APPLICATION OF EXPERT SYSTEM FOR ANDROID-BASED FOOD LAND SUITABILITY AND HOLTICULTURE

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Abstract— Plant land suitability is a way of evaluating the characteristics of planted land-based on certain criteria to determine which types of plants are most suitable for planting in that land, land suitability has not been utilized properly by farmers due to limited knowledge about the varieties of plant types that can be planted in their land, selection The types of plants are still based on traditions and elements of the surrounding agricultural environment which are only limited to a few types of plants without taking into account the suitability of the plants planted to their land characteristics. For this reason, an expert system application was created to help farmers determine the suitability of land for food crops and horticulture on an Android basis because on an Android basis it can make it easier for users, especially farmers to determine the suitability of their land without the need to find a plant land expert and can easily accessible to anyone, anywhere. To produce a good expert system, the research method will be used, namely the certainty factor method. The results of testing expert system applications with certainty factor methods are proven to be able to provide accurate land suitability information.

Keywords: *Expert System, Food Plants & Horticulture, Method Certainty Factor*

Intisari— *Kesesuaian lahan tanaman merupakan suatu cara evaluasi karakteristik lahan tanam berdasarkan kriteria-kriteria tertentu untuk menentukan jenis tanaman yang paling cocok untuk ditanam dilahan tersebut, kesesuaian lahan belum dimanfaatkan dengan baik oleh para petani dikarenakan keterbatasan pengetahuan mengenai varietas jenis tanaman yang dapat ditanam dilahan mereka, pemilihan jenis tanaman masih didasarkan kepada tradisi dan unsur lingkungan pertanian disekitar yang hanya terbatas pada beberapa jenis tanaman tanpa memperhitungkan kesesuaian tanaman yang ditanam terhadap karakter lahan mereka. Untuk itu, dibuatkan sebuah aplikasi sistem pakar untuk membantu para petani menentukan kesesuaian lahan tanaman pangan dan hortikultura dengan berbasis android, karena dengan berbasis android dapat memudahkan para pengguna khususnya petani agar dapat menentukan kesesuaian lahannya dengan tidak perlu mencari seorang pakar lahan tanaman dan bisa dengan mudah diakses oleh siapa saja, dimanapun. Untuk menghasilkan sistem pakar yang baik maka akan digunakan metode penelitian yaitu metode certainty factor. Hasil pengujian aplikasi sistem pakar dengan metode certainty factor, terbukti mampu memberikan informasi kesesuaian lahan yang akurat.*

Kata Kunci*: Sistem Pakar, Tanaman Pangan & Hortikultura, Metode certainty factor*

INTRODUCTION

Indonesia has great potential in agricultural production, it can even become a world food barn, this can be achieved by increasing agricultural productivity which plays an important role in achieving food sovereignty, which is also a priority for the government(Tan, Merdikawati, Amri, & Tan, 2016). In increasing the productivity of agricultural products, both quality and quantity can be done by conducting land evaluations(Putrawansyah & Arif, 2018), In essence, land evaluation can be carried out by comparing the requirements for land use with the quality of the resources available on the land(Sitimaria, Rajamuddin, & Zainuddin, 2019). With the evaluation of land cultivation and knowing the types of plants suitable for this land, it can help farmers to increase crop productivity and reduce the problem of crop failure. In various fields, at present, there has been much use of artificial intelligence (AI) to help their work, one of the most widely used branches of artificial intelligence, namely expert systems(Rahmi Ras, Nelly Astuti, & Efori, 2017). The existence of an expert system helps a lot in various types of work, one of which is in the field of agriculture, in agriculture, an expert system can help farmers gain knowledge before carrying out the agricultural process on their land(Sevani, Marimin, & Sukoco, 2009).

In this expert system research using the certainty factor method, because the certainty factor method can provide accurate results based on the calculation results of the predetermined weights chosen by the user and can provide answers to problems that are not certain to be true(Halim & Hansun, 2016). Many programming languages can be used in the implementation of expert systems, in this study using an android-based application, which with an android-based expert system can help users dig up information and get knowledge through the user's smartphone anywhere and anytime(Nurajizah & Saputra, 2018).

There have been many researchers who have researched land suitability expert systems, such as research conducted (Sulistiyani, 2019) discusses the design of an expert system to determine the suitability of the types of crops and land conditions, in this study a 2.9 value system can be generated for results by reality and a value of 3.0 for the results of helping users, as well as for the satisfaction of respondents for the entire expert system is worth 2.9. Meanwhile, the view of the expert system is still too standard and less attractive, it is worth 2.6. According to research (Rahayu, Regasari, Putri, & Widodo, 2018) discusses the decision support system for selecting food plants is based on soil conditions using the Electre and TOPSIS methods, with the Electre and TOPSIS methods as decision support resulting in an accuracy of 85.714%. According to research (Putrawansyah & Arif, 2018) discussing the expert system determining the suitability of agricultural land for fruit cultivation with the forward chaining method, the test results of the application show that the application is feasible & can be used. According to research (Egasari, Puspitaningrum, & Prawito, 2017) discusses expert systems in identifying land suitability for plantation crops using the Bayes method and forward chaining inference, from the results of system validity testing conducted on 60 land data using the Bayes method, an accuracy rate of 75% is produced. According to research (Yusida, Kartini, Nugroho, & Muliadi, 2017) discusses the implementation of fuzzy Tsukamoto in determining land suitability for rubber and oil palm plants, the results obtained from the expert system application are prioritized land suitability data for planting in a land. According to research (Saputra & Mustafidah, 2016) discussing the expert system determining the level of land suitability in teak plants with the forward chaining method, the results of the study show that the forward chaining method can show the level of land suitability for teak plant types.

Of the six related studies above, there are similarities, namely in the expert system of land suitability, but what distinguishes this study is the suitability of land which is discussed more towards land for food and horticulture, the method used uses certainty factors and the application used is based on applications. android. This application is expected to help farmers in determining food and horticultural land to prevent crop failure.

MATERIALS AND METHODS

Data Collection Technique

In this study, expert data collection techniques were obtained in several ways, namely:

a. Direct observation or observation of relevant places that are competent in the field of agriculture, especially regarding land and soil as a planting medium.
b. Interviews with several experts who work as land cultivators or farmers and objects who are competent in the fields of land and agriculture, including staff from Dinas Pertanian Perikanan dan Ketahanan Pangan Kota Sukabumi.
c. Literature study from books, scientific articles, as well as from various internet websites that provide information relevant to the research taken.

Expert System Development Method

In this study, the method used is the Certainty Factor method for the manufacture of an expert system of land suitability for food and horticulture which is applied to android-based applications.

The Certainty Factor (CF) method was proposed by Shortliffe and Buchanan in 1975 to accommodate the inexact reasoning of an expert (Gaol, 2020). he following is the equation for the Certainty Factor method (Rahmah & Saputra, 2017):

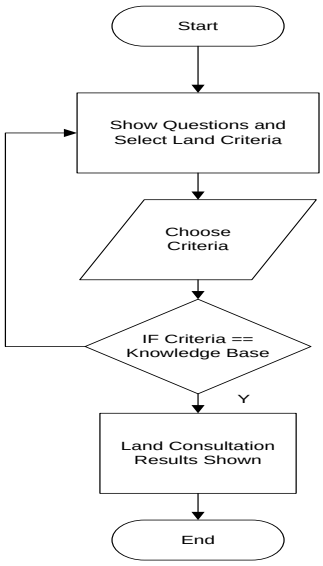
$$CF(H,E)=MB(H,E)-MD(H,E) \quad \text{..... (1)}$$

Note:
CF(H, E): certainty factor of hypothesis H which is influenced by symptoms (evidence) E. The amount of CF ranges from -1 to 1. The value of -1 shows absolute distrust while the value of 1 indicates absolute trust.
MB(H, E): a measure of increased belief against hypothesis H which is influenced by the E phenomenon (between 0 and 1).
MD(H, E): a measure of increased disbelief in the hypothesis H that is affected by the E phenomenon (between 0 and 1).

Expert System Algorithm

Before the expert system is applied, first design the algorithm of the expert system. This

algorithm is used to explain as well as describe the process of how the application of the Android-based land suitability and the horticultural expert system runs. To describe the algorithm of this expert system using flowcharts and logic or pseudocode functions. The following is Figure 1 algorithm design on the expert system created:



Source: (Ramdhani, Susilawati, & Saputra, 2020)

Figure 1. Expert System Algorithm

Expert Table Knowledge Base

From the results of interviews with five experts in the field of agriculture, a conclusion can be drawn regarding the suitability of land for food crops and horticulture. The knowledge base of the five experts can be described in table 2 as follows:

Table 2. Expert Table

	K001	K002	K003	K004	K005	K006	K007	K008	K009	K010	K011	K012	K013	K014	K015
T001	√					√		√			√				√
T002	√				√			√			√			√	
T003		√				√		√			√		√		
T004		√					√		√	√					√
T005		√					√		√		√		√		
T006	√				√				√		√				√
T007	√				√				√		√		√		
T008			√				√		√	√				√	
T009	√			√					√	√		√			
T010	√				√				√	√		√			
T011		√				√		√		√			√		
T012		√					√	√		√		√			
T013			√		√			√		√		√			
T014			√			√			√		√		√		
T015		√					√	√		√				√	
T016			√			√		√		√			√		
T017			√			√		√			√		√		
T018			√	√					√		√	√			
T019	√					√		√		√			√		
T020		√					√		√	√		√			

Source: (Ramdhani, Susilawati, & Saputra, 2020)

Description in Table 2 as follows:

The first line shows the land criteria for food crops and horticulture among them:

Criteria Code

K001 Temperature 15-20 oC

K002 Temperature 21-25 oC

K003 Temperature 26-32oC

K004 Water Availability 50-200

K005 Water availability 200-500

K006 Water Availability 500-800

K007 Water availability 800-1300

K008 Soil depth> 50

K009 Soil depth> 75

K010 Base Saturation> 35

K011 Base Saturation> 50

K012 pH H2O 6.0-6.5

K013 pH H2O 6,6-7,0

K014 pH H2O 5.0-5.9

K015 pH H2O 7,1-7,9

The first column of the table describes the rules for plant types, including::

T001 Shallots, Garlic, Broccoli, Wheat
T002 Biet, Carrot
T003 Cantaloupe, Fruit Tomato, Vegetable Tomato
T004 Red Chili, Soybeans
T005 Corn, Sweet Potatoes
T006 Chickpeas
T007 Long Beans, Green Beans, Chickpeas
T008 Peanuts, Paprika
T009 Potatoes
T010 Radish. Mustard
T011 Melon, Cucumber
T012 Pineapple
T013 Gogo Rice
T014 Padi Tadahujan, Padi Sawah
T015 Pare
T016 Watermelon
T017 Sorghum
T018 Taro
T019 Eggplant
T020 Cassava

And in table 3 also explains the percentage value of suitability based on land criteria, which is taken based on experts in their fields, namely:

Table 3. Value of Criteria for Planted Land

Land Criteria Data	Weight
Temperature 15-20 oC	0,5
Temperature 20-25 oC	0,5
Temperature 26-30 oC	0,6
Water Availability 50-200	0,8
Water availability 200-500	0,7
Water availability 500-800	0,6
Water availability 800-1300	0,6
Soil Depth> 50	0,2
Soil Depth> 75	0,2
Base Saturation> 35	0,2
Base Saturation> 50	0,3
pH H2O 6,0-6,5	0,6
pH H2O 6.6-7.0	0,4
pH of H2O 5.0-5.9	0,7
pH H2O 7,1-7,9	0,7

Source: (Indra, 2020)

Expert Rules

After being shown the expert table such as table 3, an expert rule is obtained to determine the types of food and horticultural crops based on land criteria, including:

a. Rule plants Shallots, Garlic, Broccoli, Wheat
If = "[K011] Base Saturation> 50
And "[K008] Soil depth> 50
And "[K001] Temperature Temperature 15-20 oC
And "[K006] Water availability 500-800
And "[K015] H2O pH 7,1-7,9

b. Rule Biet and Carrot Plants
If = "[K011] Base Saturation> 50
And "[K008] Soil depth> 50
And "[K001] Temperature Temperature 15-20 oC
And "[K005] Water availability 200-500
And "[K014] H2O pH 5.0-5.9

c. Rule Cantaloupe, Fruit Tomatoes, Vegetable Tomatoes, Cabbage
If = "[K011] Base Saturation> 50
And "[K008] Soil depth> 50
And "[K002] Temperature 21-25 oC
And "[K006] Water availability 500-800
And "[K013] H2O pH 6,6-7,0

d. Rule Red Chili and Soybean Plants
If = "[K010] Base Saturation> 35
And "[K009] Soil depth> 75
And "[K002] Temperature 21-25 oC
And "[K007] Water availability 800-1300
And "[K015] H2O pH 7,1-7,9

e. Rule Corn and Sweet Potatoes
If = "[K012] Base Saturation> 50
And "[K009] Soil depth> 75
And "[[K002] Temperature 21-25 oC
And "[K007] Water availability 800-1300
And "[K013] H2O pH 6,6-7,0

f. Rule Chickpea Plants
If = "[K011] Base Saturation> 50
And "[K009] Soil depth> 75
And "[K001] Temperature Temperature 15-20 oC
And "[K005] Water availability 200-500
And "[K015] H2O pH 7,1-7,9

g. Rule Long Beans and Green Beans
If = "[K011] Base Saturation> 50
And "[K009] Soil depth> 75
And "[K001] Temperature Temperature 15-20 oC
And "[K005] Water availability 200-500
And "[K013] H2O pH 6,6-7,0

h. Rule Peanut and Paprika Plants
If = "[K010] Base Saturation> 35
And "[K009] Soil depth> 75
And "[K003] Temperature Temperature 26-32oC
And "[K004] Water availability 800-1300
And "[K014] H2O pH 5.0-5.9

i. Rule Potato Plants
If = "[K010] Base Saturation> 35
And "[K009] Soil depth> 75
And "[K001] Temperature Temperature 15-20 oC
And "[K004] Water availability 50-200
And "[K012] H2O pH 6,0-6,5

j. Rule Radish and Mustard Plants
If = "[K010] Base Saturation> 35
And "[K009] Soil depth> 75
And "[K001] Temperature Temperature 15-20 oC
And "[K005] Water availability 200-500
And "[K012] H2O pH 6,0-6,5

k. Rule Melon and Cucumber Plants

If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K002] Temperature 21-20 oC
And "[K006] Water availability 500-800
And "[K013] H2O pH 6,6-7,0

l. Rule Pineapple
If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K002] Temperature 21-25 oC
And "[K007] Water availability 800-1300
And "[K012] H2O pH 6,0-6,5

m. Rule Upland Rice Plants
If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K003] Temperature Temperature 26-32 oC
And "[K005] Water availability 200-500
And "[K012] H2O pH 6,0-6,5

n. Rule Tadahujan Rice and Paddy Sawah Plants
If = "[K011] Base Saturation> 50
And "[K009] Soil depth> 70
And "[K003] Temperature Temperature 26-32 oC
And "[K006] Water availability 500-800
And "[K013] H2O pH 6,6-7,0

o. Rule Pare plant
If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K002] Temperature 21-25 oC
And "[K007] Water availability 800-1300
And "[K0114] H2O pH 5.0-5.9

p. Rule Watermelon Plants
If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K003] Temperature Temperature 26-32 oC
And "[K006] Water availability 500-800
And "[K013] H2O pH 6,6-7,0

q. Rule Sorghum Plants
If = "[K011] Base Saturation> 50
And "[K003] Temperature Temperature 26-32 oC
And "[K006] Water availability 500-800
And "[K008] Soil depth> 50
And "[K013] H2O pH 6,6-7,0

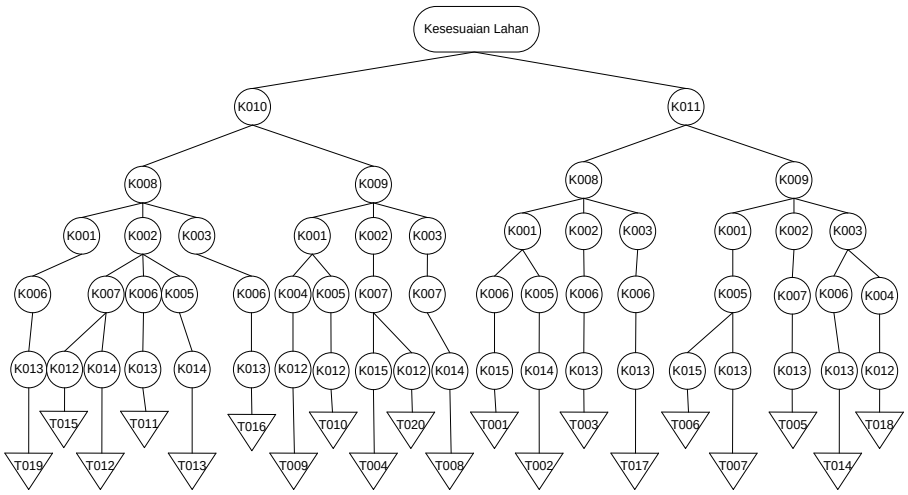
r. Rule Taro Plants
If = "[K011] Base Saturation> 50
And "[K009] Soil depth> 75
And "[K003] Temperature Temperature 26-32 oC
And "[K004] Water availability 50-200
And "[K012] H2O pH 6,0-6,5

s. Rule Eggplant plant
If = "[K010] Base Saturation> 35
And "[K008] Soil depth> 50
And "[K001] Temperature Temperature 15-20 oC
And "[K006] Water availability 500-800
And "[K013] H2O pH 6,6-7,0

t. Rule Cassava Plants
If = "[K010] Base Saturation> 35
And "[K010] Soil depth> 75
And "[K002] Temperature 21-25 oC
And "[K007] Water availability 800-1300
And "[K012] H2O pH 6,0-6,5

Expert Decision Tree

After an expert rule is formed, after that an expert tree is created to describe the expert rules that are related to each other, here is a Figure 2 Expert decision tree below:



Source: (Ramdhani, Susilawati, & Saputra, 2020)

Figure 2 Expert Decision Tree

RESULTS AND DISCUSSION

A. Software Requirements Analysis

1. Analysis Stages

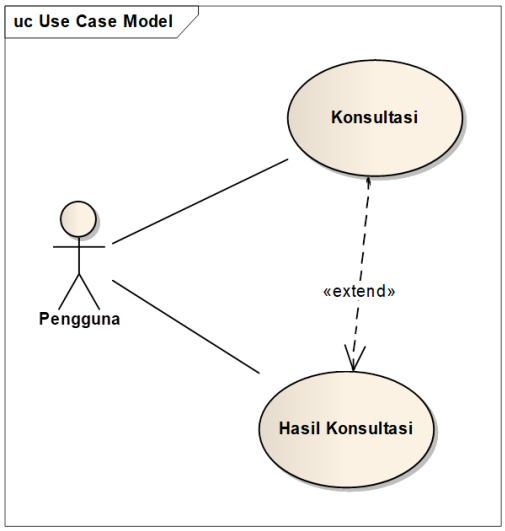
The system requirements of the expert system application to determine the suitability of an Android-based planting area are:

User Pages:

A1. User Select Main Menu
A2. User Select Menu Consultation
A3. User Select Menu Crop List
A4. User Select Menu About Application

2. Use Case Diagram Consultation Page

In the use case diagram, the consultation page illustrates the business process, the user conducts consultations, and will display the results of the consultation, here is Figure 3 use case diagram of the consultation page below:



Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 3. User Use Case Diagram

The description of the User Page Use Case Diagram can be explained in table 6, namely:

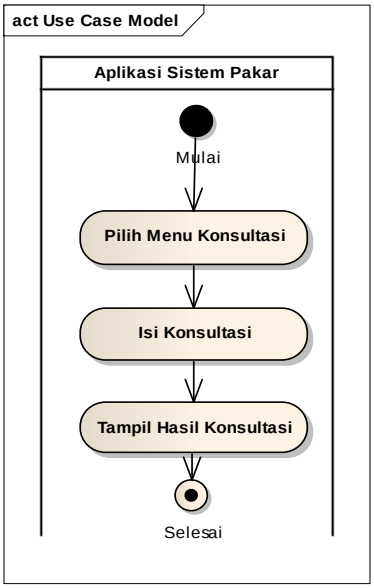
Table 6. Description of the User Use Case Diagram

Use Case Name	User Diagram
Requirement	A1-A2
Goal	Users get the results of the consultation on the land suitability of food crops and horticulture
Pre-condition	Users answer consultation questions
Post-condition	Users consult through the android application
Failed end condition	The user cancels the consultation
Primary Actor	User
Main Flow/Basic Path	1. The user selects the consultation menu 2. Users fill in their data 3. Users consult by answering consultation questions

Source: (Ramdhani, Susilawati, & Saputra, 2020)

3. User Page Activity Diagram

Activity diagrams show user activity in using the application. The following figure 4 Activity diagram on the user page:

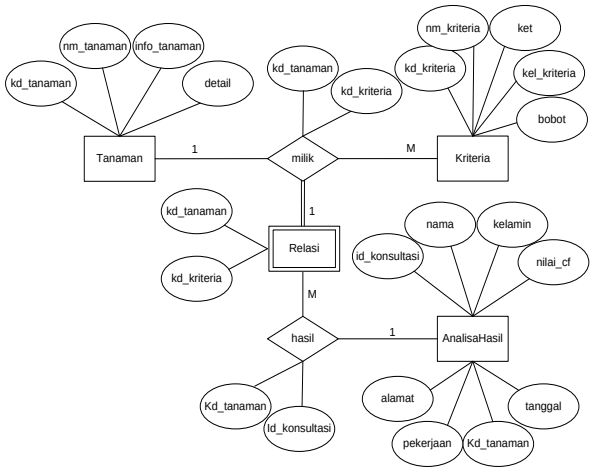


Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 4. ERD Expert System Application

B. Design

1. Database Design

The form of the Entity-Relationship Diagram used in this Android-based expert system is as shown in Figure 5 below:



Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 5. ERD Expert System Application

2. User Interface Design

a. Main Menu Display

The first expert system application is run and will display the main menu, as shown in Figure 6 below:

Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 6. Main Application Page

b. Application Menu Display

Users can display all menus in the application, as shown in Figure 7 below:

Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 7. Application Menu page

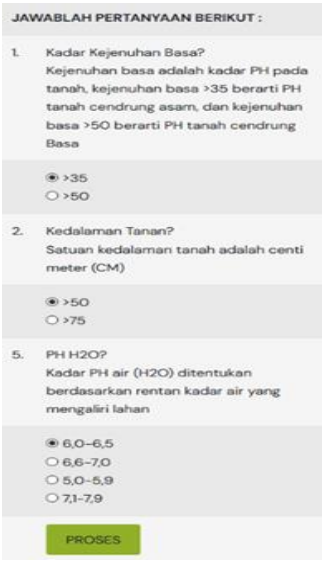
c. Biodata Input Display

When the user is going to consult, the user is asked to enter data in the application, as shown in Figure 8 below:

Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 8. Biodata Input page

d. Question Display

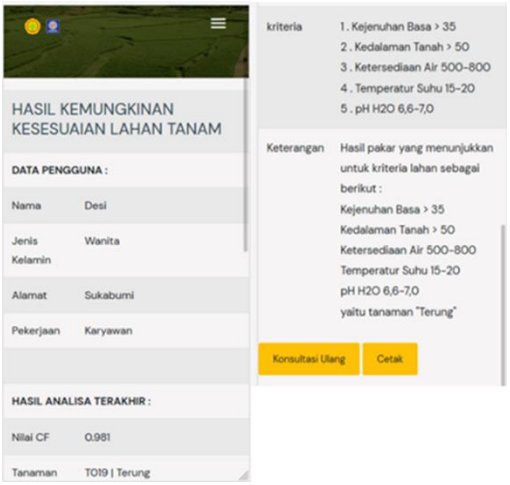
The user selects several questions - land suitability that has been input based on processed results, here is a picture of 9 display questions in the land suitability expert system application:



Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 9. Question page

e. Result Display

After the user selects the questions on the consultation page, the system will then display the results of the possible suitability of cropland, as shown in Figure 10 below:



Source: (Ramdhani, Susilawati, & Saputra, 2020)
Figure 10. Land Suitability Results Page

CONCLUSION

This expert system of land suitability for food crops and horticulture was created to assist the community, especially farmers, in obtaining

information about the types of plants that best match their land criteria, so that good crop production results are obtained in terms of quality and quantity. This expert system is designed based on android, making it easier to use. Also, by using the Android application, the information obtained will be more real-time and can be used immediately anywhere and anytime as long as it is connected to the internet. For further research, it is hoped that application testing will use methods such as the User Acceptance Test (UAT), to measure the level of acceptance of application users.

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