EXPERT SYSTEM FOR SOIL MACRONUTRIENT RECOMMENDATION

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Abstract: In the agriculture system plant growth is relies on 16 essential nutrients which are present in the soil. Plant growth depends on balance nutrient level and that level was obtained by soil testing. Based on the nutrients level laboratory recommends the amount and type of fertilizers. Over the decade's several sensor techniques are developed and used for in-field soil measurement. The Exactitude of the in-field detection is low compares to standard laboratory testing methods. In the agriculture accuracy and robustness of sensors are influenced by several physical and environmental factors. The complexity and uncertainty of the system affect decision-making in the in-field measurement techniques. Using exclusive technical monitoring methods to collect the required information could increase the monitoring cost. In order to minimize the cost and to address the scale issue, the blend of the technical and local knowledge is proposed in this work. This paper intends to calculate the required amount of macronutrient level of the soil using the fuzzy expert system and the proposed work is designed with Fuzzy Inference System [FIS] tool in MATLAB platform.

Keywords: Agriculture, Soil Nutrients, Soil fertility Ratings, Expert System, MATLAB FIS Tool.

1. INTRODUCTION

The goal of precision agriculture is revenue maximization, reduce environmental degradation, and agriculture cost reduction by utilizing the proper usage of fertilizers, pesticides and herbicides. Decision-making is the vital property of precision agriculture. Sound expertise, reliable information and precise data are essential for good environmental decision making system. Decision-making technique can be implemented using an expert system. An Expert system is artificial intelligent based computer program, it emulating the decision-making ability of the human expert. At the mid of 1970's expert system are started to apply in agriculture domain. Over the three decades of development expert system applications are spread in soil preparation, seed selection, pest management, fertilizer management, weed and irrigation control and nutrient management. The Fuzzy expert system is a collection of membership function and rules that are used reason about data, recently it was applied in various agriculture activities. Unlike conventional expert system is symbolic reasoning, a fuzzy expert system is originated towards numerical reasoning. The fuzzy expert systems handle the uncertainty and ambiguous data in agriculture domain. Several researchers have developed the fuzzy based expert system in different agriculture platform. The comparison made between the traditional control system vs. fuzzy logic control in greenhouse environment. In fuzzy based control approach allows the human expert knowledge in computer based control via a fuzzy inference system. An expert system was simulated by FIS GUI tool in MATLAB platform. The input variables are Air temperature, relative humidity, CO2, growth stage of the plant. Heating, ventilation, CO2 dosing system and irrigation system are taken as an output variable [1]. The expert system based pest management approach was developed to help to resolve the pest related problem in soybean farming. The aim of SOYPEST is to provide the knowledge about pest management to the farmers through the web services. This expert system has been used to increase the crop yield in different states in India [2]. This author developed pest control in groundnut using fuzzy based expert system. The system was split into two parts. The first section is to identify various symptoms and insects and the second part is used to identify actual problem and suggest corresponding control measure [3]. The author proposed on fuzzy logic-based decision support technique for apple grading. Grading results obtained from FL showed a good general agreement with the results from the human expert, providing good flexibility in reflecting the expert's expectations and grading standards into the results. It was also seen that colour, defects and

size are 3 important criteria in apple classification [4]. The author discussed different crop irrigation system using the fuzzy expert system. Different input and output membership function are executed in fuzzy inference tool. Moisture level in the soil, leaf witness, temperature and humidity are the input parameter. Output is crop water requirement i.e. MSWD [maximum soil water deficit] calculated based on input. This system was developed for fertilizer recommendation purpose that used validated fertilizer adjustment equations [5].This paper took index values of nitrogen(N), phosphorous(P) and potassium(K) using the laboratory test and calculated correspondingly equivalent of soil nutrients values of N, P and K required using fuzzy expert systems[6]. This paper discussed the soil ph control for horticulture crops using the fuzzy expert system. The input parameters are temperature, light intensity and humidity and Ph level control act as an output. The entire system was designed and simulated using FIS tool in MATLAB Software [7].

2. SYSTEM METHODOLOGY

2.1. Nutrient Types

Plant growth relies on soil nutrient level, in-order to obtain the nutrient status soil testing are conducted. Totally 16 essential nutrients are present in the soil which act as a immune system to the crops they are called as primary, secondary and micronutrients. After the soil testing the level nutrients is decided based on soil fertility table, the table might be varied in view of topographical situations. Soil fertility table is illustrated below.

Table 1 Soil fertility rating

S.No	Primary Nutrients	Laboratory Test Method	Soil Fertility Rating		
			Low	Medium	High
1	Available Nitrogen N (Kg\Ha)	Iterative Method	0-113	113-180	180 above
2	Available Phosphorous P (Kg\Ha)	Bray Method	0-10	10-20	20 above
		Olsen Method	0-4.50	4.50-9	9 above
3	Available Potassium K (Kg\Ha)	Neutral Normal Ammonium Acetate	0-48	48-113	113 above

Note: In India each state having the different level of fertility table based on their soil conditions. Table 1 represents the Nutrient status rating of secondary nutrients i.e. NPK. This fertility status was given by Tamil Nadu agricultural university ratings may be varied based on soil conditions.

In this proposed framework, just focus on primary level of nutrients in the soil. Primary nutrients or macro nutrients are partitioned into three sorts they are nitrogen, phosphorous and potassium [NPK]. This soil fertility table helps to builds the input and output Membership function values.

2.2 Proposed system:

At first soil samples are accumulated from the field, and then the samples are extraction and pre-treatment by using the proper soil testing method. After the implementation of the soil test, some mathematical techniques required for nutrient and fertilizer level recommendation. In order to improve the decision-making and get an optimal value of soil nutrients level, fuzzy based expert system is proposed in this paper. The FIS mechanisms for soil nutrient recommendation are delineated in fig 1.

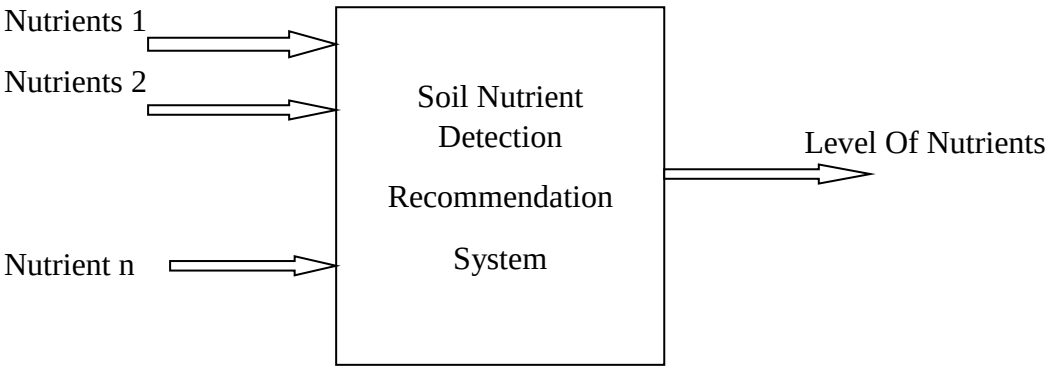

Figure 1. Block Diagram Of Soil Nutrient Detection

The fuzzy logic improves the decision-making technique in modern agriculture system as well as handles the vagueness and uncertainty of the system. Therefore, proposed system was implemented using Mamdani type FIS (Fuzzy Inference System) toolbox in Matlab. In FIS the interaction between input and output, both are the crisp value, is made by linguistics transformation of input membership function, implication and aggregation using rule base and defuzzification which is creating the crisp value as an output. NPK need was simulated using the fuzzy logic inference system of MATLAB 2013a (Matrix laboratory). The block diagram of FIS editor is illustrated in figure2. The knowledge acquisition is a vital part of building an expert system. In this proposed system the greater part of learning was gotten from an expert, i.e. soil science expert or agriculturist .And obtained knowledge is converted into a knowledge base using the facts and set of rules. In this paper only concentrated on soil primary nutrients level and FIS editor tool recommends the amount of nutrients level for hector conversion. Based on the soil nutrients level and type of fertilizer are recommended.

3. RESULT

The block diagram of Mamdani fuzzy expert system developed for NPK recommendation is illustrated in fig1. It represents the three input and output variables i.e. present level of nitrogen, phosphorous and potassium [NPK] are taken as input variables. Recommended level of NPK is considered as output.

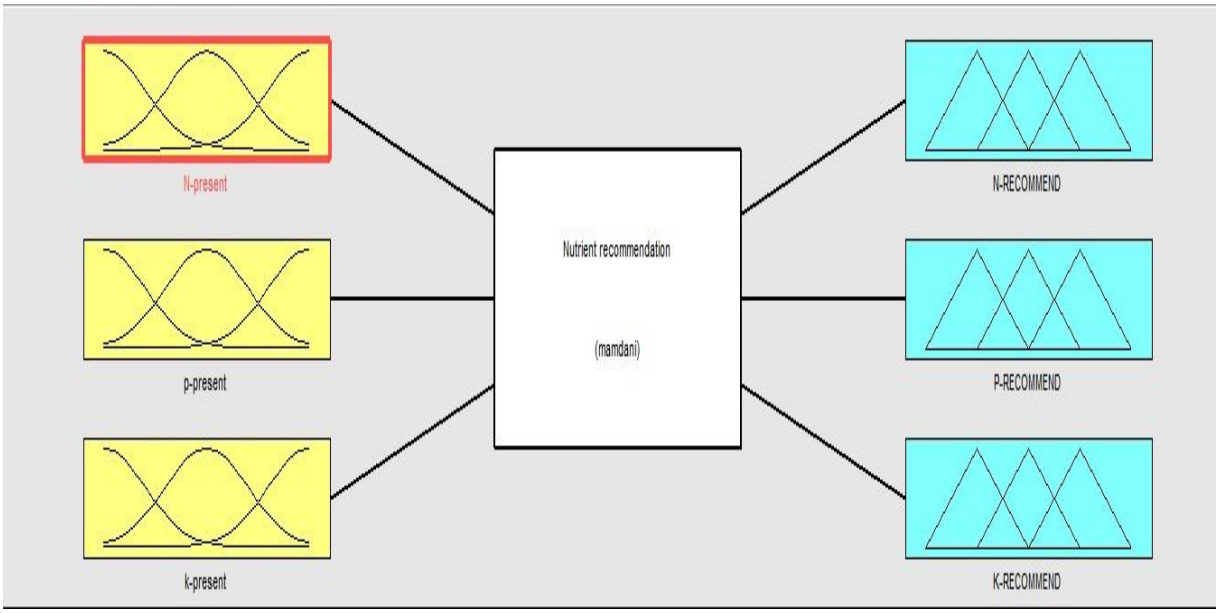

Figure 2. FIS Editor for Nutrients Recommendation

The ranges of the FIS input and output variables are decided based on soil fertility table. The ranges of input Membership function for NPK present level is (0-200 kg\ha), (0-30 kg\ha) and (0-120 kg\ha). Similarly output ranges of NPK recommendation is (0-100 kg\ha)(50-100 kg\ha) and(0-100 kg\ha) taken respectively. Membership functions are either triangular or trapezoidal types for example, input membership function for Nitrogen present level is given in fig 2

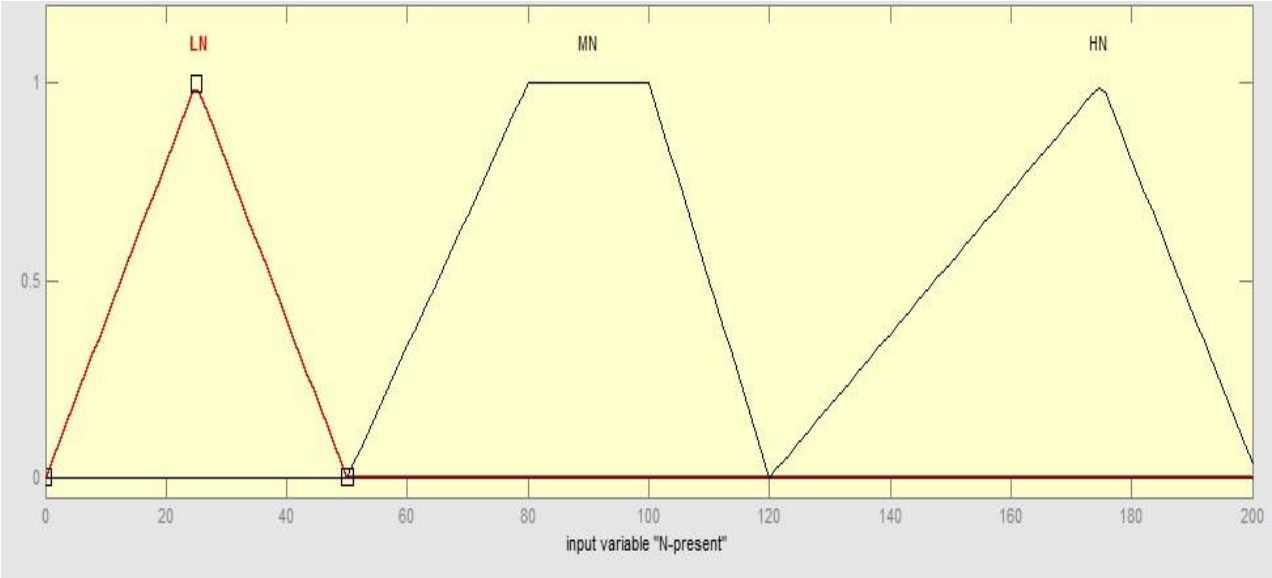

Figure 2. Membership function for input variable N-present

Each and every input and output functions have a separate membership function plot and different type of membership function are used. In this proposed system triangular and trapezoidal type membership functions are used. The output membership function of nitrogen recommendation for kg\ha is given in fig 3. Similarly, other input and output variables have separate membership function.

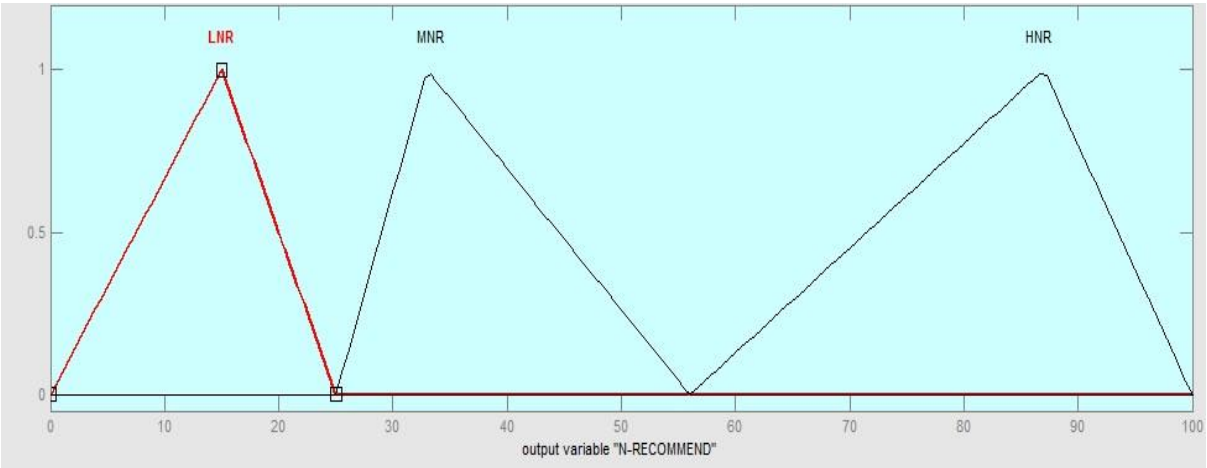

Figure 3. Membership function plot for output variable N-recommendation

In the rule base system totally 18 rules are generated for 3 input and 3 output variable of FIS system. The if- then rules are given in fig 4 and some of the rule firing example is given bellow.

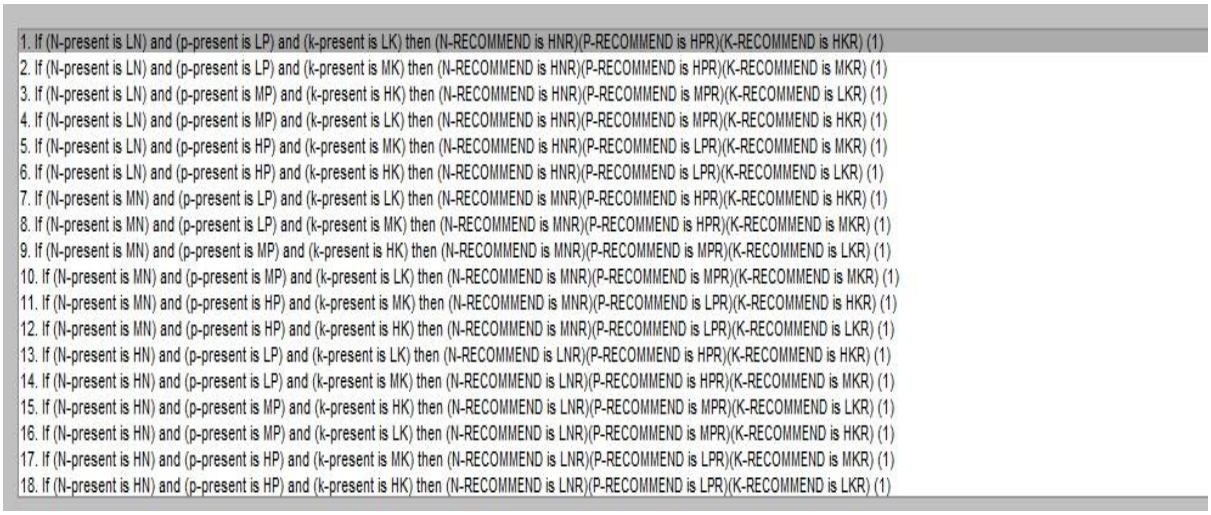

Figure 4. Rule Editor For NPK Recommendation

1. If (Nitrogen level is low)and (phosphorous level is low) and (potassium level is low) then (Nitrogen recommended is high) and (phosphorous recommended is high) and (potassium recommended is high).
2. If (Nitrogen level is medium) and (phosphorous level is medium) and (potassium level is medium) then(Nitrogen recommended is medium) and (phosphorous recommended is medium) and (potassium recommended is medium).
3. If (Nitrogen level is high)and (phosphorous level is high) and (potassium level is high) then (Nitrogen recommended is low) and (phosphorous recommended is low) and (potassium recommended is low).

The rule viewer of corresponding rules are given in fig.5 and 3D The Surface Viewer of FIS is given in fig.6.

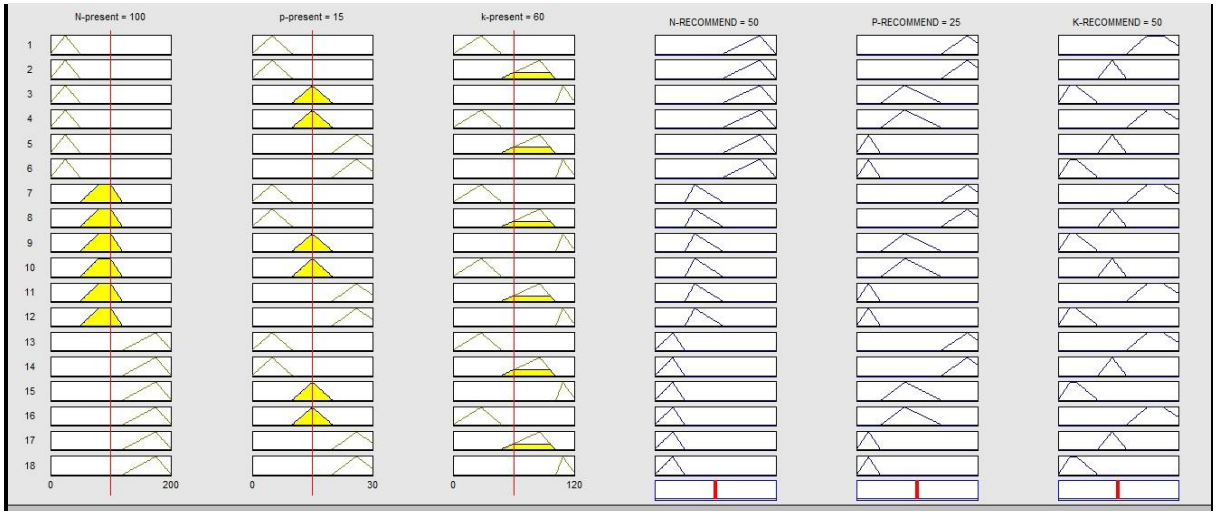

Figure 5. Rule Viewer

The Surface viewer is used for presenting the mapping from two inputs to one output. This capability allows keeping the calculation time reasonable for complex problems three dimension view.

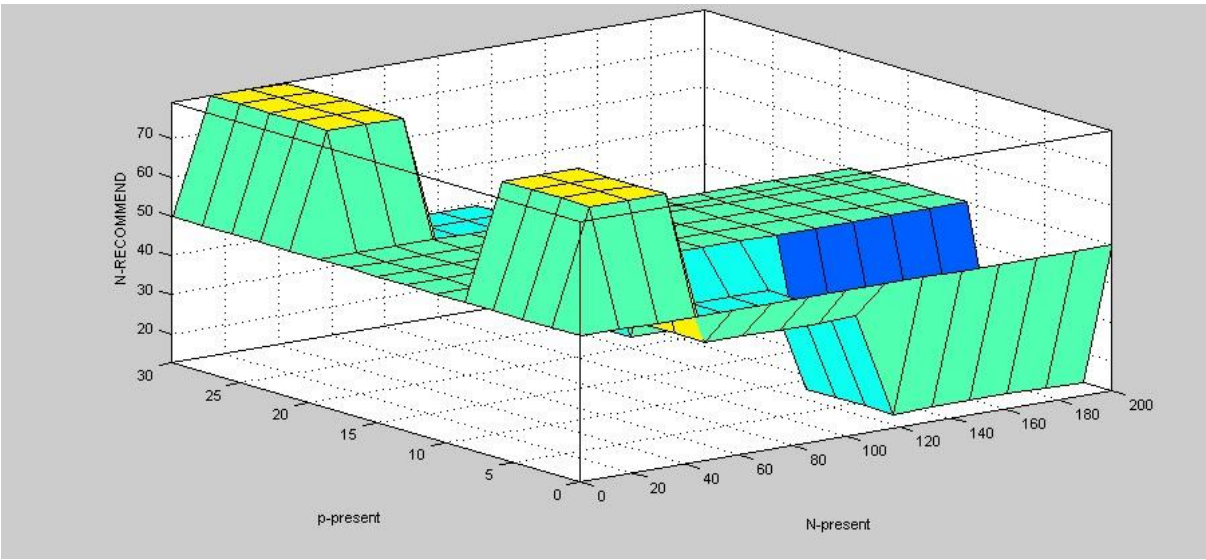

Figure 6. The surface viewer for NPK recommendation

4. CONCLUSION AND FUTURE WORK

An expert system for nutrient recommendation is proposed and simulated using MATLAB fuzzy inference system tool. The FIS-based expert system calculates the secondary nutrient level in soil per hectare using the laboratory soil testing method. Instead of using the time consume mathematical calculation for find the nutrient recommendation level, a fuzzy-based expert system improves the decision-making knowledge and precision of nutrient recommendation. In this proposed method, knowledge of human experts is incorporated with technical knowledge to improve decision-making techniques. In future, in-field nutrient measurement based prototype is developed with help expert system to enhance the system performance.

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