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Adapting Induced Fuzzy Cognitive Maps to the Issues Facing Cashew Cultivators

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Abstract - *Using the Induced Fuzzy Cognitive Maps (IFCM) Technique, the author attempts to discover the challenges experienced by cashew producers during marketing in the Kokan Region of Maharashtra. Using a linguistic questionnaire, I questioned 40 farmers in the research region. Because the challenges they faced in general had so many uncertainties, they were able to employ fuzzy theory in general and IFCMs in particular to solve them. When the data is unsupervised, IFCMs are the ideal technique to use.*

Key Words: **Directed graph, Cashew, Connection matrix, FCM, Induced FCMs**

1.INTRODUCTION

India is a developing country whose economy is based on agriculture. The most important agriculture-based activity in rural areas is fruit production and marketing. As a result, farming is the cornerstone of rural life. The cashew industry is one industry that has the potential to boost India's foreign exchange revenues while also creating jobs. According to the majority of agriculture and economics surveys, farmers and investors in the cashew business in the region are under-resourced and under-motivated to contribute successfully to the growth of the local economies.

Economics strives to understand the complexities of customer and producer behaviour, and then formulates ideas and procedures that supervisors and farmers can use to make better judgments. Because there are so many factors in economics that are difficult to define, it is a good topic for using Induced fuzzy cognitive maps. Cashew was originally thought to be primarily a tree-planting crop. However, cashew nut growers have struggled to achieve optimal output and return in recent years. It is consequently vital to conduct research into the cashew sector in the chosen region in order to discover the industry's issues and opportunities.

Zadeh[7] invented fuzzy logic in the 1960s to express uncertain and imperfect knowledge. It can be used to describe the behaviour of systems that are difficult to define precisely. As a result, fuzzy logic techniques have found success in a variety of fields, including computer science, decision making, social sciences, economics, industrial engineering, agriculture, and management. R. Axelord [8], a political scientist, used this fuzzy model to examine decision-making in social and political systems after a decade in 1976.

Then, using fuzzy values for the cognitive map's ideas and fuzzy degrees of interrelationships between concepts, B. Kosko [6] improved the power of cognitive maps. By building models, fuzzy cognitive maps try to describe and understand the cognitive process of human thought and behaviour on specific areas. Axelord [7] introduced cognitive maps as a formal decision-making tool in 1976. He represented and studied social scientific information using the matrix representation of the directed graph. It is a very useful, easy, and powerful instrument that is utilised in a variety of sectors, including social, economic, and medical, as well as agriculture, as illustrated by W.B. Vasantha Kandasamy[10] in her paper.

Now we'll use a fuzzy model called Induced Fuzzy Cognitive Maps, which is a modified version of FCM (IFCMs). Pathinathan [9] proposed IFCMs, which focused on algorithmic approaches to FCMs that work on unsupervised data to obtain an optimistic solution. IFCM is a fuzzy-graph modelling technique that relies on expert views.

2. MATERIALS AND METHODS

2.1 Simple IFCM Model:

The study's goal is to identify marketing issues in the cashew industry, and we'll use a suitable sampling technique to collect data. The Konkan region will be chosen as a key cashew-producing area in Maharashtra State using a targeted sampling technique. Using a systematic sampling technique with contact farmers and employees, a detailed questionnaire was provided to sample respondents on a proportional basis.

Definition- An FCM is a directed graph with nodes representing policies, events, and causalities representing edges. It depicts the causal relationship that exists between concepts. Give the value 1 if an increase (or decrease) in one idea leads to an

increase (or decrease) in another. If no relationship exists between two concepts, the value 0 is used. Give the number 1 if increasing (or decreasing) one causality diminishes (or enhances) another. As a result, FCMs are described in this manner. When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes and FCMs with edge weights or causalities from the set {−1,0,1}, are called simple FCMs.

Definition- Consider the Fuzzy Cognitive Map concepts $C_1, C_2,.... C_n$, then build the directed graph using the edge weight $e_{ij} \in \{0,1,-1\}$. $E = (e_{ij})$, where e_{ij} is the weight of the directed edge C_iC_j, defines the matrix M. M stands for the Fuzzy Cognitive Map's adjacency matrix, also known as the FCM's link matrix. Let's call the notions of an FCM $C_1, C_2,... C_n$. $A = [a_1, a_2,.... a_n]$, where $a_i \in \{0,1\}$ is the initial value. The instantaneous state vector (A) represents the node's on-off position at any given time.

$$a_i = \begin{cases} 0 & \text{if } a_i \text{ is OFF} \\ 1 & \text{if } a_i \text{ is ON} \end{cases}$$

Definition – Let the nodes of an FCM be $C_1, C_2,..., C_n$. Let's say the FCM's edges are $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3} \ldots, \overrightarrow{C_iC_j}$ ($i \neq j$). The edges form a directed cycle after that. If an FCM has a directed cycle, it is said to be cyclic. If an FCM does not have a directed cycle, it is said to be acyclic. A feedback is defined as an FCM with cycles. The FCM is considered a dynamical system when it has feedback, that is, when the causal links run through a cycle in a revolutionary way.

Definition- Consider $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3} \ldots, \overrightarrow{C_iC_j}$ a cycle. We say the dynamical system spins round and round when C_i is turned on and causation runs along the boundaries of a cycle, causing C_i again. For i = 1,2,...,n, this is true for any node C_i. The hidden pattern is the equilibrium state for this dynamical system. A fixed point is the equilibrium state of a dynamical system that is a single state vector.

Algorithmic approach in Induced FCMs

Even though Induced FCM is an upgrade of FCM, it adheres to the same principles as FCM, with the exception of Algorithmic methods. The following procedures must be done to generate an optimistic solution to the problem using unsupervised data:

Steps in algorithm:

I : Gather unsupervised data in determinant factors known as nodes for the given model (problem).

II: Draw the directed graph based on the expert's advice.

III: From the directed graph, obtain the M connection matrix (FCM). The number of rows in the specified matrix equals the number of steps that must be completed.

IV: Consider the ON position of the state vector C_1. Look for C_1xM. At each stage, the state vector and threshold are updated.

V : Threshold value is calculated by assigning 1 to values greater than 1 and 0 to values less than 1. The symbol $\hookrightarrow$ denotes the product of the result's threshold value.

VI: Now take each component of the C_1 vector individually and calculate the product of the given matrix. The vector with the greatest number of ones is discovered. C_2 is the vector with the greatest number of ones that appears initially.

VII :When the same threshold value occurs twice, this is referred to as VII. The fixed point is defined as the value. The iteration comes to an end.

2.2 Data Preparation

In this study, we use a fuzzy model to analyze data from 40 cashew growers in the Konkan region. We use the Induced Fuzzy Cognitive Maps (IFCMs) to assess the marketing challenges faced by cashew producers in two districts in the Konkan Region, namely Sindhudurg and Ratnagiri.

Sr. No.	Constraints particular	Opinion of Farmers
M_1	Inaccessibility of processing units	38

M_2	Lack of information on market intelligence	39
M_3	Ignorance of market regulations	23
M_4	Non-availability of transport vehicle	18
M_5	Forced indebtedness to pre-harvest contractors	10
M_6	High price fluctuations	36
M_7	Fraudulent weightings	32
M_8	Non-availability of grading facilities	30
M_9	Non-availability of packaging materials	26

Table 1: Marketing problems of cashew cultivators

Now we illustrate the dynamical system by a very simple model from the production problem faced by cashew cultivators. At the first stage we have the following eleven arbitrary attributes ($M_1, M_2, \ldots, M_9$) are taken as the main nodes for study. Based on the first expert's opinion, the corresponding directed graph and connection matrix M is given as

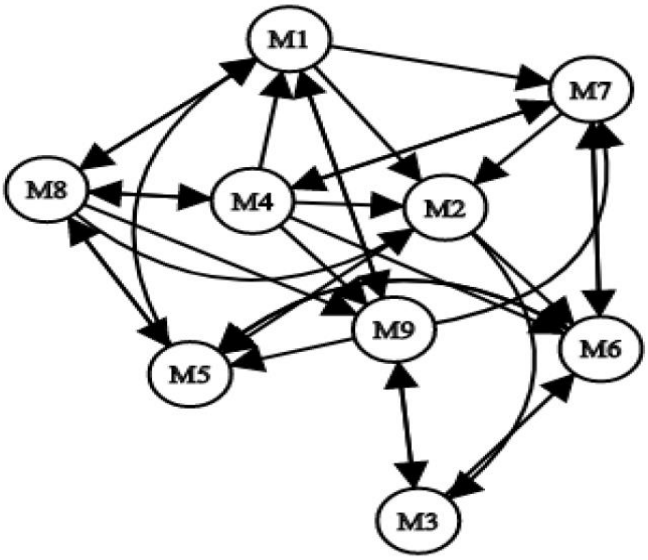

Fig. 1 : Directed Graph

$$M = \begin{pmatrix} & M_1 & M_2 & M_3 & M_4 & M_5 & M_6 & M_7 & M_8 & M_9 \\ M_1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ M_2 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ M_3 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ M_4 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ M_5 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ M_6 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ M_7 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ M_8 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 \\ M_9 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \end{pmatrix}$$

2.3 Results:

Using the matrix M, we were able to identify the issues.

Let us start Illiteracy is taken as the ON state and all the other nodes are in the OFF state.

Let C_1 =(1 0 0 0 0 0 0 0 0).

Product of C_1 and M is calculated.

$C_1 \times M$ = (010000000) = C_1'

$C_1' \times M$ = (010000000) × M, $\hookrightarrow$ (000101100)

Threshold value is calculated by assigning 1 for the values > 1 and 0 for the values < 0. The symbol , $\hookrightarrow$ represents the threshold value for the product of the result.

Now as per Induced Fuzzy Cognitive Map methodology, each component in the S' 1 vector is taken separately and product of the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as C_2. The symbol denotes the calculation performed with the respective vector, here C_1'

Now

$C_1' \times M$ = (000000100) × M = (010101000)

$C_1' \times M$ = (000000001) × M = (110110001) = C_2

$C_2 \times M$ = (110001111) × M = (321213432) , $\hookrightarrow$ (111111111) = C_2'

$C_2' \times M \approx$ (100000000) × M = (010000111)

$C_2' \times M$ = (010000000) × M = (000101100)

$C_2' \times M$ = (100000000) × M = (000001001)

$C_2' \times M$ = (000100000) × M = (110001111) = C_3

$C_2' \times M$ = (000010000) × M = (100001010)

$C_2' \times M$ = (000001000) × M = (000010100)

$C_2' \times M$ = (000000100) × M = (010101000)

$C_2' \times M$ = (00000010) × M = (110110001)

$C_2' \times M$ = (00000001) × M = (101010100)

$C_3' \times M \approx (010000111) \times M = (010001111)$

$C_3 \times M = (110110001) \times M = (231332412) \hookrightarrow (1111111111) = C_3'$

$C_3' \times M = (010000000) \times M = (000101100)$

$C_3' \times M = (100000000) \times M = (000001001)$

$C_3' \times M = (00010000) \times M = (110001111) = C_4$

$C_3' \times M = (000010000) \times M = (1000010100)$

$C_3' \times M = (000000100) \times M = (010101000)$

$C_3' \times M = (000000100) \times M = (010101000)$

$C_3^0 \times M = (000000010) \times M = (110110001)$

$C_3' \times M = (00000001) \times M = (101010100)$

$C_3 \times M = (110110001) \times M = (231332412) \hookrightarrow (1111111111) = C_4'$

$C_3' \times M = (110001111) = C_4$

Therefore $C_3 = C_4$ and (1 1 0 0 0 1 1 1 1) is the fixed point which is the triggering pattern is when the first attributes kept in on state vector. Similarly, the following table is the Triggering patterns when other attributes kept ON state.

No.	Attribute ON State	Triggering Pattern
Step 1	C_1:(1 0 0 0 0 0 0 0 0)	$C_1 \rightarrow C_8 \rightarrow C_4 \rightarrow C_4$
Step 2	C_2:(0 1 0 0 0 0 0 0 0)	$C_2 \rightarrow C_4 \rightarrow C_4$
Step 3	C_3:(0 0 1 0 0 0 0 0 0)	$C_3 \rightarrow C_1 \rightarrow C_4 \rightarrow C_4$
Step 4	C_4:(0 0 0 1 0 0 0 0 0)	$C_4 \rightarrow C_4 \rightarrow C_4$
Step 5	C_5: (0 0 0 0 1 0 0 0 0)	$C_5 \rightarrow C_4 \rightarrow C_4$
Step 6	C_6:(0 0 0 0 0 1 0 0 0)	$C_6 \rightarrow C_4 \rightarrow C_4$
Step 7	C_7: (0 0 0 0 0 0 1 0 0)	$C_7 \rightarrow C_4 \rightarrow C_4$
Step 8	C_8:(0 0 0 0 0 0 0 1 0)	$C_8 \rightarrow C_4 \rightarrow C_4$
Step 9	C_9:(0 0 0 0 0 0 0 0 1)	$C_9 \rightarrow C_4 \rightarrow C_4$

3. Conclusion

The interrelationship between the qualities reveals that the terminal node is non-availability of transport method. As a result, the limit point (1 1 0 0 1 1 1) emphasizes the traits and (M_1, M_2, M_6, M_7, M_8, M_9), which appear to be key marketing issues for cashew growers. This is the fixed point (1 1 0 0 0 1 1 1 1). When the same threshold value appears twice, it is referred to as a fixed point. The iteration gets terminated and the calculation is completed. M_1 Inaccessibility of processing units, M_2- Lack of market intelligence information, M_6- High price volatility, M_7- Fraudulent weighing, M_8- Non-availability of grading facilities, and M_9- Non-availability of packing materials are all ON states if discrimination M_1 is ON. This clearly

demonstrates that the difficulties are caused by (M_1, M_2, M_6, M_7, M_8, M_9). This research aids in the analysis of the most pressing restrictions affecting the Cashew industry's marketing issues.

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