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A Fuzzy Logic Approach for Best Crop Selection

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Abstract

The agricultural sector faces challenges in selecting suitable crop due to complexity and uncertainty of environmental factors. By using fuzzy technique, we enhance the accuracy in crop selection compare to traditional statistical method. Statistical approaches often rely on precise numerical threshold while, fuzzy logic excels in capturing the vagueness associated with linguistic terms by standard intersection. Considering all parameters like temperature, soil compatibility, water required, production cost and profit enabling farmers to make context aware approach for crop selection. First calculating the gradation of variables and taking minimum intersection of all fuzzy sets from all parameters and then preferring the crop with maximum index. Finite accuracy got by fuzzy logic can be trusted more than statistical method.

Keywords: Fuzzy Logic, Parameters, Fuzzification, Crops, Statistical Method

Introduction:

Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1. It is employed to handle the concept of partial truth, where the truth value may range between completely true and completely false. By contrast, in Boolean logic, the truth values of variables may only be the integer values 0 or 1. Furthermore, when linguistic variables are used, these degrees may be managed by specific (membership) functions.
The term fuzzy logic was introduced in 1965 as a proposal of fuzzy set theory by Lofti Zadeh. Fuzzy logic had however been studied since the 1920s, as infinite-valued logic.

Objectives:

- To employ fuzzy logic for precise crop selection in designated area, waving together multiple factor.
- To elevate the accuracy of crop selection, ensuring an accurate and adaptive approach to crop selection for specific geographical region.

Methodology:

The information collected is based on temperature, Compatibility with soil, water required, production cost and profit of Panvel area. The predominant soil in Panvel is alluvial soil and the data was collected from June to September. This selection of crop process is divided into five parameters such as temperature, Compatibility with soil, water required, production cost and profit. For these five parameters, selection of the crops A, B, C, D were evaluated and the result were presented in table 1 to 5.

Calculation of Gradation by Fuzzy Technique:

1. On the basis of Temperature:

Function A (x) = 1, if x≥37

= 0 if x<19

Therefore (x-19)/18

For crop A: =(29-19)/18=0.55

Accordingly, all gradation were calculated and presented in table 1

SR NO.	CROPS	CROP SUITABLE TEMPERATURE (◦C)	AVERAGE	GRADATION
A	RICE	21-37	29	0.55
B	SOYABEAN	20-30	25	0.33
C	GROUNDNUT	26-30	28	0.5
D	FENUGREEK	20-30	20	0.05

Table 1: Temperature

2. On the basis of Compatibility with soil:

Function A (x) = 1, if x≥100

= 0, if x<60

Therefore, (x-60)/40

For crop A , (97.5-60)/40=0.94

Similarly, all calculations are carried out. The result obtained are given in table 2

SR NO.	CROPS	COMPATIBILITY WITH ALLUVIAL SOIL	AVG	GRADATION
A	RICE	95-100	97.5	0.94
B	SOYABEAN	85-90	87.5	0.16
C	GROUNDNUT	70-90	80	0.50
D	FENUGREEK	90-95	92.5	0.81

Table 2: Compatibility with soil

3. On the basis of Water:

Function A (x) = 1, if x≥71,400

= 0 if x<4,000

Therefore (x-4,000)/67,400

For crop A: (53,550-4000)/67,400 = 0.73

The result obtained for all crops are given in table 3

SR.NO	CROPS	WATER REQUIRED (LITER/DAY)	AVERAGE	GRADATION
A	RICE	35,700-71,400	53,550	0.73
B	SOYABEAN	35,700-42,900	39,300	0.52
C	GROUNDNUT	5,000-7,000	6,000	0.03
D	FENUGREEK	12,000-15,000	13,500	0.13

Table 3: Water

4. On the basis of Production Cost:

Function A (x) =1, if x≥45,500

=0 if x<13,500

Therefore, (x-13,500)/32,000

For crop A ,(38,000-13,500)/32,000 =0.77

The result obtained for all crops are given in table 4

SR NO.	CROPS	COST	AVERAGE COST	GRADATION
A	RICE	31,500-45,500	38,000	0.77
B	SOYABEAN	26,500-28,000	27,250	0.43
C	GROUNDNUT	30,000-32,400	31,200	0.55
D	FENUGREEK	14,000-15,300	14,650	0.04

Table 4: Production Cost

5. On the basis of Profit:

Function A (x) =1, if x≥1,50,000

=0 if x<18,000

Therefore, (x-18,000)/1,32,000

For crop A , (59,625-18,000)/1,32,000 = 0.32

The result obtained for all crops are given in table 5

SR NO.	CROPS	PROFIT	AVERAGE ROFIT	GRADATION
A	RICE	56,500-62,750	59,625	0.32
B	SOYABEAN	18,500-21,860	20,180	0.013
C	GROUNDNUT	56,800-57,380	58,090	0.30
D	FENUGREEK	50,000-1,50,000	1,00,000	0.62

Table 5: Profit

Thus, the gradation value and their membership value obtained by fuzzy logic technique were presented in table 6

	SR. NO.	CROP	TEMP	SOIL	WATER	COST	PROFIT	TOTAL	INDEX
WEIGHTAGE			(0.3)	(0.3)	(0.1)	(0.1)	(0.2)		
	A	RICE	0.55 0.16	0.94 0.28	0.73 0.07	0.77 0.08	0.32 0.06	0.65	0.13
	B	SOYABEAN	0.33 0.01	0.16 0.05	0.52 0.05	0.43 0.04	0.013 0.003	0.15	0.03
	C	GROUNDNUT	0.50 0.15	0.50 0.15	0.03 0.003	0.55 0.06	0.30 0.06	0.42	0.08
	D	FENUGREEK	0.05 0.01	0.81 0.24	0.13 0.01	0.04 0.004	0.62 0.12	0.38	0.08

Table 6: Gradation value and their membership value

Result and Discussion:

For crop A: (0.55*0.3) + (0.94*0.3) + (073*0.1) + (0.77*0.1)+(0.32*0.2) = 0.62/5 =0.13 and so on
Finally maximum Index of Selection of crops is 0.13
Using statistical method, it concludes that Crop A is best to grow in panvel.
And Universal set = set of crops {A, B, C, D} with the help of table fuzzy set corresponding to each parameters are performed.
P_1: Fuzzy set corresponds to temperature
P_1: {0.55/A+0.33/B+0.50/C+0.05/D}
P_2: Fuzzy set corresponds to soil
P_2: {0.94/A+0.16/B+0.50/C+0.81/D}
P_3: Fuzzy set corresponds to water
P_3: {0.73/A+0.52/B+0.03/C+0.13/D}
P_4: Fuzzy set corresponds to cost
P_4: {0.77/A+0.43/B+0.55/C+0.04/D}
P_5:fuzzy set corresponds to profit
P_5:{0.32/A+0.013/B+0.30/C+0.62/D}
Intersection of all fuzzy sets from P_1 to P_5 is taken that
$P_1 \Lambda P_2 \Lambda P_3 \Lambda P_4 \Lambda P_5$ = {0.32/A + 0.013/B + 0.03/ C + 0.04/D}
Finally maximum Index is 0.32
According to fuzzy technique, Crop A is best to grow in panvel.

Conclusion:

The fuzzy logic approach for crop selection offers a flexible and intelligent decision-making tool for agriculture, contributing to increased efficiency, sustainability, and resilience in the face of a dynamic and uncertain environment.

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