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An Efficient Decision making in Crop cultivation using Soft Set Theory

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***Abstract*—** India is associate agricultural country and majority of its population is engaged in agricultural works and farming outcomes being their own supply of financial gain. Agriculture sector faces several challenges of enhancing production with accessible natural resources. Soft set theory plays an important role to show great ability in decision making model like crop selection, crop planning, irrigation planning, water resource management etc. Even if a near optimal solution is obtained, it will have a very large impact. This can be achieved by the use of soft set techniques. This paper brings in awareness on decision making model in crop cultivation by using soft set theory that helps to identify the crop to be cultivated by a farmer which suits best of his expectations by the questionnaire and it can be optimized by various statistical measures.

***Keywords*—** Soft Set, Quickreduct, K-Means, Statistical Measure.

I. INTRODUCTION

Agriculture plays associate degree major role directly or indirectly in up economy of developing countries like India, China, Brazil etc. In fact, one aspect agriculture provides food security to the individuals and on the opposite hand it provides raw materials to agro based mostly industries. The expansion of human civilization over the ages was principally impact by the advancement in agriculture sector. the increase and fall civilizations like Indus vale civilization, Harappan civilization were supported the progression and regression in agriculture. Even though mankind has progressed from farming to manufacture associate degreed to an era of technology, agriculture is that the one sector which will ne'er lose its significance attributable to its impact. The merchandise and outcome of agriculture is extremely a lot of necessary for the upkeep of mankind.

A. *Soft Set Theory*

Soft set theory has a rich potential for applications in several directions which include the smoothness of function, gametheory, operations research, Riemann integration, Perron integration, probability theory, and measurement theory had been shown by Molodtsov in his pioneer work and their applications of soft set to stability and regularization. Extension of soft set theory in real analysis was going on in fast track. Applications of soft set theory in other disciplines and real life problems are now on fast track development in the decision making area. In this section, recall some basic notions of soft set theory [29].

In this section, define some basic notation of soft set theory introduced by Molodtsov and some useful definition from Majiet al., [20]. Here, U to be an initial universal set and E to be a set of parameters and A, B subset of E.

a) Definition 1(Soft Set)

A pair (F, E) is called a soft set (over U) if and only if f is a mapping of E into the set of all subsets of the set U. In other words, the soft set is a parameterized family of subsets of the set U. Every set F (e), e ε E, from this family may be considered as the set of e-approximate elements of the soft set. Let us consider the following example.

Ex:1 A soft set (F, E) describes the attractiveness of the bikes which Mr. x is going to buy. U is the set of bikes under consideration. E is the set of parameters.
E= (e1=stylish; e2=heavy duty; e3=light; e4=steel body; e5=cheap; e6=good mileage; e7=easily started; e8=long driven; e9=costly; e10=fiber body)
In this case, to define a soft set means to point out stylish bikes, heavy duty bikes, and so on.

Ex:2 Let U= {u1, u2, u3, u4, u5} be a universal set and E= {x1, x2, x3, x4} be a set of parameters. If A= {x2, x3, x4} and then the soft set F_A is written by F_A= {(x2, {u2, u4}), (x4, U)}.

b) Definition 2 (Operation with Soft Sets)

Suppose a binary operation denoted by *, is defined for all subsets of the set U. Let (F, A) and (G, B) be two soft sets over U. Then the operation * for the soft set is defined in the following way: (F, A) *(G, B) = (H, AXB) Where H (α,β)

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=F(α)*G(β), α ε A, β ε B and A×B is the Cartesian product of the sets A and B.

c) Definition 3 (Not Set of a Set of Parameters)

Let E = {e1, e2, e3…en} be a set of parameters. The NOT set of E denoted by ┐E and is defined by ┐E= {┐e1, ┐e2, ┐e3…. ┐en} where ┐e_i =not $e_i$for all i. It may be noted that ┐ and ┐ are two different operations.

d) *Definition 4 (Complement of a Soft Set)*

The complement of a soft set (F, A) is denoted by $(F, A)^c$ and is defined by $(F, A)^c = (F^c, ┐A)$ where F^c: ┐A→P(U) is a mapping which is defined by $F^c(α)$=U-F(┐α), for all α ε ┐A.

e) Definition 5 (NULL Soft Set)

A soft set (F, A) over U is said to be NULL soft set denoted by ϕ, if for all ϵ ε A, F(ϵ)=φ(null-set).

f) Definition 6 (Relative null Soft Set)

A soft set (F, A) over U is said to be relative NULL soft set with respect to parameter set A denoted by φ A if ϵ ε A, F(ϵ)=φ (null set).

g) Definition 7 (Relative Whole Soft Set)

A soft set (F, A) over U is said to be relative whole soft set (with the respect to the parameter set A) denoted by UA, if for all ϵ ε A, F(ϵ)=U.

This paper gives the overview of the crop cultivation based on the desired features of the farmers acceptance. It divides into Five sections: The First section gives Introduction. The Second section focuses Review of the related works. Third section describes the Algorithm and its Optimization methods. The fourth section presents proposed work and Finally, in the last section the conclusions are presented.

II. REVIEW OF RELATED WORK

This section focuses Soft set and its applications. P.K. Maji et al., outlined the thought of the core is twofold. First, it is used as a basis for computation of all reducts, then the core is enclosed in each reduct, and its computation is simple. Secondly, the core is understood because the set of the foremost characteristic a part of information, that can't be eliminated once reducing the knowledge [15].

F.Feng et al., mentioned the appliance of interval-valued fuzzy soft sets to unravel higher cognitive process issues [8]. They contributed to the present analysis direction by proposing versatile schemes for higher cognitive process supported (weighted) interval-valued fuzzy soft sets. In fact, they need shown that by considering applicable reduct fuzzy soft sets and level soft sets, IVFS based mostly higher cognitive process is reduced to a lot of less complicated treatment of crisp soft sets at constant time a good type of reduct fuzzy soft sets and level soft sets (available within the call process) might lead to nice flexibility and modelling power furthermore.

K.V.Babitha and J.J. Sunil., extended the ideas of relations and functions in soft pure mathematics context. They need conjointly created a shot to clarify the equivalent version of some theories on relations and functions within the background of sentimental sets [3]. The basic supporting structures for analysis and development on soft pure mathematics.

Z.Kong et al. delineate the issues of suboptimal selection and intercalary parameter set area unit mentioned within the reduction of sentimental sets. Abrand new definition of traditional parameter reduction was introduced. The info of best objects is deleted directly from the conventional parameter reduction, and therefore the next best selection is obtained precisely from the conventional parameter reduction during which the info of best objects area unit deleted. The formula excludes supernumerary parameters and searches for appropriate parameters within the possible sets victimization the choice partition and parameter importance degree. so, this formula performed a lot of with efficiency [13].

D.Chen et al., noted some incorrect and unreasonable statements. The thought of using the attributes reduction in rough pure mathematics to scale back the quantity of parameters to cipher the best objects appears purposeless. If their algorithms area unit applied to different similar call issues, they're going to fail [4]. The fundamental distinction between parameterization reduction of sentimental sets and attributes reduction in rough sets is additionally mentioned.

M.I.Ali et al., introduced some new notions like the restricted intersection, the restricted union, the restricted distinction and therefore the extended intersection of 2 soft sets. Moreover, they improved the notion of complement of a soft set, and prove that bound Diamond State Morgan's laws hold in soft pure mathematics with relevancy these new definitions [1].

T.Herawan et al., planned the many algorithms exist to handle the problems regarding reduction of sentimental sets. The foremost recent thought of traditional parameter reduction is introduced in [9], that overcomes the matter of suboptimal selection and intercalary parameter set of sentimental sets. However, the formula is tough to grasp and involves an excellent quantity of computation.

Z.Xiao et al., mentioned the soft sets application in recognizing soft info patterns, foremost analyze the fundamental definition of sentimental sets, create use of table to explain soft sets and provides the conception of sentimental sets reduction in step with the characters of sentimental sets[26]. Then, the strategy is intended that recognizing soft info patterns by establishing the data table supported soft sets theory, at constant time the solutions area unit planned equivalent to the various recognition vectors.

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This methodology with sensible mobility will operate collaterally and by batch thus on unleash the problem and quality in info analysis by some extents.

B.K.Tripathy et al., outlined the soft sets, fuzzy soft set may be a notion that permits indistinctness over a soft set model. Several connected ideas like complement of a fuzzy soft set, null fuzzy soft set, and absolute fuzzy soft set, intersection of fuzzy soft sets and union of fuzzy soft sets area unit redefined [24].

J.Q.Wang et al., planned the notion of hesitant fuzzy soft sets that mix the hesitant fuzzy sets and soft sets then they outlined the complement, "AND", "OR", union and intersection operations on hesitant fuzzy soft sets. The fundamental properties like De Morgan's laws and therefore the relevant laws of hesitant fuzzy soft sets area unit proved. Finally, they need applied it to a choice creating drawback with the assistance of level soft set [25].

S.Alkhazaleh et al., introduced the thought of sentimental pure mathematics as a general mathematical tool for managing uncertainty. The solutions of such issues involve the utilization of mathematical principles supported uncertainty and in exactitude. During this paper, they recalled the definition of a soft set, its properties and its operations. As a generalization of Molodtsov's soft set, they need introduced the definitions of a soft multiset, its basic operations like complement, union and intersection. They gave examples for these ideas and basic properties of the operations also are given [2].

J.H. Park et al., outlined Soft set Theory is a good methodology for finding issues of uncertainty. It is extended the ideas of relation and functions in soft pure mathematics. During this paper, they need any studied the equivalence soft set relations and procure soft analogues of the many results regarding normal equivalence relations and partitions [17]. The transitive closure of a soft set relation was mentioned and a few basic properties area unit proved.

N.Sundaravalli and Dr.A.Geetha., helped the farmers to acknowledge however lots production are going to be tired next coming back season and the way an excellent deal amount of precipitation can seem in order that farmers will get awareness and that they will manage themselves from their serious loss. The device used here is wont to predict coproduction of anywhere positively uploading the facts in accordance to users [19].

Ehsan Houshyar et al., evaluated the property and potency of corn production with respect to energy consumption within the Fars province, Southwest Asian country. To achieve the goal, fuzzy modeling and information enclosing Analysis (DEA) were used. Some DEA models like CCR (Charnes, Cooper and Rhodes), BCC (Banker, Charnes and Cooper) and SBM (Slack based mostly Measure) were applied in assessment of potency scores. Therefore, economical and inefficient farmers should modification the trends of energy utilization for approaching even a lot of property production [7].

Leila Naderloo et al., mentioned reconciling neuro-fuzzy abstract thought system was to predict the grain yield of irrigated wheat in Abyek city of Ghazvin province, Iran. The amount of inputs (eight inputs) for ANFIS, the input vector was clustered into 2 teams and 2 networks were trained. The results show that ANFIS one and ANFIS two might well predict the yield. Finally, the expected values of the 2 networks were used as inputs to the third ANFIS [14].

Hajare et al., bestowed the forecasting and warnings area unit the main services provided by the meteorologic profession. Several government and personal agencies area unit functioning on its behavior however still it's difficult and incomplete. They have a tendency to propose a brand new technique to construct the training set of pictures that represents the particular data [18].

Dinesh K.Sharma and R.K.Jana., proposed a tolerance fuzzy goal programming (FGP) and a FGP based genetic formula (GA) model for nutrient management decision-making for rice crop designing. Within the planned model, they need enclosed fuzzy goals like plant food price and rice yield within the decision-making method [6]. Fuzzy goals area unit reborn to goal constraints victimization their corresponding membership operate values and therefore the settled equivalent of the fuzzy model was obtained victimization tolerance based mostly FGP approach.

H.Wu and X.Su., planned a gaggle generalized interval-valued intuitionistic fuzzy soft set (G-GIVIFSS) and discuss its application in higher cognitive process. For achieving G-GIVIFSS, a generalized interval-valued intuitionistic fuzzy soft set (GIVIFSS) is initial planned, and therefore the vital operations, properties and aggregation operators of GIVIFSS were mentioned. Then, supported GIVIFSS, G-GIVIFSS was derived by embedding a lot of senior specialists to scale back the impact of single expert's preference. The vital operations, properties and therefore the weighted averaging operator of G-GIVIFSS also are mentioned [27].

F.Karaaslan and S.Karatas, outlined OR and AND – merchandise between intuitionistic fuzzy parameterized intuitionistic fuzzy soft sets (ifp- intuitionistic fuzzy soft sets) and they need planned a choice creating methodology referred to as ^-aggr higher cognitive process methodology supported ifp- intuitionistic fuzzy soft sets. Finally, offer Associate in Nursing application for this higher cognitive process methodology on a retardant together with ifp-intuitionistic fuzzy soft sets [12].

Jhunjhunwala et al., [10] outlined however the user will leverage the advantages for mobile technology to assist the farmers. This paper discussed various problems faced by the farmers will improve the value by a decent level. A farmer

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will act with someone UN agency has information or UN agency will guide them victimization varied databases and results out there with him to supply a satisfactory resolution to the issues baby-faced by the farmers.

Yanbo Huangaet al., [28] presented the soft computing techniques is applied in agriculture sector. And conjointly specify however varied factors that directly and indirectly have an effect on the farming is studied and analyzed in preciseness farming. It coined varied applications of sentimental computing techniques in soil and water context also are mentioned.

Jiang et al., extended fuzzy soft sets with fuzzy DLs, i.e., extended fuzzy soft pure mathematics by victimization the ideas of fuzzy DLs to act because the parameters of fuzzy soft sets and outline some operations for the extended fuzzy soft sets [11].

Deka Ganapati Chandra et al., [6] highlights on the issues and prospects of e-agriculture in rural Indian context. It includes facts on info imbalance between farmers, regions and countries. This paper describes the e-agriculture with the appliance of existing info and communication technologies.

Manav Singhal et al., [16] delineate a mobile based mostly application, particularly Krishi Ville, for farmers. This application takes care of the updates of assorted agricultural commodities, agricultural news updates, weather outlook updates etc.

Pethalakshmiet al., [19] studied and reviewed the thought of the soft set theory, and their development within the varied fields of its existing literature is dole out like Medical, Agriculture and Business etc.,

III. METHODOLOGY AND PROPOSED ALGORITHM

In this section, presents an algorithm for crop cultivation using Soft Set Theory and various optimization methods are discussed. Here a questionnaire is prepared which is focusing on common features in crop cultivation. Thus, obtained data is to be used in the further data analysis and research process. The Model questionnaire of the crop cultivation includes the following features which are tabulated in Table1. This questionnaire helpful to take the information table from the different farmer's suggestions for crop cultivation process.

A. K-Means Algorithm

Partitioning algorithms construct partitions of a database of N objects into a set of k clusters. The construction involves determining the optimal partition with respect to an objective function. K-Means algorithms, where each cluster is represented by the center of gravity of the cluster [22]. The basic algorithm is given below

1. Select k points as initial centroids.
2. Repeat
3. Form k clusters by assigning all points to the closest centroid.
4. Recompute the centroid of each cluster
5. until the centroids don't change.

Table 1: Sample Survey Features of the Various Crops

SLNo	Features	Sugarcane	Paddy	Maize	Turmeric	Tomato	Cotton	Groundnut	Plantain	Tapioca
1	Minimum Capital	6	4	7	5	7	7	6	2	7
2	Short duration(yield)	5	2	6	3	6	6	5	1	4
3	Minimum irrigation	4	1	4	3	3	2	2	2	2
4	Low manpower	5	3	2	4	3	4	4	3	3
5	Easy cultivation	4	2	4	3	4	2	3	1	2
6	Minimum Fertilizer	4	3	2	4	5	5	4	4	3
7	Low risk	5	2	4	2	4	3	3	3	2
8	Easy harvesting	6	3	3	4	5	2	2	5	3
9	Marketing facilities	7	5	6	6	7	4	7	7	6
10	High profit	8	6	6	7	7	6	7	8	7

B. Quick reduct Algorithm

The reduction of attributes is achieved by comparing equivalence relations generated by the sets of attributes. Attributes are removed so that the reduced set provides the same predictive capability of the decision feature as the original. A reduct is defined as a subset of minimal cardinality R_{min} of the conditional attribute set C such that $\gamma_R(D) = \gamma_C(D)$.

$$R = \{X : X \text{ subset of } C;\ \gamma_x(D) = \gamma_c(D)\}$$

$$R_{min} = \{X : X \in R;\ Y \in R;\ |X| < |Y|\}$$

The intersection of all the sets in R_{min} is called the core, the elements of which are those attributes that cannot be eliminated without introducing more contradictions to the dataset. In this method a subset with minimum cardinality is searched for. The Quick reduct algorithm [23] is detailed hereunder:

Quickreduct(C,D)

C: the set of all conditional features.
D: The set of decision features.
R ← {}
Do
T← R

∀X∈ (C-R)
if $\gamma_{R \cup \{x\}}(D) > \gamma_T(D)$, where $\gamma_R(D) = card(POS_R(D)) / card(U)$
T ← R U {x}
R← T
until $\gamma_R(D) = \gamma_C(D)$
return R

C. Rank Correlation Method

In some situation, the data may be available in the form of ranks of variables, X and Y. Consider the situation in which

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the objective is to determine the coefficient of correlation between ranks of features in two different situations [17]. Such coefficient of correlation is known as Spearman's rank correlation coefficient (rs). Like this, there are many other examples as listed below:

- Ranks of selected industries based on Earnings per share in two consecutive years.
- Preference ratings (ranks) of similar products by two persons.
- Ranks of employees in two different skill tests.

The formula for the Spearman's rank correlation coefficient (rs) is

$$\text{Rank correlation (rs)} = 1 - \frac{6\sum (Rf1 - Rf2)^2}{n(n^2-1)}$$

where X_i is the rank of the i^{th} observation of the variable X; Y_i is the rank of the i^{th} observation of the variable Y; and n is the total number of observations.

D. Arithmetic Mean Method

This is Statistical Measure Method. Arithmetic mean is a mathematical average and it is the most popular measure of central tendency [17]. The arithmetic mean of a series of items is the sum of the values of all items divided by their total number.

$$\text{Arithmetic Mean} = \sum X_i / N \text{ (or) } \sum fX_i / N$$

E. Proposed Algorithm:

In this section, the proposed algorithm for crop cultivation is detailed below.

STEP 1: Select the group of crops depending on decision of Farmer by applying K-Means algorithm.
STEP 2: Select the features which are closely related to all crops by applying Quick reduct Algorithm.
STEP 3: Apply the Rank correlation method to optimize the Feature selection.
STEP 4: Select the particular crop by All Features Mean Method and Reduct Features Mean Method.
STEP 5: Finally crop selection can be optimized by Maximum Arithmetic Mean Value.

IV. EXPERIMENTAL ANALYSIS

In this section analyzes which crop is to be cultivated by the farmer. Here we get the acceptance from 100 Farmers in Nallampatti village. The content or input of the Table 2 can be created by the choice of the farmers decision from the Table 1 with the maximum acceptance of the farmer.

Table 2: Selected Features Information Table

Features/Crops	Minimum Capital (f1)	Flexible Marketing (f2)	High Yields (f3)
C1(Sugarcane)	6	7	8
C2(Paddy)	4	5	6
C3(Maize)	7	6	6
C4(Turmeric)	5	6	7
C5(Tomato)	7	7	7
C6(Cotton)	7	4	6
C7(Groundnut)	6	7	7
C8(Plantain)	2	7	8
C9(Tapioca)	7	6	7

STEP 1: Select the group of crops depending on all the features by applying K-Means algorithm with k=3.

After applying the K –Means algorithm and the final Clusters arecluster1 = {C1, C4, C5, C7}; cluster2 = {C2, C8} and cluster3 = {C3, C6, C9}. The above cluster values are tabulated in Table 3. This Table 3 contains three input features with one "decision value" column which can be yielded from K-Means algorithm.

Table 3: Decision Table

Features/ Crops	Minimum Capital (f1)	Flexible Marketing (f2)	High Yields (f3)	Decision Value
C1(Sugarcane)	6	7	8	c1
C2(Paddy)	4	5	6	c2
C3(Maize)	7	6	6	c3
C4(Turmeric)	5	6	7	c1
C5(Tomato)	7	7	7	c1
C6(Cotton)	7	4	6	c3
C7(Groundnut)	6	7	7	c1
C8(Plantain)	2	7	8	c2
C9(Tapioca)	7	6	7	c3

STEP 2: Select the features which are closely related to all crops by applying Quick reduct Algorithm.

In Table 3, after applying the Quick reduct algorithm two features are selected such as the final reduct set is {(Minimum capital) and (Flexible Marketing)}.

STEP 3: Apply the Rank correlation method to optimize the Feature selection which is shown in Table 4.

Table 4: Rank Correlation Method

Features/Crops	Minimum Capital (f1)	Flexible Marketing (f2)	Rank (f1)	Rank (f2)	Rf1 –Rf2	$(Rf1 - Rf2)^2$
C1(Sugarcane)	6	7	2	1	1	1
C2(Paddy)	4	5	4	3	1	1
C3(Maize)	7	6	1	2	-1	1
C4(Turmeric)	5	6	3	2	1	1
C5(Tomato)	7	7	1	1	0	0
C6(Cotton)	7	4	1	4	-3	9
C7(Groundnut)	6	7	2	1	1	1
C8(Plantain)	2	7	5	1	4	16
C9(Tapioca)	7	6	1	2	-1	1
				Total	$\sum(Rf1 - Rf2)^2$	31

$$6\sum (Rf1 - Rf2)^2$$

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Rank correlation (rs) = $1 - \frac{}{n(n^2-1)}$

= 1- 186/720 = 0.7416667

where rs = 0, The rank of the two features are not associated. and here rs≠ 0, The rank of the two features are associated. If the features are associated means it will helpful to make the decision. Here we have to concluded that the rank correlation method is used to optimize the two features (Minimum capital and Flexible Marketing) which are derived from the Quickreduct algorithm for crop cultivation.

STEP 4: Select the particular crop by AFMM and RFMM and its tabulated in Table 5.

The Mean Value of each Crop = $\sum x_i / n$

AFMM = $f_1+f_2+f_3 / n$

RFMM = f_1+f_2 / n, where n = No of Features

Table 5: Arithmetic Mean Method

Features/Crops	Minimum Capital (f_1)	Flexible Marketing (f_2)	High Yields (f_3)	AFMM	RFMM
C1(Sugarcane)	6	7	8	7	6.5
C2(Paddy)	4	5	6	5	4.5
C3(Maize)	7	6	6	6.3	6.5
C4(Turmeric)	5	6	7	6	5.5
C5(Tomato)	7	7	7	7	7
C6(Cotton)	7	4	6	5.6	5.5
C7(Groundnut)	6	7	7	6.6	6.5
C8(Plantain)	2	7	8	5.6	4.5
C9(Tapioca)	7	6	7	6.6	6.5

STEP 5: Finally crop selection can be optimized by Maximum Arithmetic Mean Value.

From the above Table 5, Crop Tomato (C5) has Maximum Mean Value. Thus proved, Tomato (C5) is suitable for cultivation depending on the farmers decision.

V. CONCLUSION

Agriculture is one among the very essential sector upon that human existence depends on. However, evolution of humans has perpetually established growth of science and technology. Integration of science and technology in agriculture is taken into account a even handed action. The proposed work of this paper, K-Means algorithm was applied to group the crop which is taken from the questionnaire depending on the motivating features of the Farmers. Then Quickreduct algorithm was used to find the features which are closely related to all the crops. Finally, make the effective decision for the particular crop cultivation depending on the features which can be optimized by Rank correlation and Arithmetic Mean Method. In this crop data set among nine crops Tomato crop was hand-picked for cultivation. Further research work limits to presenting the applicability of the above said technology to improve agricultural conditions.

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