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Expert System in Determining the Quality of Nutmeg Breed using Website-Based Forward Chaining Methods

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Abstract: ***The need for information about datermining quality nutmeg seedlings is currently needed, This usually occurs in areas far from settlements one of which is farmers located in rural areas far from technological developmebts. The lack of experts or experts in the surrounding environment has increasingly triggered crop failure due to lack of knowledge. by building expert systems whose data is obtained from experts so that the system built has the ability to provide solutions such as an expert who is an expert in their field. This process continues until it reaches a goal or there are no rules whose premise matches the known facts. Media system maker application uses the language of PHP and MySQL as a database. Therefore the authors will review about how to choose quality and superior nutmeg seedlings, the implementation of an expert system to determine the quality of nutmeg seedlings is expected to provide easy access for users, through the use of website-based media tools.***

Index Terms**:** ***Expert System, Nutmeg Seedlings, Forward Chaining, Website***

I. INTRODUCTION

A. Background

Indonesia is a tropical country that is rich in various types of plants, one of which is nutmeg. Indonesian nutmeg production is relatively stable and tends to increase since 1994. Nutmeg generally starts to bear fruit at the age of 7 (seven) years and at the age of 10 years has produced profitably. Nutmeg production will continue to increase and at the age of 25 reach the highest production, and continue to produce until the age of 60-70 years. Lampung is one of the provinces that began to develop nutmeg plants on a community plantation scale. Some of them are nutmeg has become a source of income for farmers, except that at the farmer level the development is slow and the business scale is relatively small.

The area and production of nutmeg scale of community plantation (PR) in Lampung province in 2010 can be seen in Table 1.

Table 1. Area and production of smallholder nutmeg (PR) in Lampung Province in 2010.

No	Kabupaten	Luas areal (ha)/*plant area*				Produksi	Produktifitas
		TBM	TM	TT/TR	Jumlah	(ton)	(kg/ha)
1	Kota B. Lampung	1	4	-	5	-	-
2	**Tanggamus**	**39**	**72**	**5**	**115**	**8**	**111**
3	Lampung Timur	568	2	-	570	1	500
4	Pesawaran	25	21	-	46	5	238
	Total	633	99	5	736	14	141

Source: Lampung Province Plantation Office, 2011
Forestry and Plantation Service District Tanggamus, 2011.

In Table 1, it can be seen from 12 districts and 2 (two) cities in Lampung Province, there are 3 (three) districts and 1 (one) city has an area of nutmeg plantations. The biggest regency that has nutmeg production area is Tanggamus Regency. Tanggamus is the district that has the largest area of yielding plants (TM) and the highest level of nutmeg production compared to other regions in Lampung Province. The area of nutmeg producing (TM) in Tanggamus Regency in 2010 reached 72 hectares and the amount of nutmeg production was 8 (eight) tons. The area and production of nutmeg in Tanggamus Regency in 2010 can be seen in Table 2.

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Table 2. Area and nutmeg production in Tanggamus District in 2010.

No	Kecamatan /*Distrik*	Luas areal (Ha)/*plant area* TBM	TM	TT/ TR	Tot.	Prod. (ton)	Produktifitas (kg/ha)	Jumlah Pekebun
1	Wonosobo	-	2,0	-	2,0	0,8	400,0	45,0
2	Semaka	23,5	20,5	-	44,0	3,08	150,0	45,0
3	Pematang Sawa	5,0	-	-	5,0	0,0	0,0	-
4	Kota Agung Timur	10,0	20,0	5,0	35,0	0,6	30,0	47,0
5	Sumberejo	-	3,0	-	3,0	1,2	400,0	24,0
6	**Gisting**	-	**26,0**	-	**26,0**	**3,12**	**120,0**	**125,0**
	Jumlah/total	39,0	72,0	5,0	115,0	8,0	111,0	286,0

Source: Forestry and Plantation Service District. Tanggamus, 2011.

In Table 2, it can be seen that of the 20 sub-districts in Tanggamus, there are 6 (six) sub-districts that already have an area planted with nutmeg. Gisting is a sub-district that has the largest production and producing plants (TM) from other sub-districts. Gisting Subdistrict has 26 hectares of producing area (TM) and 3.12 tons of nutmeg production and 125 nutmeg growers [1].

Some of the previous studies that have been carried out before have become references to this research, the results of Eva Fauziyah's research, Devy Priambodo Kuswantoro, & Sanudin [2], examined the prospects for developing nutmeg (Myristica Fragrans Houtt) in community forests. Nutmeg has good prospects to be developed in community forests in village Kemawi because there are factors that support its development, namely: 1) physically having conformity with nutmeg plant growth, 2) socially acceptable to the community because many farmers have previously cultivated nutmeg on land 3) economically has a fairly high and stable price so as to provide additional income, 4) marketing conditions for both fruit and seeds are very easy, and 5) government attention to the development of nutmeg at the production level until post-harvest processing is quite large. However, efforts are still needed from various parties both at the production and post-harvest levels so that nutmeg in Desa Kemawi can meet needs on a larger scale and can contribute more to increasing farmers' income [1].

Research by Zeth Patty and Ariance Y. Kastanja [3] study of nutmeg cultivation in northern halmahera district. Most farmers cultivate nutmeg as the main crop on separate land with coconut plants or other plants that can be used as protective plants and most farmers in the research locations have applied regular spacing, while the rest are only a small proportion who have not applied the spacing arrangement [3].

Tanti Kristanti's research, Theopilus Sitepu [4], Expert system for pests and diseases in sweet orange plants in Karo District. Expert system is a computer-based system that uses knowledge, facts and reasoning techniques to solve problems that can usually only be solved by an expert in a particular field. An expert system is one area in artificial intelligence (AI), which is one area of computers that has the concept of "making computers think like humans" [4].

In an effort to increase the production of nutmeg, efforts were made through the implementation of complete farming practices with farmers. Sapta farming includes using superior and high-quality seeds, good irrigation, farming methods, good fertilization methods, eradicating pest, post-harvest handling, marketing results. The use of superior seeds is one of the factors that influence the productivity of nutmeg farming. Therefore, the availability of quality seeds for farmers to carry out farming activities is an important requirement in increasing yield and quality of production.

The expert system determines the quality of nutmeg seedlings using a website-based forward chaining method that is made only in connection with nutmeg seedlings which are not related to other fruit seeds. The system created will be implemented by the community and nutmeg farmers to find quality nutmeg seeds.

The benefits and objectives of this expert system are to produce high-quality, high-quality crops and to satisfy farmers and business people.

B. Problem Formulation

Based on the background above, the formulation of the problem can be arranged as follows:

a. How to make a website-based application system to help and facilitate decision making in determining and choosing quality nutmeg seeds?
b. What is the farmer's decision to choose quality nutmeg seeds with the Website Application?
c. What is the satisfaction of farmers for quality nutmeg seeds?

C. Research Benefits and Objectives

Based on the background above the benefits and objectives of the research can be arranged as follows:

a. Making Application Website using the forward chaining method makes it easier for people to choose and determine quality nutmeg seeds.
b. As a means of training and development of insights for writers in applying theory as a basis for research.
c. To find out the quality nutmeg seeds.

II THEORETICAL BASIS

A. Expert System

Expert System is a knowledge-based program that provides expert quality solutions to problems [5].

Expert systems in general are systems that try to adopt human knowledge to computers that are designed and implemented using certain programming languages so that computers can solve problems as done by experts. Currently, the middle expert system has been developed in various fields, one of which is in agriculture or plantations [6].

B. Forward Chaining

Forward Chaining is a fact to get a conclusion from that fact. This reasoning is based on existing facts (data driven), this method is the opposite of the Backward Chaining method, where this method is executed by gathering existing facts to draw conclusions. In other words, the process starts from the facts (facts that exist) through the interface fact process (reasoning facts) towards a goal (a goal). This method is also called using the IF – THEN rule where the premise (IF) goes to the conclusion (THEN) or can be written as follows:

THEN (conclusion) There are two opinions regarding the implementation of this method. First, by bringing all the data obtained to the expert system. Second, by bringing only the important parts of the data obtained to the expert system.

The first way is better to use if the expert system is connected with an automatic process and the recipient of all data from the database. The second way saves time and money by reducing data and retrieving data that is deemed necessary. For example, as in the case of the two methods above, based on this method steps are taken:

R1: IF A and C, THEN B
R2: IF D and C, THEN F
R3: IF B and E, THEN F
R4: IF B, THEN C
R5: IF F, THEN G

These two types of strategies will lead to a conclusion. However, efficiency depends on the condition of the problem at hand, if a problem has fewer premises than the conclusion, then the strategy that will be offered is Backward Chaining.

C. Website

The website is a collection of web pages that are related to other related files [7-15]. In a website there is a page known as Home Page [16-20]. Homepage is a page that was first seen when someone visited the website [21-25]. From the Home Page, visitors can click on a hyperlink to move to another page found on the website [26 – 29].

D. PHP

PHP is a server-side scripting language that integrates with HTML to create dynamic web pages [30-35]. The purpose of server-side scripting is the syntax and the commands given will be fully executed on the server but included in the HTML document. Making this web is a combination of php itself as a programming language and HTML as a web page builder [36-40]

E. Characteristics of Good Nutmeg Seeds

Nutmeg is a two-housed plant, namely male and female nutmeg plants separate in different trees. However, plants can also be found in which male and female flowers are in a monoecious tree.

Propagation of nutmeg plants generally uses seeds. Seed germination takes 1-3 months, and is ready to plant into the field after 1 year of age. Nutmeg plants start to bear fruit at the earliest 3 years after planting, but generally nutmeg plants from seeds start to bear fruit at the age of 5-7 years. Productive age can reach more than 100 years.

a. Sorting fruit / nutmeg seeds. Plant seeds for seeds must be of high quality and meet physical, physiological, and genetic quality. Physical quality is not wrinkled, not broken, there is no attack of pests / diseases. Physiological quality, namely seeds can grow when germinated / sown. Genetic quality is related to varieties, the origin of the parent seed. The seeds that have been removed from the fruit from the fulcate are then sorted to obtain seeds that are truly old to be added to. Young nutmegs generally cannot be used for seeds and if germinated they cannot grow.
b. Seed germination. Before the cooking, there are stages of fruit, mace and seed selection that must be done. Fruit selection, which is carefully selected ripe fruit, is characterized by fruit that has been split and free from pests and diseases. Selection of seeds, namely select seeds that are dark brown, round and large shiny, free of pests and diseases. Nutmeg seed germination is carried out on moist sand media or mix soil and manure (2: 1), or soil: sand: manure (1: 1: 1). Germination that can be done using a tub or plastic filled with sand, sawdust and coconut coir powder, then stirred evenly. To accelerate germination, the shell is knocked / split at the base of the seed without damaging the seed meat. Then cover the tub with gunny sacks or newsprint to keep moisture. After 4 weeks the seeds are moved into polybags.
c. Detection of male and female nutmeg in seed stadia. When observed, the nutmeg seed tip is pointed, rounded and there is even a protrusion at the end. Based on the information of some nutmeg seed breeders in the islands of Ternate, West Java, West Sumatra, Bogor, and Central Lampung, the seed that has a bulge (like a horn) at its end, will grow into male nutmeg. Seeds that will grow into female nutmegs have characteristics of the two sides of the shape that are smooth or flat and there are no protruding parts. In nutmeg plants with this type of seed, based on local wisdom, the seeds that will grow into males will have clearer / more prominent horns, while those that develop into female nutmegs will have the size of the bulge according to the average.
d. Detect male and female nutmeg in the nursery. Based on local wisdom from various regions such as North Maluku, North Sulawesi, West Java, and Lampung, seeds that are estimated to grow into female nutmeg have branching growth almost flat / tend to be horizontal, leaf position on branches slightly flat to slightly drooping, leaf size rather large and width. While the male seedlings do not have branches, but the branches are narrow / sharp, so the canopy growth tends to be upright, the position of the leaves on the branches is rather erect, the leaves look slimmer. When viewed from the roots, usually the root formed is a straight taproot, with lateral roots that are small and soft [41]. Figure 1 shows nutmeg. Figure 2 shows characteristic of good nutmeg.

Fig. 1. Nutmeg

Fig. 2. Characteristics of good nutmeg

In Indonesia, several types of nutmeg are known, namely:

1) Myristica fragrans Houtt, which is the main type and dominates other types in terms of quality and productivity. This plant is a native plant of the island of Banda.
2) M. argenta Warb, better known as Papuanoot aka nutmeg of West Papua, native to West Papua, especially in the area of the bird's head. Growing in forests, the quality is below the nutmeg of Banda.
3) M. scheffert Warb. found in the forests of Papua.
4) M. speciosa, found on Bacan island. This type has no economic value.
5) M. succeanea,on the island of Halmahera. This type has no economic value.

F. Expert System Application

Applications can be interpreted as a program in the form of software that runs on a particular system that is useful to help various activities carried out by humans. This expert system application is created using a website-based expert system using the Forward Chaining method. Purpose of creating this website-based expert system application to make it easier for the community, namely farmers, to obtain information on quality and superior nutmeg seedlings for cultivation.

III RESEARCH METHODS

A. Method of collecting data

a. Observation

Observation is a research method for measuring individual actions and processes in an event [42-50]. Observation is an accurate method of collecting data [51-58]. The aim is to find information about the activities that took place to later become the object of research studies [59 – 65].

The author observes what the characteristics of nutmeg are good and quality directly so that the results of the research can be known.

b. Interview

With the development of the current expert system, researchers conducted question and answer directly to nutmeg farmers to obtain information needed in the design of expert systems to determine the quality of nutmeg seedlings using a website application [66-70].

c. Library Study

Library Study is to study various reference books and the results of similar previous studies that are useful for obtaining a theoretical basis for the problems to be studied [71-77].

In this study, a search and learning was carried out from various existing library sources. Among them are expert journal systems for nutmeg cultivation using web applications, web-based expert systems to diagnose pests in banana plants, which are related and help create expert systems to determine the quality of nutmeg seedlings using website applications.

B. SDLC Method

SDLC (System Depelopement Life Cycle), System Development Lifecycle is the process of making and changing systems and the models and methodologies used to develop software systems, which consist of the stages of Plan, Design, Building, Implementation, Management.

a. Planning

This stage aims to identify and prioritize what information systems will be developed, what goals to be achieved, the period of implementation and, considering the available funds and who implemented them.

Some of the advantages of planning computer-based IS are:

1. Improve communication between managers, users and makers.
2. Increasing the effectiveness of the use of organizational resources.
3. Support communication for accountability of activities carried out by individuals and departments.
4. Support the evaluation process.
5. Enables managers to manage long-term system development.

b. System Design Stage (Design)

System analysis is used to answer questions what? System design is used to answer the question how? Design concentrates on how the system is built to meet the needs of the analysis phase.

The benefit of system design is to provide a complete design image (Blue Print), as a guide (guideline) for programmers in creating applications. A computerized information system consists of:

1. Hardware: consists of input, process, output, and network components.
2. Software: consists of information systems, utilities, and applications.
3. Data: includes data structure, data security and integrity.
4. Procedures: such as documentation, system procedures, operational and technical manuals.
5. Humans: parties involved in the use of information systems.

Some of the things that are done in system design are:

1. System modeling.
2. Design application database.
3. Application design.
4. Hardware / network design.
5. Design the position / user description.

c. Making System (Buliding)

A manufacturing information system / application based on the design that has been made. In addition, make a guidebook for the use of an information system / application so that it is easy when conducting training during implementation. The process of testing information systems / applications, including:

1. Performance testing.
2. Logic program testing / syntax.
3. Testing the implementation of business rules.
4. Testing human factors.
5. Testing business processes / procedures.
6. Input efficiency testing.
7. Testing output.

d. System Implementation

Namely implementing the system that has been made. Before implementation, make careful preparations regarding hardware, software, rooms and other supporting facilities.

Some of the things that are also important to consider in implementing the system are:

1. Conversion
   Usually conversion from an old system to a new system is needed, especially if users have previously used a computerized application.
2. Training
   Perform overall training for each party that uses it. And don't forget to socialize to parties involved in the system but do not use system applications directly.
3. Testing acceptance
   Perform testing for a certain period as a learning process.

e. System Maintenance

The stages of system maintenance cover all the processes needed to ensure continuity, smoothness and improvement of the system that has been operated. Some things to do:

1. Monitoring operations.
   Involve the development team to monitor directly at certain times about how the users operate the system created.
2. Anticipate small bugs.
   Usually there is a small interference in a newly developed application.
3. Make improvements.
4. Anticipate external factors
   Viruses, data damage / data loss, or systems accessed by outsiders.

C. Research Thinking Framework

The research thinking framework is a form of process from the whole of the research process in the form of diagrams that explain the outline of the logic of the running of a research based on research on website-based research information systems journals along with descriptions using the Flowchart figure 3 below:

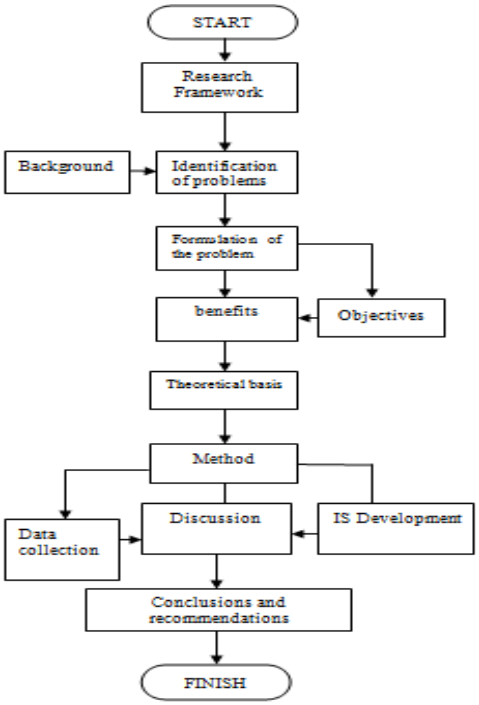

Fig. 3. Research Thinking Framework

Description in the flowchart:

The research framework explains the stages in the research activities carried out, starting from the background of the problem and then identifying problems in the system that are running. After identifying the problem, it is continued by formulating a problem that will later be used as a reference material to provide research benefits and objectives. after that the theoretical basis explains the theory or system in accordance with the research then the method used from the start of data collection, to the research framework

Then explain in detail the discussion of the system that will be used to provide conclusions and suggestions. Until Finished Lah Research Activities Study.

III. DISCUSSION

A. System Design

After analyzing existing data and information, the next stage is a system design that describes the real system concept.

a. Flowchat

Website application using the Flowchart as shown in figure 4:

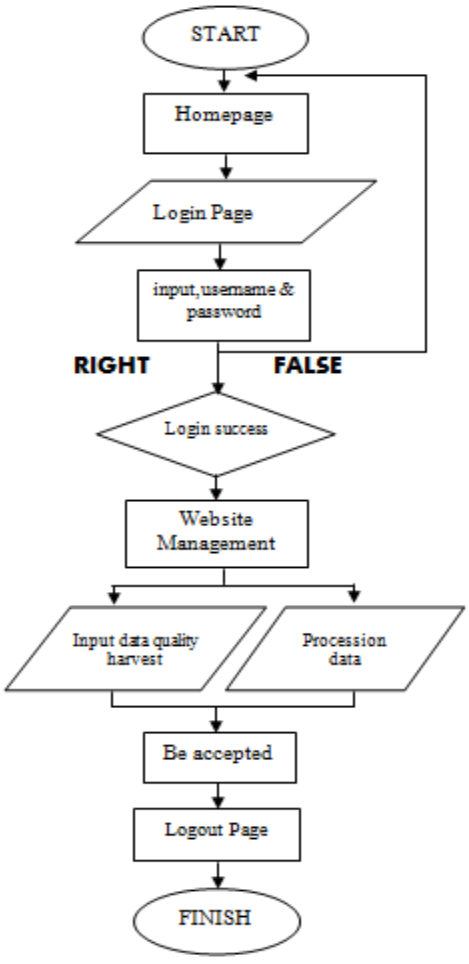

Fig. 4. Flowchart

b. Context Diagram

Context Diagram is a diagram consisting of a process and describing the scope of a system

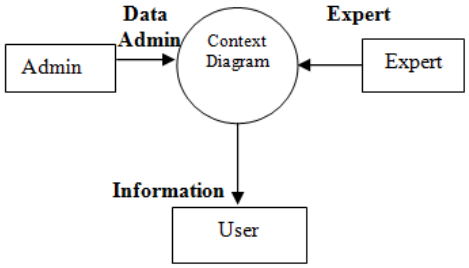

Fig. 5. Context Diagram

c. ERD

ERD (Entity Relation Diagrams) is a tool that can be used to organize data that can be collected where this diagram shows the entity and the relationship of the entity.

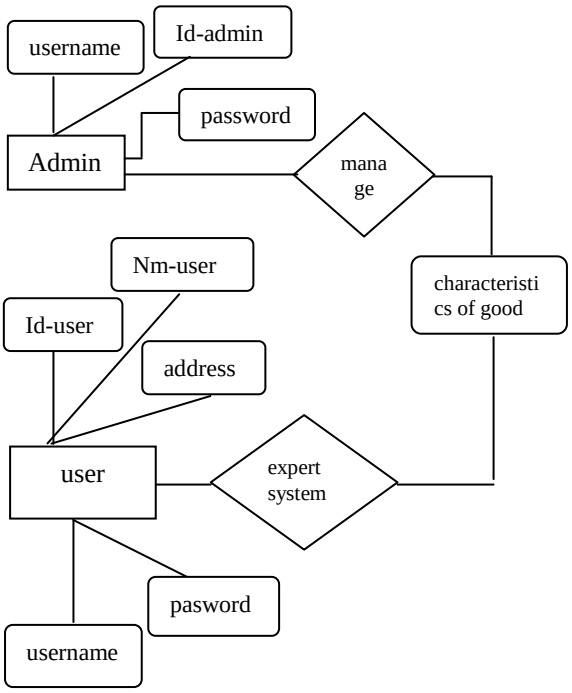

Fig. 6. Entity Relation Diagrams

d. Designing the Interface

The expert system interface design determines quality nutmeg seedlings using a website application. Figure 7 shows design of the login page interface. Figure 8 shows draft web-based main page interface. Figure 9 shows draft interface for matching web-based nutmeg seed criteria page.

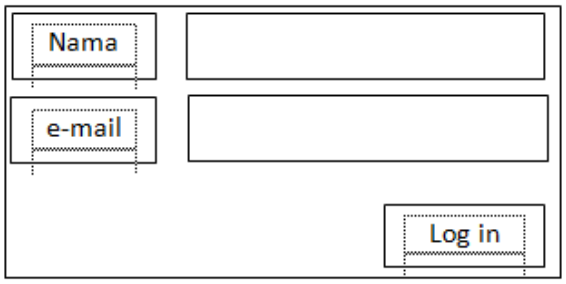

Fig. 7. Design of the login page interface

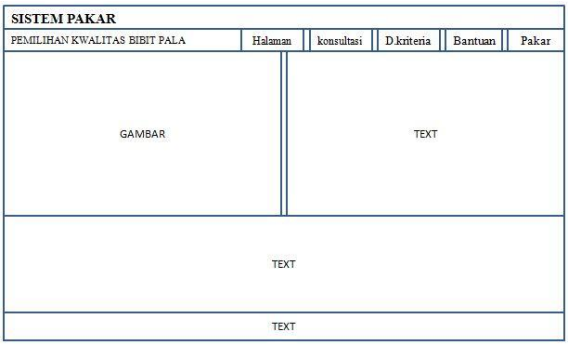

Fig. 8. Draft web-based main page interface

Fig. 9. Draft interface for matching web-based nutmeg seed criteria page

B. Analysis of needs

The analysis is done by collecting the required data from the results of the research as well as several related references.

Table 3. Criteria for good nutmeg seedlings

ID-Criteria	Seed Criteria
G001	Already old
G002	Not wrinkled
G003	Not broken
G004	Big Nutmeg
G005	Absence of pests or diseases
G006	Seeds can grow when germinated
G007	Selected seed parent varieties

Table 3 explains the list of criteria for good nutmeg seeds used in the system. There are 7 criteria that are used, namely old, not wrinkled, not broken, large nutmeg, no pest or disease attack, the seeds are able to grow when in germination, varieties of origin of selected parent seeds.

Table 4. Knowledge Base

No	Rule
1	IF No wrinkled and Not broken AND Absence of pests or diseases THEN Physical Quality
2	IF Seeds can grow when germinated AND sprinkle THEN Physiological Quality
3	IF Selected seed parent varieties THEN Genetical Quality

Table 4 explains the rules used in the quality criteria system that has been determined in determining quality nutmeg seeds.

a. System Implementation

System implementation is a transformation from interface design to finished product form in the form of a web page that connects users, experts or administrators with expert systems to determine the quality of nutmeg seedlings using a website application.

The results of implementing the interface design:

1. Data input page

By selecting the consultation menu, the system will display the data input page, this page is a page to fill in the data of users who want to consult, before consulting the user must first fill in their personal data, namely the name line to fill in the username, gender line to fill in the gender user, address line to fill in the user's address, then the user can choose the advanced button to register if the user has filled in all the data and the reset button to cancel. The following figure 10 is the user data input page display:

Fig.10. Implementation of the user data input page interface to start a web-based consultation.

b. Answer questions

After the user enters consultation data, then the user is faced with a page answering the question. This page is a page to answer questions based on the criteria given to the user by the system. On this page there is a line of questions, the line select true (YES) or wrong (NO), and the answer button to answer the question. The following figure 11 is the page view, answer the question:

Fig. 11. Web-based nutmeg criteria matching page interface implementation

c. Results of analysis

If the user has already answered the question posed by the system, the system will display the results of the prediction of the results of the input from the user. Users can also see the solutions displayed by the expert system.

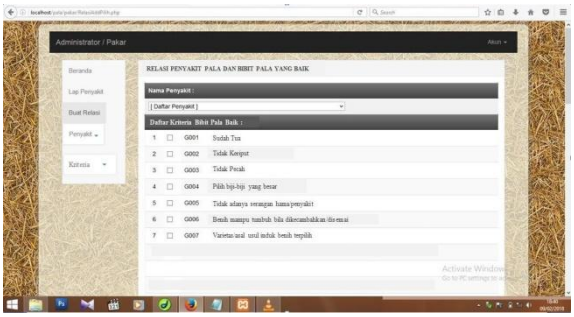

Fig. 12. Implementation of a web-based criteria page interface

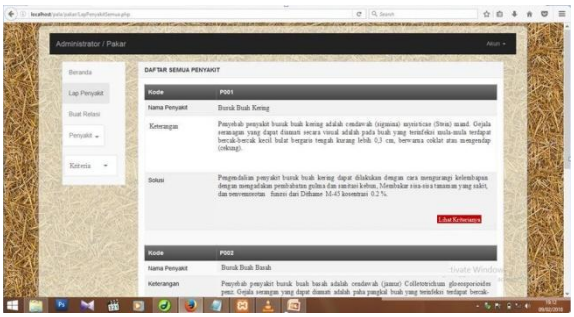

Fig. 13. Implementation of page interfaces that are not web-based criteria and solutions

IV. CONCLUSION AND SUGGESTION

A. Conclusion

Conclusion The expert system for determining quality nutmeg seedlings using this website-based forward chaining method is:

1. From the evaluation test on the results of Validation on experts, determining the quality of nutmeg seedlings can be concluded that the results of the validation show that the total number of 66 is classified as Valid.
2. From the material Validation test by material experts it can be concluded that the validation results show a value of 2.9, which is between 2.51-3.25 which is classified as a Valid category.
3. From the Validation test on experts it can be concluded that the results of the validation show a value of 3.2, which is between 2.51-3.25 which is classified as a Valid category.
4. Using the website application in this study can be used to select quality nutmeg seeds for nutmeg production with the characteristics specified in this study.
5. Things that need to be considered in choosing good nutmeg seeds choose nutmeg seeds that are healthy, of superior quality and not diseased. Seed age should be more than a year and less than 2 years.

B. Suggestion

After the creation of this expert system is carried out, there are several suggestions that must be applied for the development of further expert systems, namely:

1. From the expert system that has been created, the author only uses the forward chaining method because according to the author this method is suitable for use on the system created. It does not rule out the possibility of another, better method that can be used.

2. From the expert system that has been built, there may be system shortcomings in its implementation. It is necessary to add data for quality characteristics and new solutions that are developing so that the results obtained can be more precise and more accurate.

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