



## Classification of Subsidized Organic Fertilizer Stock Ratios using Based of Website Naive Bayes Method (Farmers' Groups in Sumberagung Village)

Achmad Rizki Nur Fakiki<sup>1\*</sup>, M. Ghofar Rohman<sup>2</sup>, M. Rosidi Zamroni<sup>3</sup>

<sup>1,2,3</sup> Informatics Engineering Study Program, Faculty of Science and Technology, Islamic University of Lamongan, East Java, Indonesia

[Rizkykikik072@gmail.com](mailto:Rizkykikik072@gmail.com)<sup>1\*</sup>, [m.ghofarrohman@unisla.ac.id](mailto:m.ghofarrohman@unisla.ac.id)<sup>2</sup>, [rosidizamroni@unisla.ac.id](mailto:rosidizamroni@unisla.ac.id)<sup>3</sup>

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### Abstract

The distribution of subsidized organic fertilizer to farmers often encountered challenges, such as unequal allocation, mismatches between the amount requested and the amount distributed, and a manual and subjective selection process. Therefore, this research aimed to develop a web-based classification system to assist in the fair and automated determination of fertilizer allocation. The system was built using the Naive Bayes classification method, with input parameters including fertilizer type, land area, and the amount of fertilizer requested. The training dataset was derived from historical application data that had been evaluated by the farmers' group leader, with decisions categorized as accepted or rejected, and classification results labeled as "Insufficient", "Sufficient", or "Excessive". The system was developed using PHP as the programming language and MySQL as the database, and was tested using the black-box testing method to evaluate the functional accuracy of each feature. The test results indicated that the system operated as intended and successfully classified fertilizer application data. Additionally, the system provided visual representation of classification results in bar chart format, facilitating administrators in analyzing distribution trends. With this system, the fertilizer distribution process was expected to become more transparent, efficient, and objective.

**Keywords:** Naive Bayes, Subsidized Fertilizer, Classification System, Website.

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### 1. Introduction

Fertilizer is a substance used to improve soil quality and enhance plant growth and production. Fertilizers can be derived from both organic and inorganic sources, containing essential nutrients such as nitrogen, phosphorus, and potassium required for healthy plant growth [1]. The main purpose of fertilizer application is to increase crop yields, improve the quality of agricultural products, and enhance the efficiency of land use and other natural resources. In Sumberagung Village, the subsidized fertilizer allocation includes Urea, ZA, NPK, and Organic fertilizers. Determining the required stock of fertilizers for each farmer is crucial to ensure higher productivity and optimal harvests. Therefore, a fertilizer stock classification system is needed to monitor and manage farmers' fertilizer requirements in Sepatan Village, Gondang Subdistrict, Tulungagung Regency, in a more structured and targeted manner [2].

Subsidized fertilizer is partially funded by the government, allowing it to be sold to farmers at a lower price. This policy aims to reduce production costs, increase land productivity, and safeguard national food security. However, in practice, the distribution of subsidized fertilizer often encounters challenges, such as limited availability, uneven distribution, and differences in fertilizer needs among farmer groups [3]. Several studies have shown that although subsidy allocations are planned at the national level, the actual availability of fertilizers at the farmer level is often below target due to weak inter-agency coordination and suboptimal field supervision [4]. A study conducted in Probolinggo, for example, reported that the effectiveness of subsidized fertilizer distribution in the village was relatively low due to gaps in the distribution system and misallocation [5]. Uneven distribution and weak supervision also remain the main obstacles to farmer groups' access to subsidized fertilizers in many regions [6].

Classification methods such as Naïve Bayes can be applied to categorize subsidized organic fertilizers based on features such as acceptance, type of fertilizer, and the amount distributed to each recipient according to the cultivated land area, as well as the amount of fertilizer left unused by farmers [7]. The Naïve Bayes method has several advantages: it is easy to understand, relatively simple, and efficient, making it suitable for the classification of fertilizer distribution in Sumberagung Village. Furthermore, Naïve Bayes does not require complex assumptions because it is a parametric method, which means the data do not have to meet complicated prerequisites. Naïve Bayes is also capable of handling noisy data quite well. If anomalies exist in the fertilizer stock data that may affect classification, Naïve Bayes can still provide reliable results by considering the dominant probability patterns. However, it should be noted that in order to classify fertilizer

stock using the Naïve Bayes method, it is crucial to have relevant features and accurate data to generate valid results. Additionally, factors such as proper metric selection and data normalization need to be considered. In this study, Naïve Bayes is applied using land area as a numerical attribute and fertilizer type as a categorical attribute. Furthermore, expert systems are AI-driven computer programs designed to replicate the decision-making abilities of human experts in various fields. These systems utilize a knowledge base and inference rules to provide solutions and support the decision-making process, making them relevant tools in optimizing fertilizer allocation and distribution strategies [8].

This research is motivated by the recurring issue of subsidized fertilizer distribution not aligning with the actual needs of farmers. In Sumberagung Village, farmer groups often face shortages of subsidized organic fertilizers, requiring allocation to be conducted fairly and accurately. However, the classification and allocation process is still carried out manually, which can lead to errors and delays. Therefore, a web-based system is needed to classify fertilizer allocations quickly and accurately. The Naïve Bayes method was chosen because of its advantages in processing historical data, its simplicity, and its effectiveness in achieving good classification accuracy. With this system, the distribution of subsidized organic fertilizers is expected to become more accurate, transparent, and efficient for farmer groups in Sumberagung Village.

The purpose of this study is to develop a web-based classification system for subsidized fertilizer stock using the Naïve Bayes method so that fertilizer recipients in Sumberagung Village can be better managed and monitored, ultimately improving crop yields. In the classification stage, the probability value of each class label is calculated against the given input, and the label with the highest probability is assigned as the classification result [9].

## 2. Methodology

The classification process in this study is described systematically, starting from data input until producing the final classification decision. The research workflow can be seen in Fig 1.

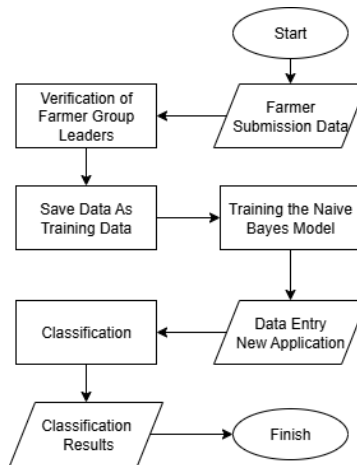


Fig: 1: Flowchart

Fig 1 shows the stages of research, beginning with data collection, data cleaning, data conversion, and ending with the classification stage using the Naïve Bayes algorithm.

### 2.1. Type and Research Approach

This research is categorized as applied research with a quantitative approach. The objective is to build a web-based system for classifying the allocation of subsidized organic fertilizer that can assist farmer groups in Sumberagung Village in determining the appropriate amount of fertilizer according to land size. The Naïve Bayes classification method was chosen because it is simple, computationally efficient, and has been proven to produce good accuracy for both numerical and categorical data, especially with small to medium-sized datasets.

### 2.2. Data Collection and Processing Techniques

The research data were obtained using three main techniques: interviews, observations, and documentation. Interviews were conducted with the head of farmer groups to understand the fertilizer application process and existing distribution challenges. Observations were carried out on farmland conditions and fertilizer distribution practices, while documentation was obtained from village archives containing historical fertilizer application records.

To facilitate the classification process, raw data were preprocessed through data cleaning to remove duplication and inconsistencies, followed by data conversion into categories. For example, the amount of fertilizer requested was grouped into low, medium, and high categories, as shown in Table 1, while land area was grouped into small, medium, and large categories, as shown in Table 2.

Table 1: Fertilizer Request Categories

Category	limit
Sedikit	<= 200
Sedang	<= 400
Banyak	> 400

**Table 2:** Land Area Categories

Category	limit
Sempit	$\leq 1$
Sedang	$\leq 2$
Luas	$> 2$

Categorization such as this helps to simplify data processing and provides clearer patterns in the classification results.

### 2.3. Dataset

The dataset used in this study consisted of 80 records of fertilizer applications from farmer groups in Sumberagung Village. The dataset contains four attributes:

1. Fertilizer Type (NPK, Organic, ZA, Urea)
2. Amount Requested (in sacks/units)
3. Land Area (in hectares)
4. Classification Result (Insufficient, Sufficient, Excessive)

A sample of the dataset can be seen in Table 3.

**Table 3:** Dataset

No	Fertilizer	Amount submitted (sack/unit)	Land area (hectare)	results
1	Npk	115	0.65	not enough
2	Organik	125	0.75	not enough
3	Za	135	0.85	Enough
4	Urea	155	1.05	Enough
5	Npk	120	0.7	not enough
...	...	...	...	...
76	Urea	170	1.2	excessive
77	NPK	135	0.85	Enough
78	Organik	145	0.95	Enough
79	ZA	155	1.05	Enough
80	Urea	175	1.25	excessive

From the total 80 data, 64 records (80%) were used as training data and 16 records (20%) were used as testing data. This division was applied to train the Naïve Bayes model and then evaluate its accuracy performance.

### 2.4. Analysis Method

The Naïve Bayes method is a classification technique based on probability and statistics. This method is used to predict future possibilities by utilizing previous data or experiences. Naïve Bayes allows calculations in each decision-making process through probability values that are determined based on certain conditions. One of its advantages is that it requires only a small amount of training data to determine the values needed in the classification process. Therefore, the Naïve Bayes method is relatively easy to understand, simple to implement, and efficient in training [10]. The classification process in this study employed the Naïve Bayes Classifier. The steps include:

1. Calculating the prior probability for each class (Insufficient, Sufficient, Excessive).
2. Calculating the conditional probability for each attribute (fertilizer type, amount requested, land area).
3. Applying Bayes' Theorem to obtain the posterior probability.
4. Determining the classification result based on the class with the highest posterior probability.

For illustration, if a farmer applies for 130 sacks of ZA fertilizer with a land area of 0.8 hectares, the system calculates the probability of the application belonging to each class (Insufficient, Sufficient, or Excessive). The class with the highest probability is then assigned as the prediction result.

The model's performance was evaluated by comparing predicted results with actual labels in the testing dataset, and the accuracy metric was calculated to measure system effectiveness.

## 3. Results and Discussion

### 3.1. System Design

The system design in this study uses Unified Modeling Language (UML), a visual modeling method applied in the process of designing and developing object-oriented software. UML serves as a standardized modeling language that allows system designs to be represented as blueprints, making them easier to understand, communicate, and document. Several UML diagrams are used, including the Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram.[11].

#### A. Use Case Diagram

The use case diagram is the result of system design analysis that serves to describe system requirements. These requirements will later be used by the end users so that the system design can be clearly mapped [12]. This diagram is an abstraction of the interaction between actors and the system; therefore, selecting the right level of abstraction is very important to match the system's needs. Essentially, a use case describes typical interactions between administrators and users through a diagram that illustrates how the system is used [13].

Fig 2 shows the use case diagram design that illustrates the interaction between actors and the system in the subsidized fertilizer allocation classification application. The diagram depicts two main actors, Admin and Farmer Group, as well as the main features (use cases) accessible to each actor. The purpose of this use case diagram is to describe the available functions of the system and the boundaries of each actor's role.

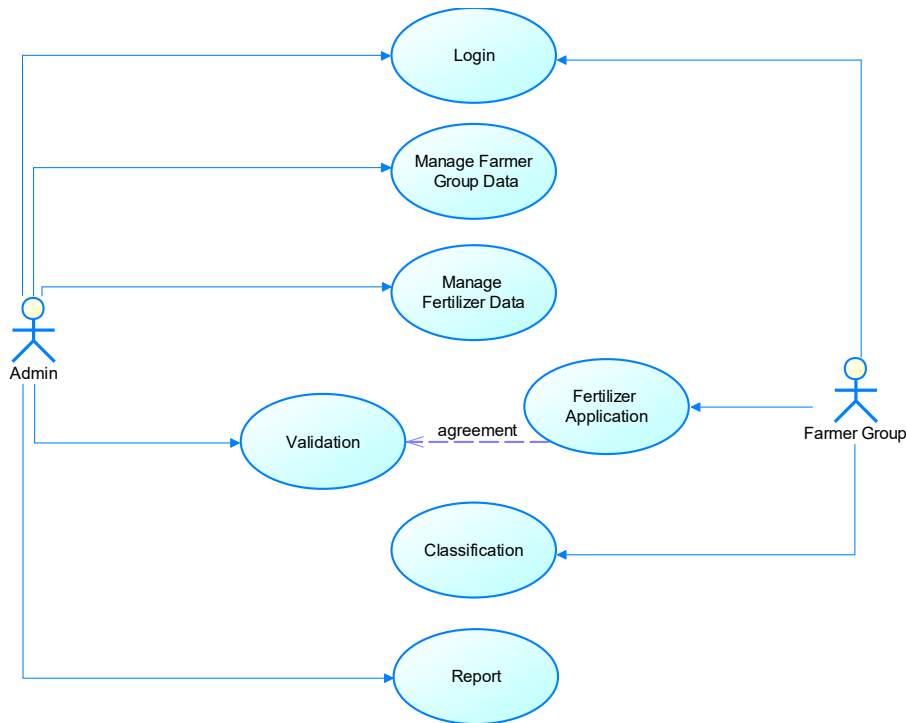


Fig. 2: Use Case Diagram

In this system design, there are two main actors, namely Admin and Farmer Group, with distinct roles and interactions. The Admin has full access rights to the system, including login, management of farmer group and fertilizer data, and validation of each fertilizer request. After validation, the system performs classification using the Naïve Bayes method to determine fertilizer allocation status (less, sufficient, or excessive). The Admin can also access and print classification reports for evaluation. On the other hand, the Farmer Group acts as a requester by logging into the system to submit fertilizer requests through a form based on land area and needs. The request is then sent to the Admin for validation. The relationship between submission by Farmer Groups and validation by Admin is external, since approval decisions lie entirely under the Admin's authority. Thus, the use case diagram depicts clear interactions between both actors, where Farmer Groups act solely as applicants, while the Admin serves as manager, evaluator, and decision-maker in the system.

## B. Activity Diagram

An activity diagram is one type of diagram in UML used to describe the flow of activities or business processes within a system. This diagram shows how a process starts, the steps that must be taken, possible decisions, and how the process ends. The activity diagram is a visual representation of the workflow within a system or business. It is important to note that this diagram focuses on activities that occur within the system, not the actions performed by the actors [14].

This diagram typically uses standard symbols, such as a black circle to mark the start of a process, a rounded rectangle to indicate an activity, a diamond shape for decision-making, and a circle with a thick border to mark the end of the process.

The main purpose of an activity diagram is to visualize process logic in a simpler and more understandable way for all parties system developers, users, and management. With activity diagrams, workflow analysis becomes clearer, potential process errors can be identified early, and system development and documentation are simplified.

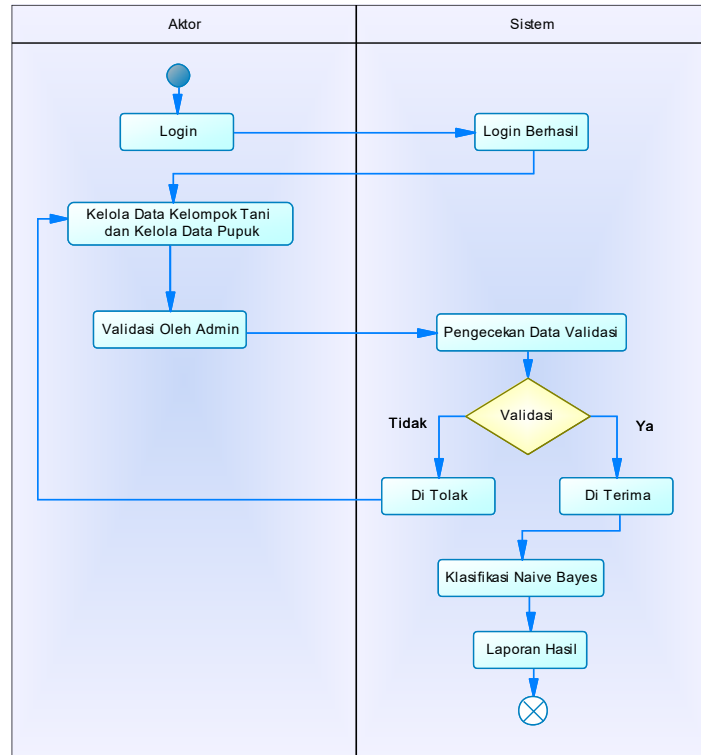


Fig. 3: Activity Diagram Admin

Fig 3 illustrates the Admin Activity Diagram, which explains the system flow starting from login to report generation. The process begins with the Admin login; if successful, the Admin can access the farmer group and fertilizer management menu. The entered data is then validated by the Admin to ensure its accuracy and completeness. The validation results can be either rejected data if invalid, or accepted if valid. Accepted data is processed using the Naïve Bayes method for classification, and the results are displayed in the form of a report that can be used for evaluation and decision-making.

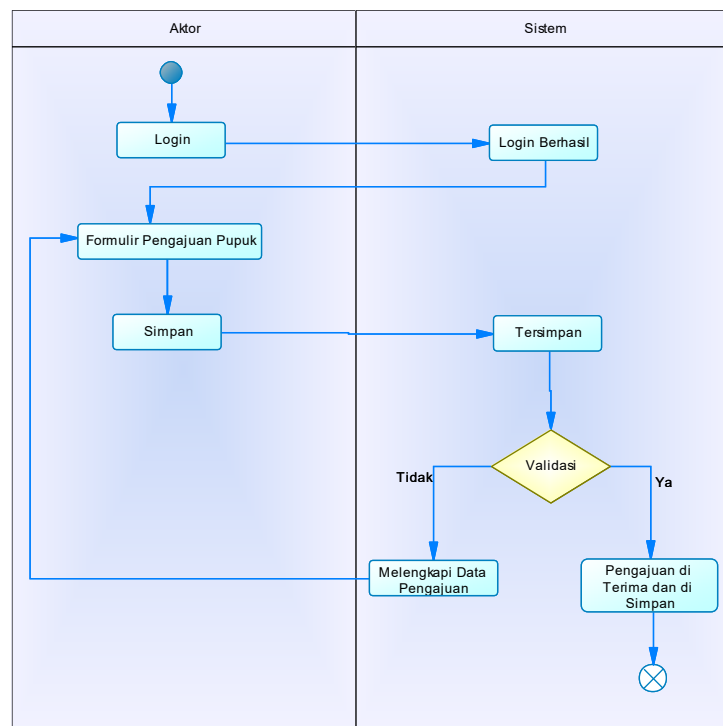


Fig. 4: Activity Diagram (Farmer Group)

Fig 4 illustrates the Farmer Group Activity Diagram, which describes the fertilizer request process flow. The process starts when the user logs into the system, then fills in the fertilizer request form. After the data is entered and saved, it is temporarily stored in the system. Validation is then carried out; if the data is incomplete, the user is asked to complete it. If the data is valid, the request is accepted and permanently stored in the system.

### C. Sequence Diagram

A sequence diagram is created to show the flow of interactions between objects, illustrating object behavior in a use case by describing their lifetimes and the messages sent and received between objects. [15].

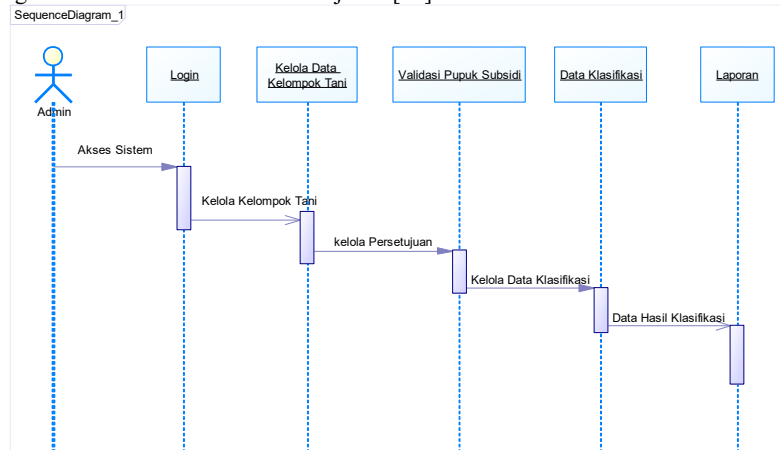


Fig. 5: Sequence Diagram Admin

The Admin sequence diagram in Fig 5 illustrates the flow of interaction between the Admin actor and the system. The Admin first logs in to access the system. Once logged in, the Admin can manage farmer group data and approve user requests. Next, the Admin validates subsidized fertilizer requests based on incoming data. After validation, the system displays the classification results generated using the Naïve Bayes method. The Admin can also access reports that summarize classification results from previous requests.

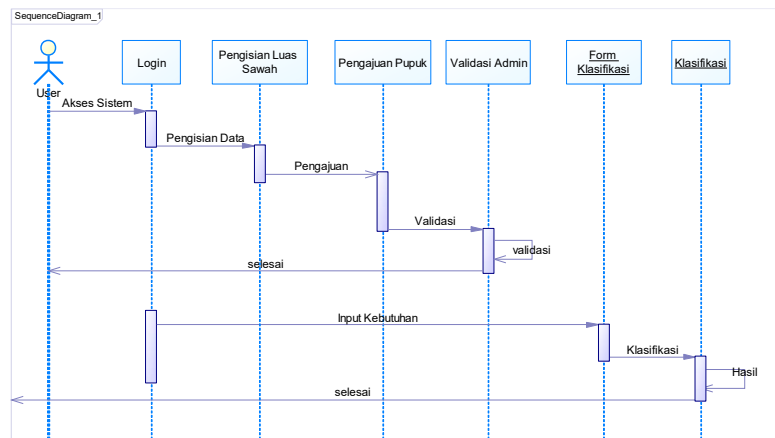


Fig. 6: Sequence Diagram User

In Fig 6, the User sequence diagram starts with the User logging in to access the system. Once inside, the User enters land area data and submits a fertilizer request according to their needs. The submitted data goes through a validation process by the Admin. If approved, the User can input detailed requirements, which are then processed by the system. Next, the system performs classification using the Naïve Bayes method to determine fertilizer requirement categories. The classification results are presented to the User as the final output, serving as a reference for determining the allocation of subsidized organic fertilizers they receive.

### D. Class Diagram

The class diagram is a type of UML diagram used to depict the static structure of an object-oriented system or application. It shows the classes within the system, along with their attributes (data they contain) and methods (functions they perform). Each class is represented as a box divided into three sections: class name, attributes, and methods [16]. Additionally, class diagrams display relationships between classes such as:

1. Association (general relationship),
2. Inheritance (parent-child class hierarchy),
3. Aggregation (a “has-a” relationship that is not mandatory), and
4. Composition (a part-whole relationship that cannot be separated).

These relationships can also include cardinality/multiplicity, indicating how many objects of one class can be associated with objects of another.

Class diagrams are very important in system design because they serve as a reference for database structure creation and object-oriented program development, helping developers understand entity relationships in the overall system.

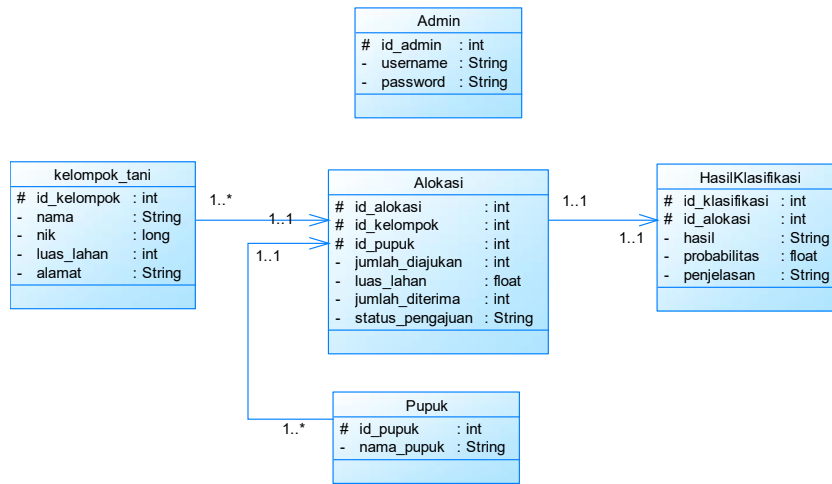


Fig. 7: Class Diagram

Fig 7 shows the database design using a class diagram. This design produces five tables, each serving its function in storing and managing data related to the subsidized fertilizer classification system. These five tables are interconnected to support the data flow, from farmer group data entry to the classification results of fertilizer requests.

### 3.2. System Implementation

The web-based subsidized fertilizer classification system developed in this study consists of several integrated components. The implementation process begins with the login page, which serves as the entry point for two types of users, namely administrators and farmer groups. Login validation ensures that only registered users can access the system, after which they are directed to their respective dashboards according to their access rights.

The implementation results can be seen in Fig 2, which displays the administrator dashboard page.

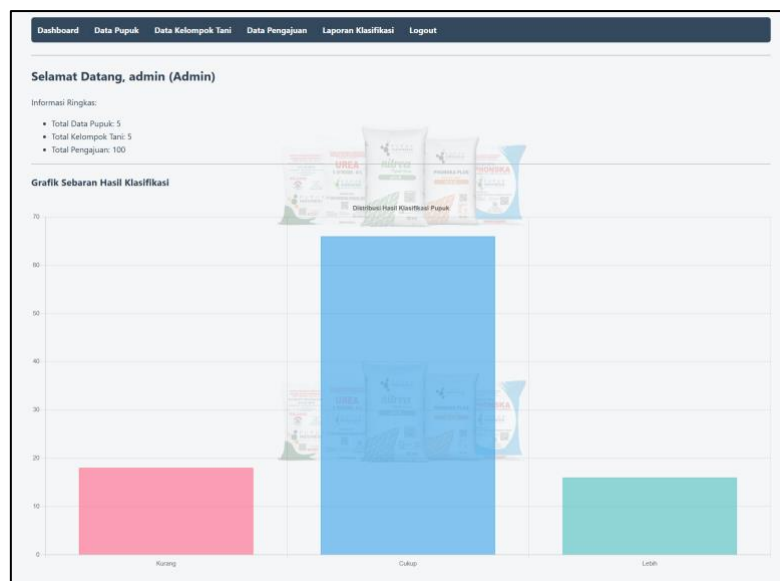


Fig. 8: Administrator Dashboard

Fig 8 shows a summary of fertilizer data, farmer groups, the number of submissions, and a classification chart generated using Chart.js. This visualization helps administrators to quickly understand the distribution of fertilizers in the categories Insufficient, Sufficient, and Excessive. In addition, administrators can manage farmer group data by adding or removing entries, ensuring that the database remains accurate and consistent. Next, the fertilizer application feature is shown in Fig 3.

### Pengajuan Pupuk

Pilih Jenis Pupuk:

Jumlah Diajukan (pupuk):

Luas Lahan (hektar):

Ajukan

No	Jenis Pupuk	Jumlah Diajukan	Luas Lahan	Status
1	NPK	250 pupuk	1.8 ha	diterima
2	Organik	400 pupuk	2 ha	diterima
3	NPK	200 pupuk	1 ha	diterima
4	NPK	100 pupuk	0.5 ha	diterima

Fig. 9: Fertilizer Application Page

As presented in Fig 9, farmer groups can enter data such as fertilizer type, requested quantity, and land area. The system then processes this data and automatically classifies it using the Naïve Bayes method. Administrators may review each submission to either approve or reject it, and approved submissions are stored in the classification report page for further reference.

Moreover, the system provides a classification simulation feature that can be used by farmer groups before submitting an official request. This feature is illustrated in Fig 10.

Dashboard
pengajuan
Logout

### Selamat Datang, CAHYO!

Uji Coba Klasifikasi Pupuk (Tanpa Simpan ke Database)

Pilih Jenis Pupuk:

Jumlah Diajukan:

Luas Lahan (hektar):

Klasifikasikan

Fig. 10: Classification Page

In Fig 10, the classification page allows farmer groups to input fertilizer type, requested amount, and land area, after which the system instantly displays the classification result into one of three categories: Insufficient, Sufficient, or Excessive. This feature enables farmer groups to estimate fertilizer needs based on their land conditions prior to formal submission. The classification results processed by the system are presented in Fig 11.

```

Input: Pupuk='ZA', Jumlah=150, Luas=1

Jika kelas 'kurang':
- n_kelas = 16, P(kelas) = 0.25
- P(pupuk='ZA' | kurang) = 0.05 (Laplace, K=4)
- μ_jumlah=122.8125, var_jumlah=31.152344, P(150 | kurang) = 5.0333e-7
- μ_luas=0.7281, var_luas=0.003115, P(1 | kurang) = 5.03333e-5
→ Skor posterior ∝ 3.16678e-13

Jika kelas 'cukup':
- n_kelas = 39, P(kelas) = 0.609375
- P(pupuk='ZA' | cukup) = 0.395349 (Laplace, K=4)
- μ_jumlah=143.2051, var_jumlah=95.504462, P(150 | cukup) = 0.0320568
- μ_luas=0.9321, var_luas=0.00955, P(1 | cukup) = 3.20576
→ Skor posterior ∝ 0.0247581

Jika kelas 'lebih':
- n_kelas = 9, P(kelas) = 0.140625
- P(pupuk='ZA' | lebih) = 0.076923 (Laplace, K=4)
- μ_jumlah=170, var_jumlah=16.666667, P(150 | lebih) = 6.00416e-7
- μ_luas=1.2, var_luas=0.001667, P(1 | lebih) = 6.00418e-5
→ Skor posterior ∝ 3.89964e-13

■ Prediksi: **cukup** (skor 0.0247581, probabilitas ~ 1)
    
```

Fig. 11: Classification Result Page

Fig 11 displays a summary of the classification results generated from the data submitted by farmer groups. This information assists users in identifying fertilizer requirements according to land conditions, thereby ensuring that submissions are more aligned with actual needs. With this design, the system functions not only as an administrative tool for fertilizer distribution but also as a predictive tool that supports data-driven decision-making.

### 3.3. Results

The testing process was conducted using a dataset of 80 records, which was divided into 64 training data (80%) and 16 testing data (20%). The Naïve Bayes algorithm was applied to process the data by calculating prior probabilities, conditional probabilities, and applying the Gaussian distribution for numerical attributes (amount requested and land area).

Table 4: Testing Data Results

No	fertilizer	Amount	Land Area	Actual	Prediction	True/False
1	NPK	120	0.7	kurang	kurang	Benar
2	Organik	130	0.8	kurang	kurang	Benar
3	ZA	140	0.9	cukup	cukup	Benar
4	Urea	160	1.1	cukup	cukup	Benar
5	NPK	125	0.75	cukup	kurang	Salah
6	Organik	135	0.85	cukup	cukup	Benar
7	ZA	145	0.95	cukup	cukup	Benar
8	Urea	165	1.15	lebih	lebih	Benar
9	NPK	130	0.8	cukup	kurang	Salah
10	Organik	140	0.9	cukup	cukup	Benar
11	ZA	150	1	cukup	cukup	Benar
12	Urea	170	1.2	lebih	lebih	Benar
13	NPK	135	0.85	cukup	cukup	Benar
14	Organik	145	0.95	cukup	cukup	Benar
15	ZA	155	1.05	cukup	cukup	Benar
16	Urea	175	1.25	Lebih	Lebih	Benar

Based on Table 4, it can be seen that 14 out of 16 testing data were correctly classified, resulting in an overall accuracy of 87.5%. When analyzed by fertilizer type, the classification accuracy was: NPK (50%), Organic (100%), ZA (100%), and Urea (100%). The errors occurred only with NPK fertilizer, which was due to overlapping data distributions between the *Insufficient* and *Sufficient* categories. These results indicate that although the dataset was relatively limited, the Naïve Bayes algorithm was still effective in classifying fertilizer needs with a high level of reliability.

### 3.4. Discussion

The findings demonstrate that the web-based subsidized fertilizer classification system provides practical benefits for both administrators and farmer groups. For administrators, the system facilitates monitoring of fertilizer distribution through an informative dashboard that displays data summaries and classification charts in real time. For farmer groups, the system enables simulation of fertilizer needs before submitting an official application, thereby making the distribution process more transparent, measurable, and better aligned with land conditions.

In terms of performance, the accuracy of 87.5% indicates that the Naïve Bayes method is sufficiently reliable when applied to classification tasks involving relatively simple data. The high accuracy achieved for Organic, ZA, and Urea fertilizers shows that data patterns for these types were consistent, while the lower accuracy for NPK was caused by overlapping attributes across categories. This suggests that accuracy could be improved by increasing the number of training samples, applying data normalization, or comparing the performance with other algorithms such as Decision Tree or Random Forest.

Furthermore, black-box testing confirmed that all system features including login, data management, fertilizer application, classification reports, and simulation functioned properly. Each input was validated accurately and outputs were generated as expected, proving the system's robustness and reliability in practice.

## 4. Conclusion

This research successfully developed a web-based subsidized fertilizer classification system using the Naïve Bayes method. The system provides features such as login, farmer group data management, fertilizer application, classification reports, and simulation, which can be accessed by both administrators and farmer groups. Black-box testing demonstrated that all functionalities worked properly, making the system a reliable digital tool for simplifying and monitoring fertilizer distribution more efficiently.

Based on testing with 80 data records, the Naïve Bayes method achieved an overall accuracy of 87.5%, with perfect classification for Organic, ZA, and Urea fertilizers, but only 50% accuracy for NPK due to overlapping data distributions. These results confirm that Naïve Bayes is effective for this classification problem, although its accuracy can be further improved through larger training datasets or by comparing results with alternative algorithms.

Practically, this research contributes a digital solution that supports fairer and more transparent fertilizer distribution, while academically it provides empirical evidence that simple probabilistic algorithms such as Naïve Bayes remain relevant for real-world cases with limited data. For future work, it is recommended to expand the dataset, integrate the system with government databases, and explore other classification algorithms to further enhance the reliability and scalability of the system.

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