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Decision support system for "porang plants" fertilizer selection using the simple additive weighting (SAW) method

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Abstract

Porang (*Amorphophallus muelleri Blume*) is a tuber crop from the *Araceae* family that has high economic value and is widely cultivated by farmers in Indonesia. This plant offers various benefits in the fields of food, industry, and health. One of the key factors in porang cultivation is fertilization, as essential nutrients such as nitrogen (N), phosphate (P), and potassium (K) play a significant role in tuber growth. However, the high cost of fertilization reaching 40–60% of maintenance costs or 15–20% of total production costs often leads to inefficient and ineffective fertilizer use, which may also disrupt environmental balance. Therefore, this study aims to develop a Decision Support System (DSS) to determine the most suitable fertilizer type during the growth phase of porang plants to optimize crop yields. The system was built using the Simple Additive Weighting (SAW) method with five criteria: potassium content (weight 0.45), nitrogen content (0.26), phosphate content (0.16), fertilizer price (0.09), and fertilizer dosage (0.04). Empirical testing was conducted by comparing system calculations with manual SAW computations and expert validation. The results showed that the DSS produced consistent and accurate outputs, with NPK 16.16.16 ranked as the best fertilizer alternative, achieving a preference score of 0.8025. The system's recommendations were also confirmed by agricultural experts as being relevant to porang's growth needs. In conclusion, the developed DSS effectively supports decision-making in fertilizer selection by providing reliable, consistent, and data-based recommendations, which can potentially contribute to more efficient fertilizer management in porang cultivation.

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Keywords

Decision support system, Fertilization, NPK, Porang, Simple additive weighting

Introduction

Porang (*Amorphophallus muelleri* Blume) is a potential agricultural commodity from the *Araceae* family that is widely cultivated in Indonesia due to its high economic value. Its

tubers contain 45–65% glucomannan, which is widely utilized in the food, pharmaceutical, and cosmetic industries [1], [2]. Along with the increasing export demand, Indonesia's porang production reached 142,000 tons in 2020 and is targeted to increase to 600,000 tons by 2024 [3]. This situation emphasizes the need to improve efficiency in porang cultivation.

One of the key factors in enhancing porang yield is fertilization. Macronutrients such as nitrogen (N), phosphate (P), and potassium (K) play essential roles in vegetative growth, tuber formation, and plant resistance [4]. However, fertilizer costs account for approximately 40–60% of maintenance expenses, or 15–20% of total production costs. Therefore, selecting the most appropriate fertilizer type is crucial for achieving efficient resource utilization.

Several previous studies have developed Decision Support Systems (DSS) to assist in fertilizer selection based on multiple criteria. For instance, Siregar et al. (2023) compared the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) and Profile Matching methods for selecting fertilizers for porang plants [5]. Although these systems facilitated decision-making, the resulting recommendations were not optimal because the weighting of criteria did not fully reflect their actual importance.

Therefore, a more objective approach is required to evaluate various fertilization criteria. The Simple Additive Weighting (SAW) method is chosen in this study because it provides a straightforward yet effective calculation process for handling multi-criteria problems with proportional weighting [6].

This research aims to develop a Decision Support System for selecting the most suitable fertilizer for porang plants using the SAW method. The proposed system is expected to assist farmers in determining the optimal fertilizer type according to the plant's growth phase, thereby improving cost efficiency and maximizing crop yield.

Method

This study employed a developmental research approach to build a Decision Support System (DSS) for determining the best fertilizer for Porang (*Amorphophallus muelleri* Blume) using the Simple Additive Weighting (SAW) method. The research procedure consisted of seven stages, as illustrated in Figure 1.

Problem formulation

The research began by identifying the main problem faced by porang farmers, namely the difficulty in selecting the most appropriate fertilizer due to various types, nutrient compositions, and costs. Inefficient fertilizer selection often results in suboptimal yields and higher production costs. The problem formulation stage aimed to define system objectives and determine the scope of the decision model.

Literature study

A comprehensive literature review was conducted to gather information related to porang cultivation, fertilization techniques, and decision support systems. Theoretical foundations of the SAW method and previous studies on fertilizer recommendation systems were also examined. This stage served as the basis for designing the proposed system and determining relevant criteria.

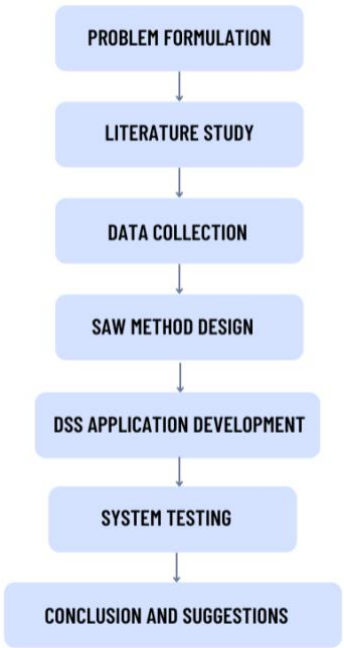

Figure 1. Research methodology flow diagram

Data collection

Data were collected from agricultural experts, field observations, and supporting literature. The criteria used in this study included:

1. Potassium (K) content-weight 0.45
2. Nitrogen (N) content-weight 0.26
3. Phosphorus (P) content-weight 0.16
4. Fertilizer price-weight 0.09
5. Fertilizer dosage-weight 0.04

Several fertilizer alternatives were evaluated based on these criteria, including NPK 16-16-16, NPK Mutiara, Phonska Plus, and organic compost.

SAW method design

At this stage, the decision model was formulated using the Simple Additive Weighting (SAW) approach. The SAW method was chosen because it is simple, efficient, and capable of handling multi-criteria problems. The steps include:

1. Constructing the decision matrix X=[xij]X = [x_{ij}]X=[xij]
2. Normalizing the matrix based on benefit and cost criteria
3. Calculating the weighted normalized values using Vi=∑wjrijV_i = \sum w_j r_{ij}Vi=∑wj rij

4. Ranking all alternatives, where the highest value indicates the best fertilizer recommendation.

DSS application development

The DSS was implemented as a web-based application using PHP as the programming language and MySQL as the database management system. The system architecture consists of three layers:

1. Input layer: users enter fertilizer data and criteria values.
2. Processing layer: executes the SAW algorithm to compute rankings.
3. Output layer: displays ranked fertilizer recommendations.

System testing

System testing was performed to ensure accuracy and functionality. Three types of evaluation were conducted:

1. Validation testing-comparing the system's SAW results with manual calculations;
2. Expert validation-verifying that the recommendations are relevant to agronomic practice;
3. User testing-assessing usability and satisfaction among porang farmers.

Results and Discussion

Results

This study produced a web-based Decision Support System (DSS) designed to recommend the best fertilizer for Porang (Amorphophallus muelleri Blume) cultivation using the Simple Additive Weighting (SAW) method. The system assists farmers in selecting the most suitable fertilizer based on multiple predefined criteria.

Five main criteria were used in this research, namely potassium (K) content, nitrogen (N) content, phosphorus (P) content, fertilizer price, and fertilizer dosage. Each criterion was assigned a specific weight based on expert consultation, as presented in Table 1.

Table 1. Criteria and weight values for fertilizer selection

Criterion	Description	Weight
K	Potassium Content	0.45
N	Nitrogen Content	0.26
P	Phosphorus Content	0.16
Price	Fertilizer Price	0.09
Dosage	Fertilizer Dosage	0.04

The fertilizer alternatives evaluated in this study included NPK 16.16.16, Phonska Plus, NPK Mutiara, and Organic Fertilizer. Each alternative was assessed based on the nutrient composition and market price.

The SAW calculation process was conducted through the following steps:

1. Constructing a decision matrix based on the score of each alternative for every criterion;

2. Normalizing the decision matrix to equalize the scale among criteria;
3. Multiplying the normalized values by their corresponding weights;
4. Summing all weighted values to obtain the final preference score for each alternative.

The results of the preference value calculation are presented in Table 2.

Table 2. Preference values and ranking results of fertilizer alternatives

Alternative	Preference Value	Rank
NPK 16.16.16	0.8025	1
Phonska Plus	0.6984	2
NPK Mutiara	0.6552	3
Organic Fertilizer	0.5417	4

The developed DSS displays the SAW calculation results in the form of ranking tables, graphical visualizations, and fertilizer recommendations. The user interface provides several key features, including:

1. Input menus for entering criteria and alternative data,
2. Automated calculation using the SAW method, and
3. Output display showing the best fertilizer recommendation.

The system was tested using the same dataset as the manual SAW computation, and the results were identical. This confirms that the SAW algorithm was accurately implemented and that the system operates correctly.

Based on the experimental results, the system recommended NPK 16.16.16 as the best fertilizer alternative with a preference value of 0.8025. This result indicates that NPK 16.16.16 provides the most balanced nutrient composition suitable for the growth needs of Porang plants.

Discussion

The results of this study demonstrate that the developed Decision Support System (DSS) using the Simple Additive Weighting (SAW) method can effectively assist in selecting the most suitable fertilizer for Porang cultivation. The system produced consistent and accurate results, with the fertilizer NPK 16.16.16 ranking highest with a preference value of 0.8025. This finding suggests that NPK 16.16.16 provides a balanced composition of macronutrients nitrogen (N), phosphorus (P), and potassium (K) which are crucial for vegetative growth, root development, and tuber formation in Porang plants.

The ranking results also indicate that fertilizers with higher potassium and nitrogen contents tend to achieve better preference scores. Potassium (K) plays an essential role in improving plant resistance to environmental stress and enhancing tuber quality, while nitrogen (N) supports chlorophyll formation and vegetative growth. These results align with agricultural studies highlighting the importance of balanced NPK nutrients for optimal crop productivity [4].

Compared to previous research by Siregar et al. (2023), which implemented MOORA and Profile Matching methods for fertilizer selection, the SAW method in this study offers a simpler computation process and more proportional weight distribution. The weighted normalization process in SAW allows each criterion to contribute objectively according to its level of importance, resulting in more consistent and transparent decision-making outcomes. Furthermore, the accuracy of the system was confirmed by validation tests showing identical results between the manual and system-based calculations.

From a system development perspective, the web-based implementation provides accessibility and usability advantages. Farmers can input fertilizer data and immediately obtain ranked recommendations without requiring deep technical knowledge. This supports the digital transformation of agricultural practices and contributes to smart farming initiatives by integrating information technology with decision-making in the agricultural domain.

Overall, the implementation of the SAW method within the DSS framework has proven to be an effective and practical approach for optimizing fertilizer selection in Porang cultivation. The system not only improves decision accuracy but also enhances efficiency in fertilizer management, potentially reducing production costs and increasing crop yields. Future work can expand the system by integrating real-time soil nutrient data, weather conditions, or sensor-based monitoring to further refine the decision-making process and adapt recommendations dynamically according to field conditions.

Conclusion

This study successfully developed a web-based Decision Support System (DSS) for determining the best fertilizer for Porang (*Amorphophallus muelleri* Blume) cultivation using the Simple Additive Weighting (SAW) method. The system evaluates multiple fertilizer alternatives based on five weighted criteria: potassium (K) content, nitrogen (N) content, phosphorus (P) content, fertilizer price, and fertilizer dosage.

The experimental results show that the system accurately implemented the SAW algorithm and produced consistent results with manual calculations. Among the evaluated alternatives, NPK 16.16.16 achieved the highest preference value of 0.8025, indicating it as the most suitable fertilizer option for optimizing Porang growth. This outcome validates the capability of the proposed DSS to provide objective, efficient, and reliable recommendations to assist farmers in fertilizer selection.

The application of the SAW method in this context has proven effective due to its simplicity, transparency, and suitability for multi-criteria decision-making problems. The integration of the DSS into agricultural practices can contribute to improving resource efficiency, reducing costs, and supporting sustainable Porang cultivation.

For future research, the system can be enhanced by incorporating additional parameters such as soil nutrient data, climate factors, and real-time sensor inputs to generate more adaptive and data-driven recommendations. Furthermore, expanding

the system's usability for other crop types may broaden its impact in the agricultural technology domain.

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