Crop Cultivation in Namakkal District – A Decision Making Model Using Fuzzy Soft Sets

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ABSTRACT

SoftSet Theory is one of the recent topics gaining significance in finding rational and logical solutions to various real life problems which involve uncertainty, impreciseness and vagueness. In this article, the authors intended to develop a Decision Making Model using Fuzzy Soft Sets to facilitate farmers to selectthe crop, from the various alternatives available, that suitsbest their expectations.

KEYWORDS: **Soft set,Fuzzy Set,Fuzzy Soft Set.**

I. INTRODUCTION

India is an agricultural country and one third population depends on the agricultural sector directly or indirectly. Agriculture remains as the mainstay of the Indian economy since times immemorial. Indian agriculture contributes to about 25% to the national gross domestic product (GDP). With food being the crowning need of mankind, much emphasis has been laid on commercializing agricultural production. For this reason, adequate production and even distribution of food hasof late become a high priority global concern. In earlier days when the village economy was more or less self-sufficient, the marketing of agricultural products presented no difficulty as the farmer sold his product to the consumer on a cash or barter basis. Today's

agricultural marketing has to undergo a series of exchanges or transfers from one person to another before it reaches the consumer.

No doubt, every farmer has the prime motive of earning higher revenue out of their cultivation process. The farmers generally prefer to cultivate crops that yield high returns at a short period of time. The cultivation process varies from one crop to another in terms of financial requirement, manpower requirement, irrigation, fertilizer requirement and so on.

Here the authors attempted to develop a mathematical model, using fuzzy soft sets that help to identify the crop to be cultivated by a farmer which suits best his expectations.

II. BASIC DEFINITIONS

Definition:1

Let U be a nonempty finite set of objects called universe and let E be a nonempty set of parameters. An ordered pair (F, E) is said to be a **Soft set** over U, where F is a mapping from E into the set of all subsets of U. That is, $F : E \longrightarrow P(U)$.

It has been interpreted that a soft set indeed is a parameterized family of subsets of U.

Example:2

Let $U = \{c_1, c_2, c_3\}$ be the set of three cars and $E = \{\text{costly}(e_1), \text{metallic color}(e_2), \text{cheap}(e_3)\}$ be the set of parameters, where $A = \{e_1, e_2\} \subset E$. Then $(F, A) = \{F(e_1) = \{c_1, c_2, c_3\}, F(e_2) = \{c_1, c_3\}\}$ is the crisp soft set over U which describes the " attractiveness of the cars" which Mr. S(say) is going to buy.

Definition: 3

Let U be a universe. A fuzzy set X over U is a set defined by a function μ_x representing a mapping $\mu_x : U \to [0,1]$. Here, μ_x called **Membership Function** of X, and the value $\mu_x(u)$ is called the **Grade of Membership** of $u \in U$. The value represents the degree of u belonging to the fuzzy set X. Thus, a fuzzy set X over U can be represented as $X = \{(u/(\mu_x(u)) : u \in U, \mu_x(u) \in [0,1]\}$. The set of all the fuzzy sets over U will be denoted by F(U).

Definition:4

Let U be a universal set, E a set of parameters and A⊂ E. Let F(U) denotes the set of all fuzzy subsets of U. Then a pair (F, A) is called **Fuzzy Soft Set** over U, where F is a mapping from A to F(U).

Example:5

Let U = {c_1, c_2, c_3} be the set of three cars and E = {costly(e_1), metallic colour(e_2), getup(e_3)} be the set of parameters, where A = {e_1, e_2} ⊂ E. Then (G, A) = {G(e_1) = {c_1/0.6, c_2/0.4, c_3/0.3}, G(e_2) = {c_1/0.5, c_2/0.7, c_3/0.8}} is the fuzzy soft set over U describes the "attractiveness of the cars" which Mr.S (say) is going to buy.

Definition: 6

Let (F, A) and (G, B) be two fuzzy soft sets over a common universal set. Then a **RelationR** of (F, A) on (G, B) may be defined as a mapping R: A×B⟶P(U^2) such that for each e_i∈ A,e_j∈ B and for all u_l∈ F(e_i), u_k ∈ G(e_j), the relation R is characterized by the following membership function, $\mu_R(u_l,u_k)=\mu_{F(e_i)}(u_l)\times\mu_{G(e_j)}(u_k)$, where u_l ∈ F(e_i), u_k∈ G(e_j).

III. APPLICATION OF FUZZY SOFT SETS

The authors adopted convenient sampling technique and solicited response from 100 sample farmers residing at **Karkoodalpatty, Namagiripettai** and**Muniappanpalayam** villages in **Namakkal** district. Based on the pilot survey in the study area, the authors identifiedthe various crops cultivated and the features influencing the choice of crop. The details are presented below:

Features influencing choice of crop

1. Low Capital(P_1)
2. Low Short Duration for yield(P_2)
3. Minimum irrigation facilities(P_3)
4. Minimum manpower requirement(P_4)
5. Easy cultivation process(P_5)
6. Minimum use of fertilizers(P_6)
7. Low risk of damage to crops(P_7)

8. Easy harvesting process(P_8)
9. Easy marketing facilities(P_9)
10. High Returns(P_{10})

List of Crops

1. Sugarcane (C_1)
2. Paddy (C_2)
3. Maize(C_3)
4. Turmeric(C_4)
5. Tomato(C_5)
6. Cotton(C_6)
7. Groundnut(C_7)
8. Plantain(C_8)
9. Tapioca (C_9)

To apply Fuzzy Soft Sets to this crop selection problem, consider the various types of crops as the universal set U = {C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9} and the factors influencing choice of crop as the set of parameters E. That is E = {P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}}.

Based on the opinion of the respondents, the Fuzzy Soft Sets (F_i, P_i), i = 1 to 10 were framed by considering the membership value $\mu_{F_i(P_i)}(I_j)$ as the ratio between the number of respondents who gave favorable response to the feature P_i for the cultivation of crop C_j and the total number of respondents.

(F_1, P_1) =F_1(Low Capital) = {C_1/0.6,C_2/0.4,C_3/0.7,C_4/0.5,C_5/0.7,C_6/0.7,C_7/0.6,C_8/0.2,C_9/0.7}

(F_2,P_2)=F_2(Shortdurationofcrop={C_1/0.6,C_2/0.5,C_3/0.8,C_4/0.3,C_5/0.7,C_6/0.5,C_7/0.7,C_8/0.3,C_9/0.4}

(F_3,P_3) =F_3(Minimum irrigation facilities) = {C_1/0.3,C_2/0.3,C_3/0.9,C_4/0.4,C_5/0.6,C_6/0.8,C_7/0.7,C_8/0.4,C_9/0.7}

(F_4, P_4) =F_4(Minimum manpower requirement) = {C_1/0.4,C_2/0.4,C_3/0.8,C_4/0.5,C_5/0.7,C_6/0.2,C_7/0.6,C_8/0.7,C_9/0.6}

(F_5, P_5) =F_5(Easy cultivation process) = {C_1/0.7,C_2/0.5,C_3/0.7,C_4/0.4,C_5/0.6,C_6/0.7,C_7/0.5,C_8/0.7,C_9/0.7}

(F_6, P_6) =F_6(Minimum use of fertilizers) = {C_1/0.4,C_2/0.5,C_3/0.7,C_4/0.6,C_5/0.7,C_6/0.6,C_7/0.6,C_8/0.8,C_9/0.8}

(F_7, P_7) =F_7(Low risk of damage to crops) = {C_1/0.8,C_2/0.8,C_3/0.6,C_4/0.7,C_5/0.5,C_6/0.5,C_7/0.7,C_8/0.5,C_9/0.6}

$(F_8, P_8) = F_8$(Easy Harvesting Process) = {C_1/0.7,C_2/0.6,C_3/0.7,C_4/0.5,C_5/0.6,C_6/0.5,C_7/0.7,C_8/0.8,C_9/0.6}

$(F_9, P_9) = F_9$(Easy Marketing Facilities) = {C_1/0.7,C_2/0.5,C_3/0.6,C_4/0.6,C_5/0.7,C_6/0.4,C_7/0.7,C_8/0.7,C_9/0.6}

$(F_{10}, P_{10}) = F_{10}$(High Returns) = {$C_1$/0.8,$C_2$/0.6,$C_3$/0.6,$C_4$/0.7,$C_5$/0.7,$C_6$/0.6,$C_7$/0.7,$C_8$/0.8,$C_9$/0.7}

The authors developed a Decision Making Model using fuzzy soft relations by considering a set of features preferred by a farmer to identify the choice of crop cultivation that suits best the expectations of the said farmer.

Case 1: Features preferred by a farmer X

Minimum Irrigation Facilities(P_3) and Easy Harvesting process(P_8)

The problem can be solved by virtue of the definition 6,a fuzzy soft relation (R, C) among the fuzzy soft sets (F_3, P_3) and (F_8, P_8) of the choice of crop cultivation that ensures Minimum irrigation facilities and Easy harvesting process is formed.

(R, C) = R(Minimum Irrigation Facilities,Easy Harvesting Process)

= {C_1/0.21,C_2/0.18,C_3/0.63,C_4/0.20,C_5/0.36,C_6/0.4,C_7/0.42,C_8/0.32,C_9/0.4}

Therefore, the choice of crop cultivation that best satisfies the expectations of thefarmer X is the crop which has the largest membership value in the above relation. Here C_3 has the largest membership value (0.63). Hence the crop '**Maize**' best suits the expectations of the farmer X.

In the same manner the choice of crop cultivation of any farmer can be arrived at by taking into account any set of features expected by a farmer. Some of such are given below:

Case 2: Features preferred by afarmer Y

Minimum Use of Fertilizers (P_6) and Low Risk of Damage to Crops(P_7)

(R, C) = R(Minimum use of Fertilizers, Low risk of Damage to Crops)

= {C_1/0.32,C_2/0.4,C_3/0.42,C_4/0.42,C_5/0.35,C_6/0.3,C_7/0.42,C_8/0.4,C_9/0.48}

Here C_9 has the largest membership value (0.48). Hence the crop'**Tapioca**' best suits the expectations of thefarmer Y.

Case 3: Features preferred by afarmer Z

Low Capital(P_1), Easy Marketing Facilities(P_9) and High Returns(P_{10})

(R, C) = R(Low Capital, Easy Marketing Facilities, High Returns)

$= \{C_1/0.336, C_2/0.12, C_3/0.252, C_4/0.21, C_5/0.343, C_6/0.168, C_7/0.294, C_8/0.112, C_9/0.294\}$

Here C_5 has the largest membership value (0.343). Hence the crop'**Tomato**' best suits the expectations of the farmer Z.

IV. CONCLUSION

In the real life situations there are vast numbers of problems that warrant rational, logical and scientific decisions that fit best for the accomplishment of desired objective. The concept of fuzzy soft sets has rich potentials for developing such decision making models suitable for personal, social, technical, commercial and managerial issues.

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