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Comparative Study on the Effect of Organic and Inorganic Fertilizers on Maize Yield

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Abstract: *Organic and inorganic fertilizers are two broad classes of fertilizer that have distinct functional properties that may depend on various factors. In this work, independent T-Test statistics are employed to compare the effectiveness of organic fertilizer and inorganic fertilizer on the yield of maize. The study arises as a solution approach to settle some debates among farmers on the use of organic and inorganic fertilizers in maize production. Data were collected from the Agricultural Research Institute in Tarauni local government area of Kano state, Nigeria) and analyzed statistically. The collected data were categorized into two groups, namely, (i)based on the number of cobs per maize plant and (ii) based on the number of grains per maize cob. The analysis has shown that inorganic fertilizers (NPK) produce higher maize yields than organic (farmyard manure) with a dependable function on the number of cobs per plant and the number of grains per maize cob.*

Keywords: *Organic, inorganic, maize, fertilizer, farmyard manure, soil fertility, NPK Nitrogen (N) Phosphorus (P) Potassium (K)*

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1.0 Introduction

Inadequate nutrient supply is one of the major constraints affecting crop production in Nigeria because the cultivated areas by farmers need to be supplemented with synthetic fertilizers in addition to organic fertilizers for the improvement of agricultural productivity (Zhnag *et al*., 2023). Globally there is growing interest in the use of traditional fertilizers due to the depletion in soil fertility arising from the frequent use of chemical fertilizers (Li *et al*., 2023). Such usage can cause potentially hazardous effects on the environment (Albert and Bloem, 2023). The recycling and use of nutrients from organic manure have been given more consideration concerning effective land use and agricultural productivity (Verhulst *et al*., 2010). Some researchers believe that the use of organic fertilizer is more effective than inorganic fertilizer on maize yield (Jjagwe *et al*., 2020). Maize (*Zea mays*) is a member of the grass family Poaceae, a classification it shares with, many other important crops including wheat, rice, oat sorghum and sugarcane (Elisa *et al*., 2022). The maize crop is one the world's leading crops cultivated over an area of 159 million hectares with a

global production quota of 1,141,359,868 billion metric tons in 2019 which increased by 1.84% to 1,162,352,997 metric tons in 2020 which is ahead of rice production with a figure of 499.6 million tons and wheat,772 million metric tons (Erenstein *et al*., 2022). Although the United States of America is the largest producer of maize, in Nigeria, maize is the most important staple food among the cereals that are cultivated in the largest land mass (Olasehinde, *et al*., 2023). The application of organic and inorganic fertilizers are very essential to the growth and production of maize because of their ability to renew the nutrient content of the soil and accessibility to crops. However, each class of fertilizer contains different ingredients and supplies these nutrients in different ways. Organic fertilizers work overtime to create a healthy growing environment, while inorganic provide rapid nutrition. On the contrary, excessive application of inorganic fertilizers can lead to negative environmental consequences. Making your choice on which should be better for your plant depends among other things on the need of the crop and your preferences in terms of cost and environmental impact. While there is an increased need for the use of synthetic fertilizers, their excessive use is associated with soil, water, and air pollution. Furthermore, inorganic fertilizers are expensive and their use may not be economically justifiable, especially for the poor smallholder farmers who mainly practice subsistence farming. The use of organic amendments such as cattle manure is an alternative to these tremendous effects of inorganic fertilizers because of its widespread availability, its additional value for soil carbon sequestration, and its capacity for storing and releasing nutrients. To achieve high maize yields, it is important to maximize the number of cobs per plant as well as the number of grains per cob. Different varieties of maize crops that were supplied with organic fertilizer produce different yields compared to the yield of maize that is been supplied with inorganic fertilizer. Saha *et al*., (2008) inferred that the use of organic manures alongside inorganic fertilizers often leads to increased soil organic matter (SOM), soil structure, water holding capacity and improved nutrient cycling and helps to maintain soil nutrient status, cation exchange capacity (CEC) and soil biological activity.

Although chemical fertilizers are an important input to get higher crop productivity, over-reliance on chemical fertilizers is associated with declines in some soil properties and crop yields over time and causes serious land problems, such as soil degradation (Zhai *et al*., 2023).Synergistic effects of organic manures with inorganic fertilizers accumulate more total nitrogen in soils (Huang et al., 2007), but the sole application of farm yard manure (FYM) resulted in an increased yield of maize (Morris *et al*., 2007).

Toungos Mohammed (2019) during his research on the effect of organic and inorganic fertilizers on maize yield in the Mubi Local government Area of Adamawa State Nigeria uses several types of fertilizers to assess their effectiveness on maize yield. He records plant height at three weeks intervals after fertilizer application. He used cow dung, NPK, and a combination of NPK and cow dung and also set up the control. The results obtained indicated that those applied with cow dung had the tallest plant 6 weeks after supplication with 49.02cm followed by NPK with 48.52 cm, while the combination had 46.11 cm and the controlled with 41.06 cm. The work led to the conclusion that the effect of organic and inorganic fertilizers on growth and maize yield parameters of maize has a significant difference. Plants supplied with NPK gave the highest yield of 4620.6kg/ha^{-1}. Even though there was no significant difference with those applied with a combination of cow dung and NPK which gave 4430.7kg/ha^{-1}. The control recorded the lowest yield with 2035.2kg/ha^{-}

The present study aims to conduct a comparative study on the effect of organic and inorganic fertilizers on maize yield. This should be achieved through the following objectives:

- To find out if there is a significant difference between organic and inorganic fertilizers on maize yield.
- To examine which fertilizer gives the optimum yield between organic and inorganic.
- To find out if there is a significant difference between the number of grains per maize cob raised using the two different fertilizers respectively.

2.0. Materials and Methods

2.1 Design of the study

The study was conducted by collecting a secondary source of data from the Agricultural Research Institute Tarauni. The data was based on two variables (i.e. maize cob and maize grain). The first data collected was based on the number of cobs per maize plant that are solely grown with farmyard manure while the second data was collected based on the number of grains per maize cob that are grown using NPK fertilizers. 100 samples were taken randomly in both cases. Table 3.1.1 shows data on the number of cobs per maize plant in both cases while Table 3.1.2

3.2 A statistical package for the social sciences (SPPS) was used to analyze the data. Two samples independent T-TEST was carried out. Tests for equality of means and equality of variances were carried out as well but the analysis was made based on the assumption of equal variances. The significant difference level was expressed at $p<0.05$ probability level.

4.0 Results

Table 1 shows group statistics data for the effect of fertilizers on maize. Consideration of the results presented in the Table reveals that the mean cobs for a particular maize plant raised using organic fertilizer are 2.52 cobs and the mean cobs for a particular maize plant raised using inorganic fertilizer is 2.99. This suggests that an average maize plant grown with organic fertilizer will grow 2.52 cobs per plant while that of inorganic on average will grow 2.99 cobs per plant. The standard error of the mean describes how precisely the sample means to estimate the population means. Since the standard error of the means is both small, they indicate a precise estimate of the population mean and the small standard deviations show that the variability within the samples is also minimum.

Table 1: Group Statistics

	Fertilizer	N	Mean	Std. Deviation	Std. Error Mean
Cobs	Organic	100	2.5200	.85847	.08585
	Inorganic	100	2.9900	.57726	.05773

Table 2 presents 95% confidence interval test for equality of the mean at upper and lower levels while Table 3 presents test results for the equality of variance. The two sample t-test estimates that the mean difference is -0.47000. however, the estimate is based on 200 observations split between two groups and it is unlikely to be equal to the population difference. The confidence interval indicates that the mean difference between these two methods for the entire population is likely between -0.26599 and -0.67401. The negative value (-0.47000) reflects the fact that organic fertilizer has a lower mean than inorganic fertilizer (i.e., 2.52-2.99 <0). The confidence interval excludes zero (no difference), hence

we conclude that the population means are different.

Table 2: 95% confidence interval test for equality of means

		t-test for Equality of Means
Cobs		95% Confidence Interval of the Difference
		Upper
Fertilizers	Equal variances assumed	-.26599
	Equal variances not assumed	-.26581
		t-test for Equality of Means
Cobs		95% Confidence Interval of the Difference
		Lower
Fertilizer	Equal variances assumed	-0.67401
	Equal variances not assumed	-0.61408

Table 3: Test for equality of variances

	Test statistics	p-value
F-test	2.21	0.000
Levene test	13.12	0.000

Table 3 is an output from an F-test for equal variances at 5 % level of significance with t=2.21 and p-value = 0.000 which is significant since it is less than 0.05. Thus, provides sufficient evidence that the variance of the two groups is equal and therefore we shall proceed with an independent t-test of equal variances assumed. If we are to stick to the equal variances assumed, our t-value = -4.543 (Table 5) and we have 198 degrees of freedom.

Table 4: Independent samples test

		t-test for Equality of Means		t-test for Equality of Means	
		F	Sig.	t.	df.
GRAINS	Equal variances assumed	11.281	0.000010	-4.543	198
	Equal variances not assumed			-4.543	178.268

Our significance or p-value is 0.000010 and since it is less than 0.05 we are to reject the null hypothesis at 5% level of significance and conclude that, there is a significant difference between the number of maize cobs per maize plant raised with organic fertilizers and number of maize cobs per maize plant raised with inorganic fertilizer.

2nd Hypothesis

H_0: there is no significant difference between the number of grains per maize cob for both organic and inorganic fertilizers

H_1:there is a significant difference between the number of grains per maize cob for both organic and inorganic fertilizers.

It is evident from Table 5 that the mean grain for organic is 255.80 and the mean grain for inorganic is 367.67. Here from the above output tables of the analysis, we can see from the first table that the mean grains for a particular maize cob raised using organic fertilizer is 255.8000 grains and the mean grains for a particular maize cob raised using inorganic fertilizer 367.6700 grains. This means that an average maize plant grown with organic fertilizer will grow 255.8000 grains per cob while that of inorganic on average will show a response estimated at 367.6700 grains per cob. The standard error of the mean describes how precisely the sample means to estimate the population means. Since the standard error of the means is both small, they indicate a precise estimate of the population mean and the small standard deviations show that the variability within the samples is also minimum.

Table 5: Group statistics

	FERTILIZER	N	Mean	Std. Deviation	Std. Error Mean
GRAINS	ORGANIC	100	255.8000	106.03935	10.60393
	INORGANIC	100	367.6700	149.85441	14.98544

Table 6: 95%confidence interval test for equality of means

		t-test for Equality of Means
Grains		95% Confidence Interval of the Difference Upper
	Equal variances assumed	-75.66820
Fertilizer	Equal variances not assumed	-75.64355
		t-test for Equality of Means
Grains		95% Confidence Interval of the Difference Lower
	Equal variances assumed	-148.07180
Fertilizer	Equal variances not assumed	-145.06741

Table 7 above is an output from an F-test for equal variances at 5 % level of significance with t=2.00 and p-value = 0.001, the Levene test also signifies equal variance which is significant since it is less than 0.05. Thus, provides sufficient evidence that the variance of the two groups is equal and therefore, we shall proceed with an independent t-test with equal variances assumed.

Table 7: Test for equality of mean

	Test statistics	p-value

F-test	2.00	0.001
Levene test	10.83	0.001

From Table 8, it is indicative that if we are to stick to the equal variances assumed, the t-value = -6.094 and we have 198 degrees of freedom. Our significance or p-value is 0. 001 and since it is less than 0.05 we are to reject the null hypothesis at 5% level of significance and conclude that, there is a significant difference between the number of grains per maize cob for the two different groups respectively. Therefore, the data sample provides us with sufficient evidence that the two population means are not equal. Specifically, the inorganic fertilizer means is greater than that of the organic. Hence since the number of grains is also greater in favour of inorganic, then the effect of inorganic fertilizer on maize yield is higher than that of organic fertilizer on maize yield. The two sample t-test estimates that the mean difference is -111.87. However, the estimate is based on 200 observations split between two groups and it is unlikely to be equal to the population difference. The confidence interval indicates that the mean difference between the two fertilizers' effect on the number of grains per maize cob for the entire population is likely between -75.66820 and -148.07180. The negative value reflects the fact that organic fertilizer has a lower mean than inorganic fertilizer (i.e., 255.8000-367.6700<0). The confidence interval excludes zero (no difference), and we conclude that the population means are different.

Table 8: Test for equality of means

		t-test for Equality of variances		**t-test for Equality of Means**	
		F	Sig.	t.	df.
GRAINS	Equal variances assumed	11.281	0.001	-6.094	198
	Equal variances not assumed			-6.094	178.268

4.0 Conclusion

In modern agriculture, the management of nutrients and fertilizer application are the most important factors affecting plant growth, yield, quality and performance after the availability of water. The result of this study brought to light that inorganic fertilizers on maize produce higher yields than organic as all farmers would like it but not without paying the price of unfavourable environmental conditions. In addition to the variables taken into account, it is been observed that maize plants grown with inorganic produce more leaves and are lengthier than maize grown by organic fertilizers. Our conclusion regarding this research is that inorganic fertilizers produce higher maize yields and prove much more effective than organic fertilizers, particularly nitrogenous fertilizers. On average, maize yield and quality of maize are significantly affected by the application or use of inorganic fertilizer. The highest number of grains per maize cob (organic) out of the 100 maize cobs is 424 the inorganic is 672 grains which is a significant difference between the two. It is also recommended that further research be taken to discover new modern application methods and an appropriate amount of inorganic fertilizer based on the type or variety of maize.

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