alkalinity problems are more common in clay soils than in loamy, silty or sandy soils. Anderson (1995) noted that Montimorrillonitic or smectitic clay soils (swelling clays) are more subject to alkalinity problems than Illitic or kaolinitic clay soils because the former clay types have larger specific surface areas than the latter. Sodic soils are not better than alkaline soils.

In the submission of Das (2012) and Adepetu (2000), a soil is regarded as sodic when percentage of exchange sites occupied by Sodium exceeds 15%. Hydrolysis of sodium ion produces a PH greater than 8.5. Thus, sodic soils are relatively lower in soluble salt concentration than saline soils. As a result of the high PH associated with soil sodicity, calcium precipitates as $CaC0_3$ (in the presence of $C0_2$) while magnesium and potassium form secondary minerals, leaving sodium as the dominant ion in the soil solution and thus dominating the soil exchange sites. In sodic soils, the scenario is that high sodium concentration on the cation exchange sites disperses the soil aggregates causing the destruction of soil structure (Brady and Weil, 2014). The soil pores are clogged resulting in poor aeration and preventing water infiltration. Hard crust are formed which greatly impede seed emergence. Sodic soils are sometimes referred to as black alkali soils because of the dispersion and dissolution of humic substances which result in black colored soils the farmers cannot use.

Acidic soils or alkaline sodic soils are not what farmers need for sustainable arable crop production in the study area. The presence of this type of soils adversely affects most crops except for few salt tolerant crops. Organic matter plays a vital role in soil productivity. Although, the percentage of soil organic matter is relatively low compared to other soil components (mineral matter, water and air), organic matter exerts a dominant influence on many soil chemical, physical and biological characteristics and is fundamental to health, fertility and productivity of any soil (Ekele, Okeme and Agbo, 2016). Soil organic matter together with soil clay, account for most of the cation exchange capacity (CEC) of soil. Ige, Adepetu and Obi (2005) averred that cation exchange capacity is the ability of soil to adsorb cations on to soil surfaces due to the presence of negative charges on soil sufaces. Nelson and Oades (1998) further explained that the presence of negative charges results in the retention of cations on the soil surface through electrostatic forces of attraction. Cations adsorbed on the exchange sites are readily available for plant uptake while the bond between the cations and the exchange sites is strong enough to resist loss through leaching. In an acidic, alkaline sodic soil where organic matter is low the CEC as described above, may be relatively slow.

Preliminary investigation conducted by the researcher revealed that farmers in the affected parts of the states in the study area are simply ignorant on the type of soil on which they carry out their crop production activities. Observations by the researcher further revealed that the farmers could not explain the continuous decline in their output of crop production. This may be as a result of the nature and type of soil (acidic, alkaline sodic soil) on which farmers carry out their crop production activities. Acidic, alkaline-sodic soil are prevalent or common in the study area, hence, the researcher felt there is need for farmers to have competencies (knowledge and skills) in revamping these type of soils for improved crop production in the study area (Nasarawa,Taraba and Kogi states). Specifically, the study sought to determine:

1. Skills required by farmers in identifying good qualities of liming materials used for correcting acidic soils in the study area.
2. Skills required by farmers in identifying neutralizing materials for soil acidity.
3. Skills required by farmers in the management of acidic alkaline –sodic soil.
4. Skills required by farmers in handling the challenges associated with salt affected soil.

Methods

Four research questions guided the study. Descriptive survey research design was adopted for the study because it is a tool for assessing opinions from representative group of population being investigated. The study was carried out in southern part of Nasarawa, Western part of Kogi and southern part of Taraba States in Nigeria. The population of the study was 186 made up 53 farmers from Nasarawa State, 45 farmers from Kogi State and 47 farmers from Taraba State. 9 extension agents from kogi, 21 from Nasarawa, and 11 from Taraba State (Source: Ministry of Agriculture from various states) were all used as respondents. There was no sampling as the whole population was used for the study. A 24 items questionnaire on acidic, alkaline- sodic soil (AASSQ) was developed and used for data collection. The instrument has a 4-point response options of Highly Required, Required, Slightly Required and Not Required with a corresponding value of 4, 3, 2, and 1. The instrument was subjected to face validation by three experts, one from the Department of soil science and two from the Department of Agricultural Education, all from the University of Agriculture, Makurdi. The corrections of the Validates were used to produce the final version of the questionnaire. Cronbach Alpha reliability method was used to determine internal consistency of the items and a coefficient of 0.75 was obtained. Three research assistants who are familiar with Nasarawa, Kogi and Taraba States were involved and were taught/and given orientation on how to administer and collect the questionnaire from respondents. One hundred and eighty six copies of the questionnaire were administered to respondents and all the 186 were retrieved and analyzed using mean and standard deviation. Real limit of numbers were used in which any item with a mean value of 2.50 to 4.49 was regarded as required while any item with mean value of 0.5 to 2.49 was regarded as not required.

Results

Research Question 1

What are the skills required by farmers in identifying good qualities of liming materials used for correcting acidic soil?

S/N	Item statement	X_1	SD_1	X_2	SD_2	XG	Remarks
1	Ability to identify material that will not hinder the growth of crops and has a mild and neutralizing ability on soil.	3.79	0.42	4.00	0.00	3.90	Required
2	Ability to recognize liming material that result in a desirable properties of adsorbed cations on the exchange sites	2.37	0.36	2.03	0.36	2.20	NR
3	Capacity to identify liming material that possesses favorable effect on soil structure.	3.71	0.46	3.80	0.40	3.76	Required
4	Knowledge of the specific liming materials that impart positively the desired soil pH change in the study area.	3.54	0.51	3.77	0.42	3.66	Required
5	Capacity to identify the liming material that possesses soil buffer capacity before application.	3.71	0.46	3.79	0.41	3.75	Required
6	Ability to identify finess and reactivity of liming material.	2.00	0.50	2.02	0.40	2.1	NR

X_1= Mean of farmers, SD_1 = Standard Deviation of farmers X_2 = Mean of Extension Agents, SD_2 = Standard Deviation of Extension Agents, XG = Grand mean of the respondent. NR=Not Required.

Table 1: *Mean and Standard Deviation of the responses of farmers and extension agents on good qualities of liming materials used for correcting acidic soil. (N1 = 145, N2 = 41).*

Analysis of Table 1 revealed that the mean of respondents ranged from 3.43 to 4.00 which are above the cut-off point of 2.50. This showed that the respondents rated 4 skill items on desirable qualities of liming materials required. However, item 2 and 6 had grand mean of 2.20 and 2.1 which revealed that the respondents rated the skill items not required (NR). The standard deviation ranges from 0.00 to 0.51 indicating that the respondents are not too far from one another in their response and from their mean.

Research Question 2. What are the skills required by farmers in identifying neutralizing materials for acidic soil?

S/N	Item statement	X_1	SD_1	X_2	SD_2	XG	Remarks
1	Ability to identify and use chalk-like substances (carbonates)	3.68	0.48	3.80	0.41	3.74	Required
2	Knowledge of and capacity to apply silicates	3.64	0.49	3.79	0.40	3.72	Required
3	Ability to apply oxides and hydroxides of calcium and magnesium prepared or purchased.	3.67	0.43	3.80	0.42	3.74	Required
4	Ability of farmers to identify and use local wood ash as neutralizing materials.	3.86	0.34	3 56	0.50	3.71	Required

X_1 = Mean of farmers, SD_1 = Standard Deviation of farmers, X_2 = Mean of Extension Agents, SD_2 = Standard Deviation of Extension Agents, Xg = Grand mean of the respondents.

***Table 2:** Mean and Standard Deviation of the responses of farmers and extension agents on skills required by farmers for identifying neutralizing material for acidic soil. (N1=145, N2=41).*

Analysis of Data in Table 2 showed that the mean of respondents ranged from 3.56 to 3.80 which are above the bench mark score of 2.50, hence, the respondents required all the four items (skills) for identifying neutralizing materials for soil acidity in the area of study. Furthermore, the standard deviation of the respondents ranged from 0.34 to 0.50, an indication that the respondents are not too far from one another in their mean and responses

Research Question 3: What are the skills required by farmers in the management of acidic alkaline-sodic soils?

S/N	Item statement	X_1	SD_1	X_2	SD_2	XG	Remarks
1	Ability to carry out procedure to leach out soluble salt from soil.	3.61	0.50	3.92	0.72	3.77	Required
2	Capacity to flood the soil until surface ponding occurs.	3.75	0.44	3.65	0.82	3.70	Required
3	Ability to treat water with low sodium to avoid accumulation of same.	3.79	0.41	3.12	0.33	3.45	equired
4	Capacity to apply mulch which promotes the downward movement of water.	3.64	0.49	3.64	0.48	3.64	Required
5	Ability to apply organic matter to improve the soil structure.	3.54	0.51	3.84	0.37	3.69	Required
6	Capacity to treat sodic soil with gypsum and locally improvised gypsum.	3.61	0.50	3.69	0.61	3.65	Required
7	Ability to use saline water containing calcium and magnesium which are low in sodium before applying to soil to leach excess salt.	3.60	0.49	3.72	0.56	3.67	Required

X_1 = Mean of farmers, SD_1 = Standard Deviation of farmers, X_2 = Mean of Extension Agents, SD_2 = Standard Deviation of Extension Agents, Xg = Grand mean of the respondents.

***Table 3:** Mean and Standard Deviation of the responses of extension agents and farmers on management of acidic, alkaline- sodic soils. (N1=145, N2=41).*

Data analysis in Table 3 above revealed that respondents required all the 7 skill items on management procedures for acidic, alkaline-sodic soils. This is evident in the mean scores of respondents which ranges from 3.12 to 3.84 and are above the cut- off point of 2.50. The standard deviation ranges from 0.41 to 0.82. This further indicates that the respondents are not too far from the mean and from one another in their responses

Research Question 4. What are the skills required by farmers in handling the challenges associated with salt affected soil?

S/N	Item statement	X_1	SD_1	X_2	SD_2	XG	Remarks
1	Ability of farmers to understand the crops that do not take up water into cell due to high salt concentration.	3.82	0.37	3.78	0.51	3.69	Required
2	Capacity to reduce salt in the soil before it accumulates.	3.64	0.49	3.77	0.42	3.71	Required
3	Ability to know that High sodium (Na) salt leads to high soil pH	3.75	0.44	3.80	0.40	3.78	Required
4	Capacity to neutralize high salt concentration in the soil that leads to foliar scorch on crops.	3.82	0.39	3.73	0.35	3.78	Required
5	Ability to provide antidote to alkalinity which impairs plant growth and obstructs root development.	3.25	0.44	3.84	0.37	3.55	Required
6	Ability to replace high percentage of sodium in sodic soils with macro nutrients suitable for the crops on the farm.	3.43	0.50	3.79	0.41	3.61	Required
7	Capacity to prevent water logging associated with sodic soil.	3.82	0.39	3.80	0.40	3.81	Required

X_1 = Mean of farmers, SD_1 = Standard Deviation of farmers, X_2 = Mean of Extension Agents, SD_2 = Standard Deviation of Extension Agents, X_g = Grand mean of the respondent.

Table 4: *Mean and Standard Deviation of the responses of farmers and extension agents on problems associated with salt affected soils. (N1=145, N2=41).*

Data analysis in Table 4 showed that the grand mean of respondents ranged from 3.61 to 3.81 which are above the cut off point of 2.50. This indicates that the respondents rated the skill items required on all the seven skills required by farmers in handling problems associated with salt affected soil. The standard deviation ranges from 0.37 to 0.51 which is a pointer to the fact that the respondents are not too far from the mean in their responses and from one another.

Discussion of findings

The findings from Table 1 that respondents rated 4 out of the 6 items on skills required in identifying good qualities of liming materials used for correcting acidic soil was in agreement with the findings of Adepetu, Adetunji and Ige (2014) which asserts that liming material possessed desirable properties of adsorbed cation on the exchange site and good buffer capacity. Findings from Table 1 was also in consonance with the study by Chenu, Bissonnais and Arrouys (2000) which reaffirmed the desirable qualities of liming materials to include suitable change of soil structure and positive effect on soil PH. Findings from Table 2 revealed that respondents rated required the use of carbonates, silicates, oxides and hydroxides of calcium and magnesium, wood ash as neutralizing materials for soil acidity. These findings was supported by the work of Adekoyode (2014) who confirmed the use of wood ash and carbonates as liming agents and capable of neutralizing soil acidity. Finding from Table 3 that respondents rated all the skill items required by farmers in the management procedure for acidic alkaline-sodic soils was in line with study by Nwabuisi and Ekele (2002).

They re-echoed the fact application of mulching and organic matter improve soil structure and promote downward movement of water within the reach of plant root (rhizosphere). Table 3 findings was also in agreement with the findings of Adekoyode and Akomolafe (2011) which confirmed that sodic soil can be treated with gypsum and that soluble salt from the soil could be leached out. The findings in Table 3 was also in line with study by Idowu and Aduayi (2006), Ekele and lan (2012). They assert that treatment water must be low in sodium to avoid accumulation of sodium in the soil. Finding from Table 4 that respondents rated all the item skills required in handling the challenges associated with salt affected soil was in agreement with findings by Ekele (2018) who found out that chemical inhibition, aeration (poor water infiltration associated with sodic soil are some of the factors that affects mineralization of nitrogen. Table 4 finding confirmed the finding of Idowu and Aduayi (2006).They found out that high sodium salt leads to high PH and that alkalinity impairs plant growth and obstruct root development.

Conclusion

The study had established that skills are required in identifying good qualities of liming materials, neutralizing materials that could be used for acidic soils, skills in the management procedures for acidic, alkaline-sodic soil and skills in handling challenges associated with salt affected soil. It should be noted that environmentally, alkalinity indirectly results in poor water quality and poor water infiltration associated with sodic soil. Also, high PH and high salt concentration can enhance the dissolution of some trace elements with their potential adverse effects on crops.

Recommendations

Based on the findings from the study, the following recommendations were made.

1. Extension agents should assist farmers by making available good quality liming materials that would improve soil structure and have ability to act as buffer for soil.
2. Ministry of agriculture in collaboration with extension agents should provide neutralizing materials (carbonates, wood ash and silicates to enable farmers' re-awaken acidic soil for proper use.
3. Extension agents should organize workshop where farmers could be trained on management procedures for acidic, alkaline sodic soils.
4. Ministry of agriculture in the various states should organize seminars and symposium for farmers wherein farmers could be sensitized on the problems associated with salt affected soil with a view to mitigating or ameliorating these challenges.

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