



ANALYSIS OF THE BEST FERTILIZER SELECTION FOR CORN PLANTS USING THE MULTI-ATTRIBUTE UTILITY THEORY METHOD

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ABSTRACT

Corn (*Zea mays* L.) is one of the most important food crops in the world, serving as a staple food for many countries, as well as a primary source of livestock feed and an industrial raw material. This research aims to determine the best fertilizer for corn plants (*Zea mays* L.) by applying the Multi-Attribute Utility Theory (MAUT) method, a systematic approach to multi-criteria decision making. This research was conducted in Rundeng District, Subulussalam City, Aceh, with three alternative fertilizers analyzed, namely NPK Mutiara, Urea, and Phonska. The criteria used include price, nutritional efficiency, and availability of fertilizer on the market, with weights for each criterion of 0.3, 0.5, and 0.2. The research results show that Phonska fertilizer has the highest global utility value of 0.895, making it the best choice based on the specified criteria. Phonska stands out for its optimal balance between affordable price, high nutritional efficiency and good availability on the market. Urea is in second place with a global utility value of 0.856, superior in terms of cheaper price, but lower efficiency than Phonska. Mutiara NPK, despite having the highest nutritional efficiency, only obtained a global utility value of 0.807 due to its higher price and lower availability. This research provides data-based guidance for farmers to choose the most suitable fertilizer, which is expected to increase corn crop productivity, reduce production costs, and support agricultural sustainability. By using the MAUT method, this research proves that a data-based approach can help make more rational decisions in the agricultural sector.

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1. INTRODUCTION

Corn (*Zea mays* L.) is one of the most important food crops in the world that is a staple food for many countries, both as a primary food source, animal feed, and industrial raw materials. The history of corn cultivation began in Mesoamerica, especially Mexico, which then spread throughout the world through trade and colonization routes. Now, corn is one of the three largest cereal crops, along with rice and wheat, with global production reaching more than 1 billion tons per year according to FAO data. Corn plays a strategic role in global food security and supports renewable energy needs through its derivative products such as bioethanol.

In developed countries such as the United States, corn is a major commodity used for bioethanol fuel, animal feed, and processed food ingredients. Brazil, as the second largest corn producer in the world, also uses corn for export and domestic consumption, especially to support the livestock sector. In Europe and

Asia, corn is used in various forms such as snacks, corn flour, and poultry feed ingredients. The role of corn in the global industrial sector includes the production of biodegradable plastics, lactic acid, corn oil, and various other chemicals. However, global corn production faces increasing challenges, such as climate change, soil degradation, and rising costs of agricultural inputs, especially fertilizers. Corn is known as a nutrient-hungry plant that requires a large supply of nutrients, especially nitrogen, phosphorus, and potassium. This makes the use of fertilizers a determining factor in the success of corn cultivation. However, in various developing countries, including Indonesia, access to quality fertilizers is often limited, both due to high prices and uneven distribution.

Indonesia has abundant natural resources, making Indonesia one of the countries with great potential in the agricultural sector. So that agriculture is a sector that plays an important role in the welfare of the Indonesian people. In Indonesia, corn has a strategic position in supporting national food security. In addition to being an alternative food source, corn is also the main raw material for animal feed, which contributes greatly to the livestock sector. The Central Statistics Agency (BPS) records an increase in corn production every year, with the main corn-producing areas such as East Java, Lampung, South Sulawesi, Gorontalo, and West Sumatra. However, despite its great potential, Indonesia still faces challenges in meeting domestic corn needs, which often require imports.

One of the biggest obstacles faced by corn farmers is low productivity due to suboptimal management of agricultural inputs, especially fertilizers. One effort to increase corn production, either by fertilization, many fertilizers have been tested for corn plants, both in the form of organic and inorganic fertilizers. As a plant that is highly dependent on soil fertility, corn requires fertilizer with the right nutrient content to support its vegetative and generative growth. Sweet corn, for example, requires 150-300 kg of nitrogen per hectare, much higher than the needs of other plants. Dependence on chemical fertilizers such as Urea, NPK Mutiara, and Phonska is the main solution, but this is often constrained by high fertilizer prices, uneven government subsidies, and lack of information on choosing the right fertilizer.

At the local level, for example in Rundeng District, Subulussalam City, Aceh Province, corn farmers face a similar situation. Despite having supportive soil and climate conditions, farmers are often faced with limited access to quality fertilizers and minimal knowledge about the most appropriate types of fertilizers to increase productivity. Many farmers choose fertilizers based on tradition or recommendations without considering cost efficiency and their impact on crop yields. With these challenges, a data-based approach is needed that is able to provide objective recommendations to farmers regarding fertilizer selection. One method that can be applied is the Multi-Attribute Utility Theory (MAUT), a systematic approach to decision-making by considering various relevant criteria. This method allows the evaluation of fertilizer alternatives based on the weight of criteria such as price, nutrient efficiency, and availability in the market.

This study aims to analyze and determine the best fertilizer for corn plants using the MAUT method. With the results of this study, it is hoped that farmers can obtain more rational guidance in choosing fertilizers, so that plant productivity can increase, production costs can be reduced, and environmental sustainability is maintained. This effort will not only support farmers economically, but also contribute to sustainable agricultural management at the local and national levels.

2. RESEARCH METHODE

This research was carried out in Rundeng District, precisely in Dah Village, Subulussalam City, Aceh Province. This location was chosen because it has soil characteristics and environmental conditions that are suitable for cultivating corn. Research begins on November 19, 2024 and continues until completion..

The type of research used is qualitative research. A qualitative approach was chosen because it aims to provide a systematic, factual and accurate description of the phenomena that are occurring, as well as to understand the relationship between the variables analyzed in this research. This approach focuses on collecting data and analyzing the factors that influence the selection of the best fertilizer for corn plants.

The data used in this research consists of primary data and secondary data. Primary data was obtained through direct interviews with corn farmers in Dah Village. The information collected includes the type of fertilizer used, the price of fertilizer at the farmer level, farmers' perceptions of fertilizer efficiency, and the availability of fertilizer on the local market. Meanwhile, secondary data, collected from various sources, such as statistical reports, market information, and official documents related to fertilizer use and corn production.

The analytical method used in this research is Multi-Attribute Utility Theory (MAUT). MAUT is a multicriteria decision making approach used to evaluate alternatives based on a number of relevant criteria. In this research, the criteria used are fertilizer price, nutritional efficiency, and fertilizer availability on the market. This method allows evaluating each fertilizer alternative to produce the most optimal choice based on global utility value.

The data analysis process using the MAUT method begins by determining alternative fertilizers to be evaluated, namely NPK Mutiara, Urea, and Phonska. Next, the data from each criterion is normalized using a formula.

$$u(x) = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \quad (1)$$

Where $U(x)$ is the normalized utility value, x is the actual value of a particular alternative, and x_{\min} and x_{\max} are the minimum and maximum values of the criterion, respectively. After the data is normalized, each criterion is given a weight based on its level of importance, namely price with a weight of 0.3, nutritional efficiency with a weight of 0.5, and availability with a weight of 0.2. The next step is to calculate the global utility value for each alternative using the formula.

$$v(x) = \sum(w_i \cdot U(x_i)) \quad (2)$$

Where $V(x)$ is the global utility value of alternative x . W_i is the weight of the 1st criterion, and $Uf(x_i)$ is the normalized utility value and the 1st criterion: The results of this calculation are used to determine the best fertilizer alternative based on the highest global utility value.

This study uses three main variables as the basis for analysis in determining the best fertilizer for corn plants. The first variable is the price of fertilizer, which is measured based on the cost per kilogram (Rp/kg). Cheaper prices are considered more profitable for farmers, so they get a higher value. The second variable is nutrient efficiency, which measures the nutrient content in fertilizer and is expressed in percentage. Fertilizers with higher nutrient efficiency are considered better because they can support optimal plant productivity. The third variable is the availability of fertilizer in the market, which is measured on a scale of 1-10 based on the ease of farmers getting fertilizer in the local market. Fertilizers that are easier to find get a higher value because they support smooth agricultural management. These three variables are weighted according to their level of importance and are used in the MAUT method to determine the global utility of each fertilizer alternative. With this approach, analysis can be done objectively to produce relevant recommendations for farmers.

The research procedure begins with the preparation stage which includes the preparation of proposals, determination of research subjects in Rundeng District, and selection of corn farmer samples as respondents. The instrument in the form of a questionnaire was prepared to collect data related to the type of fertilizer used, fertilizer prices, nutrient efficiency and availability of fertilizers in the market. Primary data was obtained through direct interviews with farmers, while secondary data was collected from agricultural shops, statistical agencies, and other related documents to complete the information. The next stage is data processing and analysis. The collected data is arranged in a table to facilitate the normalization process, namely equalizing the data scale so that it can be compared fairly. Furthermore, the MAUT method is used to calculate the global utility value of each fertilizer alternative based on the weight of the predetermined criteria, namely price, nutrient efficiency, and availability. The calculation results are then analyzed and compared to determine the best fertilizer based on the highest utility value. The discussion is conducted to provide rational reasons behind the selection of the best fertilizer and produce recommendations for farmers.

The results of the analysis are then interpreted to provide recommendations to farmers to identify the most appropriate fertilizer based on price criteria, nutrient efficiency and availability in the market. This process is done by compiling recommendations that are expected to help farmers increase corn productivity efficiently and sustainably.

3. RESULT AND ANALYSIS

In this study, there are three types of fertilizers as alternatives for corn plants, namely:

1. NPK Mutiara
2. Urea
3. Phonska

Three criteria were used to select the best fertilizer:

1. Price: The cheaper, the better.
2. Nutritional Efficiency: The higher the nutritional value provided by the fertilizer, the better.
3. Market Availability: The easier it is to find in the market, the better

Each criterion was given a weight indicating its importance in selecting a fertilizer. The following is the data used in the study

Table 1. weight criteria and alternative fertilizer data

Criteria	Weight	NPK Mutiara	Urea	Phonska
Price (Rp/Kg)	0.3	12,000	6,000	8,000
Nutritional Efficiency (%)	0.5	85	70	80
Market Availability (Skala 1-10)	0.2	8	7	9

To calculate the best fertilizer value, we take the following steps:

Normalization means that we change the values so that they can be compared in a fair way, by changing them to the same scale. For example, the price of Mutiara NPK is higher, so the value is normalized to be smaller.

Table 2. Data normalization results

Criteria	NPK Mutiara	Urea	Phonska
Price	0.50	1.00	0.75
Nutritional Efficiency	1.00	0.82	0.94
Market Availability (Skala 1-10)	0.89	0.78	1.00

After the data is normalized, we calculate the global utility value (overall value) of each fertilizer. This value is calculated by multiplying the weight of each criterion by the normalization value and summing them up. The fertilizer with the highest utility value is considered the best

The global utility value is calculated using the formula:

$$U(A) = \sum (Criteria\ weight \times Normalization\ value) \quad (3)$$

Table 3. global utility value calculation results

Alternatives	Utility Value
NPK Mutiara	$(0.3 \times 0.50) + (0.5 \times 1.00) + (0.2 \times 0.89) = 0.807$
Urea	$(0.3 \times 1.00) + (0.5 \times 0.82) + (0.2 \times 0.78) = 0.856$
Phonska	$(0.3 \times 0.75) + (0.5 \times 0.94) + (0.2 \times 1.00) = 0.895$

The results of this study indicate that the selection of the best fertilizer for corn plants in Rundeng District, Subulussalam City, Aceh, can be done effectively using the Multi-Attribute Utility Theory (MAUT) method. In this study, there were three fertilizer alternatives evaluated, namely NPK Mutiara, Urea, and Phonska, based on three main criteria: price, nutrient efficiency, and market availability. Each of these criteria is given a different weight according to its level of importance, with nutrient efficiency being the most dominant aspect. From the data normalization analysis, Phonska fertilizer showed the best performance with the highest global utility value of 0.895. This value makes Phonska the optimal fertilizer choice for corn farmers at the research location. The price criterion, although not the cheapest compared to Urea, shows that Phonska has a high level of efficiency in providing nutrients. This is important because adequate nutrient needs can have a direct impact on plant productivity. In addition, the availability of Phonska in the market is better than other alternatives, which provides easy access for farmers.

Urea fertilizer, despite having the lowest price, only got a utility value of 0.856. This is due to its lower nutrient efficiency compared to Phonska and NPK Mutiara. Although its availability is quite good, this aspect is not enough to compensate for the weakness in terms of efficiency. Meanwhile, NPK Mutiara has the lowest utility value, which is 0.807, even though its nutrient efficiency is the highest. The main factor causing the low value is the higher price compared to other fertilizers, thus reducing its attractiveness as an economically efficient choice. These results show the importance of a balance between various factors in fertilizer selection. Farmers tend to choose based on cost efficiency and ease

of access, but crop productivity also depends heavily on the nutrient efficiency of the fertilizer used. By using the MAUT method, this approach has succeeded in providing objective data-based recommendations that are relevant to the needs of local farmers.

Overall, the results of this study provide clear guidance to corn farmers to choose fertilizers that provide maximum benefits in terms of cost, availability, and yield. Phonska fertilizer, with the highest utility value, is the main recommendation to support increased corn productivity while supporting sustainable agricultural practices.

4. CONCLUSION

This study analyzes the selection of the best fertilizer for corn plants using the Multi-Attribute Utility Theory (MAUT) method. This method has proven effective in evaluating fertilizer alternatives based on several criteria, namely price, nutrient efficiency, and market availability. Based on the results of the global utility value calculation, Phonska fertilizer has the highest value (0.895), making it the best choice compared to other fertilizers. Phonska provides an optimal balance between affordable prices, high nutrient efficiency, and good market availability. Therefore, this fertilizer is recommended to support increased corn productivity, especially for farmers in the research area.

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