

## Evaluation of the Agricultural Efficiency of Different Combinations of Poultry Manure and NPK Cabbage Yield (*Brassica oleracea*, var. *Acephala*) in Maputo: A Contribution to Sustainable Land Use

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### ABSTRACT

As recommended by the United Nations, member countries must make efforts to ensure an acceptable quality of life for their populations, developing actions that make it possible to achieve the 17 Sustainable Development Goals (SDGs) by 2030. Seeking to respond to this call, the present research was developed as a relevant strategy for the pursuance of these objectives, highlighting: SDG15 (Protect Life on Earth), SDG12 (Sustainable Production and Consumption), SDG13 (Climate Action), SDG2 (Eradicate Hunger) and SDG1 (Eradicate poverty) . The main aim of the study is *to evaluate the agricultural effectiveness of poultry management (organic) and its mixtures with mineral fertilizer (NPK) in different proportions in the growth of the cabbage crop in Baixa de Infulene in Maputo, as a contribution to the sustainable and safe use of land.* Baixa de Infulene is characterized by being the largest and most relevant green belt in Maputo City; where different vegetables are produced that supply most of the markets in the city and province of the same name. The research problem is based on three main aspects: i . excessive and uncontrolled use of chemical/mineral fertilizers, without prior knowledge of the real soil nutrient demand, making them dependent and contaminated, ii. proliferation of poultry handle in areas where poultry is cultivated in the city and province of Maputo without adequate destination and treatment, which contributes to the contamination of soil, surface water and springs, iii. Existence of cases of food poisoning among consumers of vegetables produced in this area. Starting from two premises: H<sub>0</sub>: mixtures of poultry manure with NPK do not influence the development of Cabbage and H<sub>1</sub>: mixtures of poultry manure with NPK influence the development of Cabbage, field observation, semi-structured interview and experimentation were defined as a methodology for carrying out the research. The study parameters were defined as *growth time, leaf blade size, plant weight, plant height, number of commercial leaves, leaf appearance and degree of attachment to the soil, measured over 45 days.* Six (06) soil fertilization treatments (T) were carried out, namely: (T 1) with application of only 100g NPK per plot, (T2) only poultry manure in the proportion of 7Kg/plot, (T3) 3.5 Kg poultry manure and 50g NPK, (T4) 25g NPK and 5Kg poultry handling, (T5) 75g NPK and 1.5 Kg chicken handling and the control treatment T0 where no fertilization regimen was applied. The results of the interview showed that all of them use mineral fertilizer, NPK and none of them has ever tried mixing it with organic waste (poultry manure). Regarding the experimentation, the results show that, in the production of Kale, fertilization provides satisfactory yields in terms of weight, height and number of leaves per plant. For the fresh weight variable, higher cabbage yields (1.1Kg/Plant) were obtained in the treatment (T3 - 50 grams of NPK and 3.5Kg of poultry handling per plot). Treatment T4 showed the lowest value of fresh weight (0.4Kg/Plant). With regard to plant height, the best result was also obtained in the treatment (T3 - 50 grams of NPK and 3.5Kg of poultry handling per plot). On the other hand, the non-fertilized area showed lower values for these parameters. Regarding the number of leaves/plant, higher yields were obtained in the treatment (T1 - 100g/plot) with an average of 14.1 leaves/plant. The other fertilization models did not show a significant effect on the number of leaves/plants, given that the control treatment T0 presents an average (12.2) of leaves/plant, being higher than the other treatments. Based on these results, it is concluded that fertilization based on mixtures of NPK and poultry manure positively influences the development and appearance of cabbage. Thus, farmers are recommended to use these mixtures with greater emphasis for T3, contributing to the reduction of financial waste and improving the quality of the Cabbage produced, as well as the excessive use of chemical fertilizers, which will guarantee a sustainable and safe use of the soil in that plot.

**Key words:** *Organic fertilization, clean production, agricultural waste recovery, sustainable land use.*

## INTRODUCTION AND PROBLEM STATEMENT

The demand for food in quantity and quality has been debated in various world social spheres and in Mozambique in particular [6,8]. In Mozambique, more than half of the population (63%) lives in rural areas and agriculture is the main economic activity for the income generating and subsistence, [1, 9, 11].

Unfortunately, agriculture practiced in rural and suburban areas is for sustenance, using rudimentary production equipment and techniques (short-handled hoes, animal traction and no use of agrochemicals), which translates into low productivity associated with the use of less productive sandy soils, [2, 3].

This model of agriculture, in addition to being exhausting for the producers provides poor productivity, which significantly contributes to food shortages, putting families in a situation of hunger and severe chronic malnutrition, [1, 2]. To address this problem, the Government of Mozambique has encouraged rural producers to organize themselves into Agricultural Associations to access funding and technical assistance through government projects, with emphasis on the current project, SUSTENTA, [3, 7, and 13] .

This model of agriculture encourages the use of agricultural equipment and agro-chemicals that make it possible to increase productivity, but it causes a great degradation of soils, making them less productive, vulnerable to erosion and contamination of watercourses, in the long term, contrasting with the United Nations, Sustainable Development Goals, namely: SDG12, SDG13 and SDG15, [4, 5].

In urban areas, the case of Baixa do Infulene in Maputo, the cultivation of vegetables with emphasis on Cabbage has taken on alarming proportions and the use of pesticides and agro-chemicals to accelerate productivity has been a common practice among producers. In these areas, the use of mineral fertilizers predominates, especially *Nitrogen-Kallium-Phosphorous (NKP)*, considered polluting and toxic, [3, 7, 9 and 16].

On the other hand, Maputo is one of the main chicken/broiler producers, and the production system generates a significant amount of biodegradable solid waste with recognized agricultural potential, [2, 6 and 9]. Despite its agricultural potential, poultry manure is not properly used in the production of cabbage, thus constituting on a public health problem because its management is inefficient, [6, 8 and 13].

In this way, the search for a balance between "increased productivity and environmental protection" is the main reason for carrying out this study oriented towards the following starting question: ***What is the agricultural effectiveness of mixtures of poultry manure and NPK in the development and quality of Cabbage (*Brassica Olareceae*) cultivated in Biaxa de Infulene, Maputo City?***

## OBJECTIVES

This study seeks to:

- Determine the agronomic parameters of Cabbage (fresh weight, height and number of kale leaves under different conditions of organic fertilization ) in the different experimental areas;
- Compare the agronomic parameters of Cabbage (fresh weight, height and number of kale leaves under different conditions of organic fertilization) in different experimental areas;
- Analyze the environmental and economic viability of using poultry manure in the production of cabbage.

## RESEARCH METHODOLOGY

This research is classified as applied in terms of nature, experimental in terms of procedures and exploratory in terms of objectives. The methodology adopted consisted of the experimental method, prioritizing a mixed approach (quantitative and qualitative) based on systematic non-probabilistic sampling. To achieve the objectives, systematic observation and experimentation were used as data collection techniques.

- **Location of the study area**

The study was carried out in the province of Maputo, in the south of Mozambique, where the majority (~98%) of the population is engaged in agriculture as their main activity for subsistence and income [5].

The study area is the lower zone, Baixa de Infulene, one of the largest horticultural production centers in the province. The study was carried out specifically in the neighborhood of Inhagoia A, which is historically known as an area with the highest production of vegetables in Maputo, being responsible for supplying the entire city of Mpauto and a large part of the Matola city, [10]. The study area is shown in Figure 1 below:



**Figura 1:** Geografic location of the study area

- **Field work and experimental analysis**

To achieve the objectives proposed, an field experiment was carried out in an agricultural area in Bairro do Inhagoia A in order to determine the effect of different combinations of NKP and poultry manure on the growth of cabbage (*Brassica oleraceae*). The experiment was installed on November, 2021.

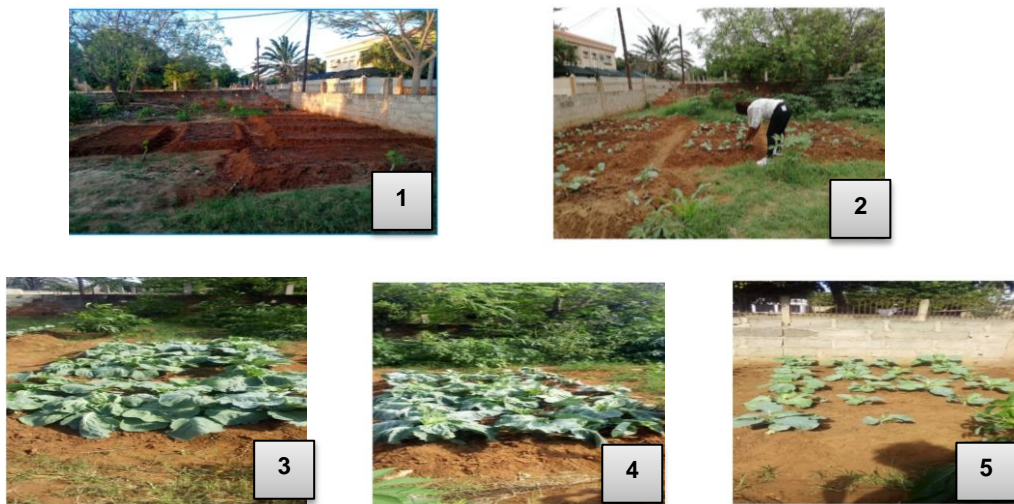
The tests were carried out in six (06) rectangular plots of 4.2 m<sup>2</sup> in area. The following parameters were defined: *growth time, leaf blade size, plant weight, plant height, number of commercial leaves, leaf appearance and degree of attachment to the soil*, measured during 45 days.

To analyze the agricultural effectiveness of the mixtures, Six (06) soils were made fertilization treatments (T) as shown in table 1 below:

**Table 1:** Characterization of the different treatments performed

Treatments	fertilized area	Proportions
T1	NPK only	(100g of NPK/portion)
T2	Poultry manure only	7kg/portion
T3	Poultry manure and NPK	50g of NPK and 3.5Kg of Poultry Manure per Plot
T4	NPK and dung	25g of NPK and 5Kg of Poultry Manure per Plot
T5	NPK and dung	75g of NPK and 1.5Kg of Poultry Manure per Plot
T0	Control site	No application of any fertilizer

Soil preparation was carried out manually, with a hoe, proceeding with raising the soil and transplanting locally acquired cabbage seedlings. The irrigation of the areas was done twice daily, during the morning and late afternoon, being carried out manually using the watering can. Weed control was carried out by hand weeding. The figure below shows the development level of cabbage under different fertilization conditions.



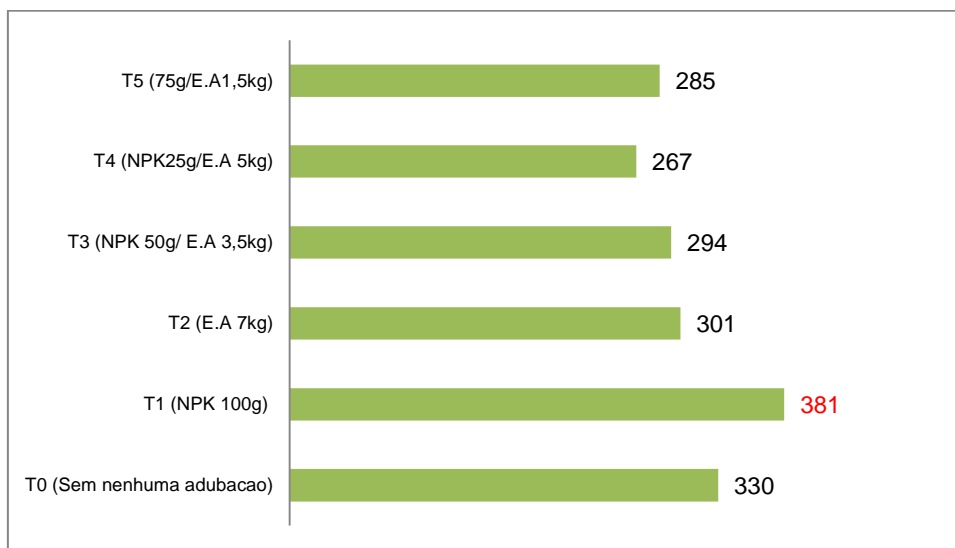
**Figure 1:** Soil preparation (1 and 2) and Cabbage development in the treated areas (3, 4 and 5)

## RESULTS AND DISCUSSION

Considering the objectives and the outlined methodology, the results are presented in three main categories, all in line with the initial question formulated, regarding the verification of the influence of the mixtures of poultry manure with NPK in the development and appearance of the Cabbage.

- **Yield analysis analysis results (number of leaves per plant)**

Treatment T1 had the highest average in terms of number of leaves (NL) per plant (11.4) when compared to the other treatments, with the lowest average found in treatment T4 (NPK 25g/Poultry Manure 5kg) with the value of 9.9 leaves per plant, which is lower than the control treatment (T0) where no fertilization method was applied. The results obtained for this analysis are presented in the following graph:



**Figure 2:** Graph with yield (number of leaves/plant) in different treatments

This result is in line with previous studies by, [11, 12 and 13,] which prove that fertilization of cabbage and other Brassica crops favors their yield. Overall results show that Treatment T4 does not favor most yield indicators (plant weight and number of leaves), [14, and 15]. This could be a result of excess nutrients or another factor that could be explored in further research, [6 and13].

The Coefficient of Variation is generally close to normal (26%) for the various treatments in the present study, thus being an indicator of homogeneity of data from the experiments, [11,14]. In general terms, in order to obtain a greater number of leaves per plant, fertilization using the T1 treatment (NPK 100g) would be recommended to obtain greater yields by farmers. The figure below clearly shows the differences between the various treatments, [9, 14, 15 and 16].

- **Yield analysis analysis results (number of leaves per treatment regime)**

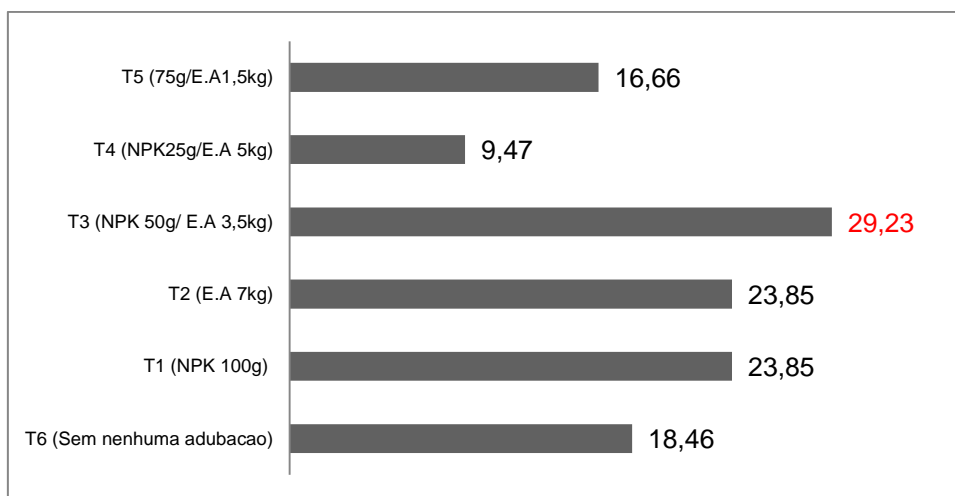
The results of this analysis indicate that treatments T1 and T2 did not present statistically significant differences between them.

The Coefficient of Variation is generally high for the various treatments in the present study, as was also obtained by [14, 16 and 18]. According to them, “the coefficient of variation is a measure of dispersion used to estimate the precision of experiments and represents the standard deviation expressed as a percentage of the mean”.

On the other hand, a low coefficient of variation is desirable in scientific research. According to [15,16 and 17], the coefficient of variation is low when it is less than or equal to 25% . A low CV indicates homogeneity of experiment data. The high variation found in the study may be related to the microenvironment of the study site, such as shading or other variables.

In general terms, the application of poultry manure or its combination with NPK presents higher yields. Based on the results, fertilization of the cabbage crop using the T3 treatment (NPK 50g/ Poultry Manure 3.5kg) can be recommended to obtain higher yields by farmers. However, it is

necessary to adjust the proportions depending on the size of the farmer's cultivation area. The figure below clearly shows the differences between the various treatments.



**Figure 3:** Graph with yield (number of leaves/plant) in different treatments

- **Aspect analysis analysis results (leaf height in different treatments)**

Plant height is another very important yield indicator in assessing agricultural efficiency, [7, 13 and 16]. Its analysis as a yield indicator is suggested by [18,17 and 6], in their studies concerning the quantitative analysis of plant growth. The table below shows the result of height yield of cabbage plants when subjected to different fertilization regimes and combinations.

The results of the analysis of plant height variation in the different treatments studied are shown in table 11 below:

**Table 2:** Results of plant height analysis in different treatments

	Height of Plants (cm)						Overall average
	T0	T1	T2	T3	T4	T5	
Total per treatment (Kg)	837	1300	1272	1311	1210	1218	1191.3
Average	31.0	48.1	47.1	48.6	44.8	45.1	44.1
Standard deviation	6.6	7.3	6.0	3.8	7.3	6.5	6.3
CV	21%	15%	13%	8%	16%	14%	15%

On average, the plants were 44.1 cm tall. The highest height values of cabbage plants were observed when applying Treatment T3 (50g of NPK combined with 3.5 Kg of poultry manure) per plot with an average of 48.6cm per plant. The lowest value (31 Cm) was observed in the control treatment (T0) where no fertilizer was applied. For this variable, the coefficient of variation is low, indicating excellent data homogeneity, reflected in higher quality conclusions to be drawn, [7, 8, 12 and 13].

## CONCLUSION AND SUGESTIONS

- The results of the study allow us to conclude that the agricultural yield and the quality of the cabbage produced are influenced by the type of fertilization;
- There is a relationship between the proportion of the constituents (manure and NPK) in the mixture with the yield and aspect of the cabbage obtained in the different treatments;
- The use of poultry manure for agricultural purposes is an environmentally and economically viable practice;
- Therefore, it is recommended that farmers and vegetable producers use poultry manure for agricultural purposes only to increase their productivity and reduce the environmental impacts generated by the poor disposal of this waste.

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