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An Application of Fuzzy Soft Set TOPSIS Method for Fertilizer Recommendation

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ABSTRACT:

Agriculture is done based on various approximations of fertilizer quantity and the type of crop to be grown or planed. For maintaining of soil quality and attainable crop yield, it is required to add proper amount of fertilizer. This proposed work presents TOPSIS method in fuzzy soft set environment based on fertilizer recommendation system for the farmers. Results Shows that Nitrogen is the best recommendation for the farmers.

Keywords: Fuzzy soft sets, TOPSIS, Decision Matrix, Fertilizer Selection, and Weighted Normalized Decision Matrix.

1. Introduction

As the global population continues to expand, the demand for food production has never been more critical. Agricultural practices play a pivotal role in meeting this demand, but achieving sustainable and high-yielding crop cultivation requires meticulous attention to soil fertility and nutrients management. Fertilizer serving as essential supplements to naturally occurring nutrients in the soil are pivotal in ensuring optional plant growth and addressing nutritional deficiencies. Fertilizer recommendation form the backbone of modern crop management strategies, guiding farmers towards judicious nutrient application for enhance soil fertility and foster thriving crops. For maintaining of soil quality and attainable crop yield it is required to add proper amount of fertilizers.

Decision making in today's world is characterized by several unique challenges and opportunities shaped by complexities of modern society. Effective decision making is a cornerstone of success in the contemporary world. The inherent problem of decision making is related to vagueness and uncertainty aspects. It is well known that Zadeh [1] in 1965 developed fuzzy set theory to deal with uncertainties. In 1999, Molodstov [2] claimed that these theories have their challenge to overcome those challenges. He proposed a new theory known as soft set theory. Maji et.al. [3] have done further research on soft set theory and developed fuzzy soft set theory by combining fuzzy set and soft set. Evaluation of membership and non membership values is not always possible because of the insufficiency in the available information and as a result there exists an indeterminate part upon which hesitation survives. In those situation intuitionistic fuzzy soft set theory may be more applicable. In the year 2001, Maji et.al. [4] have introduced the concept of intuitionistic fuzzy soft set. Cagman [5] coined the notion of fuzzy soft matrices in the year 2010.Hawang and Yoon [6] was initiated TOPSIS method. The concept behind the method is that the ideal alternative has the best level for all attributes considered, whereas the negative ideal is the one with all the worst attribute values. In [7] Chen & Hwang extend the idea of the TOPSIS method and presented a new model for TOPSIS. The technique of order preference by similarity to ideal solution (TOPSIS) is a multi –criteria decision making method was introduced by Tzeng & Huang [8] to solve decision making problems involving multiple conflicting criteria. Eraslan [9] gave a decision making method by using TOPSIS on soft set theory. Mohammadi et al.[10] presented a grey relational analysis and TOPSIS approach to solving decision making problem. Yesim et al. apply the fuzzy TOPSIS method[11]for selecting supplier in a company. Jahanshahloo et al.[12] using the TOPSIS method for decision making by the help of fuzzy data

Considering the versatility of fuzzy soft set theory and the importance of TOPSIS method this paper extends the TOPSIS strategy to the fuzzy soft environment. In the present paper we developed an algorithm on fuzzy soft set TOPSIS method and we present an application of suggested method for the selection of fertilizer.

2. Preliminaries

Definition 2.1[2].Let U be the initial universal set and E be the set of parameters. Let P(U) denotes the power set of U. Let A ⊂ E, A pair (F_A, E) is called soft set over U where F_A is mapping given by F_A:E→ P(U) such that $F_A(E)$ =Ø if e∉ A.

Here F_A is called approximate function of the soft set (F_A, E). The set $F_A(e)$ is called e-approximate value set which consists of related objects of the parameters e∈ E.

Example: Let Ube the set of four diseases given by U = { d_1, d_2, d_3, d_4} Let E be the parameters given by

E= {fever, indignation, headache, stomach problems} = { e_1, e_2, e_3, e_4} where

e_1Represents the parameter fever

e_2 Represents the parameter indigation

e_3 Represents the parameter headache

e_4 Represents the parameter stomak problems.

Let A⊂E, given by A= $\{e_1, e_2, e_3\}$. Now suppose that F_A is a mapping defined as diseases and given by F_A (e_1) = $\{d_2,d_4\}$, $F_A(e_2)$ = $\{d_1,d_3\}$, F_A (e_3)= $\{d_2,d_3\}$.

Then the soft set (F_A, E) = { fever=$\{d_2,d_4\}$, indigation = $\{d_1,d_3\}$,headache= $\{d_2,d_3\}$.}

Definition 2.2. [5] Let U be an initial universe set and E be a set of parameter. Let F^U denotes the set of all fuzzy subsets of U. Let A⊂ E, then a pair (F_A, E) is called fuzzy soft set over U, where F_A is mapping given by F_A :E→ $F^U$and F_A (e)= Ø if e∉ A, where Ø is a null fuzzy set.

Example: Let U be the set of four students say U= { p_1, p_2, p_3, p_4}. Let E be the set of parameters where each parameter is a fuzzy word, given by E= {good, very good, excellent, outstanding}.Let A⊂E given by A= {good, excellent, outstanding}= {e_1, e_2, e_3}.

e_1 Represents the parameter good

e_2 Represents the parameter excellent

e_3 Represents the parameter outstanding.

Now suppose that

$F_A(e_1)$ = {p_1/.8, p_1/.2,p_1/.5,p_1/.4 }

$F_A(e_2)$ = { p_1/.3, p_1/.2,p_1/.9,p_1/.7 }

$F_A(e_3)$ = { p_1/.2, p_1/.7,p_1/.8,p_1/.5 }

Then the fuzzy soft set(F_A,E) describing the students performance is given by

(F_A,E) = { good students ={p_1/.8, p_1/.2,p_1/.5,p_1/.4 }, very good students ={ p_1/.3, p_1/.2,p_1/.9,p_1/.7 }, excellent students ={ p_1/.2, p_1/.7,p_1/.8,p_1/.5 }

3. TOPSIS Method

The technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision making method used to determine the best alternatives from a set of options.This method depends on the fact that the best choice should have the minimum distance from the positive ideal solution and the maximum distance from the negative ideal solution. The ranking of the ideal solution is done based on their proximity values. The alternative with the highest proximity of the ideal solution is considered the most favorable and the worst alternative a rank approaching zero.

Fuzzy Soft TOPSIS method

Step-1 Construct the set of decision makers, set of fertilizers and the set of parameters respectively as

$\text{Ᵽ} = \{ \text{б}_1, \text{б}_2, \text{б}_3, \ldots\ldots\ldots \text{б}_n \}$,

$\text{Ƒ} = \{ \text{þ}_1, \text{þ}_2, \text{þ}_3, \ldots\ldots\ldots \text{þ}_n \}$

$$\text{Ҿ} = \{\text{ҿ}_1 \text{ҿ}_2 \text{ҿ}_3, \ldots\ldots\ldots \text{ҿ}_n \}$$

We construct a fuzzy soft set (F,A) , where A = {$\text{ҿ}_1, \text{ҿ}_2, \text{ҿ}_3, \text{ҿ}_4$ }

Step-2 We form the decision matrix for each decision makers

$$\text{Ë} = \left\{ \begin{matrix} \text{þ}_1 \text{ǵ}_{11} & \text{ǵ}_{12} & \text{ǵ}_{13} \ldots\ldots\ldots \text{ǵ}_{1n} \\ \\ \text{þ}_1 \text{ǵ}_{21} & \text{ǵ}_{22} & \text{ǵ}_{23} \ldots\ldots\ldots \text{ǵ}_{2n} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \end{matrix} \right\}$$

$$þ_n ǵ_{21} \quad ǵ_{22} \quad ǵ_{23} \ldots\ldots ǵ_{2n}$$

Step-3 Construct the weighted normalized decision matrix

$$\hat{W} = \begin{Bmatrix} ƴ_{11} & ƴ_{12} & ƴ_{13} \ldots\ldots ƴ_{1n} \\ ƴ_{21} & ƴ_{22} & ƴ_{23} \ldots\ldots ƴ_{2n} \\ \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots \\ ƴ_{21} & ƴ_{22} & ƴ_{23} \ldots\ldots ƴ_{2n} \end{Bmatrix}$$

$ƴ_{kt} = \sum_{i=1}^{5} \mu_{Ā'_{ҿ_i}(,ҿ_1)}$ ($þ_i$) for all i, k, t$\in I_n$

Step-4 We construct the decision matrix

$$Ɣ\,(þ_i) = \sum_{i=1}^{n} ƴ_{ij}$$

Where Ɣ ($þ_i$) decide the value of $þ_i$, So the decision matrix is

$$R = [Ɣ\,(þ_1),\ Ɣ\,(þ_2), Ɣ\,(þ_3) \ldots\ldots\ Ɣ\,(þ_n)]$$

Step-5 Rank the preference order in descending order.

Application

A farmer wants to select a fertilizer for cultivate his land out of from three which is our universal set

$Ƒ = \{ þ_1, þ_2, þ_3, þ_4, þ_5 \}$

Where $þ_1$ represents Potassium, $þ_2$ representsPhosphorus and $þ_3$ represents Nitrogen, $þ_4$ represents Muriate of potash and $þ_5$ represents Super phosphate.

Farmers decide the parameters for the selection of fertilizer which are

$$ҿ = \{ҿ_1, ҿ_2, ҿ_3, ҿ_4, ҿ_5\}$$

Where $ҿ_1$ is represents pH level, $ҿ_2$ represents environmental impact, $ҿ_3$ represents cost of the fertilizer, $ҿ_4$ is represents fertilizer form and $ҿ_5$ is represents crop type

Farmers hire a team of four selectors (Decision makers) to choose the best fertilizer out of five.

$Ᵽ = \{ б_1, б_2, б_3, б_4, \}$

For the first selector $б_1$ we construct the following fuzzy soft set

$$Ā'_{ҿ_1} = (F,A) = \begin{cases} F(ҿ_1) = \{(þ_1, 0.8), (þ_2, 0.6)(,þ_3, 0.5)(þ_4, 0.1)(,þ_5, 0.5),\} \\ F(ҿ_2) = \{(þ_1, 0.4), (þ_2, 0.5)(,þ_3, 0.3)\}(þ_4, 0.8)(,þ_5, 0.1)\} \\ F(ҿ_3) = \{(þ_1, 0.8), (þ_2, 0.3)(,þ_3, 0.9)\}(þ_4, 0.5)(,þ_5, 0.2)\} \\ F(ҿ_4) = \{(þ_1, 0.5), (þ_2, 0.1)(,þ_3, 0.1)\}(þ_4, 0.2)(,þ_3, 0.6)\} \\ F(ҿ_5) = \{(þ_1, 0.6), (þ_2, 0.7)(,þ_3, 0.8)(þ_3, 0.1)(,þ_5, 0.1)\} \end{cases}$$

Now for the second selector $б_2$ we construct the fuzzy soft set

$$\bar{A}'_{\text{ҿ}_2} = (F,A) = \begin{cases} F(\text{ҿ}_1) = \{(\text{þ}_1, 0.1), (\text{þ}_2, 0.8)(, \text{þ}_3, 0.6)(\text{þ}_4, 0.4)(, \text{þ}_5, 0.7)\} \\ F(\text{ҿ}_2) = \{(\text{þ}_1, 0.6), (\text{þ}_2, 0.9)(, \text{þ}_3, 0.7)(\text{þ}_4, 0.3)(, \text{þ}_5, 0.5)\} \\ F(\text{ҿ}_3) = \{(\text{þ}_1, 0.4), (\text{þ}_2, 0.2)(, \text{þ}_3, 0.7)\}(\text{þ}_4, 0.5)(, \text{þ}_5, 0.1) \\ F(\text{ҿ}_4) = \{(\text{þ}_1, 0.7), (\text{þ}_2, 0.7)(, \text{þ}_3, 0.8)\}(\text{þ}_4, 0.1)(, \text{þ}_5, 0.6) \\ F(\text{ҿ}_5) = \{(\text{þ}_1, 0.8), (\text{þ}_2, 0.1)(, \text{þ}_3, 0.1)(\text{þ}_4, 0.2)(, \text{þ}_5, 0.1)\} \end{cases}$$

For the third selector б_3 we construct the fuzzy soft set as follows

$$\bar{A}'_{\text{ҿ}_3} = (F,A) = \begin{cases} F(\text{ҿ}_1) = \{(\text{þ}_1, 0.4), (\text{þ}_2, 0.2)(, \text{þ}_3, 0.7)(\text{þ}_4, 0.5)(, \text{þ}_5, 0.4)\} \\ F(\text{ҿ}_2) = \{(\text{þ}_1, 0.7), (\text{þ}_2, 0.7)(, \text{þ}_3, 0.8)(\text{þ}_4, 0.1)(, \text{þ}_5, 0.1)\} \\ F(\text{ҿ}_3) = \{(\text{þ}_1, 0.8), (\text{þ}_2, 0.1)(, \text{þ}_3, 0.1(\text{þ}_4, 0.2)(, \text{þ}_5, 0.6))\} \\ F(\text{ҿ}_4) = \{(\text{þ}_1, 0.5), (\text{þ}_2, 0.3)(, \text{þ}_3, 0.9)(\text{þ}_4, 0.5)(, \text{þ}_5, 0.2)\} \\ F(\text{ҿ}_5) = \{(\text{þ}_1, 0.1), (\text{þ}_2, 0.5)(, \text{þ}_3, 0.3)(\text{þ}_4, 0.8)(, \text{þ}_3, 0.1)\} \end{cases}$$

For the fourth selector б_4 we construct the fuzzy soft set as follows

$$\bar{A}'_{\text{ҿ}_4} = (F,A) = \begin{cases} F(\text{ҿ}_1) = \{(\text{þ}_1, 0.5), (\text{þ}_2, 0.3)(, \text{þ}_3, 0.9(\text{þ}_4, 0.5)(, \text{þ}_5, 0.2))\} \\ F(\text{ҿ}_2) = \{(\text{þ}_1, 0.1), (\text{þ}_2, 0.5)(, \text{þ}_3, 0.3(\text{þ}_4, 0.8)(, \text{þ}_5, 0.1))\} \\ F(\text{ҿ}_3) = \{(\text{þ}_1, 0.9), (\text{þ}_2, 0.6)(, \text{þ}_3, 0.5(\text{þ}_4, 0.1)(, \text{þ}_5, 0.5))\} \\ F(\text{ҿ}_4) = \{(\text{þ}_1, 0.1), (\text{þ}_2, 0.8)(, \text{þ}_3, 0.6)(\text{þ}_4, 0.4)(, \text{þ}_5, 0.7)\} \\ F(\text{ҿ}_5) = \{(\text{þ}_1, 0.6), (\text{þ}_2, 0.9)(, \text{þ}_3, 0.7(\text{þ}_4, 0.3)(, \text{þ}_5, 0.1))\} \end{cases}$$

Now the fuzzy decision matrices can be constructed by decision makers as follows

$$\bar{A}'_{\text{ҿ}_1} \quad \text{ҿ}_1, \text{ҿ}_2, \text{ҿ}_3, \text{ҿ}_4, \text{ҿ}_5$$

$$\text{б}_1 = \begin{array}{c} \text{þ}_1 \\ \text{þ}_2 \\ \text{þ}_3 \\ \text{þ}_4 \\ \text{þ}_5 \end{array} \left\{ \begin{array}{ccccc} .8 & .4 & .8 & .5 & .6 \\ .6 & .5 & .3 & .1 & .7 \\ .5 & .3 & .9 & .1 & .8 \\ .1 & .8 & .5 & .2 & .1 \\ .5 & .1 & .2 & .6 & .1 \end{array} \right\}$$

$$\bar{A}'_{\text{ҿ}_2} \quad \text{ҿ}_1, \text{ҿ}_2, \text{ҿ}_3, \text{ҿ}_4, \text{ҿ}_5$$

$$\text{б}_2 = \begin{array}{c} \text{þ}_1 \\ \text{þ}_2 \\ \text{þ}_3 \\ \text{þ}_4 \\ \text{þ}_5 \end{array} \left\{ \begin{array}{ccccc} .1 & .6 & .4 & .7 & .8 \\ .8 & .9 & .2 & .7 & .1 \\ .6 & .7 & .7 & .8 & .1 \\ .4 & .3 & .5 & .1 & .2 \\ .7 & .5 & .1 & .6 & .1 \end{array} \right\}$$

$$\bar{A}'_{\text{ҿ}_3} \quad \text{ҿ}_1, \text{ҿ}_2, \text{ҿ}_3, \text{ҿ}_4, \text{ҿ}_5$$

$$\text{б}_3 = \begin{array}{c} \text{þ}_1 \\ \text{þ}_2 \\ \text{þ}_3 \\ \text{þ}_4 \\ \text{þ}_5 \end{array} \left\{ \begin{array}{ccccc} .4 & .7 & .8 & .5 & .1 \\ .2 & .7 & .1 & .3 & .5 \\ .7 & .8 & .1 & .9 & .3 \\ .5 & .1 & .2 & .5 & .8 \\ .4 & .1 & .6 & .2 & .1 \end{array} \right\}$$

$$\bar{A}'_{ȩ_4} \quad ȩ_1,\ ȩ_2,\ ȩ_3,\ ȩ_4,\ ȩ_5$$

$$б_4 = \begin{array}{c} ᵽ_1 \\ ᵽ_2 \\ ᵽ_3 \\ ᵽ_4. \\ ᵽ_5 \end{array} \left\{ \begin{array}{ccccc} .5 & .1 & .9 & .1 & .6 \\ .3 & .5 & .6 & .8 & .9 \\ .9 & .3 & .5 & .6 & .7 \\ .5 & .8 & .1 & .4 & .3 \\ .2 & .1 & .5 & .7 & .1 \end{array} \right\}$$

We construct weighted normalized decision matrix

$ƴ_{11} = \sum_{i=1}^{5} \mu_{\bar{A}'_{ȩ_i}(,ȩ_1)}(ᵽ_1) = \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_4,(ȩ_1)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_5,(ȩ_1)}}(ᵽ_1)$

= .8+.1+.4+.5 = 1.8

$ƴ_{12} = \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_4,(ȩ_1)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_5,(ȩ_1)}}(ᵽ_2)$

.= .4+.6+.7+.1 = 1.8

$ƴ_{13} = \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_4,(ȩ_1)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_5,(ȩ_1)}}(ᵽ_3)$

.= .8+.4+.8+.9 = 2.9

$ƴ_{14} = \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_4,(ȩ_1)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_5,(ȩ_1)}}(ᵽ_4)$

.= .5+.7+.5+.1 = 1.8

$ƴ_{15} = \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_5) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_5) + \mu_{\bar{A}'_{ȩ_1,(ȩ_1)}}(ᵽ_5) + \mu_{\bar{A}'_{ȩ_4,(ȩ_1)}}(5) + \mu_{\bar{A}'_{ȩ_5,(ȩ_1)}}(ᵽ_5)$

.= .6+.8+.1+.6 = 2.1

$ƴ_{21} = \mu_{\bar{A}'_{ȩ_1,(ȩ_2)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_2,(ȩ_2)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_3,(ȩ_2)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_4,(ȩ_2)}}(ᵽ_1) + \mu_{\bar{A}'_{ȩ_5,(ȩ_2)}}(ᵽ_1)$

.= ..6+.8+.2+.3 = 1.9

$ƴ_{22} = \mu_{\bar{A}'_{ȩ_1,(ȩ_2)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_2,(ȩ_1)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_3,(ȩ_2)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_4,(ȩ_2)}}(ᵽ_2) + \mu_{\bar{A}'_{ȩ_5,(ȩ_2)}}(ᵽ_2)$

.= .5+.9+.7+.5 = 2.6

$ƴ_{23} = \mu_{\bar{A}'_{ȩ_1,(ȩ_2)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_2,(ȩ_2)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_3,(ȩ_2)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_4,(ȩ_2)}}(ᵽ_3) + \mu_{\bar{A}'_{ȩ_5,(ȩ_2)}}(ᵽ_3)$

.= .3+.2+.1+.6 = 1.2

$ƴ_{24} = \mu_{\bar{A}'_{ȩ_1,(ȩ_2)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_2,(ȩ_2)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_3,(ȩ_2)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_4,(ȩ_2)}}(ᵽ_4) + \mu_{\bar{A}'_{ȩ_5,(ȩ_2)}}(ᵽ_4)$

.= .1+.7+.3+.8 = 1.9

$\acute{y}_{25} = \mu_{\bar{A}'_{ę_1,(ę_2)}}(þ_5) + \mu_{\bar{A}'_{ę_2,(ę_2)}}(þ_5) + \mu_{\bar{A}'_{ę_3,(ę_2)}}(þ_5) + \mu_{\bar{A}'_{ę_4,(ę_2)}}(þ_5) + \mu_{\bar{A}'_{ę_5,(ę_2)}}(þ_5)$

.= .7+.1+.5+.9 = 2.2

$\acute{y}_{31} = \mu_{\bar{A}'_{ę_1,(ę_3)}}(þ_1) + \mu_{\bar{A}'_{ę_2,(ę_3)}}(þ_1) + \mu_{\bar{A}'_{ę_3,(ę_3)}}(þ_1) + \mu_{\bar{A}'_{ę_4,(ę_3)}}(þ_1) + \mu_{\bar{A}'_{ę_5,(ę_3)}}(þ_1)$

.= .5+.6+.7+.9= 2.7

$\acute{y}_{32} = \mu_{\bar{A}'_{ę_1,(ę_3)}}(þ_2) + \mu_{\bar{A}'_{ę_2,(ę_3)}}(þ_2) + \mu_{\bar{A}'_{ę_3,(ę_3)}}(þ_2) + \mu_{\bar{A}'_{ę_4,(ę_3)}}(þ_2) + \mu_{\bar{A}'_{ę_5,(ę_3)}}(þ_2)$

.= .3+.7+.8+.03= 2.1

$\acute{y}_{33} = \mu_{\bar{A}'_{ę_1,(ę_3)}}(þ_3) + \mu_{\bar{A}'_{ę_2,(ę_3)}}(þ_3) + \mu_{\bar{A}'_{ę_3,(ę_3)}}(þ_3) + \mu_{\bar{A}'_{ę_4,(ę_3)}}(þ_3) + \mu_{\bar{A}'_{ę_5,(ę_3)}}(þ_3)$

.= .9+.7+.1+.5= 2.2

$\acute{y}_{34} = \mu_{\bar{A}'_{ę_1,(ę_3)}}(þ_4) + \mu_{\bar{A}'_{ę_2,(ę_3)}}(þ_4) + \mu_{\bar{A}'_{ę_3,(ę_3)}}(þ_4) + \mu_{\bar{A}'_{ę_4,(ę_3)}}(þ_4) + \mu_{\bar{A}'_{ę_5,(ę_3)}}(þ_4)$

.= .1+.8+.9+.6= 2.4

$\acute{y}_{35} = \mu_{\bar{A}'_{ę_1,(ę_3)}}(þ_5) + \mu_{\bar{A}'_{ę_2,(ę_3)}}(þ_5) + \mu_{\bar{A}'_{ę_3,(ę_3)}}(þ_3) + \mu_{\bar{A}'_{ę_4,(ę_3)}}(þ_5) + \mu_{\bar{A}'_{ę_5,(ę_3)}}(þ_5)$

.= .8+.1+.3+.7= 1.9

$\acute{y}_{41} = \mu_{\bar{A}'_{ę_1,(ę_4)}}(þ_1) + \mu_{\bar{A}'_{ę_2,(ę_4)}}(þ_1) + \mu_{\bar{A}'_{ę_3,(ę_4)}}(þ_1) + \mu_{\bar{A}'_{ę_4,(ę_4)}}(þ_1) + \mu_{\bar{A}'_{ę_5,(ę_4)}}(þ_1)$

.= .1+.4+.5+.5= 1.5

$\acute{y}_{42} = \mu_{\bar{A}'_{ę_1,(ę_4)}}(þ_2) + \mu_{\bar{A}'_{ę_2,(ę_4)}}(þ_2) + \mu_{\bar{A}'_{ę_3,(ę_4)}}(þ_2) + \mu_{\bar{A}'_{ę_4,(ę_4)}}(þ_2) + \mu_{\bar{A}'_{ę_5,(ę_4)}}(þ_2)$

.= .8+.3+.1+.8= 2

$\acute{y}_{43} = \mu_{\bar{A}'_{ę_1,(ę_4)}}(þ_3) + \mu_{\bar{A}'_{ę_2,(ę_4)}}(þ_3) + \mu_{\bar{A}'_{ę_3,(ę_4)}}(þ_3) + \mu_{\bar{A}'_{ę_4,(ę_4)}}(þ_3) + \mu_{\bar{A}'_{ę_5,(ę_4)}}(þ_3)$

.= .5+.5+.2+.1= 1.3

$\acute{y}_{44} = \mu_{\bar{A}'_{ę_1,(ę_4)}}(þ_4) + \mu_{\bar{A}'_{ę_2,(ę_4)}}(þ_3) + \mu_{\bar{A}'_{ę_3,(ę_4)}}(þ_4) + \mu_{\bar{A}'_{ę_4,(ę_4)}}(þ_4) + \mu_{\bar{A}'_{ę_5,(ę_4)}}(þ_4)$

.= .2+.1+.5+.4= 1.2

$\acute{y}_{45} = \mu_{\bar{A}'_{ę_1,(ę_4)}}(þ_5) + \mu_{\bar{A}'_{ę_2,(ę_4)}}(þ_5) + \mu_{\bar{A}'_{ę_3,(ę_4)}}(þ_5) + \mu_{\bar{A}'_{ę_4,(ę_4)}}(þ_5) + \mu_{\bar{A}'_{ę_5,(ę_4)}}(þ_5)$

.= .1+.2+.8+.3= 1.4

$y_{51} = \mu_{\bar{A}'_{e_1,(e_5)}}(þ_1) + \mu_{\bar{A}'_{e_2,(e_5)}}(þ_1) + \mu_{\bar{A}'_{e_3,(e_5)}}(þ_1) + \mu_{\bar{A}'_{e_4,(e_5)}}(þ_1) + \mu_{\bar{A}'_{e_5,(e_5)}}(þ_1)$

.= .5+.7+.4+.2= 1.8

$y_{52} = \mu_{\bar{A}'_{e_1,(e_5)}}(þ_2) + \mu_{\bar{A}'_{e_2,(e_5)}}(þ_2) + \mu_{\bar{A}'_{e_3,(e_5)}}(þ_2) + \mu_{\bar{A}'_{e_4,(e_5)}}(þ_2) + \mu_{\bar{A}'_{e_5,(e_5)}}(þ_2)$

.= .1+.5+.1+.1= 0.8

$y_{53} = \mu_{\bar{A}'_{e_1,(e_5)}}(þ_3) + \mu_{\bar{A}'_{e_2,(e_5)}}(þ_3) + \mu_{\bar{A}'_{e_3,(e_5)}}(þ_3) + \mu_{\bar{A}'_{e_4,(e_5)}}(þ_3) + \mu_{\bar{A}'_{e_5,(e_5)}}(þ_3)$

.= .2+.1+.6+.5= 1.4

$y_{54} = \mu_{\bar{A}'_{e_1,(e_5)}}(þ_4) + \mu_{\bar{A}'_{e_2,(e_5)}}(þ_4) + \mu_{\bar{A}'_{e_3,(e_5)}}(þ_4) + \mu_{\bar{A}'_{e_4,(e_5)}}(þ_4) + \mu_{\bar{A}'_{e_5,(e_5)}}(þ_4)$

.= .6+.6+.2+.7= 2.1

$y_{55} = \mu_{\bar{A}'_{e_1,(e_5)}}(þ_5) + \mu_{\bar{A}'_{e_2,(e_5)}}(þ_5) + \mu_{\bar{A}'_{e_3,(e_5)}}(þ_5) + \mu_{\bar{A}'_{e_4,(e_5)}}(þ_5) + \mu_{\bar{A}'_{e_5,(e_5)}}(þ_5)$

.= .1+.1+.1+.1= .4

So, the weight matrix is obtained

$$\hat{W} = \begin{bmatrix} 1.8 & 1.8 & 2.9 & 1.8 & 2.1 \\ 1.9 & 2.6 & 1.2 & 1.9 & 2.2 \\ 2.7 & 2.1 & 2.2 & 2.4 & 1.9 \\ 1.5 & 2 & 1.3 & 1.2 & 1.4 \\ 1.8 & 0.8 & 1.4 & 2.1 & .4 \end{bmatrix}$$

Now we construct the decision matrix vector R and we find all elements of R individually

$\boldsymbol{Y}(þ_1) = \sum_{i=1}^{3} y_{1j} = y_{11} + y_{12} + y_{13} + y_{14} + y_{15}$ = 1.8+1.8+2.9+1.8+2.1= 10.4

$\boldsymbol{Y}(þ_2) = \sum_{i=1}^{3} y_{2j} = y_{21} + y_{22} + y_{23} + y_{24} + y_{25}$ = 1.9+2.6+1.2+1.9+2.2= 9.8

$\boldsymbol{Y}(þ_3) = \sum_{i=1}^{3} y_{3j} = y_{31} + y_{32} + y_{33} + y_{34} + y_{35}$ = 2.7+2.1+2.2+2.4+1.9= 11.3

$\boldsymbol{Y}(þ_4) = \sum_{i=1}^{3} y_{4j} = y_{41} + y_{42} + y_{43} + 4 + y_{45}$ = 1.5+2+1.3+1.2+1.4= 7.4

$\boldsymbol{Y}(þ_5) = \sum_{i=1}^{3} y_{3j} = y_{51} + y_{52} + y_{53} + y_{54} + y_{55}$ = 1.8+.8+2.2+1.4+2.1+ .4= 6.5

Now we ranking among the fertilizers in descending order of values of $\boldsymbol{Y}(þ_i)$

We have

$$\boldsymbol{Y}(þ_3) > \boldsymbol{Y}(þ_1) > \boldsymbol{Y}(þ_2) > \boldsymbol{Y}(þ_4) > \boldsymbol{Y}(þ_5)$$

The result shows that the Nitrogen ($þ_3$) fertilizer is the best fertilizer for the farmers.

4. Conclusion

The prevailing scenario in agriculture of our country can be drastically improved if the research findings and development can be practically being made available for the farmers. The main goal of this paper is to present fuzzy soft set TOPSIS method for recommendation of fertilizers. Finally we have given one elementary application for decision making problem on the basis of fuzzy soft set TOPSIS. In future this method can be applied having uncertain parameters.

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