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The 6 ==th International Conference on Cyber and IT Service Management (CITSM 2018) Inna Parapat Hotel – Medan, August 7-9, 2018== Certainty Factors in Expert System to Diagnose Disease of Chili Plants 1 Anik Andriani, 2 Anastasya Meyliana, 3 Sardiarinto, 4 Wahyu Eko Susanto, 5 Supriyanta 1)2)5) AMIK BSI Yogyakarta, Jalan Ringroad Barat, Ambarketawang, Gamping, Sleman, Yogyakarta, Indonesia 3) AMIK BSI Purwokerto, Jalan HR. Bunyamin 106, Purwokerto Utara, Jawa Tengah, Indonesia 4) AMIK BSI Tegal, Jalan Sipelem No.22, Kraton, Tegal Bar, Kota Tegal, Jawa Tengah, Indonesia Abstract- The accurate analysis of pests and diseases of the chili plants can determine the right solution to reduce the production failure of plants.

But the number of horticulture experts who can help ==to diagnose pests and diseases== of the chili plants is still limited. The expert system is built with the aim to help diagnosing pests and diseases of the chili plant. This expert system extracts expert's knowledge by using inference engine. The inference engine used is the Forward Chaining, which works by analyzing symptoms to achieve a demanded conclusion. The incompleteness of the experts' domain knowledge and the difference of the expert sources or the incompleteness of information provided by the expert system users, can lead into uncertain result of the expert system.

The application of Certainty Factors in Expert System is able to anticipate Uncertainty from the Expert System result. The result presented by the expert system is in the form disease names, the definition, the solution and the certainty value from conclusion . Keyword: Expert System, Forward Chaining, Certainty Factors I . I NTRODUCTION Pest and disease are the major obstacles in increasing chili production. Chili plant diseases like Anthracnose and Thrips make 35%-90% chili productions are lost [1].

Incorrect diagnosis in detecting pests and diseases of chili plants make countermeasures become ineffective and inefficient. Consultation with experts in horticulture is one of the ways to diagnose pests and diseases of chili plant, which is considered to be the correct action. But the limited number of experts in horticulture and the limited consultation time become the obstacles in detecting pests and diseases of chili plants. One solution for these problems is by transferring knowledge from experts in horticulture.

The knowledge base of an expert can be transferred into computer system. This computer system contains a distribution of knowledge and new communication channel that contains the expert knowledge base and a system called as expert system. Expert system is computer programs that emulsify expert behavior in problem solving related to knowledge domain in particular field [2]. The prior research in expert system has been done in the previous years, but uncertainty factor in expert system is a problem to be solved [3].

The uncertainty is caused by the difference in value during the consultation, such as the differences caused by expert system user who are less confident of the answers given [4]. One theory that can be used to solve the problem of uncertainty is Certainty Factors, which contain a value to measure expert confidence level [5]. Prior research entitles "Expert Systems With Genetics Probability [6] has built Expert System Application to diagnose diseases using Genetics Probability method.

Another research with the title "The Comparison between Forward Chaining and Backward Chaining" [7] has built Expert System Application with the comparison between Forward Chaining method and Backward Chaining method. In this research built expert system in academic sectors. The results of this study indicate Forward Chaining method is better than Backward Chaining. Unfortunately, in this study did not use methods to overcome decision uncertainty. The difference of this research with first research study is that in the first research, they used Fuzzy Inference Engine method and in this research, the researcher uses Forward Chaining method.

This research and the second research have similarity in the use of Forward Chaining method. The difference lies in the use of Certainty Factors to measure the confidence level of the experts in this study. The objective of this research is to build expert system to diagnose pests and diseases in chili plants by applying Certainty Factors and using Forward Chaining method. The expected results achieved from this study is the application of expert systems that can be used to diagnose pe sts and diseases in chili plants by showing the value of the certainty of the diagnosis.

In addition, this expert system also provides a solution to overcome them. II . E XPERT S

YSTEM A. Expert System Concept Expert system is one branch of Artificial Intelligent (AI). Expert system has some advantages compared to other AI methods [8]. Expert system is a process of analyzing and interpreting knowledge possessed by experts in certain fields and transforming such knowledge in a machine [9]. Expert system consists of two important parts, which are knowledge base and inference engine.

The knowledge base takes the domain knowledge from the experts. Furthermore, the representation of knowledg e in the knowledge base was manipulated by the inference engine [10]. There are two important types of inference engine, which are Forward Chaining and Backward Chaining. Both of them are also known as data-driven and goal-driven [11]. The differences of both of them is that the Forward Chaining begins by tracking of facts done by forward coherently until it gets the conclusion, while Backward Chaining process begins by making conclusion and followed by tracking backwardly of facts coherently [12]. B. Uncertainty Factor The results of diagnosis or conclusion from expert system often do not present certainty values completely or in a full form.

This uncertainty can be in the form of probability that depends on the outcome of an event [4]. The uncertainty that occurs in many domain of the knowledge occurs because the data that is given to the user and the domain knowledge are from the experts system itself [13]. Some sources of uncertainty can be seen in Fig 1 below: Fig 1. Sources of Uncertainty Factor [14] From Figure 1, the sources of uncertainty factors are elaborated as follow [14]: 1) Incomplete domain knowledge refers to incomplete knowledge in certain domains.

Incomplete domain knowledge causes the result may or impossible to be accurate. Example: Doctor must have complete domain knowledge about the some information of patient such as patient's illness, patient's medical history, period of disease, symptoms shown or perceived by the patient, and others. Domain knowledge owned by doctors can generate action and treatment that is precise and accurate for the patient. 2) Noisy and Conflicting Data, data obtained from the real world is usually the data that is not clean.

When data collected from variety of different sources, it can occur noisy and conflicting data. Noisy data is data that contain no meaning, while conflicting data is a contradictory data. Example: Coins are upside to produce figures, definitely worth heads or tails (noisy data). A student's test score is 100 and this value is between 60-90 (conflicting data). 3) Incomplete information is information that only partial or not enough to meet the needs of necessary information. Example: Software can't be

established if the information needs of users about this software are incomplete.

This may cause the software can't meet the needs of users in terms of its function. 4) Selection Among the Alternatives, alternative is an option that can be the considerable so lution in certain situation. There are many alternatives that can be used for a given problem. This causes differences in the use of the best alternatives to problem solving. C. Certainty Factor Certainty theory is a framework to measure and represent confidence level whether it is right and wrong in the knowledge based system. Certainty theory depends on Certainty Factor (CF).

CF represents value of belief on fact or hypothesis based on evidence [15]. Value of CF in between -1 (definitely wrong) and +1 (definitely true) to measure level of confidence (a positive number) and uncertainty (negative numbers) of conclusion generated [16]. Uncertain Terms and their interpretation show in Table 1. TABLE I U NCERTAIN T ERMS A ND T HEIR I NTERPRETATION [17] CF is defined by following equation(1): CF [ ] [ ] (1) CF[h,e]= Certainty Factor MB[h,e]= Size of trust/confidence level of hypothesis h, if given/influenced evidence e (between 0 and 1) MD[h,e]= Size of distrust/uncertainty level of hypothesis h, if given/influenced evidence e (between 0 and 1) Expert could have taken two conclusions of hypotheses from a case. That matter one of combinations can occur on Certainty Factor.

There are some combinations in Certainty Factor with some evidences among others [17]: 1) Rules of use AND The 6 th International Conference on Cyber and IT Service Management (CITSM 2018) Inna Parapat Hotel – Medan, August 7-9, 2018 so, calculation of CF value is: [1 2] (2) 2) While rules of use OR So, calculation of CF value is: [1 2] (3) III . R ESEARCH M ETHOD In this study, the conclusion that is drawn is about the type of pests or diseases that attack chili plant. However, the number of it is quite a lot. So in this study, the inference engine that is considered being the most suitable one is Forward Chaining.

It is because in Forward Chaining method, the tracking is done by using ahead traces that starts from premise examination toward the final conclusion; thus, it is considered to be suitable for cases which have many conclusions [18]. Research framework that contains stages that are conducted in this study can be seen in Fig 2. Fig 2. Research Framework Stages in research framework in Figure 2 presents this study through six main stages i.e. (1) Identification of Problem, this step determines expert system boundaries and decision type (2) Knowledge extraction, it is taken from expert that be done by two ways, there is a Graphical Representation with Block Diagram and the second way is Dependency Diagram (3) Knowledge Representation by making rule (4)Create Inference Engine with Forward Chaining method (5)User interface

development with application developer software and database developer software (6)Product Testing consisting of product testing and usage testing in new system. Testing phase was conducted to determine the limitation of the expert system. If we found the limitation, then we will do product revision. IV. R ESULT A ND D ISCUSSION A.

Identification of Problems In this study, we develop application of expert system to diagnose pests and diseases in chili plants. Expert system that is built is a user interface that presents questions such as consultation with horticulture expert. The result is in the form IF <evidence E1> AND <evidence E2> . . . AND <evidence En> THEN <hypothesis H> {cf} IF <evidence E 1 > OR <evidence E 2 > . . . OR <evidence E n > THEN <hypothesis H> {cf} The 6 th International Conference on Cyber and IT Service Management (CITSM 2018) Inna Parapat Hotel – Medan, August 7-9, 2018 of conclusion of pests and diseases and it shows certainty value from its conclusion.

More over this application presents the solution to overcome pests and diseases in chili plants. B. Knowledge Extraction 1) Block Diagram that is created aims to explain situation that is determined by the conclusion of pests and diseases of chili plant. In the Block diagram, it can be seen what factors are involved in determining conclusion as shown in Fig 3. Fig 3. Block Diagram Expert System for Diagnosis of Pests and Diseases Chili Plant Fig 3 shows the factors involved in making conclusions of expert system for diagnosing the pests and diseases in chili plant, some of them are the symptoms which can be seen in fruit, plants, roots, stems, and leaves. 2) Dependency Diagrams are used to describe correlation of question, rules, values, and factors to determine conclusion in expert system.

Dependency diagram is considered to be easier for user s to read the information in diagram [19]. Fig 4. Dependency Diagram Expert System for Diagnosis Pests and Diseases Chili Plant Fig 4 shows determining factors of conclusions as illustrated in block diagram in Fig 3. Dependency diagram forms several rule sets with input data obtained from the questions to get a final conclusion. C.

Knowledge Representation and Creation of Inference Engine Having created knowledge extraction with Block Diagram and Dependency Diagrams, the next step is to convert them into IF-THEN rules. In this expert system application, IF- THEN rules drawn up by using the AND operator. Hence, some rules that should use OR operator or ELSE will be made into two rules by using AND operator. The rules are built by adopting inference engine with Forward Chaining. So expert system analyzes symptoms from consultation result to get the conclusion. D.

User Interface Development The implementation results of expert system in the form of

consulting page are shown in Figure 5. In this page, user can choose the symptoms that appear in chili plants according to category namely fruit, plant, rod, leaf, and root. Furthermore, symptoms data will be analyzed as shown in Fig 6. The 6 th International Conference on Cyber and IT Service Management (CITSM 2018) Inna Parapat Hotel – Medan, August 7-9, 2018 Fig 5. Consultation page Fig 6.

Analysis Result Analysis result presents the name of a disease that attack chili plant, Latin name, value of certainty, definition, and solution. D. Product Testing The last phases from expert system development is the testing. Software testing is an activity that is done after software source code has been developed where the activity is done with series dynamic executions [20]. Software testing technique used for testing is Black Box testing. Black Box testing is a software testing technique that focuses on the functionality from systems that test case designed based on information entered into the system [21].

TABLE II F UNCTIONALITY T ESTING R ESULTS B Y T HE B LACK B OX T ESTING M ETHODE Based on the test result of system functionality that shown in Table 2, it can be concluded that system functionality can run well. V . C ONCLUSION Expert systems that are built are used to store knowledge from expert in horticulture, especially chili plant. Expert systems can be used to diagnose diseases of pepper plants, conducted by the farmers. Expert system also provides knowledge about the disease and its solution. In addition, expert system can be used as an assistant to the experts themselves. The difference with the two previous studies is certainty value display on the decision result.

The implementation of certainty factor in expert system can show certainty value of disease diagnosis, so expert system can anticipate uncertainties that may happen. R EFERENCES [1] L. L. Black, S. K. Green, G. L. Hartman, and J. M. Poulos, The Main Disease of Chili Plants, A. Dibyantoro, et al., Eds. Taiwan: The World Vegetable Center, 2010. [2] I. O. Folorunso, O. C. Abikoye, R. G. Jimoh, and K. S. Raji, "A Rule- Based Expert System for Mineral Identification," J ournal of Emerging Trends in Computing and Information Sciences , vol. III, no. 2, pp. 205- 210, Feb. 2012. [3] N. Nnamoko, F. Arshad, D. England, and J.

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