Fuzzy System for Maximum Yield from Crops

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ABSTRACT

Agricultural producers, consultants, service providers, and industry representatives are faced with crop management and cropping system decisions throughout the growing season. The need of the agricultural person to manage and predict a crop behavior over a wide range of planting dates, geographies and crops has become increasingly important as the need (value) for good, timely decisions and a decision making process has greatly increased. Use of crop simulation models incorporating local climatic conditions with management operations may increase the agricultural person's ability to make more timely and educated decisions. Soils vary in texture, drainage, native fertility, organic matter, structure, temperature, etc. All of these factors have an impact on how well a crop's root system can develop and take in essential elements for growth. Scientific crop growth simulation models have traditionally been used to address research problems, answer questions and most importantly, to increase knowledge on crop growth, development and yield.

Agriculture comprises much of the Indian land area and is critical to environmental economic and social sustainability. Fuzzy system for maximum yield from crop is a system to predict the name of crop that will give maximum yield and this crop will be more suitable for a particular type of soil & atmospheric condition. Maximum yield from crops depends on the various soil parameters. In this system total 15 important soil parameters and 22 crops are considered. This system uses the hardware part, which is interfaced with PC to form a Intelligent system for prediction of crop. The software used is MATLAB with Fuzzy logic toolbox. The hardware part comprises of transducer/sensors, ADC 0809 is used to convert the analog quantity to its equivalent digital quantity, which is given to the system model. Input to the system is soil parameters, which are sensed using transducers and are converted in to equivalent digital values using ADC. The hardware part is interfaced to PC using RS232 bus. The output of a system is one most suitable crop depending on the current parameter of soil.

1. INTRODUCTION

Design of this system is devoted to Indian farmers. Using this system farmer can easily predict the most suitable crop, which gives maximum yield and improves the standard of Indian agriculture sector. It becomes difficult for the farmers to identify one suitable crop among the list of crops for maximum yield because farmer cannot see the soil parameter with their open eye. The old method for checking the soil parameter involves the tedious and complex approach, which is not convenient for the farmers. The intelligent system predicts the name of crop that will be suitable for a particular type of soil parameter. At the primary level 22 crops and 15 soil parameters are considered. This system uses hardware and software approach. Soil Parameters include pH, humidity, temperature, moisture, water level, nitrogen, Salinity of water, Acidity of water, water level, Nitrogen, Phosphate, Manganese and Potassium. All these parameters are sensed using appropriate transducer and signal

conditioning circuit. Microcontroller 89C51 and ADC 0809 converts these analog parameters in to digital equivalent. These parameters are then transmitted to the computer system using RS232 bus interface. Received parameters are then given to fuzzy inference system, which uses Mamdani model in which min-max method is used for fuzzification & centroid method for Defuzzification. Finally the output of the system is one suitable crop among the list of 22 crops. The Predicted crop by the system will provide maximum yield.
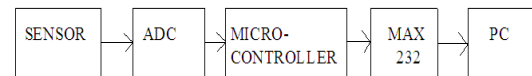
2.1 THE HARDWARE SYSTEM
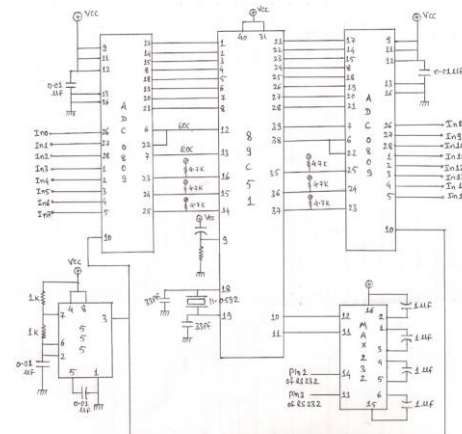

Fig 1. General Block Diagram

Fig 2. Interfacing diagram for DAC & Microcontroller

89c51 Micro controller is given a reset signal to start program execution from starting location 0000H. This reset signal is given using a combination of R & C. We are using 15 different sensors to measure the parameter of soil. Initially the output of sensor is given to the input terminal of ADC. Microcontroller reads all the ADC channels one by one .It will store these values at 30 H-3F H address. To start conversion, 89C51 will provide SOC signal to ADC1.All the output of 8 channels of ADC1 are stored at the Microcontroller memory location 30H - 37 H. After reading all the 8 channels, it will give the SOC signal to ADC2 and reads the next 8 channels of ADC2, after reading 8 channels of ADC2, the extracted parameters are stored at the memory location 38H - 3F H. The parameters are now in hex format . These hex values are converted in to equivalent decimal using microcontroller. After converting parameters in to decimal, Microcontroller will send this data to serial port IC MAX232 through Pin no.11 of Microcontroller i.e. transmitting pin. MAX232 is a level shifter IC that will shift the level of the input signal as per requirement of serial port. After shifting the level of input signal, they will be transferred to serial port of IC .Out

put of IC 555 is connected to Pin no.10 of ADC which provide the oscillating frequency to ADC. Crystal oscillator produces clock frequency of 11.0592 MHZ, which provide clock frequency to the Microcontroller. It is connected between Pin no.18 & 19 of microcontroller.

2.2 Serial port section encoder

MATLAB's serial port interface provides direct access to peripheral devices such as modems, printers, and scientific instruments, which we connect to our computer's serial port. This interface is established through a serial port object. The serial port object supports functions and properties that allow us to: 1) Configure serial port communications 2) serial port control pins 3) Write and read data 4) Use events and callbacks. [8].
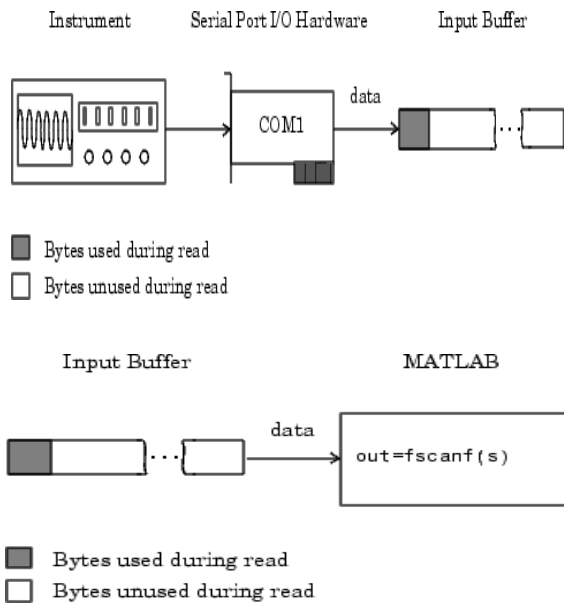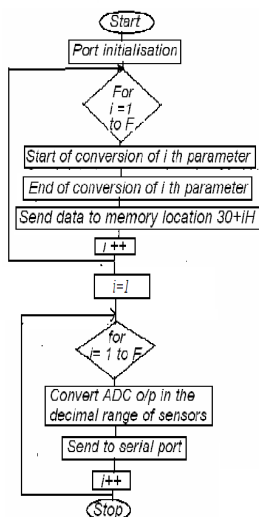

Fig 3.

2.3 Algorithmic approach of Microcontroller Programming

The AT89C51 is low power high performance CMOS 8 bit microcontroller with 4K bytes of flash programmable and erasable read only memory. The AT 89C51 is normally shipped with the on chip flash memory array in the erased state & ready to be programmed. Before programming the AT89C51 the address, data and control signals should be set up according to the flash-programming mode. Steps for programming are-
1) Input the desired memory location on the address lines.
2) Input the appropriate data bytes on the data lines.
3) Activate the correct combination of control signals.
4) Raise EA bar/ VPP to 12V for high voltage programming mode.
5) Pulse ALE/PROG bar once to program a byte in the flash array or the lock bits.

ALP for the system is written by referring the flow chart as shown in fig. This program is then loaded in to the memory of microcontroller using above steps for programming. Program is executed at 0000H , soil parameters are extracted and are stored in memory.

3 FUZZY LOGIC

Fuzzy logic is all about the relative importance of precision. Fuzzy logic is a fascinating area of research because it does a good job of trading off between significance and precision — something that humans have been managing for a very long time. Fuzzy logic sometimes appears exotic or intimidating to those unfamiliar with it, but once you become acquainted with it, it seems almost surprising that no one attempted it sooner. In this sense fuzzy logic is both old and new because, although the modern and methodical science of fuzzy logic is still young, the concepts of fuzzy logic reach right down to our bones.
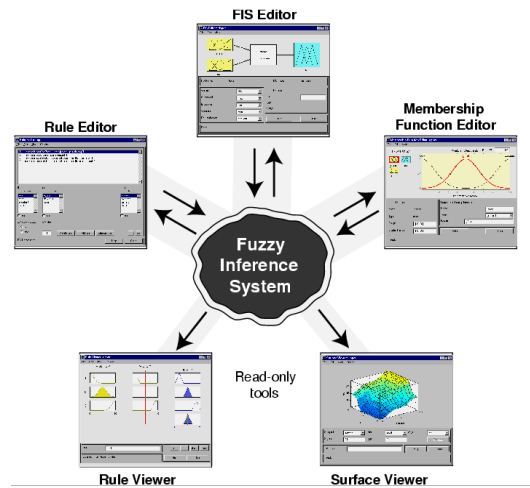
3.1 Fuzzy interface system

Fig.4 Fuzzy Inference System

Fuzzy inference system is shown in Fig.4, which are also called fuzzy rule-based systems, or fuzzy models, are composed of 4 blocks.[7]
Fuzzifier: Transforms the crisp inputs into fuzzy inputs by membership functions (MFs) that represent fuzzy sets of input vectors. In this work. two-sided Gaussian membership function is used for fuzzifying 22 crops and Triangular membership function is used for fuzzifying 15 soil parameters.

1) **Gaussian membership function**
The Gaussian function shown in Fig.5 depends on two parameters sig and c as given by: [7]

GAUSSMF (X,[SIGMA,C])=EXP(-(X-C).^2/(2*SIGMA ^2));

The function gauss2mf is a combination of two of these. The first function, specified by sig1 and c1, determines the shape of the leftmost curve. the second function determines the shape of the rightmost curve. Whenever c1 < c2, the gauss2mf function reaches a maximum value of 1. Otherwise, the maximum value is less than one. The parameters are listed in the order:
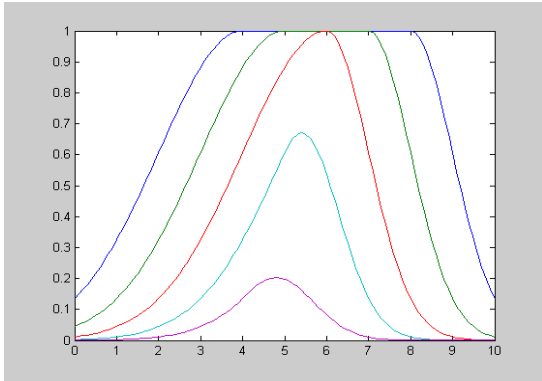
[sig1, c1, sig2, c2].

Fig. 5 Gaussian membership function

2) **Triangular membership function**

Triangular membership function is shown in Fig.6 TRIMF(X, PARAMS) returns a matrix which is the triangular membership function evaluated at X. PARAMS = [A B C] is a 3-element vector that determines the break points of this membership function. Usually we require A <= B <= C. This MF always has a height of unity. To have a triangular MF with a height less than unity, we can use TRAPMF instead. [7]
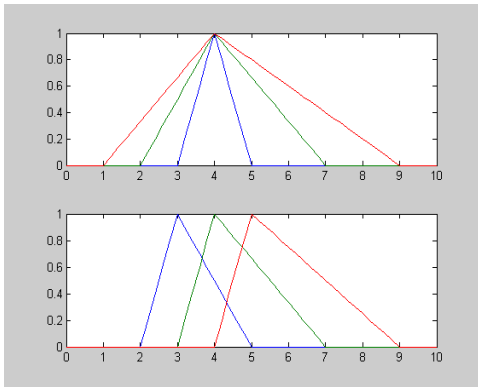

Fig. 6 Tringular Membership Function

• *Rules:* Consists of fuzzy IF-THEN rules;
The major component in an FIS is "Rules", and Rules are expressed in the form of IF-THEN statements. Let *U* and *V* be universe of discourses for *antecedent* and *consequent* of the rules, then the rule of *if x is A, then y is B,* where *x ∈ U,* and *y* **e** *V,* represents a relation between *A* and *B,* and extension to multiple rules and multiple antecedents can be easily done by specifying both *composition* and *inference* methods [1]
• *Inference:* Inference engine for fuzzy rules;
After the fuzzy matching step, a fuzzy step is invoked for each of the relevant rules to produce a conclusion based on their matching degree. How should the conclusion produced? There

are two methods: (1) the clipping method and (2) the scaling method. Both methods generate an inferred conclusion by suppressing the membership function of the consequent. The extent to which they suppress the membership function depends on the degree to which the rule is matched. Lower the matching degree, more severe the suppression of membership functions.

• *Defuzzifier:* Transforms the fuzzy output into crisp out put. Defuzzification process requires the most computational complexity in FIS, and center-of-gravity or height defuzzification method is common. In this work centroid method is used for defuzzification [1].

In the CENTROID method, the crisp value of the output variable is computed by finding the variable value of the center of gravity of the membership function for the fuzzy value. MATLAB fuzzy logic toolbox provides the facility as under [7]. Centroid defuzzification returns the center of area under the curve as shown in Fig 7. If we think of the area as a plate of equal density, the centroid is the point along the x-axis about which this shape would balance.
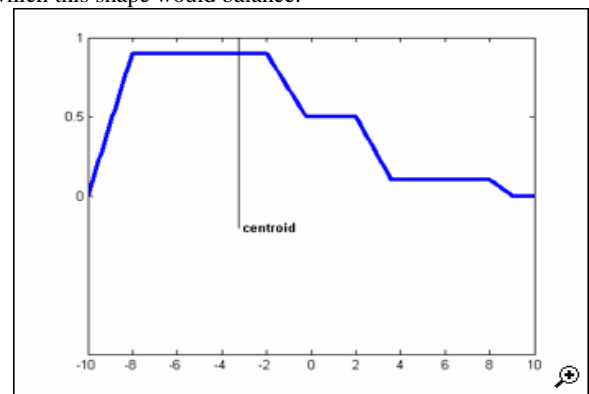

Fig.7

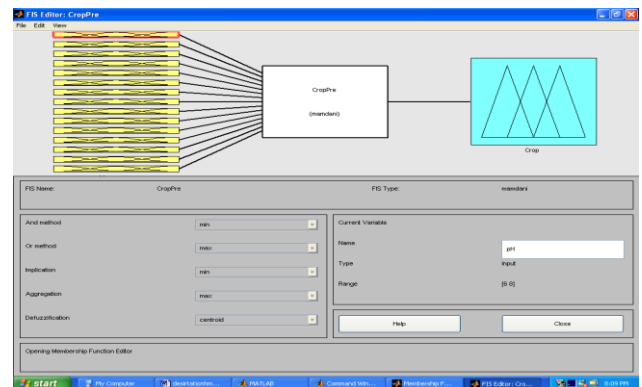3 **3.2 Fuzzy system (MAM. MODEL)**

fig-8

The FIS editor displays general information about fuzzy inference system. Using MATLAB Fuzzy logic toolbox Mamdani type of fuzzy inference system is developed which

rule base inference is its capability to perform inference under partial matching [1].

A large database is collected from PKV, Akola to design the

3.3 DATA BASE FOR SIMULATION OF CROPPING SYSTEM
TABLE I

Range	6 to 8	.2 to .8	1 to 4	10 to 100	20 to 70	20 to 300	0 to 200	1 to 3
Parameter crop	ph	Salinity of Water	Acidity of Water	water Level	Nitrogen	Phospate	Potassium	Depth of Land
Wheat	7.5(H)	0.45	3.8	85	55	52	25	2
Mung	8	0.2	2	40	50	25	70	2
Harbara	7	.2395	2.5	55	20	23.78	7.895	3
Cotton	7.1(A)	0.7	1.9	70	65	34	25	2
Sugarcane	6.9	0.8	1.6	85	50	32	30	1
Tomato	6.2	0.2	1.2	70	25	56	30	2
Potato	6.5	0.3	2.3	85	30	120	35	2
chilly	6.7	0.65	1.7	60	50	96	42	2
onion	7.1	0.7	3.7	85	40	116	31	2
Mango	6.8	0.56	1.5	50	25	90	150	1
orange	7.2	0.9	2.2	65	50	150	115	1
Coconut	6.4	0.6	3.3	60	50	80	170	1
Fanas	7	0.5	2	65	32	85	50	2
Groundnut	6.4	0.4	2.5	55	23	75	25	2
Soyabin	6.5	0.4	3.5	65	33	50	15	2
Sunflower	6.9	0.5	2.4	72	47	55	10	2
Tur	6.6	0.65	2.5	90	40	46	25	3
Banana	7.2	0.67	1	70	60	110	200	2
Jowar	7.2	0.2	1.3	60	25	20	25	3
Rice	6.8	0.2	2.4	70	30	35	30	3
bajara	6.7	0.3	3.1	65	35	40	30	3
Corn	7.3	0.75	3.3	80	45	32	35	3

consist of 15 input parameter, one out. The input uses gauss2mf membership function for fuzzification of input and trimf membership function is used for fuzzification of output. There are 22 rules in the system.
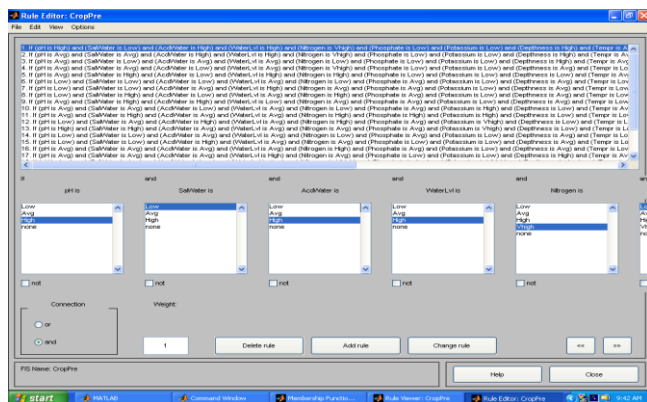
3.3 FUZZY RULE BASE SYSTEM

fig-9

Fuzzy if then rule is a knowledge representation scheme for capturing knowledge i.e. imprecise and inexact by nature this is achieved by using linguistic variables to describe elastic conditions in the if part of fuzzy rule. The main feature of fuzzy

rule base part of the system. Table I shows the standard parameters of soil for maximum yields from crops. Considering these values rule based is prepared for the fuzzy system.

TABLE II

| Range	25 to 45	20 to 60	1 to 3	1 to 3	4 to 5	0 to 2	0 to 4
Parameter crop	Temperature	Humidity	Oxygen	Sunlight	Iron	Zinc	Manganse
Wheat	41	30	3	3	0.68	1.3	3
Mung	35	20	2	2	4	1	2.4
Harbara	35	20	3	2	4	1	4
Cotton	30	31	3	3	4.81	0.65	2.7
Sugarcane	32	33	3	2	4.8	0.8	2.5
Tomato	28	42	3	1	4.5	0.6	1.1
Potato	28	44	3	2	4.6	0.8	2.2
chilly	29	51	3	2	4.6	0.68	2.3
onion	29	52	3	2	4.53	0.82	1.8
Mango	40	20	3	2	4.5	0.8	1.2
orange	25	35	3	2	4.9	1.9	2.9
Coconut	30	40	2	1	5.9	1	2
Fanas	37	40	2	2	4.5	0.9	1.5
Groundnut	28	53	2	2	4.6	0.2	0.5
Soyabin	30	30	2	2	1.2	3	2
Sunflower	27	29	3	3	4.5	0.9	4
Tur	25	33	3	2	4.62	0.8	1.5
Banana	30	40	3	3	5.5	2	1.7
Jowar	30	35	3	2	4.5	0.6	2.2
Rice	40	30	2	3	0.62	1.2	3
bajara	39	39	3	2	4.51	1.72	1.8
Corn	36	33	3	3	4.61	0.7	1.1

3.3 RULE VIEWER FOR CROPS
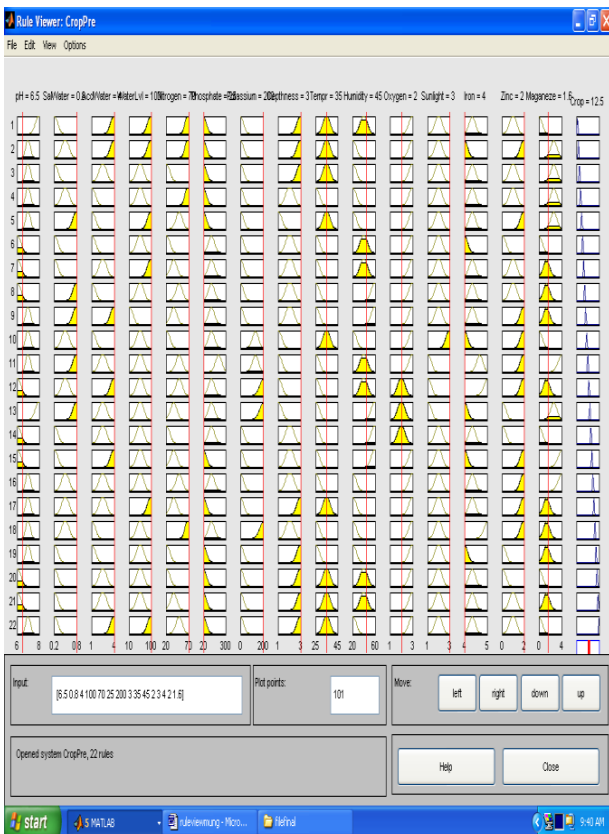
fig-10

The rule viewer displays a road map of the whole fuzzy inference process its based on the fuzzy inference diagram. The rule viewer allows us to interpret the entire fuzzy inference process at once. The rule viewer also shows, how the shape of certain membership functions influences the overall result. The rule viewer one calculation at a time and in great detail [7].

4 . RESULT AND CONCLUSION:

The system has been integrated and tested to function properly. The goal of crop prediction for maximum yield is achieved. The results shown by the system are given. The results have been obtained as follows.
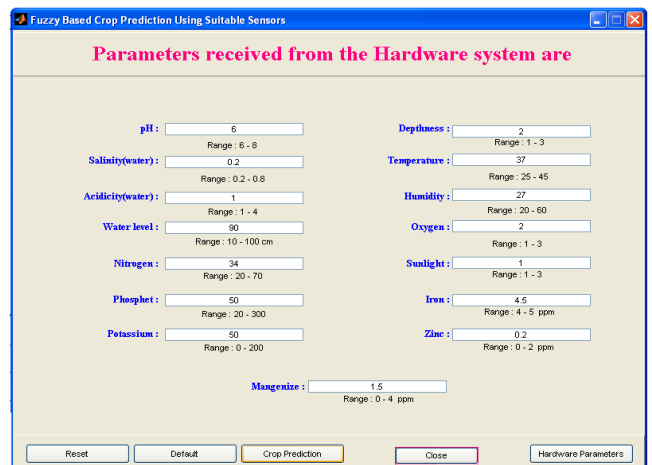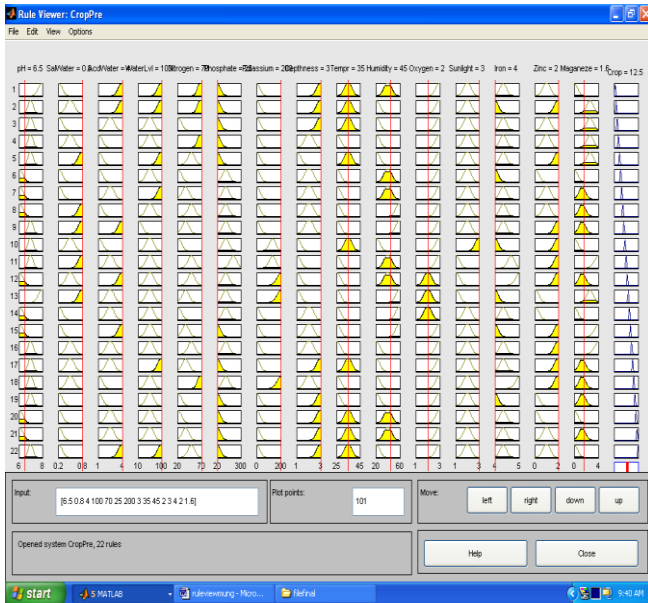
Result-1 (Parameters input to system:)

fig-11
fig-12

Crop for maximum yield shown by system:

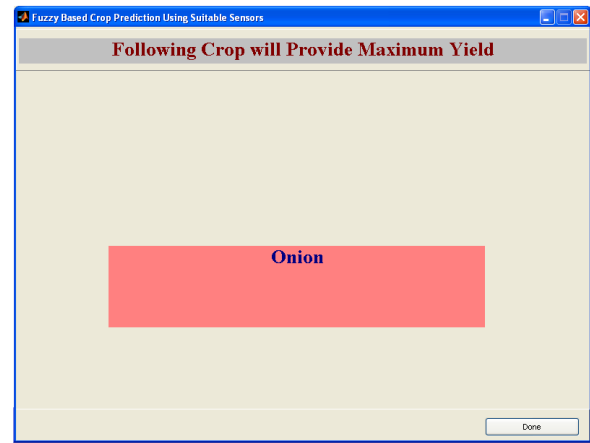**fig-13**

Crop for maximum yield shown by system:

fig-15
CONCLUSION

In our developing country like India about 75% of the land is under agriculture, which makes it a very important occupation. This paper provides the technical approach for getting the best suitable crop for a particular type of soil. Thus the burden for selecting the crop will be reduced for the farmers. This paper provides the novel application of fuzzy logic in the field of agriculture, which is the remarkable feature of this paper.

5. REFERENCE:

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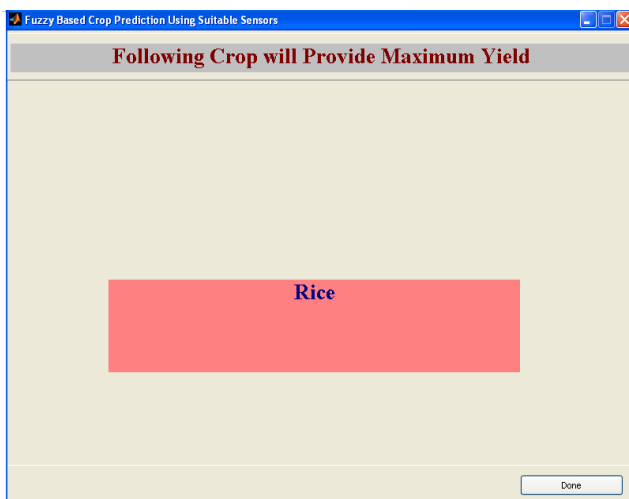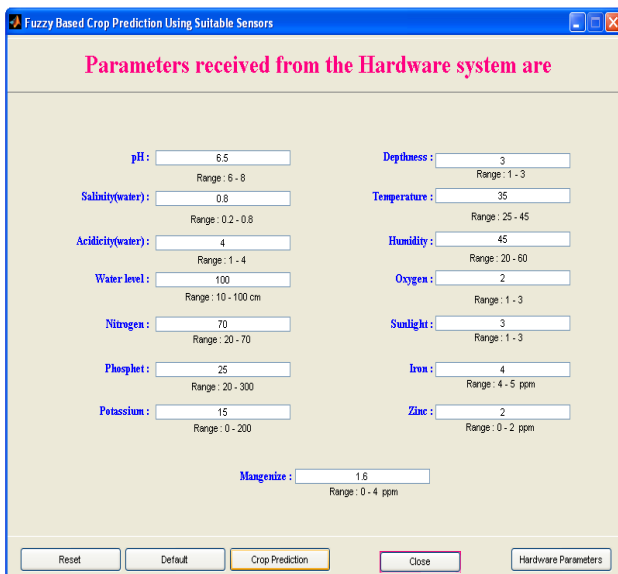
[8] Krishi- Sanvardini 2003-2004(PKV Akola)

fig-14

Result-2(Parameters input to system)