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# FUZZY PROLOG RULES IN KNOWLEDGE BASED DIAGNOSIS OF NUTRIENT DEFICIENCY IN SUGARCANE CROP

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Abstract: This paper presents the knowledge based diagnosis of nutrient deficiency observed in sugarcane crop using fuzzy prolog rules. Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. For the adequate growth of sugarcane crop, nutrients are required. It assists or guides the farmers, experts, counselors in agricultural field to find out nutrient deficiency on the basis of symptoms appeared on the leaves of sugarcane crop using fuzzy prolog rules.

Keywords: Fuzzy Prolog, Knowledge Based Diagnosis, Nutrient Deficiency.

## 1. Introduction:

Prolog (PROgramming in LOGic) is one of the major AI language. It is simple, powerful, declarative symbolic language based on predicate logic. Prolog is particularly suitable when a problem is expressed in form of logic (for e.g. if q and r then p), or a problem is goal-oriented (for e.g. to satisfy p, satisfy q and r). Fuzzy logic rules provide a basis for both capturing imprecise knowledge and performing approximate reasoning. Fuzzy logic or expert systems consider fuzziness in terms of fuzzy implication and a generalization of two or finitely- valued logic, fuzzy control systems aim reproducing the behavior of intuitive control rule groups by computing with fuzzy sets (See Turunen 1999; Jang & Sun 1997).

In agriculture field, farmers face difficulties in diagnosis the proper nutrient deficiency in sugarcane crop. Diagnosis may be done by doing soil testing or by observing symptoms appeared on the leaves of sugarcane crop. Nutrients are mainly classified into three types such as

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a) Primary Nutrients:- Nitrogen, Phosphorus and Potassium are primary nutrients.
b) Secondary Nutrients:- Calcium, Magnesium and Sulfur are secondary nutrients.
c) Micronutrients:-Iron, Manganese, Molybdenum, Boron, copper and Zinc are micronutrients.

Carbons, Oxygen & Hydrogen are essential elements for plant growth. They are supplied by air and water i.e. they are easily available in surrounding. Therefore they are not treated as nutrients by the fertilizer industries. The main aim of fertilizer industry is to provide the primary and secondary nutrients which are required in macro quantities.

This study deals with the diagnosis of nutrient deficiency by observing symptoms appeared on the leaves of sugarcane crop. The main aim of the study is to offer the decision support system to identify deficient nutrients in sugarcane crop. However, the decision support should be knowledge-oriented to improve effectiveness of the decision made. Knowledge-oriented decision making helps in identifying most plausible diagnosis. This type of knowledge based system will be an efficient means to store and to pass experts knowledge in documental form for long time and it can provide advice to farmers at every stage of sugarcane crop. The research paper includes Knowledge-oriented approach, structure of the system and an illustrative case.

## 2. Knowledge-Oriented Approach:

A knowledge base is a special kind of database for knowledge management, providing the means for the computerized collection, organization, and retrieval of knowledge. Also collection of data representing related experience and results are related to their problems and solutions.

“Agriculture is backbone of Indian “said Mahatma Gandhi, six decade ago. Also agriculture was key in rise of sedentary human civilization. Today India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and logging accounted for 16.6% of GDP in 2007, employed 52% of the total workforce. Today more than 60% of peoples are living in villages and most of them are farmers. Considering the farmers, maximum yield is one of their goals. Government of India provides Statutory Minimum Price to Sugarcane.

Knowledge base system can be used to make decisions at different levels in agriculture: “Operation Level and Planning Level. On Operation Level, the extension workers in the villages, districts and /or Governorate can use the system to support him in making his decision in giving appropriate advice to growers (farmers). On the Planning level, the decision makers can use system who predicates need of fertilizers. (Rafea, 1996). Knowledge base system can be used as training tool because of its explanation facility which provides reasoning which is important as a training tool for new personnel. Since it combines a lot of knowledge of so many experts at

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one point. “By helping people to consider all of the relevant information and by assimilating this information into an understandable format, KBS assists people in making of environmentally sound and economically viable for farm management decision” (Robinson, 1996). Knowledge base system uses Artificial Intelligence techniques for efficient and effective decision making in unstructured domain and apply reasoning and explanation facility for the domain problem to achieve high level of performance.

The knowledge of the expert in the decision making can be represented in various forms. It can be easily represented into rule based format as a set of conditional rules. Considering the uncertainty of the diagnosing process, the fuzzy rules are used here. To accommodate such fuzziness, typical prolog rule format is modified. Each rule has a basic form-

*IF antecedents THEN consequent*

## 3. Structure of the System:

The model of the discussed system is shown in figure-1, which represents the overall process structure of knowledge base system for diagnosis of nutrient deficiency. The various components of the system are Case specific database, knowledge base, inference engine and knowledge acquisition system. Knowledge base stores the domain knowledge. Case specific database exists data about the appearance of sugarcane crop and in detail information of symptoms. Inference engine is a set of program, which represent as a problem solving model. It uses the rules in the knowledge base and situation specific knowledge in the working memory, to solve problems. It is program part of expert system. It accepts facts from user, searches these facts through rule base and finds the final results.

If certain antecedents are evaluated as true, then it logically follows the consequent. As denoted above, the modified Prolog rule format is

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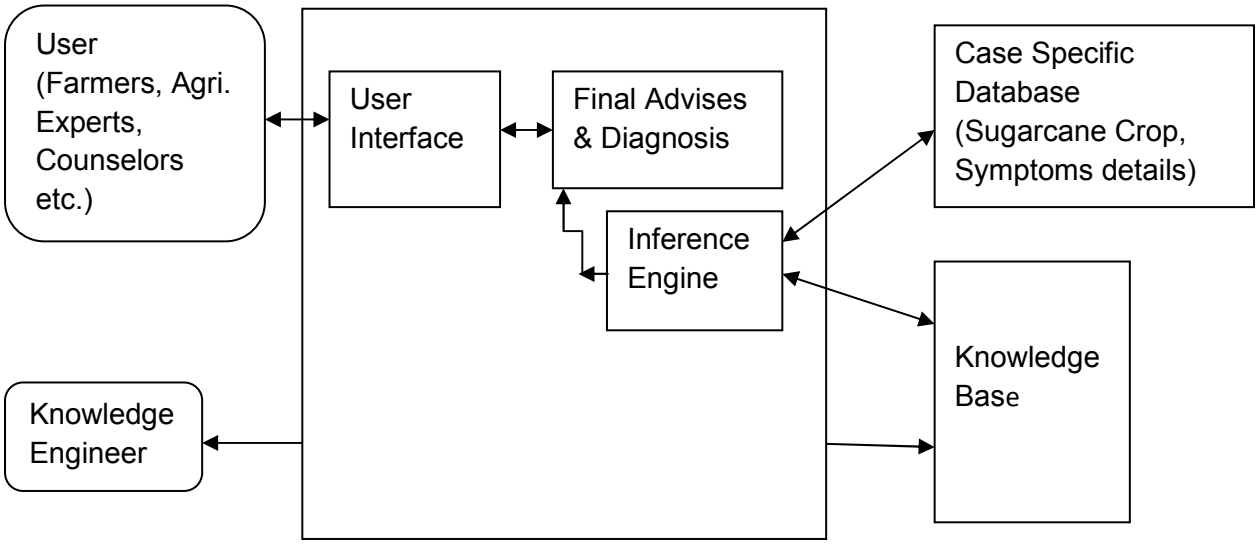


Fig. 1 Structure of the system

Hypothesis (Name of crop, Name of Deficient Nutrient, Probability);

Symptom (Indication, Probability);

Symptom (Indication, Probability);

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Symptom (Indication, Probability);

Here hypothesis and symptoms are user defined predicates in prolog. These predicates use symbols (variables) like Name (crop name), Nutrient name and probability (Chances in percentage). Probability factors given along with the rules for the concerned advices are considered as the degrees of uncertainty related with the decision taken. These values are considered by taking samples from experts. The hypothesis proved true if sugarcane crop has all indications (symptoms) given in symptom lists. So such multiple fuzzy rules are exists in system knowledge base, which represents the domain knowledge in the form of prolog code.

## 4. An Illustrative Case of a Nutrient Deficiency Problem

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In this system, interactive sample rules are proposed, that can directly guide to farmers in finding the probability of deficient nutrients in sugarcane crop. The system prepares data by asking several questions and predicts the probability of having deficient nutrient.

4.1 Sample Rules for the Above Case

Sample rules in modified prolog for the prototype implementation of the system are given as follows:

**R1** Hypothesis (Sugarcane crop, Nitrogen Deficiency, 1.0):-

Symptom (Yellow green colored leaves, 0.7) (NS1) Or

Symptom (Shortening of internodes, 0.8) (NS2) Or

Symptom (Reduction in growth, 1.0) (NS3) Or

Symptom (Premature drying of older leaves, 0.7) (NS4) Or

Symptom (Long hairy root system, 0.7) (NS5).

**R2** Hypothesis (Sugarcane crop, Phosphorus Deficiency, 1.0):-

Symptom (Length and diameter of cane stalk or stems is reduced resulting in short & slender stalks that tappers rapidly at the growing point, 0.7) (PS1)Or

Symptom (Tillering is affected adversely, 0.8) (PS2) Or

Symptom (The leaves turn to greenish blue, 0.7) (PS3) Or

Symptom (The leaves remain narrow and somewhat reduced in length, 0.7) (PS4) Or

Symptom (Shoot or root ratio is decreased considerably, 0.8) (PS5).

**R3** Hypothesis (Sugarcane crop, Potassium Deficiency, 1.0):-

Symptom (Plant shows depressed growth yellowing and spotting of older leaves & development of slender stalks, 0.8) (KS1) Or

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Symptom (Yellowing of young leaves starts at the base of the blade and taper towards tip, 0.9) (KS2) Or

Symptom (The older leaves turn orange and later brown, 0.7) (KS3) Or

Symptom (The leaves will start die-back from the margin and tips, 0.8) (KS4).

**R4** Hypothesis (Sugarcane crop, Calcium Deficiency, 1.0):-

Symptom (Older leaves may have rusty appearance and may die prematurely, 1.0) (CaS1) Or

Symptom (Spindles often become necrotic at the leaf tip & along margins, 0.7) (CaS2) Or

Symptom (Immature leaves are distorted and necrotic, 0.8) (CaS3).

**R5** Hypothesis (Sugarcane crop, Magnesium Deficiency, 1.0):-

Symptom (The symptoms appear on the older leaves & later change into brown, 0.8) (MgS1)Or

Symptom (Red necrotic lesions result in a “rusty” appearance, 0.9) (MgS2) Or

Symptom (The “rusty” appearance can spread across all leaves & may result in premature dropping of older leaves, 0.7) (MgS3)Or

Symptom (The stems/stalks become shorter and severely “rusted” & brown, 0.7) (MgS4).

**R6** Hypothesis (Sugarcane crop, Sulfur Deficiency, 1.0):-

Symptom (Leaf tips and margins may become necrotic within 3 to 7 days after $SO_2$ exposure, 0.7) (SS1) Or

Symptom (Leaves are narrower & shorter than normal, 0.8) (SS2) Or

Symptom (Stem or Stalk are slender, 0.8) (SS3).

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**R7** Hypothesis (Sugarcane crop, Iron Deficiency, 1.0):-

Symptom (The normal green color disappears between the vascular bundle (Veins) and such pale strips extend the entire length of the leaf blade, 0.9) (FeS).

**R8** Hypothesis (Sugarcane crop, Manganese Deficiency, 1.0):-

Symptom (Pale-yellowish, green, longitudinal strips which alternate with normal green color, 0.9) (MnS1) Or

Symptom (The entire leaf becomes bleached, 0.7) (MnS2) Or

Symptom (Interveinal chlorosis occurs from the leaf tip toward the middle of the leaf, 0.9) (MnS3).

**R9** Hypothesis (Sugarcane crop, Molybdenum Deficiency, 1.0):-

Symptom (Short longitudinal chlorotic streaks on the apical one-third of the leaf, 0.9) (MoS).

**R10** Hypothesis (Sugarcane crop, Boron Deficiency, 1.0):-

Symptom (Boron deficient plants have distorted leaves, particularly along the leaf margins on immature leaves, 0.9) (BS1) Or

Symptom (Apical meristem may die, 0.8) (BS2) Or

Symptom (Translucent lesions (“Water Sacks”) along leaf margins occur, 0.8) (BS3) Or

Symptom (Young sugarcane plants tend to be brittle & bunched with many tillers, 0.9) (BS4).

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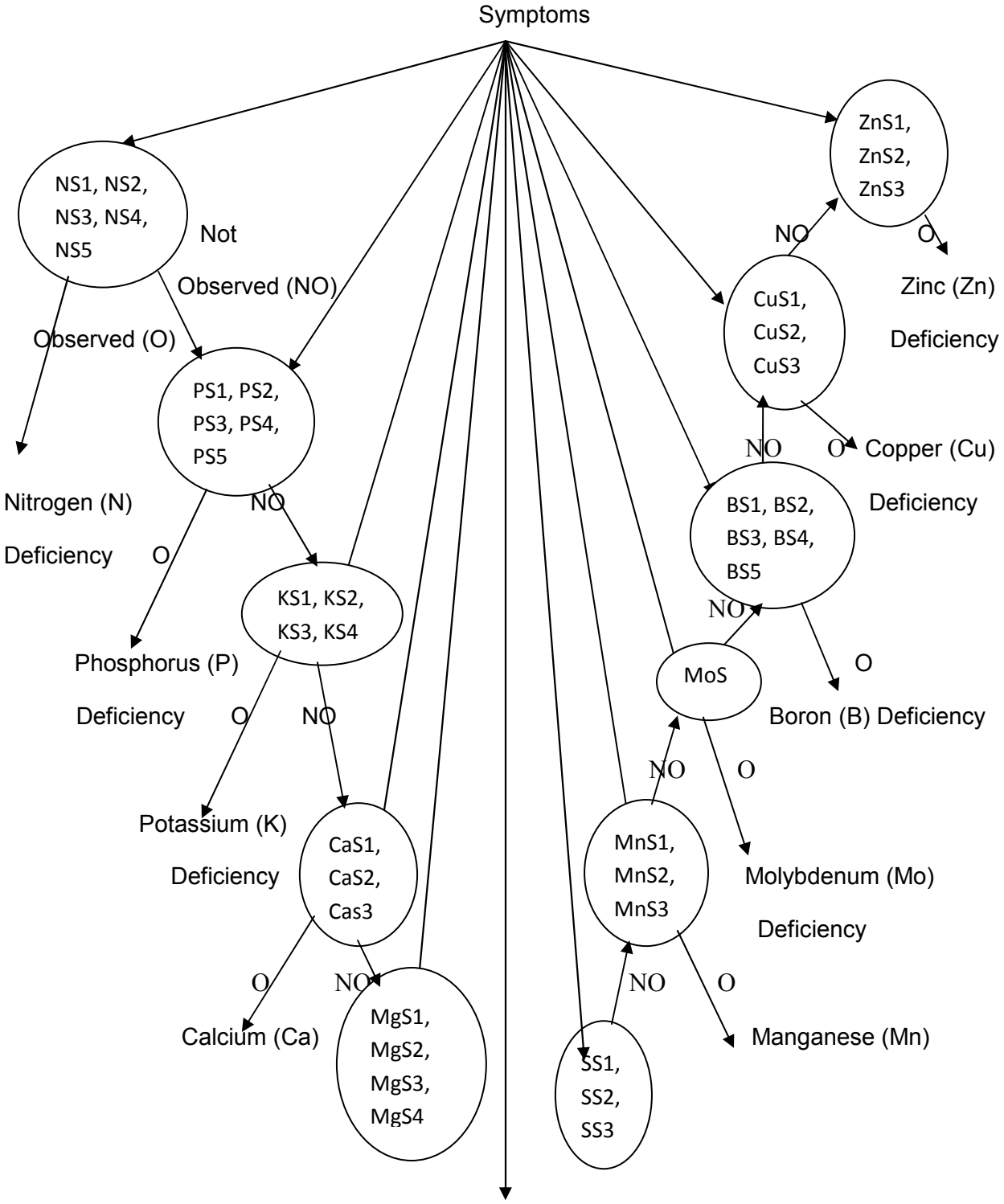

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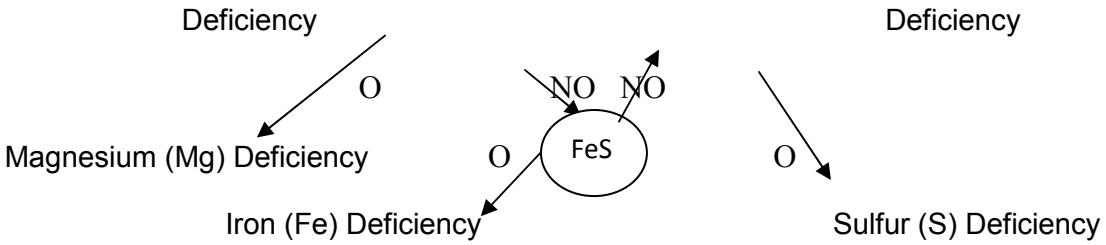


Fig. 2 A decision tree

Or

Symptom (Leaf margins become chlorotic, 0.7) (BS5).

**R11** Hypothesis (Sugarcane crop, Copper Deficiency, 1.0):-

Symptom (Green splotches are an early symptom, 0.9) (CuS1)Or

Symptom (Apical meristems remain alive, but internodes elongation will be reduced, 0.9)

(CuS2) Or

Symptom (General vigor and tillering are reduced, 0.8) (CuS3).

**R12** Hypothesis (Sugarcane crop, Zinc Deficiency, 1.0):-

Symptom (A broad band of yellowing in the leaf margin occurs, 0.8) (ZnS1) Or

Symptom (The midrib and leaf margins remain green except when the deficiency is severe, 0.9)

(ZnS2) Or

Symptom (Red lesions are often noticed, 0.8) (ZnS3).

As stated above, to form a rule base for the application, the knowledge collected from the field expert is codified in the Prolog language. These rules are sequentially executed to

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come to a conclusion or diagnosis. If the above mentioned symptoms match, the hypothesis of having certain nutrient deficiency is true to some extent. For example, in Rule 1 (R1) after observing sugarcane crop, if one or more symptoms like Yellow green colored leaves, shortening of internodes, Reduction in growth etc are observed then Nitrogen deficiency with 100% probability is observed. In this way all rules will be checked sequentially and test results in the symptom and conclude the probability of having certain nutrient deficiency.

As shown in fig. 2 multiple rules can be developed and are represented in the form of decision tree. For structured decision making, all symptoms are divided into groups. And individual group of symptoms is observed to find out particular nutrient deficiency. If leaves of sugarcane crop show such group of symptoms then it indicates that, the sugarcane crop suffering from certain nutrient deficiencies.

## 5. Conclusion

This research paper is purely based on the observation of appearance of sugarcane crop. No specific tests have been conducted to confirm any symptom.

Using the proposed design one may go for the diagnosing and advisory systems in different domain. This type of system can be proved an efficient means to store and pass experts knowledge in documental form for long time. Hence it can be used as a training and documentation too also.

## References

[1] Priti Srinivas Sajja, Dipti M Shah, *Knowledge based diagnosis of abdomen pain using Fuzzy Prolog Rules,* Journal of Emerging Trends in Computing & Information Services, 2010.

[2] Toshinori Munakata, *Notes on implementing Fuzzy sets in Prolog,* Fuzzy Sets and System, 1998.

[3] Ossi Nykanen, *An Approach to Logic Programming with Type-1 Fuzzy Models Using Prolog,* IADIS International Conference Applied Computing 2006.

[4] )*"Modern Irrigation and Fertigation Methodologies for Higher Yields in Sugarcane"* Published By Jain Irrigation Systems Ltd Jalgaon Maharashtra India.