Submitted: 16 June 2025 | **Accepted: 24 July 2025** | **Published: 25 July 2025**

DOI:

GHEI' BINTANG ISSUE

Decision Support System for Selecting Superior Rice Seeds Using Simple Additive Weighting Method

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Abstract Choosing the right rice seeds greatly influences harvest results and farmer welfare. This research aims to develop a web-based decision support system that can help farmers in Parsanga Village in selecting superior rice seeds using the Simple Additive Weighting method. The SAW method was chosen because of its ability to carry out multi-criteria assessments which can provide recommendations based on ranking. Seed selection criteria are determined by the Department of Agriculture and implemented in the system to provide precise calculations and analysis. The results of this system are expected to increase the effectiveness and efficiency of selecting rice seeds, thereby increasing agricultural productivity in Parsanga Village.

Keywords: Decision Support System, Selection of Superior Rice Seeds, Simple Additive Weighting.

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Introduction

Rice is the staple food for the majority of Indonesians and is processed into rice grains. The production and quality of rice crops in certain swampy lands are influenced by the variety, and production variables are crucial to achieving production goals. Rice plants are divided into three common varieties: superior seeds, hybrid, and local. Many varieties within each group have unique characteristics. Successful rice harvesting depends on understanding the variety of rice being cultivated (Nanda & Anggraeni, 2022).

Rice is a staple food crop that is very important to nearly the entire population of Indonesia, as rice provides the main source of calories for most Indonesians. With Indonesia's population increasing every year, the demand for rice continues to rise. The government has been striving to increase national rice production; however, the productivity of rice crops in Indonesia remains low. As a result, the government even has to resort to imports to meet the rice demand (Insani et al., 2023).

The majority of Indonesia's population has utilized natural resources to meet their livelihood needs, with agriculture being one of the most important sectors in the country. However, communities often face many difficulties in selecting high-quality rice seeds for planting. Since the use of superior quality seeds is a key factor in increasing agricultural productivity, the availability of superior seeds is an essential requirement for improving crop yields and production quality (Pakam & Metode, 2021), a system capable of selecting superior rice seeds is needed to improve crop yields and production quality.

To address the above issue, the researcher conducted a study to solve the problem of selecting superior rice seeds in Parsanga Village. The government releases new rice seed varieties designed with superior specifications almost every year (Sri Maulidah Noor, 2024). With the development of many new agricultural areas, farmers may lack the knowledge and experience needed to select the appropriate rice seeds for their new locations. As a result, they may rely on trial-and-error methods when choosing seeds, without considering the specific characteristics of each variety. Choosing the wrong seeds can lead to poor harvests or even total crop failure. One of the main factors contributing to such mistakes is the lack of experience and knowledge among farmers (Maintang et al., 2022). Therefore, farmers employ consultants or field workers to assist them in cultivation, such as in selecting seeds (Ahzar & Nurohman, 2022). The selection of rice seeds is carried out by comparing seed specifications based on the criteria required to increase the likelihood of success and reduce the risk of loss. These criteria include planting duration, shattering resistance, grain shape, rice texture, yield potential, plant lodging resistance, resistance to pests and diseases, and suitability for the planting season (Budiarto et al., 2019).

Given the existing problems, the researcher chose to use the Simple Additive Weighting method because of its advantages, which make it highly useful in developing a Superior Rice Seed Selection System. The Simple Additive Weighting method is easy to understand and implement due to its straightforward concept—summing the normalized weights of criteria for each alternative (Rizky et al., 2022). The Simple Additive Weighting method has a drawback in that it is highly sensitive to the weights assigned to each criterion. Inaccurate or subjective weight determination can significantly affect the final results, which is why specialized expertise is required to assign appropriate weights (Pare et al., 2022). Despite its limitations, the Simple Additive Weighting method with its flexibility and ability to handle various criteria is highly useful in supporting decision-making across different fields. It helps in selecting the best

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alternative based on a systematic and structured evaluation (Rachman, 2019). In addition, its ease of maintenance and modification makes it a practical and effective choice for selecting superior rice seeds.

Literature Review

1. Decision Support System

   A system consists of a set of interconnected components that work together to achieve various objectives. It includes elements of input, processing, and output. The system is designed to improve data processing (Syafiatun ihsani luthfiyah & Candra Noor Santi, 2022).

   A decision support system is an interactive computer-based system that assists in decision-making by utilizing data and models to solve problems (Gede Surya Mahendra et al., 2023).

2. Simple Additive Weighting Method

   Uncertainty or imperfect information is the primary reason for the complexity of decision-making problems. However, other factors also contribute, such as the variety of selection criteria and the weighting of each criterion, which make problem-solving highly complex. In various fields today, multi-criteria decision-making techniques have been widely applied. After defining the problem objectives, criteria for evaluation, and possible alternatives, decision-makers can use one or more methods to solve their problems. The Simple Additive Weighting method has recently been introduced to address multi-criteria decision-making problems (Fransiska et al., 2020).

   The basic concept of the Simple Additive Weighting method is to find the weighted sum of performance ratings for each alternative across all attribute (Kusuma et al., 2024). The Simple Additive Weighting method requires normalizing the decision matrix (X) into a scale that allows comparison among all available alternative ratings. This method is widely used in Multiple Attribute Decision Making (MADM) situations. MADM is a process to find the best alternative among several options based on specific criteria. The Simple Additive Weighting method requires decision-makers to assign values to each attribute. Summing the products of ratings and their respective attribute weights provides a total score for each alternative.

3. Rice Seed

   A seed is the beginning of a plant's life. It means that a plant can live and pass on its traits through seeds. The genetic material and chemical content in seeds are very important for the growth and development of plants. Seed is synonymous with "grain" or "kernel." The meaning and definition of seed or grain vary depending on the field and perspective used to assess them (Pianto Ramadhan Prastio et al., 2023).

4. Rice Plant Varieties

   A variety is defined as a group of plants of a certain species characterized by their shape, growth, leaves, flowers, fruit, seeds, and the expression of characteristics or a combination of genotypes that distinguish them from others of the same species by at least one trait and remain unchanged when propagated. In Indonesia, since 2008, the term INPA is used for inbred rice varieties and HIPA for hybrid rice varieties (Herdiyanti et al., 2021).

Submitted: 16 June 2025 |Accepted: 24 July 2025 | Published: 25 July 2025

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Research Methods

1. Research Flow

The research flow is as follows:

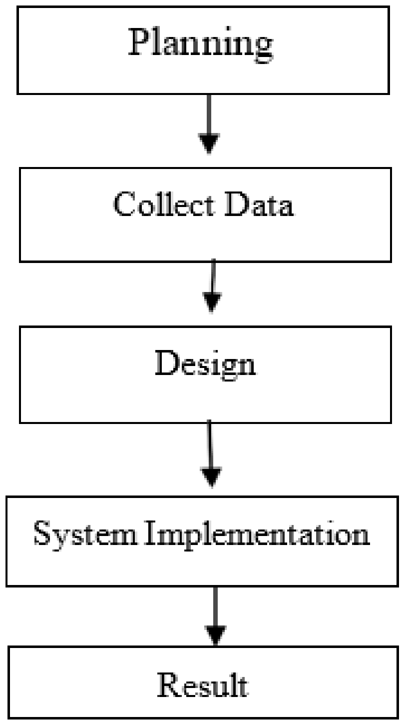

Figure 1. Research Flow

The research stages are carried out starting from system planning, data collection, system design, system implementation, and finally the results of the developed system.

2. System Design

The system starts with the initiation process. Then, the required data is inputted into the system, which will automatically perform calculations using the Simple Additive Weighting method and produce the final ranking scores. Before the process is considered complete, an output of the ranking results based on the Simple Additive Weighting calculations is generated. Below is the flowchart illustrating each step of the system process to be developed

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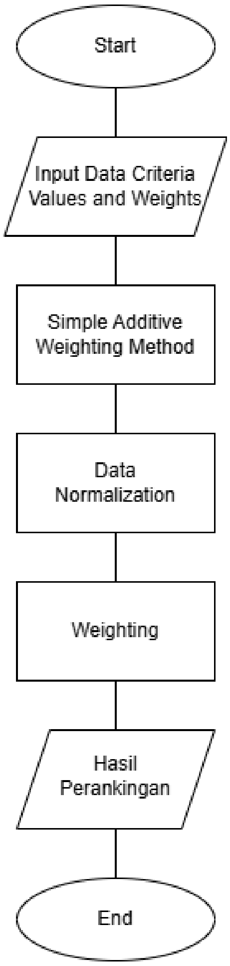

Figure 2. Flowchart System

3. Calculation Simple Additive Weighting
   The following are the calculation steps in the Simple Additive Weighting method:

   1. Determination of Alternative (Ai) dan Criteria (Ci)
      Out of 5 evaluation data sets for selecting superior rice seeds conducted in Parsanga village, 5 sample data sets were used as a trial to determine the superior or high-quality rice seeds based on the highest cumulative score.

Table 1. Alternative

Alternative Code	Alternative
A1	IR 64
A2	Inpari 43
A3	Inpari 32
A4	Ciherang
A5	Situpagendit

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Determining the criteria and the weight of each criterion.

Table 2. Criteria

Criteria Code	Criteria	Weight
C1	Production Results	25%
C2	Harvest Age	25%
C3	Resistance	20%
C4	Color	15%
C5	Cluster	15%
Total		100%

2. Next, the determination of the assessment for each Alternative (Ai) and Criterion (Ci).

Table 3. Assessment

Value		Percentage
1	Excellent	85% - 100%
2	Great	75% – 84%
3	Currently	61% - 74%
4	Lacking	55% - 60%
5	Very Lacking	<50%

3. Weighted Decision Matrix Normalization (Rij)

   The matrix normalization process is based on adjustment formulas according to the attribute type (benefit or cost) assigned to each criterion, resulting in the following normalized matrix.

Table 4. Weighted

Criteria	Range	Value	Description
Production Results	7 ton/ha	5	Benefit
	>6 ton/ha	3	
	<6 ton/ha	1	
Harvest Age	120 days	5	Benefit
	< 100 days	3	
	>125 days	1	
Resistance	Resistant to more than 4 deseases	5	Benefit

	Resistant to more than 3 deseases	3	
	Resistant to fewer than 3 deseases	1	
Color	Dark yellow	5	Benefit
	Light yellow	3	
	Brown	1	
Cluster	9 - 11 produktive tillers	5	Benefit
	>6 produktive tillers	3	
	<6 produktive tillers	1	

4. Next is the dataset of alternatives for each criterion.

Table 5. Dataset

Alternatif	Criteria				
	C1	C2	C3	C4	C5
A1	1	5	4	1	1
A2	3	1	3	2	3
A3	4	2	2	3	1
A4	3	4	1	2	4
A5	5	3	3	5	3

5. Decision Matrix Normalization (Rij)

The matrix normalization process is based on adjustment formulas according to the attribute type (benefit or cost) assigned to each criterion, resulting in the following normalized matrix.

Normalization formula for cost-type criteria values:

$$Rij = \frac{\min Xij}{Xij}$$

Normalization formula for benefit-type criteria values:

$$Rij = \frac{Xij}{\max Xij}$$

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From the matrix normalization process described above, the normalized matrix (R) values are obtained as follows:

$$R=\begin{bmatrix} 0,2 & 1 & 1 & 0,2 & 0,25 \\ 0,6 & 0,2 & 0,75 & 0,4 & 0,75 \\ 0,8 & 0,4 & 0,5 & 0,6 & 0,25 \\ 0,6 & 0.8 & 0,25 & 0,4 & 1 \\ 1 & 0,6 & 0,75 & 1 & 0,75 \end{bmatrix}$$

6. The preference value (Vi) is obtained by calculating the sum of the product of each row in the normalized matrix (R) with the corresponding weights (W) from the matrix columns.

   V1 = (0,2 x25 %) +(1 x 25%) + (1 x 20%) + (0,2 x15 %) + (0,25 x 15%)
   0,05+0,25+0,2+0,03+0,37=0,9
   V2 = (0,6 x 25%) _+ (0,2 x 25%) + (0,75 x20 %) + (0,4 x 15%) + (0,75 x15 %)
   0,15+0,05+0,15+0,06+0,11= 0,52
   V3 = (0,8x 25%) + (0,4 x25 %) + (0,5 x20%) + (0,6 x15 %) + (0,25 x15 %)
   0,2+0,1+1+0,09+0,03 = 1,42
   V4 = (0,6 x 25%) + (0,8 x 25%) + (0,25 x 20%) + (0,4 x 15%) + (1 x 15%)
   0,15+0,2+0,05+0,06+0,15=0,61
   V5 = (1 x 25%) + (0,6 x 25%) + (0,75 x 20%) + (1 x 15%) + (0,75 x 15%)
   0,25+0,15+0,15+0,15+0,11 =11,7

Based on the results obtained from the value calculations (Vi), a ranking determination table can be created as follows:

Table 6. Ranking Results

Alternatif	Value	Ranking	Precentage	
IR 64	0,9	3	Currently	61% - 74%
Inpari 43	0,52	5	Very Lacking	<50%
Inpari 32	1,42	2	Great	75% - 84%
Ciherang	0,61	4	Lacking	55% - 60%
Situpagendit	11,7	1	Excellent	85% - 100%

Results and Discussion

System implementation is the phase where the designed system is transformed into a working program. In this study, the program was developed using Laravel, a PHP framework. Additionally, MySQL was utilized for database management.

The result of this implementation is a web-based system that employs the Simple Additive Weighting method for selecting superior rice seeds based on predefined criteria, producing a ranked list of seed options.

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The landing page includes several menus, such as Home, About, and Seed Application Information. This page provides fundamental information about the Superior Rice Seed Selection System.

Figure 3. Landing Page

The registration page displays a form with fields such as name, email, and password. On this page, there are also submenus for users who already have an account and want to log in.

Figure 4. Register Account Menu

This page is used by Users (Farmers) and Admins (Department of Agriculture) to log in and access the features available within the application.

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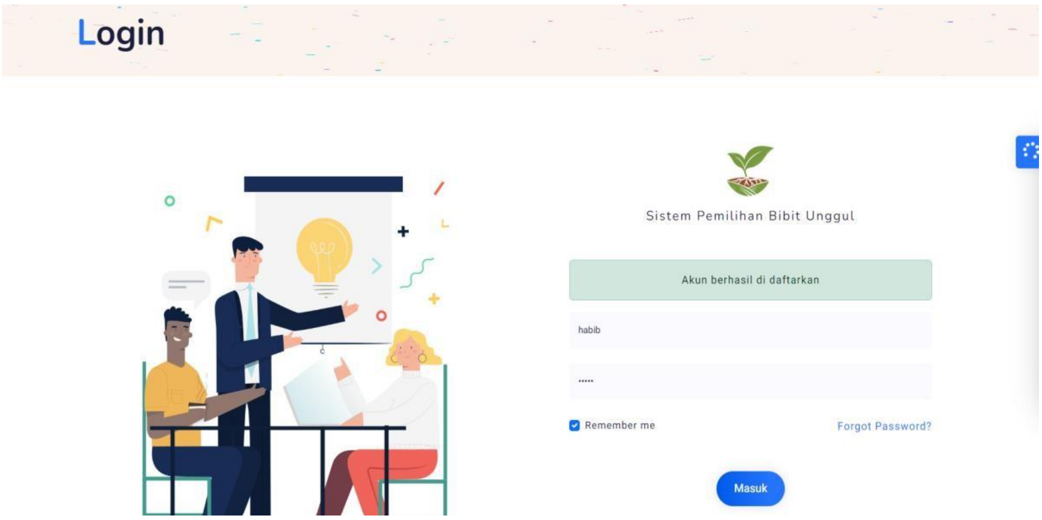

Figure 5. Login Page

This page features a criteria data table listing various criteria, including columns for serial number, an add value button, criteria code, and criteria names such as Production Yield, Age and Harvest Period, Resistance, Color, and Cluster, each with weights ranging from 15% to 25%.

Actions to edit or delete criteria are also available. On the left side of the screen, there is a navigation menu with links to Home, Criteria Data, Seed Analysis, and Account.

At the top-right corner, a "Add Data" button allows the addition of new criteria, and below the table, pagination controls enable navigation between pages

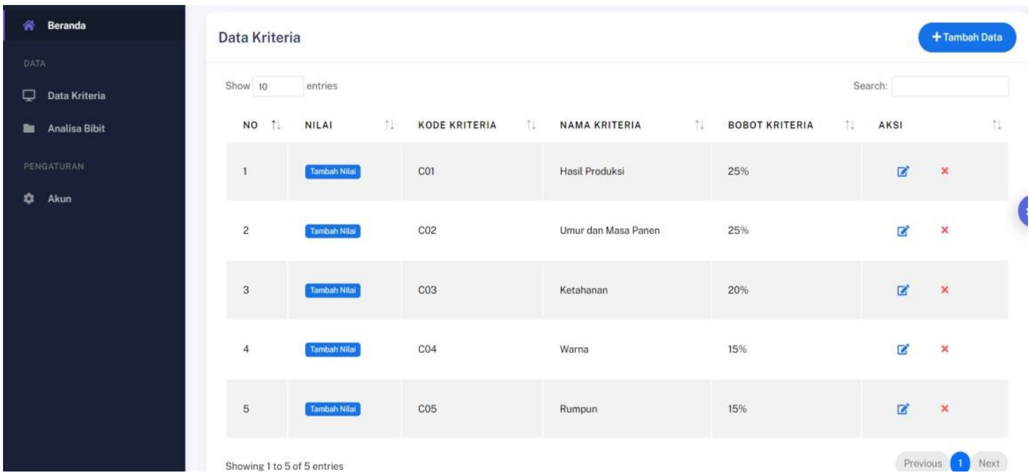

Figure 6. Criteria Page

On this page, the admin can manage criteria values as needed. This page specifically serves as the interface for adding new criteria values.

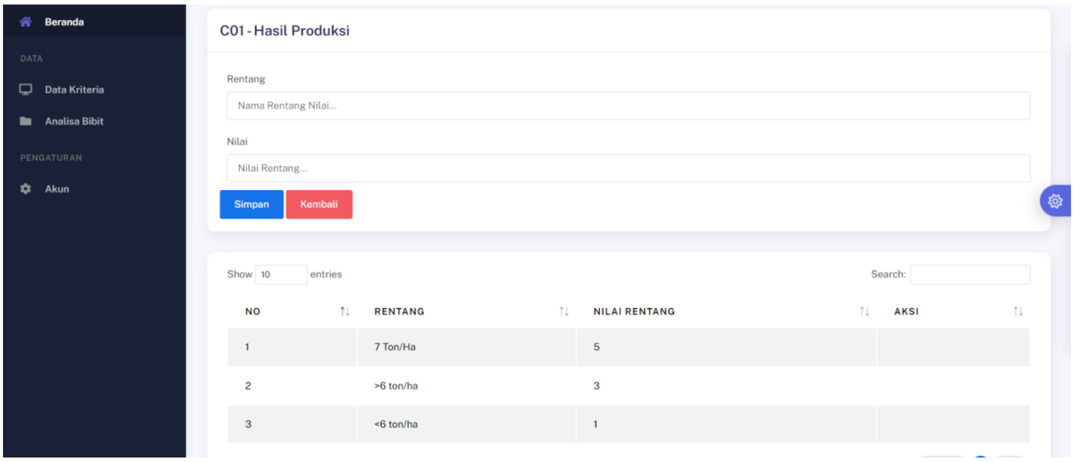

Figure 7. Add Criteria Page

This page displays the Data Analysis interface featuring a table listing seed entries. The table includes columns for serial number, seed name, and scores for each criterion such as Production Yield (C01), Age and Harvest Period (C02), Resistance (C03), Color (C04), and Cluster (C05), along with their respective weights.

In the top-right corner, there are buttons to add new analyses or reset the current data. The table currently shows two seed entries: Inpari seed and IR 64 seed, each with different values across the criteria

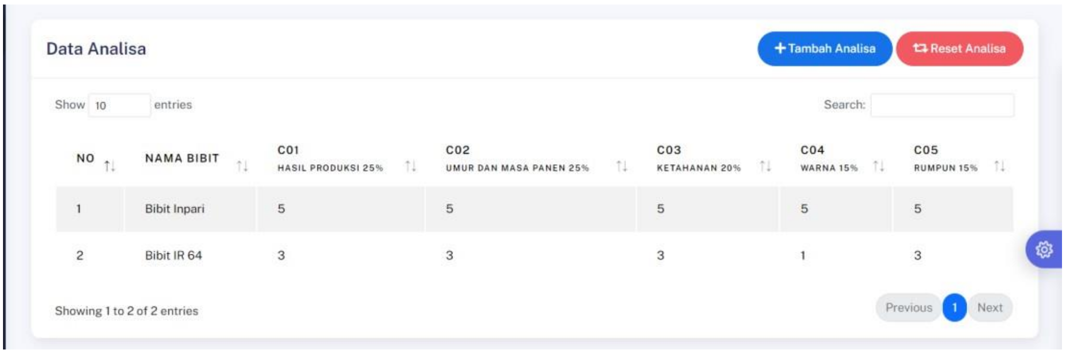

Figure 8. Analysis Data Page

On this page, the admin can view the normalized matrix data, which consists of original values processed through the decision matrix normalization formula, resulting in the normalized matrix values.

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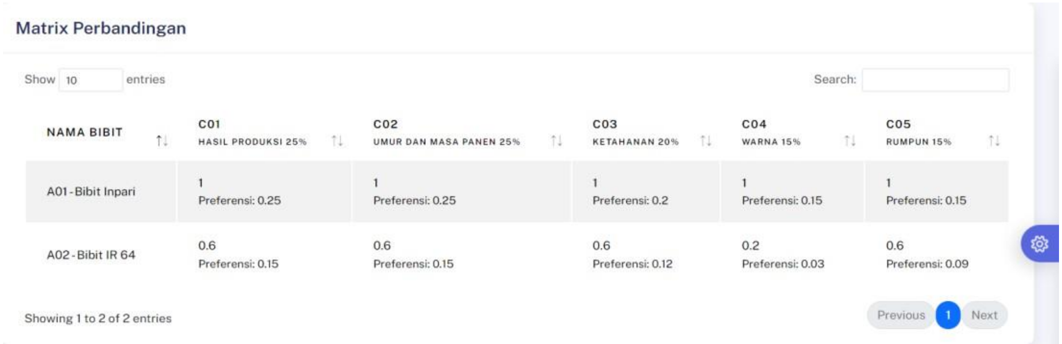

Matrix Perbandingan

Show 10 entries Search:

NAMA BIBIT	C01 HASIL PRODUKSI 25%	C02 UMUR DAN MASA PANEN 25%	C03 KETAHANAN 20%	C04 WARNA 15%	C05 RUMPUN 15%
A01 - Bibit Inpari	1 Preferensi: 0.25	1 Preferensi: 0.25	1 Preferensi: 0.2	1 Preferensi: 0.15	1 Preferensi: 0.15
A02 - Bibit IR 64	0.6 Preferensi: 0.15	0.6 Preferensi: 0.15	0.6 Preferensi: 0.12	0.2 Preferensi: 0.03	0.6 Preferensi: 0.09

Showing 1 to 2 of 2 entries Previous 1 Next

Figure 9. Matrix Normalization Page

On this page, the administrator can view the ranking results data and also has the option to reset the rankings generated from the previous calculations.

Perankingan

Show 10 entries Search:

NAMA BIBIT	NILAI	RANK
A01 - Bibit Inpari	1.00	1
A02 - Bibit IR 64	0.54	2

Showing 1 to 2 of 2 entries Previous 1 Next

Figure 10. Ranking Result Page

Conclusions and Practical Implication

This research resulted in the development of a web-based system designed to streamline the selection process of high-quality rice seeds. The system allows users to input seed data according to specific criteria established by the Department of Agriculture and performs calculations using the Simple Additive Weighting (SAW) method.

Each seed entry is analyzed and evaluated through the SAW method, producing a ranked recommendation list for superior rice seed selection.

The system is intended for use by the Department of Agriculture and local farming groups, particularly in Parsanga Village. Key stakeholders include the Department of Agriculture, farming groups in Parsanga, and the farmers themselves.

By applying the Simple Additive Weighting method, the system provides a structured analysis based on predefined criteria and delivers recommendations for top-performing rice seeds in the form of a ranking system.

Acknowledgement

The authors would like to express their sincere gratitude to University of KH. Bahaudin Mudhary Madura for the support and resources provided during the completion of this research. The author thank to rector of Bahaudin University for funding this research.

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