Naive Bayes Method in Determining Diagnosis of Corn Plant Disease

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Abstract—Corn is one of the leading agricultural commodities from the food crop sub-sector that is multi-purpose and has strategic value to be developed. At this time, corn is not only used for food but also for animal feed, and also fuel. The amount of production, productivity and price of corn always fluctuates due to the influence of the ever-changing amount of demand and supply. The high demand for maize in the domestic market is an opportunity for Indonesia to balance the demand for and supply of maize. An expert system is a system that seeks to adopt human knowledge to computers, so that computers can solve problems as is usually done by experts. A good expert system is designed to be able to solve a particular problem by imitating the work of experts. Naive Bayes method is a method used to predict probability. While the Bayes classification is a statistical classification that can predict the class of a probability member. For a simple Bayesian classification known as the Naïve Bayesian Classifier, it can be assumed that the effect of an attribute value of a given class is independent of other attributes. From the results of testing on the Expert System Application that was built, the expert system can solve the problem that is it can display the diagnostic results quickly and precisely based on the symptoms entered by the user. Based on the tests carried out with the accuracy of the diagnosis obtained from the comparison between the results of expert diagnoses and system diagnoses with a percentage of 90%, the system can be clarified that it is feasible to use.

Keywords: Bayesian, Classification, Diseases, Expert System, Naïve Bayes

1. INTRODUCTION

Corn is one of the leading agricultural commodities from the food crop sub-sector that is multi-purpose and has strategic value to be developed. At this time, corn is not only used for food but also for animal feed (feed), and also fuel (fuel)[1][2]. The amount of production, productivity and price of corn always fluctuates due to the influence of the ever-changing amount of demand and supply[3]. The high demand for maize in the domestic market is an opportunity for Indonesia to balance the demand for and supply of maize. As for the way that can be taken to achieve a balance of demand and supply of domestic corn is to produce corn itself in the country by using domestic resources or by importing corn from other countries[4][5].

Corn plants have the potential to be attacked by pests and diseases that can attack at any time. Some of the diseases that attack corn include leaf blight, leaf rot, downy mildew, cob rot, and many others. Downy mildew in corn has long been considered to cause considerable losses, so it is widely known among farmers. Losses due to downy mildew on maize vary widely[6][7]. Certain plots can suffer a 90% loss.

An expert system is a system that seeks to adopt human knowledge to computers, so that computers can solve problems as is usually done by experts[8]. A good expert system is designed to be able to solve a particular problem by imitating the work of experts. With this expert system, it can help in solving quite complex problems that can only be solved with the help of experts. In addition, this expert system also helps farmers who are experiencing problems regarding diseases and pests and their solutions without relying on an expert. Expert System is an information system that contains the knowledge of an expert so that it can be used for consultation. The knowledge of an expert owned by the Expert System is used as a basis for answering questions (consultation). Expert systems can collect and store the knowledge of an expert or several expert people into a computer.

The knowledge is then used by anyone who needs it. in a knowledge-based system it is used to help solve problems that exist in the real world. who have a knowledge base for a particular domain and use interference reasoning to resemble an expert or as an advisor to solve a problem. Expert systems have the ability to perform analysis and performance improvement and also the ability to learn from these performances. This ability is important in computerized learning, making the program will be able to analyze the causes of success and failure experienced and also evaluate whether existing knowledge is still suitable for use in the future.

Naive Bayes method is a method used to predict probability[9][10]. While the Bayes classification is a statistical classification that can predict the class of a probability member[11]. For a simple Bayesian classification known as the Naïve Bayesian Classifier, it can be assumed that the effect of an attribute value of a given class is independent of other attributes[12][13]. Naïve Bayes Classifier is a classification method rooted in Bayes' Theorem[14][15]. The main feature of this Naïve Bayes Classifier is a very strong (naive) assumption of the

independence of each condition/event[16][17]. Naive Bayes is based on the simplifying assumption that attribute values are conditionally independent if given an output value. In other words, given the output value, the probability of observing collectively is the product of the individual probabilities[18][19]. The advantage of using Naive Bayes is that this method only requires a small amount of training data to determine the parameter estimates needed in the classification process[20][21]. Naive Bayes often performs much better in most complex real-world situations than one might expect[22][23].

2. RESEARCH METHODS

2.1 Research Method

This research method is described about the steps applied in this research. Based on the existing framework, the research framework used can be seen in Figure 1.

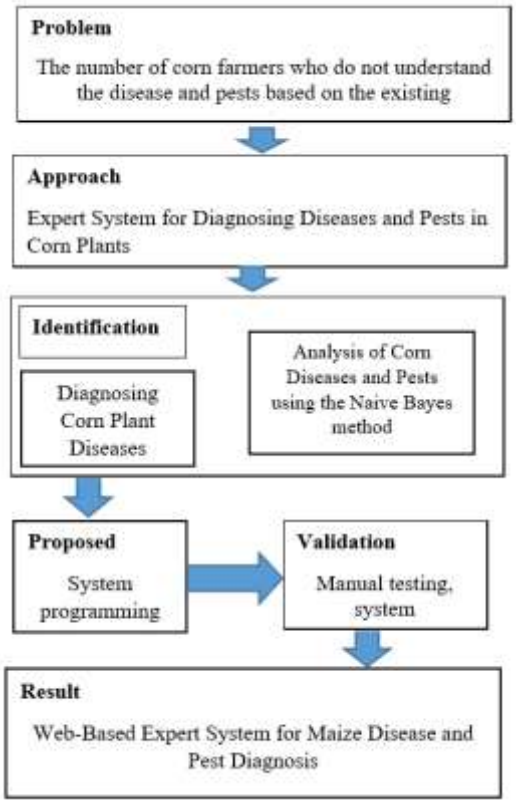

Figure 1. Research Method

a. Problems
The research stage begins with determining the research problem, namely regarding the lack of knowledge of farmers about Diseases and Pests in Corn Plants
b. Approach
The approach in research is the author's way of approaching things to be studied including solutions to problems, namely an expert system for diagnosing Corn Diseases and Pests.
c. Identification
The identification in question is related to the variables that will be used in this study regarding the method used, namely Naive Bayes, so that the results will be presented in accordance with the expected objectives, namely diagnosing Corn Diseases and Pests.
d. Proposed
The proposal presented in this study is to create a web-based program for diagnosing Diseases and Pests so that users can access it online.
e. Validation (Testing)
Tests are carried out using manual calculations, Microsoft Excel and systems.
f. Result
Application of an expert system to diagnose web-based Corn Diseases and Pests.

2.2 Naïve Bayes

The calculation of the comparison of new cases with old cases is indexing based on existing input parameters and mathematical calculations are carried out using the probabilities that occur for cases that are considered similar (Bayesian model)[24]. Naïve Bayes Classifier is a simple probability classifier based on Bayes theorem. Naïve Bayes Classifier can be trained efficiently in supervised learning[25][26]. The advantage of classification is that it requires only a small amount of training data to estimate the parameters (means and variances of the variables) required for classification[27][28]. Since independent variables are assumed, only the variation of the variables for each class must be determined, not the entire covariance matrix[29][30]. The Naive Bayes classifier model is shown in the following equation.

$$P(H \mid X) = \frac{P(X \mid H)P(H)}{P(X)} \quad (1)$$

Where :

p(H|E) = probability of hypothesis H occurring if evidence E occurs

p(E|H) = probability of emergence of evidence E if hypothesis H occurs

p(H) = probability of hypothesis H regardless of any evidence

p(E) = probability of evidence E regardless of anything

3. RESULTS AND DISCUSSIONS

Data acquisition is the entirety of the data needed to build an expert system for diagnosing diseases and pests of corn crops. The analysis of data needs in this expert system is obtained from the reference knowledge of the book Pests and diseases of food crops and the knowledge of farmers. After conducting interviews with Corn Farmers, data were obtained in the form of Prior values, namely the percentage of each type of disease and plant pest in corn and the Likelihood value, which is the chance of symptoms of a disease. Data on the types of diseases of corn crops can be seen in the table 1.

Tabel 1. Types of Diseases in Corn Crops

Types of Diseases	*Prior*
Peronosclerospora maydis	0,03
Bipolaris maydis Syn	0,03
Puccinia polysora	0,04
Swollen Burnt	0,01
Leaf Blight	0,03
Stem and Cob Rot	0,036
Dwarf Mosaic Virus Disease	0,05

Data on the pets can be seen in the table 2.

Tabel 2. Data Pets

Types of Diseases	*Prior*
Earthworm	0,03
Grayak caterpillar	0,07
Seed Flies	0,01
Stem Borer	0,04
Cob Borer	0,02
Aphids	0,06
Horn Beetle	0,01

Data on the likelihood value of corn crop symptoms can be seen in the table 3.

Tabel 3. Data on the likelihood value of corn crop

Code	Symptom	Probability
G001	The presence of bite marks on the leaves	0,5
G002	Withered Leaves	0,8
G003	The stem is broken near the ground	0,5
G004	The presence of bite marks on the trunk	0,7
G005	Damaged Roots Due to Grub Bites	0,8
G006	Plants Wither	0.5
G007	Partial or Whole Leaf Chlorosis	0,5
G008	Plants Become Dwarfs	0,9
G009	Fruitless	0,8
G010	The Cob Is Not Normal	0,9
G011	Leaves Are Green And Interspersed With Yellow Lines	0,6
G012	Leaves Look Yellow Striped	0,3
G013	The Presence of Short Dotted Lines on the Leaf Bones	0,3
G014	Leaves Look Long Yellow Striped	0,3
G015	Gray Brown Spots on Leaf Surface	0,4
G016	Brown Leaf Surface	0,5
G017	Widening Spots on Leaves	0,5
G018	Grayish-red midrib	0,1
G019	The presence of white granules	0,5
G020	Broken Leaf Bone	0,5
G021	Rotten Stem	0,6
G022	The Top Wither And Dry	0,7
G023	Broken Cob	0,5
G024	There are Red-Brown Dots Like Rust	0,9
G025	Cob Wrapping Broken	0,8
G026	There is a caterpillar on the cob of corn	0,5
G027	Leaf Color From Normal Green To Yellowish	0,5
G028	Damaged Young Plant Leaves	0,9
G029	In the morning on the underside of the corn leaves there is a layer of white velvet	0,5
G030	The lower and upper leaves are held without feeling the presence of spore powder	0,5
G031	Small Hole In Leaf	0,7
G032	Slitting Hole in the Trunk	0,8
G033	Fragile Rod And Tassel	0,8
G034	Broken Tassel Pile	0,5
G035	Seeds Will Be Damaged And Rotten, Even Cobs Can Fall	0,5
G036	The surface of the seeds is covered with mycelium, gray to black	0,5
G037	Plants Die Fast Or Dry	0,8
G038	Leaves Become Transparent	0,2
G039	Hollowed Even Only Bones	0,5
G040	The base of the stem or cob is pink, red brown or brown	0,5
G041	Are Plants Easily Collapsed	0,1
G042	Is the Outer Bark Thin?	0,1
G043	There is a yellow-brown powder,	0,5
G044	Black Swollen Corn	0,5
G045	Some Swollen Corn Seeds Poking Out	0,5
G046	There are Dirts in Corn Cobs	0,5

The rule base of diseases and pests on corn crops can be seen in the table 4.

Tabel 4. Rule Base of Diseases On Corn Crops

Number	Diseases	Symptom
1	Bulai	g7,g8,g9,g10,g29
2	Leaf Spots	g15,g16,g35,g36,g6
3	Rust Disease	g24,g16,g43
4	Burn Swelling	g24,g25,g44,g4
5	Blight Upih Leaves	g17,g16,g19
6	Stem and Cob Rot	g21,g22,g23,g40,g41,g42
7	Dwarf Mosaic Virus Disease	g11,g8,g30
8	Earthworm	g3,g1,g28
9	Grayak caterpillar	g8,g20,g38,g39
10	Seed Flies	g1,g2,g27,g21
11	Stem Borer	g12,g13,g14,g8,g6,g31,g32,g33,g34
12	Cob Borer	g26,g23,g46
13	Aphids	g14,g22,g27,g28
14	Horn Beetle	g12,g2,g14,g8,g6
15	grasshopper	g1,g4,g20

3.1 Corn Disease Prediction Using Naive Bayes

This discussion will provide an example of calculating the naive bayes method to determine the diagnosis of corn disease, in the early stages we must have data on the symptoms experienced by corn, namely The Presence of Bite Marks on the Stem (G001), Plants Become Wilted (G002), Partially Or Entire LeafRying Leaves (G003).
Based on the symptom data, then determine the probability value of each symptom, G001 has a value of 0.5, G002 has a value of 0.8, G003 has a value of 0.5. After obtaining the probability value, then look for the evidence value resulting from the number of symptoms present.

Evidence = G001 + G002 + G003
= 0.5 + 0.8 + 0.5 = 1.8

After obtaining the evidence, then calculate the posterior value of each disease based on symptom data with the formula

$$Posterior = \frac{Prior \times likelihood}{evidence}$$

Calculating the comparative value of each disease

1. Earthworm
   Presence of Bites on Leaves (G001)|Earthworm (H001) = 0.5 x 0.03/1.8 = 0.008333
   young plant leaves damaged (G028)|Soil caterpillar (H001) = 0
   Stem Broken Near Ground Surface (G003)|Earth Worm (H001) = 0.5 x 0.03/1.8 = 0.008333
   Earthworm (H1) = 0.008333 + 0.008333 = 0.16667
   grasshopper
   Presence of Bites on Leaves (G001)| Grasshopper (H008) = 0.5 x 0.5 / 1.8 = 0.138889
   the presence of bite marks on the trunk (G004)| Grasshopper (H008) = 0
   broken leaf bone G020| Grasshopper (H008) = 0
   Grasshopper (H2) = 0.138889
2. Seed Flies
   Seedling Flies (H003)| presence of bite marks on leaves (G001) = 0.01 x 05/1.8 = 0.002778
   Seedling Flies (H003)| withered leaf shoots (G002) = 0.01 x 08/1.8 = 0.004444
   Seedling Flies (H003)| stem rot (G21) = 0
   Seedling Flies (H003)| leaf color from normal green to yellowish (G027) = 0
   Seed Flies (H3) = 0.002778 + 0.004444 = 0.007222
3. Horn Beetle
   Horn Beetle (H007) | withered leaf shoots (G002) = 0.01 x 0.8 / 1.8 = 0.004444
   Horn Beetle (H007) | leaves appear yellow striped spots (G012)
   Horn Beetle (H007) | Leaves appear long yellow stripes (G014)
   Horn Beetle (H007) | plants wilt (G006)
   Horn Beetle (H007) | plants become stunted (G008)
   Horn Beetle (H4) = 0.004444

Final Comparison Results Comparison
H1 Earthworm = 0.16667
H2 Grasshopper = 0.138889
H3 Seedling Flies = 0.007222
H4 Horn Beetle = 0.004444

The result of the largest comparison is H1 then the diagnosis of the disease suffered from the existing symptoms is Earthworm with a value of 0.16667.

3.2 Validation of Feasibility of Expert System for Diagnosing Diseases and Pests in Corn Plants

System Validation is carried out as a process of testing the performance or level of success of the system. The system validation process is carried out after the design and implementation of the system. The process of validating the system by entering test data into the system. This is done with the aim of knowing the extent to which the system has a success rate, based on the test data entered. In this study the success rate of the system is determined based on the accuracy of the diagnosis. The calculation of the accuracy of the diagnosis is obtained from a comparison between the results of the diagnosis of the same system and the diagnosis of an expert compared to the amount of data being tested and multiplying by 100%.

No	Gejala	Identifikasi Pakar	Identifikasi Sistem
1	The presence of bite marks on the leaves Damaged Roots Due to Grub Bites The presence of bite marks on the trunk	Grasshopper	Grasshopper
2	Plants Become Dwarfs Fruitless The Cob Is Not Normal Plants Wither	Downy mildew	Downy mildew
3	The stem is broken near the ground The presence of bite marks on the trunk Damaged Young Plant Leaves	Grayak caterpillar	Grayak caterpillar
4	Leaves Are Green And Interspersed With Yellow Lines The lower and upper leaves are held without feeling the presence of spore powder Plants Become Dwarfs	Dwarf Mosaic Virus	Dwarf Mosaic Virus
5	Rotten Stem Are Plants Easily Collapsed The Top Wither And Dry Is the Outer Bark Thin? Broken Cob	Rotten Stems And Cobs	Rotten Stems And Cobs
6	Seeds Will Be Damaged And Rotten, Even Cobs Can Fall Brown Leaf Surface The surface of the seeds is covered with mycelium, gray to black	Rust Disease	Rust Disease
7	The Presence of Short Dotted Lines on the Leaf Bones Plants Become Dwarfs Leaves Look Long Yellow Striped	Stem Borer	Stem Borer
8	.Little Hole In Leaf Broken Tassel Pile .Slit Hole In The Trunk Fragile Rod And Tassel	Stem Borer	Stem Borer
9	Leaf Color From Normal Green To Yellowish The Top Wither And Dry Damaged Young Plant Leaves	Aphids	Aphids

	Leaves Look Long Yellow Striped		
10	Broken Cob There is a caterpillar on the cob of corn There are Dirts in Corn Cobs	Cob Borer	Cob Borer
11	Leaves Become Transparent, Broken Leaf Bone Hollowed Even Only Bones	Grayak caterpillar	Grayak caterpillar
12	The presence of bite marks on the leaves The presence of bite marks on the trunk Broken Leaf Bone	grasshopper	grasshopper
13	Plants Wither Withered Leaves Plants Become Dwarfs Leaves Look Yellow Striped Leaves Look Long Yellow Striped	Corn Planthopper (Horn Beetle)	Corn Planthopper (Horn Beetle)
14	Brown Leaf Surface There is a yellow-brown powder, There are Red-Brown Dots Like Rust	Rust Disease	Rust Disease
15	Black Swollen Corn There are Red-Brown Dots Like Rust The presence of bite marks on the trunk Cob Wrapping Broken	Swollen Burn Disease	Swollen Burn Disease
16	Damaged Roots Due to Grub Bites Plants Wither Leaves Look Yellow Striped	Stem Borer	Stem Borer
17	The lower and upper leaves are held without feeling the presence of spore powder Plants Become Dwarfs Rotten Stem	Dwarf Mosaic Virus	Dwarf Mosaic Virus
18	The Presence of Short Dotted Lines on the Leaf Bones Plants Become Dwarfs Rotten Stem	Downy mildew	Downy mildew
19	Is the Outer Bark Thin? Broken Cob There is a brownish yellow powder, Seeds Will Be Damaged And Rotten, Even Cobs Can Fall	Rotten Stems And Cobs	Rotten Stems And Cobs
20	The presence of bite marks on the trunk Damaged Young Plant Leaves Plants Wither	Aphids	Aphids

Number of diagnoses tested: 20

Number of correct answers : 18

Number of incorrect answers: 2

Eligibility assessment : 18/20 X 100% = 90%

Based on the tests carried out with the accuracy of the diagnosis obtained from the comparison between the results of expert diagnoses and system diagnoses with a percentage of 90%, the system can be clarified that it is feasible to use.

4. CONCLUSION

This expert system is designed by applying the Naive Bayes method, where the symptoms of diseases and pests on corn plants are selected by the user and then processed which will produce the output, namely the type of

disease or pest and solutions. Meanwhile, the one who determines the probability value for each symptom is an expert. From the results of testing on the Expert System Application that was built, the expert system can solve the problem that is it can display the diagnostic results quickly and precisely based on the symptoms entered by the user. Based on the tests carried out with the accuracy of the diagnosis obtained from the comparison between the results of expert diagnoses and system diagnoses with a percentage of 90%, the system can be clarified that it is feasible to use.

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