Mobile Expert System to Diagnose Diseases and Pests in Tobacco Using Analytical Hierarchy Process (AHP)

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Abstract. Tobacco, also known as the money tree by the Madurese people, is a second crop after the most cultivated corn. In the process of cultivating tobacco crops, diseases and pests become a threat to the farmers to realize the desire to make a lot of money. Generally, farmers often struggle to distinguish between pests and diseases. This failure will have a significant impact on the treatment, the disease that should be washed with the drug, but because the wrong diagnosis can be solved using insecticide (pest). This research aims to facilitate farmers to obtain information, appropriately diagnose and solutions in overcoming diseases and pests in tobacco. The experts who contributed to this study are agricultural experts in the district office of Sumenep. The method used is Analytical Hierarchy Process (AHP). This method is selected because it can perform consistency tests on data, so it is expected to improve the accuracy of the diagnosis. Based on research that has been done, using 21 data symptoms of diseases and pests, as well as nine types of diseases in tobacco, obtained the accuracy value of the mobile expert system by 65%. This accuracy is achieved by comparing the diagnose results by agricultural experts with the diagnose results using the mobile expert system.

1. Introduction

Madura is an island located in East Java that very famous with tobacco that has a distinctive aroma. Tobacco is classified as plantation crops that have high economic value. Based on Statistics Indonesia, known in Indonesia as BPS, the production of tobacco in the Sumenep district from 2011 to 2015 likely to decrease as in Figure 1. There are many factors that become a reason of this issue, one of the reason is pests and diseases in tobacco. The occurrence of disease attacks that force plants can raises to crop crash. Hence, the precise control is needed to prevent that issue. The delayed of diagnosis activity is caused by the absence of farmers' information about the types of diseases[1]. Farmers have different levels of knowledge and experience, and this greatly affects the accuracy of pest and disease handling. To solve this problem, in this research carried out the transformation of knowledge which is called an expert system. The Expert system is the procedure of approval of human understanding to a computer with the purpose of computers can have human expertise and solve problems like an expert[2][3][4].

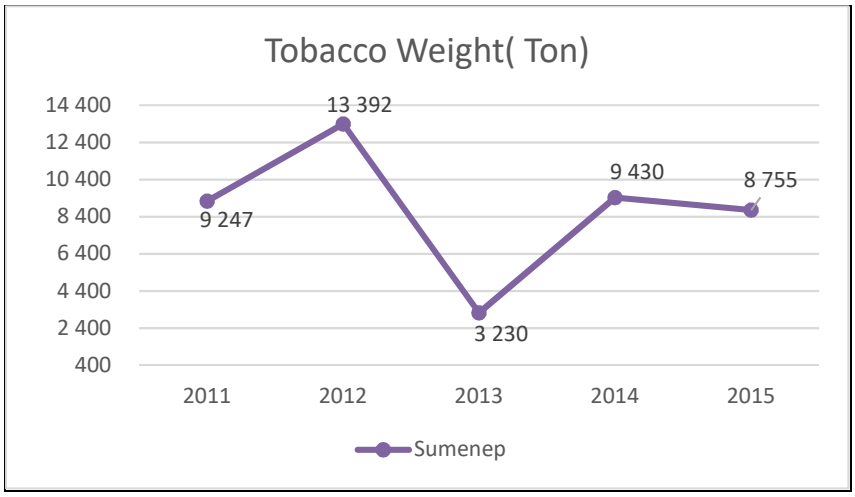

Figure 1. Development of Tobacco production in Sumenep, 2011-2015.

Analytical Hierarchy Process (AHP) is the process of decision making by using pairs comparison (Pairwise Comparisons) to explain the factors of evaluation and weight factor in multi-factor conditions. AHP method is widely used when decision makers feel the difficulty in weighing each factor. At the completion of this case how to present decision determination[5]. This method is selected because it can perform consistency tests on data, so it is expected to improve the accuracy of the diagnosis. Hopefully with this application will standardize the experience and knowledge of farmers so that it is easy and precise in diagnosing pests and diseases in tobacco crops.

2. Related Work

This section provides a review of articles mainly studying application of expert system and AHP. Andino Maseleno proposed an expert system of headache selection using AHP method, gives the result that the application can be used for determining the type of headache based on symptoms that the patient's perceived as a tool help doctors or paramedics in determine the type of headache, with using AHP process determination of choice using several criteria and each criterion uses the total value the integral is not always the same that has the weight vary. The choice of headache can done more quickly by using AHP[6].

3. Methods

In this study, mobile expert system developed using the AHP method. Data about disease and symptoms of tobacco were obtained from interviews with agricultural experts and literature studies. Knowledge base was developed based on information and knowledge obtained from agricultural experts and literature studies.

3.1. Analytical Hirarki Process(AHP)

Analyitical Hierarchy Process (AHP) is a method used in decision making process of a complex problem such as planning issues, alternative determination, priority drafting, selection of wisdom, allocation of resources, Determination of needs, forecasting of needs, perfomance planning, optimization and conflict resolution[7]

The Analytic Hierarchy Process (AHP) is a method of measurement through pairwise comparisons and

relies on the judgments of experts to derive priority scales. It has been one of the most widely used multiple criteria decision-making tools. It is used by decision makers and researchers, because it is a simple and powerful tool.[8]

AHP method is one of the methods of decision making using logic factor, intuition, experience, knowledge, emotion, and taste to be optimized in a systematic process, and able to compare in pairs the things that are not reliable or that can be felt, quantitative data and qualitative[9].
The advantage of this AHP method is that in the final stage can be withdrawn a con appropriation which is a combination of opinions from all parties that are used as a resource (expert). The AHP method measures include:

1. Defining problems and goal setting. If you choose alternatives or make alternative priorities, alternative development is performed.
2. Compile problems into hierarchies so that complex problems can be reviewed from the detailed and measured side.
3. Formulation of priorities for each element of the problem in the hierarchy by generating the weight of each element.
4. Conduct contingency testing of comparisons between elements obtained at each level of the hierarchy.

3.2. Proposed Solution for Tobacco Disease and Pest

Metode Analytic Hierarchy Process (AHP) is one form of a decision support model that uses functional hierarchy with the main input is human perception. So to draw conclusions from the facts the decision tree is used. Decision tree is a knowledge representation tool generated from the questions that asked to get a solution. Decision trees use several criteria to choose which branches to go through so that later only one branch will be chosen to make a decision result [10]. The conclusions from the symptoms was found is used the Best First Search method, which is this search method relies on two existing search methods, namely the Breadth First and the Depth First Search method. Diseases and pests as a conclusion of the search and tracking process shown in Table 1.

Table 1. Symptoms of tobacco

Sympthoms Code	Symptoms	Weighted
G1.	The leaves holes irregular and white on bite-used wounds	3
G2	The leaves are holes and long run out	5
G3	Leaves become lined, yellow, and wither	8
G4	Stem seedlings broken	15
G5	Plants become fallen and wither because the base of the stem is cut.	14
G6	The points of the scar are blackish or silvery.	8
G7	Yellow leaf	10
G8	Plants become dwarfs	12
G9	Crops wither and eventually die	13
G10	Striped leaves with green to yellow color	8
G11	Leaves wrinkle-looking curly	8
G12	Dried leaves	4
G13	Narrow leaves	6
G14	Brownish-spotting (concentric) leaves	9
G15	The leaves of the round patches are white to the yellow leaf and then brown.	9
G17	Brown stem Base as scorched	5
G18	Pith rod dries, crumpled and shrinkage.	6
G19	Roots covered in white mushrooms.	14
G20	Plant stem if it is torn in the white slime of milk.	13
G21	The roots become rotten Brown to black.	16

Table 2 shows the rule-based diseases and symptoms. Based on this rule, diseases and pests in tobacco are diagnosed.

Table 2. Symptoms and diseases of tobacco

M,	Cause	Symptoms
‘1	Insects	1,2,3,4,5,6
2	Virus	3,7,8,9,11
3	Mushrooms	10,12,13,14,15,,16,17,18,19,20
4	Bacteria	10,11,12,13,15,16,20,21

The process of diagnosing the disease starts with examining the symptoms that most appear in teak disease and pests, as shown in the Table 2 which is G1. There are five types of diseases that have symptoms of G1, namely diseases P1, P2, P3, P4 and P5. If the symptom of G1 is true then the probability of disease is P1, P2, P3, P4 and P5. then the system checks the second symptom, if G2 is true then the probability of the disease is P1. in this iteration, if G5 is also true then P1 disease is detected. repetitive iterations until one fact is found to be true, but if there are facts that have not been set on rule based and are equally true or equally false, the system cannot detect or undefined.

4. Result and Discussion

This research has success in develop an mobile expert system that can detect diseases and pests in tobacco based on information from human expert. The interface of mobile expert system is shown in Figure 1. There are several features provided, the user interface for input symptoms of the disease that found by the user, then the diagnosis results and suggestions for handling diseases and pests detected is provide in another screen of application as show in figure 2.

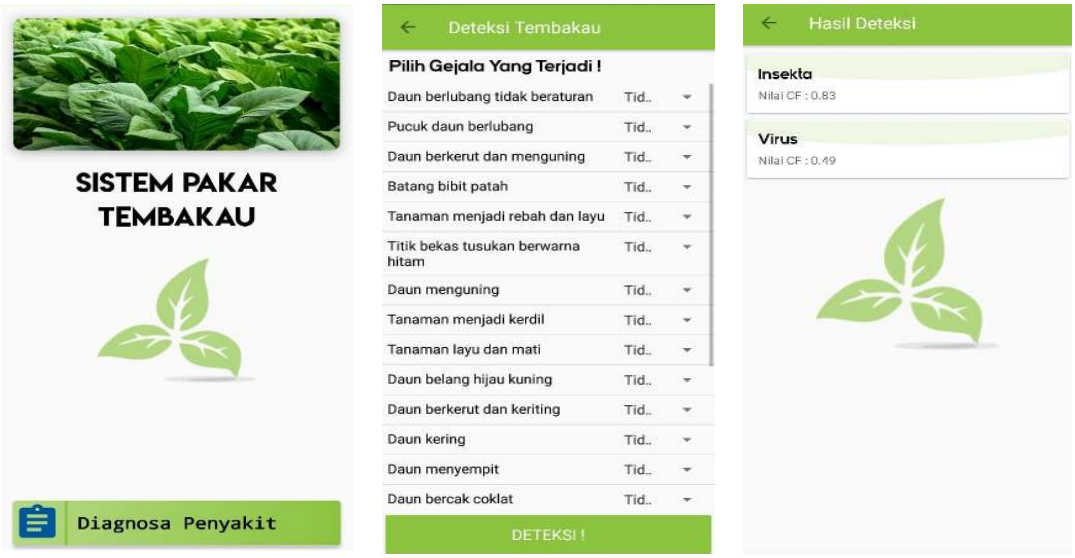

Figure 2. Display menu on mobile expert system.

Figure 3. Recommendation for pest and disease handling

In this system, the user should choose a diagnosis menu, then the system will ask questions according to the symptoms in table 2. if user set true for the first symptoms question as show in table 2, then system will lead the user to the next question. If the user set not true for the second symptoms question then system will be directed to the other question until the system finds a result or prove symptoms adjusted to rule based. The final results of the diagnosis will be displayed as in figure 1.

4.1. Accuracy Testing

In order to be used, this expert system must go through a due diligence process. due diligence is done by comparing the results of diagnosis by a mobile expert system with the results by human experts. The comparison results are shown in Table 3.

Table 3. Comparison Result Expert System and Human Expert

No	Symptoms Codes	Answers (Y=Yes, G=Greatly)	Human Expert	Mobile Expert	Score of Verification
1	G1,G6	Y, G	Insects	insect	1
2	G10,G19	Y,Y	Mushrooms	mushrooms	1
3	G1,G11,G16,G21	Y,G,Y,G	Mushrooms	bacteria	0
4	G11,G15,G18	Y,Y,G	Mushrooms	mushrooms	1
5	G10,G15,G20,G21	G,G,Y,Y	Mushrooms	bacteria	0
6	G8,G11,G15,G17	Y,G,Y,Y	Virus and Bacteria	virus	0.5
7	G17,G19, G20	Y,G,G	Mushrooms	mushrooms	1
8	G10 ,G16,G17	G,Y,Y	Mushrooms	mushrooms	1
9	G11,G18	Y,Y	Virus	mushrooms	0
10.	G1,G11,G16, G17	G,G,Y,Y	Bacteria	Bacteria	1
Total Score					6.5

Table 3 shows the test results performed on the mobile expert system based on the symptoms that were input by the user. In the first test, the user enters the symptoms of diseases and pests found in tobacco i.e. The Symptom code G1 (the leaves holes irregular and white on bite-Used wounds) and G6 (the points of the scar are blackish or silvery), the result of this test show that tobacco is infected with insect pests. The test conducted on this research as much as10 times, there are 3 errors diagnose done by the system is on the third, eighth and ninth testing. While in the sixth Test, the system only managed to refer to that the symptoms with the code G8, G11, G15, G17 caused by viruses, but according to the expert symptoms are caused by viruses and bacteria, so that the treatment process is not only based on the handling of tobacco disease because of viruses but is done by the first bacterial

disease caused by the virus eradication. So the test results get a score of 0.5. Based on this result, accuracy results are calculated as follows:

Accuracy = (Mobile expert Result/ Human expert Result) * 100% …..(1)

Accuracy = (6.5/ 10) * 100% = 65 %

Based on this test, the accuracy of mobile expert system using AHP is 65%.

5. Conclusion

The method used is Analytical Hierarchy Process (AHP). This method is selected because it can perform consistency tests on data, so it is expected to improve the accuracy of the diagnosis. Based on research that has been done, using 21 data symptoms of diseases and pests, as well as nine types of diseases in tobacco, obtained the accuracy value of the mobile expert system by 65%. This accuracy is achieved by comparing the diagnose results by agricultural experts with the diagnose results using the mobile expert system. in future research we can combine AHP with other method to increase accuracy mobile expert application for diagnose disease and pest in tobacco.

Acknowledgments

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