

Risk Avoidance in Crop Cultivation - A Mathematical Model Using Possibility Intuitionistic Fuzzy Soft Set

S.Saranya¹, A.Rohini²Assistant Professor, Department of Science & Humanities (Mathematics), M.Kumarasamy College of Engineering,
Karur, Tamil Nadu, India¹Assistant Professor, Department of Science & Humanities (Mathematics), M.Kumarasamy College of Engineering,
Karur, Tamil Nadu, India²

ABSTRACT: The decision making is a process of identifying problems and choosing the best alternative for resolving them successfully. The main aim of this paper is to avoid the risks in crop cultivation by using Possibility intuitionistic fuzzy soft set [PIFSS].

KEYWORDS: Fuzzy set, Soft set, Intuitionistic fuzzy soft set [IFSS], Possibility intuitionistic fuzzy soft set [PIFSS].

I. INTRODUCTION

In 1965, Zadeh [3] introduced the concept of fuzzy set. Maji, Biswas and Roy [1] initiated the concept of fuzzy soft set which is a combination of fuzzy set and soft set. Atanassov [5] defined the concept of intuitionistic fuzzy set which is more general than the fuzzy set. Maji, Roy and Biswas [6] introduced the concept of intuitionistic fuzzy soft set. Molodtsov [2] initiated the theory of soft sets as a new mathematical tool for dealing with uncertainties which traditional tools cannot handle. Maruah et.al.,[7] introduced possibility intuitionistic fuzzy soft set.

Now a days, the farmers have to face many difficulties to get a sizeable profit in the field of agriculture. Hence, we would like to provide a solution on how to avoid risks particularly in crop cultivation.

II. PRELIMINARIES

Definition: 2.1

Let U be a non-empty set. A “**Fuzzy set**” in U is a function with domain U and values in the closed unit interval $I = [0,1]$.

Definition: 2.2

An “**Intuitionistic Fuzzy Set (IFS in short)**” A in a nonempty set U (a universe of discourse) is an object having the form $A = \{(x, \mu_A(x), \gamma_A(x)) : x \in U\}$, where the functions $\mu_A(x) : U \rightarrow [0,1]$, $\gamma_A(x) : U \rightarrow [0,1]$, denotes the degree of membership and degree of non-membership of each element $x \in U$ to the set A respectively, and

$$0 \leq \mu_A(x) + \gamma_A(x) \leq 1 \text{ for all } x \in U.$$

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Definition: 2.3

Let U be an initial universe set and E be the set of parameters and A be the subset of E . Let $P(U)$ denotes the power set of U , then the pair (F, A) is called a “**Soft set**” over U where F is a mapping given by $F: A \rightarrow P(U)$.

Definition: 2.4

Let U be an initial universe set and E be the set of parameters. Let IF^U denotes the collection of all intuitionistic fuzzy subsets of U . Let $A \subseteq E$, a pair (F, A) is called “**Intuitionistic Fuzzy Soft Set (IFSS in short)**” over U , where F is a mapping given by $F: A \rightarrow IF^U$.

Definition: 2.5

Let $U = \{x_1, x_2, x_3, \dots, x_n\}$ be the universal set of elements and $E = \{e_1, e_2, e_3, \dots, e_m\}$ be the universal set of parameters. The pair (U, E) will be called a soft universe. Let $F: E \rightarrow (I \times I)^U \times I^U$, where $(I \times I)^U$ is the collection of all intuitionistic fuzzy subsets of U and I^U is the collection of all fuzzy subsets of U . Let P be a fuzzy subset of E , $P: E \rightarrow I^U$. Let $F_P: E \rightarrow (I \times I)^U \times I^U$ be a function defined as follows:

$$F_P(e) = (F(e)(x), P(e)(x)), \text{ where } F(e)(x) = (\mu(x), \gamma(x)), P(e)(x) = \gamma(x), \forall x \in U.$$

Then F_P is called a “**Possibility Intuitionistic Fuzzy Soft Set (PIFSS in short)**” over the soft universe (U, E) . For each parameter e_i , $F_P(e_i) = (F(e_i)(x), P(e_i)(x))$ indicates not only the degree of belongingness of the elements of U in $F(e_i)$, but also the degree of possibility of belongingness of the elements of U in $F(e_i)$, which is represented by $P(e_i)$, so one can write $F_P(e_i)$ as follows:

$$F_P(e_i) = \left\{ \left(\frac{x_1}{F(e_i)(x_1)}, P(e_i)(x_1) \right), \left(\frac{x_2}{F(e_i)(x_2)}, P(e_i)(x_2) \right), \dots, \left(\frac{x_n}{F(e_i)(x_n)}, P(e_i)(x_n) \right) \right\}$$

APPLICATION OF POSSIBILITY INTUITIONISTIC FUZZY SOFT SET:

The universal set $U = \{x_1, x_2, x_3, x_4, x_5\}$ and eight specific criteria which form the parameter set $E = \{e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8\}$.

Modes of Crop Cultivation (Universal set of U):

- x_1 = Turmeric
- x_2 = Sugarcane
- x_3 = Tapioca
- x_4 = Paddy
- x_5 = Groundnut

Criteria (Parameter set E):

- e_1 - Destruction of crops by pests and animals
- e_2 - Labour shortage
- e_3 - High cost of inputs
- e_4 - Difficulties in curing process
- e_5 - Unstable selling prices
- e_6 - Lack of holding power in case of price decrease
- e_7 - Inconsistent yield

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e_8 - Power shortage

Construction of Possibility Intuitionistic Fuzzy Soft Set:

For the purpose of ascertaining membership function, non-membership function and degree of possibility of belongingness, the problems of the crop cultivators about the eight criteria for each mode of crop cultivation was collected from Namakkal district in Tamil Nadu, India.

The counts of membership function of each criterion for all the five modes were added and the proportion of count of each mode to the total was ascertained to fix degree of possibility of belongingness.

Therefore the PIFSS for this model are,

$$F_P(e_1) = \left\{ \left(\frac{x_1}{0.45, 0.30}, 0.22 \right), \left(\frac{x_2}{0.24, 0.54}, 0.12 \right), \left(\frac{x_3}{0.61, 0.26}, 0.30 \right), \left(\frac{x_4}{0.53, 0.32}, 0.26 \right), \left(\frac{x_5}{0.18, 0.29}, 0.09 \right) \right\}$$

$$F_P(e_2) = \left\{ \left(\frac{x_1}{0.19, 0.24}, 0.13 \right), \left(\frac{x_2}{0.11, 0.63}, 0.07 \right), \left(\frac{x_3}{0.46, 0.32}, 0.31 \right), \left(\frac{x_4}{0.59, 0.16}, 0.40 \right), \left(\frac{x_5}{0.14, 0.67}, 0.09 \right) \right\}$$

$$F_P(e_3) = \left\{ \left(\frac{x_1}{0.54, 0.39}, 0.25 \right), \left(\frac{x_2}{0.17, 0.38}, 0.08 \right), \left(\frac{x_3}{0.43, 0.24}, 0.20 \right), \left(\frac{x_4}{0.36, 0.14}, 0.17 \right), \left(\frac{x_5}{0.65, 0.16}, 0.30 \right) \right\}$$

$$F_P(e_4) = \left\{ \left(\frac{x_1}{0.51, 0.47}, 0.28 \right), \left(\frac{x_2}{0.14, 0.21}, 0.08 \right), \left(\frac{x_3}{0.62, 0.13}, 0.34 \right), \left(\frac{x_4}{0.31, 0.52}, 0.17 \right), \left(\frac{x_5}{0.26, 0.39}, 0.14 \right) \right\}$$

$$F_P(e_5) = \left\{ \left(\frac{x_1}{0.14, 0.72}, 0.07 \right), \left(\frac{x_2}{0.53, 0.38}, 0.26 \right), \left(\frac{x_3}{0.44, 0.51}, 0.22 \right), \left(\frac{x_4}{0.62, 0.79}, 0.30 \right), \left(\frac{x_5}{0.31, 0.65}, 0.15 \right) \right\}$$

$$F_P(e_6) = \left\{ \left(\frac{x_1}{0.41, 0.71}, 0.21 \right), \left(\frac{x_2}{0.24, 0.68}, 0.13 \right), \left(\frac{x_3}{0.23, 0.66}, 0.12 \right), \left(\frac{x_4}{0.47, 0.18}, 0.25 \right), \left(\frac{x_5}{0.56, 0.41}, 0.29 \right) \right\}$$

$$F_P(e_7) = \left\{ \left(\frac{x_1}{0.68, 0.47}, 0.28 \right), \left(\frac{x_2}{0.43, 0.16}, 0.18 \right), \left(\frac{x_3}{0.57, 0.22}, 0.24 \right), \left(\frac{x_4}{0.49, 0.32}, 0.21 \right), \left(\frac{x_5}{0.22, 0.60}, 0.09 \right) \right\}$$

$$F_P(e_8) = \left\{ \left(\frac{x_1}{0.65, 0.26}, 0.36 \right), \left(\frac{x_2}{0.50, 0.23}, 0.27 \right), \left(\frac{x_3}{0.17, 0.47}, 0.09 \right), \left(\frac{x_4}{0.38, 0.28}, 0.21 \right), \left(\frac{x_5}{0.13, 0.59}, 0.07 \right) \right\}$$

Suppose the wishing parameters of farmer Mr.Y is $A \subseteq E$, where $A = \{e_2, e_3, e_5, e_8\}$, then consider the following operations:

i) For membership function:

$$\alpha(e_j) = \mu_i + \gamma_i - \mu_i \gamma_i$$

ii) For non-membership function:

$$\beta(e_j) = \nu_i \gamma_i, \text{ for } i = 1, 2, 3, 4, 5 \text{ \& } j = 2, 3, 5, 8$$

These two operations are taken to ascend the membership value and descend the non-membership value of $F(e_j)$ on the basis of the degree of preference of Mr.Y. Then the PIFSS $F_P(e_j)$ reduced to an intuitionistic fuzzy soft set $\Psi(e_j)$ given as follows:

$$\Psi(e_2) = \left\{ \frac{x_1}{0.30, 0.03}, \frac{x_2}{0.17, 0.04}, \frac{x_3}{0.63, 0.10}, \frac{x_4}{0.75, 0.06}, \frac{x_5}{0.22, 0.06} \right\}$$

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$$\Psi\Psi(e_3) = \left\{ \frac{x_1}{0.66,0.10}, \frac{x_2}{0.24,0.03}, \frac{x_3}{0.54,0.05}, \frac{x_4}{0.47,0.02}, \frac{x_5}{0.78,0.05} \right\}$$

$$\Psi(e_5) = \left\{ \frac{x_1}{0.20,0.05}, \frac{x_2}{0.65,0.10}, \frac{x_3}{0.56,0.11}, \frac{x_4}{0.73,0.24}, \frac{x_5}{0.41,0.10} \right\}$$

$$\Psi(e_8) = \left\{ \frac{x_1}{0.78,0.09}, \frac{x_2}{0.64,0.06}, \frac{x_3}{0.24,0.04}, \frac{x_4}{0.51,0.06}, \frac{x_5}{0.19,0.04} \right\}$$

Algorithm:

- i) Input the set $A \subseteq E$ of choice of parameters of Mr. Y
- ii) Consider the reduced Intuitionistic fuzzy soft set
- iii) Consider the tabular representation of membership function and non-membership function (Table 1 & Table 4 respectively)
- iv) Compute the comparison table membership function and non-membership function (Table 2 & Table 5 respectively)
- v) Compute the membership score and non-membership score (Table 3 & Table 6 respectively)
- vi) Compute the final score by subtracting non-membership score from membership score (Table 7)
- vii) Find the minimum score, if it occurs in i^{th} row then x_i will suits for Mr. Y to cultivate the best crop with minimum risk.

Table: 1

Tabular representation of Membership Function:

U	e_2	e_3	e_5	e_8
X_1	0.30	0.66	0.20	0.78
X_2	0.17	0.24	0.65	0.64
X_3	0.63	0.54	0.56	0.24
X_4	0.75	0.47	0.73	0.51
X_5	0.22	0.78	0.41	0.19

Table: 2

Comparison table of the above table:

A comparison table is a square table in which number of rows and number of columns are equal and both are labelled by object name of the universe such as $x_1, x_2, x_3, \dots, x_n$ and the entries are C_{ij} where C_{ij} = the number of parameters for which the value of x_i exceeds or equal to the value of x_j .

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U	X ₁	X ₂	X ₃	X ₄	X ₅
X ₁	4	3	2	2	2
X ₂	1	4	2	1	2
X ₃	2	2	4	1	3
X ₄	2	3	3	4	3
X ₅	2	2	1	1	4

Table: 3

Membership score table:

U	Row sum (a)	Column sum (b)	Membership score (a-b)
X ₁	13	11	2
X ₂	10	14	-4
X ₃	12	12	0
X ₄	15	9	6
X ₅	10	14	-4

Table: 4

Tabular representation of Non-Membership Function:

U	e ₂	e ₃	e ₅	e ₈
X ₁	0.03	0.10	0.05	0.09
X ₂	0.04	0.03	0.10	0.06
X ₃	0.10	0.05	0.11	0.04
X ₄	0.06	0.02	0.24	0.06
X ₅	0.06	0.05	0.10	0.04

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Table: 5

Comparison table of the above table:

U	X ₁	X ₂	X ₃	X ₄	X ₅
X ₁	4	2	2	2	2
X ₂	2	4	1	2	2
X ₃	2	3	4	2	4
X ₄	2	3	2	4	3
X ₅	2	3	2	2	4

Table: 6

Non-Membership score table:

U	Row sum (a)	Column sum (b)	Membership score (a-b)
X ₁	12	12	0
X ₂	11	15	-4
X ₃	15	11	4
X ₄	14	12	2
X ₅	13	15	-2

Table: 7

Final score table:

U	Membership score (m)	Non- Membership score (n)	Final score (m-n)
X ₁	2	0	2
X ₂	-4	-4	0
X ₃	0	4	-4
X ₄	6	2	4
X ₅	4	-2	6

In the above table, Parameter X₃ has the least score -4. Hence, the crop “**Tapioca**” best suits the expectations of the farmer Y.

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III. CONCLUSION

In this article we have applied the concept of possibility intuitionistic fuzzy soft set [PIFSS] to avoid the risks in crop cultivation. The concept of possibility intuitionistic fuzzy soft sets has rich potentials for developing such decision making models suitable for social, technical, managerial and commercial issues.

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