

## Implementation of Forward Chaining in a Web-Based Fruit Plant Disease Diagnosis Expert System

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### ABSTRACT

Horticultural plants are classified into several types, one of which is dicotyledon fruit plants, dicotyledonous fruit plants are two-piece plants with seeds having two institutional leaves or cotyledons, dicotyledonous fruit plants have many benefits from their stems, leaves and fruit, but there are problems when farmers or people plant the plants. dicot fruit, that is, there is a disease that attacks the plant. Because the types of diseases that attack fruit plants are quite diverse but have almost the same symptoms, farmers and the public are still confused and do not have a definite scientific basis for knowing the types of diseases and the correct treatment method. Farmers and the community still rely only on experience from problems that exist around them and do not come from the knowledge of an expert who has mastered the field. So an expert system for dicotyledon plant diseases is needed. This expert system adopts knowledge from plant experts and is built using the Forward Chaining method which can predict disease based on the criteria and symptoms that appear to reach conclusions. This expert system produces accurate data based on an expert's knowledge which is poured into a computer program which will later be used to diagnose plant diseases and provide solutions to the disease.

## **INTRODUCTION**

Fruit plants which are part of horticultural crops have many benefits, starting from fruit that can be consumed every day to fulfill the nutritional and vitamin content of the human body, each fruit is also classified based on the vitamin content it contains and also based on the type of fruit. Dicotyledonous plants which means plants with double seeds. Seeds in dicotyledonous plants are protected by a kind of fruit leaf which is usually called a carpel (Azizah, 2021). More specific characteristics of dicotyledonous plants include, splitting when germinating, tap roots, having branched stems, oval or fingered leaves, having no root cap, stems with cambium, having xylem and phloem (Harbani, 2021). One of the problems in plant cultivation is pests and diseases (jomangkab.go.id, 2019). In fact, almost all the diseases that fruit plants suffer from are the same for both dicotyledonous and monocotyledonous fruit plants, but the criteria that emerge are what differentiates diseases in dicotyledonous and monocotyledonous fruit plants. Many farmers or people who like farming encounter disease problems in their plants, and of course they To find out what actually causes the disease and what diseases appear on their plants, the first step they take on average is to ask the plant seller or someone who works in the plant sector to ask what disease is attacking their plants. On average, the dicotyledonous fruit plants planted by these farmers are dicotyledonous plants or have two pieces, often the problem is that the dominant fruit plants have two pieces, such as mango, avocado, rambutan, durian, guava and others, when they ask to the plant sellers at UMKM Plants Shop Guyung, the answer they got was still uncertain because the plant sellers at Plant Shop Guyung still did not have a definite scientific basis for solving these problems, starting from identifying to determining what type of disease was attacking the plant. In fact, to determine a disease that attacks a plant and how to treat it properly, there are several factors. According to (Marcelina, 2022) the factors that cause disease include non-living creatures (abiotic, physiopath, inanimate or noninfectious diseases), and living creatures (biotic, animate or infectious diseases). The factors that influence dicotyledon fruit plant diseases include criteria for each disease that appears, as a basis for knowledge to account for these problems, there must be an expert who operates in the field, the knowledge possessed by this expert will later become the basis for the answer to the problem. plant diseases, so that plant sellers in MSMEs can provide solutions to problems faced by farmers or the public more accurately based on knowledge from plant experts, because the answers given are not just random, but based on the criteria for diseases that appear on the plant.

## **THEORETICAL REVIEW**

An Expert System is a computer-based system that adopts facts, reasoning and human knowledge, so that it can solve problems as an expert or expert in its field would do. Abdelkader Hameurlain explained that with this expert system even ordinary people can solve their problems or just search for quality information which can only be obtained with the help of experts in that field. In its creation and preparation, an expert system combines inference rules with a certain knowledge base provided by one or more experts in a particular

field. The combination of these two things is stored in a computer which is then used in the diagnosis and decision making process to resolve certain problems (Pratiwi, 2019).

Conceptually, Decision Trees are a technique of Decision Analysis. There are many technical definitions that can be found in various sources regarding decision trees because of the variety of applications of these decision trees in various types of processes and different industries. The simplest definition of what a Decision Tree is, is an analysis diagram that can help decision makers when facing several options by projecting possible outcomes. The tree also shows the possibility/probability factors that will influence the decision alternatives, accompanied by an estimate of the final results that will be obtained if we take the decision alternative (Pati, 2020).

Dicotyledonous plants are flowering plants that have two seeds. In dicotyledonous plants, the seeds are protected by fruit leaves or called carpels. Plants that are classified as dicotyledonous plants have a pair of institutional leaves or cotyledons. The leaves of this institution have been formed since the seed stage, therefore most of its members have seeds that are easily split into two parts. This is what differentiates dicot plants from monocot plants (Telaumbanua, 2021).

Plants become sick due to pathogens (disease causes). A sign of a disease is the vegetative or reproductive form of the pathogen. To be able to recognize the signs of a disease, you must first learn about the various vegetative or reproductive forms of the pathogen. Signs of a pathogen can sometimes be seen with the naked eye without magnification (macroscopic) and sometimes must be seen with a magnifying tool (microscope). Determining the causes of a plant disease is determined from the results of observing symptoms and signs. Therefore, observing symptoms and signs is very important in the field of phytopathology (Mustafa, 2020).

Morphologically and anatomically, the symptoms of plant disease can be seen from several indicators that are used to indicate that the plant is sick based on physiological functions that are not normal. Knowledge of the indicators and symptoms of disease is very important to know so that the cause of plant disease can be known, so that preventive and control measures can be taken. can be done immediately (Nugraha, 2021).

## **METHODOLOGY**

### ***Data Processing Techniques***

#### ***Symptom & Disease Dataset***

The symptom dataset is the coding of several symptoms based on the type of disease that attacks dicotyledonous fruit plants. This data processing comes from the knowledge of an expert which is arranged in the form of a table containing codes and symptoms which will then be related to disease and solutions for handling dicotyledonous fruit plants later, symptom data & disease. obtained as follows:

Table 1. Symptom Code Dataset

No	Symptom code	Information
1	G-01	The appearance of the fungus <i>Collectricum Gloeosporiodies</i> (Avocado)
2	G-02	The appearance of the <i>Collectricum Mangifirae</i> (Mango) fungus
3	G-03	The appearance of the fungus <i>Lasiodiplodia theobromae</i> (Guava)
4	G-04	The appearance of the fungus <i>Phytophthora citriphora</i> (Citrus)
5	G-05	The appearance of the <i>Phytophthora spp</i> (Jackfruit) fungus
6	G-06	The appearance of the fungus <i>Phytophthora palmivora</i> (Sawo)
7	G-07	The texture of the fruit becomes mushy, soft and wet, with a distinctive rotten smell
8	G-08	Infected fruit is blackish brown in color
9	G-09	The appearance of white or yellowish fluid from the surface of infected fruit
10	G-10	The affected parts eventually die
11	G-11	The appearance of the fungus <i>Pseudocercospora pupurea</i> (Avocado)
12	G-12	The appearance of the fungus <i>Colletotrichum Gloeosporioides</i> (Mango)
13	G-13	The appearance of the fungus <i>Cephaleuros sp.</i> (Guava)
14	G-14	The appearance of the fungus <i>Glomerella cingulata</i> (Rambutan)
15	G-15	The appearance of the fungus <i>Sphaceloma</i>

No	Symptom code	Information
		fawcetti (Orange)
16	G-16	The appearance of Fusarium sp (longan) fungus
17	G-17	The appearance of the fungus Colletotrichum durionis (Durian)
18	G-18	The appearance of the fungus Phyllosticta ampelicida (Grapes)
19	G-19	The appearance of the fungus Pestalotiopsis sp. (Sawo)
20	G-20	There is yellowing of the leaves and it spreads to the leaves until they dry out
21	G-21	Brown, red, orange and yellow spots appear
22	G-22	The surface of a leaf is hollow through which organisms enter
23	G-23	The appearance of the Phytophthora fungus (Avocado)
24	G-24	The appearance of the Phytophthora palmivora (Durian) fungus
25	G-25	The appearance of the Dolabra nepheliae Boot & Ting fungus (Rambutan)
26	G-26	Diseases that attack will cause stunted stem growth and disrupt the production process
27	G-27	If there is a wound that produces red mucus, it will eventually turn black
28	G-28	The appearance of the fungus Rigidoporus lignosus (Rambutan)
29	G-29	The appearance of the fungus Fusarium oxysporum (longan)

No	Symptom code	Information
30	G-30	The appearance of the Phytophthora palmivora (Durian) fungus
31	G-31	Plant leaves appear yellow and wilted
32	G-32	The roots of infected plants will rot and dry out
33	G-33	The surface of the roots will show white threads growing like a net
34	G-34	If the root is dissected the inner skin/cortex shows a brown color
35	G-35	The woody roots appear pink with brown spots
36	G-36	The appearance of the Oidium Nephelii (Rambutan) fungus
37	G-37	The appearance of the Microsphaera Diffusa (Grape) fungus
38	G-38	There is gray-white flour on the leaves
39	G-39	The surface of the leaves appears slightly yellowish colored spots, then expands to become brown spots then dries and falls
40	G-40	Attacks on small fruit cause fruit rot
41	G-41	Attacks on large fruit cause deformed fruit in the form of brown, crusty spots
42	G-42	There are worms Meloidogyne spp. (Oranges & Grapes)
43	G-43	There are Pratylenchus coffeae worms (Avocado & Mango)
44	G-44	Plant growth is hampered or stopped
45	G-45	Plant leaves turn yellow or red

No	Symptom code	Information
46	G-46	Sudden loss of leaves or plant death
47	G-47	The plant roots look swollen, slimy, or rotting
48	G-48	The appearance of Phytophthora spp. (Orange)
49	G-49	The appearance of Fusarium spp (Mango) fungi
50	G-50	The appearance of lumps or tumors on plant stems
51	G-51	The skin around the lump or tumor will look damaged, cracked or cracked
52	G-52	Plant leaves dry out and die
53	G-53	Tumors or lumps on the stem may emit a sticky, dark, or foul-smelling fluid
54	G-54	The appearance of the fungus Peronospora sparsa (Grapes)
55	G-55	There are white and gray powdery spots that spread so that the top of the leaves appear gray
56	G-56	In dry conditions the affected leaves curl upwards
57	G-57	The color of the gray flour changes to black/dark and affected plants appear wilted and stunted

Table 2 Disease Dataset

Recommendation ID	List of Diseases	Part
P-01	Fruit Rot	Fruit
P-02	Leaf Spot	Leaf

P-03	Stem Rot	Stem
P-04	Root Rot	Root
P-05	Powdery Mildew	Stems & Leaves
P-06	Root Nematodes	Root
P-07	Stem Cancer	Stem
P-08	Flour Mushrooms	Stems & Leaves

### **Solution Dataset**

The solution dataset is a collection of data on providing treatment and care based on chemistry in the form of drugs and dosages, then physical treatment based on the disease that attacks the dicotyledon fruit plant. This solution dataset is a recommendation from an expert based on the knowledge he has, solution data for the disease that attacks it as follows:

Table 3 Solution Dataset

solution_ID	Solution
S1	<ol style="list-style-type: none"> <li>1) Spraying a fungicide containing the active ingredient maneb such as Velimex 80 WP at a dose of 2-2.5 grams/liter</li> <li>2) Apply Bordeaux slurry</li> <li>3) Waxing the fruit and pruning the bottom of the tree</li> </ol>
S2	<ol style="list-style-type: none"> <li>1) Spraying a fungicide containing the active ingredient benomyl such as Masalgin 50 WP at a dose of 1-2 grams/liter</li> <li>2) Apply Bordeaux slurry</li> <li>3) Spraying using a fungicide containing the active ingredient Carbendazine at a dose of 0.4 cc/liter</li> <li>4) Kuproxat 345 SC. Dose 2 -3 ml/l with application interval once every 7 days</li> <li>5) Sanitize the garden to reduce humidity and remove infected lower leaves as soon as possible so that they do not become a source of infection</li> </ol>

solution_ID	Solution
S3	<ol style="list-style-type: none"> <li>1) How to scrape the skin from the diseased stem to the healthy part. The scraping is shaped like an oval that tapers at the top and bottom so that the wound closes quickly again</li> <li>2) The scraped wound is smeared with fungicide, then covered with a covering such as carbolinum or difolate 4 F 3%</li> </ol>
S4	<ol style="list-style-type: none"> <li>1) Spraying a fungicide containing the active ingredient Triazin with 0.3% benlate with the dosage stated on the packaging.</li> <li>2) 8 bottle caps with 14 liters of water</li> <li>3) dismantle/eradicate the affected plants then burn them and lime the holes</li> </ol>
S5	<ol style="list-style-type: none"> <li>1) Spraying a fungicide containing the active ingredient Triazole with the drugs propiconazole and karetonazole at a dose according to the packaging or a concentration of 0.2% (2 g/liter of water)</li> <li>2) Carry out sanitation, namely by cutting branches/twigs whose flower buds and fruit are heavily infested, removing flowers and fruit for moderately infested plants and cleaning flowers and fruit for lightly infested plants.</li> </ol>
S6	<ol style="list-style-type: none"> <li>1) Spraying the active ingredient Nematicide with the drug Furadan at a dose of 2-4 liters/hectare</li> <li>2) Using soil sterilization methods, such as using direct sunlight or water vapor.</li> </ol>
S7	<ol style="list-style-type: none"> <li>1) Spraying fungicides containing the active ingredient Dithiocarbamate with the drugs Kaptan and Mancozeb at a dose of 2-4 grams / liter of water</li> <li>2) Infected stems or twigs must be immediately cut and discarded so that the disease does not spread to wider parts of the plant.</li> </ol>
S8	<ol style="list-style-type: none"> <li>1) Spraying a fungicide containing the active ingredient Triadimenol with the Bayleton type of drug and administering a dose ranging from 200-300 grams/ha.</li> <li>2) Pruning and removing infected plant parts</li> </ol>

**Dataset Knowledge Base**

A knowledge base dataset is a data structure that stores data information, rules, relationships between data and rules in drawing conclusions. A knowledge base can be said to be a collection of information and experience from an expert in a particular field. The knowledge base consists of facts as well as theory books and heuristics which are the steps an expert takes in making decisions. Dataset rules and tests for diagnosing dicotyledonous fruit plant diseases are as follows:

Table 4 Rules Knowledge Base

No	Datasets	Symptom	Disease	Solution
1	Uji 1	G1, G7, G8, G9, G10	P1	S1
2	Uji 2	G1, G7, G8, G9	P1	S1
3	Uji 3	G1, G7, G8	P1	S1
4	Uji 4	G1, G7	P1	S1
5	Uji 5	G2, G7, G8, G9, G10	P1	S1
6	Uji 6	G2, G7, G8, G9	P1	S1
7	Uji 7	G2, G7, G8	P1	S1
8	Uji 8	G2, G7	P1	S1
9	Uji 9	G3, G7, G8, G9, G10	P1	S1
10	Uji 10	G3, G7, G8, G9	P1	S1
11	Uji 11	G3, G7, G8	P1	S1
12	Uji 12	G3, G7	P1	S1
13	Uji 13	G4, G7, G8, G9, G10	P1	S1
14	Uji 14	G4, G7, G8, G9	P1	S1
15	Uji 15	G4, G7, G8	P1	S1
16	Uji 16	G4, G7	P1	S1
17	Uji 17	G5, G7, G8, G9, G10	P1	S1
18	Uji 18	G5, G7, G8, G9	P1	S1
19	Uji 19	G5, G7, G8	P1	S1
20	Uji 20	G5, G7	P1	S1
21	Uji 21	G6, G7, G8, G9, G10	P1	S1
22	Uji 22	G6, G7, G8, G9	P1	S1
23	Uji 23	G6, G7, G8	P1	S1
24	Uji 24	G6, G7	P1	S1
25	Uji 25	G7, G8, G9, G10	P1	S1
26	Uji 26	G7, G8, G9	P1	S1
27	Uji 27	G7, G8	P1	S1
28	Uji 28	G1	P1	S1
29	Uji 29	G2	P1	S1
30	Uji 30	G3	P1	S1
31	Uji 31	G4	P1	S1
32	Uji 32	G5	P1	S1
33	Uji 33	G6	P1	S1
34	Uji 34	G7	P1	S1
35	Uji 35	G8	P1	S1
36	Uji 36	G9	P1	S1

No	Datasets	Symptom	Disease	Solution
37	Uji 37	G10	P1	S1
38	Uji 38	G11, G20, G21, G22	P2	S2
39	Uji 39	G11, G20, G21	P2	S2
40	Uji 40	G11, G20	P2	S2
41	Uji 41	G11	P2	S2
42	Uji 42	G12, G20, G21, G22	P2	S2
43	Uji 43	G12, G20, G21	P2	S2
44	Uji 44	G12, G20	P2	S2
45	Uji 45	G12	P2	S2
46	Uji 46	G13, G20, G21, G22	P2	S2
47	Uji 47	G13, G20, G21	P2	S2
48	Uji 48	G13, G20	P2	S2
49	Uji 49	G13	P2	S2
50	Uji 50	G14, G20, G21, G22	P2	S2
51	Uji 51	G14, G20, G21	P2	S2
52	Uji 52	G14, G20	P2	S2
53	Uji 53	G14	P2	S2
54	Uji 54	G15, G20, G21, G22	P2	S2
55	Uji 55	G15, G20, G21	P2	S2
56	Uji 56	G15, G20	P2	S2
57	Uji 57	G15	P2	S2
58	Uji 58	G16, G20, G21, G22	P2	S2
59	Uji 59	G16, G20, G21	P2	S2
60	Uji 60	G16, G20	P2	S2
61	Uji 61	G16	P2	S2
62	Uji 62	G17, G20, G21, G22	P2	S2
63	Uji 63	G17, G20, G21	P2	S2
64	Uji 64	G18, G20	P2	S2
65	Uji 65	G18	P2	S2
66	Uji 66	G19, G20, G21, G22	P2	S2
67	Uji 67	G19, G20, G21	P2	S2
68	Uji 68	G19, G20	P2	S2
69	Uji 69	G19	P2	S2
70	Uji 70	G20, G21, G22	P2	S2
71	Uji 71	G20, G21	P2	S2
72	Uji 72	G21, G22	P2	S2
73	Uji 73	G21, G20	P2	S2
74	Uji 75	G22, G20	P2	S2
75	Uji 76	G20	P2	S2
76	Uji 77	G21	P2	S2
77	Uji 78	G22	P2	S2
78	Uji 79	G23, G26, G27	P3	S3
79	Uji 80	G23, G26	P3	S3
80	Uji 81	G23	P3	S3

No	Datasets	Symptom	Disease	Solution
81	Uji 82	G24, G26, G27	P3	S3
82	Uji 83	G24, G26	P3	S3
83	Uji 84	G24	P3	S3
84	Uji 85	G25, G26, G27	P3	S3
85	Uji 86	G25, G26	P3	S3
86	Uji 87	G25	P3	S3
87	Uji 88	G26, G27	P3	S3
88	Uji 88	G26	P3	S3
89	Uji 89	G27	P3	S3
90	Uji 90	G28, G31, G32, G33, G34, G35	P4	S4
91	Uji 91	G28, G31, G32, G33, G34	P4	S4
92	Uji 92	G28, G31, G32, G33	P4	S4
93	Uji 93	G28, G31, G32	P4	S4
94	Uji 94	G28, G31	P4	S4
95	Uji 95	G28	P4	S4
96	Uji 96	G29, G31, G32, G33, G34, G35	P4	S4
97	Uji 97	G29, G31, G32, G33, G34	P4	S4
98	Uji 98	G29, G31, G32, G33	P4	S4
99	Uji 99	G29, G31, G32	P4	S4
100	Uji 100	G29, G31	P4	S4
101	Uji 101	G29	P4	S4
102	Uji 102	G30, G31, G32, G33, G34, G35	P4	S4
103	Uji 103	G30, G31, G32, G33, G34	P4	S4
104	Uji 104	G30, G31, G32, G33	P4	S4
105	Uji 105	G30, G31, G32	P4	S4
106	Uji 106	G30, G32, G33	P4	S4
107	Uji 107	G30, G33, G34	P4	S4
108	Uji 108	G30, G34, G35	P4	S4
109	Uji 109	G31, G32, G33	P4	S4
110	Uji 110	G31, G33, G34	P4	S4
111	Uji 111	G31, G34, G35	P4	S4
112	Uji 112	G31, G35, G30	P4	S4
113	Uji 113	G32, G33, G34	P4	S4
114	Uji 114	G32, G34, G35	P4	S4
115	Uji 115	G32, G35, G30	P4	S4
116	Uji 116	G32, G30, G33	P4	S4
117	Uji 117	G33, G35, G32	P4	S4
118	Uji 118	G33, G31, G35	P4	S4
119	Uji 119	G33, G30, G34	P4	S4
120	Uji 120	G33, G34, G35	P4	S4
121	Uji 121	G34, G30, G33	P4	S4
122	Uji 122	G34, G32, G35	P4	S4
123	Uji 123	G34, G31, G33	P4	S4
124	Uji 124	G34, G30, G35	P4	S4
125	Uji 125	G35, G31, G30	P4	S4

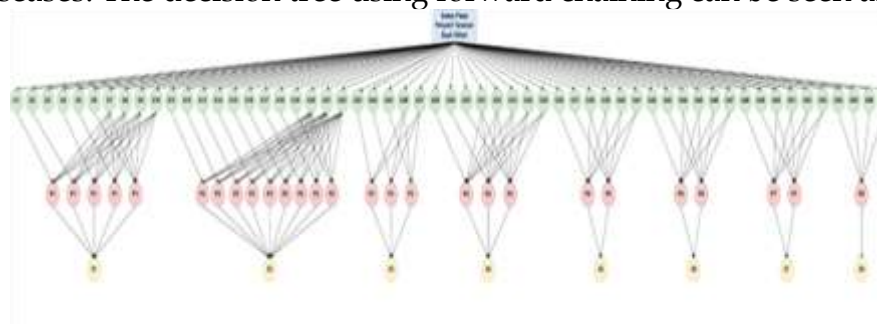
No	Datasets	Symptom	Disease	Solution
126	Uji 126	G35, G33, G32	P4	S4
127	Uji 127	G35, G34, G30	P4	S4
128	Uji 128	G35, G32, G34	P4	S4
129	Uji 129	G30, G31	P4	S4
130	Uji 130	G31, G32	P4	S4
131	Uji 131	G32, G33	P4	S4
132	Uji 132	G33, G34	P4	S4
133	Uji 133	G34, G35	P4	S4
134	Uji 134	G30	P4	S4
135	Uji 135	G31	P4	S4
136	Uji 136	G32	P4	S4
137	Uji 137	G33	P4	S4
138	Uji 138	G34	P4	S4
139	Uji 139	G35	P4	S4
140	Uji 140	G36, G38, G39, G40, G41	P5	S5
141	Uji 141	G36, G38, G39, G40	P5	S5
142	Uji 142	G36, G38, G39	P5	S5
143	Uji 143	G36, G38	P5	S5
144	Uji 144	G36	P5	S5
145	Uji 145	G37, G38, G39, G40, G41	P5	S5
146	Uji 146	G37, G38, G39, G40	P5	S5
147	Uji 147	G37, G38, G39	P5	S5
148	Uji 148	G37, G38	P5	S5
149	Uji 149	G37	P5	S5
150	Uji 150	G38, G39, G40, G41	P5	S5
151	Uji 151	G38, G39, G40	P5	S5
152	Uji 152	G38, G39	P5	S5
153	Uji 153	G38	P5	S5
154	Uji 154	G39, G38, G40, G41	P5	S5
155	Uji 155	G39, G38, G40	P5	S5
156	Uji 156	G39, G40	P5	S5
157	Uji 157	G39	P5	S5
158	Uji 158	G40, G38, G39, G41	P5	S5
159	Uji 159	G40, G38, G39	P5	S5
160	Uji 160	G40, G41	P5	S5
161	Uji 161	G40	P5	S5
162	Uji 162	G41, G38, G39, G40	P5	S5
163	Uji 163	G41, G34, G39	P5	S5
164	Uji 164	G41, G38	P5	S5
165	Uji 165	G41	P5	S5
166	Uji 167	G41, G39	P5	S5
168	Uji 168	G40, G38	P5	S5
169	Uji 169	G39, G41	P5	S5
170	Uji 170	G42, G44, G45, G46, G47	P6	S6

No	Datasets	Symptom	Disease	Solution
171	Uji 171	G42, G44, G45, G46	P6	S6
172	Uji 172	G42, G44, G45	P6	S6
173	Uji 173	G42, G44	P6	S6
174	Uji 174	G42	P6	S6
175	Uji 175	G43, G44, G45, G46, G47	P6	S6
176	Uji 176	G43, G44, G45, G46	P6	S6
177	Uji 177	G43, G44, G45	P6	S6
178	Uji 178	G43, G44	P6	S6
179	Uji 179	G43	P6	S6
180	Uji 180	G44, G45, G46, G47	P6	S6
181	Uji 181	G44, G45, G46	P6	S6
182	Uji 182	G44, G45	P6	S6
183	Uji 183	G44	P6	S6
184	Uji 184	G45, G44, G46, G47	P6	S6
185	Uji 185	G45, G44, G46	P6	S6
186	Uji 186	G45, G46	P6	S6
187	Uji 187	G45	P6	S6
188	Uji 188	G46, G44, G45, G47	P6	S6
189	Uji 189	G46, G44, G45	P6	S6
190	Uji 190	G46, G47	P6	S6
191	Uji 191	G46	P6	S6
192	Uji 192	G47, G44, G45, G46	P6	S6
193	Uji 193	G47, G44, G45	P6	S6
194	Uji 194	G47, G44	P6	S6
195	Uji 195	G47	P6	S6
196	Uji 196	G45, G47	P6	S6
197	Uji 197	G46, G44	P6	S6
198	Uji 198	G47, G45	P6	S6
199	Uji 199	G48, G50, G51, G52, G53	P7	S7
200	Uji 200	G48, G50, G51, G52	P7	S7
201	Uji 201	G48, G50, G51	P7	S7
202	Uji 202	G48, G50	P7	S7
203	Uji 203	G48	P7	S7
204	Uji 204	G49, G50, G51, G52, G53	P7	S7
205	Uji 205	G49, G50, G51, G52	P7	S7
206	Uji 206	G49, G50, G51	P7	S7
207	Uji 207	G49, G50	P7	S7
208	Uji 208	G49	P7	S7
209	Uji 209	G50, G51, G52, G53	P7	S7
210	Uji 210	G50, G51, G52	P7	S7
211	Uji 211	G50, G51	P7	S7
212	Uji 212	G50	P7	S7
213	Uji 213	G51, G50, G52, G53	P7	S7
214	Uji 214	G51, G50, G52	P7	S7
215	Uji 215	G51, G50	P7	S7

No	Datasets	Symptom	Disease	Solution
216	Uji 216	G51	P7	S7
217	Uji 217	G52, G50, G51, G53	P7	S7
218	Uji 218	G52, G50, G51	P7	S7
219	Uji 219	G52, G50	P7	S7
220	Uji 220	G52	P7	S7
221	Uji 221	G53, G50, G51, G52	P7	S7
222	Uji 222	G53, G50, G51	P7	S7
223	Uji 223	G53, G50	P7	S7
224	Uji 224	G50, G52	P7	S7
225	Uji 225	G51, G53	P7	S7
226	Uji 226	G52, G51	P7	S7
227	Uji 227	G54, G55, G56, G57	P8	P8
228	Uji 228	G54, G55, G56	P8	P8
229	Uji 229	G54, G55	P8	P8
230	Uji 230	G54	P8	P8
231	Uji 231	G55, G56, G57	P8	P8
232	Uji 232	G55, G56	P8	P8
233	Uji 233	G55	P8	P8
234	Uji 234	G56, G55, G57	P8	P8
235	Uji 235	G56, G57	P8	P8
236	Uji 236	G56	P8	P8
237	Uji 237	G57, G55, G56	P8	P8
238	Uji 238	G57, G55	P8	P8
239	Uji 239	G57	P8	P8

**Decision Tree**

Based on the knowledge base rules that have been determined, these rules can be formed into a decision tree to facilitate the use of the forward chaining method in building an expert system for diagnosing dicotyledon fruit plant diseases. The decision tree using forward chaining can be seen as follows:



**Figure 1. Decision Tree**

Figure 1. is a decision tree from an expert system for diagnosing diseases of dicotyledonous fruit plants, a rule is obtained that will be used when processing data on symptoms, types of disease that attack and solutions to the disease.

## RESULTS

### *Implementation of User Interface with Forward Chaining*

Implementation of the User Interface on the system is the interface display between the user and the system. Good, intuitive design helps users understand how to use the software or system quickly and efficiently. The following is a display of the user interface of the expert system for diagnosing dicotyledonous fruit plants:

### *Landing Page*

Implementation of the display of the landing page which is the initial display of the system is as follows:

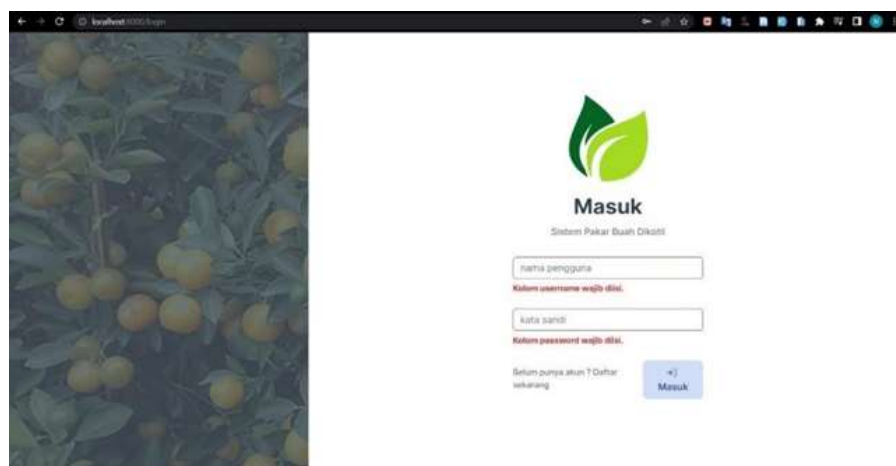


**Figure 1. Landing Page (Home) Implementation**

Figure 1 Implementation of the landing page (home) is the initial display of the system. On the landing page there are several features, including home, about experts, care procedures, dicotyledonous fruit plants and about. The home display displays a light green design and leaf patterns, this is because it is in harmony with the environmental colors of the fruit plants, apart from that, there is also an illustration of the logo of the Guyung Plant Shop, then there is the writing "Expert System for Diagnosing Diseases of Docotyl Fruit Plants".

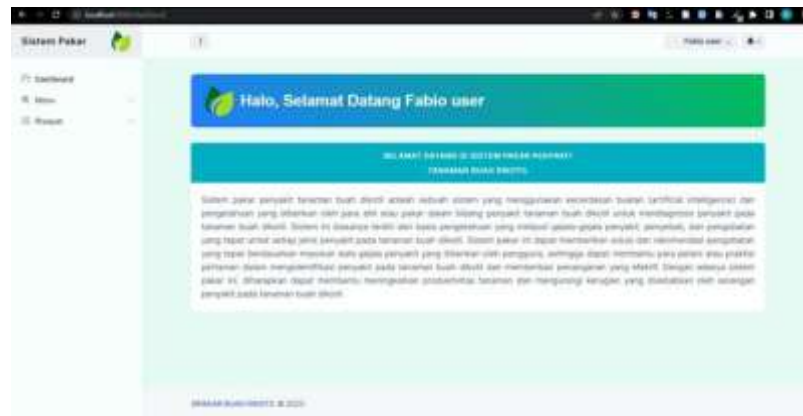
### *Login*

Implementation of the user or farmer, admin and owner login displays used to enter the application is as follows:



**Figure 2. Login Implementation**

Figure 2 Login implementation (1) is the user or farmer, admin and owner page for logging in. After they successfully enter this expert system, the user or farmer dashboard will be displayed as follows:

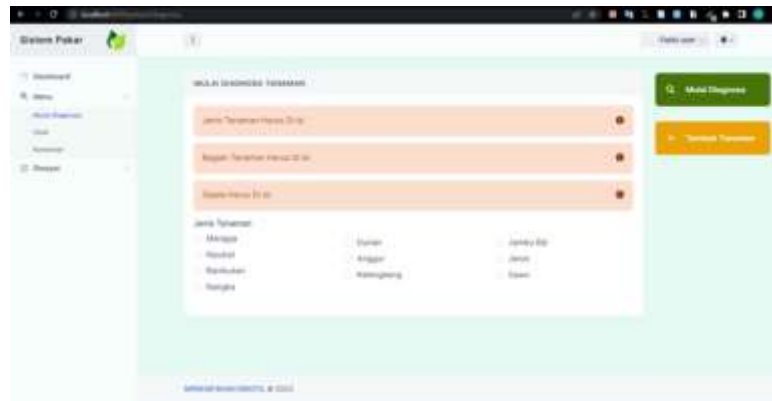


**Figure 3. User Dashboard Implementation**

Figure 3 Implementation of the user dashboard is the page that will appear first after the user logs in to the application. The user dashboard display on the left has a gradient light green sidebar so it looks smoother in terms of user experience and there are several navigation menus for this expert system with a sidebar section. At the top there is an expert system logo from Plant Shop Guyung which means the owner of this system, the sidebar itself will help simplify navigation, provide quick access to features and content, and improve the user experience in using the application or website. Then on the main page of the user dashboard there is information provided to the user regarding the use of the expert system for dicotyledonous fruit plants. On this page there are several features that can be used by the user. There are three features on the menu, namely diagnostics which are used for users to diagnose diseases of their sick fruit plants, this feature is the main feature of this expert system, the second feature is chat which is used for further consultation via short messages which can be sent to admins and experts, then The comment feature is used by users to assess the application in the form of ratings and provide suggestions for this application. After the user comments, it will be accepted by the admin and appear on the landing page of this dicotyledon fruit plant disease expert system.

### ***Diagnostic menu***

Implementation of a display from the diagnostic menu that users can use to diagnose diseases of their fruit plants by selecting the symptoms that appear based on the plant disease as followst :



**Figure 4. Implementation of the Diagnostic Menu**

Figure 4 Implementation of the diagnosis menu (plant type) is a page for users to diagnose diseases of their fruit plants. In the initial display of this diagnostic menu there are values used to carry out plant diagnosis, namely the value of the type of plant, on the left there is a sidebar which is used to make it easier to access several features such as the diagnosis menu, chat, comments and diagnosis history to make it faster and more effective as well as the system logo. Guyung plant shop expert, then the main part of this diagnosis is an object of the value of what type of plant is affected by the disease for the user to choose when first carrying out the diagnosis, in this selection part a radio button is used because the user or farmer has to choose only one type of plant option from several options given when carrying out diagnostics, this too allows users to select valid options according to certain rules. Apart from that, there is validation of the input that must be selected by the user or farmer before starting the diagnosis. If the user does not select the given option at all, an error message will appear according to the validation of each option.

On the right there is a fixed toolbar in the form of buttons to add plants and start diagnosing plant diseases. This aims to improve navigation, accessibility and overall user experience, as well as ensuring that important features are always visible and easy to access, so users or farmers Don't be confused when you want to add plants and start the diagnosis process when there is a lot of value in the plant disease diagnosis process. Apart from that, there is also a button to start the diagnosis process, after the user or farmer fulfills all the input options and clicks the start diagnosis button, all plant diagnostic input options will be processed according to the facts that appear based on the forward chaining method shown in Figure 5.



**Figure 5. Implementation of Diagnostic Results**

Figure 5. Implementation of diagnostic results, the display on this page uses tabular data which provides a clear and structured framework for displaying and analyzing complex data. This tabular data allows users to easily obtain the information they need, as well as make decisions based on a better understanding of the data. Apart from that, at the top of the diagnostic results table data there is navigation or several buttons to print the results of the diagnosis in the form of PDF, Excel, CSV, copy and print files, this aims to make it easier for users or farmers when they want to directly print the data section of the diagnostic results table. Then in the data table there are plant diagnosis results which contain the number, date, type of plant, picture and details of the diagnosis results. Later, if the user or farmer clicks on the dash button, he will be directed to a page of detailed results of the farmer's fruit plant disease diagnosis.

The results of this diagnosis are the result of the decision of the forward chaining method which has been applied to this expert system to determine the suitability for the user's dicotyledon fruit plant disease, the application of forward chaining rules which start from tracking several factors which then converge to a conclusion, so starting from each Disease has several factors, such as which fruit is affected by the disease, then the part of the plant that is affected by the disease, then symptoms appear according to each fruit and part that is affected by the disease, and a conclusion is drawn about what disease appears based on the facts according to the choice of that user.

## DISCUSSION

This forward chaining method requires data obtained from experts in dicot fruit plant diseases, so that it can help in the process of building a good diagnostic expert system. The compatibility rules used in this expert system have succeeded in achieving a success rate of 100% which is supported by the results of expert compatibility testing 2 times with an expert on dicotyledon fruit plant diseases, thus providing precise and accurate solution results. The success of this system shows its ability to provide an effective solution in diagnosing diseases in farmers' dicotyledon fruit plants.

## CONCLUSIONS AND RECOMMENDATIONS

The forward chaining method can help in the process of developing an expert system for diagnosing dicotyledon fruit plant diseases and providing treatment solutions and the necessary drugs.

## FURTHER STUDY

Development of an expert system for diagnosing diseases of dicotyledonous fruit plants using the Forward Chaining Method, adding new or unknown types of symptoms and diseases of dicotyledonous fruit plants later to be diagnosed and to diagnose more than one plant disease as well as handling errors in the system if the results are invalid.

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