International Journal on Advanced Science Engineering Information Technology

Vol.14 (2024) No. 1
ISSN: 2088-5334

Application of Forward Chaining Method, Certainty Factor, and Bayes Theorem for Cattle Disease

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***Abstract*— Indonesia is a country that has many natural resources, especially mammals. The Papua and West Papua regions are large provinces with abundant natural resources and tremendous livestock potential. The availability of natural resources in the form of live cattle provides a great opportunity to develop animal husbandry in West Papua province. This research was conducted to create a new expert system with a knowledge base to solve the problems that occur and be useful for the community, especially cattle breeders. The current problem is the delay and lack of medical personnel in diagnosing cattle diseases, the distance that must be traveled, which is still very difficult to travel, and the lack of understanding of farmers in early handling when implications indicate animals. So, the Certainty Factor Method and Bayes Theorem with Forward-Chaining search are used to handle current problems. From the results of manual calculations, Certainty Factor Forward Chaining search is a method that has an uncertainty value of 99.84% for 3-day fever compared to Bayes Theorem Forward Chaining search with a value of 50% for worms, 50% for 3-day fever and 50% for nail rot, if applied then Certainty Factor Forward Chaining search is the most appropriate. Likewise, updating the knowledge base must be done from time to time. So that in the future, it can be compared with other methods and Android-based to facilitate current breeders.**

***Keywords*—Forward chaining; certainty factor; Bayes' theorem; bovine expert system.**

Manuscript received 24 Apr. 2023; revised 5 Dec. 2023; accepted 9 Jan. 2024. Date of publication 29 Feb. 2024.

I. INTRODUCTION

The additional livestock population in West Papua Province, averaging 1,000 heads/year, is relatively slower than the consumption rate. Population increases of beef cattle from 2009 to 2010 reached 93%. In West Papua Province, it has been identified that diseases that often attack cattle or goats are mainly parasitic worms, resulting in a decrease in livestock body weight and death. This is evidenced by the discovery of *Fasciola sp* worm species in the liver organs of sacrificial animals in 2013 [1]. Previous researchers have discussed that finding a skill set that matches current marketing trends is difficult, especially for new (employees). It is even more complicated for employers to see people with the required skills because there will be massive data [2]. This researcher solves the problem of a Graduation project, which is a form or work requested by the study authority from the student to measure what he made during the study [3]. Distributed Denial of Service (DDoS) attacks are still attacking in terms of business, production, reputation, data theft, etc. [4]. A fuzzy expert system (FES) approach for FCPTL locate the inter-circuit faults and improve shunt fault location accuracy [5]. Parkinson's disease, a brain condition that causes difficulty walking, standing, concentrating, shaking, and weakness [6]. Patients who show symptoms of Influenza to verify that they are infected with the Coronavirus, commonly identified as COVID-19 [7]. A study as in [8] aims to build a small microgrid testing system with multiple sources and a few loads with different types of resistive (R), capacitive (C), and inductive (L) elements equalized. There are many process threat factors on the network when exchanging data between devices [9]. Millions of people die every year, and the mortality rate is increasing alarmingly due to cardiovascular diseases worldwide, including mainly in Bangladesh [10]. Furthermore, machine learning-based CBM currently has limitations, new machine learning algorithms, and an ever-increasing capacity to collect data that allows failure detection [11]. This review highlights the importance of validation in ensuring the reliability and trustworthiness of fuzzy and wearable expert systems. Advantages and issues are examined, along with the importance of validation in system deployment. The process concludes with a discussion on the need for further validation and supporting methods in developing medical expert systems [12]. It presents a hybrid expert system for computer-aided design of ship thruster subsystems. The system uses simulation tests as an additional source of knowledge. It can support the designer in creating a technical description of the thruster subsystem, evaluating its static and dynamic properties, and checking whether the design solution meets the requirements of classification societies. The application of the system can help reduce the cost and time of the design process [13]. BurrXII distributions were firstly review by the Burr back in 1942, as they have receive special attentions in recent times because of their widespread applicability, including the areas reliability and modeling of times to failure [14]. Infectious diseases such as typhoid, dengue fever, etc., are caused by water and environmental changes [15]. Lack of adequate knowledge in handling hardware damage [16]. It is essential to find out how to meet the increasing demand for electrical energy using a fuzzy expert system. For improved protective performances of the power system, good monitoring of the system in a dynamic state is required, based on a fuzzy interface system [17], [18].

A hybrid expert system for quantification of Epilepticus Electrical Status during Sleep (ESES) in children is proposed in this paper. It integrates a morphological analysis-based expert decision model with biogeography-based optimization (BBO) for parameter selection. The system was evaluated based on clinical datasets and showed superior performance over existing methods [19]. The effectiveness of two advanced data mining techniques - bivariate statistics models (certainty factor (CF)) and machine learning models (random forest (RF)) for accurate gully head erosion susceptibility mapping using Dongzhi Loess Tableland in China comprises an example at a regional scale. Databases consisting of 11 geographic and environmental parameters were extracted with 415 spatially distributed gully heads, of which 70% (291) were selected for model training, and 30% (124) were used for validation [20].

A study in [21] has shown comorbid conditions worsen the prognosis of cancer patients. With hazard ratios ranging from 1.1 to 5.8, most studies found that cancer patients with comorbidities had worse 5-year survival rates than those without. The dataset was handled throughout the classification phase using CHI2-based feature selection. These two techniques address the problems posed by inconsistent data sets. A study by [22] proved that the components are conditionally independent with information about the class variables, allowing us to design new mathematical methods with substantial reductions in classification and learning complexity. Experiments on 34 datasets obtained from the OpenML repository show that MILC-NB outperforms state-of-the-art classifiers regarding area under the ROC curve (AUC) and classification accuracy (ACC). We are working to develop and validate a system that can perform automated diagnosis of common and rare neurological diseases involving gray matter on clinical brain MRI studies [23]. Recently, many improved naive bayes methods with enhanced discrimination ability have been developed [24]. To address this issue, we propose a semi-supervised adaptive discriminative discretization framework for Naive Bayes, which can better estimate data distribution by utilizing labeled and unlabeled data through pseudo-labeling techniques. The issue of speed should provide a balance between safety and traffic flow [25]. For example, in Brazil, standard guidelines list factors that affect speed limits, but they do not provide a transparent methodology for selecting the speed limit on a highway segment. The results show that with the fuzzy system, the system can deliver an output that matches the experts' evaluation with the existing speed limit. The fuzzy controller developed in this study can assist practitioners in setting highway speed limits on Brazilian highways. A study by [26] presented a novel framework that integrates machine learning and domain knowledge-based expert systems to improve building energy flexibility. In this framework, a rule-based expert system is used to maximize solar photovoltaic (PV) power consumption. At the same time, a reinforcement learning (RL) agent is built to optimize grid power import for battery charging efficiently and facilitate decision-making. The rule-based expert system can reduce electricity cost and grid power consumption by 7.0% and 10.6%, respectively, and increase PV electricity consumption by 9.2% compared to the rule-based expert system alone. For example, the daily average cost reduction ratio is 0.89 from 1.0 when the daily maximum solar radiation is above 717.5 W/m2 and drops to 0.28 when the daily average solar radiation is below 62.4 W/m2. Investigating how Expert Systems can be used to facilitate resource management was conducted in this study to determine the level of readiness to accept ES to assist management. The majority of respondents agreed with the use of Expert Systems (ES) to aid in the management of primary education [27].

This experiment aimed to obtain application results and the highest scores from both methods utilized, namely certainty factor (CF) and Bayes theorem (BT), by adding forward chaining search to CF and BT; this technique is used to handle problems whose answers are uncertain. Since this uncertainty can be a possibility. Here is a picture of the expert system architecture displayed in Fig 1.

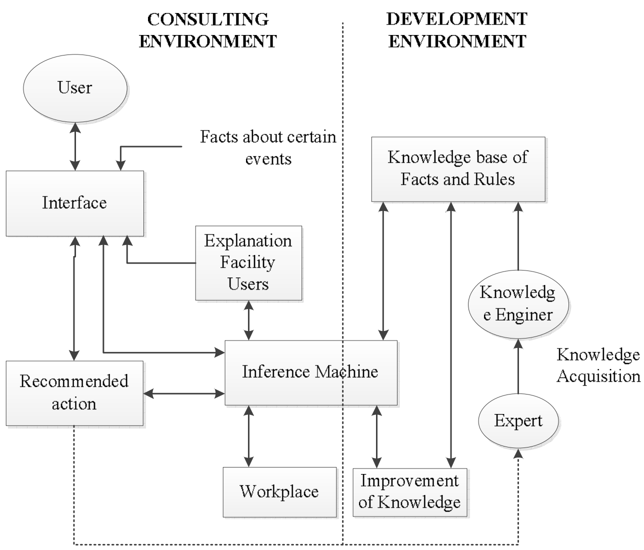

Fig 1 Expert System Architecture [28], [29], [30]

The expert system architecture above explains the flow of the expert system where users and experts are connected through an inference engine system. Specialist knowledge is also the basis of the interpretability of the expert system belief rule base (BRBES) [31], [32].

II. Materials and Method

The purpose of this research is to apply the methods listed in the paper's title to get the highest percentage of results from each method [33]. The research flow is shown in Fig 2.

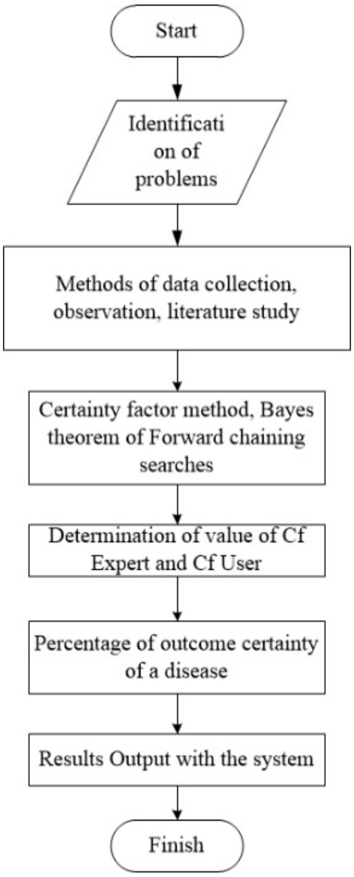

Fig 2 Flowchart of research [34]

Phases of research conducted include:

- Earliest stage in the research framework. Compilation and identify cattle disease data from Sorong District Livestock and Animal Health Services for 2022-2023.
- Observations in direct interviews with several cattle farmers to look at the issues & obtain a reliable database of cattle illnesses.
- In this research, the Certainty factor and Bayes theorem are used in diagnosing cow disease and forward chaining as a search.
- This stage is to manually calculate the CF Expert and CF User values given by the expert from each fact of the symptoms of disease in cattle and the value provided by the user as a reference in calculating the Bayes' theorem method & certainty factor.
- This stage is to determine the level of certainty from calculations of CF values obtained from percentage level (%) and the accuracy of a disease and the Bayes value probability as a certainty value to see the percentage level of accuracy of the disease that appears.
- This stage will explain the work results and data testing that has been done using Bayes's theorem and certainty factor method using forward-looking methods. Solutions were provided for cattle disease in the interior of Sorong district and early handling of sick cattle.
- The last step is testing the system as a whole. The system has two access rights: users to conduct consulting, & administrators to manage the system [35].

A. *Expert System Flowchart*

Expert systems are one of the most accomplished fields in artificial intelligence; Some argue that expert systems were introduced in 1965 by Feigenbaum and Lederberg [36], [37], [38], [39], [40]. Expert systems are rule-based decision engines that help non-expert users to improve their skills. It is a program that is built based on knowledge gained from experts [41]. Below is a flowchart of diagnosing dairy cow disease in the system, shown in Fig 3.

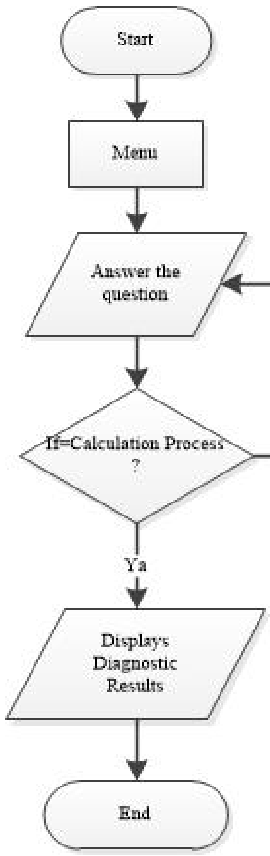

Fig 3 Expert system flowchart

B. *Knowledge Base of Expert System*

An expert system is defined as a computer system that allows computational design methods to replicate and and categorize a human expert's decision-making process. Knowledge-based in this system contains a database of diseases, symptoms, and solutions. With nine diseases & 24 symptoms analyzed by experts in the system to diagnose livestock diseases, there are also four confidence weight tables for user input [42]. These facts are listed under Table 1 and Table 2.

TABLE I
INFORMATION ON CATTLE DISEASE SYMPTOMS

No.	Symptom Code	Detail Information
1	GP01	Thin body
2	GP02	Standing body hair
3	GP03	Diarrhea
4	GP04	Lack of appetite
5	GP05	Visible wounds on the body
6	GP06	Seen flies in the wound area
7	GP07	There are maggots in the wound area
8	GP08	Soft stools tend to be liquid
9	GP09	Dirt mixed with blood
10	GP10	There is runny in the eyes, nose and it smells bad
11	GP11	Swelling of the eyes, nose
12	GP12	Red eyelids
13	GP13	Eyes close
14	GP14	Hard to breathe
15	GP15	Fever
16	GP16	Convulsions
17	GP17	Legs are limping or difficult to stand
18	GP18	Weak Body
19	GP19	Decreased milk production
20	GP20	Six months of pregnancy, there is brown discharge on the lips of the vagina
21	GP21	The fetus comes out on time
22	GP22	The affected part of the nail has a yellow discharge and has a foul smell
23	GP23	Itchy body
24	GP24	Peripheral diarrhea

TABLE II
DISEASE INFORMATION

Disease Name	
PY01. Worms	PY06. Salmonellosis
PY02. Myiasis	PY07. Miscarriage/Brucellosis
PY03. Dysentery	PY08. Nail Rot
PY04. Coryza	PY09. Scabies
PY05. Fever 3 Days	

Source: Data from expert interviews

TABLE III
DISEASE RULES

No.	Disease	Symptom Data
1	Worms	Thin standing hair Diarrhea Lack of appetite
2	Myiasis	There are wounds on the body There are flies in the wound area There are maggots in the wound area
3	Dysentery	Diarrhea Soft stools tend to be liquid Dirt mixed with blood
4	Coryza	There is runny in the eyes, nose and it smells bad Swelling of the eyes, nose red eyelids Eyes close Hard to breathe
5	Fever 3 Days	Lack of appetite Fever convulsions Difficulty standing or limping legs
6	Salmonellosis	Diarrhea Weak
7	Miscarriage/Brucellosis	Decreased milk production Six months of pregnancy, there is a rash Chocolate on the lips of the vagina The fetus comes out on time
8	Nail Rot	Difficulty standing or limping legs The affected part of the nail has a yellow discharge and has a foul smell
9	Scabies	Itchy rash Scabies in the peripheral area

TABLE IV
CERTAINTY FACTOR, CONFIDENCE WEIGHT

No.	*Certainty Term*	Final CF
1	No	0
2	Don't know	0.2
3	Enough	0.4
4.	Pretty Sure	0.6
5.	Certain	0.8
6	Very certain	1

Tabular description:
a) D (Disease)
b) SD (Symptom Data)

C. Methods of Forward Chaining

A forward chaining search technique begins as known facts, matching those with the IF section of an IF-THEN rule & is also known as a direct search or a data-driven trace. The steps of tracing with *forward chaining* are:

- Identify conditions.
- Directed search to find variables in the rule base; find rules are saved, otherwise go to step 4.
- A search then goes through to check if the user input facts match the rules. If they do, add them to the waiting list. If not the same, proceed to step 4.
- If there are no more IF statements with the same variable as those in the first order of the queue list, then delete the first order. If there are more, Return to stage 2.
- If nothing else is in the queue list, the search will be terminated. If it's still there, go back to stage 2.

D. Certainty Factor Method

Expert System is one of the most common artificial intelligence applications [43] and the *Certainty factor* (CF) is a method to prove the uncertainty of an expert's thinking, to accommodate this one usually uses CF to describe the level of confidence. First stage involves calculating CF score for a symptom within parallel (parallel CF) by multiplying the calculation results between the CFuser value and the expert CF as in equation (1). The second stage uses the results of the parallel CF calculation to determine the combined CF value (CF combination) using equation (2). The calculation process for the second stage is carried out repeatedly according to the number of inputs for the number of symptoms. The main requirement for using equations (1) and (2) is that the CF value of both users and experts must be more than zero (CFuser and expert CF>0) [44]–[46].

$$CF(H \mid E)parallels = CF\ (E)user * CF\ (E)expert \quad (1)$$

$$CF(H \mid CF_1, CF_2)\ combinations = CF_1 + CF_2 *(1 - CF_1) \quad (2)$$

where CF (H | E)$_{parallel}$ is rate certainty factor parallel hypothesis H if given symptoms, or evidence H [45]. CF (E)$_{user}$ is values certainty factor by the symptoms or evidence E given by the user. CF (E)$_{experts}$ is value certainty factor by symptoms or evidence E given by experts. CF(H | CF$_1$, CF$_2$) combination is value of certainty factor combination of symptoms or evidence E on hypothesis H, then the probability of this method is to get the certainty value between the multiplication of CF$_{user}$ and CF $_{expert}$.

E. Bayes' Theorem Method

Bayes' theorem is a way to resolve uncertain data by utilizing a formula called Bayes and an algorithm built on the premise that each pair of properties used to categorize something stands alone which is expressed as follows [21], [47]:

$$P(H_k|E) = \frac{P(E|H_k)\ P(H_k)}{\sum k=1,nP(E|H_k)P(H_k)} \qquad (3)$$

where $P(H_k|E)$ is Probabilities hypothesis H$_k$, given evidence E. $P(E|H_k)$ is Probabilities proof E when hypotheses known H$_k$ Correct. $P(H_k)$ is Probabilities hypothesis H$_k$, without seeing any evidence. n is Amount possible hypotheses. k is 1,2…n. From Bayes' theorem if hypothesis testing comes up with a lot of evidence, it can expand, and the equation becomes:

$$P(H \mid E,e) = \frac{P(H \mid E)\,P(e \mid E,H)}{P(e \mid E)} \qquad (4)$$

So, e is evidence long, E is evidence new. $P(\mathrm{H} \mid \mathrm{E},e)$ is probability of hypothesize H being true given a new proving E over old evidences e [48]. $P(\mathrm{e} \mid \mathrm{E},H)$is likelihood of association with e and E when hypothesis H so correct. $P(\mathrm{e} \mid \mathrm{E})$ is probability of relationship between e and E irrespective of any hypothesis. $P(\mathrm{H} \mid \mathrm{E})$ indicates the probabilities those evidence E appears if a hypothesis is known H.

F. Application Forward Chaining

Decision Tree techniques have previously been applied for disease diagnosis by researchers [49]. Artificial Intelligence techniques have generally been applied for the same purpose, for example in this new article, a decision tree has been obtained from a database of cattle symptom and disease tables using forward chaining search. following is grounded on real data from experts:

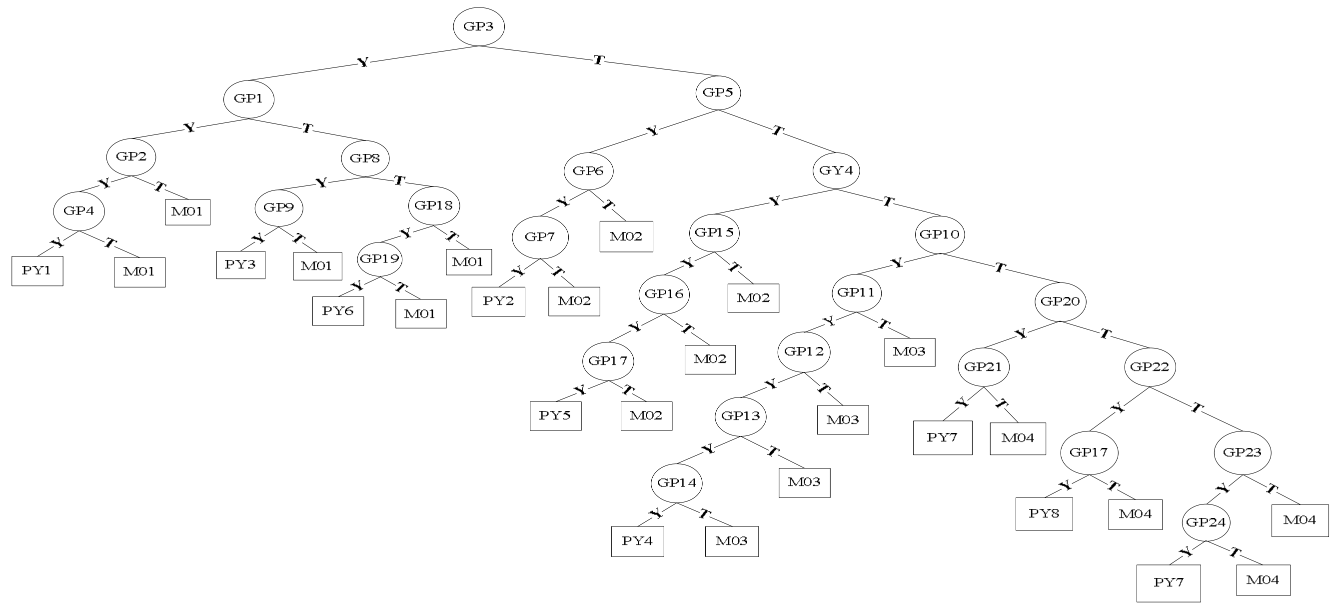

Fig 4 Forward chaining tracing decisions tree [50]

Explanation in the decision tree Fig 4 is the process of the forward chaining method rule flow which has codes, GP01-GP24 (Symptoms), PY01-PY09 (Illness) and M01-M04 (Dead/Stops). The process flow above also has options with Y (Yes) and T (No) codes which determine the results based on the input choices. The following is a table of disease rules in cattle based on the symptoms obtained.

TABLE V
RULE DISEASE

No.	Code	Rule Disease
1	PY 01	GP 01, GP 02, GP 03, GP 04
2	PY 02	GP 05, GP 06, GP 07
3	PY 03	GP 03, GP 08, GP 09
4	PY 04	GP 10, GP 11, GP 12, GP 13, GP 14
5	PY 05	GP 04, GP 15, GP 16, GP 17
6	PY 06	GP 03, GP 18, GP 19
7	PY 07	GP 20, GP 21
8	PY 08	GP 17, GP 22
9	PY 09	GP 23, GP 24

G. Calculation of Certainty Factor

Carry out calculation steps CF

1) Symptoms found:

- GP 04: Lack of Appetite
- GP 15: Fever
- GP 16: Convulsions
- GP 17: Legs are limping or difficult to stand

2) Tracing forward traces of existing rules:

Rule 1 If: Lack of appetite = YES AND Fever = YES AND Seizures = YES THEN = Fever 3 days

3) CF calculation process:

- Calculating the value of CF_{user} *CF_{expert} and CF_{User} is the value given by the user while CF_{expert} is the value given by the expert as a knowledge base which will later be associated with disease symptoms and solutions.

TABLE VI
VALUE CF_{USER}*CF_{EXPERT}

Symptom Code	Symptom	CF_{expert}	CF_{user}
GP 04	Lack of appetite	0.8	0.8
GP 15	Fever	0.8	0.8
GP 16	Seizures	0.8	0.8

Then look for the value of $CF_{symptoms}$ by formula (1).
CF (H | E)$_{parallel}$ = CF (E)$_{user}$ * CF (E)$_{expert}$
CFgp 04 = 0.8 * 1 = 0.8
CFgp 15 = 0.8 * 1 = 0.8
CFgp 16 = 0.8 * 1 = 0.8
CFgp 17 = 0.8 * 1 = 0.8

- Then calculate using formula (2) because it exceeds one symptom that is added up:
CF(H | CF_1, CF_2)$_{combination}$ = CF_1 + CF_2 * (1 - CF_1)
$CF_{combination}$ (GP 04, GP 15)
= CF1 + CF2 * (1 - CF1)
= 0.8 + 0.8 (1 - 0.8)
= 0.96
$CF_{combine}$ (GP04, GP15, GP16)
= 0.96 + 0.8 (1 - 0.96)
= 0.992
CFc_{ombine} (GP 04, GP 15, GP 16, GP 17)
= 0.992 + 0.8 (1 - 0.992)
= 0.9984
- Next, calculate the first sign of symptoms 004 and 015 using formula (2), find the CF value for the symptoms:
CF(H | CF1, CF2)$_{combination}$ = CF1 + CF2 * (1 - CF1)
CFcombinatio (GP 04, GP 15)
= CF1 + CF2 * (1 - CF1)
= 0.8 + 0.8 (1 - 0.8)
= 0.96
- Value results with the $CF_{Combine}$ formula:

TABLE VII
VALUE $CF_{COMBINATION}$

Symptom	$CF_{combination}$
Lack of Appetite, Fever	0.96
Lack of Appetite, Fever, Convulsions, Legs are limping or difficult to stand	0.9984

- Calculating value $CF_{percentage}$
Perform calculations to find the value of CF percentage with the final value of the calculated CF combination of symptoms 04, 15, 16.
$CF_{percentage}$=$CF_{combination}$*100%
$CF_{percentage}$=0.9984*100%
$CF_{percentage}$= 99.84%
Then the disease in cows is obtained, namely fever 3 days with percentage 99.84%

H. Calculation Bayes' Theorem:

1) Symptoms found:

GP 04: Lack of Appetite
GP 15: Fever
GP 16: Convulsions

2) Tracing forwards traces of existing rules:

Rule 1 If: Lack of appetite = YES AND Fever = YES AND Seizures = YES THEN = Fever 3 days.

3) CF calculation process

- Calculating value probabilities of disease

$$Prob.disease = \frac{Possible\ disease}{Sum\ of\ all\ diseases}$$

$$Prob.disease = \frac{1}{9} = 0{,}11$$

$$GP\ 04 = \frac{1}{2} = 0.5$$

$$GP\ 15 = \frac{1}{1} = 1$$

$$GP\ 16 = \frac{1}{1} = 0{,}33$$

$$GP\ 17 = \frac{1}{2} = 0.5$$

- Calculate the number of bayes disease one using formulae (4)

$$H(PY\ 05 \mid GP\ 04) = \frac{[H(GP\ 04 \mid PY\ 05) * H(PY\ 05)]}{[H(GP\ 04 \mid PY\ 05) * H(PY\ 05) + H(GP\ 04 \mid PY\ 01) * H(PY\ 01) + H(GP\ 04 \mid PY\ 08) * H(PY\ 08)]}$$

$$= \frac{[0.5 * 0.11]}{[(0.5 * 0.11) + (0.5 * 0.11) + (0 * 0.11)]}$$

$$= \frac{0.055}{0.055 + 0.11 + 0} = \frac{0.055}{0.165} = 0.333333$$

$$H(PY\ 05 \mid GP\ 15) = \frac{[H(GP\ 15 \mid PY\ 05) * H(PY\ 05)]}{[H(GP\ 15 \mid PY\ 05) * H(PY\ 05) + H(GP\ 15 \mid PY\ 01) * H(PY\ 01) + H(GP\ 15 \mid PY\ 08) * H(PY\ 08)]}$$

$$= \frac{[0.5 * 0.11]}{[(0.5 * 0.11) + (0 * 0.11) + (0 * 0.11)]}$$

$$= \frac{0.055}{0.055 + 0 + 0} = \frac{0.055}{0.055} = 1$$

$$H(PY\ 05 \mid GP\ 16) = \frac{[H(GP\ 16 \mid PY\ 05) * H(PY\ 05)]}{[H(GP\ 16 \mid PY\ 05) * H(PY\ 05) + H(GP\ 16 \mid PY\ 01) * H(PY\ 01) + H(GP\ 16 \mid PY\ 08) * H(PY\ 08)]}$$

$$\frac{[0.5 * 0.11]}{[(0.5 * 0.11) + (0 * 0.11) + (0 * 0.11)]}$$

$$= \frac{0.055}{0.055 + 0 + 0} = \frac{0.055}{0.055} = 1$$

$$H(PY\ 05 \mid GP\ 16) = \frac{[H(GP\ 17 \mid PY\ 05) * H(PY\ 05)]}{[H(GP\ 17 \mid PY\ 05) * H(PY\ 05) + H(GP\ 17 \mid PY\ 01) * H(PY\ 01) + H(GP\ 17 \mid PY\ 08) * H(PY\ 08)]}$$

$$\frac{[0.5 * 0.11]}{[(0.5 * 0.11) + (0 * 0.11) + (0.5 * 0.11)]}$$

$$= \frac{0.055}{0.055 + 0 + 0.055} = \frac{0.055}{0.11} = 0.5$$

The totaling Bayes' value of PY 05 = 0.33+1+1+0.5= 2.83 formula to (9)

- Then look for the percentage results of the predicted value with formula (4)

$$(PY01) = \frac{total\ bayes\ PY01}{total\ hasil} * 100\%$$

$$= \frac{2{,}83}{5{,}66} * 100\% = 50\%$$

The value of 3.99 is obtained from the total results = total bayes PY05 + PY01 + PY08. Amount result = 2.83+0.33+1+0.5= 5.66. Using the same formula, namely to (3) and to (4).

- Calculating percentage value.

TABLE VIII
PERCENTAGE VALUE

Probability Value Results	
Symptom	Total value
	4
Worms	50
Fever 3 Days	50
Nail Rot	50

$$Percentage = \frac{value\ bayes}{total\ value\ bayes} * 100\%$$

$$Worms = \frac{1}{2} * 100\% = 50\%$$

$$Fever\ 3\ days = \frac{1}{2} * 100\% = 50\%$$

$$Nail\ Rot = \frac{1}{2} * 100\% = 50\%$$

I. Result of Application of Method

Since implementing the methods above, using the forwards Bayes search chains theorem (BT P FC), we can conclude that there are 50% worms, 50% 3-day fever, and 50% nail Rot. Foot rot while the certainty factor search forward chaining (CF P FC) has a result of 99.84% 3-day fever. From the application of these methods, certainty factor having a score larger than Bayes' Theorem. For level to confidence in the results of this calculation, CF P FC is most suitable because the value obtained is very high compared to BT P FC.

III. RESULTS AND DISCUSSION

Evaluate provides very significant apps systems, valuable thought on how this bovine disease expert system was received. This evaluation is carried out using three types, which are the use of expert design tests, testing with users (breeders) of diagnostic accuracy test results. User interface tests were carried out for several people, namely Mrs. Nur Masmatin (breeders), Drg. Hari Naljum Camase and Drh. Fitri Setiyoningsih (experts in animals) used the system as they wanted. There is no response regarding the system when it is given, but the researcher is ready to receive questions from users (farmers). Experts answered 24 questions in 9 diseases where experts provided explanations for the attack of cattle diseases. Cases that often arise are cow worms, myiasis, nail rot. Diagnosis results based on the system can be seen clearly seen at Fig. 5 and Fig. 6.

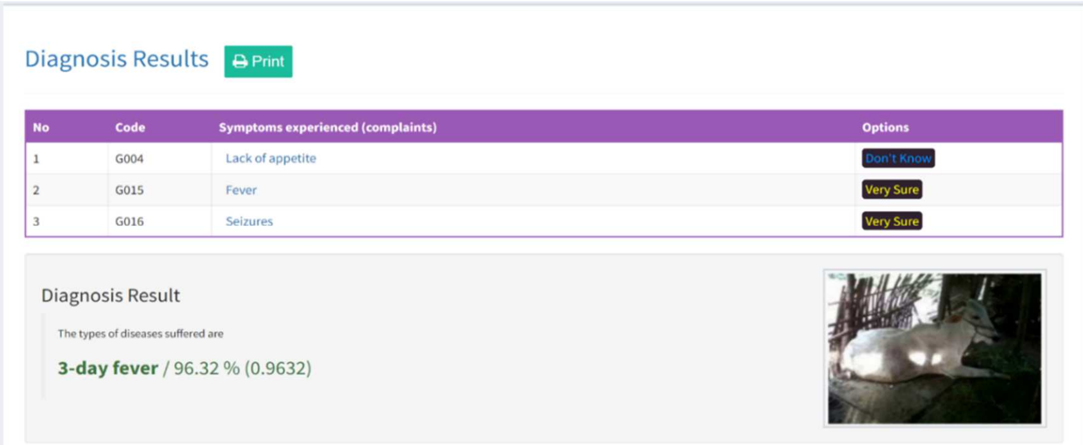

Fig 5 FC tracking CF system test results on calculations when tested by the system

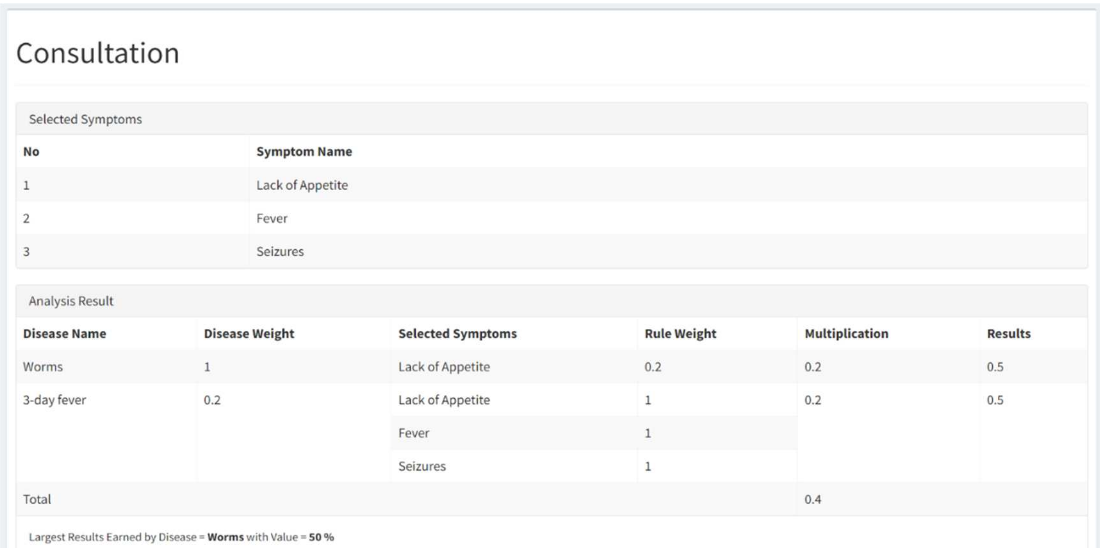

Fig 6 FC tracing BT system test results in calculations when tested through the system

A. Method Test Results

This section is the result of testing the system based on 10 cases. The researcher tries to make a table where between the FC tracing CF method and FC tracing method will get maximum results through the system. Seen in Table 9. Applications of the above with three methods, the most suitable search in this research is the certainty factor with forwards chaining (CF P FC) because, the probability value of CF P FC has the highest value while BT with forward chaining tracing techniques has a lower value, then CF P FC is the most suitable for the application of cattle disease consultation.

TABLE IX
APPLICATION OF METHODS

Diagnostic Results							
No	**Name**	**Symptom**	**Name Symptom**	**CF P FC (%)**	**Name Symptom**	**BT P FC (%)**	**Appropriate/ No**
1	Case 1	GP01, GP03, GP04	Worms	95.33	Worms	68.09	✓
2	Case 2	GP06, GP07, GP10	Myasis	87.04	Myasis	50	✓
3	Case 3	GP03, GP18, GP17	Salmonellosis	81.28	Worms	61.54	
4	Case 4	GP22, GP23, GP24	scabies	87.04	scabies	80	✓
5	Case 5	GP04, GP15, GP17	Fever 3 Days	87.27	Worms	81.63	×
6	Case 6	GP01, GP11, GP12	Coryza	72.96	Worms	50	×
7	Case 7	GP01, GP04, GP06	Worms	87.04	Myasis	52.63	×
8	Case 8	GP06, GP07, GP08	Myasis	87.04	Myasis	80	✓
9	Case 9	GP07, GP13, GP15	Myasis	64	Myasis	44.44	✓
10	Case 10	GP15, GP16, GP17	Fever 3 Days	81.28	Fever 3 Days	66.67	✓
11	Case 11	GP03, GP04, GP08, GP15	Worms	87.04	Worms	31.37	✓
12	Case 12	GP04, GP15, GP16	Fever 3 Days	97.28	Fever 3 Days	57.14	✓
13	Case 13	GP01, GP05, GP13	Worms	64	Worms	33.33	✓
14	Case 14	GP09, GP22, GP23	Bloody stools/ Diarrhea	64	Bloody stools/ Diarrhea	44.44	✓
15	Case 15	GP18, GP19, GP20	Salmonellosis	81.28	Salmonellosis	50	✓

B. System Consultation Results

After applying the calculations using the Certainty Factor method for Forward Chaining tracing and Bayes theorem for Forward Chaining tracing, the next step is the process of determining the most appropriate and good method for diagnosing diseases in cattle. Thus, based on the calculation method applied concluded below:

- The results of the application with Certainty Factor of Forward Chaining searches that were selected were worms 96.32, while Bayes' Theorem of Forward Chaining searches got 57.14 as shown in Figures 5 and 6. From these test results, Certainty Factor of Forward Chaining searches have the highest probability compared to Bayes' Theorem searches. Forward Chaining.
- The stage of calculating the level of certainty with Certainty Factor tracing Forward Chaining and Bayes theorem Forward Chaining tracing for data more than 2 evidence, must be repeated several times when processing the calculation of the search combination.

IV. CONCLUSION

Based on discussion of the results linked to application Obtained method Certainty Factor of Forward Chaining search and Bayes Theorem of Forward Chaining search that has been stated, the following conclusions are obtained: The results based on manual calculations can be seen that Certainty Factor search Forward Chaining is a method that has an uncertainty value of 99.84% for a 3-day fever while with Bayes Theorem search Forward Chaining with a value of 50% for worms, 50% 3-day fever and 50% for rotten nails. With application of calculations on these methods, the Certainty Factor search Forward Chaining method is most suitable for use in diagnosing cattle diseases. However, there is also a need to update the knowledge base from time to time. So that in the future it can be juxtaposed with other Android-based methods to facilitate farmers.

ACKNOWLEDGMENT

Thanks for being an inspiration so far. For parents and friends and loved ones who always support this research.

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