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EFFECT OF VARIETAL AND TILLAGE METHODS ON AGRONOMIC AND YIELD CHARACTERS OF RICE (ORYZA SATIVA L)

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ABSTRACT

This work investigates the effect of rice varietal and tillage methods on the agronomic and yield characteristics of rice under fadama plantation. This is vital in order to quantify technology engagement and rice yield towards enhanced rice sector revolution in the nation's Zero Hunger Developmental plan (ZHD_P). The experimental layout involved three varieties of rice (Faro 52, Faro 44, and Local) and three field preparation techniques (no-tillage flat field (A), tillage with shanti hydropower (China made model DF-121) (B) and tillage with Sawah eco-technology rice farming (serif) (Indonesian made QUICK G1000 BOXER) (C)). During the rice developmental stages, data collected focused on rice varietal and power tiller effect on days to *flowering, days to maturity, number of tillers, panicle length, plant height and grain yield. Data collected were analyzed using descriptive statistics and Minitab 17 package to investigate the interaction effects as well as show details on the agronomic relationship and yield data with tillage methods. The result also provided information on the interaction effect of the varieties and the tillage methods as well as identified the resultant yields from each of the three tillage methods used. The analyzed field output is a pointer in identifying the best tillage method that could enhance rice revolution in reducing and/or eliminating the current hunger index table posing threats to food availability and sustainability in under-developed nations of Africa.*

Keyword: Rice Variety, Power Tiller, Tillage Methods, Agronomy, Yield.

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1. INTRODUCTION

Rice (Oryza*sativa L.)* belongs to the grass family and one of the most cultivated cereal crops in Nigeria. A staple food item in most homes because of its nutritive values and the socio-cultural importance attached to the crop. There have been keen interests in rice farming in recent times to meet the local demand for this essential food item. Government policies on rice importation have also increased the acreage of land under cultivation for rice thereby enhancing the economic capacity of the local rice farmers in the country. The acreage under cultivation have increased using various rice technology to reduce the drudgery involve in traditional methods of rice cultivation. Many rice cultivation machinery have been imported to the country in order to boost government efforts at meeting the rice demand of the populace [1-8].

There are numerous varieties of rice that are cultivated in Nigeria. These include the indigenous red grain species (Oryza*glaberrina*), fadama rice, upland rice, lowland rice. The process involved in rice cultivation depends on the geographical and ecological factors of the locality. This implies that different varieties thrive in different geographical and ecological zones in Nigeria.Rice requires a fertile soil with a moderately high water holding capacity. Heavy soils characteristic of river valleys and fadamas are suitable soil, but lands having clayey soils are considered most desirable. Rice fields can be prepared under dry or wetland conditions; the choice of which depends on time of operation, soil properties and implements to be used. Tillage which is the mechanical manipulation of the soil plays a key role in the successful establishment of any crop. It helps to prepare a good seedbed for the plant, a requisite factors for a bounty harvest [9-10]. Tillage has been identified as the most costly item on the budget of the farmer, an intensive process involved in crop production [11]. Various technologies have been employed in this activity for rice cultivation. The environment for rice cultivation is so different from most conventional tillage operations. Therefore special machinery (power tiller) are designed for tillage operations such as Shanti hydropower (China made model DF-121) and sawah eco-technology rice farming (serif) (Indonesian made QUICK G1000 BOXER). Most of these technologies are imported into the country [12-13](Ademiluyi,*et al.*, 2008. The need to evaluate and compare them with the traditional method becomes necessary, which is the focus of this research work.

2. MATERIAL AND METHODS

2.1. Description of the experimental site

The experimental site is located at the Landmark University Teaching and Research farm. It is on Latitude 8.1239°N and Longitude 5.0834° in the North Central region of Nigeria. The experiment is a 3x3 factorial design that was completely randomized. It involved three methods of tillage namely, no-tillage but flat field (A); tillage using Shanti hydropower tiller (B) and Serif technology (C). The no-tillage was prepared using hoes and shovel, the hydropower (China made model DF-121) and serif technology (Indonesian made QUICK G1000 BOXER) as shown in Figure 1**.** The three varieties of paddy rice were raised in the nursery for 4 weeks to produce seedlings for transplanting. Using the two other tillage methods, basin sizes of dimension 3m x 2m were created. These were guarded by bunds to control water flow in and out of the basins and the seedlings transplanted into the 3 m x 2 m dimension plot sizes (Gupta and Kumar, 2001). Each variety was transplanted after 4 weeks into the basin which is the plot size for the no-tillage, hydropower (Shanti) and serif technology plot and replicated 3 times to give a total of 1350 plant stands.

Some agronomic characteristics such as days to flowering, days to maturity, number of tillers, panicle length, and plant height) and grain yield data were counted/measured. Measuring tape, visual counting and weighing scale were used for the data collection.

1.2. Experimental Design

The experimental plot was cleared and divided into three (3) plots, each a hectare area of land. Each of the hectares was prepared differently using different tillage methods and labelled A (No-till), B (Shanti hydro-power tiller), C (Sawah eco-technology), while the sub-units were labelledA_1 (Faro 52), A_2 (Faro 44), A_3 (local)) Liu, *et al.,*(2015). Different tillage (Figure1) treatments were practice on the three (3) different units. Using complete randomized design with three replications, each of the three rice varieties were sown in each of the A, B, C tillage methods. The collected data were analyzed using IBM SPSS Statistics 22, Microsoft Excel and Minitab 17.

(a) No-tillage

(b) Hydropower tiller

(C) Serif technology: Puddling

(D) Seedlings transplanting operation in a sawah rice farm

Figure 1: Pictorial view of the different tillage practice

3 RESULTS AND DISCUSSIONS

The work investigated the effect of tillage techniques and rice varietal on some agronomic and yield characteristics of rice under fadama cultivation. Measurable parameters such as days to flowering, days to maturity, number of tillers, panicle length, plant height and grain yield were taken, using a measuring tape, visual counting and weighing scale. This was analysed and results as presented.

3.1. Experimental Result of the Measured Parameters for the Descriptive Statistics and Analysis of Variance

3.1.1. Descriptive Statistics and ANOVA for the Days to Flower

The descriptive statistics and the Analysis of Variance for the days to flower for the three varieties using the three tillage techniques is as presented in Figure 1 and Table 1.

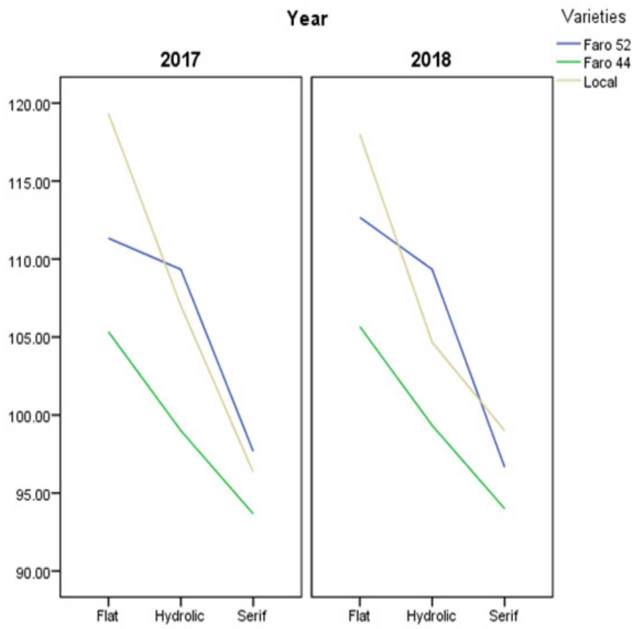

Figure 1: Estimated marginal mean plot of days to flower

1 shows the relationship between the varieties and the tillage systems; though the effect of the tillage systems seems not to deviate too much across the year, the effect is certainly not the same across the system. For instance, the number of days to a flower of the plant is high for flat system compared to the hydrolic and serif systems. Faro 54 and Local rice seems to have intersecting tillage system effects.

The effect of the varieties and tillage systems are significantly different from one another while other main effects and interactions are not significant. Comparison analysis between the varieties on days to a flower of the plants shows that Faro 52 and Local are not significantly different from each other but the two are significantly different from Faro 44. Also for the tillage systems, it shows that the effect of serif, hydropower and flat tillage systems on the days to a flower of the plant are significantly different from each other.

Table 1: Analysis of Variance (ANOVA) for the days to flower

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	649.037	2	324.519	7.235	.002
Tillage	2261.148	2	1130.574	25.207	.000
Year	.019	1	.019	.000	.984
Varieties * Tillage	243.296	4	60.824	1.356	.268
Varieties * Year	1.037	2	.519	.012	.989
Tillage * Year	4.037	2	2.019	.045	.956
Varieties * Tillage * Year	21.074	4	5.269	.117	.975
Error	1614.667	36	44.852		
Total	592817.000	54			

R Squared = 0 .663(Adjusted R Squared = 0.504)

3.1.2. Descriptive Statistics and ANOVA for the Days toMaturity

As shown in Figure 2, the relationship between the varieties and the tillage systems for the days to maturity follow a similar pattern as the day to flower. The deviation among the effect of the tillage systems on the maturity period of the plants is not pronounced across the year, the effect is certainly not the same across the system.

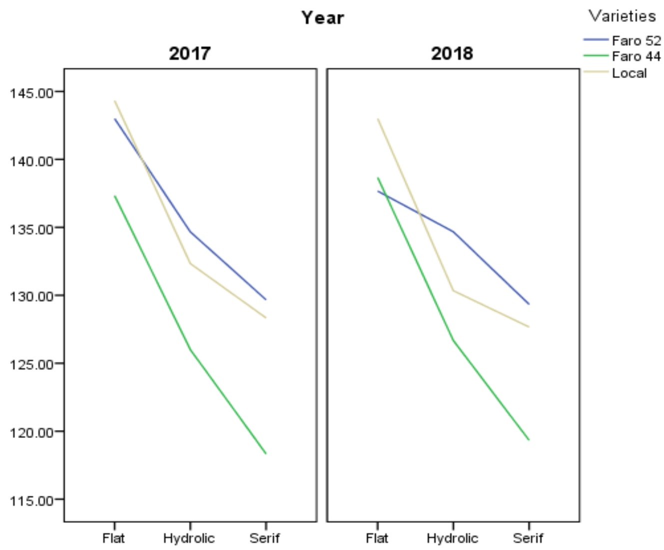

Figure 2: Estimated marginal mean plot of days to maturity

The effect of varieties and tillage systems are significantly different from one another while other main effects and interactions are not significant. Comparison investigation between the varieties on days to a flower of the plants shows that Faro 52 and Local are not significantly different from each other but the two are significantly different from Faro 44. Also, for the test comparison among the tillage systems considered, it shows that the effect of serif, hydropower and flat tillage systems on the days to maturity of the varieties are significantly different from each other.

Table 2: Analysis of Variance (ANOVA) for Days to Maturity

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	567.250	2	283.625	5.335	.009
Tillage	2147.643	2	1073.821	20.200	.000
Year	7.407	1	7.407	.139	.711
Varieties * Tillage	141.462	4	35.365	.665	.620
Varieties * Year	21.148	2	10.574	.199	.821
Tillage * Year	7.704	2	3.852	.072	.930
Varieties * Tillage * Year	20.741	4	5.185	.098	.983
Error	1913.733	36	53.159		
Total	949957.120	54			

R Squared = .604 (Adjusted R Squared = .416)

3.1.3. Descriptive Statistics and ANOVA for the Number of Tillers

Figure 3 shows the relationship between the varieties and the tillage systems. It can be seen that there was an intersect in the effect of flat tillage systems on Faro 52 and local in 2017 and this intersection occurred again in the hydropower tillage system in 2018; the flat system also maintains the highest number of tillers across the year 2017 and 2018.

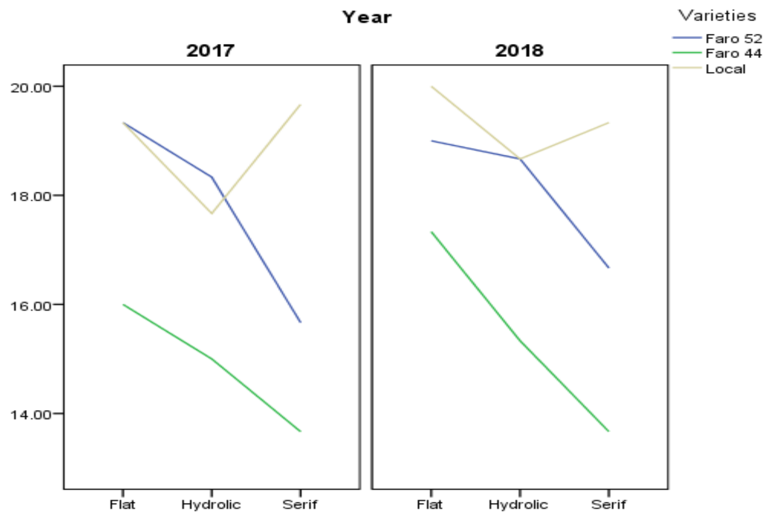

Figure 3: Estimated marginal mean plot of numbers of tillers

It can be observed from Table 3; the effect of varieties and tillage systems are significantly different from one another while other main effects and interactions are not significant. Comparison analysis test between the varieties shows that Faro 44, Faro 52 and Local are significantly different from each other while the testamong the tillage systems considered shows that the effect of serif and hydropower systems are not significantly different from each other but both are significantly different from the flat systems.

Table 3: Analysis of Variance of the Number of Tillers

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	147.815	2	73.907	26.785	.000
Tillage	38.481	2	19.241	6.973	.003
Year	2.667	1	2.667	.966	.332
Varieties * Tillage	26.407	4	6.602	2.393	.069
Varieties * Year	.111	2	.056	.020	.980
Tillage * Year	.333	2	.167	.060	.941
Varieties * Tillage * Year	3.889	4	.972	.352	.841
Error	99.333	36	2.759		
Total	16682.000	54			

R Squared = 0.689 (Adjusted R Squared = 0.542)

3.1.3. Descriptive Statistics and ANOVA for the Panicle Length

Figure 4 shows the relationship between the varieties and the tillage systems for the two years. In 2017, the effect of the three systems seems to almost have a parallel relationship which was not the case in 2018. The effect of flat and serif on local seems to be almost the same in 2017 but the discrepancy increased in 2018.

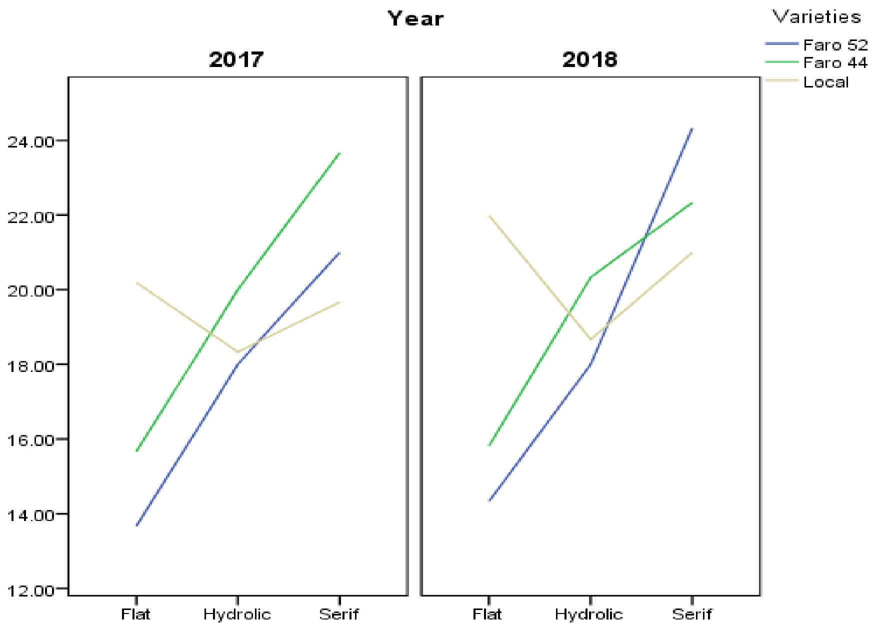

Figure 4: Estimated marginal mean plot of panicle length

Table 4: Analysis of Variance for PanicleLength

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	31.103	2	15.552	3.237	.051
Tillage	234.158	2	117.079	24.367	.000
Year	7.297	1	7.297	1.519	.226
Varieties * Tillage	173.487	4	43.372	9.027	.000
Varieties * Year	7.073	2	3.537	.736	.486
Tillage * Year	1.905	2	.952	.198	.821
Varieties * Tillage * Year	11.619	4	2.905	.605	.662
Error	172.970	36	4.805		
Total	20707.393	54			

R Squared = .730 (Adjusted R Squared = .602)

It can be observed from Table 4 that rice varieties, year and all possible interaction do not have a significantly different effect except tillage systems and the interaction between varieties and tillage all have significantly different effects on the panicle length.Comparison analysis among the tillage systems shows that none of them has a significant similarity, hence a different mean from each other.

3.1.4. Descriptive Statistics and ANOVA for the Plant Height

Figure 5 shows the relationship between the varieties and the tillage systems for the two years; where flat and serif mean effect seems to almost be on a straight line especially in 2018. There was no interaction among the investigated factors for the plant height.

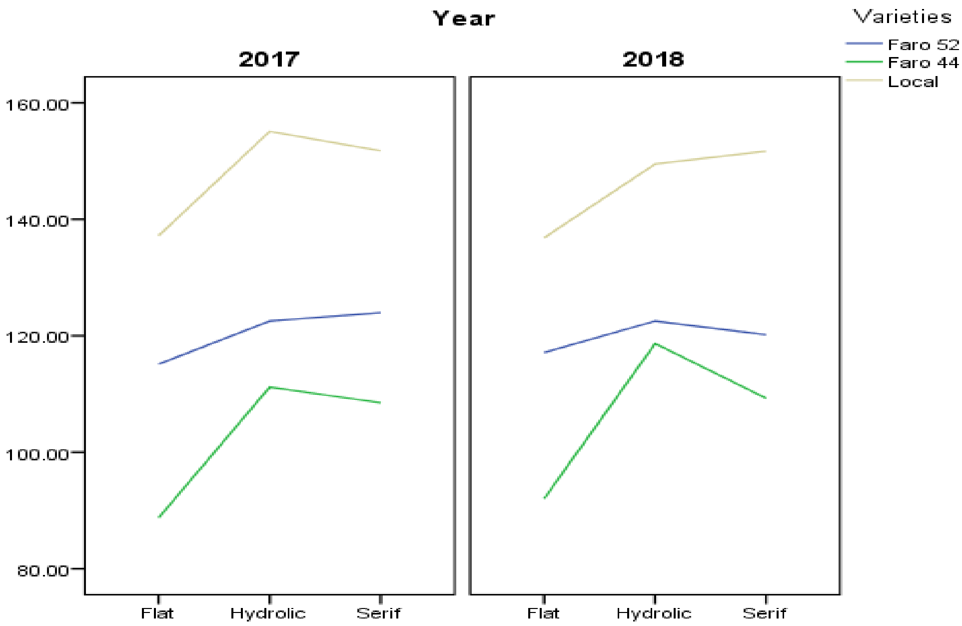

Figure 5: Estimated marginal mean plot of plant height

It can be observed from Table 5; most possible interaction and main effects do not have a significantly different effect except tillage systems and varieties which have significantly different effects on the plant height. Comparison of the means among the varieties shows that each of one is significantly different from the other. Serif and hydropower systems have similar significant effects but both are different from the flat tillage systems.

Table 5: Analysis of Variance (ANOVA) for Plant Height

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	16469.989	2	8234.995	68.928	.000
Tillage	2481.560	2	1240.780	10.386	.000
Year	2.269	1	2.269	.019	.891
Varieties * Tillage	536.286	4	134.071	1.122	.361
Varieties * Year	83.959	2	41.979	.351	.706
Tillage * Year	16.217	2	8.109	.068	.935
Varieties * Tillage * Year	73.216	4	18.304	.153	.960
Error	4301.000	36	119.472		
Total	854246.177	54			

R Squared = 0.821 (Adjusted R Squared = 0.736)

3.1.4. Descriptive Statistics and ANOVA for the Grain Yield

Figure6 shows the relationship between the varieties and the tillage systems for the two years. This shows the different effects of the tillage systems on each variety and similar patterns across the years.

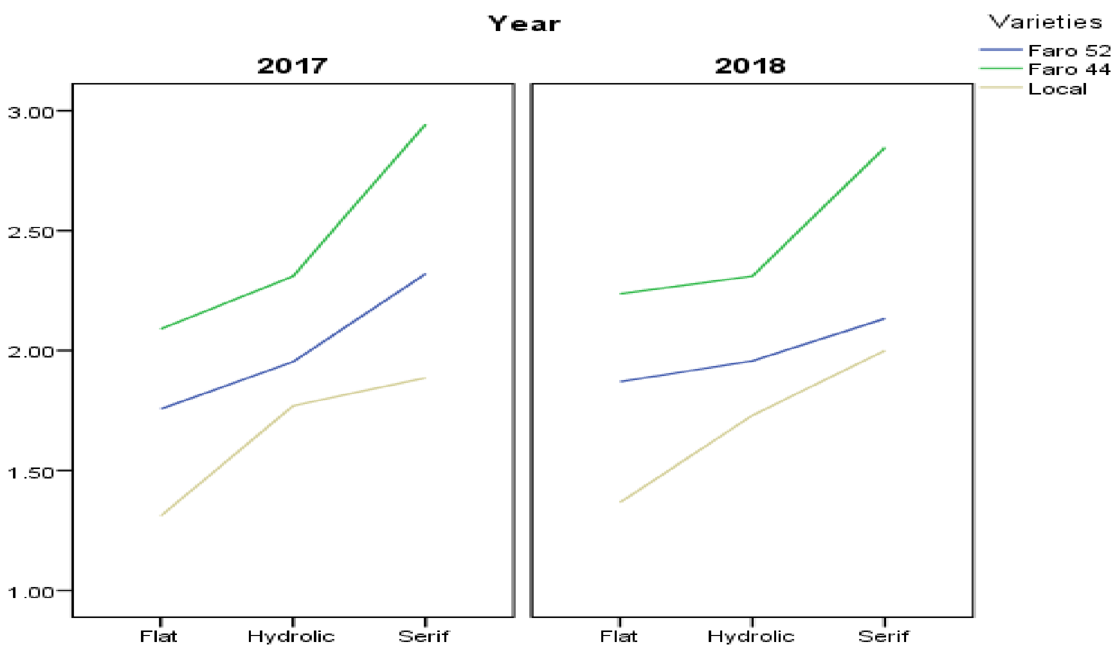

Figure 6: Estimated marginal mean plot of grain yield

Table 6: Analysis of Variance (ANOVA) for Grain Yield

Source	Sum of Squares	df	Mean Square	F	P-Value
Varieties	5.516	2	2.758	45.688	.000
Tillage	3.103	2	1.552	25.704	.000
Year	.002	1	.002	.033	.856
Varieties * Tillage	.370	4	.092	1.532	.214
Varieties * Year	.010	2	.005	.084	.920
Tillage * Year	.063	2	.032	.524	.597
Varieties * Tillage * Year	.069	4	.017	.285	.885
Error	2.173	36	.060		
Total	236.891	54			

R Squared = 0.808 (Adjusted R Squared = 0.717)

It can be observed from Table 5; most possible interaction and main effects do not have a significantly different effect except tillage systems and varieties which have significantly different effects on the grains yield. Comparison of the means shows among the varieties shows that each of them is significantly different from the other; serif and hydropower systems have similar significant effects but both are different from the flat tillage systems.

4. CONCLUSION

An investigation into the effect of varietal and tillage methods on agronomic and yield characteristics of rice under lowland cultivation. This is to help rice farmers identify appropriate tillage practice and varieties that would offer a better performance in lowland farming under savanna ecology where only flat land rice farming is prevalent especially in North central region of Nigeria. Result obtained is a tool to help agronomist in knowing the significant effect of the tillage practice and varietal differences on the plant development and grain yield. Also, this will guide designers and fabricators of agricultural equipment in precision/automation decisions towards effective agricultural machinery development.

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