Design of Backward Chaining for Identification Palm Oil Diseases Base on Expert System

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Abstract. The most important oil crop and highest production in the world is oil palm. Crude Palm Oil (CPO) and Palm Kernel Oil (PKO) are the products of the fruit. The benefits of palm oil include being used for food, chemical industry, pharmaceuticals, health supplements and as a source of biofuels. The challenges faced by oil palm growers are the diseases and pests that attack them. This research will design of backward chaining methode for expert system that can identify diseases in oil palm to provide treatment. The designs that have been produced include: knowledge representation about symptoms, diseases and treatment, input output systems and process design which includes data flow diagrams, databases, search for backward chaining using a decision tree. This design can be implemented using various programming languages, especially database or visual programming. The results of this research are very suitable as a reference for novice researchers who are interested in expert systems. The weakness of this research lies in the research domain that only comes from literature, it has not directly involved oil palm experts.

1. Introduction
The most important and highest producer of oil in the world is palm oil. The challenges facing oil palm growers are diseases that affect growth and reduce oil yield such as Ganoderma (common in Asia), rot (Latin America) and ship wilt (Africa). Vascular wilt caused by Fusarium oxysporum attack f. sp. Elaeidis caused serious damage to oil palm cultivation in Africa. Control measures that have been taken to prevent these diseases include: selection of resistant or tolerant plant materials, soil renewal, chemical control, stimulation of defense reactions, and use of cover crop fertilizers and potassium (K) [1]. Studies on the control of Basal Stem Rot Disease (BSR) in oil palm plantations have been carried out in the form of a geographic information system to assess the spread of the disease. Ganoderma Boninense causes Basal Stem Rot (BSR) disease which is the most serious oil palm tree disease in Malaysia. The infection caused by the fungus results in a loss of yield and eventually kills the tree [2].

Testing of house conditions to determine the effectiveness of the fungus as a biocontrol agent has been carried out to reduce disease in oil palm seedlings infected with Ganoderma. Treatment methods after artificial infection are the best control. Reduction of affected plants gave the lowest disease severity index (DSI) value of 5.0%, compared to infected and untreated controls who had the highest DSI of 70.0% [3]. Bioorganics formulation containing Burkholderia Gano EB2 has been shown to suppress Ganoderma disease in oil palm [4]. Groundwater level and pH correlate with Ganoderma attack, but the biological characteristics are not significantly correlated, except for the dominant vegetation ratio which tends to have a positive correlation with the number of Ganoderma antagonists. This study shows that Ganoderma attacks can be reduced through peatland water management and vegetation management by maintaining the diversity of vegetation around oil palm [5].
A technology study to detect the presence of disease in oil palms has been carried out, namely the application of an LDA-based algorithm to distinguish healthy leaves from infected leaves at three stages of infection with high classification accuracy (90%) [6]. The development of an expert system using the Forward Chaining algorithm has been used to carry out the process of sorting oil palm fruit to obtain superior quality oil palm fruit based on the characteristics and criteria of fresh oil palm fruit bunches by determining 5 criteria and 39 characteristics of fresh oil palm bunches [7]. An expert system using the Forward Chaining method has also been developed to diagnose diseases in cocoa plants based on the symptoms that have been entered based on any predetermined rules. This system can provide recommendations for the right diagnosis for farmers [8]. The ability of the expert system also succeeds in diagnosing eye diseases according to the choice of symptoms entered as a query and system evaluation through usability testing shows that the expert system for the diagnosis of eye diseases has a very good level of usefulness [9]. The concept of multi-knowledge made with database design will increase the ability of expert systems to diagnose various diseases and have more solutions to health problems [10].

This study will design an expert system that can identify diseases in oil palm to provide solutions using the backward chaining method. The results of this study will produce a different technology from previous studies using different methods and the same domain but from a different side.

2. Method

The method used in this research is the waterfall software development method. The research method is divided into two, namely the domain of research and the domain of research focus. In the domain of research, through a literature study on pests and diseases of oil palm and an analysis, a representation of knowledge about oil palm disease identification based on symptoms was obtained to find a solution. In the realm of research focus, after conducting a literature study on expert systems and forward chaining methods, input, output, and process analysis can be carried out. The results of the analysis are used to design input, output, and process in the form of context diagrams, level 1 data flow diagrams, and table relation designs (figure 1). The tracing process design uses the forward chaining method in the form of a decision tree.

3. Results

3.1. Representasi Pengetahuan

Based on the literature study on oil palm pests and diseases, there are 11 kinds of diseases, 29 symptoms of disease and 23 solutions that can be done to eliminate these diseases. Each disease can be identified by one or more symptoms or causes, so it can be represented as follows.
Rule Disease : \text{if \ symptom}_1 \text{ and \ ... \ and \ symptom}_n \text{ then \ disease}_1

Table 1. Palm oil diseases

| Id  | Name of palm diseases     |
|-----|---------------------------|
| D01 | Crown Disease             |
| D02 | Spear Rot Disease         |
| D03 | Bunch Rot                 |
| D04 | Basal Stem Rot            |
| D05 | Nematode pests            |
| D06 | Mite pests                |
| D07 | Setora pests              |
| D08 | The Oil Palm Bunch Moth   |
| D09 | Blast Disease             |
| D10 | Patch Yellow              |
| D11 | Dry Basal Rot             |

11 oil palm diseases can be represented in table 1, 29 symptoms or causes of disease are represented in table 2 and 23 solutions are represented in table 3

Table 2. Symptom of palm oil diseases

| Id symtom | Name of symptom                                                                 |
|-----------|-------------------------------------------------------------------------------|
| S01       | The appearance of leaf midribs that do not open completely and are swollen     |
| S02       | The color of the leaves changes to shiny bronz-colored                         |
| S03       | Caterpillars or larvae perforate young fruit or eat the surface of ripefruit   |
| S04       | The occurrence of rot (dry rot) at the base of the brick                       |
| S05       | Fungus formed from the base of the stem.                                      |
| S06       | The bunches of flowers rot and do not open they do not bear fruit              |
| S07       | Flowering fruit bunches decompose                                             |
| S08       | After the leaves open, you will see pale yellow oval dots surrounding the brown conidiophores |
| S09       | The rotten pup is easily removed, then the disease attacks the growing point   |
| S10       | The fronds break easily, but the leaves remain green for a while, although they will eventually rot and dry out. |
| S11       | Frond rot caused by secondary fungi such as Fusarium sp, Phytophthora sp       |
| S12       | In young plants the leaves turn yellow, dry quickly starting from the leaves on the lower midrib and eventually the plant dies |
| S13       | In an advanced state most of the leaves become dry and the plant dies          |
| S14       | Old leaf necrosis starts from the lowest midrib                                |
| S15       | Attack ripe fruit and can penetrate the pulp, thus reducing the quality of palm oil |
| S16       | The discharge is yellow and has a foul odor                                   |
| S17       | The adults enter the growing area and feed on the soft parts                  |
| S18       | Withering throughout such as lack of water and nutrients                      |
| S19       | If you look at the roots of the plant, you can see that there is rot in the roots of the plant. |
| S20       | Disease infection has occurred when the leaves have not opened                |
| S21       | Disruption of mites in the nursery can cause damage to seedlings              |
| S22       | Old leaves that dry out of cloves                                             |
| S23       | Leaves withered, dry and gray-brown, then broken at the base.                |
| S24       | Mature leaves are damaged like scissors cut                                   |
| S25       | The leaves turn yellow then dry out                                           |
Table 2. Name of symptom

| Id | Name of symptom |
|----|----------------|
| S26 | The new leaves that will open become curled and grow upright |
| S27 | When attacking mature plants it will cause the leaves to wither, then the plant will die |
| S28 | If you attack the nursery, it can cause sudden death of the seedlings |
| S29 | Shiny white mushroom threads extend over the surface of the Old bunch, causing wet rot. This spoilage greatly increases the fatty acid levels |

Likewise each disease can be selected from several solutions, so that it can be represented as follows:

Rule solution : if disease₁ then treatment₁ or ...... or treatmentₙ

Table 3. Treatment of palm oil diseases

| Id | Treatment |
|----|-----------|
| T01 | Stumps, the remains of roots around the stump are dismantled, collected for burning. The old stems were cut into pieces, collected, stacked and burned Poisoning old plants before they are cut down can reduce the attack of Ganoderma in the next generation. |
| T02 | Spraying the fungicide with Antimucium WBR (ferrile mercury acetate) coupled with an Actidone (Cyclo Heximide) and 0.7 liter / ha Difolatan (Kaptatol) leveler with a spray volume of 150 liters / ha at intervals of 2 weeks Spraying with acaricide Tetradifon (Tedion) 0.1 - 0.2%. This poison can be used well because it does not kill natural enemies Fungicide and antibiotic pouring, namely 1 gr Benlate + 1 gr streptomycin in 1 liter of water, carried out at 1 month intervals |
| T03 | Making a good nursery for healthy and strong seed growth. Providing irrigation water during the dry season can prevent this disease from occurring Biological eradication using the fungus Metharrizium anisopliae and Baculovirus oryctes virus. |
| T04 | Pruning sore midribs to reduce disease attacks Poison the infected tree with sodium arsenite and after it is dead / dry it is immediately dismantled to remove the source of infection Plant at the appropriate spacing for the land class Plant seeds that are free from Yellow Patch disease infection Planting seeds that are free from infection with dry rot disease from the base of the blades Planting seedlings whose roots have not penetrated the polybag or if there is root injury, they must be smeared with a protectant (Colter) Remove all rotten tissue and burn it. Remove all rotten flowers and FFB Clean the source of infection before planting, especially in areas that were formerly planted with coconut or oil palm plantations. Conducting pruning of leaves (pruning) before and after harvest regularly around the base of the stem Castration |
| T05 | |
| T06 | |
| T07 | |
| T08 | |
| T09 | |
| T10 | |
| T11 | |
| T12 | |
| T13 | |
| T14 | |
| T15 | |
| T16 | |
| T17 | |
| T18 | |
| T19 | |
| T20 | |

Castration cleanliness around the plant must be maintained well. Garbage or dead trees are burned so that the larvae of these pests die.
| Id | Treatment |
|----|-----------|
| T21 | Can be controlled by spraying contact toxins, for example Hostation 25 ULV, Sevin 85 ES, Dursban 20 EC with a concentration of 0.2 - 0.3%. |
| T22 | Can be controlled with Dipterex or Thiodan. |
| T23 | Seedlings affected by disease do not need to be taken to the field and destroyed |

3.2. Database relation

Representation of disease rules $\text{Rule}_{\text{Deseas}}$ can be implemented in a database system as a relation between the symptom table (table 2) and the disease table (table 1). Meanwhile, the representation of disease rules $\text{Rule}_{\text{Solution}}$ can be implemented in the database as a relation between the disease table (table 1) and the solution table (table 3).

3.3. Data flow diagram

The context diagram (Figure 3) illustrates that the Backward Chaining for Identification of Palm Oil Diseases Base on Expert System has two entities, namely admin and user. Admin as a user who has the task of data acquisition and rules. The data inputted include symptom data, disease data, solution data, disease rule data and solution rule data. Meanwhile, users will use the Backward Chaining for Identification Palm Oil Diseases Base on Expert System as a media for consultation to identify oil palm disease by inputting the symptoms of oil palm disease that was consulted. Based on the input from the user, the Backward Chaining for Identification Palm Oil Diseases Base on Expert System will provide alternative solutions that can be selected based on rules $\text{Rule}_{\text{Deseas}}$ and rules $\text{Rule}_{\text{Solution}}$. 

Figur 2. Table realtime of Palm oil diseases identification
Figur 3. Context data flow diagram of Palm oil diseases identification

Level 1 data flow diagram (figure 4) illustrates that the Backward Chaining for Identification of Palm Oil Diseases Base on Expert System consists of four processes, namely data input, disease rule acquisition, solution rule acquisition and identification consultation. Data input is used to enter symptom data, disease data, and solution data to be stored in the database. Acquisition of disease rule used for acquisition Rule Disease. Acquisition of solution rule used for acquisition Rule solution. Identification consultation is used to find oil palm disease based on the symptoms entered.

Figur 4. Level 1 data flow diagram of Palm oil diseases identification
3.4. Decision tree for backward chaining
The decision tree (Figure 5) illustrates that the search for oil palm disease identification uses the forward chaining method in the form of yes or no question. The root to the left indicates the answer to yes, and the root to the right shows the answer to no. Questions begin with S01 symptoms. If the question S01 is answered yes then the symptom of S11 is continued. If the answer to question S11 is yes, then D01 disease is found. If the answer to question S01 is not then continue with question S09. And so on an analogous basis for tracing the identification of oil palm collectors will be found. If the investigation of oil palm diseases has found one of the diseases, then based on the disease, the treatment will also be found.

Figur 5. Decision tree for Backward chaining for Palm oil diseases identification

4. Conclusion
The backward chaining method can be applied in the design of expert systems to identify oil palm diseases with decision tree representations, table relationships and data flow diagrams. Data on oil palm disease is only based on literature studies, so that the improvement of the knowledge base about oil palm diseases needs to be collaborated with oil palm experts so that more complete and accurate data can be obtained. Design of backward chaining for identification of Palm Oil Diseases Base on Expert System can be implemented on database and visual programming.

References
[1] G. N. Ntsefong et al., “Control Approaches against Vascular Wilt Disease of Elaeis guineensis Jacq. Caused by Fusarium oxysporum f. sp. elaeidis.,” J. Biol. Life Sci., vol. 3, no. 1, pp. 160–173, 2012.
[2] T. M. Azahar, A. S. Idris, D. Abu Hassan, and I. Norazlin, “Assessment of Basal Stem Rot Disease Distribution in Palm Oil Plantation Using Geographical Information System,” J. Sci.
[3] Z. Mohd and A. Faridah, “Disease Suppression in Ganoderma-infected Oil Palm Seedlings Treated with Trichoderma harzianum,” *Plant Prot. Sci.*, vol. 44, no. 3, pp. 101–107, 2008.

[4] N. I. Nadhrah, R. Nulit, R. Nurrashyeda, and A. S. Idris, “Effect of Formulated bioorganic containing Burkholderia GanoEB2 in suppressing Ganoderma Disease in oil Palm Seedlings,” *Plant Prot. Sci.*, vol. 51, no. 2, pp. 80–87, 2015.

[5] Supriyanto, Purwanto, S. H. Poromarto, and Supyani, “The relationship of some characteristics of peat with oil palm basal stem rot (BSR) caused by Ganoderma in peatlands,” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 423, no. 1, 2020.

[6] P. Ahmadi, F. M. Muharam, K. Ahmad, S. Mansor, and I. A. Seman, “Early detection of ganoderma basal stem rot of oil palms using artificial neural network spectral analysis,” *Plant Dis.*, vol. 101, no. 6, pp. 1009–1016, 2017.

[7] S. N. Wahyuni and R. Affan, “Oil Palm Sorting System of Fresh Fruit Bunch (FFB) Using Forward Chaining Algorithm,” *J. Phys. Conf. Ser.*, vol. 1501, no. 1, 2020.

[8] V. Ariandi, H. Kurnia, Heriyanto, and H. Marry, “Expert system for disease diagnosis in cocoa plant using android-based forward chaining method,” *J. Phys. Conf. Ser.*, vol. 1339, no. 1, 2019.

[9] C. P. C. Munaiseche, D. R. Kaparang, and P. T. D. Rompas, “An Expert System for Diagnosing Eye Diseases using Forward Chaining Method,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 306, no. 1, 2018.

[10] Melina, E. K. Putra, W. Witanti, Sukrido, and V. A. Kusumaningtyas, “Design and Implementation of Multi Knowledge Base Expert System Using the SQL Inference Mechanism for Herbal Medicine,” *J. Phys. Conf. Ser.*, vol. 1477, no. 2, 2020.