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Analysis of land tillage practices and related problems among rice farmers in the tropic of sub-saharan Africa

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Abstract

The decision “to till” or “not to till” is premised on the farmers’ perception of the inherent negative effects of tilling vis-à-vis the crop output performance and the profitability of the farm venture. Land tillage practices and land related problems of farmers were assessed in Agricultural Zone I of Niger State, Nigeria. Furthermore, the relation between land related problems and rice production levels was also investigated. Cross sectional data was collected for the analysis using questionnaire from one hundred and twenty (120) rice farmers. Descriptive statistics as well as the Chi-Square Test were used to analyze data collected. Findings revealed that 40.8 % and 56.7% of the respondents utilize manual and mechanized tillage methods on their farms, respectively. Thus indicating a majority (97.5%) of the farmers intensively tilling the soil as a cultivation practice. Land related problems reported by farmers include induce erosion, loss of nutrient, insect pest attack and change in soil texture. Furthermore, it was also found that farmers operating at a higher level of production experience more land related problems on the fields. The Chi square analysis revealed a strong relationship between tillage method and prevalence of land related problems and incidences of pests and diseases. Also levels of production at which farmers operate was found to have a relationship with the incidence of tillage related problems observed on the farms. It is therefore the opinion of this study that agronomist need to research and put forward environmentally friendly tillage methods that best suits farmer needs in the study area. Furthermore, farmer education about the negative effects of tilling without recourse to the environment is also advocated.

Introduction

Arable land in Nigeria and especially in Niger state is abundant (Merem *et al.*, 2017). The cultivation system practiced is mostly extensive, with fallowing being a strategy adopted by most farmers to reclaim exhausted land (Andrew, 1995). The cultivation of rice requires heavy tillage activity especially where the land is prone to water logging and clayey in nature (Michael, 2003). Tilling of the land for crop cultivation is usually carried out using power tillers, ox plough, tractors or manually (Xinshen *et al.*, 2016). This practice disturbs the structure of the land and therefore alters the soil micro-ecosystem. The consequence of this action is the occurrence of land related issues that will pose a threat to the realization of the full potential of crop being cultivated and a problem to the farmer (Stockdale *et al.*, 2006, Tiziano, 2016).

The cultivation of rice in Nigeria has received a boost from farmers in recent times, this is because the Government and developmental agencies have directed efforts towards supporting the farmers. This support was given in the form of farm inputs and extension service. Rice being a staple crop for most Nigerian households need to be cultivated in higher quantities if the demand for the crop is to be satisfied. The increase in cultivation of the crop means an expansion in the land used. The cultivation of the crop requires the tilling of the land.

Land related problems is prevalent among rice farmers in Agricultural zone I of Niger State. Problems such as erosion, nutrient lose, increase in insect pest attack and alteration of soil structure and texture are among the issues identified (Bwala, *et al.*, 2017). The scale at which cultivation of the land is cultivated may increase the occurrence of these problems. Hence it is necessary to determine whether or not tillage method practiced by farmers have relationship with land related problems as well as the prevalence of pests and diseases (Tiziano, 2016). It is also pertinent to determine whether or not the scale of production increases the intensity or magnitude of the problems observed by farmers on their land. Is there a relationship between the problems experienced by farmers on-farm with the scale of production? This study attempts to ascertain whether or not there is a correlation between scale of production and land related issues experienced by rice farmers in the Zone.

Methodology

The study was carried out in agricultural Zone I of Niger State, Nigeria. The study area consists of eight Local Government Areas. Rice is widely cultivated in the area due to the suitability of the soil condition. The selection of the study area was premised on the fact that, agricultural zone I of Niger State is most suitable for rice cultivation. Hence, rice is widely cultivated in the area, both in the wet and dry seasons.

Data for the Study

Primary data was utilized for the study. The data were obtained from local farmers cultivating rice in the area through the administration of questionnaire. Information collected borders on type of tillage method, problems observed on farm by farmers and land size cultivated and harvested quantity of rice.

Sampling Method

Simple random sampling was used to draw a sample of rice farmers from the area. The samples were drawn using multistage sampling technique where three Local Government Areas (Agai, Lapai and Edati) were first of all drawn from the eight constituting the zone. Thereafter, two communities, each were selected from the Local Government Areas in the second stage; and finally a total of one hundred and twenty (120) respondents were selected with twenty from each community. The sample size was determined using the sample size calculator on the basis of a confidence interval of 9 at a confidence level of 95%. This is because, it is the assumption of this research that the population of farmers cultivating rice in the study area is large.

Analytical Method

Tools used for the analysis include descriptive statistics, contingency tables and Chi-Square analysis (Equation 1).

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

O = observed frequency

E = expected frequency

Hypotheses

The hypothesis whether or not tillage practices by rice farmers in the study area has any relationship with the levels of production was tested. The null and alternate hypothesis are stated below:

Hypothesis I:

H₀: there is no relationship between level of production and land till related problems.

H₁: there is a relationship between level of production and land till related problems.

Hypothesis II:

H₀: there is no relationship between land till methods and prevalence of pest and disease .

H₁: there is a relationship between land till methods and prevalence of pest and disease.

Result and Discussion

Farmers Ability to Own Power Tiller

Tilling the ground to make the land suitable for crop cultural practices is important in the cultivation of rice. However, the task is extremely tedious when carried out manually. Power tillers are used for the purpose of

breaking the soil to facilitate improved crop performance. It can therefore be said that a farmer who owns or have access to the power tillers will find task of tilling the ground for rice cultivation easier. From the results obtained , it was observed that majority of the respondents (85.0%) do not own power tiller while only 15.0% of the respondents owned power tillers, this indicates that majority of the farmer in the study area could find it difficult to till their land (Table 1).

Table 1. Distribution of respondents according to ownership and source of labour saving device

	Frequency	Percentage
Power tiller ownership		
Do not own Power tiller	102	85.0
Own Power tiller	18	15.0
Total	120	100.0
Ox plough ownership		
Do not owned ox plough	118	98.3
Owned ox plough	2	1.7
Total	120	100.0
Source of land till device		
Cooperative	47	39.2
Government	39	32.5
Family/Relative	34	28.3
Total	120	100.0
Access to power tiller		
Very Difficult	30	25.0
Difficult	60	50.0
Not difficult	30	25.0
Total	120	100.0
Reason for difficulty		
Expensive to hire	88	73.3
Non-availability	32	26.7
Total	120	100.0

Source: Field survey, 2016

Furthermore, result show that half (50.0%) of the rice farmers find it difficult to access power tiller machine. Those that responded very-difficult and not difficult are 25.0% each respectively (Table 1).With regards to the reason why the farmers find it difficult to access tiller machines, majority of the respondents (73.3%) gave reason that it is expensive, while 26.7% attributed the difficulty to non-availability (Table 1).

Ownership and source of farm machinery by farmers in the study area as presented in (Table 1) show that supreme majority of the respondents do not own ox plough (98.3%) while 1.7% own ox plough. The inability of the farmers to own an ox plough could be an indication of their economic status or farm asset deficiency. The possession of a labor reducing farm machinery that relates to the cultivation of the land will definitely reduce time lag in accessing the machinery if hired and also reduce cost. The implication of this finding is that farmers' tendencies to increase hectareage of rice crops may be hindered due to the intricacies associated with non-ownership of such vital machinery.

Furthermore, about 39.2%, 32.5%, and 28.3% of the respondents reported having sourced their machinery from cooperative venture, Government and family/relatives, respectively (Table 1).

Farming Experience

The length of time an individual invest doing a task is critical to the skill acquired in doing the task in the future in an improved and efficient manner. It was observed from the study that one third (33.3%) of the respondents had farming experiences between 16 -25 years; while furthermore 24.2%, 15% and 13.3% of the farmers had experiences between 31–35, 26–30 and 11–15 years, respectively. The implication of this finding is that majority of the rice farmers in the study area have skills in the cultivation of rice which will translate to efficient utilization of resources *ceterisparibus* (Table 2).

Table 2. Distribution of Respondents According to Farming Experience in Years

Farming Experience	Frequency	Percentage
Less than 10.0	10	8.3
11 – 15	16	13.3
16 – 25	40	33.3
26 – 30	18	15.0
31 – 35	29	24.2
More than 36	7	5.8
Total	120	100.0

Source: Field survey 2016

The practice of land tillage is strongly related to the culture of the people and environmental conditions prevalent in the area. The study identified land tillage methods practiced by farmers in the study area (Table 3). It was observed that more than half (56.7) of the farmers practice mechanical tillage, while 40.8 percent till the land manually. Furthermore, a small percentage of the farmers reported zero tillage.

Table 3. Land tillage practices by farmers in the study area

Tillage system adopted	Frequency	Percentage
Manual tillage	49	40.8
Mechanized tillage	68	56.7
Zero tillage	3	2.5
Total	120	100.0

Source: Field survey, 2016

Considering the total percentage of farmers that engage in tilling (agitating) the land, it can be said that about 97 percent of the farmers till the soil. The culture of agitating the soil has been encouraged by technology (Xinshen *et al.*, 2016) for the simple benefits of reduction of drugery and time required for the task. It may therefore, be difficult to obtain a good number of farmers who do not agitate the soil as a cultural practice.

Prevalence of pests and diseases on the farms can be due to several factors, however, literature has it that tilling

creates a conducive environment for some pests and also diseases to thrive (Mid West Plan Service, 2000). The occurrence of pests and diseases amongst the respondents as recorded is presented in Table 4. The stem borer appears to be the major pest rampaging as mentioned by one third (33%) of the farms in the study area, followed by the suck bug (25%). The possible damage caused by these pests could be huge in general. The economic consequence of the havoc caused by pest to farmers can be two fold. These could be in the form of control of the pests (strategies involved such as cost of pesticides etc) and also actual crop lose. Furthermore, with regards to diseases, the rice yellow mottle virus (RYMV) was reported by majority (38%) of the farmers. The leaf spot was reported by 36 percent of the farmers, indicating that it is a disease to reckon with after RYMV. The brown spot also has a large percent of occurrence as compared to other diseases reported by the respondents.

Table 4. Occurrence of Pest and Disease on farm

	Frequency	Percent
Pest		
Army worm	22	18
Beetles	29	24
Stem borer	39	33
Suck bug	30	25
Total	120	100
Disease		
Blight	2	2
Blast	5	4
Brown spot	22	18
Leaf spot	43	36
RYMV	46	38
Smuts	2	2
Total	128	100

Source: Field survey 2016

Land Tillage Problems and Rice Production Levels

Loosening the soil before planting facilitates high crop performance, this is because tilling works-in the nutrients necessary for plant growth, improves aeration and reduces weeds: it has also been attributed to improve beneficial microbial activity (Diane, 2009). the practice is needed more where the soil is clayey in nature, and therefore, hard to carry out crop cultural practice. However, tilling the ground comes with a consequence that may not be good for the environment. The tillage problems that were identified in this study include pest attack, induced erosion, low water infiltration, leaching, loss of nutrients and change in soil texture. Information concerning water infiltration rate was elicited through farmers' recall of time taken for water to drain after rain. The longer it takes for the water to drain after rain (to attain a shiny dry spot of land), the lower the infiltration rate and vice-versa. Furthermore, with regards to nutrient loss, farmers reported the need to apply fertilizer increasingly across seasons. This according to the farmers, indicates that the soil nutrient is diminished, thus the need for application of fertilizer.

The contingency table reveals that about half (49%) of the farmers experienced loss of nutrient and 22 percent experienced low water infiltration (Table 5). A further

Land tillage practices and related problems

10 percent of the farmers indicated erosion as a consequence of their tilling operation. It has been established that tilling operation contributes to the occurrence of erosion (FAO, 1993). The implication of erosion on the soil is, of course the loss of nutrients among other negative effects. It can therefore, be asserted that erosion activity leads to loss of nutrients. This may happen because tillage does expose soil to erosion which will eventually bring about loss of nutrients.

Further analysis of the contingency table show that one third (33.3%) of the farmers who experienced most of the land related problems are within the harvested quantity ranged from 36 to 45 bags production level.

Findings also reveal that one third(33%) of the farmers experiencing land till related problems are within the production level of 36 to 45 bags (Table 5). A further 24 percent of farmers experiencing tillage related problems are within the production level of 26 to 35 bags. However, results showed that 23% of the farmers experiencing land till related problems produce below 25

bags. Taking 25 bags production level as a boundary, it was observed that 77% of the farmers experiencing land till related problems are above the twenty five bags production level. It can therefore be asserted that farmers cultivating above twenty five bags of rice in the study area experience more land till related problems than those producing less.

The implication of this assertion is that farmers who cultivate larger expanse of land are expected to have more land till related problems as opposed to those cultivating smaller sizes. The reason for such an observation can be linked to the fact that farmers who cultivate large fields of rice do employ both intensive and extensive cultivation methods. The use of machinery to loosen the soil provides a convenience to farmers to increase hectarage and also deepen the depth of soil agitation. It could, therefore, be expected that farmers who practice deeper and extensive soil agitation should experience more land till related problems.

Table 5. Cross-tabulation of Land tillage problems and level of production in Kg

Land Related problem	≤ 25.00	26.00–35.00	36.00–45.00	46.00–55.00	56.00 ≤	Total	percent
Insect pest attack on seeds	0	2	6	2	0	10	8
Induced erosion	4	0	4	4	0	12	10
Low water Infiltration	3	10	10	2	1	26	22
Leaching	0	0	0	0		1	1
Loss of nutrient	17	13	17	12	0	59	49
Change in Soil texture	3	1	0	0	0	4	3
Change in Soil topography	1	3	3	1	0	8	7
Total	28	29	40	21	2	120	
Chi Square Test							
	Value	Df	Asymp. Sig				
Pearson Chi-Square	91.575	35	0.000				
Likelihood Ratio	46.998	35	0.085				

Source: Field survey, 2016

The observation that farmers operating at higher rice production levels in the study area experience more land till related problems need to be ascertained; whether or not it is due to chance or there is a significant relationship. The Chi-Square analysis was used to test for the relationship. It shows a Pearson correlation value of 91 with a 35 degree of freedom (Table 5); the value is significant at the 1% level of significance. The tabulated Chi-Square value (66.62 at 35 df) for the relationship is less than the calculated. Hence, the Null hypothesis was rejected, whereas the alternative was accepted. The implication of this finding is that the observation that rice farmers operating at higher levels of production experience more incidences of land till related problems; and the occurrence is not due to chance.

It is therefore, asserted that there is a significant relationship between land till related problems and rice production levels in the study area. The association of incidences of land till problems and rice production level in the study area is rather dicey.

This is because the average rice farmer aspires to mechanize farm tillage practice through the use of tractor or power tiller. This is because suitable land for rice cultivation requires high labor expenditure due to the fact that the land is usually hard and clayey in nature. If farmers are to profitably produce rice crop within the ambit of sustainable tillage culture, then a change in the perception towards the environment is needed. Developing an environmentally friendly tilling culture is inevitable for a sustainable land management, however, the livelihood concerns of the farmer must be kept in focus.

Relationship Between Land Tillage Methods and Prevalence of Pests And Diseases

Pests and diseases are the bane in farming enterprises (Biplob, 2017), the prevalence and degree of severity may be exacerbated by weather conditions and possibly, cultural practices adopted by the farmer. In as much as pests and diseases thrive under favourable weather conditions, do tillage methods facilitate a conducive

environment? The relationship of land tillage methods and prevalence of pests and diseases on farm is presented in this section. Cross tabulation of pest infestations recorded on the farms and the tillage technology adopted by farmers showed that the stem borer (20.83%) was the dominant pest on farms where manual tillage was practiced (Table 6); whereas the beetle (21.6%) was dominant on farms that were mechanically tilled.

Considering the overall occurrences of pests under different tillage practices, mechanical tillage method

seems to harbour most (66.7%) of the infestations. This can be due to the fact that mechanical tillage practices increases soil moisture content (Majid and Keshavarspour, 2011) which creates conducive condition for the pest to thrive. Furthermore, mechanical tillage reduces the penetration rate (PR) as well as the bulk density of soil (Majid and Keshavarspour, 2011). It is the assertion of this study that lower soil penetration rate and bulk density may also facilitate harbouring of pests in the soil. The Chi-square test revealed significant relationship between tillage practices and pest infestation.

Table 6. Cross Tabulation of land tillage methods and disease infections on rice farms

	Disease infections						Total
	Blight	Blast	Brown spot	Leaf spot	RYMV	Smuts	
Manual	1 (0.83)	2(1.67)	2(1.67)	7 (5.83)	24(20.00)	1(0.83)	37 (30.83)
Mechanical	1(0.83)	3 (2.50)	19 (15.8)	36 (30)	20(16.67)	1(0.83)	80 (66.67)
Zero Till	0	0	1(0.83)		2(1.67)	0	3 (2.50)
Total							120
	Chi Square Test						
	Value	df	Asymp				
Pearson Chi-Square	36.12	20	0.015				
Likelihood ratio	43.86	20	0.002				

Source: Field survey, values in parenthesis are percentages

With regards to diseases, analysis showed that majority (20%) of farmers that practiced manual tillage reported RYMV incidences on farm (Table 6). While about 5 % of the same group reported having experienced leaf spot disease. Farmers that practiced mechanical tillage had the highest incidences (66.67%) of disease experience. A majority (30%) of them reported leaf spot disease,

furthermore, about 16.67 % and 15.8% reported RYMV and brown spot diseases respectively. Farmers that practice manual tillage reported less disease attack. On the whole, a higher percentage of the diseases identified were observed among farmers that had practiced mechanical tillage.

Table 7. Cross Tabulation of land tillage methods and disease infections on rice farms

Tillage System	Pest infestation				
	Army worm	Beetles	Stem borer	Suck back	Total
Manual Tillage	3(2.50)	3(2.50)	25(20.83)	4(3.33)	37(30.83)
Mechanical Tillage	18(15.00)	26(21.67)	9(7.5)	4(3.33)	80(66.7)
Zero Tillage	1(0.83)	1(0.83)	2(1.67)	0	3(2.50)
Total					120
	Chi-Square Tests				
	Value	df	Asymp. Sig		
Pearson Chi-Square	53.35	14	0.00		
Likelihood Ratio	57.98	14	0.00		

Source: Field survey, values in parenthesis are percentages

The Pearson Chi-Square value revealed the relationship among tillage methods and the prevalence of diseases to be significant. Hence the relationship is not due to chance rather as a result of a significant correlation between and among the variables.

Further analysis revealed majority of farmers who practiced manual tillage experienced a medium level of severity with respect to prevalence of pest and disease (Table 7). The case is also the same for farmers who practiced mechanical tillage. The Chi-Square test revealed a significant relationship between land tillage methods and severity of pest and disease.

Analysis revealed significant relationship between land tillage practices and pest and disease occurrences on farms. Mechanical tillage methods have a higher level of pest infestations as well as disease infections of crops as compared to manual or zero tillage practices. The severity of infestation and infection by pest and disease is higher under mechanical tillage than the manual or zero practices. Degradation of the land can no doubt be attributed to human activities, while tillage is not an exception amongst other factors.

Table 8. Cross Tabulation of tillage methods and severity of attack

	Severity			
	High	Medium	Low	Total
Manual	2(1.67)	33(27.5)	2(1.67)	37(30.83)
Mechanical	4(3.33)	45(37.5)	31(25.83)	80(66.67)
Zero Tillage	1(0.83)	2(1.67)	1(0.83)	3(2.5)
Chi Square Test				
Pearson Chi Square	19.18	4	0.001	
Likelihood ratio	20.622	4	0.000	

Source: 2016 survey, values in parenthesis are percentages

Conclusion and Recommendation

The decision “to till” or “not to till” is premised on the farmers’ perception of the inherent negative effects of tilling vis-à-vis the crop output performance and the profitability of the farm venture. Land preparation is vital in the farmers’ calendar of crop cultural practice. Tilling the ground through soil agitation is a component of the land preparation brochure. However, the accompanying problems of tillage practices need to be weighed against the advantages. The incidences of land related problems, pest and diseases on the farm is strongly correlated with the level of production and tillage method adopted by farmers. The suitability of a tillage method lies in its ability to sustainably conserve the land asset and also the livelihood of farmers.

It is therefore, the opinion of this study that agronomist intensify research on environmentally friendly tillage methods that best suits farmers needs in the study area. Furthermore, farmers’ education about the negative effects of tilling without recourse to the environment is also advocated.

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