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The effect of maize yield to fertilizer type, soil type, and plot type using multivariate analysis of variance (MANOVA)

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Abstract:
The research shows the significant of modern farming over traditional farming by studying multiple variables simultaneously so that practitioners will have high (yield) result. It examine the effect of maize yield to fertilizer, soil and plot type using one way multivariate analysis of variance. ANOVA test differences among various group of means while MANOVA test differences between two or more groups of vectors of mean. Gombe state maize production estimate from 2009 to 2019 was collected from ministry of Agriculture and animal husbandry for sassakawa and cultural practices. The result satisfied the assumptions of normality and homogeneity of variance. Also multivariate analysis of variance shows that all the four statistics wilk's lambda, pillai's trace, hotelling lawley trace and roy's largest root indicated that maize yield has significance effect to fertilizer type, soil type and plot type using either of the two practices and when transformed the data to upper tail exact F – test give the same interpretations. Hence using maize yield in a classify way and a very concise land give an optimal results depending on which variety you used and also hold for large area of land.

Keywords: *Multivariate analysis, Homogeneity, Vectors, Hotelling Lawley, Soil type*

1. Introduction

Multivariate Analysis of Variance (MANOVA) which is an extension of univariate analysis of variance (ANOVA), compares two or more ANOVA's in one analysis (Test). In ANOVA; differences among various group means on a single response variable are studied. In MANOVA, the number of response variables is increased to two or more. The hypothesis concern a comparison of vectors of group means. Using univariate analysis, multiple ANOVA's were conducted independently [1]. The research study the response of Maize performance to fertilizer type, plot, soil type and method of farming which will be conducted using MANOVA since there are dependent variables and independent variables. When only two groups are being compared, the results are identical to Hotelling's T^2 procedure. The multivariate extension of the F-test is not completely direct Instead, several test statistic are available, such as Wilks' Lambda and Lawley's trace [2]. Draft animals are often in poor condition at the end of the dry season, and many extension programs have recommended that farmers need to grow and conserve fodder for their draft animals. Several trials have demonstrated the potential for growing forage legumes and pasture grasses, but up to date, the production of single-purpose fodder crops at farm-level in West Africa has been minimal. In southern Mali, small quantities of forage cowpeas have been grown, because this was made a condition of credit allocation [3]. Even in this situation there has been a tendency to make this dual-purpose crop, with a small harvest for human consumption [4]. Crops cultivation is the most important portion in agriculture and the other portion are animal husbandry and rearing. Agriculture in Nigeria has greatly improved in the past few years because of the advent of technology and other necessary infrastructure. Initially, most Nigerian farmers merely engage two types of farming first one is subsistence agriculture that is to provide food for their family usage in the small scale, the second one is the commercial agriculture that is when the farmer have a very large scale farming made available in the market. Growth in agriculture output has no doubt been on the rise as farmers are stepping away from subsistence agriculture and move to modern civilization-investing in large scale farming and ultimately increasing agricultural products [5]. Soil fertility replenishment should be considered as an investment in natural resource capital [6]. Reversing soil fertility depletion is one of the requirements for increasing and enhancing capital agricultural production in Africa [6]. Majority aimed at improving soil fertility by rely on soil nutrient-supplying capacity, available soil amendments, and judicious use of mineral fertilizers to achieve balanced nutrient-management systems. Such an approach is usually referred to as Integrated Soil Fertility Management (ISFM) and should be embedded in a framework that includes aspects such as: weather, the presence of weeds, pest and diseases, crop management, and socio-economic aspects such as input and output prices and labor availability [7].

The Nigerians soil and climate condition is very important for the production of wide varieties of crops, there are over a hundred different food crops produced by farmers in Nigeria on yearly basis which includes yams, maize, millet, sorghum, beans, groundnut, potatoes, rice, onions, carbage, carrot, pear, cocoa, mango, cocoa yam, okra, vegetables and very many others. Therefore, whatever type of cultivation a farmer wants to carry out or practice, the knowledge of fertilizer, method of farming and the type of soil is the, most important in determining the farmers outputs. Soil and fertilizer type are very significant factors in crop production. Nigeria is the world number 1 producer of cassava because of the topography of the soil structure and texture; cassava farming has been leading the center stage in Nigeria and contributes over 45 percent of Nigerian agricultural Gross Domestic Production (GDP). Agriculture in Nigeria contributes merely about 20% percent of the Nigeria total GDP, trailing behind petroleum which is the major Nigerian domestic product. Although Nigeria depends heavily on the oil industry for its budgetary revenue, it is believed that if the agricultural sector is properly managed, utilized and enhanced, it would greatly boost the country's gross domestic product and even replace oil on the top of the list, considering the vast area of land that is unused and misuse in Nigeria [8].

There are two major situations in which MANOVA is used. The first is when there are several correlated dependent variables, and the researcher desires a single, overall statistical test on this set of variables instead of performing multiple individual tests. The second, and in some cases, the most important purpose is to explore how independent variables influence some patterning of response on the dependent variables [9]. The study literally uses an analogue of contrast codes on the dependent variables to test hypotheses about how the independent variables differentially predict the dependent variables. MANOVA also has the same problems of multiple post hoc comparisons as ANOVA [9]. An ANOVA gives one overall test of the equality of means for several groups for a single variable [10]. The ANOVA will not tell you which groups differ from which other groups (of course, with the judicious use of a priori contrast coding, one can overcome this problem) [11]. The MANOVA gives one overall test of the equality of mean *vectors* for several groups. But it cannot tell you which groups differ from which other groups on their mean vectors [11]. As with ANOVA, it is also possible to overcome this problem through the use of a priori contrast coding). The aim is to investigate the MANOVA on the response of maize performance to fertilizer type, plot, soil type and method of farming.

2. Materials and method

2.1 Source of data

The data used for this study was secondary, obtained from Ministry of Agricultural Development and Animal Husbandry. Department of agricultural production survey (APS) Gombe State maize production estimate for the period of 11 years (2009 – 2019), and SASAKAWA technology practice. To know the response of fertilizer types, plots, soil types and method of farming on maize performance using MANOVA. The purpose of using MANOVA is to determine the method of farming that contribute greatly and give more quantity on maize performance (production) using multivariate test and to explore how independent variables influence some patterning of response on the dependent variables at 0.05 level of significance. The following assumptions were tested and validated before the real analysis.

2.2 Normal Distribution

The dependent variables are normally distributed within groups. Overall, the F test is robust to non-normality, if the non-normality is caused by skewness rather than by outliers. Test for outliers should be performed and removed or transformed if any in the MANOVA. To test normality statistically, we can use a Shapiro Test on each response for each level treatment and we can also check for normality graphically by looking at the box plots of residuals and looking for equality. Normality means the data are nearly same with mean 0 and variance σ^2 [12]

2.3 Linearity

MANOVA assumes that there are linear relationships among all pairs of dependent variable in each cell. Therefore when the relationship deviates from linearity, the power of the analysis will be compromised [12].

2.4 Homogeneity of variance

Homogeneity of variance assumes that the dependent variables exhibit equal levels of variance across the range of predictor variables. Remember that the error variance is computed (SS error) by adding up, the sums of square error within each group. If the variances in the two groups are different from each other, then adding the two together is not appropriate, and will not yield an estimate of the common within-group variance. Homoscedasticity can be examined graphically or by means of a number of statistical test. To test normality statistically, we can use a Bartletts Test on each response for each level treatment [13].

2.5 Homogeneity of variance and covariance

In multivariate designs, with multiple dependent measures, the homogeneity of variances assumption described earlier also implies. There are various specific tests of this assumption that has minimal impact, if the groups are approximately of equal size. Therefore, every effort should have equal cells sizes. To test this assumption we use Box's M-test. The Box's M-test suggest that the data from all groups have common variance-covariance matrix [13].

2.6 One way MANOVA

In balanced one-way MANOVA, there are *k* samples one from each of *k* different populations, each with *n* observations. The populations being sampled might be individuals subjected to different treatments in a medical experiment or crops being given different fertilizer/watering regimes. If it is not an experiment, the different populations might represent different groups, such as different varieties of a crop or different ethnicities/nationalities for people. Values from observations within a particular group are denoted by y_{ijr} [14]. The model sketch is given below as;

Where i = 1. . . k denotes the sample and j = 1, . . . n denotes the observation within the sample.

	Sample 1 from $N_p(\mu_1,\Sigma)$	Sample 2 from $N_p(\mu_2,\Sigma)$	…	Sample k from $N_p(\mu_k,\Sigma)$
	y_{11}	y_{21}	…	y_{k1}
	y_{12}	y_{22}	…	y_{k2}
	⋮	⋮		⋮
	y_{1n}	y_{2n}	…	y_{kn}
Total	$y_{1.}$	$y_{2.}$		$y_{k.}$
Mean	$\bar{y}_{1.}$	$\bar{y}_{2.}$		$\bar{y}_{k.}$

Total and means are defined as follows:

Total of the *i*th sample $y_{i.}=\sum_{j=1}^{n} y_{ij}$. Overall total: $y_{..}=\sum_{i=1}^{k}\sum_{j}^{n} y_{ij}$.

Mean of *i*th sample: $\bar{y}_{i.}=y_{i.}/n$. Overall mean: $\bar{y}_{..}=y_{..}/kn$.

The model can be written as in equation 1

$$y_{ij}=\mu + a_i+\varepsilon_{ij}=\mu_i + \varepsilon_{ij} \quad (1)$$

Where we assume $y_{ij}\sim N_p(\mu_i,\Sigma)$

For *r* = 1,...,*p*, you can also write the model as in equation 2

$$\begin{pmatrix} y_{ij1} \\ y_{ij2} \\ \vdots \\ y_{ijr} \end{pmatrix}=\begin{pmatrix} \mu_{i1} \\ \mu_{ij} \\ \vdots \\ \mu_{ir} \end{pmatrix}+\begin{pmatrix} \varepsilon_{ij} \\ \varepsilon_{ij} \\ \vdots \\ \varepsilon_{ijr} \end{pmatrix} \quad (2)$$

So that for each variable *r* = 1. . .P, the model as in equation 3

$$y_{ijr}=\mu_{ir} + \varepsilon_{ijr} \quad (3)$$

The null and alternative hypotheses are

$H_O: \mu_1 = \cdots = \mu_k$, $H_1: \mu_i \neq \mu_j$ for at least one pair i≠j

i.e., that each population has the same mean vector and that at least two populations have different mean vectors, or two populations have at least one variable with different means [14].

The null hypothesis can be written also as *p* sets of *k* − 1 equalities:

$$\mu_{12}= \mu_{21}= ...= \mu_{k1}= 0$$

$$\mu_{21}= \mu_{22}= ...= \mu_{k2}= 0$$

$$\vdots \;=\; \vdots \;=\; \;=\; \vdots \;= 0$$

$$\mu_{1p}= \mu_{21}= ...= \mu_{kp}= 0$$

This is a total of p(k − 1) equalities, and any one of these failing is sufficient to make H_O false. The E and H matrices are both *p* × *p*, but not necessarily full rank.The rank of H is min(*p*,v_H), where v_H is the degrees of freedom associated with the hypothesis, i.e *k* − 1. However, if the sample mean vectors were equal for each population, then you would have H = 0 [10].

Thus H has the form

$$H = \begin{pmatrix} SSH_{11} & SPH_{12} & \cdots & SPH_{1P} \\ SPH_{12} & SSH_{22} & \cdots & SPH_{2P} \\ \vdots & \vdots & \vdots & \vdots \\ SPH_{1P} & SPH_{2P} & \cdots & SSH_{PP} \end{pmatrix}$$

Where for example,

$$SSH_{22} = n\sum_{i=1}^{k}(\bar{y}_{i.2} - \bar{y}_{..2})^2 = \sum_i \frac{y^2_{i.2}}{n} - \frac{y^2_{..2}}{kn} \quad (4)$$

$$SPH_{12} = n\sum_{i=1}^{k}(\bar{y}_{i.1} - \bar{y}_{..1})(\bar{y}_{i.2} - \bar{y}_{..2}) = \sum_i \frac{y_{i.1}y_{i.2}}{n} - \frac{y_{..1}y_{..2}}{kn} \quad (5)$$

$$E = \begin{pmatrix} SSE_{11} & SPE_{12} & \cdots & SPE_{1P} \\ SPE_{12} & SSE_{22} & \cdots & SPE_{2P} \\ \vdots & \vdots & \vdots & \vdots \\ SPE_{1P} & SPE_{2P} & \cdots & SSE_{PP} \end{pmatrix}$$

$$SSE_{22} = \sum_{i=1}^{k}\sum_{j=1}^{n}(\bar{y}_{i.2} - \bar{y}_{..2})^2 = \sum_{ij} y^2_{ij} - \sum_i \frac{y^2_{i.2}}{kn} \quad (6)$$

$$SPE_{12} = \sum_{i=1}^{k}\sum_{i=j}^{n}(y_{ij1} - \bar{y}_{i.1})(y_{ij2} - \bar{y}_{i.2}) = \sum_{ij} y_{ij2} - \frac{y_{i.1}y_{i.2}}{n} \quad (7)$$

The E and H matrices can be used in different ways to test the null hypothesis. Wilks' Test Statistic is

$$\mathbf{\Lambda} = \frac{|E|}{|E+H|} \quad (8)$$

The null is rejected if $\Lambda < \Lambda_{\alpha,p,VH,VE}$ where v_H is the degrees of freedom for the hypothesis, k− 1, and v_E is degrees of freedom for error, *k*(*n* − 1). Critical values are in Table 1 below. The test statistic can instead be converted to an *F*, but there are different cases [10].

Table 1: Transformations of Wilk's Λ to Exact Upper Tail F-Tests [14]

Parameters P, V_H	Statistics Having F-Distribution	Degrees of Freedom
Any p, V_H =1	$\frac{1-\Lambda}{\Lambda}\frac{v_E - p + 1}{p}$	p, $v_E - p + 1$
Any p, V_H =2	$\frac{1-\sqrt{\Lambda}}{\sqrt{\Lambda}}\frac{v_E - p + 1}{p}$	2p, 2($v_E - p + 1$)
P=1,any V_H	$\frac{1-\Lambda}{\Lambda}\frac{V_E}{V_H}$	V_H,V_E
P=1,any V_H	$\frac{1-\sqrt{\Lambda}}{\sqrt{\Lambda}}\frac{v_E - 1}{V_H}$	$2V_H$,2(V_E-1)

Table 2: One Way MANOVA [14]

Source variation	Degree of freedom(df)	Matrix sum of squares	F-ratio
Treatment	V_H = K-1	$\|H\|$	$\frac{\|H\|}{\|H+E\|}$
Error within	$V_E = \sum n_i - K$	$\|E\|$	
Total	$\sum n_i - K$	$\|H+E\|$	

2.7 Hypothesis Testing in MANOVA

All current one way MANOVA tests are made on **A** = **E**$^{-1}$H. There are four different multivariate tests that are made on **E**$^{-1}$H. Each of the four test statistics has its own associated *F* ratio. In some cases the four tests give an exact *F* ratio for testing the null hypothesis and in other cases the *F* ratio is approximated. The reason for four different statistics and for approximations is that, the mathematics of MANOVA gets so complicated in some cases. In terms of notation, assume that there are *q* dependent variables in the MANOVA, and let λ_i denote the ith eigenvalue of matrix **A** which, of course, equals **HE**$^{-1}$ [14].

The four most widely used measures for assessing and testing statistical significance between groups on the independent variables are [10]:

a. Wilk's lamda
b. Roy's Largest Root
c. Pillai's Criterion
d. Hotelling's Trace

2.7.1 Wilk's Lambda

Wilk's Lambda is a test statistics used in MANOVA)to test whether there are differences between the means of identified groups of subjects on a combination of dependent variables. wilk's lamda was the first MANOVA test statistics developed and is very important for several multivariate procedures in addition to MANOVA. It was proposed by [15]. This statistics (Wilk's) may be defined as the ratio of the two determinants (variances) of the S matrices.

The test statistics is mathematically define as

$$\Lambda = \frac{|E|}{|E+H|} \quad (9)$$

The null is rejected if $\Lambda < \Lambda_{\alpha,p,V_H,V_E}$ where V_H is the degrees of freedom for the hypothesis, $k-1$, v_E is degrees of freedom for error, $k(n-1)$ and p is the number of variables

The quantity (1- Λ) is often interpreted as the proportion of variance in the dependent variables explained by the model effect however, this quantity is not unbiased and can be quite misleading in all samples [15].

It can be shown that the value of λ_i may be determined in a manner other than as in above this determination involves finding functions of matrix called eigenvalues. The matrix of interest for the Wilk's λ_i is actually a product of two matrices $E^{-1}H$ where the p × p matrices, E and H are as described earlier. The eigenvalues are obtained by solving the determinant equations [15].

$$|E^{-1}H - \lambda_i I| = 0.$$

Thus Wilk's Λ is computed as:

$$\text{Wilk's Lambda: } \Lambda = \prod_{v=1}^{a}\left(\frac{1}{1+\lambda_i}\right) \quad (10)$$

The number of non-zero eigenvalues of $E^{-1}H$ is q = min (p, h) which is the rank of the H. The matrix HE^{-1} has the same eigenvalues as $E^{-1}H$ and could be used in its place to obtain Λ . However we prefer $E^{-1}H$ because we use it in eigenvectors.

2.7.2 Roy's largest root

This test measures the differences on only the first discrimination function among the dependent variables. This criterion provides advantages in power and specificity of the test but make it less useful in certain situation where all dimensions should be considered. This test is more appropriate when the dependent variables are strongly interrelated on a single dimension but it is also the measure that severely affected by violation of assumptions. This is often test for Ho $=\mu_1 = \mu_2 = \cdots \mu_{k,}$ based on λ_i, we use Roy's largest root to test for differences in vectors v. The test statistic is computed as;

Roy's largest root, $\theta = \frac{\lambda_i}{1+\lambda_i}$ (11)

The maximum eigenvalue of A=HE $^{-1}$ (Recall that a "root" is another name for an eigenvalue) Hence, this statistic could also be called Roy's largest eigenvalue. In some cases; the four test statistics will generate identical F statistics and identical probabilities. In others, they will differ. When they differ, Pillar's trace is often used because it is the most powerful and robust. Roy's largest root is an upper bound on F, it give a lower bound estimate of the probability of F. Thus, Roy's largest root is generally disregarded when it is significant but the others are not significant [16]. Generally, if group sizes are equal, the tests are sufficiently robust with respect to heterogeneity of covariance matrices so that we need not to worry. If the n^{ith} are unequal and we have heterogeneity, then the α -level of the MANOVA test may be affected as follows. If the larger variance and covariance are associated with the large samples, the true a-level is reduced and the tests become conservative. On the other hand, if the larger variances and covariance come from the smaller samples, α inflated, and the tests become liberal [17].

2.7.3 Pillai's trace

The Pillai's trace is the sum of explained variances on the discriminant variates, which the variables are computed based on canonical coefficients for a given root. The larger the Pillai's trace, the more the given effect contributes to the model. Pillai's trace is always smaller than Hoteling's trace. This is the robust test of all. Each test is preferred in differing situations. [18].

Pillai's criterion is considered more robust and should be used if sample size decreases, unequal cell sizes appear or homogeneity of covariances is violated. Some statisticians consider it to be most powerful and most robust of four statistics .An alternative criterion for testing the null hypothesis Ho $=\mu_1 = \mu_2 = \cdots = \mu_j$, was proposed by [19].

The formula for the Pillai's Trace is given as:

Pilla's Trace, $v^s = \sum_{i=1}^{s} \frac{\lambda_i}{1+\lambda_i}$ (12)

2.7.4 Hotelling's - lawley's trace

It is a test to assess the statistical significance on the difference of the mean of two or more variables between the groups. It is a special case of MANOVA used with two or more groups of a treatment variable. The larger the Hoteling's trace, the more the given effect contributes to the model. [20] is defined as

Hoteling's Trace $=\sum_{i=1}^{q} \lambda_i$ (13)

3. Result and discussion

Tables 4 to 7 and Figures 1 to 3 are given below in order to ascertain and interpret the outcomes of our findings. Table 3 and 4 affirm that the data is normally distributed which is free from outliers while Tables 5 and 6 shows that the data are homogenous in nature indicating that it has equal variance and covariance which signal how significance it is. Also Figure 1 to three shows the box plot which the difference between the two methods of farming and the effectiveness of fertilizer using two different method of farming and there production output.

Table 3: Shapiro-Wilk normality test for SASAKAWA and Cultural practice

Shapiro-Wilk normality test	**W**	**p-value**
Sasakawa Practice	0.97098	0.5079
Cultutural Practice	0.87753	0.3172

The Shapiro-Wilk normality test, test the null hypothesis that the data are normally distributed. From Table 3 all the two variables reports a p-value>0.05. Thus we accept H_o and concluded that normality assumption was violated, in the factor i.e. SASAKAWA and Cultural practice, which means the two method are not the same. Hence SASAKAWA modern practice is more effective than the traditional cultural practice because of the seed and chemical improvement.

Table 4: Shapiro-Wilk normality test Area, Fertilizer and production

Shapiro-Wilk normality test	W	p-value
Area	0.75225	0.0000978
Fertilizer	0.89152	0.02019
Production	0.89152	0.1402

From Table 4 the residual for two variables i.e Area and Fertilizer reports a p-value <0.05 Thus we reject H_o and concluded that normality assumptions was present and the variable production reports a p-value >0.05 .Thus we accept H_o and concluded that normality assumptions was violated. Hence, we can conclude that a medium size area that has modern fertilizer will give more yield than large area of land without fertilizer. From Table 5 all the three variables reports a p-value<0.05. Thus we reject H_o and concluded that homogeneity among the variances exist. Homogeneity of Variance indicates the amount of yield produce in an area with enough fertilizer than the area without fertilizer. Hence ascertain that SASAKAWA practice produce higher quantity of yield than Cultural Practice.

The Box's M-test suggest that the data from all groups have common variance-covariance matrix . From table 6 (p – value = 0.2658 > 0.05). So this assumption wasn't violated. Box's M-test for homogeneity of Covariance matrices approximate the value of Chi-square and shows how good practicing modern method is with cultural practice.

Table 5: Bartlett test of homogeneity of variances Area, Fertilizer and production

Bartlett test	Bartlett's K-squared	Df	p-value
Area	0	1	0
Fertilizer	4.2311	1	0.03969
Production	11.499	1	0.0006964

Table 6: Box's M-test for Homogeneity of Covariance Matrices Method

Box's M-test	Chi-Sq (approx.)	Df	p-value
Method	14.569	12	0.2658

Decision: The p-value (0.00000009042) corresponding to the Method of farming is less than level of significance (0.05), therefore we reject null hypothesis for all the four test statistics and concluded that there is significant difference between the means of the two method of farming. From table 7, we made a general conclusion that fertilizer types, plots and soil types have significant effect on maize performance. Also SASAKAWA Practice is more effective and give higher quantity of yield than Cultural Practice because of improve seed and fertilizer.

From Figure 1, it shows the mean of the SASAKAWA and cultural practice of the fertilizer applied in the plots. From Figure 1 SASAKAWA produces more than cultural method of farming as a result of applying modern fertilizer. From Figure 2 it shows the mean of the SASAKAWA and cultural practice of the production for the periods of 11 years. SASAKAWA Practice produces more quantity of maize yield than Cultural practice.

Table 7: MANOVA table for Multivariate test statistics

Criterion	Df	Test statistics	approxF	NumDf	Den Df	Pr(>F)
Wilk's	(1,20)	0.14453	35.515	3	18	0.00000009042
Hotelling-lawley	(1,20)	5.9192	35.515	3	18	0.00000009042
Pillai's	(1,20)	0.85547	35.515	3	18	0.00000009042
Roy's	(1,20)	5.9192	35.515	3	18	0.00000009042

Figure 1: Boxplots for fertilizer applied for both method of farming

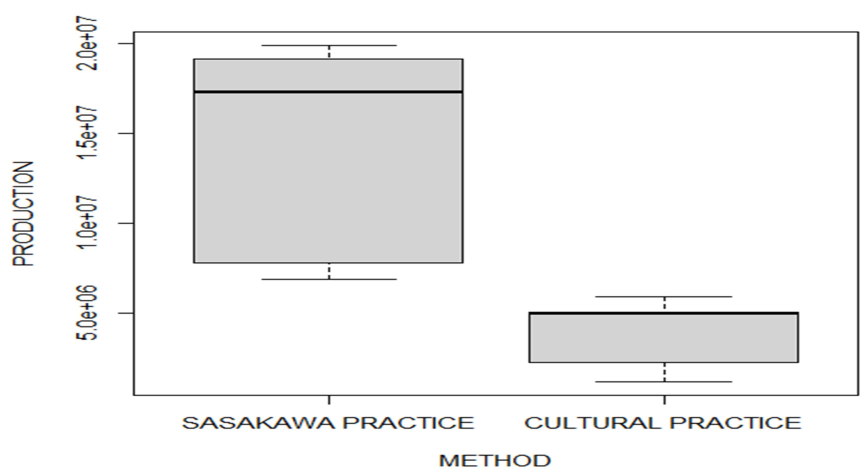

Figure 2: Boxplots for production for both method of farming

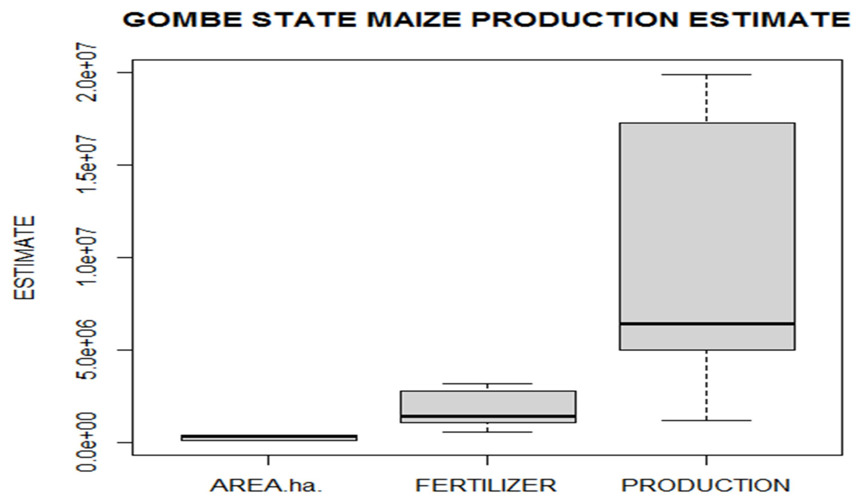

Figure 3: Boxplots for Gombe state maize production estimate

From Figure 3 it shows the estimated area, fertilizer and production of Gombe state maize production estimate for the period of 11 years. This ascertains that a fertile land mixed with modern fertilizer will produce more maize yield than land without modern fertilizer. Hence the estimate will be different.

4. Conclusion

In this research, we observed the effects of maize yield to fertilizer type, plot type and soil type. Taking method of farming as our major independent variable with two factors SASAKAWA and Cultural practice, our dependent variables are area, fertilizer and production for the period of 11 years .We tested some assumptions of MANOVA, normality test is violated in the factors and residual of production are significant in the residuals of others. Box's M test for homogeneity of variance and Bartlett's test for homogeneity of variance assumptions were not violated. The four Multivariate test statistics; Wilk's lambda, Pillai's trace, Hotelling-Lawley trace and Roy's largest root were all significant. Univariate analysis of variance for the response variable show significant difference in fertilizer and production, while area show no difference, partial eta-squared show that for individual differences in group 85.5% of the variance of the estimates are due to the difference in the method of farming. Lastly we concluded that using modern method of farming will bust and contributed to the high quantity of maize yield production in Gombe state. Also recommend that government and non – governmental organization should empower farmers with subsidies improve seeds and modern fertilizer in order to enhance their production capacity and also organize a routine sensitization and enlightenment awareness on the important of modern farming as against the cultural farming.

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