Mechanism for Exploring Nitrification Process by Agricultural Education Graduates for Sustainable Soil Utilization in North-Central Nigeria

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Abstract -*The study identifies mechanism for exploring nitrification process by agricultural education graduates for sustainable soil utilization in North Central Nigeria. Survey research design was used for the study. Four research questions guided the study, two null hypotheses were posited and tested at .05 level of probability. A 29 item questionnaire titled 'Mechanism for exploring nitrification process questionnaire' (MENPQ) was developed from literature and used for data collection. The instrument was face validated by 3 experts in the Department of Agricultural education and soil science in the University of Agriculture Makurdi. A reliability coefficient of 0.79 was obtained using Cronbach Alpha method. Weighted Mean and Standard deviation were used to answer the research questions. The result of data analysis revealed that respondents agreed on all the 7 items involved in the transformation of Nitrogen, 10 items on factors affecting mineralization of Nitrogen, 6 items on ways of Nitrogen gain and 6 items on loss of nitrogen from the soil. It was recommended amongst others that training and workshop should be organized by lecturers of Agricultural education and extension agents for students on methods in which Nitrogen is gained and lost from the soil.*

Keywords: Nitrification, soil utilization, Graduates and Agricultural education.

INTRODUCTION

Soil is usually seen in relation to growth, nutrition and yield of crops. The general understanding about soil which most people have come to accept is that it is a loose surface of the earth or a natural body on the surface of earth in which plants find nourishment. Das [1] explained soil as an accumulation of natural bodies which has been synthesized from diversified mixture of disintegrated weathered minerals and decaying organic matter. The author further asserts that soil contains mineral matter, organic matter, water and air and that its utilization depends on adequacy of its constituents. Karlan, Mausbech, Doran, Harris and Schuman [2] viewed soil utilization based on three major components-sustained biological productivity, environmental quality and plant and animal health. The concept attempts to balance multiple soil uses for agricultural production, remedial wastes, urban development with goals for soil and environmental quality.

Soil utilization by crops depends on the amount of organic matter present in the soil. Ekele [3] explained that organic matter is made up of decomposing plant and animal residues. Soil organic matter contains living and dead microbial cells, microbially synthesized compounds and a number of derivatives produced as a result of microbial activity. Das, [1]. The author reported that organic matter contributes to the fertility or productivity of the soil through its positive effects on the chemical, physical and biological properties of the soil. The role performed by organic matter ranges from sources of plant nutrients which are liberated in available forms during mineralization. Hence, soil utilization by crops anchors on availability of organic matter in adequate amount (WHO,[4]).The Nitrogen produced by organic matter is transformed via mineralization for use by crops.

In the view of Ekele[3] transformation of nitrogen in soil undergoes several pathways such as mineralization and fixation. Mineralization of nitrogen according to Cabrera and Gordillo [5] is the process by which nitrogen in organic compounds becomes converted into the inorganic ammonium and nitrate ions.Brady[6] reiterates that this process is accomplished through a three step-by- step reactions namely aminization, ammonification and nitrification.

Nitrification in the submission of Nwabuisi andEkele[7] is the process by which the microbial oxidation of ammoniacal nitrogen to nitrate form of nitrogen takes place. In this process, ammonium is first converted to nitrite and then to nitrate which sustains the crop in the presence of other nutrients. Food and agricultural Organization [8] reported that sustainable agriculture stems from proper utilization of soil without harming the environment. Sustainable utilization of soil in this study means to avoid damage to plants and understand the pattern nitrogen in nitrate form is made available to plant for proper growth so as to promote good quality food, Sustainability in this context also connotes the capacity to maintain some entity, outcomeor process overtime, hence, it refers to the ability of the soil to furnish crops with adequate nitrate at the right time and the right proportion depending on the type of crop planted and the amount required by such crop. The realization of this fact by graduates of agricultural education is important for appropriate utilization of soil.

Agricultural education programme is offered in colleges of education and some universities in North Central States of Nigeria. In colleges of education, the programme is of three years duration that leads to the award of National Certificate in Education (NCE) and at the university level, the programme runs for four years duration resulting to the award of Bachelor degree in Agricultural education. Ekele[3] asserts that graduates of this programme are looked upon as employers of labour rather than job seekers. In order to fulfill this expectation, they need to understand nitrification process (in crop production enterprise) which would enhance sustainable soil utilization. Nitrogen is one of the most important primary nutrient non-metal elements which is required in large quantity for plant growth and nutrition. Nitrogen occurs in soils mainly in the form of nitrate ammonium ions, and it occurs primarily in organic combination in the soil. Nitrogen in its elemental form is useless to plants. Nwabuisi and Ekele[7] asserts that various processes like fixation of nitrogen by rhizobia, azospirillum and other soil micro-organism, fixation as ammonia, nitrate by various industrial processes (synthetic nitrogenous fertilizer are responsible for the conversion of nitrogen into nitrate which is readily available in the soil for plants.

Mineralization process makes nitrate available in the soil. Okunola[9] maintained that several factors such as soil moisture, temperature and soil reaction affects the rate of nitrate availability. Nitrification process takes place through various ways. Biological nitrogen fixation could be symbiotic or non- symbiotic, addition through precipitation and addition through manures, fertilizers, compost including green manures. The capability of biological fixation of atmospheric nitrogen is restricted to organisms with prokaryotic cells structure and cyanobacteria. As explained byDas[1] the losses of nitrogen from soil occur through various mechanisms such as leaching, run –off, gaseous losses (ammonia, volatilization and denitrification. Such rapid losses of nitrogen through the aforementioned process can to some extent be minimized through efficient management of nitrogenous fertilizers like use of slow release nitrogen-fertilizers, combined application of inorganic and organic sources of nitrogen in different ratios. Depending on the plant species, development stage, and organ, the nitrogen content required for optimum growth varies from 2 to 5% of the plant dry weight. Phiha and Giler[10]posits that when nitrogen supply is sub-optimal, growth is retarded, nitrogen is mobilized in mature leaves and re-translocatedto regions of new growth. An increase in the nitrogen supply not only prevents yellowing of leaves, but stimulates growth and changes morphology of plant during the early growth. Nitrogen modifies plant composition to a greater extent than any other mineral nutrient.

The researcher observed through preliminary investigation and interaction in the study area that agricultural education graduates of tertiary institutions who are supposed to be equipped with knowledge and skill on soil utilization best practices are ill-equipped. The graduates, it was observed did not know when leguminous or cereal crops should be planted on a particular type of soil. This could be due to insufficient knowledge in soil nutrient composition and utilization. Further inquiry from the graduates as to the reasons for their inability to identify crops that fix nitrogen in their root nodules, graduates did not clearly blame their lecturers for lack of knowledge in the nitrification process. It therefore becomes necessary for the researcher to investigate mechanism for exploring nitrification process by agricultural education graduates for sustainable soil utilization in North – Central States of Nigeria.

OBJECTIVES OF THE STUDY

The study identifies the steps involved in the transformation of nitrogen in the soil; the factors affecting mineralization of nitrogen; the ways of nitrogen gains in the soil; and the methods of losses of nitrogen from the soil.

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Hypotheses. Two null hypotheses were raised and tested at .05 level of probability.

HO$_1$: There is no significance difference in the mean rating of the responses of agricultural education lecturers and extension agents in the ways in which soil gain nitrogen.

HO$_2$: There is no significant difference in the mean ratings of the responses of extension agents and lecturers in the methods in which nitrogen is lost from the soil.

METHODS

Four research questions and two hypotheses guided the study. Sample and descriptive survey research design was adopted for the study. The design involves the systematic collection and presentation of data from a sample of a population in order to obtain solutions to problems in research using questionnaire in collecting, analyzing and interpreting the data. The design was suitable for the study because a set of questionnaire was used to collect data from lecturers of agricultural education and extension agents. The study was carried out in Benue, Nasarawa and Kogi States of Nigeria. The population of the study was 105 agricultural education lecturers in the tertiary institutions in the three states (Field survey, 2017) and 95 extension agents Benue-45; Nasarawa- 33; and Kogi-27(State Ministries of Agriculture, 2017). There was no sampling. All the 105 agricultural education lecturers and all the 95 extension agents were used for the study. The instrument for the study was a 29-item questionnaire developed from literature reviewed. It was titled '*Mechanism for exploring nitrification process questionnaire MENPQ'* and used for data collection. The questionnaire had four points response options of strongly agree, agree, disagree and strongly disagree with a corresponding nominal values of 4,3,2 and 1 respectively. Also, real limits of numbers were used to interpret the result of the data gathered (for example,0.49-1.49,1.50-2.49,2.50-3.49,3.50-4.49.)

Three experts validated the instrument. Two from the department of agricultural education and one from the Department of soil science, federal university of agriculture, Makurdi. Their corrections and suggestions were used to improve the questionnaire. Cronbach Alpha reliability method was used to determine the internal consistency of the questionnaire items. A reliability coefficient of 0.79 was obtained. The researcher engaged three research assistants (one from each state) in the administration of MENPQ on the respondents. A total of 200 copies of the questionnaire were distributed to the respondents. One hundred and ninety seven (197) copies of questionnaire were retrieved and analyzed using statistical package for social science (SPSS). Weighted mean and standard deviation were used to answer the research questions while t-test was used to test the hypotheses at.05 level of probability. The benchmark of 2.50 was established to accept any item with a mean rating of 2.50 and above was regarded as disagreed. The decision rule for rejection or otherwise of hypothesis was based on p-value and alpha value. A hypothesis of no significant difference will not be rejected for any cluster of item whose p-value is equal or greater than alpha value of .05 while it will be rejected for any cluster of item whose p-value is less than alpha value of .05.

RESULTS

Data in Table 1 revealed that all the 7 items had their grand mean values ranged from 2.99 to 3.41. This shows that the respondents agreed on all the items on mineralization of nitrogen.

Table1. Mean rating and standard deviation of the responses of extension agents and lecturers on steps in the transformation of nitrogen in the soil (N=197).

Items (mineralization of nitrogen)		X_1	SD_1	X_2	SD_2	X_g	Remark
1.	Aminization takes place through the activities of heterotrophic soil micro-organisms to release amines and amino acids.	2.74	.76	3.23	.71	2.99	Agreed
2.	Ammonification process reduces amines to ammoniacal compounds.	2.92	.80	3.40	.82	3.16	Agreed
3.	First step of nitrification is conversion of ammonium to nitrite.	3.46	1.02	2.80	1.16	3.13	Agreed
4.	Second step of nitrification is the conversion of nitrite to nitrate.	2.88	1.22	3.94	.56	3.41	Agreed
5.	Nitrosomonas bacteria are involved in the conversion of ammonium to nitrite.	3.05	.93	3.00	1.06	3.02	Agreed
6.	Nitrobacter also known as nitrobacteria converts nitrite to nitrate.	2.70	1.04	3.82	.51	3.26	Agreed
7.	Nitrifying bacteria acts favourably in soils having neutral or slightly acidic conditions.	3.54	.55	2.66	.87	3.1	Agreed

Key:*X_1 = mean of farmers, SD_1 = Standard Deviation of farmer, X_2 = mean of extension agents,SD_2 = Standard Deviation of extension staff, X_g = Grand mean of the respondents.*

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The Table further revealed that the standard deviation ranged from .55 to 1.16 which showed that the respondents were not too far from the mean and opinion of one another in their response.

Table 2: Mean rating and standard deviation of the responses of lecturers and extension agents on factors affecting mineralization of nitrogen. (N=197)

Items statement	X_1	SD_1	X_2	SD_2	X_g	Remark
1. Nature of organic materials	3.75	.58	2.58	.60	3.16	Agreed
2. Soil moisture	3.09	.64	2.92	.82	3.01	Agreed
3. Temperature	3.06	.67	2.76	.84	2.91	Agreed
4. Alternate wetting and drying	3.16	.72	3.22	.65	3.19	Agreed
5. Amount and sources of applied nitrogen	2.84	.71	3.57	.77	3.20	Agreed
6. Soil reaction	3.26	.74	2.68	.92	2.97	Agreed
7. Amount of nitrogen in the soil	3.40	.66	3.92	.68	3.66	Agreed
8. Chemical inhibition	3.37	.64	3.30	.83	3.33	Agreed
9. Aeration	2.90	.53	3.00	.80	2.95	Agreed
10. Soil plant interactions.	3.40	.53	3.35	.88	3.38	Agreed

Key:*X_1 = mean of farmers, SD_1 = Standard Deviation of farmer, X_2 = mean of extension agents, SD_2 = Standard Deviation of extension staff, X_g = Grand mean of the respondents*.

Data in Table 2 revealed that all the 10 factors affecting mineralization of nitrogen were rated agreed by respondents (all the 10 items had their grand mean values ranged from 2.91 to 3.66). The standard deviation of respondents ranged from .53 to .88 which revealed that the respondents were not too far from the mean and opinion of one another in their response.

Table 3: Mean rating and standard deviation of the responses of lecturers and extension agents on ways of nitrogen gain in the soil. (N=197).

Items statement	X_1	SD_1	X_2	SD_2	X_g	Remark
1. Symbiotic bacteria with the host plant legume fix nitrogen in the nodules.	2.60	.77	3.80	.52	3.2	Agreed
2. Nodulated legumes and non-legumes.	3.99	.85	2.78	.73	3.38	Agreed
3. Symbiosis with cyanobacteria(blue green algae)	2.74	.57	2.63	.72	2.68	Agreed
4. Non-symbiotic process fix nitrogen in the soil by certain free living and associative organism	3.16	.62	3.72	.61	3.44	Agreed
5. Addition through precipitation	3.06	.60	3.40	1.02	3.23	Agreed
6. Addition through manure, fertilizers, compost including green manures.	3.18	.72	3.33	1.06	3.25	Agreed

Key:*X_1 = mean of farmers, SD_1 = Standard Deviation of farmer, X_2 = mean of extension agents, SD_2 = Standard Deviation of extension staff, X_g = Grand mean of the respondents.*

Data presented in Table 3 revealed that all the 6 items had their grand mean values ranged from 2.68 to 3.44 indicating that the respondents agreed on all the items on ways of nitrogen gain in the soil. Furthermore, the table revealed that the standard deviation ranged from .57 to .85 which showed that the respondent were close in their response and opinion of one another.

Table 4. Mean rating and standard deviation of the responses of extension agents and lecturers on methods of loss of nitrogen from the soil (N=197)

Items (mineralization of nitrogen)	X_1	SD_1	X_2	SD_2	X_g	Remark
1. Leaching in flooded land or in aneorobic soils.	2.56	.91	3.38	.59	2.97	Agreed
2. Denitrification through microbial reduction of nitrate.	3.30	.65	3.40	.55	3.35	Agreed
3. Facultative aerobic bacteria such as pseudomonas and bacillus are responsible for denitrification.	2.90	.97	3.72	.62	3.31	Agreed
4. Activities of denitrifiers	3.42	.71	3.01	.70	3.22	Agreed
5. Nature and amount of organic matter determines denitrification at a particular temperature.	3.80	.73	3.25	.53	3.53	Agreed
6. Ammonia volatilization	3.27	.70	3.20	.76	3.24	Agreed

Data presented in Table 4 revealed that all the 6 items had their grand mean values ranged from 2.97 to 3.53 which indicate that respondents agreed on all the items on ways or methods of loss of nitrogen from the soil. The standard deviation of the respondents ranged from .53 to .97 indicating that the respondents were not too far from the mean and opinion of one another in their response.

HO_1**:** There is no significant difference in the mean ratings of the responses of lecturers and extension agents on the ways in which the soil gain nitrogen.

Table 5: t-test analysis of mean ratings of responses of lecturers and extension agents on the ways in which the soil gain nitrogen (N=197).

Status	N	Mean	Standard deviation	Std error mean	Df	t-calculated	Sig	Remark
Lecturers	103	3.487	.76235	.0733	195	1.495	.186	NS
extension agents	94	2.946	.6134	..0820				

Key:*N=Number of Lecturers & ext. Agents, df=degree of freedom, Sig=Significant p value ,NS=Not significant.*

Table 5 shows a p-value of .186 which is greater than alpha value of .05 indicating that there was no significant difference between the mean ratings of responses of lecturers and extension agents on ways in which the soil gain nitrogen.

HO_2: There is no significant difference in the mean ratings of the responses of lecturers and extension agents on the methods in which nitrogen is lost from the soil.

Table 6: t-test analysis of mean ratings of responses of lecturers and extension agents on the methods in which nitrogen is lost from the soil. (N=197)

Status	N	Mean	Std-deviation	Std error mean	Df	t-cal	Sig	Alpha value
Lecturers	103	2.862	.837	.0631	195	.192	.178	.05
extension agents	94	3.245	.729	.0305				

Key:N=Number of Lecturers & ext. Agents, Std=Standard deviation, df=degree of freedom, t-cal=t-calculated, Sig=Significant p value. NS=Not significant.

Table 6 revealed a p-value of .178 which is greater than alpha value of .05 which shows that there was no significant difference between the mean ratings of responses of lecturers and extension agents on methods in which nitrogen is lost from the soil.

DISCUSSION

The findings from Table 1 that respondents agreed on all the seven steps involved in the transformation of nitrogen via mineralization process was supported by Das[1] who found out that ammonification process reduces amines to ammoniacal compounds, and that activities of heterotrophic soil micro-organisms releases amines and amino acids. The findings were also in consonance with study by Kerlen, Duran, Cline, Harris and Schuman[2]. The authors found out thatnitrosomonas and nitrobacter converts nitrite to nitrate and ammonium to nitrite. Findings from Table 2 that respondents agreed on the ten factors affecting mineralization of nitrogen in the soil was in line with findings of Okunola[9] who affirmed that nature of organic materials, soil moisture, temperature and alternate wetting and drying are among factors affecting mineralization of nitrogen. Cabrera and Gordillo[5] supported the findings as they asserted that soil reaction, aeration and amount of applied nitrogen affect mineralization.

Findings from Table 3 that respondents agreed on all the six items on the ways of nitrogen gain in the soil were in agreement with findings of Ekele[3]. The authors found out that addition through manure, fertilizers, compost including green manures and addition through precipitation are ways of nitrogen gain in the soil. Findings from Table 4 on methods of loss of nitrogen from soil were also in agreement with study by Phiha and Giler[10] The authors emphasized that activities of denitrifiers, nature and amount of organic matter which determines denitrification at a particular temperature, Also, the findings were consonance with study by Brady[6] who reiterated that ammonia is

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reduced through volatilization and leaching in flooded land. Findings by Abdullahi and Kutama[11] and Das[1] were also in support of findings from Table 4 on the methods of loss of nitrogen. The authors stated that facultative aerobic bacteria are responsible for denitrification. The two hypotheses tested were in agreement with the findings of Agbulu, Ekele and Lan[12] which revealed that there was no significant difference in the mean rating of lecturers and extension agents on ways in which the soil gain and lost nitrogen in the soil.

CONCLUSION AND RECOMMENDATION

It is evident that the nitrate which is obtained from nitrogenous fertilizer, fixed by bacteria in root nodules of leguminous crops or by nitrification process has the most important effect in terms of increasing crop production. Proper soil utilization for crop production also depends on the extent to which graduates of agricultural education fathom nitrification process. The response of nitrogen therefore depends on soil conditions, crop species and nutrient supply in general. Water is the most important growth factor which can limit the responses of nitrogen application in different crops. The responses of nitrogen are equally dependent on how best the crop is supplied with other plant nutrients. The rate of denitrification of added nitrate nitrogen to submerged soils is dependent upon the carbon content in soils, being slower in soils low in carbon than in soils rich in carbon. The study has established steps involved in the transformation of nitrogen, factors affecting mineralization of nitrogen and ways of gain and losses of nitrogen from the soil. Hence, the graduates are equipped with the competence to prevent denitrification of nitrogen and enhance sustainable soil utilization in the study area.

It is recommended that the lecturers in the institutions of higher learning where agricultural education is offered should pay specific attention to the teaching and learning of steps involved in the transformation of nitrogen through mineralization procedures. Workshop and training should be organized by extension agents for agricultural education students in tertiary institution where factors affecting mineralization of nitrogen is given priority. In collaboration with ministry of agriculture, lecturers of agricultural education and extension agents should organize practical training workshop for students in methods in which nitrogen is gained in the soil. Extension agents should regularly be invited by lecturers to use teaching aids to demonstrate practically the methods of loss of nitrogen from the soil.

Limitations of the study

The study did not consider the instructional materials that are needed in the teaching and learning of nitrification process. The study did not consider the demographic factors such as tribe, age and socio economic background of the respondents. The study did not provide specific time limits for extension agents to train students or graduates of agricultural education.

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