An Expert System For Diagnosing Sugarcane Diseases

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Abstract— Sugarcane is one of the most important crops in the world, growing in tropical and subtropical conditions. The crop is economically important due to its industrial potential in terms of products such as crystalline white sugar. Sugarcane is a long-term crop of 10-18 months but diseases are the main concern of Sugarcane, responsible for low yield. The aim is to diagnose diseases in a timely manner to reduce losses. In this research, we proposed an expert system for the diagnosis of sugarcane diseases using CLIPS and Delphi languages and it was tested by a group of farmers interested in producing sugarcane crops and found it to be very useful. The Expert System is of generic nature and can be used in other crop environment with changes in the knowledge base.

Keywords— Sugarcane, Clips, Expert system, diseases

1. INTRODUCTION

Sugarcane is a tall tropical perennial grass that grows to between 2-4m high. Sugarcane is used to produce a range of food products including sugar, molasses, and golden syrup. The biofuel ethanol can also be produced from sugarcane which can be used as a fuel for vehicles in its pure form but is usually blended with gasoline to improve vehicle emissions [1].

Sugarcane is propagated primarily by the planting of cuttings. The sections of the stalk of immature cane used for planting are known as seed cane, or cane sets, and have two or more buds (eyes), usually three. Seed cane is planted in well-worked fields. Mechanical planters that open the furrow, fertilize, drop the seed cane, and cover it with soil are widely used [2].

Seed cane is spaced 1.4 to 1.8 meters (4.5 to 6 feet) apart at densities 10,000 to 25,000 per hectare (4,000 to 10,000 per acre). Under favorable conditions, each bud germinates and produces a primary shoot. Root bands adjacent to each bud give rise to a large number of roots, and each young shoot develops its own root system. Tillering, or sprouting at the base of the plant, takes place, and each original seed cane develops into a number of growing canes, forming a stool. The plant crop is obtained from these stools [3].

Agricultural crops need awareness among farmers of the latest technological developments of great interest in producing agricultural crops to save the time, effort and money needed to call experts to solve problems and find the causes of the spread of diseases in agricultural crops. An Expert System is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution.

Presently, sugarcane is also looked upon as a feed stock for biofuels and would be one of the major sources of energy for the future(See Fig. 1 and Fig. 2 for sugarcane). Diseases are a major constraint affecting the sugarcane productivity world-wide, which can be broadly classified as fungal, bacterial and viral [3].

Fig. 1: The figure shows the sugarcane field [2]

Fig. 2: The figure shows sugarcane fruit [4]

1.1 BENEFITS SUGAR CANE

Sugar cane juice has a number of health benefits [4]:

- **Improve the Immune System**

  A rich source of minerals, vitamins, and such nutrients as chlorophyll, antioxidants, protein, fiber, and more, sugar cane helps build up the immunity. It prevents cancer, stabilizes blood sugar levels, reduces fever and convulsions, purifies kidneys and rejuvenates all body organs, including eyes and brain.

- **Prevent Tooth Decay**

  As it contains lots of minerals, sugar cane juice fights tooth decay and helps eliminate the bad breath.

- **Help Treat Jaundice**

  Sugar cane is an effective remedy for jaundice. People with jaundice should drink daily two glasses of sugar cane juice with lemon and salt added in it. This drink also boosts energy, so you will stay up all day without feeling tired.

- **Cure Flu and Sore Throat**

  A glass of sugar cane juice daily helps prevent catching flu, colds, and cures sore throat.

- **Provide Antioxidants**

  Sugar cane juice contains lots of flavonoids and phenolic substances. They possess anti-allergic, anti-inflammatory, antiviral and anticancer properties.

- **Moisturize the Body**

  Drink sugar cane juice in hot summer days to quench the thirst and keep your body hydrated.

- **Prevent Kidney Stones**

  As sugar cane juice is an excellent body moisturizer it is great at preventing and eliminating kidney stones. Scientists proved that dehydration is the primary cause of kidney stone formation.

2. ARCHITECTURE OF AN EXPERT SYSTEM

An Expert System is a computer program that possesses or represents knowledge in a particular domain, has the capability of processing manipulating or reasoning with this knowledge with a view to solving a problem, giving some achieving or to achieve some specific goal [5].
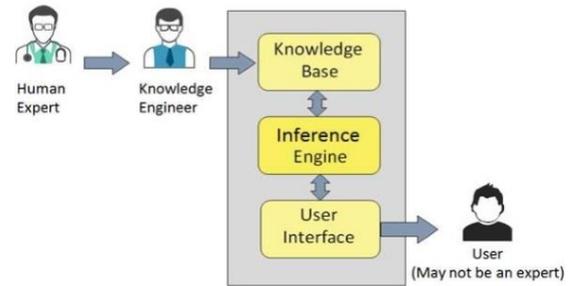

Fig. 3: The figure shows the Expert System component [5]

2.1 THE CORE COMPONENTS OF EXPERT SYSTEMS:

Expert System Component consists of (See Fig. 3):

- **Knowledge Base:**

  It contains facts and heuristic knowledge [6-8].

- **Knowledge Acquisition Subsystem:**

  The process of capturing and transformation of potentially useful information for given problems from any knowledge source (this may be a human expert) to a program in the format required by that program is the job of a knowledge acquisition subsystem. So we can say that this subsystem to help experts build knowledge base [9-11].

- **Explanation Subsystem:**

  An explanation subsystem allows the program to explain its reasoning to the user. The explanation can range from how the final or intermediate solutions were arrived at to justifying the need for additional data [12-13].

- **Inference Engine:**

  An inference engine is used to perform reasoning with both the expert knowledge which is extracted from an expert and most commonly a human expert and which is specified to the problem being solved [14-15].

- **User Interface:**

  It is used to communicate with the user. It basically keeps input from the user for better intelligence and observes all basic human requirements and usable those in future [16-17].

2.2 PROPERTIES OF EXPERT SYSTEMS

- It tries to simulate human reasoning capability about a specific domain.
- It performs reasoning over the acquired knowledge.
- It can solve problems by using heuristic or approximate models [18-20].

3. MATERIALS AND METHODS

The proposed expert system performs diagnosis for ten Sugarcane diseases as shown in Fig. 4, Fig. 5, and Fig. 6. The proposed expert system will ask the user to choose the correct Symptoms of Sugarcane disease in each screen. At the end of the dialogue session, the proposed expert system provides the diagnosis and recommendation of the disease to the user.
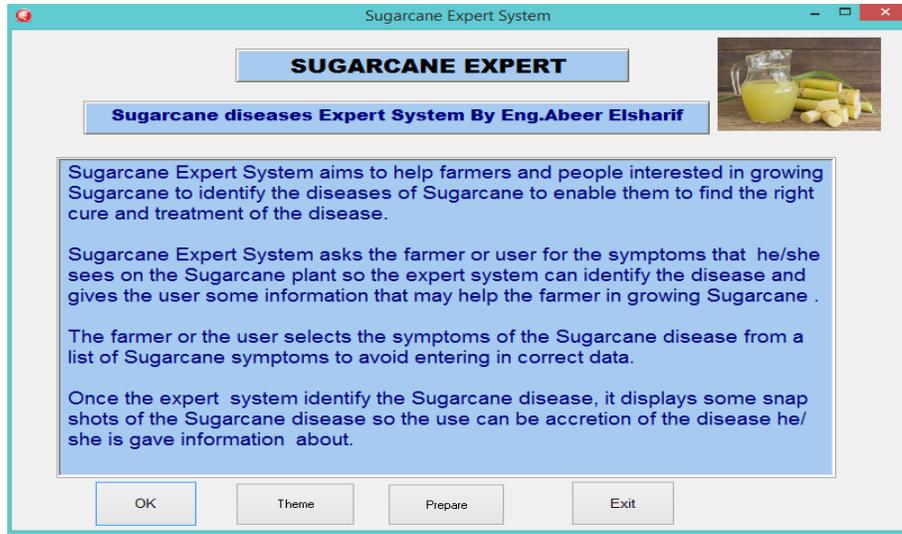

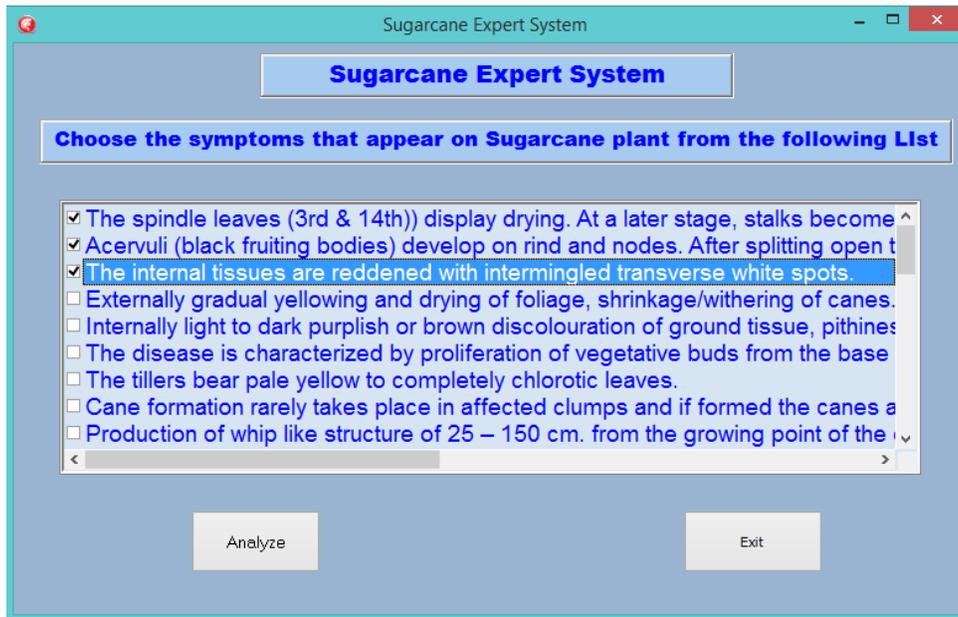Fig. 4: The figure shows **the** sugarcane expert system

Fig. 5: The figure shows a sample dialogue between the expert system and the user.
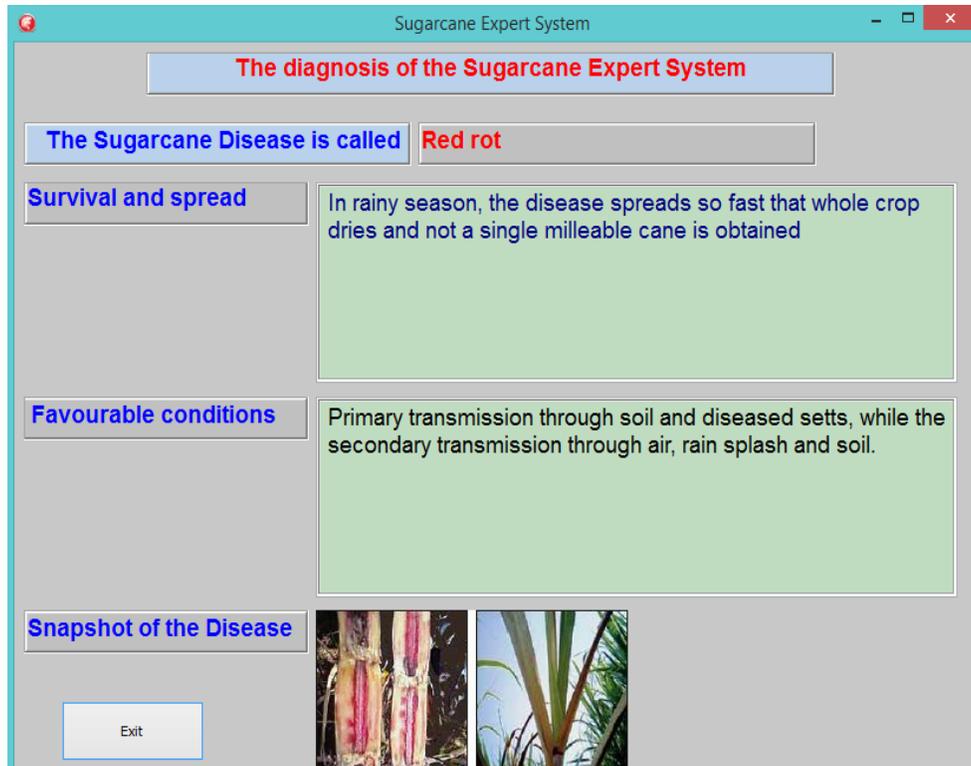
Fig. 6: The figure shows how the users get the diagnosis and recommendation

4. LITERATURE REVIEW

There are many expert systems that are designed to diagnose human health problems [21-22], plant and trees problem like: general plant [5], mango trees[6], Black pepper trees [7], banana trees [8, 23] onion plants [14], potato plants [20], Pineapple trees[3], watermelon [25] and other kinds of diseases. But there is no specialized expert system for diagnosing Sugarcane diseases available for free. Although many plant diseases have common symptoms. The proposed expert system was developed specifically to help farmers diagnose Sugarcane diseases.

5. KNOWLEDGE REPRESENTATION

The main sources of knowledge for expert systems either from an expert in the field of agriculture or a website specialized in sugarcane diseases, these sources are transferred to CLIPS knowledge as facts and rules. There are currently in the expert system a number of rules that help to treat ten diseases of sugarcane [4]:

5.1 RED ROT

Disease symptoms

- The spindle leaves (3rd & 14th)) display drying. At a later stage, stalks become discolored and hollow.
- Acervuli (black fruiting bodies) develop on rind and Fig. 7: The figure shows Red rot

- Nodes. After splitting open the diseased stalk, a sour smell emanates.
- The internal tissues are reddened with intermingled transverse white spots.

Fig. 7: The figure shows Red rot

5.2 WILT

Disease symptoms

- Externally gradual yellowing and drying of foliage, shrinkage/withering of canes.
- Internally light to dark purplish or brown discoloration of ground tissue, pithiness and boat shaped cavities in the middle of the internodes (as shown in Fig. 8).

Fig. 8: The figure shows Wilt

5.3 GRASSY SHOOT

Disease symptoms

- The disease is characterized by proliferation of vegetative buds from the base of the cane giving rise to a crowded bunch of tillers bearing narrow leaves.
  The tillers bear pale yellow to completely chlorotic leaves.
- Cane formation rarely takes place
- In affected clump and if formed the canes are thin with short internodes (as shown in Fig. 9).

Fig. 9: The figure shows Grassy shoot

5.4 SMUT

Disease symptoms

- Production of whip-like structure of 25 – 150 cm. from the growing point of the canes.
- Whip covered by translucent silvery membrane enclosing mass of black powdery spores.
- Initial thin canes with elongated internodes later become reduced in length (as shown in Fig. 10).

Fig. 10: The figure shows Smut

5.5 LEAF SCALD DISEASE

Disease symptoms

- The disease can be latent, it can develop unseen for some time and when symptoms first appear, the plant is already seriously infected.
- The first sign of the disease is the development of "pencil lines" of white with yellow borders following
- the veins on the leaf that lead to necrosis (death) of tissue.
- The term "scald" for the disease comes from areas of the leaf that loose their color and become a pale green (chlorotic) as they fail to produce chloroplasts (as shown in Fig. 11).

Fig. 11: The figure shows leaf scale

5.6 RED STRIPED DISEASE

Disease symptoms

- Red stripe is characterized by the appearance on the leaves of chlorotic lesions carrying dark red stripes 0.5-1.0 mm in breadth and several mm in length, either distributed all over the blade, or concentrated in the middle
- Several of them may coalesce to cover large areas of the leaf blade, and to cause wilting and drying of the leaves.
- Whitish flakes occur on the lower surface of the leaf, corresponding to the red lesions on the upper surface.
- These flakes are the dry bacterial ooze. When young shoots are affected, shoot or top rot may result. The growing points of the shoot are yellow and later reddish with dark brown stripes on the shoots.
- If the affected plants are cut by splitting the shoot downwards, dark red discoloration of the tissues may be seen.

- In the affected canes cavities may form in the pith region, and the vascular bundles are distinct because of the dark red discoloration (as shown in Fig. 12).

Fig. 12: The figure shows Red striped

5.7 MOSAIC DISEASE

Disease symptoms

- Young leaves of the crown held against the light source display chlorotic and normal green area imparting mosaic pattern.
- The chlorotic area may show reddening or necrosis.
- Leaf sheath may also display such symptoms (as shown in Fig. 13).

Fig. 13: The figure shows Mosaic

5.8 POKKAHBOENG
Disease symptoms

The general symptoms of Pokkahboeng are mainly;

- Chlorotic Phase: The earliest symptom of Pokkahboeng is a chlorotic condition towards the base of the young leaves and occasionally on the other parts of the leaf blades.
- Frequently, a pronounced wrinkling, twisting, and shortening of the leaves accompanied the malformation or distortion of the young leaves. The base of the affected leaves is seen often narrower than that of the normal leaves..

- Acute Phase or Top-Rot Phase: The most advanced and serious stage of Pokkahboeng is a top rot phase. The young spindles are killed and the entire top dies.
- Leaf infection sometimes continued to downward and penetrates in the stalk by way of a growing point. In the advanced stage of infection, the entire base of the spindle and even growing point showed a malformation of leaves, pronounced wrinkling, twisting and rotting of spindle leaves. Red specks and stripes also developed.
- Knife-cut Phase (associate with top rot phase): The symptoms of knife-cut stage are observed in association with the acute phase of the disease characterized by one or two or even more transverse cuts in the rind of the stalk /stem in such a uniform manner as if, the tissues are removed with a sharp knife, This is an exaggerated stage of a typical ladder lesion of a Pokkahboeng disease (as shown in Fig. 14).
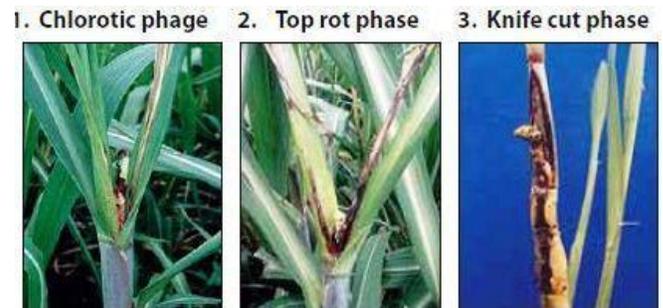

Fig. 14: The figure shows pokkahboeng

5.9 RUST
Disease symptoms

- The earliest symptoms of common rust on the leaves are small, elongated yellowish spots which are visible on both the surfaces.
- These spots increase in size, mainly in length, and turn red-brown to brown in color. A narrow, pale yellow-green halo develops around the lesions.
- When the common rust is severe, numerous lesions occur on individual leaves giving them an overall brown or rusty appearance. These lesions coalesce to form large, irregular necrotic areas is usually result in premature death of the leaf. In such cases, the number of live leaves per plant can be seriously reduced (as shown in Fig. 15).

Fig. 15: The figure shows Rust

5.10 SUGARCANE YELLOW LEAF DISEASE
Disease symptoms

- Symptoms of SCYLD are yellowing of the leaf midrib on the underside of the leaf. The yellowing first appears on leaves 3 to 6 counting down from the top expanding spindle leaf.
- Initial symptoms of yellow leaf, with a yellowing of the lower surface of the leaf midrib of leaves 3 to 6 counting from the top expanding spindle leaf.
- Yellowing is most prevalent and noticeable in mature cane from October until the end of harvest in March.
- The yellowing expands out from the leaf midrib into the leaf blade as the season progresses until a general yellowing of the leaves can be observed from a distance (as shown in Fig. 16).

Fig. 16: The figure shows yellow leaf

6. LIMITATIONS

The current proposed expert system is specialized in the diagnosis of the ten Sugarcane diseases: Red rot, Wilt, Grassy shoot, Smut, Leaf scald disease, Red striped disease, Mosaic disease, Pokkahboeng, Rust and Sugarcane yellow leaf disease.

7. SYSTEM EVALUATION

As an initial evaluation, engineering students and other interested people in sugarcane production, farmers, and agriculture instructors tested this proposed system. They were asked to evaluate the following features of the proposed system:

- Is the expert system able to diagnose sugarcane crop disorder efficiently and accurately?
- Is the user screen informative enough in using the expert system?
- Is the expert system easy to use?
- Is the layout of contents is perfectly designed to find information?
- Are the screen colors good enough to work with an expert system?

8. CONCLUSION AND FUTURE WORK

In this paper, a proposed expert system was introduced to assist agricultural engineers and farmers to treat plants with ten different sugarcane diseases. Agricultural engineers and farmers can get a faster and more accurate diagnosis than traditional diagnosis. This expert system does not require extensive training to use; it's easy to use and has an easy to use interface. It was developed using the CLIPS and Delphi languages. CLIPS language with integrated with Delphi Language to have a better user interface. In a preliminary evaluation of the proposed expert system, was introduced to a group of farmers, agricultural engineers, interested people in farming to use it and give us feedback about its content, ease of use, value, and simplicity. The result of the evaluation was very promising.

In addition, this method can be used to develop expert systems in other agricultural crops to reduce dependence on human experts to save time, effort and money.

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