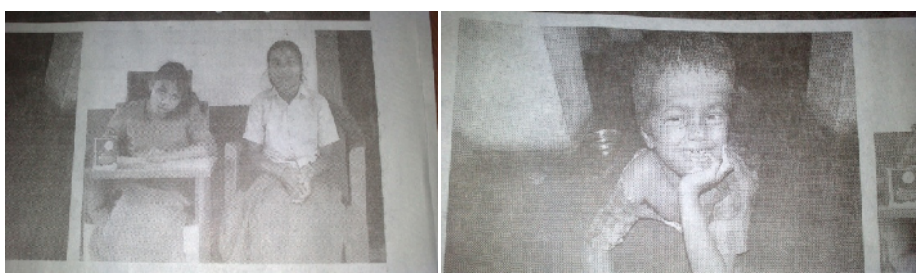
3

ANALYSIS OF THE CAUSES FOR USING ENDOSULFAN IN AGRICULTURE BY VARIOUS FUZZY COGNITIVE MAPS MODEL

3.1. Introduction

Fuzzy Cognitive Maps (FCMs) were introduced by Bart Kosko in 1986. FCMs are techniques which attempt to analyze the cognitive process of human thinking and human behavior on specific domains by creating models. Fuzzy Cognitive maps (FCMs) are fuzzy graph structures for representing casual reasoning. Their fuzziness allows hazy degrees of causality between hazy casual objects (concepts) .Their graph structure allows systematic causal propagation, in particular forward and backward chaining, and it allows knowledge bases to be grown by connecting different FCMs. Thus FCM is a directed graph with concepts like policies, events, etc. as nodes and causalities as edges. It represents the causal relationship between concepts. When the nodes of the FCM are fuzzy sets, then they are called as fuzzy nodes. FCMs with edge weights or causalities from the set {–1, 0, 1}, are called simple FCMs. FCM has several advantages as well as some disadvantages. The main advantage of this method is simple. If functions on the expert's opinion when the data happens to be an unsupervised one the FCM comes handy. This is the only known fuzzy technique that gives the hidden patterns of the situation. Endosulfan is an important cause of pesticide poisoning in many countries. It is an organochlorine pesticide used to kill insects and mites on crops .In Kerala Endosulfan has been linked to 1000s of deaths and disorders of animals and humans. There are several reasons for the farmers to apply endosulfan in agriculture. FCM is applied to study the causes for using endosulfan.



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3.2 Selection of concepts as the causes for using Endosulfan

A sample survey of 101 people in Kerala (Palakkad and Kasargod) was conducted. They were interviewed using a questionnaire relevant to the topic. From the questionnaire the concepts for predicting the causes for using endosulfan in agriculture are determined.

The following are the eleven concepts:

C_1 –Population Increase

C_2 – Increase in food productivity

C_3 –Cheap cost of Endosulfan

C_4 –Easy availability of Endosulfan

C_5- Better yield

C_6 – Need for pest control

C_7 –Illiteracy

C_8-Un awareness on ill effects of Endosulfan

C_9-Less knowledge of any other non chemical alternative

C_{10}-Non involvement of social organizations

C_{11}- Indifference or negligence of Goverentment with farmers

3.2.1: Justification for the concepts

A justification is given for the eleven concepts taken for the study

C_1: Population Increase

Food production capacity is facing a number of ever growing challenges, including world population which is expected to grow nearly 7.4 billion. As the world population, continues to grow geometrically, great pressure is being placed on land, water , energy and biological resources. We provide an adequate supply of food while maintaining the integrity of our ecosystem. In order to maintain the balance between population and food production, chemicals such as pesticides, antibiotics, hormones, etc., are used to boost production and ensure adequate food supply.

C_2: Increase in food productivity

In the current trend, arable land and population growth are inversely proportional and there in the necessity for higher food production from the limited arable land becomes inevitable. Pesticides are used for crop protection not only during the pre harvest stage, but also post harvest stage as bugs, rodents, molds may harm the grains. The usage of pesticides at the post harvest stage helps in prolonging the lifetime of the stored product, thus making it consumable over a larger duration of time. Products such as herbicides, insecticides and fungicides reduce crop losses both before and after harvest which in term increases crop yields.

C_3: Cheap cost of Endosulfan

Endosulfan is a cheap pesticide costing around ₹220 per liter against imidachloprid (its substitute) which posts about ₹2000 per litre. The next cheapest alternative costs 10 times more. India is the worldest largest manufacturer and user of Endosulfan. Even though the Government of India agreed to wind down the use of Endosulfan in 5 years, it seems to continue its use until a safer cost effective alternative is found. If Endosulfan gets banned it is going to have a deep irreversible impact on the Indian economy as the poor farmers will not be able to afford the expensive substitute for Endosulfan which is cheap as well as effective The highly toxic Endosulfan pesticide is banned in most of the countries, but still widely embraced by farmers in India. as the Govt. claims that there is no affordable alternative to this chemical, families are paying a high price.

C_4: Easy Availability of Endosulfan

The easy availability of Endosulfan from across the border has contributed to this problem in this agricultural dominated area .The continued availability of Endosulfan is desirable for the production of cotton and various other crops because of its particular suitability for use and resistance management strategies Endosulfan is easily available in the Muthalamada area from across the borders; it is just 10 to 15 minute journey to the neighbouring Tamilunadu. There is no proper mechanism to check smuggling of Endosulfan into Kerala.

C_5: Better yield

How the heck humans are going to grow enough food to feed our teeming masses without wrecking the planet? There are two assumptions embedded in this question:

1) We are going to have trouble in growing enough food.

2) We must race to keep food production to meet the requirements of the growing population. So the farmers and scientists are working to increase the yield.

C_6: Need for pest control

Pest control refers to the regulation or management of a species defined as a pest, usually because it is perceived to be detrimental to a person's health, the ecology or the economy.

C_7: Illiteracy

Due to illiteracy people are unaware about the dangerous side effects of Endosulfan. Farmers remain uneducated of the precautionary methods which have to be followed before the use of this pesticide. These workers are unaware of the disaster spread by Endosulfan. They are also unaware of the alternative bio or herbal pesticides which could be used as an alternative for Endosulfan. They are unaware about the legal regulations against the use of this deadly Endosulfan. Due to illiteracy, the pesticides are sprayed on trees with the nozzles of the pump directed skywards. This immediately affects the person who is engaged in spraying this chemical pesticide.

C_8: Unawareness on ill effects of Endosulfan

Most of the people are unaware of the ill effects of endosulfan. The most likely way for people to be exposed to Endosulfan is by consuming the food contaminated with it. Endosulfan has been found in some food products such as oils, fats and fruits and vegetable products. They are also exposed to low levels of Endosulfan by skin contact with contaminated soil or by smoking cigarettes which made from tobacco that has endosulfan residues on it. Workers breathe in the chemical while spraying the pesticides

on crops. Accidental spills and releases to the environment are also possible sources of exposure to endosulfan. The most likely exposure to endosulfan for people living near hazardous waste sites is through physical contact with soils containing it. Drinking water from the open well which is left uncovered during the aerial spraying of Endosulfan.

C_9: Less knowledge of any other non chemical alternative

Most farmers are not aware of the non chemical alternative methods like neem oil, chillies, garlic, cow urine and many other organic methods. The farmers are generally illiterates; they are not able to read about the latest technologies in organic farming. Only the government should give them non chemical pesticides free of cost and encourage them. They must be motivated by radio and TV programmes to use organic manure and insecticides.

C_{10}: Non involvement of social organization

Initially the NGO's organized local and international compare to create awareness and the ban Endosulfan which later turned into an inactive one. Such organizations can give awareness about the alternative non chemical pesticides which are available in that region and other parts of the world thereby eliminating the use of endosulfan.

C_{11}: Indifference or negligence of government with farmers

Government has to ban the production and use of Endosulfan but the Government has not yet done it. Actually Government is not taking that much interest to give awareness to the farmers because most of these farmers are not their vote banks. The goal "Adopt Land and food without poisons" can be adapted for healthy survival. Pressure Govt. to ratify the Stockholm Convention if it has not already done so and press for the addition of endosulfan to the Stockholm Conventions List.

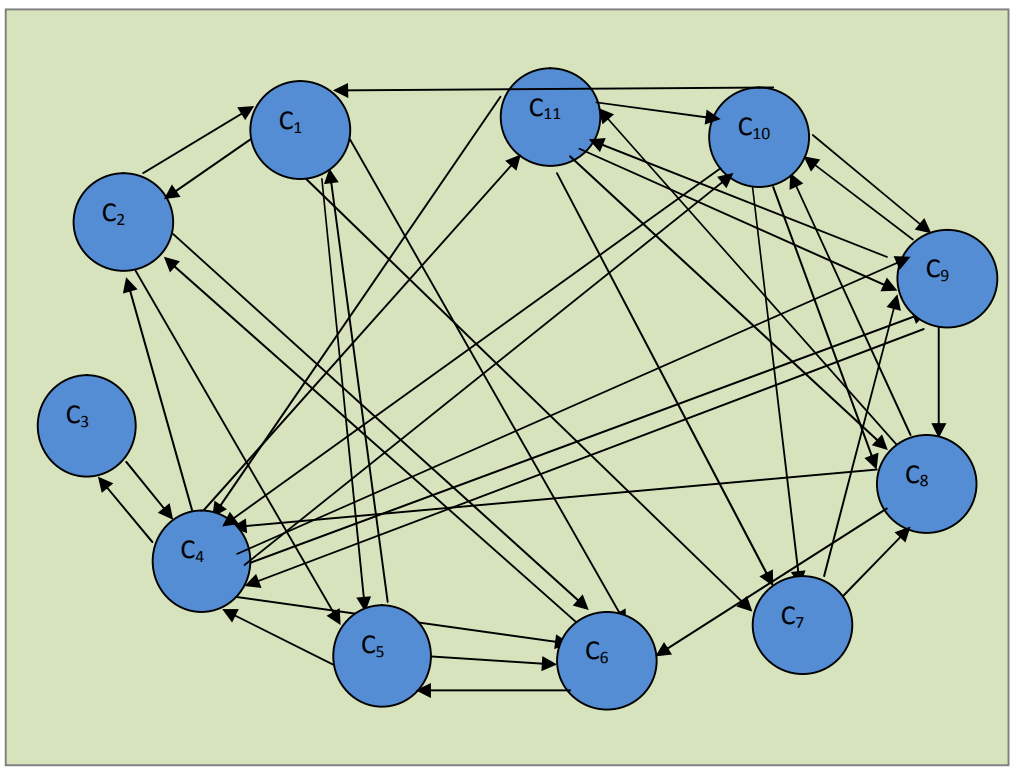
3.3. Identifying the causes for using Endosulfan in agriculture by the method of simple FCM

In this section the method of FCM is applied to study the causes for using Endosulfan. The dynamical system of the problem is considered with the help of this model the hidden pattern (fixed point) of this model is found and the conclusion is given based on the fixed point.

3.3.1 Implementation of FCM model to the study

Simple FCMS provide a quick first approximation to an expert stand or printed casual knowledge.

According to the expert's opinion, the above concepts are connected into a directed graph.



Using the above directed graph, the connection matrix M= (a_{ij}) is formulated with

a_{ij} =1 if $C_i \longrightarrow C_j$

=0 if $C_i \longrightarrow C_j$.

If increase in concept C_i leads to an increase in another concept C_j then a_{ij} is given the value 1. Otherwise a_{ij} is given the value 0. It is important to note that the connection matrix is a square matrix with diagonal entries as zero.

$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

Procedure to apply FCM model

A state vector is defined such that, one concept C_i (say) is in "ON" state and the remaining are in "OFF" states. Accordingly, as the vector P_1^i having 1 in i^{th} place and 0 in other places is introduced and the product P_1^iM of P_1^i and M is calculated. The resulting vector P_2 is modified by assigning 1 if the values of the entries are >1. Then P_2M is calculated and modified at each stage until the two consecutive vectors become equal. Finally the fixed point having some entries 1 and the remaining 0 is obtained. The concepts corresponding to the entries having 1 in the fixed vector are impactful for the concept C_i in the state vector P_1^i.

A trial is conducted for the concept C_8. consider the state vector P_1^8= (0 0 0 0 0 0 0 1 0 0 0) in which the only node C_8 is ON state ie," *un awareness on the ill effects of Endosulfan"* is ON state and all the rest are are in OFF state. Now passing P_1^8 into the

connection matrix M .i.e., $P_1{}^8M$ is calculated. It is modified by assigning 1 if the values of the entries are ≥1 keeping eighth place always 1.

$P_1{}^8M \hookrightarrow (0\ 0\ 0\ 1\ 0\ 1\ 0\ 1\ 0\ 1\ 1) = P_2$

$P_2M = (1\ 2\ 1\ 2\ 1\ 1\ 2\ 2\ 3\ 2\ 2) \hookrightarrow (1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) = P_3$

$P_3M = (3\ 3\ 1\ 6\ 3\ 5\ 3\ 4\ 4\ 3\ 3) \hookrightarrow (1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) = P_4 = P_3$, a fixed point is arrived . Hence when the concept *"No awareness on the effects of endosulfan"* is in the ON state all the concepts become ON. Thus in all cases, a hidden pattern is obtained which is never possible by way of other models. Thus, this model is well suited to give the impact of each concept in finding the causes for using endosulfan. Since the working becomes very laborious, a C++ program (Appendix III(b)) is used. The main advantage of using this programme is that it calculates the hidden pattern viz, the fixed, point for any number of concepts. Also it works for all 2n-2 difficult combinations of the concepts involved in the analysis where just a mere observation helps in the prediction of the system behavior. The results are listed below.

State Vector	Steps required to obtain fixed point	The fixed point
$P_1{}^1$=(1 0 0 0 0 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^2$=(0 1 0 0 0 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^3$=(0 0 1 0 0 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^4$=(0 0 0 1 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^5$=(0 0 0 0 1 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^6$=(0 0 0 0 0 1 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^7$=(0 0 0 0 0 0 1 0 0 0 0)	STEP 4	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^8$=(0 0 0 0 0 0 0 1 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^9$=(0 0 0 0 0 0 0 0 1 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^{10}$=(0 0 0 0 0 0 0 0 0 1 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
$P_1{}^{11}$=(0 0 0 0 0 0 0 0 0 0 1)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)

3.3.2: Conclusion

For the concept C_4 **(***Easy Availability of Endosulfan*), C_8 (*unawareness on the ill effects of endosulfan*), C_{10} *(Non involvement of social organization*), the fixed points are obtained in the 2nd step itself. Hence, these 3 concepts are considered to be major causes for using endosulfan in agriculture even though all other concepts also get the same fixed point **(1 1 1 1 1 1 1 1 1 1 1)** expressing the interdependence among them (i.e) the effect of one concept has impact on all other concepts.

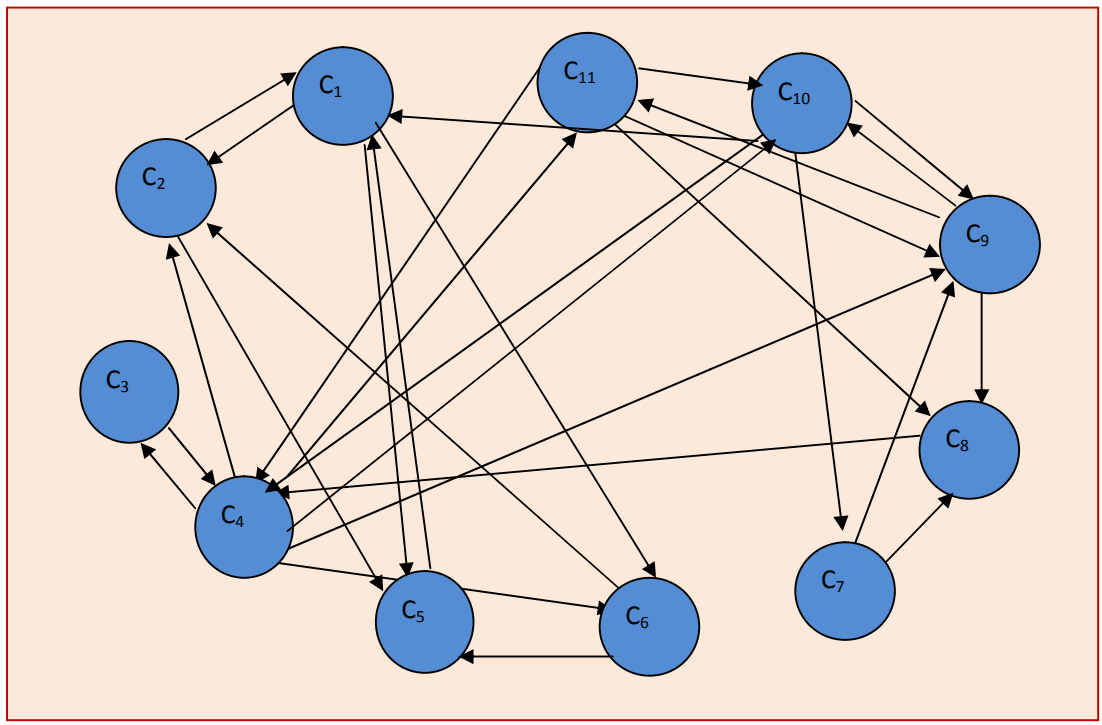
3.4. Predicting the Causes for Using Endosulfan in Agriculture by the People of Kerala by Combined Fuzzy Cognitive Maps (CFCM)

Any set of FCMs can be naturally combined (Kosko 1986). Each expert can draw a different size FCM with different causal concepts. There is no restriction on the number of experts or on the number of concepts. Indeed, the more experts are more. We are not restricted to the prejudices of a small number of experts. Larger sample sizes yield more reliable combined FCMs.

The same problem of finding the causes for using endosulfan through Combined Fuzzy Cognitive Map is analyzed in this section. The connection matrices A, B, C, D are drawn from the responses given by four experts (i) an agriculture officer (ii) an NGO (iii) A doctor (iv) a village administrative. Let S= A+B+C+D be the matrix taken for the calculation of CFCM.

3.4.1: Analysis of the first expert's view

The first expert opinion is arrived through responses from an agricultural officer for the connection between the concepts considered in section 3.2. The following represents the connections graph of the above eleven concepts given by an agriculture officer.

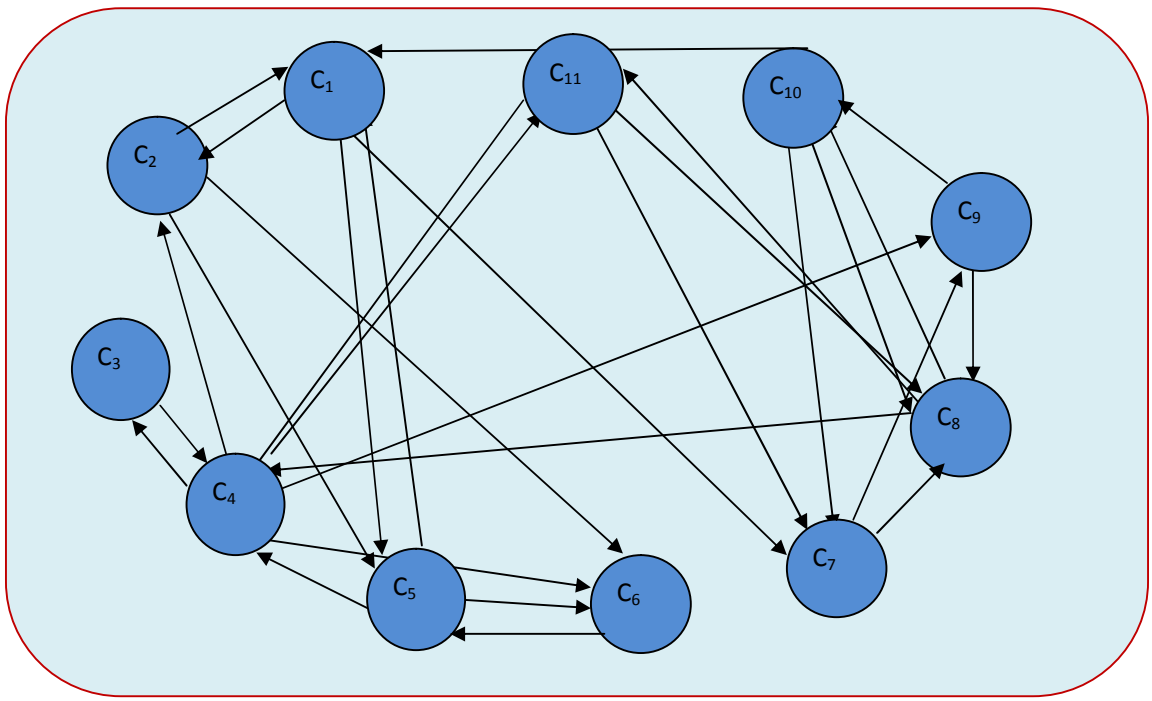


The related connection matrix is denoted by A for the above directed graph and is given below:

3.4.2: Analysis of second expert's view

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

The second expert's opinion is arrived through responses from an NGO for the connection between the concepts considered in section 3.2. The related graph is given below



The related connection matrix denoted by B for the above directed graph is given below:

$$B = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

3. 4. 3: Analysis of third expert's view

The third experts opinion is arrived through responses from a doctor for the connection between the concepts considered in section 3.2. The following represent the connection graph of the above eleven concepts.

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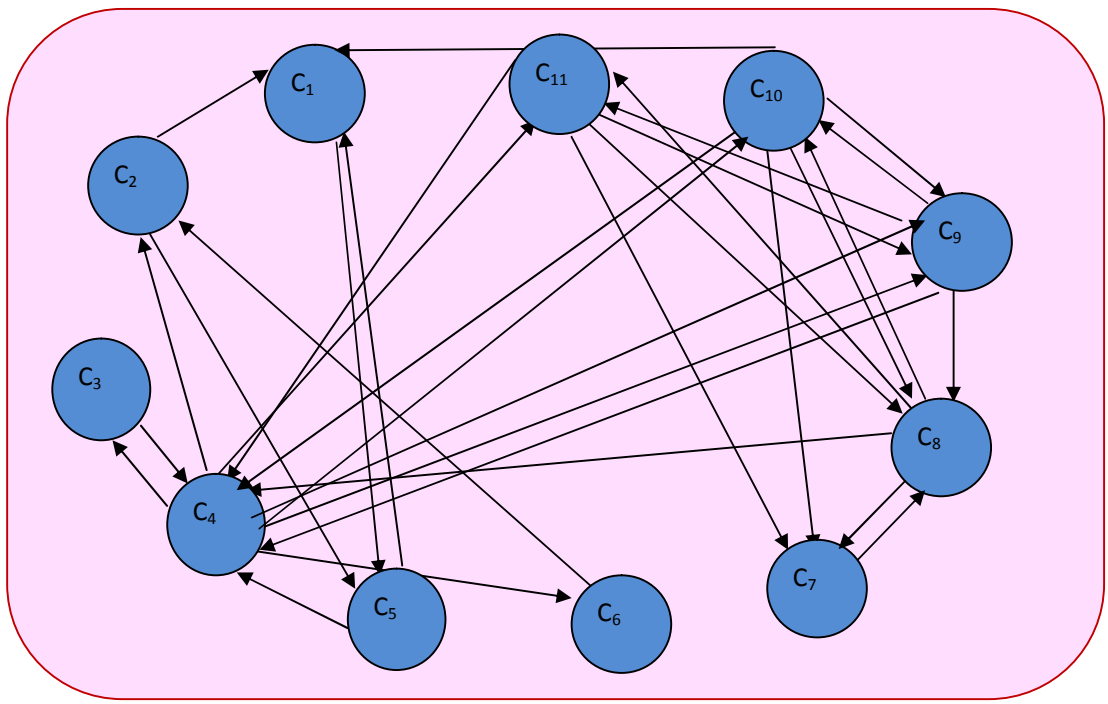
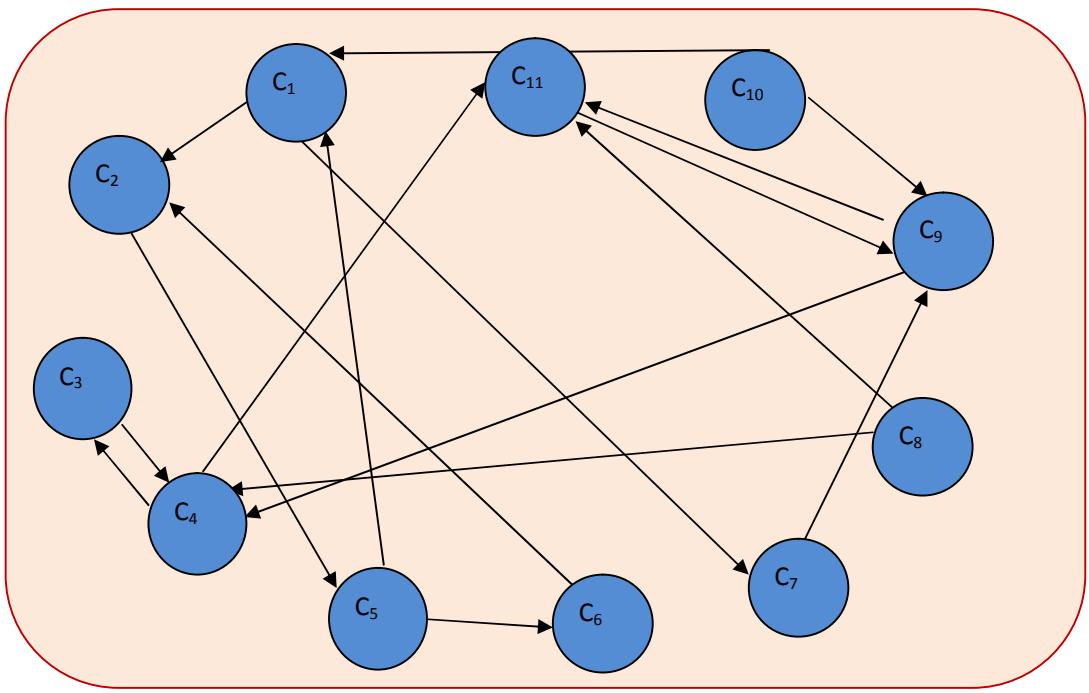


The related connection matrix is denoted by C for the above directed graph.

$$C = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

3.4.4: Analysis of fourth expert's view

The fourth expert's opinion is arrived through responses from a village officer officers for the connection between the concepts considered in section 3.2. The following represents the connection graph of the above eleven concepts.



The related connection matrix is denoted by D for the above directed graph.

$$D = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix} \end{array}$$

3.4.5: Analysis of the problem containing all the four expert's view using CFCM

The CFCM using the opinion of the above four experts is formulated .Let S demote the combined connection matrix. Then S=A+B+C+D and the matrix is given by

S=	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
C_1	0	3	0	0	3	1	2	0	0	0	0
C_2	3	0	0	0	4	1	0	0	0	0	0
C_3	0	0	0	4	0	0	0	0	0	0	0
C_4	0	1	4	0	0	3	0	0	1	1	4
C_5	4	0	0	2	0	2	0	0	0	0	0
C_6	0	3	0	0	2	0	0	0	0	0	0
C_7	0	0	0	0	0	0	0	3	4	0	0
C_8	0	0	0	4	0	1	0	0	0	2	2
C_9	0	0	2	0	0	0	0	1	0	3	1
C_{10}	4	0	0	2	0	0	1	3	3	0	0
C_{11}	0	0	0	3	0	0	2	3	3	0	0

Consider the state vector P_1^8=(0 0 0 0 0 0 0 1 0 0 0) in which the only node C_8 is ON state Now passing it through the connection matrix,we get (0 0 0 4 0 1 0 0 0 2 2)

Here the threshold is done in a different way. If an entry after multiplication is ≤2, then the value 0 is assigned and if ≥3, the value 1 is assigned keeping eighth place always1.

P_1^8S= (0 0 0 4 0 1 0 0 0 2 2) ↪(0 0 0 1 0 0 0 1 0 0 0) $=P_2$

P_2S= (0 1 4 4 0 4 0 0 1 3 6) ↪(0 0 1 1 0 1 0 1 0 1 1) $=P_3$

P_3S= (4 4 4 13 2 3 3 6 7 3 6) ↪(1 1 1 1 0 1 1 1 1 1 1) $=P_4$

P_4S= (7 7 4 10 10 8 5 10 11 6 7) ↪ (1 1 1 1 1 1 1 1 1 1 1) $=P_5$

P_5S= (11 7 4 10 9 8 5 10 11 6 7) ↪ (1 1 1 1 1 1 1 1 1 1 1) $=P_6=P_5$.

Hence (1 1 1 1 1 1 1 1 1 1 1) is a fixed point for S. The collective opinion of the above four experts highlight that all causes are interrelated. Similarly we can work with any one of the node in ON state

A C++ computer program is written and applied (Appendix III(c)). The result is listed below:

State Vector	Steps required to obtain fixed point	The fixed point
P_1^1=(1 0 0 0 0 0 0 0 0 0 0)	STEP 5	(1 1 0 0 1 1 0 0 0 0 0)
P_1^2=(0 1 0 0 0 0 0 0 0 0 0)	STEP 9	(1 1 0 0 1 1 0 0 0 0 0)
P_1^3=(0 0 1 0 0 0 0 0 0 0 0)	STEP 7	(1 1 1 1 1 1 1 1 1 1 1)
P_1^4=(0 0 0 1 0 0 0 0 0 0 0)	STEP 6	(1 1 1 1 1 1 1 1 1 1 1)
P_1^5=(0 0 0 0 1 0 0 0 0 0 0)	STEP 9	(1 1 0 0 1 1 0 0 0 0 0)
P_1^6=(0 0 0 0 0 1 0 0 0 0 0)	STEP 9	(1 1 0 0 1 1 0 0 0 0 0)
P_1^7=(0 0 0 0 0 0 1 0 0 0 0)	STEP 5	(1 1 1 1 1 1 1 1 1 1 1)
P_1^8=(0 0 0 0 0 0 0 1 0 0 0)	STEP 5	(1 1 1 1 1 1 1 1 1 1 1)
P_1^9=(0 0 0 0 0 0 0 0 1 0 0)	STEP 4	(1 1 1 1 1 1 1 1 1 1 1)
P_1^{10}=(0 0 0 0 0 0 0 0 0 1 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
P_1^{11}=(0 0 0 0 0 0 0 0 0 0 1)	STEP 5	(1 1 1 1 1 1 1 1 1 1 1)

3.4.6: Conclusion

While analyzing the problem using CFCM, we arrive at the following conclusions

1. All the state vectors get fixed points

2. The concepts C_3 , C_4, C_7, C_8, C_9, C_{10},C_{11} have fixed point as **(1 1 1 1 1 1 1 1 1 1 1)** from which it is concluded that these concepts have more impact on all Eleven concepts.

3. Whereas C_1, C_2, C_5, C_6 have **(1 1 0 0 1 1 0 0 0 0 0)** as fixed point, stating that these concepts have dependency only among them.

It is interesting to note that the attributes highlighted in the fixed point (1 1 0 1 1 0 0 0 0 0) of C_1, C_2, C_5, C_6, are also the same concepts C_1, C_2, C_5, C_6, these concepts have no impact on other concepts. The results obtained in this model CFCM give more details than that of FCM. In FCM model, it is seen only that all concepts are dependent and have the same impacts. But in CFCM model, it is well differentiated that

The concepts

C_1 –Population increase

C_2-Increase in food productivity

C_5 -To get better yield

C_6 –Need for pest control, have interdependency (ie) imply one another and have no impact on other concepts.

The concepts

C_3-Cheap cost of Endosulfan

C_4-Easy availability of Endosulfan

C_7-Illiteracy

C_8-No awareness on ill effects of Endosulfan

C_9-No knowledge of any other non chemical alternative

C_{10}-Non involvement of social oragnizations

C_{11} –Govt. indifference or negligence in farmers, have impact on all 11 concepts.

3.5: Finding the Causes for Using Endosulfan In Agriculture By Induced Fuzzy Cognitive Maps (IFCM)

Even though IFCM is advancement of FCM it follows the foundation of FCM, it has a slight modification only in Algorithmic approaches. To derive an optimistic solution to the problem with an unsupervised data, the following steps to be followed:

Algorithmic Approach in IFCM

Step 1: For the given model (problem), collect the unsupervised data that is in determinant factors called nodes.

Step 2: According to the expert opinion, draw the directed graph.

Step 3: Obtain the connection matrix, *M*, from the directed graph (FCM). Here the number of rows in the given matrix = number of steps to be performed.

Step 4: Consider the state vector P_1^i by assigning the first component of the vector to be 1 and the rest of the components as 0. Find $P_1^i \times M$ and it is denoted by P_2

Step 5: Now each component in the P_2 vector is taken separately and product of the given Matrix is calculated. The vector which has maximum number of one's is found. The vector with maximum number of one's which occurs first is considered as Q_2.

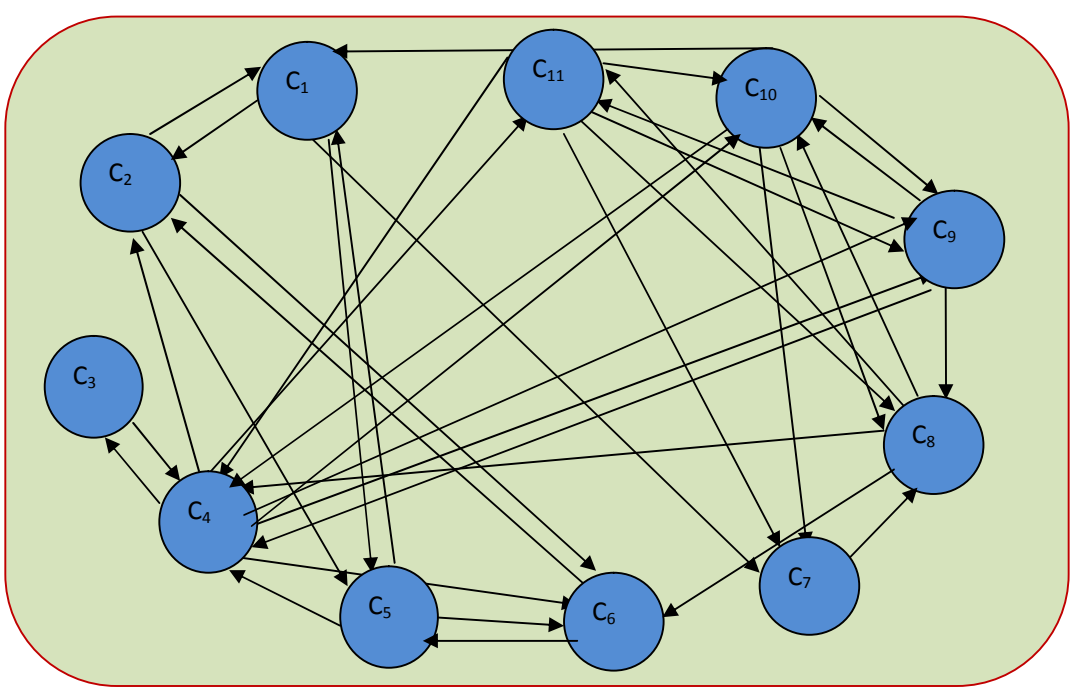
Step 6: Product of Q_2 and M is calculated and it is modified by assigning 1 if the values of the entries are ≥ 1. Let the modified vector be Q_2¤

Step 7: Repeat step 5, till the same threshold value occurs twice. The value is considered as the fixed Point. The iteration gets terminated.

Step 8: Continue Step 1to 7 for all the state vectors and find hidden pattern.

3.5.1 Implementation of IFCM model to the study

The following represents the connection graph of the above eleven concepts and its connection matrix as in section 3.2.



$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

As there are 11 concepts and IFCM model is very lengthy, only two trials are worked out manually. The rest are done using C++ computer program (Appendix III (d)).

3.5.2: Trial 1

Consider P_1^8 in the trial 1, by setting the concept C_8 in ON state, that is the eighth component of the vector is set to be 1 and the rest are assigned to 0.

Then, $P_1^8 = (0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

Product of P_1^8 and M is calculated.

$P_1^8M = (0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 0\ 1\ 1) = P_2$

Now as per Induced Fuzzy Cognitive Map methodology, each component in the P_2 vector is taken separately and product of it with the given matrix is calculated. The vector which has the maximum number of one's occurring first is considered as Q_2

$P_2M \approx$

$(0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)\ M = (0\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 1\ 1\ 1) = Q_2$

(0 0 0 0 0 1 0 0 0 0 0) M = (0 1 0 0 1 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 1 0) M =(1 0 0 1 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 0 1) M= (0 0 0 1 0 0 1 1 1 0 0)

Q_2= (0 1 1 0 0 1 0 0 1 1 1) $\neq P_2$

Product of Q_2 and M is calculated and modified by assigning 1 if the values of the entries are ≥ 1. Let the modified vector be Q_2▫

Q_2M =(0 1 1 0 0 1 0 0 1 1 1)M=(2 2 1 4 2 2 2 3 3 2 2)

↪(1 1 1 1 1 1 1 1 1 1 1)= Q_2▫

Q_2▫ =(1 1 1 1 1 1 1 1 1 1 1)

Now each component in Q_2▫ vector is taken separately and the product of it with the given matrix is calculated. The vector which has maximum number of 1s is found and is called R_3

Q_2▫M ≈

(1 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 0 1 1 1 0 0 0 0)

(0 1 0 0 0 0 0 0 0 0 0)M= (1 0 0 0 1 1 0 0 0 0 0)

(0 0 1 0 0 0 0 0 0 0 0)M= (0 0 0 1 0 0 0 0 0 0 0)

(0 0 0 1 0 0 0 0 0 0 0)M= (0 1 1 0 0 1 0 0 1 1 1) = R_3

(0 0 0 0 1 0 0 0 0 0 0)M= (1 0 0 1 0 1 0 0 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0)M= (0 1 0 0 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0)M= (0 0 0 0 0 0 0 1 1 0 0)

(0 0 0 0 0 0 0 1 0 0 0)M= (0 0 0 1 0 1 0 0 0 1 1)

(0 0 0 0 0 0 0 0 1 0 0)M= (0 0 0 1 0 0 0 1 0 1 1)

(0 0 0 0 0 0 0 0 0 1 0) M= (1 0 0 1 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 1) M= (0 0 0 1 0 0 1 1 1 0 0)

R_3=(0 1 1 0 0 1 0 0 1 1 1)=Q_2

Here R_3=Q_2 = (0 1 1 0 0 1 0 0 1 1 1) Hence the fixed point is (0 1 1 0 0 1 0 0 1 1 1).

The triggering pattern is $C_8 \rightarrow C_4 \rightarrow C_4$

3.5.3 : Trial 2

The calculation for Trial 2 is performed similar to the Trial 1. Consider P_1^4 by setting C_4 in ON state that is, assigning the fourth component of the vector to be 1 and the rest of the components as 0.

Let P_1^4=(0 0 0 1 0 0 0 0 0 0 0)

P_1^4M= (0 0 0 1 0 0 0 0 0 0)M =(0 1 1 0 0 1 0 0 1 1 1)=P_2

Each component in P_2 is taken separately and the product of the given matrix is calculated.

P_2M ≈

(0 1 0 0 0 0 0 0 0 0 0)M = (1 0 0 0 1 1 0 0 0 0 0)
(0 0 1 0 0 0 0 0 0 0 0)M= (0 0 0 1 0 0 0 0 0 0 0)
(0 0 0 0 0 1 0 0 0 0 0)M=(0 1 0 0 1 0 0 0 0 0 0)
(0 0 0 0 0 0 0 0 1 0 0)M =(0 0 0 1 0 0 0 1 0 1 1)
(0 0 0 0 0 0 0 0 0 1 0)M =(1 0 0 1 0 0 1 1 1 0 0) = Q_2
(0 0 0 0 0 0 0 0 0 0 1)M =(0 0 0 1 0 0 1 1 1 0 0)
Now the vector with maximum number of 1's for the first time is Q_2.

Q_2 =(1 0 0 1 0 0 1 1 1 0 0) ≠ P_2

Then Q_2M is calculated and modified by assigning 1 if the values of the entries are ≧ 1. Let the modified vector be $Q_2^{\square}$

Q_2M=(0 2 1 2 1 2 1 2 2 3 3 3) ↪ (0 1 1 1 1 1 1 1 1 1 1) = $Q_2^{\square}$

$Q_2^{\square}$= (0 1 1 1 1 1 1 1 1 1 1)

Now each component in Q_2°vector is taken separately and the product of it with the given matrix is calculated. The vector which has maximum number of 1s is found and is called R_3.

Q_2°M ≈

(0 1 0 0 0 0 0 0 0 0 0)M = (1 0 0 0 1 1 0 0 0 0 0)

(0 0 1 0 0 0 0 0 0 0 0)M= (0 0 0 1 0 0 0 0 0 0 0)

(0 0 0 1 0 0 0 0 0 0 0)M= (0 1 1 0 0 1 0 0 1 1 1) = R_3.

(0 0 0 0 1 0 0 0 0 0 0)M= (1 0 0 1 0 1 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0)M=(0 1 0 0 1 0 0 0 0 0 0)

(0 0 0 0 0 0 0 1 0 0 0 0)M= (0 0 0 0 0 0 0 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0)M =(0 0 0 1 0 1 0 0 0 1 1)

(0 0 0 0 0 0 0 0 0 1 0 0)M =(0 0 0 1 0 0 0 1 0 1 1)

(0 0 0 0 0 0 0 0 0 0 1 0)M= (1 0 0 1 0 0 1 1 1 0 0)

((0 0 0 0 0 0 0 0 0 0 0 1)M= (0 0 0 1 0 0 1 1 1 0 0)

R_3= (0 1 1 0 0 1 0 0 1 1 1)

Here $R_3 \neq Q_2$.So the iteration continues.

Then R_3M is calculated and modified by assigning 1 if the values of the entries are $\geq$ 1. Let the modified vector be R_3°

R_3M = (2 1 0 4 2 1 2 3 2 1 1) ↪ (1 1 0 1 1 1 1 1 1 1 1) = R_3°

R_3° =(1 1 0 1 1 1 1 1 1 1 1)

Now each component in R_3°vector is taken separately and the product of it with the given matrix is calculated. The vector which has maximum number of 1s is found and is called S_4.

R_3°M ≈

(1 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 0 1 1 1 0 0 0 0) .

(0 1 0 0 0 0 0 0 0 0 0)M = (1 0 0 0 1 1 0 0 0 0 0)

(0 0 0 1 0 0 0 0 0 0 0)M= (0 1 1 0 0 1 0 0 1 1 1)= S_4.

(0 0 0 0 1 0 0 0 0 0 0 0)M=(1 0 0 1 0 1 0 0 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0)M= (0 1 0 0 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0)M =(0 0 0 0 0 0 0 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0)M =(0 0 0 1 0 1 0 0 0 1 1)

(0 0 0 0 0 0 0 0 1 0 0)M =(0 0 0 1 0 0 0 1 0 1 1)

(0 0 0 0 0 0 0 0 0 0 1 0)M= (1 0 0 1 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 1)M= (0 0 0 1 0 0 1 1 1 0 0)

Here $S_4 = R_{3=}$ (0 1 1 0 0 1 0 0 1 1 1)

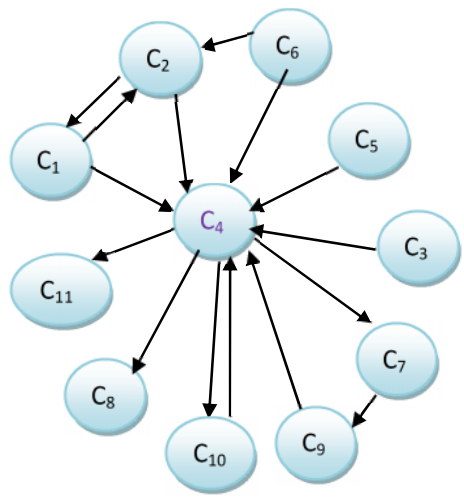
Hence the fixed point (0 1 1 0 0 1 0 0 1 1 1) is obtained when the same threshold value occurs twice. The iteration gets terminated.

Here the triggering pattern is $C_4 \rightarrow C_{10} \rightarrow C_4 \rightarrow C_4$

Using a C++ Computer Program(Appendix III(d)) is used to find out the triggering patterns when other attributes are kept in ON state are found out. The following table gives the triggering patterns for each concept.

Number	Attribute ON State	Triggering Pattern
Concept1	C_1: (1 0 0 0 0 0 0 0 0 0 0)	$C_1 \rightarrow C_2 \rightarrow C_4 \rightarrow C_4$
Concept 2	C_2: (0 1 0 0 0 0 0 0 0 0 0)	$C_2 \rightarrow C_1 \rightarrow C_4 \rightarrow C_4$
Concept 3	C_3: (0 0 1 0 0 0 0 0 0 0 0)	$C_3 \rightarrow C_4 \rightarrow C_4$
Concept 4	C_4: (0 0 0 1 0 0 0 0 0 0 0)	$C_4 \rightarrow C_{10} \rightarrow C_4 \rightarrow C_4$
Concept 5	C_5: (0 0 0 0 1 0 0 0 0 0 0)	$C_5 \rightarrow C_4 \rightarrow C_4$
Concept 6	C_6: (0 0 0 0 0 1 0 0 0 0 0)	$C_6 \rightarrow C_2 \rightarrow C_4 \rightarrow C_4$
Concept 7	C_7: (0 0 0 0 0 0 1 0 0 0 0)	$C_7 \rightarrow C_9 \rightarrow C_4 \rightarrow C_4$
Concept 8	C_8: (0 0 0 0 0 0 0 1 0 0 0)	$C_8 \rightarrow C_4 \rightarrow C_4$
Concept 9	C_9: (0 0 0 0 0 0 0 0 1 0 0)	$C_9 \rightarrow C_4 \rightarrow C_4$
Concept 10	C_{10}: (0 0 0 0 0 0 0 0 0 1 0)	$C_{10} \rightarrow C_4 \rightarrow C_4$
Concept 11	C_{11}: (0 0 0 0 0 0 0 0 0 0 1)	$C_{11} \rightarrow C_4 \rightarrow C_4$

Merging all these induced graphs on a single graph, the following graph is obtained



3.5.4: Conclusion

From the results the conclusions arrived are:

1. All the concepts get the same fixed point (0 1 1 0 0 1 0 0 1 1 1) which is the vector corresponding to the concept C_4. The triggering pattern of all the concepts in the above table and graph also reveal that C_4 – *easy availability of Endosulfan* is the terminal node. If any one of the causes is switched on to ON state, C_4 goes ON State. Hence, "*easy availability of Endosulfan* is the cause related to all the causes.

2. The limit point corresponding to C_4 (0 1 1 0 0 1 0 0 1 1 1) highlights that attribute C_2, C_3, C_6, C_9,C_{10}, and C_{11} (i.e the concepts corresponding to 1 in the vector C_4). Which seem to be the major causes for using Endosulfan in agriculture. Hence the conclusion arrived in this model is that the major causes for using Endosulfan are:

C_2 – Increase in food productivity

C_3 –Cheap cost of endosulfan

C_6 – Need for pest control

C_9-Less knowledge of any other non chemical alternative

C_{10}-Non involvement of social organizations

C_{11}- Government indifference or negligence with farmers

3. The triggering pattern shows that:

i. C_1& C_2 are related i.e population increase gives rise to increase in food productivity.

ii $C_4 \rightarrow C_{10} \rightarrow C_4 \rightarrow C_4$. reveals that C_{10} - *non involvement of social organization* plays the role of intermediary node.

iii The relation of C_6 & C_2 implies that pest control is needed to improve the food productivity.

iv. C_7 & C_9 are connected i.e illiteracy is the major cause for having poor knowledge of any other non chemical alternatives

The following **remedial measures** are suggested:

i. Population increase must be controlled

ii. To increase food productivity, alternative, preventive, and curative non chemical pest controlled methods should be applied

iii. Integrated Pest Management (IPM) strategies are to be followed

iv. As illiteracy plays an important role in using Endosulfan, farmers must be educated to adopt alternative non chemical pesticides and organic farming.

v. Educated younger generation has to enter into agriculture to make a co operative farming with the latest methods of agriculture along with using insecticides derived from natural plant extracts

The limitations of IFCMs

1. This model consists of lengthy procedure for calculation which is not suitable with the matrices having higher number of orders.

2. This calculation is fully based on the Experts opinion so it may lead to personal bias.

3.6: Analysing The Causes for Using Endosulfan In Agriculture by Maximum Fuzzy Cognitive Maps (MFCM) Approach.

MFCM is an advancement of FCM. It follows the foundation of FCM. It has a slight modification only in algorithm approaches.

3.6.1: Algorithmic Approach in Maximum Fuzzy Cognitive Maps (MFCMs)

The following steps to be adopted to drive an optimistic solution to the problem to an unsupervised data.

Step 1: For the given model (problem) collect the unsupervised data that is in determinant factors called nodes or concepts.

Step2: According to the expert opinion, draw the directed graph depicting interrelationship between the concepts.

Step3: Obtain the connection matrix, M, from the directed graph (FCM) .Here the number of rows in the given matrix = number of steps to be performed.

Step4: In the connection matrix M, choose the row having maximum number of 1's occurs first and call it R_1 vector.

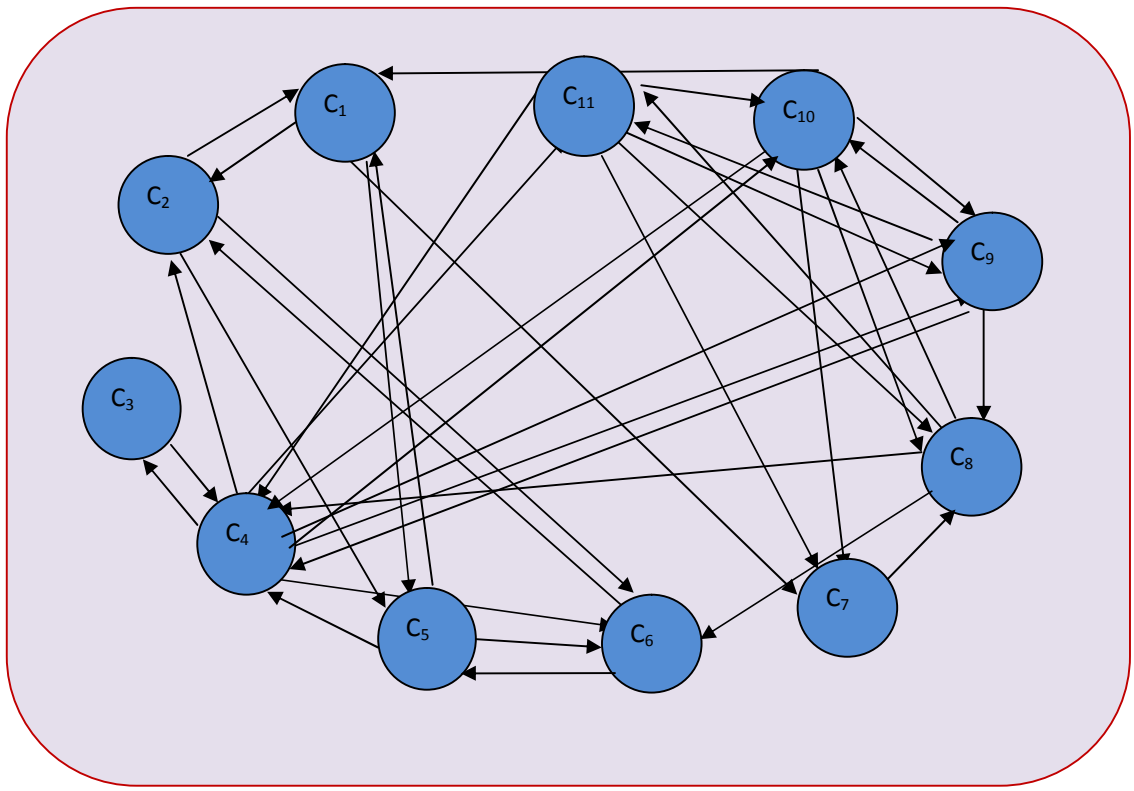
Step5: Now each component in the R_1 vector is taken separately and the product of it with the given matrix is calculated and thresholded at each stage by assigning 1 if the value of the entry is ≥ 1.

Step6: From the results, the vector which has the maximum number of one's occurring first is considered as R_2. Find $R_2 \times M$ and the vector is updated and threshold as in Step 5. It is named as R_2".

Step7: Repeat Step 5 till the same threshold value occurs twice and the value is considered as the fixed point. The iteration gets terminated.

3.6.2: Implementation of MFCM model to the study

The following represents the connection graph of the above eleven concepts and its connection matrix as in section 3.2.



$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \end{array} \begin{array}{c} \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{pmatrix} \end{array}$$

C_{10}	1	0	0	1	0	0	1	1	1	0	0
C_{11}	0	0	0	1	0	0	1	1	1	0	0

From the above matrix M the row having maximum number of 1s occurring first is found to be C_4 here. Now call C_4 as R_1.

Let R_1= (0 1 1 0 0 1 0 0 1 1 1)

Each component in R_1 vector is taken separately and the product of it with M is calculated and threshold.

$R_1M \approx$

(0 1 0 0 0 0 0 0 0 0 0) M ↪ (1 1 0 0 1 1 0 0 0 0 0)

(0 0 1 0 0 0 0 0 0 0 0)M ↪ (0 0 1 1 0 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0) M ↪ (0 1 0 0 1 1 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0) M↪ (0 0 0 1 0 0 0 1 0 1 1)

(0 0 0 0 0 0 0 0 0 0 1 0)M↪ (1 0 0 1 0 0 1 1 1 1 0)= R_2

(0 0 0 0 0 0 0 0 0 0 0 1)M ↪ (0 0 0 1 0 0 1 1 1 0 1)

In the above results, choose the row having maximum number of 1's be R_2

R_2= (1 0 0 1 0 0 1 1 1 1 0)

The product of R_2 with M is calculated and modified. The modified vector is called $R_2^{\square}$

R_2M=(2 3 1 2 1 2 3 3 3 3 3) ↪ (1 1 1 1 1 1 1 1 1 1 1)= $R_2^{\square}$

Each component in $R_2^{\square}$ vector is taken separately and the product of it with M is calculated and the threshold is obtained.

$R_2^{\square}$ M ≈

(1 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 0 1 1 1 0 0 0 0)

(0 1 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 0 1 1 0 0 0 0 0)

(0 0 1 0 0 0 0 0 0 0 0) M↪ (0 0 1 1 0 0 0 0 0 0 0)

(0 0 0 1 0 0 0 0 0 0 0)M↪ (0 1 1 1 0 1 0 0 1 1 1) = R_3

(0 0 0 0 1 0 0 0 0 0 0)M↪ (1 0 0 1 1 0 0 0 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0)M↪ (0 1 0 0 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0)M↪ (0 0 0 0 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 1 0 0 0)M↪ (0 0 0 1 0 0 1 1 1 1 1)

(0 0 0 0 0 0 0 0 1 0 0)M↪ (0 0 0 0 0 0 0 1 1 1 1 1)

(0 0 0 0 0 0 0 0 0 1 0)M↪ (1 0 0 1 0 0 1 1 1 1 0)

(0 0 0 0 0 0 0 0 0 0 1)M↪ (0 0 0 1 0 0 0 1 1 0 1)

The vector having maximum number of 1s is taken as R_3

R_3=(0 1 1 1 0 1 0 0 1 1 1) , $C_3 \neq C_2$, so the iteration continues.

R_3M=(2 2 1 3 2 2 2 2 3 1 1) = (1 1 1 1 1 1 1 1 1 1 1 1)=R_3¤

Each component in $R_3$¹ vector is taken separately and the product with M is calculated and threshold.

R_3¤ M≈

(1 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 0 1 1 1 0 0 0 0)

(0 1 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 0 1 1 0 0 0 0 0)

(0 0 1 0 0 0 0 0 0 0 0) M↪ (0 0 1 1 0 0 0 0 0 0 0)

(0 0 0 1 0 0 0 0 0 0 0)M↪ (0 1 1 1 0 1 0 0 1 1 1) = R_4

(0 0 0 0 1 0 0 0 0 0 0)M↪ (1 0 0 1 1 1 0 0 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0)M↪ (0 1 0 0 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0)M↪ (0 0 0 0 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 1 0 0 0)M↪ (0 0 0 1 0 1 0 1 0 1 1)

(0 0 0 0 0 0 0 0 1 0 0)M↪(0 0 0 1 0 0 0 1 1 1 1)

(0 0 0 0 0 0 0 0 0 1 0)M↪(1 0 0 1 0 0 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 0 1)M↪(0 0 0 1 0 0 1 1 1 0 1)

Similar to the above computation, the vector which has the maximum number of 1's is found and let it be R_4.

R_4= (0 1 1 1 0 1 0 0 1 1 1) = R_3

Since the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated and the calculation gets terminated.

The fixed point is R_4 =(0 1 1 1 0 1 0 0 1 1 1)

(The Computer Program C++ (Appendix III (e)) is also framed to work the following method)

3.6.3: CONCLUSION

In MFCM model we arrive at a fixed point (0 1 1 1 0 1 0 0 0 1 1).The above fixed point vector is nothing but the 4^{th} row after thresholding in the casual connection matrix M.ie, *easy availability of Endosulfan* .We conclude that this factor is the most impactful factor in this study , even though many attributes are present. The other interdependent attributes having impact on the cause for using endosulfan in agriculture are C_2,C_3,C_6,C_9,C_{10} and C_{11} which are the places in which 1 is present in the fixed point. This is the same fixed point which is we have arrived in IFCM in sec 4.5. While working with the IFCM model, we have performed 11 trials and got various fixed point where as in MFCM model there is only 1 trial giving the same fixed point. This model consumes less time and focuses only on a particular fixed point unlike getting various fixed points leading to vagueness. Hence this model is much suitable to work for the unsupervised data to find the most impactful factors. But in IFCM model the impact of each concept on other concepts can also be found which is an advantage of IFCM.

4

Estimation of the Reasons for Various Effects by Endosulfan in Agriculture Using Fuzzy Models

4.1 Introduction

Endosulfan is acutely toxic. It has been identified with the range of chronic effects and acute effects. Detailed studies on all these effects were given in Chapter 1 .In this chapter the reasons for various effects by Endosulfan are analysed using the mathematical models FCM, CFCM, IFCM and MFCM.

4.2 Selection of concepts for the study

From the sample survey taken, the concepts for effects of Endosulfan are derived from the expert's opinion as follows.

C_1 –Exposure to Endosulfan when spraying in agriculture field

C_2 –Consuming Endosulfan sprayed vegetables, oil/seeds,

C_3 –Lack of precaution and treatment

C_4 –Pollution of water source (river, pond) by Endosulfan

C_5- Land becoming infertile with the poor yield

C_6 – Residual effect of Endosulfan in land

C_7 –Air pollution by Endosulfan

C_8-Residues in the blood sample of breast fed children.

C_9-Endosulfan exposed domestic animals, earth worms, micro orthoposes, rabbits, rats.

C_{10}-Endosulfan contaminated water living fish, crab, frog

C_{11}-Endosulfan affected environment exposure to bettle, butterfly, birds

C_{12} - Long term exposure to Endosulfan causing cancer, kidney, skin diseases, neuro behavioral problems and infertility.

4.2.1 Justification for the concepts

A justification is given for the twelve concepts taken for the study

C_1 –Exposure to Endosulfan when spraying in agriculture field

The people are exposed by breathing air near where Endosulfa has been sprayed. Drinking water is contaminated directly. Being contact with contaminated soil. Working at endosulfan production centres and direct ingestion also they are exposed to Endosulfan. Harm may result from direct exposure during handling, spray dirft, washing contaminated work clothes, storing pesticides in the home, or indirectly via pesticide dumps and persistence in the environment.

C_2 –Consuming Endosulfan sprayed vegetables, oil/seeds

Endosulfan affects human being after consuming vegetables just after spraying endosulfan. People may be exposed to endosulfan through various avenues, the most common being ingestion of contaminated food and water.Endosulfan is one of the most commonly encountered pesticides on food especially fruits and vegetables.It is found that acute risk estimates for food and drinking water exceeded levels to concern, which prompted mitigation measure to be put in place, as well as the cancellation of the use of endsulfan on vulnerable crops such as succulent beans, grapes, and spinach.Residues on food have been detected whenever endosulfan is used.

C_3 – Lack of precaution and treatment

Farmers use Endosulfan sprayers for spraying pesticides without taking any precautions like gloves and respirator. They are spraying directly by keeping the nozzles upward. So it directly comes to the face of the workers so that they are directly affected with different types of diseases. Due to illiteracy and poor condition they will not take any treatement. They find no time to go to hospitals. Moreover the containers of Endosulfan are not disposed properly leading to contamination.

C_4 – Pollution of water source (river, pond) by endosulfan

Water is a very important constituent of our ecosystem and so we have to preserve and improve its quality. Once used or spilled, pesticides may contaminate the water used

for drinking or bathing .Pesticides can contaminate nearby ground water and surface water (riverpond). In addition to this, discharges from the pesticides manufacturing plants, accidental spills and natural processes as dilution, surface run off and leaching are the cause of the occurrence of xenobiotic compounds in surface waters. The effects of pesticides on aquatic environments are also due to their degradation products, which can be more toxic than the original substances. There is evidence that the OP compounds are sufficiently persistent to reach the marine environment at concentrations high enough to affect aquatic fauna and flora. Pestiicdes are the major cause of water pollution. The half life of Endosulfan in water varies from 35-187 days. The Stockholm convention regards a chemical as persisitent in water if its half life is > 60 days.

C_5- Land becoming infertile with the poor yield

Some pesticides are persistent organic pollutnats and contribute to the soil contaminations. Agriculture production was regarded as a main target for human needs. Because of the scarcity of land and since the reform of free trade environment policy, people have stopped using the natural fertilizer and now use chemical fertilizers which provide high cause of losing Nitorgen fertilizer and providing soil and land degradation

C_6 - Residual effects of Endosulfan in land

Pesticides are shown to have a great effect on soil organisms, Soil microbial biomass carbon is negatively correlated with the total pesticide residues in soils and it varied from 181.2 to 350.6 mg kg (-1). Pesticide residues have adversely affected the soil microbial populations, more significantly the bacterial population (ie) Actinomycetes which are beneficial bacteria that play a vital role in replenishing a supply of nutrients in the soil. Endosulfan degrades relatively quickly in water, but in soil it degrades slowly. The major degradation product, endosulfan sulphate is not only more persistent but is also toxic. By means of comparison, the Stockholm Convention regards chemicals as persistent if they have a half-life greater than 183 days where the half life of Endouslfan is 9 months to 6 years.

C_7 –Air pollution by Endosulfan

Endosulfan enters air, water and soil when it is manufactured or used as a pesticides. Endosulfan is often applied to crops using sprayers.Some endosulfan in the air

may travel long distance before it lands on crops, soil or water and pollute the environment. Pesticide drift occurs when pesticides suspended in the air as particles are carried by wind to other areas, potentially contaminating them.

C_8 -Residues in the blood sample of breast fed children.

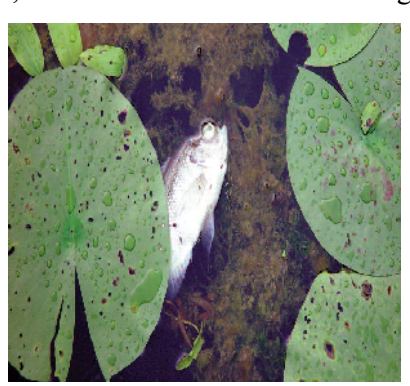
High levels of endosulfan were detected in human breast milk of younger mothers in Sub Saharan Africa. Residues were also detected in fat and blood samples from children living nearby farms in Spain. Blood, human milk and urine samples were also be contaminated. Alarmigly high levels of endosulfan residues have been detected in the blood and breast milk.

C_9- Endosulfan exposed domestic animals, earth worms, micro orthropods, rabbits, rats.

Endosulfan was found toxic to earth worms, causing a significant reduction in the growth rate and total protein content. Endosulfan is highly toxic to soil micro arthropods, micro organism soil algae. It is also toxic to mammals like rabbits and rats.The disappearance of cats, rats, frogs, bees, fresh water fishes etc. were reported from Kasaragod district is South India, where endosulfan was aerially sprayed.Farmers from endosulfan sprayed area report of acute effect to cattle at time of spray and after leading to fatalities. The cattles are born with birth disability. This causes a serious threat to biodiversity

C_{10}- Endosulfan contaminated water living fish, crab, frog

Fishes that are common instream of the region, are absent in streams running through areas where endosulfan was sprayed. The fishers reported massive death of fishes during the spray.Only two species of frogs namely Rana verrucosa and Nyctybatrachus major were recorded by the team from the area.Species such as Micrixalus and Rana temporalis adapted to the torrential streams were absent. Besides being toxic to crab larve, Endosulfan has been reported to disrupt the molting of crabs and aquatic invertebrates.



Pesticide Action Network Europe (2010)

C_{11}- Endosulfan affected environment exposure to bettle, butterfly, birds

Most of the common birds such as crows, mynas, parakeets, drongos and koel disappeared during the period of spray. It is reported that since crows were absent, certain communities felt incompleteness in performing their religious rites after death. Major species of birds missing in the plantations were flycatchers, babblers and endemics such as small sunbird, crimson throated barbet and white bellied tree pie. Common birds absent in the plantation were fairy bluebird, large cuckoo shrike and large wood shrike.

A bird that died as a result of pesticide usage

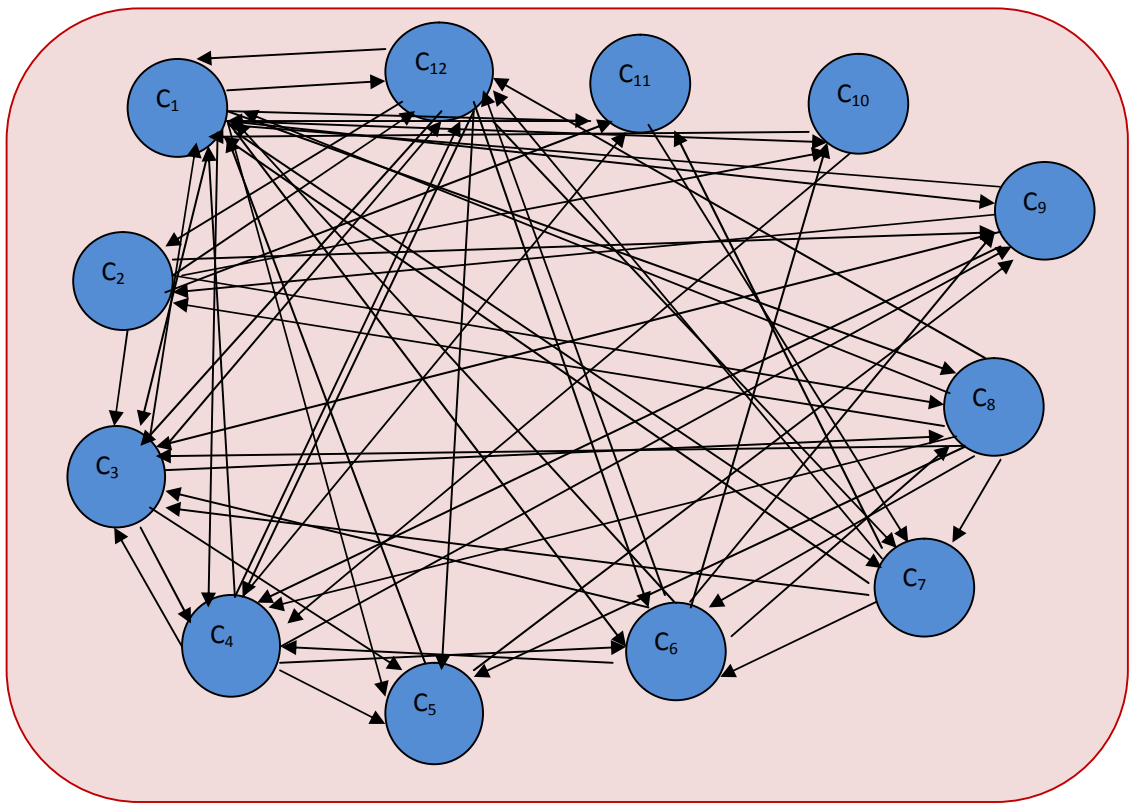
C_{12} - Long term exposure to Endosulfan causing cancer, kidney, skin diseases, neuro behavioral problems and infertility

Endosulfan is highly toxic and can be fatal if inhaled, swallowed or absorbed through the skin. The sub acute and chronic toxicity studies of endosulfan in animals suggest that the liver, kidney, immune system and testes are the main target organs. Long term exposure is linked to immune suppression, neurological disorders, congenital birth defects, chromosomal abnormalities, mental retardation, impaired learning and memory loss. Endosulfan exposure in male children may delay sexual maturity and interfere with sex harmone synthesis.

4.3 Finding out the reasons for the various the effects of Endosulfan by the method of FCM.

4.3.1 Implementation of FCM model to the study

The FCM method already discussed in Chapter III is applied to find the reasons for the various effects by Endosulfan. The concepts considered in Sec.4.2 are connected by a directed graph, by an expert which is given below.



Using the above directed graph, the connection matrix M= (a_{ij}) is formulated with

a_{ij} =1 if C_i C_j

=0 if C_i C_j.

If increase in concept C_i leads to increase in another concept C_j then aij is given the value 1. Otherwise a_{ij} is given the value 0. It is important to note that the connection matrix is a square matrix with diagonal entries as zero.

$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

A trial is conducted for the concept C_6. Consider the initial vector P_1^6= (0 0 0 0 0 1 0 0 0 0 0 0) ,in which the only node C_6 ie,*"Residue effect of Endosulfan in land*". is ON state and all the rest in OFF state. Now passing P_1^6 into the connection matrix M .i.e., P_1^6M is calculated and is modified by assigning 1 if the values of the entries are ≥1 and keeping sixth place always 1.

$C_1^6M = \hookrightarrow$ (1 0 1 1 0 0 0 1 1 1 0 1) $\hookrightarrow$(1 0 1 1 0 1 0 1 1 1 0 1) $=P_2$

P_2M =(7 3 7 7 5 4 4 3 3 2 3 5) $\hookrightarrow$ (1 1 1 1 1 1 1 1 1 1 1)=P_3

P_3M =(10 3 9 7 5 5 4 4 5 3 4 7) $\hookrightarrow$ (1 1 1 1 1 1 1 1 1 1 1)=P_4=P_3, a fixed point.

The fixed point reveals the hiddern pattern that the concept C_6 has impact on all other concepts.

As it is difficult to calcutate fixed point for all concepts. A C++ computer program (Appendix III (f)) is used to find the fixed points which are listed below.A conclusion is derived from these results is given in the next section.

State Vector	Steps required to obtain fixed point	The fixed point
P_1^1=(1 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 11)
P_1^2=(0 1 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^3=(0 0 1 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^4=(0 0 0 1 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^5=(0 0 0 0 1 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^6=(0 0 0 0 0 1 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^7=(0 0 0 0 0 0 1 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^8=(0 0 0 0 0 0 0 1 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^9=(0 0 0 0 0 0 0 0 1 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
P_1^{10}=(0 0 0 0 0 0 0 0 0 1 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1)
P_1^{11}=(0 0 0 0 0 0 0 0 0 0 0 1 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)
P_1^{12}=(0 0 0 0 0 0 0 0 0 0 0 0 1)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1)

4.3.2 Conclusion

For the concepts C_1 to C_{12}, the fixed point**(1 1 1 1 1 1 1 1 1 1 1 1)** is obtained in the 2nd or 3rd step itself. Hence all these concepts are considered to be major reasons for the effects by Endosulfan. Since all these concepts are getting the same fixed point, they are all interrelated (ie) the effect of one concept has impact on all other concepts.

It is well understood that *getting exposure to the spraying of Endosulfa*n (C_1)and *cosuming endosulfan sprayed vegetables*(C_2) lead to *neurological disorders, congenial birth defects ,cancer, kidney and skin diseases* (C_{12}).

Lack of precaution and treatment (C_3) may *lead to adverse effects* (C_{12}).*Pollution of water resources* (C4), *infertility of land* (C_5) and *air pollution*(C_7) are the major environmental effects.

The *effects will remain in the land for years* (C_6) and *blood samples of children having residues of Endosulfan* (C_8) will make the future generation affected by the deadly poison Endosulfan.

Endosulfan exposed domestic animals, earth worms, micro orthoposes, rabbits, rats (C_9) and *Endosulfan contaminated water living fish, crab, frog* (C_{10}) which are *exposed to Endosulfan in environment* (C_{11}) should be saved by banning the use of Endosulfan.

To overcome the effects of Endosulfan to the human beings, domestic animals and wild life and even to the environment,some measures are suggetsted by experts and by the study thoroughly made from the articles and reviews written on Endosulfan, in next chapter.

4.4 Identifying the Reasons for Various Effects by Endosulfan Using Combined Fuzzy Cognitive Maps (CFCM)

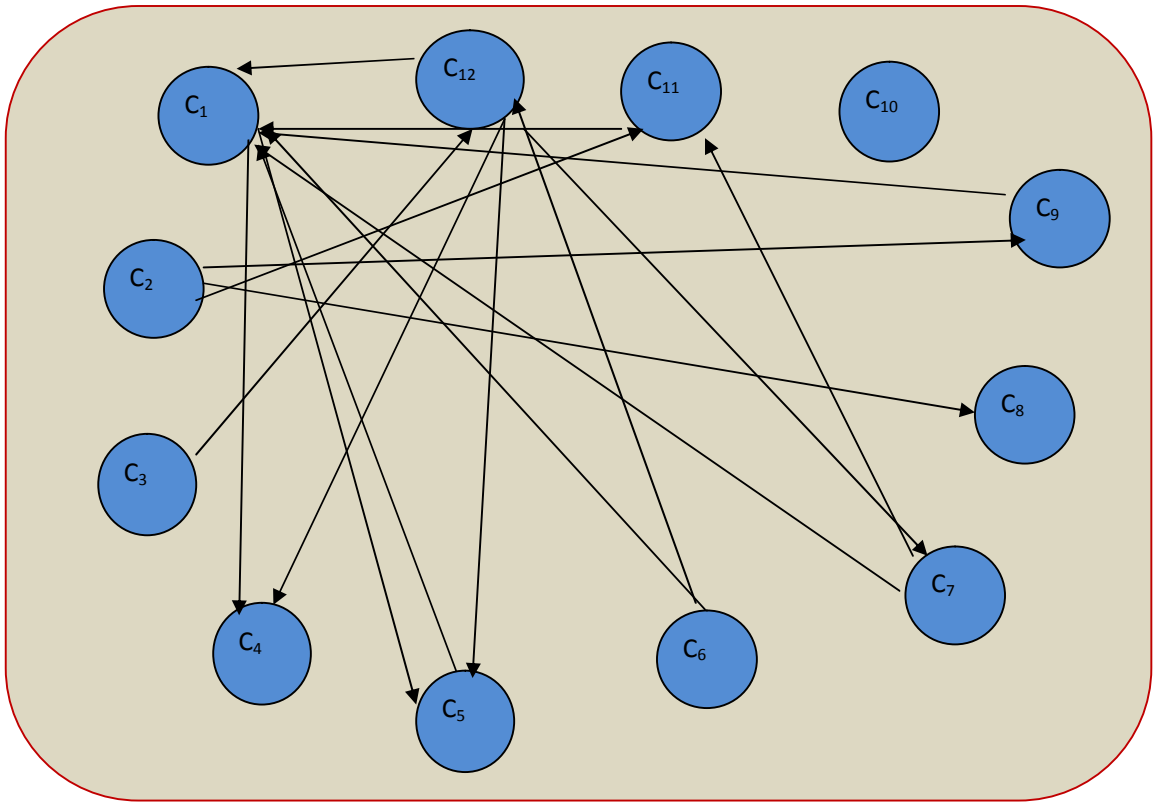
4.4.1: Implementation of FCM model to the study

The same problem of finding the reasons for the effects by Endosulfan through combined Fuzzy Cognitive Map (CFCM) is analyzed in this section .A finite number of FCMs can be combined together to produce the joint effect of FCMs here. This gives the result in an effective way by combining the opinions of 3 or more experts. For this model, giving the twelve concepts considered in sec 4.2 to four experts (i) an agriculture officer (ii) an N.G.O (iii) a doctor (iv) a village administrative officer, their opinions are collected .Then the connection matrices are drawn from their responses

4.4.2 Analysis of the first expert's view

The first experts opinion is arrived through responses from an agricultural officer for the connections between the concepts considered in section 4.2.

The following represents the connection graph of the above twelve concepts given by the Agriculture officer.

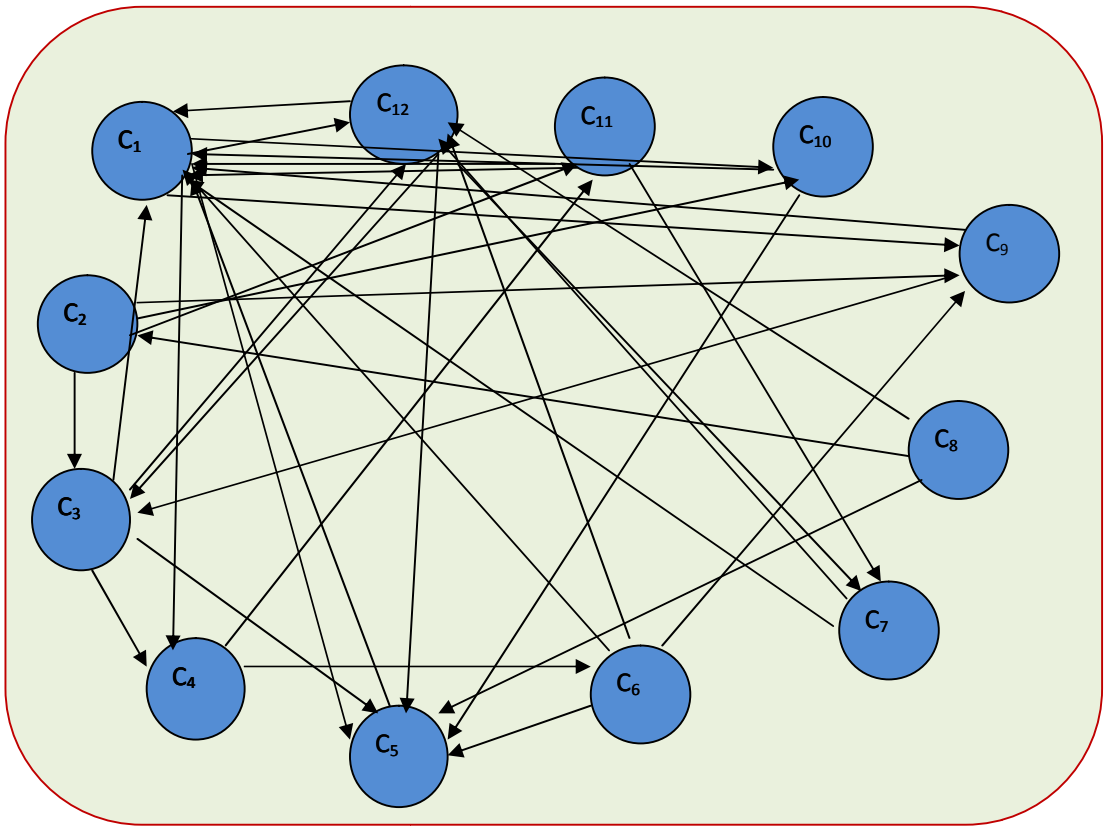


The related connection matrix denoted by A for the above directed graph is given below

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

4.4.3 Analysis of the second expert's view

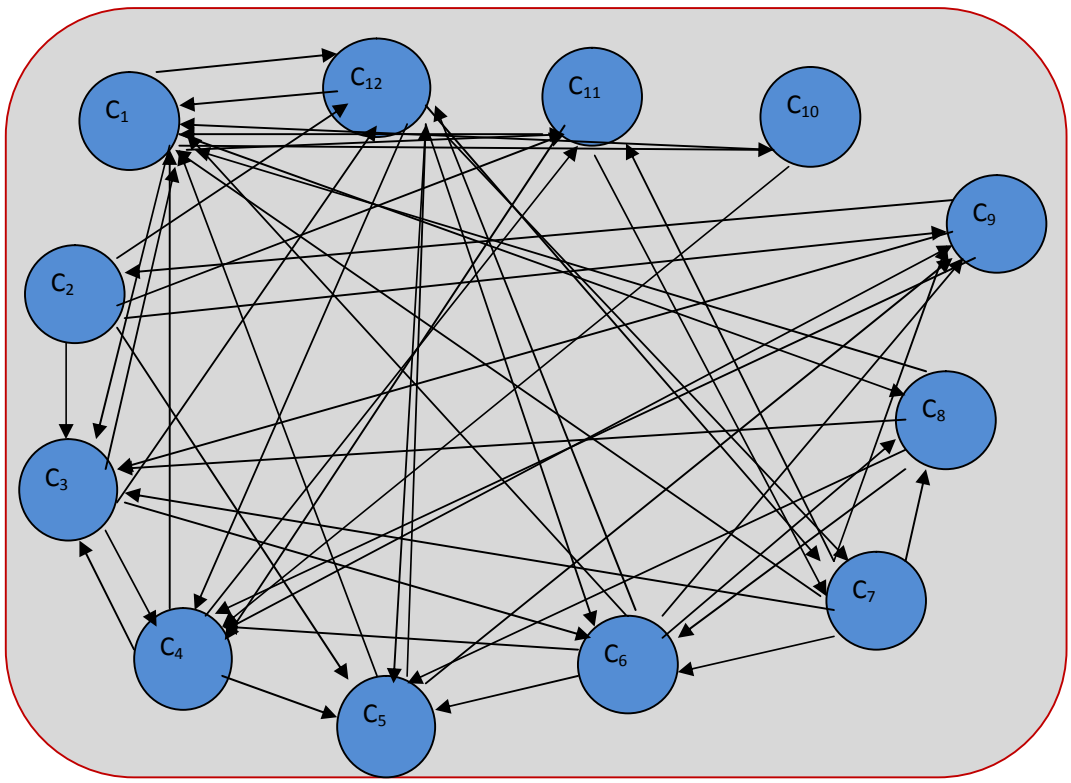
The second experts opinion is arrived through responses from an NGO for the connections between the concepts considered in section 4.2.The related graph and the matrix are given by an NGO



$$B = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

4.4.4 Analysis of third expert's view

The third experts opinion is arrived through responses from a doctor for the connections between the concepts considered in section 4.2. The following represents the connection graph of the above twelve concepts and its connection matrix given by the doctor.

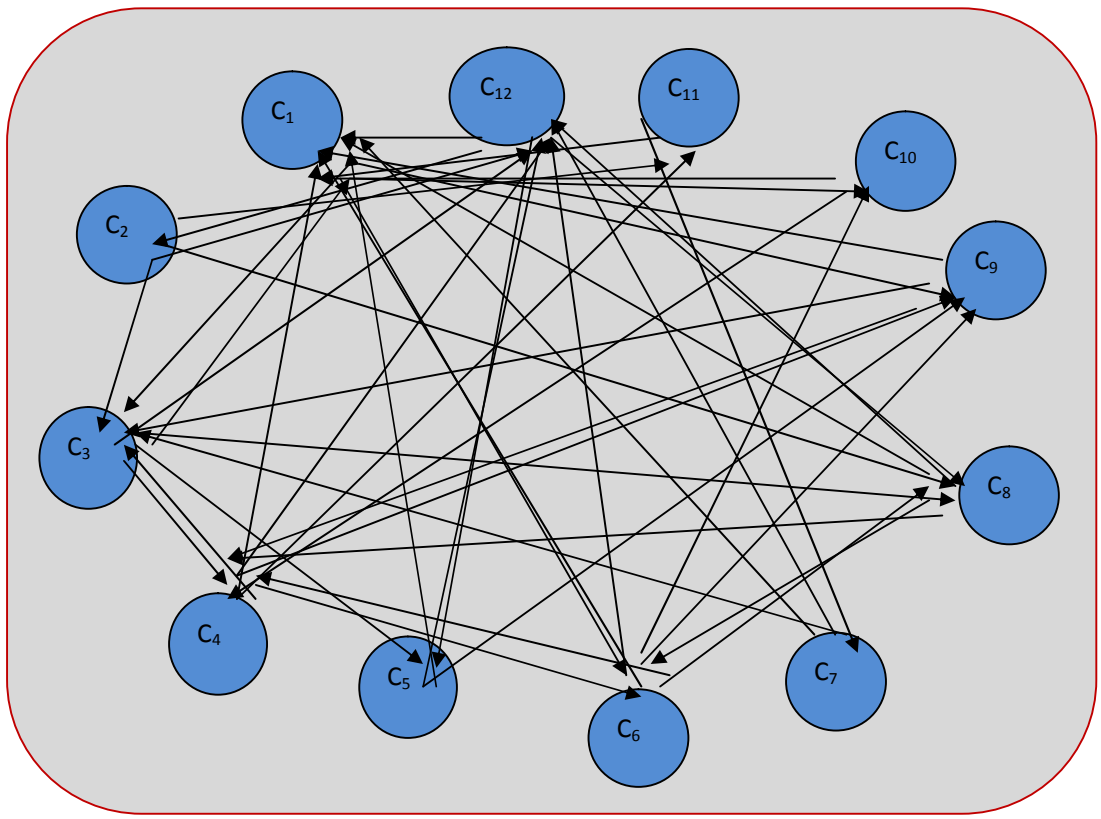


$$C = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

4.4.5 Analysis of fourth expert's view

The fourth experts opinion is arrived through responses from a village administrative officer for the connections between the concepts considered in section 4.2

The following represents the connection graph of the above twelve concepts and its connection matrix given by a village administrative officer



$$D = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

4.4.6: Analysis of the problem containing all the four expert's views using CFCM

Let us define the combined connection matrix S= A+B+C+D

$$S = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 3 & 1 & 1 & 1 & 1 & 2 & 2 & 4 & 1 & 4 \\ 0 & 0 & 4 & 0 & 3 & 0 & 0 & 1 & 3 & 1 & 2 & 3 \\ 3 & 0 & 0 & 3 & 2 & 3 & 0 & 2 & 0 & 0 & 0 & 4 \\ 3 & 0 & 3 & 0 & 2 & 2 & 0 & 0 & 3 & 0 & 4 & 1 \\ 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3 & 0 & 0 & 3 \\ 3 & 0 & 0 & 3 & 4 & 0 & 0 & 3 & 4 & 1 & 0 & 4 \\ 4 & 0 & 2 & 0 & 0 & 3 & 0 & 1 & 1 & 0 & 2 & 2 \\ 3 & 1 & 2 & 1 & 2 & 3 & 0 & 0 & 0 & 0 & 0 & 2 \\ 2 & 2 & 4 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 3 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 2 & 0 & 0 & 4 & 0 & 0 & 0 & 0 & 0 \\ 3 & 1 & 1 & 2 & 2 & 2 & 1 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

A trial is conducted for the concept C_6. Consider the state vector P_1^6=(0 0 0 0 0 1 0 0 0 0 0 0) Now passing through the connection matrix S, we get PS = (1 3 0 0 3 4 0 0 3 4 1 0 4)

Here , the threshold is done in a different way. If an entry after multiplication is ≤2, then the value 0 is assigned and if it is ≥3, the value 1 is assigned keeping sixth place always 1.

PS=(3 0 0 3 4 0 0 3 4 1 0 4) ↪(1 0 0 1 1 1 0 1 1 0 0 1)=P_2

P_2S= (16 4 13 10 11 8 2 6 12 5 5 14) ↪(1 1 1 1 1 1 0 1 1 1 1 1) =P_3

P_3S= (27 4 19 12 18 17 11 6 9 13 6 7 21) ↪(1 1 1 1 1 1 1 1 1 1 1 1)=P_4

P_4S=(31 4 22 18 17 13 6 11 18 7 9 23) ↪(1 1 1 1 1 1 1 1 1 1 1 1)=P_5=P_4

which is a fixed point for S. Similarly we can work with any one of the nodes in ON state and find out the fixed point. A C++ Computer Program (Appendix III (g)) is written and applied. The result is listed below.

State Vector	Steps required to obtain fixed point	The fixed point
$P1^1$=(1 0 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^2$=(0 1 0 0 0 0 0 0 0 0 0 0)	**STEP 9**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^3$=(0 0 1 0 0 0 0 0 0 0 0 0)	**STEP 7**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^4$=(0 0 0 1 0 0 0 0 0 0 0 0)	**STEP 6**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^5$=(0 0 0 0 1 0 0 0 0 0 0 0)	**STEP 9**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^6$=(0 0 0 0 0 1 0 0 0 0 0 0)	**STEP 9**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^7$=(0 0 0 0 0 0 1 0 0 0 0 0)	**STEP 5**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^8$=(0 0 0 0 0 0 0 1 0 0 0 0)	**STEP 5**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^9$=(0 0 0 0 0 0 0 0 1 0 0 0)	**STEP 4**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{10}$=(0 0 0 0 0 0 0 0 0 1 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{11}$=(0 0 0 0 0 0 0 0 0 0 1 0)	**STEP 5**	**(1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{12}$=(0 0 0 0 0 0 0 0 0 0 0 1)	**STEP 5**	**(1 1 1 1 1 1 1 1 1 1 1 1)**

4.4.7 CONCLUSION

All the state vectors get the same fixed point (1 1 1 1 1 1 1 1 1 1 1 1) .This indicates all the concepts have interrelationship among them as in FCM. The concepts C_1 and C_{10} get the fixed point in the 3rd step itself. Hence

C_1- Exposure to Endosulfan when spraying in agriculture field

C_{10}- Endosulfan contaminated water living fish, crab, frog

have more impact on all 12 concepts where as the concepts C_3, C_4,C_7,C_8,C_9,C_{11} and C_{12} get fixed point much earlier than the concept C_2, C_5 and C_6 (i.e)

C_3 -Lack of precaution and treatment

C_4 -Pollution of water source (river, pond) by Endosulfan

C_7-Air pollution by Endosulfan

C_{12}- Long term exposure to Endosulfan causing cancer, kidney, skin diseases, neuro behavioral problems and infertility have higher impact on all concepts for the effects of Endosulfan than the concepts

C_2- Consuming Endosulfan sprayed vegetables, oil/seeds

C_5- Land becoming infertile with poor yield

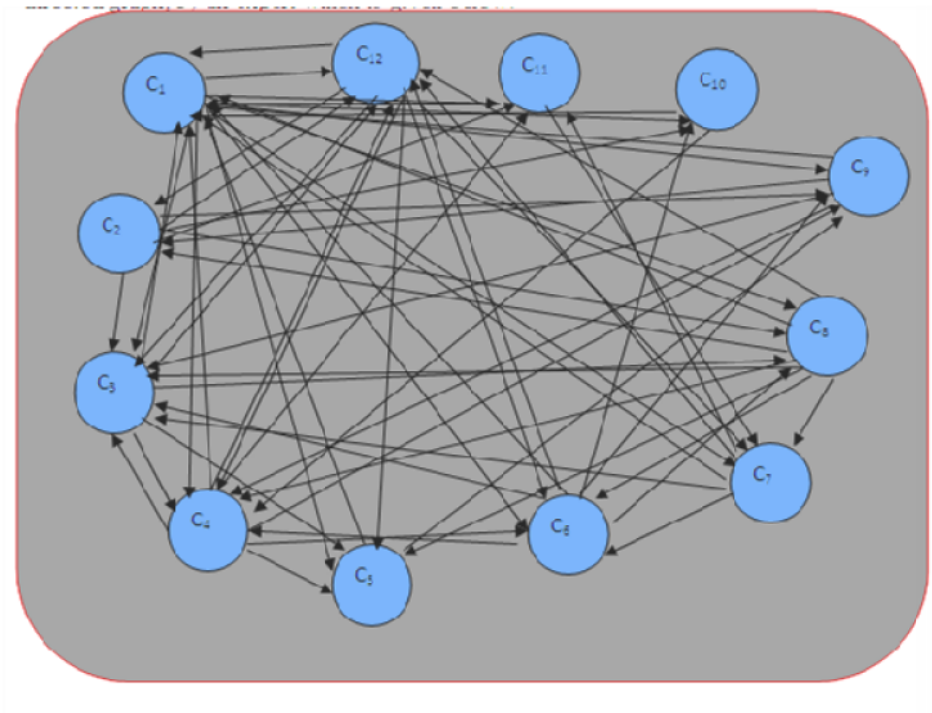
C_6 – Residual effect of Endouslfna in land

4.5 Determining the Reasons for Various Effects by Endosulfan in Agriculture By Induced Fuzzy Cognitive Maps (IFCM) Approach.

Induced Fuzzy Cognitive Maps (IFCM) is an advancement of FCM .The method is same as that of FCM until P_2 is calculated. Each component in P_2 vector is taken separately and multiplied with matrix M. Among these vectors, the vector which has the maximum number of 1's for the first time is considered as Q_2.Then the same procedure is repeated as done for P_2 until a fixed point is obtained.

4.5.1 Implementation of IFCM model to the study

The following represents the connection graph of the twelve concepts and its connection matrix as in section 4.2



$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

As there are 12 concepts and IFCM model is very lengthy, only two trials are worked out manually. The rest are done using C++ computer program (Appendix III(h))

4.5.2 Trial 1

Consider P_1^6 in the trial 1, by setting the concept C_6 to ON state, that is the sixth component of the vector is set to be 1 and the rest are assigned to 0.

Then P_1^6 = (0 0 0 0 0 1 0 0 0 0 0 0)

Product of P_1^6 and M is calculated.

P_1^6M=(0 0 0 0 0 1 0 0 0 0 0 0)M=(1 0 0 1 1 0 0 1 1 1 0 1)

P_2= (1 0 0 1 1 0 0 1 1 1 0 1)

Now as per Induced Fuzzy Cognitive Map methodology, each component in the P_2 vector is taken separately and product of it with the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as Q_2

$P_2M \approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0) M=(0 0 1 1 1 1 1 1 1 1 1 1)=Q_2

(0 0 0 1 0 0 0 0 0 0 0 0 0)M =(1 0 1 0 1 1 0 0 1 0 1 1)

(0 0 0 0 1 0 0 0 0 0 0 0 0)M =(1 0 0 0 0 0 0 0 1 0 0 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0)M=(1 1 1 1 1 1 1 0 0 0 0 1)

(0 0 0 0 0 0 0 0 1 0 0 0 0)M=(1 1 1 1 0 0 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0)M=(1 0 0 1 0 0 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 1)M=(1 1 1 1 1 1 1 0 0 0 0 0)

Q_2= (0 0 1 1 1 1 1 1 1 1 1 1) $\neq P_2$

Product of Q_2 and M is calculated and modified by assigning 1 if the values of the entries are $\geq$1 Let the modified vector be $Q_2^{\square}$

Q_2M =(0 0 1 1 1 1 1 1 1 1 1 1)M= (10 3 6 6 5 4 3 3 3 1 2 5)

↪(1 1 1 1 1 1 1 1 1 1 1 1)= $Q_2^{\square}$

$Q_2^{\square}$= (1 1 1 1 1 1 1 1 1 1 1 1)

Now each component in Q_2¤ vector is taken separately and product of it with the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as R_3

Q_2¤M ≈

(1 0 0 0 0 0 0 0 0 0 0 0 0 0)M=(0 0 1 1 1 1 1 1 1 1 1 1 1)= R_3

(0 1 0 0 0 0 0 0 0 0 0 0 0 0)M =(0 0 1 0 0 0 0 1 1 1 1 1 1)

(0 0 1 0 0 0 0 0 0 0 0 0 0 0)M =(1 0 0 1 1 0 0 1 0 0 0 1 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0)M =(1 0 1 0 1 1 0 0 1 0 1 1 1)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0)M =(1 0 0 0 0 0 0 0 1 0 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0)M =(1 0 0 1 1 0 0 1 1 1 0 1 1)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0)M =(1 0 1 0 0 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0)M=(1 1 1 1 1 1 1 0 0 0 0 1 1)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0)M=(1 1 1 1 0 0 0 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0)M=(1 0 0 1 0 0 0 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0)M =(1 0 0 0 0 0 1 0 0 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0)M=(1 1 1 1 1 1 1 0 0 0 0 0 0)

Here R_3=(0 0 1 1 1 1 1 1 1 1 1 1 1)=Q_2. Hence the fixed point is (0 0 1 1 1 1 1 1 1 1 1 1 1)

The triggering pattern is $C_6 \rightarrow C_1 \rightarrow C_1$

4.5.3 Trial 2

The calculation for Trial 2 is performed similar to Trial 1. consider P_1^9 by setting C_9 in ON state that is, assigning the nineth component of the vector to be 1 and the rest of the components as 0.

Let P_1^9=(0 0 0 0 0 0 0 0 1 0 0 0 0)

Product of P_1^9 and M is calculated and is named as P_2

P_1^9M= (0 0 0 0 0 0 0 0 0 1 0 0 0)M =(1 1 1 1 0 0 0 0 0 0 0 0 0)=P_2

Each component in the P_2 is taken separately and product of it with the given matrix is calculated.

The vector which has the maximum number of one's which occurs first is considered to be Q_2

$P_2M \approx$

$(1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M=(0\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) = Q_2$

$(0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M=(0\ 0\ 1\ 0\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 1)$

$(0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M=(1\ 0\ 0\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1)$

$(0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M=(1\ 0\ 1\ 0\ 1\ 1\ 0\ 0\ 1\ 0\ 1\ 1)$

That is, $Q_2 =(0\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) \neq P_2$

Then Q_2M is calculated and threshold as Q_2^1

$Q_2M= (10\ 3\ 5\ 6\ 5\ 4\ 3\ 3\ 3\ 1\ 2\ 5) \hookrightarrow (1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1)= Q_2^1$

Each component in the vector Q_2^1 is taken separately and product of it with the given matrix is calculated.Now the vector with maximum number of 1's be R_3.

$Q_2^1M \approx$

$(1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M=(0\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1)= R_3$

$(0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M =(0\ 0\ 1\ 0\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 1)$

$(0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M =(1\ 0\ 0\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1)$

$(0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M =(1\ 0\ 1\ 0\ 1\ 1\ 0\ 0\ 1\ 0\ 1\ 1)$

$(0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M =(1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0)M =(1\ 0\ 0\ 1\ 1\ 0\ 0\ 1\ 1\ 1\ 0\ 1)$

$(0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0)M =(1\ 0\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1\ 1)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)M=(1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 1)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)M=(1\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0)M=(1\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0)M =(1\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1)M=(1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 0)$

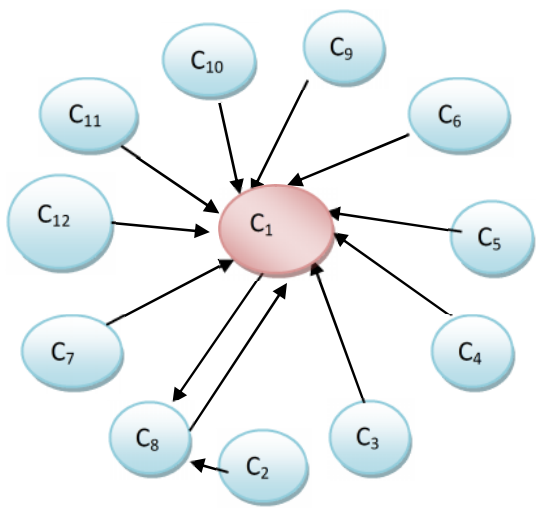
Here R_3=(0 0 1 1 1 1 1 1 1 1 1 1)= Q_2. Hence the fixed point is (0 0 1 1 1 1 1 1 1 1 1 1)

Here the triggering pattern is $C_9 \rightarrow C_1 \rightarrow C_1$

Using a C++ Computer Program (Appendix III(h)) is used to find out the triggering patterns when other attributes are kept in ON state are found out given in Appendix III .The following table gives the triggering patterns for each concept.

Number	Attribute on State	Triggering Pattern
Concept 1	C_1: (1 0 0 0 0 0 0 0 0 0 0 0)	$C_1 \rightarrow C_8 \rightarrow C_1 \rightarrow C_1$
Concept 2	C_2: (0 1 0 0 0 0 0 0 0 0 0 0)	$C_2 \rightarrow C_8 \rightarrow C_1 \rightarrow C_1$
Concept 3	C_3: (0 0 1 0 0 0 0 0 0 0 0 0)	$C_3 \rightarrow C_1 \rightarrow C_1$
Concept 4	C_4: (0 0 0 1 0 0 0 0 0 0 0 0)	$C_4 \rightarrow C_1 \rightarrow C_1$
Concept 5	C_5: (0 0 0 0 1 0 0 0 0 0 0 0)	$C_5 \rightarrow C_1 \rightarrow C_1$
Concept 6	C_6: (0 0 0 0 0 1 0 0 0 0 0 0)	$C_6 \rightarrow C_1 \rightarrow C_1$
Concept 7	C_7: (0 0 0 0 0 0 1 0 0 0 0 0)	$C_7 \rightarrow C_1 \rightarrow C_1$
Concept 8	C_8: (0 0 0 0 0 0 0 1 0 0 0 0)	$C_8 \rightarrow C_1 \rightarrow C_1$
Concept 9	C_9: (0 0 0 0 0 0 0 0 1 0 0 0)	$C_9 \rightarrow C_1 \rightarrow C_1$
Concept 10	C_{10}: (0 0 0 0 0 0 0 0 0 1 0 0)	$C_{10} \rightarrow C_1 \rightarrow C_1$
Concept 11	C_{11}: (0 0 0 0 0 0 0 0 0 0 1 0)	$C_{11} \rightarrow C_1 \rightarrow C_1$
Concept 12	C_{12}: (0 0 0 0 0 0 0 0 0 0 0 1)	$C_{12} \rightarrow C_1 \rightarrow C_1$

Merging of all these graphs on a single graph , the following graph is obtained



4.5.4: CONCLUSION

1. All the concepts have the same impact ie, the same fixed point (0 0 1 1 1 1 1 1 1 1 1 1) which is the vector corresponding to the concept C_1.Hence, the interrelationships between the attributes reveal that C_1-*Exposure to Endosulfan when spraying in agriculture* is the terminal node. The limit point corresponding to C_1 (0 0 1 1 1 1 1 1 1 1 1 1) highlights that attributes C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12} which seems to be the major reasons for the various effects byEndosulfan in agriculture. Hence by the conclusion arrived in this method, the major reasons for various effects of Endosulfan by getting exposed to Endosulfan when spraying in agriculture are:

C_3 –Lack of precaution and treatment

C_4 –Pollution of water source (river, pond) by Endosulfan

C_5- Land becoming infertile with poor yield

C_6 – Residual effect of Endosulfan in land

C_7 –Air pollution by Endosulfan

C_8- Residues in the blood sample of breast fed children.

C_9 - Endosulfan exposed domestic animals, earth worms, micro orthoposes, rabbits, rats.

C_{10} - Endosulfan contaminated water living fish, crab, frog

C_{11} - Endosulfan affected environment exposure to bettle,butterfly,birds

C_{12} - Long term exposure to Endosulfan causing cancer, kidney, skin diseases, neuro behavioral problems and infertility

2. The triggering pattern of C_1 and C_2 shows that C_8 is the intermediatry concepts (ie) C_1 exposure to Endosulfan when spraying in agriculture and C_2 consuming Endosulfan sprayed vegetables, oil/ seeds will give the residues of Endosulfan in the blood sample of breast fed children,ie, the women living in the Endosulfan contaminated area will pass on the effect of Endosulfan to their children by their milk.

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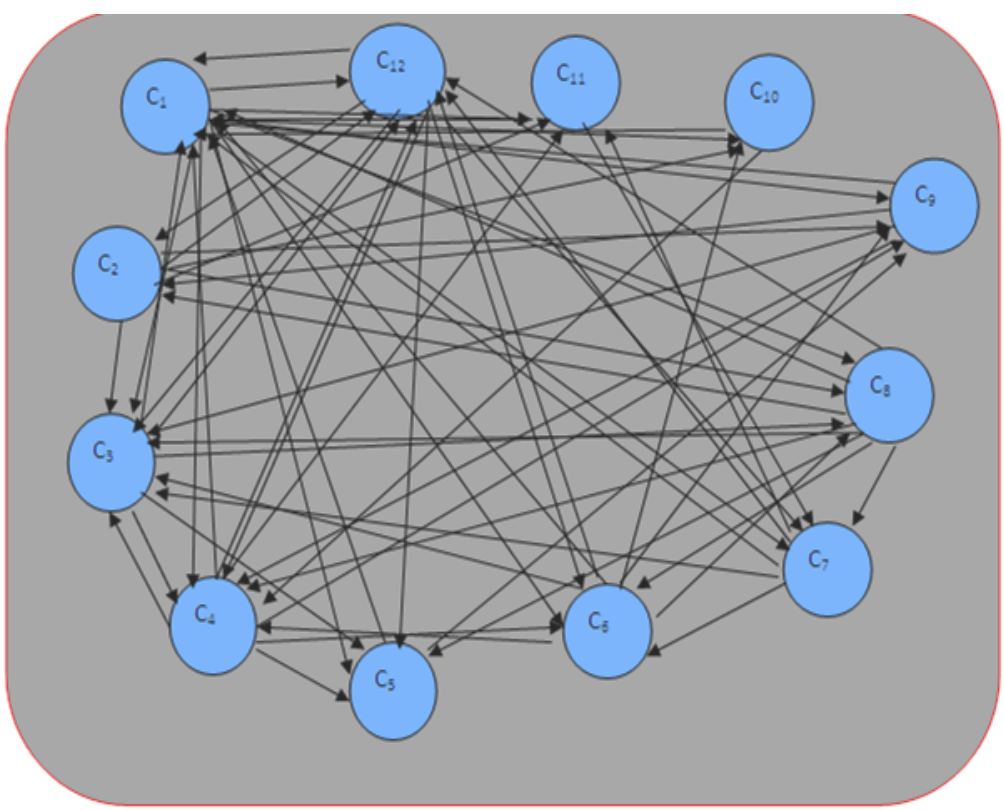
4.6 Analysis of the reasons for various effects of Endosulfan in agriculture using MFCMs

4.6.1 Implementation of MFCM model to the study

Newly introduced MFCM is an advancement of FCM. It follows the foundation of FCM. It has a slight modification only in algorithm approach. The steps to be adopted to derive an optimistic solution to the problem to an unsupervised data by MFCM model is explained in Chapter III.

4.6.2 Implementation of MFCM model to the problem under study

The following represent the connection graph of the twelve concepts and its connection matrix as in section 4.2



$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

From the above matrix M the row having maximum number of one's occurring first is found to be C_1 here. Let it be called R_1

Let R_1= (0 0 1 1 1 1 1 1 1 1 1 1)

By taking each of the vectors separately and its product of it with M is calculated and threshold

$R_1M \approx$

(0 0 1 0 0 0 0 0 0 0 0 0) $\hookrightarrow$ (1 0 1 1 1 0 0 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0)M$\hookrightarrow$ (1 0 1 1 1 1 0 0 1 0 1 1)

(0 0 0 0 1 0 0 0 0 0 0 0)M$\hookrightarrow$ (1 0 0 0 1 0 0 0 1 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0)M$\hookrightarrow$ (1 0 0 1 1 1 0 1 1 1 0 1)

(0 0 0 0 0 0 1 0 0 0 0 0) M$\hookrightarrow$(1 0 1 0 0 1 1 0 0 0 1)

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)M \hookrightarrow 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0) = R_2$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 1\ 1\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)M \hookrightarrow (1\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0)M \hookrightarrow (1\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0)M \hookrightarrow (1\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 1\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1)M \hookrightarrow (1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 1)$

The vector having maximum number of 1's is taken as R_2

$R_2 = (1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0) \neq R_1$

Then R_2M calculated and threshold as R_2^I

$R_2M = (6\ 1\ 6\ 4\ 5\ 4\ 2\ 4\ 5\ 3\ 4\ 7) \hookrightarrow (1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) = R_2^I$

Each component of R_2^I vector is taken separately and its product with M is calculated and thresholded is obtained.

$R_2^I M \approx$

$(1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M = (0\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1)$

$\hookrightarrow (1\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1) = R_3$

$(0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M = (0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 1)$

$\hookrightarrow (0\ 1\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 1)$

$(0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 0\ 1\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1)$

$(0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 0\ 1\ 1\ 1\ 1\ 0\ 0\ 1\ 0\ 1\ 1)$

$(0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 0\ 0\ 1\ 1\ 1\ 0\ 1\ 1\ 1\ 0\ 1)$

$(0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 0\ 1\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 1)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)M(\hookrightarrow 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)M \hookrightarrow (1\ 1\ 1\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)M \hookrightarrow (1\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$(0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0)M \hookrightarrow (1\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0)$

(0 0 0 0 0 0 0 0 0 0 1 0)M↪ (1 0 0 0 0 0 1 0 0 0 1 0)

(0 0 0 0 0 0 0 0 0 0 0 1)M↪ (1 1 1 1 1 1 1 1 0 0 0 1)

The vector having maximum number of 1's is taken as R_3

R_3=(1 0 1 1 1 1 1 1 1 1 1 1) ≠ R_2 , so iteration continues.

R_3M is calculated and threshold as R_3^I

R_3M=(10 3 7 7 6 5 4 3 4 2 3 6) ↪(1 1 1 1 1 1 1 1 1 1 1 1)= R_3^I

Each component of R_3^I vector is taken separately and its product with M is calculated and threshold is obtained.

R_3^I M ≈

(1 0 0 0 0 0 0 0 0 0 0 0)M=(0 0 1 1 1 1 1 1 1 1 1 1) ↪(1 0 1 1 1 1 1 1 1 1 1 1)=R_4

(0 1 0 0 0 0 0 0 0 0 0 0)M=(0 0 0 0 0 0 0 1 1 0 0 1) ↪(0 1 0 0 0 0 0 1 1 0 0 1)

(0 0 1 0 0 0 0 0 0 0 0 0)M ↪(1 0 1 1 1 0 0 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0)M↪ (1 0 1 1 1 1 0 0 1 0 1 1)

(0 0 0 0 1 0 0 0 0 0 0 0)M↪ (1 0 0 0 0 0 0 0 1 0 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0)M↪ (1 0 0 1 1 1 0 1 1 1 0 1)

(0 0 0 0 0 0 1 0 0 0 0 0)M↪ (1 0 1 0 0 1 1 0 0 0 1)

(0 0 0 0 0 0 0 1 0 0 0 0)M(↪1 1 1 1 1 1 1 1 0 0 0 0)

(0 0 0 0 0 0 0 1 0 0 0 0)M↪ (1 1 1 1 0 0 0 1 0 0 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0)M↪ (1 1 1 1 0 0 0 0 1 0 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0)M↪ (1 0 0 1 0 0 0 0 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 1 0)M↪ (1 0 0 0 0 0 1 0 0 0 1 0)

(0 0 0 0 0 0 0 0 0 0 0 1)M↪ (1 1 1 1 1 1 1 1 0 0 0 1)

. The vector having maximum number of 1s is taken as R_4

R_4= (1 0 1 1 1 1 1 1 1 1 1 1)=R_3

Since the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated and the calculation gets terminated.The Computer Program C++ (Appendix III (i)) is also framed to work the following method

4.6.3: CONCLUSION

In MFCM model we arrive at a fixed point (1 0 1 1 1 1 1 1 1 1 1 1) . The above fixed point vector is nothing but the first row of the casual connection matrix M after thresholding. That is C_1 *exposure to endosulfan when spraying in agricultural field*. We can conclude that this factor as the most impactful factor in this study even though many attributes are present. The other interdependent attributes having impact on the reasons for various effects by Endosulfan in agriculture are C_3, C_4, C_5, C_6, C_7, C_8, C_9 C_{10}, C_{11} and C_{12} which are the places in which 1 is present in the fixed point .This is the same fixed point we have arrived in section 4.5. All the concepts are considered to be reasons for various effects of Endouslfan exposure.

Remedial Measures

- ✓ Farmers must be given awareness about the ill effects of Endosulfan
- ✓ At the time of spraying pesticides precautions like using gloves and respirator must be used.
- ✓ Vegetables and fruits must be washed twice or thrice with salted water to remove the effects of pesticide.
- ✓ Water must be boiled and filtered for drinking
- ✓ People must be advised to live away from the farm to avoid the direct exposure while spraying
- ✓ To take care of wild life, domestic animals, fertility of land the only way is to ban Endouslfan forcibly.

5

ESTIMATION OF THE MEASURES TO ELIMINATE THE USE OF ENDOSULFAN IN AGRICULTURE USING FUZZY MODELS

5.1: Introduction

Chemical pesticides have become a part of farming in India since the green revolution. With the growth of agrochemical industries in India, farmers have become dependent upon pesticides like endosulfan, which is cheap and easily available. Endosulfan is acutely toxic. It has been identified by the range of chronic effects and acute effects. A detailed study on all these effects were discussed in Chapter 4 .In this chapter the measures to stop using endosulfan by different mathematical models FCM, CFCM, IFCM and MFCM are analysed.

From the sample survey taken the following 16 concepts as the measures to stop using Endosulfan are derived.

C_1 –Prohibition or restriction of production, use , import and export of Endosulfan

C_2 –Use lower risk alternative pest control practices.

C_3 –Strengthen agricultural chemical control act.

C_4 –Adopt organic, ecological and natural agriculture.

C_5- Voluntary cancellation and phase out of all existing Endosulfan

C_6 – Promote online information service on non chemical pest management.

C_7 -Use crop rotation, inter cropping, field sanitation and mechanical methods.

C_8 - Use insecticides derived from natural plant extracts, natural soaps, neem, lemon grass

C_9 - Give awareness about the ill effects of Endosulfan

C_{10} - Give severe punishment for using Endosulfan

C_{11} - Support of Govt. and research Institutions

C_{12} - Involve NGO organizations.

C_{13} - Educated younger generation to enter agriculture.

C_{14} - Give free organic pesticides to farmers.

C_{15} - Improve the status of farmers by giving incentives and loans by Govt.

C_{16} - Award the informer on Endosulfan.

5.2: Selection of concepts for the study

C_1 –Prohibition or restriction of production, use, import and export

Ultimately, the action most ably protecting human and environmental health would be the withdrawal from sale of Endosulfan. This requires the agrochemical industry to rapidly phase out production of Endosulfan and to dispose of all stockpiles safely.At the Stockholm Convention, India had agreed to phase out the use of Endosulfan by 2017. The farmers must consciously stop using Endosulfan.

C_2 –Use lower risk alternative pest control practices

Alternative pest control practices reduce or eliminate the use of chemical pesticides. These ecological options improve the surrounding land and livelihood of farmers by eliminating the dependency on toxic insecticides, promoting local markets, and reducing food poverty by creating a long-term food source. These agroecological practices have shown to cost less for farmers than conventional practices, and in some cases, they cost nothing.

C_3 –Strengthen agricultural chemical control act

Our nation's main statute governing chemicals policy — The Toxic Substances Control Act (TSCA) — is seriously flawed and needs fundamental reform.Unlike every other major environmental law, the statute has never been significantly amended since it was adopted, from 1976.An Act to control and regulate the manufacture, storage, distribution and trade in use, importation and exportation of agricultural chemicals and for other purposes connected therewith.

C_4 –Adopt organic, ecological and natural agriculture.

Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and

enhance ecological harmony. Increasing environmental awareness in the general population in modern times has transformed the original supply-driven organic movement to a demand-driven one. Premium prices and some government subsidies attracted farmers.

C_5- Voluntary cancellation and phase out of all existing endosulfan

At the Stockholm Convention, India had agreed to phase out the use of Endosulfan by 2017.The Conference of Parties to the Stockholm Convention on Persistent Organic Pollutants, meeting in Geneva, approved non-chemical as well as chemical alternatives to Endosulfan .The farmers should realize and come out voluntarily with existing Endosulfan and promise not to use it anymore.

C_6 – Promote online information service for non chemical pest management.

Online Information Service for non-chemical pest management in the Tropics (OISAT) offers easy to read web-based information, relevant for small scale farmers in the tropics on how to produce key crops using affordable, preventive and curative non-chemical crop and pest management practices in a way that prevent pests and diseases by using non-chemical pest control measures. OISAT PartnerNetwork is a platform for information dissemination, information sharing/exchange, and the integration of the online information into training and extension services. Thus an effective and efficient information flow from web to field will be ensured.

C_7 –Use crop rotation, inter cropping, field sanitation and mechanical methods

Crop rotation is one of the oldest and most effective cultural control strategies. It means the planned order of specific crops planted on the same field. It also means that the succeeding crop belongs to a different family than the previous one. The planned rotation may vary from 2 or 3 year or longer period. Advantages of crop rotation are Prevent soil depletion, Maintains soil fertility, Reduces soil erosion, Controls insect/mite pests, Crop rotation as a means to control to insect pests is most effective when the pests are present before the crop is planted have no wide range of host crops; attack only annual/biennial crops; and do not have the ability to fly from one field to another, Reduces reliance on synthetic chemicals ,Reduces the pests' build-up and prevents diseases helps control weeds. Intercropping is the cultivation of two or more crops simultaneously on the same

field. Mechanical control methods are those that physically prevent the pest from attacking or injuring the crop. Hand weeding and use of fences to exclude deer and other wildlife are examples of mechanical, or physical controls. Mechanical controls such as vacuums, flaming, row covers, hand picking can all work but may have a high cost. Sanitation involves the removal of material which allows pests to survive or be transported between plants or crops.

C_8-Use insecticides derived from natural plants extracts, natural soaps, neem, lemon grass

Fortunately, there are a ton of effective techniques and natural products out there to help you deal with pests without chemicals. Nature has given us plant extracts that make very effective pesticides and insect repellents. For example, some organic pest control products such as Orange Guard use a citrus-fruit peel base, such as from lemons and oranges. Citrus oils kill many flying and crawling insects on contact by destroying the waxy coating of the insect's respiratory system.Some products use garlic or hot peppers and essential oils of herbs such as cloves to repel insects and other pests. Neem is a plant from India that has natural abilities to repel common pests. Combined with soapy water, this neem-based insecticide is a powerful and safe form of pest control.

C_9-Give awareness about the ill effects of Endosulfan

Education to farmers about judicious use of chemical pesticides and adopting good agricultural practices & ill effects of indiscriminate use of chemical pesticides. Awareness about the harmful effects of chemical pesticides, specially to farmers as they and their families will be exposed to it first. Use all medias to give awareness about ill effects of Endosulfan.They should be taught how to protect them from the deadly poison, to have regular follow up to health centres.

C_{10}-Give severe punishment for using Endosulfan

Delhi Health Minister A. K. Walia has said that the State Government would be enforcing the new Food Safety and Standard Act-2006 within the next three months, thereby ensuring heavy fine and punishment of up to life imprisonment for adulteration. Increasing the punishment, besides fine, incorporate stringent provision of punishment to

all offenders in the Food Safety and Standards Act, 2006 of food chain such as manufacturer/importer, dealer/retailer, farmer.

C_{11}-Support of Govt. and research Institutions

Endosulfan has been banned across 74 countries in all the continents after elaborate studies. In our own country Kerala and Karnataka have banned this chemical after finding health and environment damages. But it does not follow strictly in Kerala. The use of Bio-pesticides to be encouraged. To encourage the use of Bio-pesticides, farmers should be given assistance/subsidy by the government. Though alternatives to Endosulfan are available, support for such practices are very low. If the government and research institution can support such work, use of Endosulfan can be totally eliminated in agriculture and other sectors. The government should build canals, pumps and also provide electricity at low cost for watering. They should also make aware to the farmers about new good technologies for watering. The government is providing loan to farmers, but for that in some of the areas they have to pay bribes, for example a loan of 50,000 they pay bribe as 5000. So the government should take strong action against this.

C_{12}-Involve NGO organizations.

Below is a detailed chronology of CSE's campaign against Endosulfan and the tactics the pesticide industries used to suppress information, distort truth and discredit the whistle blowers Government started taking notes after 2000. From then committees of various departments, Non Governmental Organizations, Indian Council of Medical Research and other agencies conducted visits to the area, conducted studies and surveys to understand the relation between aerial spraying of endosulfan and the sudden spurt of health problems in the village. All studies recommended banning of aerial spray of Endosulfan in the area, accepted the evident lapses in precautionary measures followed by the PCK and acknowledged the fact that there were indeed a large number of people health abnormalities.

C_{13}-Educated younger generation to enter agriculture

Engaging youth in agriculture has been a prominent topic recently and has risen up the development agenda, as there is growing concern worldwide that young people have become disenchanted with agriculture Add Agriculture to the Curriculum.Offer Younger

Farmers a Voice Farming offers the young generation a chance to make a difference by growing enough food to feed the world.Those who become farmers now have the opportunity to be the generation that end world hunger and alleviate malnutrition, as well as helping the sector adapt to climate change. As we look to find solutions to feeding a world of nine billion people by 2050, it is this new generation that – working together – can help to achieve global development.

C_{14}- Give free organic pesticides to farmers

Organic foods are defined as those foods that are grown without the use of synthetic fertilizers or pesticides. Pesticides are chemical or control agents made to kill insects, weeds and fungal pests that damage crops. In large amounts these have been found to cause different illnesses including cancer.

C_{15}- Improve the status of farmers by giving incentives and loans by Govt

In order to improve farmer's conditions Government must know their problems which are as follows:

1. Fear of loss due to either drought or storm
2. Lack of proper knowledge about modern farming among the farmers.
3. Lack of knowledge about the facilities provided by the government
4. For some segments essential commodities act is becoming a big pain.
5. Lack of manpower
6. Lack of water resource

Government should provide proper subsidy for seed and fertilizer. Farmers are still using older model tractors and other machines. Some advance model machines are also available, but they are costly. So government should provide subsidy on such machinery.The government should buy directly from farmers at a proper rate without middle manGovernment should send agriculture scientists in each village panchyat and educate the farmers about which type of crop they should grow in which type of soil.

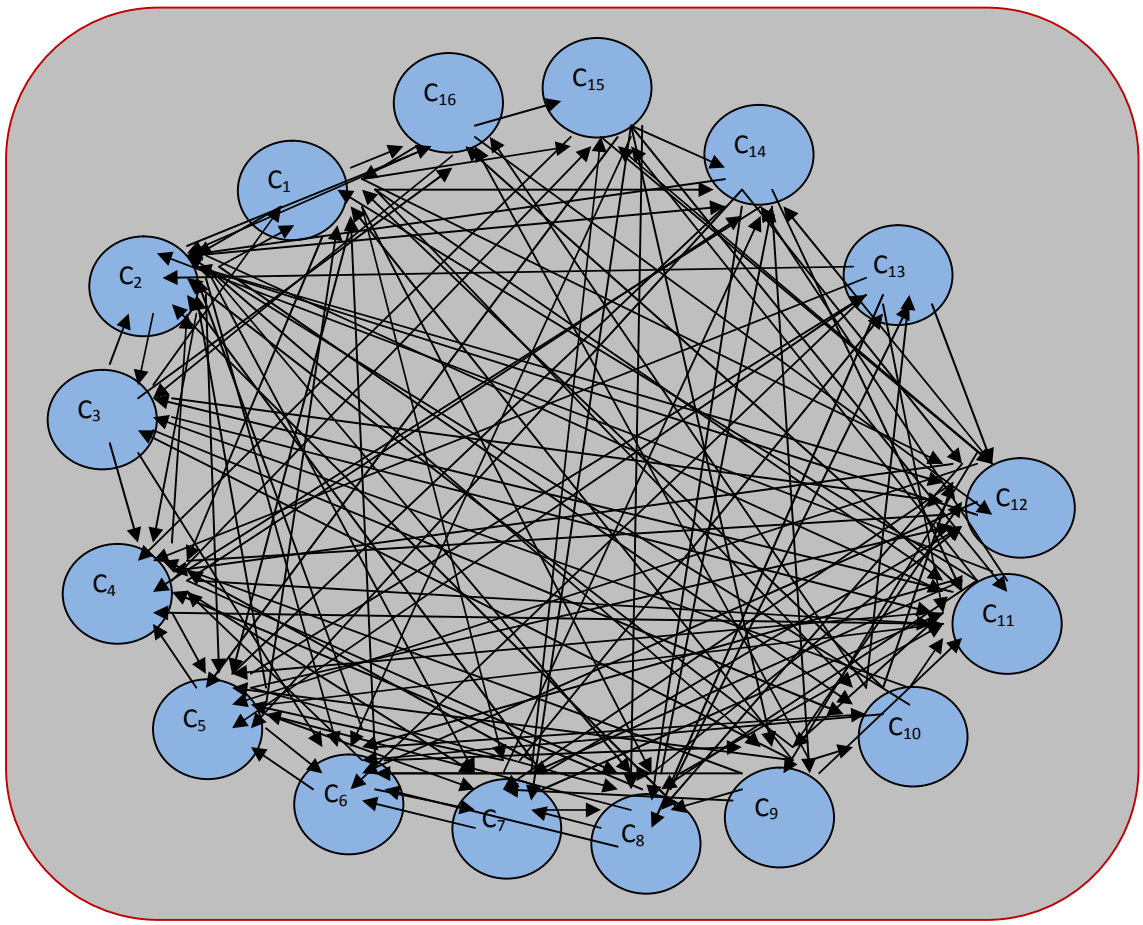
C_{16}-Award the informer on endosulfan

Give some award to the informer who tells about the usage of Endosulfan after the ban. Also give that news to media and newspapers. Such a propaganda can reduce the usage of Endosulfan. Slowl,y we can stop the usage completely using herbal pesticides.

5.3 Predicting the measures to eliminate the use of Endosulfan in agriculture using the method of FCM

5.3.1 Implementation of model to the study

Now taking the above 16 concepts as fuzzy node we proceed to give the directed graph using an expert's opinion.



Using the above directed graph, the connection matrix M= (a_{ij}) is formulated with

a_{ij} =1 if $C_i \longrightarrow C_j$

= 0 if $C_i \not\longrightarrow C_j$.

If increase in concept C_i leads to increase in another concept C_j then aij is given the value 1. Otherwise a_{ij} is given the value 0. It is important to note that the connection matrix is a square matrix with diagonal entries as zero.

M=

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1
C_2	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1
C_3	1	1	0	1	0	1	0	0	0	1	1	1	0	0	0	1
C_4	0	1	0	0	1	0	1	1	0	0	1	1	0	1	1	0
C_5	0	1	0	1	0	1	1	1	0	0	1	1	1	1	0	0
C_6	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0
C_7	0	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0
C_8	0	1	0	1	1	1	1	0	0	0	1	1	1	1	0	0
C_9	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1
C_{10}	1	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1
C_{11}	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1
C_{12}	0	1	0	1	1	1	1	1	1	0	0	0	0	1	1	0
C_{13}	0	1	0	1	1	1	0	1	0	0	1	1	0	0	0	0
C_{14}	0	1	0	1	1	0	0	1	1	0	1	1	0	0	0	0
C_{15}	0	0	0	1	1	1	1	1	1	0	1	1	0	1	0	0
C_{16}	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0

A trial is conducted for the concept C_1. Consider the state vector P_1^1= (1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0) , the only node C_1 *ie "Prohibition or restriction of production, use , import and export"* is ON state and all the rest are in OFF state.Now passing P_1^1 into the connection matrix M .i.e., P_1^1M is calculated .It is modified by assigning 1 if the values of the entries are ≥1 and keeping first place always 1.

P_1^1M = (0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1) ↪(1 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1) =P_2

P_2M is calculated and threshold as P_3

P_2M =(4 10 4 9 9 8 8 9 5 2 9 4 4 9 6 4)

↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)= $P_3 \neq P_2$

P_3M is calculated and threshold as P_4

P_3M =(7 14 5 13 12 11 10 12 6 5 12 14 4 9 6 6)

↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)=P_4=P_3, a fixed point is arrived.Hence when the concept *"Prohibition or restriction of production, use , import and export"* is in the ON state all the concepts become ON.Thus in all cases, a hidden pattern is obtained which is never possible by way of other statistical models. Thus this model is well suited to give the impact of each concept in finding the measures to stop using Endosulfan in

agriculture. Since the working becomes very laborious. A C++ program (Appendix III (j)) is used to find the fixed points which are listed below and applied. A conclusion is derived from these results is given in the next section

State Vector	Steps required to obtain fixed point	The fixed point
P_1^1=(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^2= (0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^3=(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^4=(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^5=(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^6=(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^7=(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^8=(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^9=(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{10}=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{11}=(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{12}=(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{13}=(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{14}=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{15}=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	STEP 2	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)
P_1^{16}=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	STEP 3	(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)

5.3.2 CONCLUSION:

For the concepts C_1 (*Prohibition or restriction of production, use , import and export*), C_2 (*Use lower risk alternative pest control practi*ces), C_3 (*strengthen agricultural chemical control act), ,* C_4 (*Adopt organic, ecological and natural agriculture*),C_5 (*Voluntary cancellation and phase out of all existing Endosulfan*), C_6 (

Promote online information service for non chemical pest management), C_7 (*Use crop rotation, inter cropping, field sanitation and mechanical methods*), C_8(*Use insecticides derived from natural plants extracts, natural soaps, neem, lemon grass*), C_9(*Give awareness about the ill effects of Endosulfan*), C_{10}(*Give severe punishment for using Endosulfan*), C_{11}(*Support of Govt. and research Institutions*), C_{12}(*Involve NGO organizations)*, C_{13}(*Educated younger generation to enter agriculture*), C_{14}(*Give free organic pesticides to farmers*).C_{15}(*Improve the status of farmers by giving incentives and loans by Govt*.) the fixed point **(1 1 1 1 1 1 1 1 1 1 1 1)** are obtained in the 2nd step itself except for C_9(*Give awareness about the ill effects of Endosulfan*), C_{10}**(***Give severe punishment for using Endosulfan*) and C_{16}**(***Award the informer on Endosulfan*). All these concepts are considered to be major measures to stop the usage of Endosulfan as the fixed points are obtained having 1's in all places expressing their dependency.

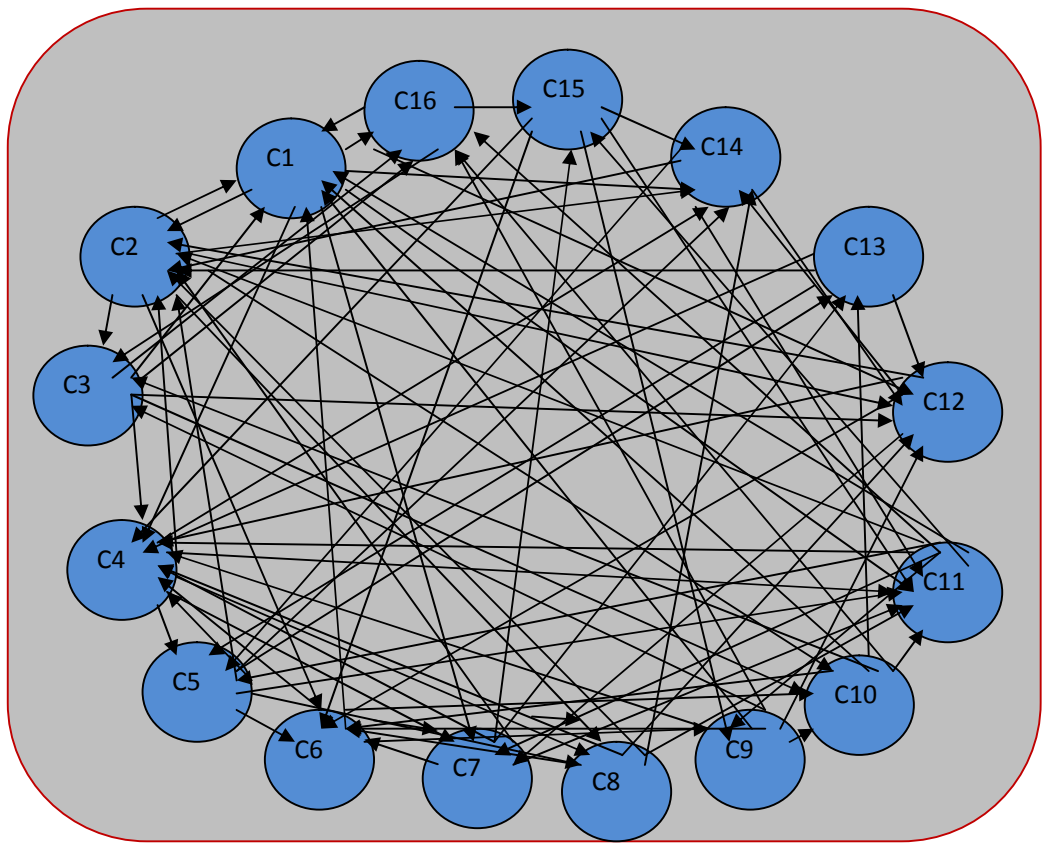
5.4 Identifying the Measures to Eliminate the use of Endosulfan Using Combined Fuzzy Cognitive Maps (CFCM)

5.4.1 Implementation of CFCM model to the study

The same problem of finding the measure to stop using Endosulfan through combined Fuzzy Cognitive Map is analyzed in this section. A finite number of FCMs can be combined together produce the joint effect of FCMs .This gives the result in an effective way by combining the opinions of 3 or more experts. For this model, giving the sixteen concepts considered in sec 5.2 to four experts (i) an agriculture officer (ii) an N.G.O (iii) a doctor (iv) a village administrative office, their opinions are collected .Then the connection graph and matrices are drawn from their responses.

5.4.2: Analysis of first expert's view

The first expert's opinion is arrived through responses from an agricultural officer for the connections between the concepts considered in section 5.2 The following represents the connection graph of the above sixteen concepts

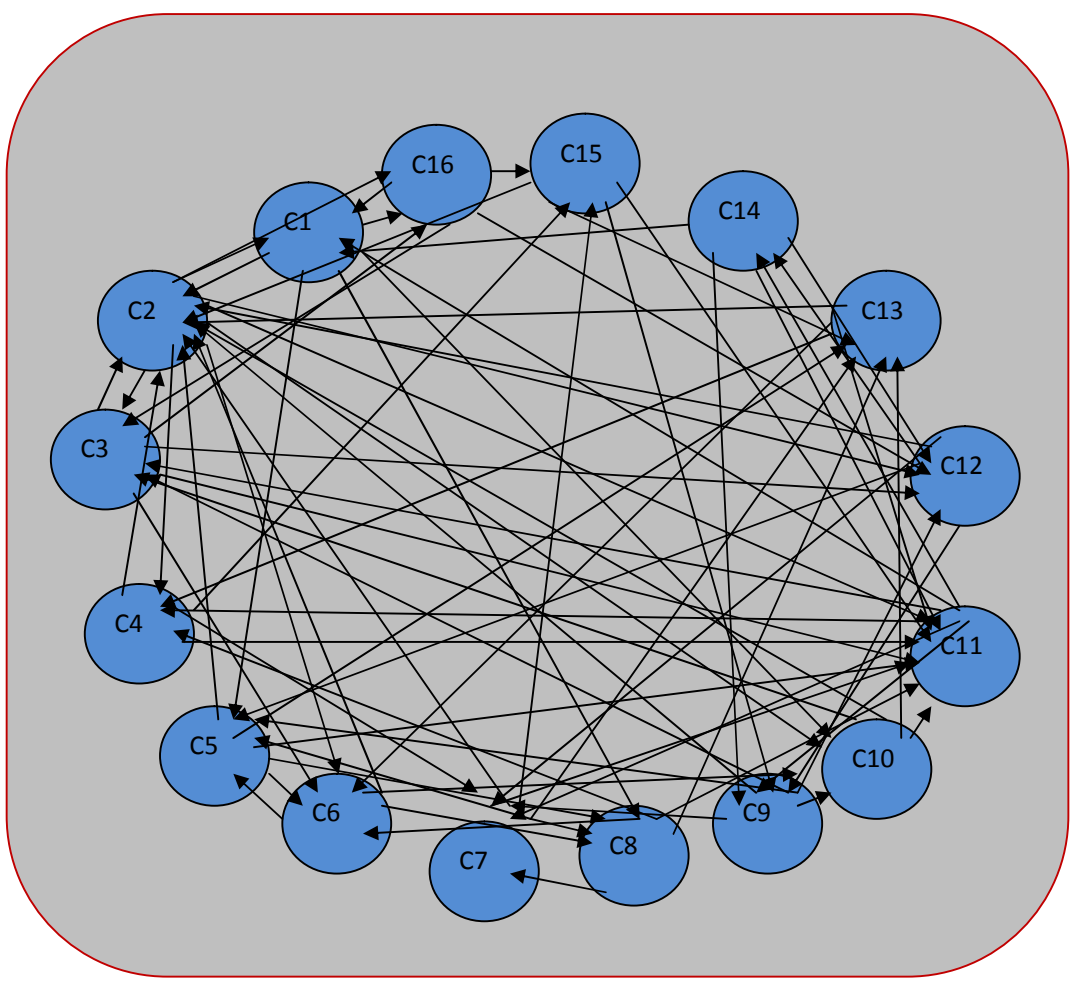


The related connection matrix is denoted by A for the above directed graph and is given below:

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \\ C_{13} \\ C_{14} \\ C_{15} \\ C_{16} \end{array} \begin{array}{c} \begin{array}{cccccccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix} \end{array}$$

5.4.3: Analysis of second expert's view

The second experts opinion is arrived through responses from an NGO for the connection between the sixteen concepts considered in section 5.2. The related graph is given below:

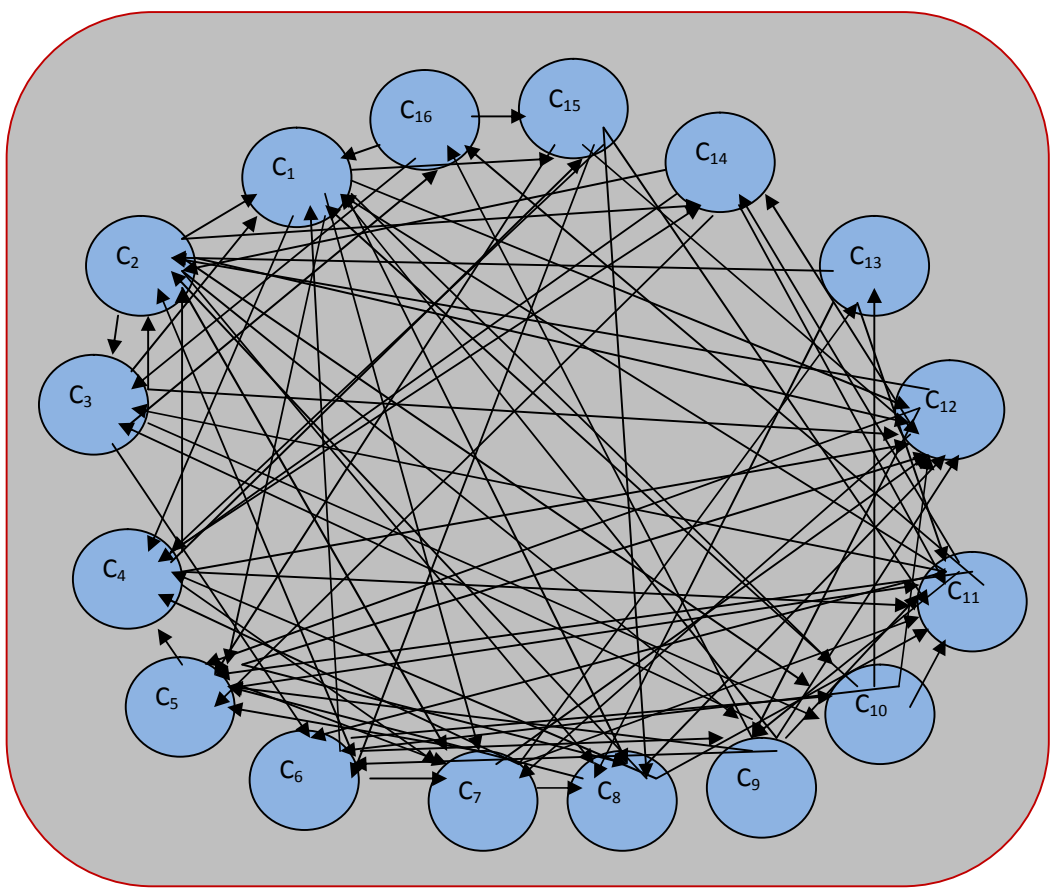


The related connection matrix is denoted by B for the above directed graph and is given below:

$$B = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \\ C_{13} \\ C_{14} \\ C_{15} \\ C_{16} \end{array} \begin{array}{c} \begin{array}{cccccccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix} \end{array}$$

5.4.4: Analysis of third expert's view

The third experts opinion is arrived through responses from a doctor for the connection between the concepts considered in section 5.2 . The following represents the connection graph of the above sixteen concepts .

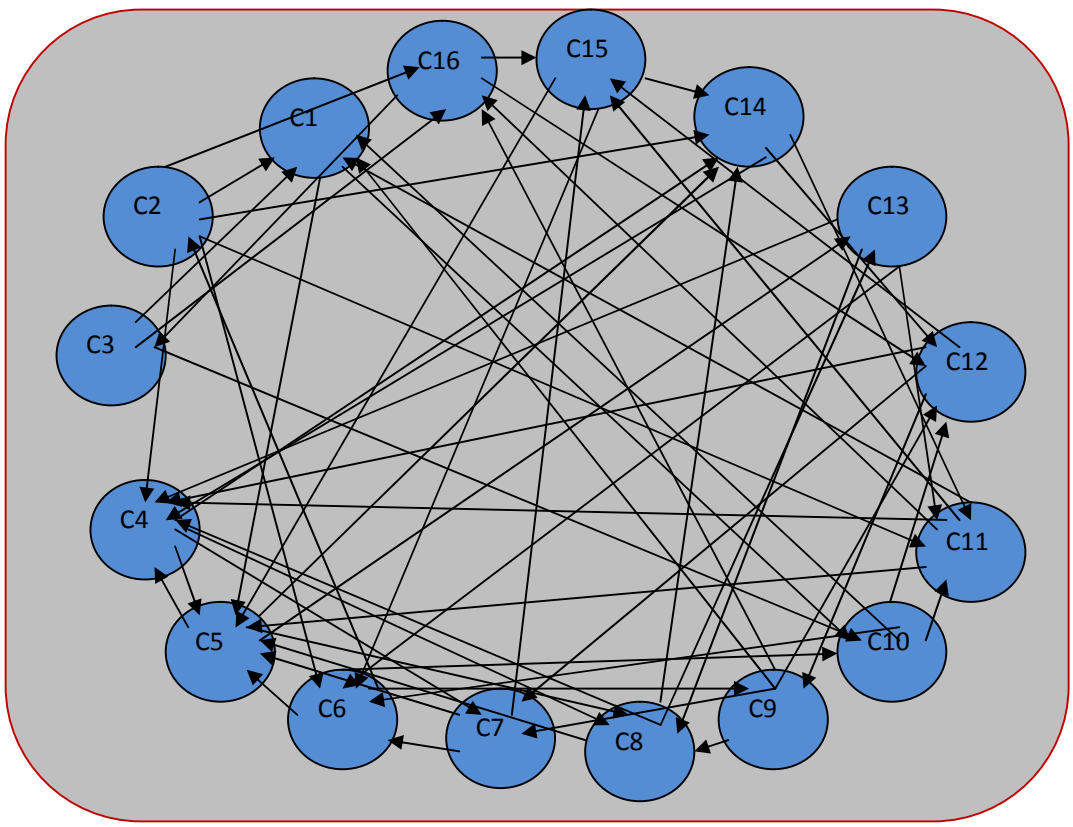


The related connection matrix is dented by C for the above directed graph.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	0	0	0	1	1	0	1	1	0	1	0	1	0	0	1	0
C_2	1	0	1	0	0	0	1	1	1	1	0	1	0	1	0	0
C_3	1	1	0	0	0	1	0	0	0	1	0	1	0	0	0	1
C_4	0	1	0	0	0	0	1	0	0	0	1	1	0	1	1	0
C_5	0	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0
C_6	1	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0
$C=C_7$	0	0	0	1	1	0	0	1	0	0	1	1	1	0	0	0
C_8	0	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0
C_9	1	0	1	0	1	1	0	0	0	0	1	1	0	0	0	1
C_{10}	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0
C_{11}	1	0	1	0	1	1	0	0	1	0	0	0	0	1	0	1
C_{12}	0	1	0	0	1	0	1	0	1	0	0	0	0	1	0	0
$_{13}$	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
C_{14}	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0
C_{15}	0	0	0	1	1	1	0	1	0	0	1	1	0	0	0	0
C_{16}	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0

5.4.5 Analysis of fourth expert's view

The fourth expert's opinion is arrived through responses from a village administrative officer for the connection between the concepts considered in section 5.2. The following represents the connection graph of the above sixteen concepts.



The related conncetion matrix is dented by D for the above directed graph.

$$D=\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_5 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \\ C_{13} \\ C_{14} \\ C_{15} \\ C_{16} \end{array}\begin{pmatrix} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix}$$

5.4.6: Analysis of the problem containing all the four expert's view using CFCM

The CFCM using the opinion of the above four experts is formulated. Let S denote the combined connection matrix by S= A+B+C+D and the matrix is given by

$$S=\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \\ C_{13} \\ C_{14} \\ C_{15} \\ C_{16} \end{array}\begin{array}{c} \begin{array}{cccccccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} \end{array} \\ \begin{pmatrix} 0 & 2 & 0 & 2 & 3 & 0 & 2 & 2 & 0 & 3 & 1 & 2 & 0 & 1 & 1 & 2 \\ 3 & 0 & 3 & 2 & 0 & 3 & 1 & 2 & 1 & 3 & 2 & 2 & 0 & 3 & 0 & 2 \\ 3 & 2 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 3 & 1 & 3 & 0 & 0 & 0 & 4 \\ 0 & 3 & 0 & 0 & 2 & 0 & 4 & 2 & 0 & 0 & 3 & 1 & 0 & 3 & 2 & 0 \\ 0 & 2 & 0 & 3 & 0 & 2 & 1 & 4 & 0 & 0 & 3 & 1 & 3 & 2 & 0 & 0 \\ 2 & 3 & 0 & 1 & 2 & 0 & 2 & 0 & 4 & 3 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 & 3 & 2 & 0 & 3 & 0 & 0 & 3 & 1 & 3 & 0 & 3 & 0 \\ 0 & 2 & 0 & 4 & 2 & 2 & 1 & 0 & 0 & 0 & 3 & 2 & 2 & 2 & 0 & 0 \\ 3 & 1 & 3 & 1 & 2 & 2 & 2 & 1 & 0 & 2 & 2 & 3 & 0 & 0 & 0 & 3 \\ 3 & 1 & 2 & 0 & 0 & 3 & 0 & 0 & 0 & 0 & 4 & 2 & 3 & 0 & 0 & 1 \\ 4 & 1 & 2 & 2 & 4 & 1 & 2 & 0 & 3 & 0 & 0 & 0 & 0 & 2 & 2 & 3 \\ 0 & 3 & 0 & 2 & 2 & 1 & 4 & 0 & 3 & 0 & 0 & 0 & 0 & 3 & 1 & 0 \\ 0 & 3 & 0 & 3 & 0 & 3 & 0 & 2 & 0 & 0 & 3 & 1 & 0 & 0 & 0 & 0 \\ 0 & 3 & 0 & 2 & 2 & 0 & 0 & 0 & 2 & 0 & 4 & 3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3 & 2 & 4 & 0 & 2 & 1 & 0 & 3 & 2 & 0 & 2 & 0 & 0 \\ 2 & 1 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3 & 0 & 0 & 3 & 0 \end{pmatrix} \end{array}$$

Consider the state vector P_1^1= =(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0) in which the only node C_1 *"Prohibition or restriction of production, use , import and export"* is ON state and all the rest are in OFF state. Now passing through the connection matrix S we get (0 2 0 2 3 0 2 2 0 3 1 2 0 1 1 2).

Here the threshold is done in a different way if an entry after multiplication is ≤2, then the value 0 is assigned and if ≥3, the value 1 is assigned keeping first place always 1.

P_1S=(0 2 0 2 3 0 2 2 0 3 1 2 0 1 1 2) ↪(1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0)=P_2

P_2S is calculated and threshold as P_3

P_2S=(3 5 2 5 5 3 8 2 0 5 8 5 3 3 1 3) ↪(1 1 0 1 1 1 1 0 0 1 1 1 1 1 0 1) =$P_3 \neq P_2$

P_3S is calculated and threshold as P_4

P_3S=(14 24 10 19 17 15 16 13 13 9 22 18 8) ↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1) =$P_4 \neq P_3$

P_4S is calculated and threshold as P_5

P_4S=(20 29 13 28 24 19 18 14 14 32 26 11 18 12 15) ↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)=P_5=P_4which is a fixed point for S.

Similarly we can work with any one of the nodes in ON state. A C++ computer program(Appendix III (k)) is written and applied. The result is listed below.

State Vector	Steps required to obtain fixed point	The fixed point
$P1^1$=(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^2$= (0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^3$=(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^4$=(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)	**STEP 2**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^5$=(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^6$=(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^7$=(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^8$=(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^9$=(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{10}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	**STEP 2**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{11}$=(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)	**STEP 2**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{12}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)	**STEP 2**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{13}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)	**STEP 2**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{14}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{15}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**
$P1^{16}$=(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	**STEP 3**	**(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)**

5.4.7 CONCLUSION

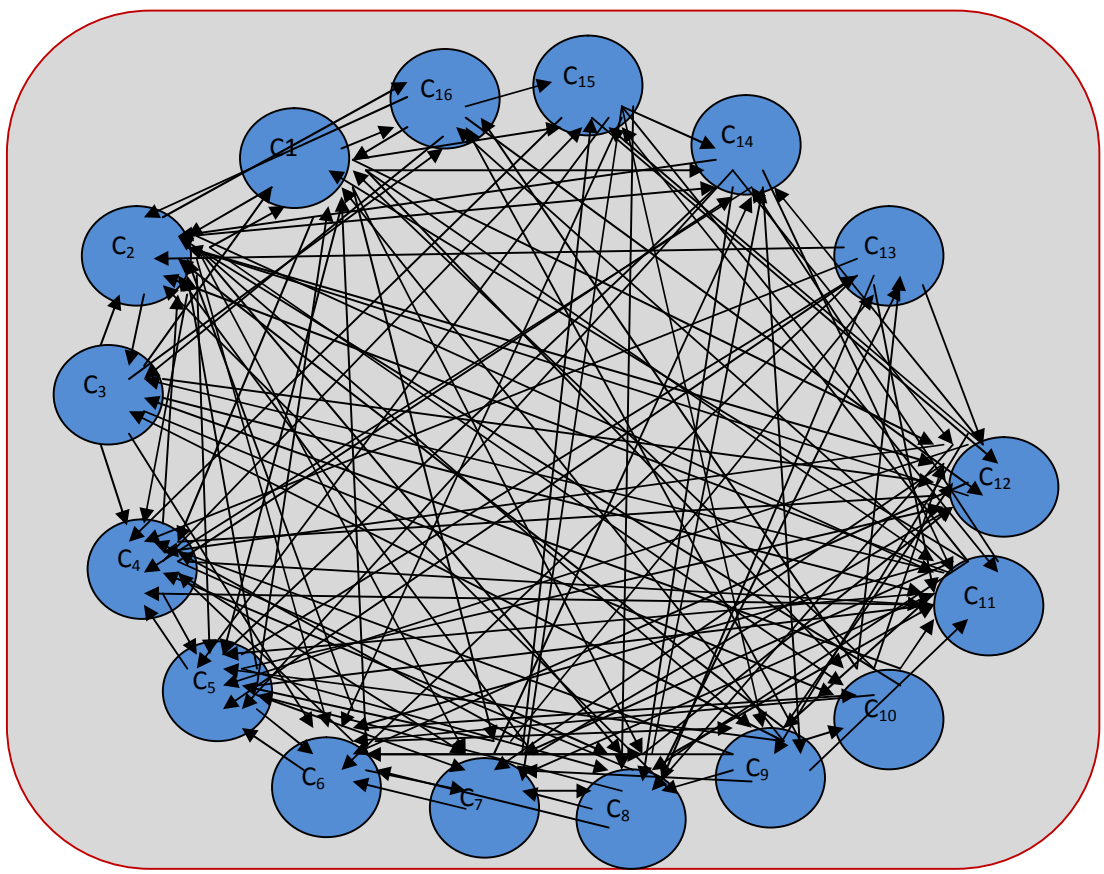
All the state vector get the same fixed point (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1). All concepts are interconnected. Hence all the concepts are measures to eliminate Endosulfan.

5.5 Deriving the Measures to Eliminate the Use of Endosulfan in Agriculture by Induced Fuzzy Cognitive Maps (IFCMS) Approach.

5.5.1 Implementation of IFCM model to the study

Induced Fuzzy Cognitive Maps (IFCM) is an advancement of FCM .The method is same as that of FCM until P_2 is calculated. Each component in P_2 vector is taken separately and multiplied with matrix M. Among these vectors, the vector which has the maximum number of 1's for the first time is considered as Q_2.Then the same procedure is repeated as done for P_2 until a fixed point is obtained.

The following represent the connection graph of the above sixteen concepts and its connection matrix as in section 5.2



M=

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1
C_2	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1
C_3	1	1	0	1	0	1	0	0	0	1	1	1	0	0	0	1
C_4	0	1	0	0	1	0	1	1	0	0	1	1	0	1	1	0
C_5	0	1	0	1	0	1	1	1	0	0	1	1	1	1	0	0
C_6	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0
C_7	0	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0
C_8	0	1	0	1	1	1	1	0	0	0	1	1	1	1	0	0
C_9	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1
C_{10}	1	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1
C_{11}	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1
C_{12}	0	1	0	1	1	1	1	1	1	0	0	0	0	1	1	0
C_{13}	0	1	0	1	1	1	0	1	0	0	1	1	0	0	0	0
C_{14}	0	1	0	1	1	0	0	1	1	0	1	1	0	0	0	0
C_{15}	0	0	0	1	1	1	1	1	1	0	1	1	0	1	0	0
C_{16}	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0

5.5.2 Trial 1

Consider P_1^1 in the trial 1, by setting the concept C_1 to ON state, that is the first component of the vector is set to be 1 and the rest are assigned to be 0.

Then ,P_1^1 = (1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)

Product of P_1^1 and M is calculated.

P_1^1M=(0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1) = P_2

Now as per Induced Fuzzy Cognitive Map methodology, each component in the P_2 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 Q_2

$P_2M \approx$

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 0 1 1 1 1 1 1 1 1 1 0 1 0 1)= Q_2

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 0 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1=0 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M= (1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M= (0 1 0 1 1 1 1 1 1 0 0 0 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M= (0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M= (0 0 0 1 1 1 1 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M= (1 1 1 0 0 0 0 0 0 0 0 0 1 0 0 1 0)

Q_2=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1) $\neq P_2$, so the iteration continues

Product of Q_2 and M is calculated and modified by assigning 1 if the values of the entries are $\geq$1 Let the modified vector be $Q_2^{\square}$

Q_2M= (6 13 6 12 11 10 11 6 6 11 11 5 8 7 6 5) $\hookrightarrow$(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)= $Q_2^{\square}$.

Now each component in the vector $Q_2^{\square}$ is taken separately and product of it with the given matrix is calculated.The vector which has maximum number of one's is found and is called R_3

$Q_2^{\square}$M $\approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M =(0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)= R_3

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 0 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 0 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 0 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M= (1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M= (0 1 0 1 1 1 1 1 1 0 0 0 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M= (0 1 0 1 1 1 0 1 0 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M= (0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M= (0 0 0 1 1 1 1 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M↪=(1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0)

Here R_3=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)=Q_2. Hence the fixed point is (1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1).

The triggering pattern is $C_1 \rightarrow C_2 \rightarrow C_2$

5.5.3 Trial 2

The calculation for Trial 2 is performed similar to the Trial 1,. Consider P_1^2 by setting C_2 in ON state that is, assigning the second component of the vector to be 1 and the rest of the component as 0.

Let P_1^2=(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)

Product of P_1^2 and M is calculated.

P_1^2M= (0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M =(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)=P_2

Now each component in the P_2 vector is taken separately and product of it with the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as Q_2

P_2M ≈

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 0 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 0 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 0 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1)= Q_2

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M= (1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M= (0 1 0 1 1 1 1 1 1 0 0 0 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M= (0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M= (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0)

That is, Q_2 =(1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1) ≠P_2, So the iteration continues

Then Q_2M is calculated and modified by assigning 1 if the values of the entries are $\geq$ 1. Let the modified vector be Q_2▫

Q_2M = (5 11 4 9 8 8 8 8 4 4 4 9 3 8 6 5) ↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1) = Q_2▫

Now each component in the vector Q_2▫ is taken separately and product of it with given matrix is calculated. The vector which has maximum number of 1s is found and is called R_3.

Q_2▫M ≈

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M =(0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)= R_3

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M =(0 1 0 0 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M =(0 1 0 1 0 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 0 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M= (1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M =(1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M=(0 1 0 1 1 1 1 1 1 0 0 0 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M =(0 1 0 1 1 1 0 1 0 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M= (0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M= (0 0 0 1 1 1 1 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M= (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0)

Now the vector with maximum number of 1's be R_3.

R_3.=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1) $\neq$ Q_2.So the iteration continues.

Then R_3M is calculated and modified by assigning 1 if the values of the entries are ≥ 1. Let the modified vector be $R_3^{\square}$

R_3M=(6 11 4 9 8 8 8 8 3 4 8 9 3 7 5 5))$\hookrightarrow$(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)= $R_3^{\square}$

Now each component in the vector $R_3^{\square}$ is taken separately and product of it with the given matrix is calculated. The vector which has maximum number of 1s is found and is called S_4.

$R_3^{\square}M \approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M =(0 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)= S_4

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M=(0 1 0 0 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 0 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M= (1 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 0 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M= (0 1 0 1 1 1 1 0 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M= (1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M= (1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M =(1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M=(0 1 0 1 1 1 1 1 1 0 0 0 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M =(0 1 0 1 1 1 0 1 0 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M= (0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M= (0 0 0 1 1 1 1 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M= (0 0 0 1 1 1 1 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M= (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0)

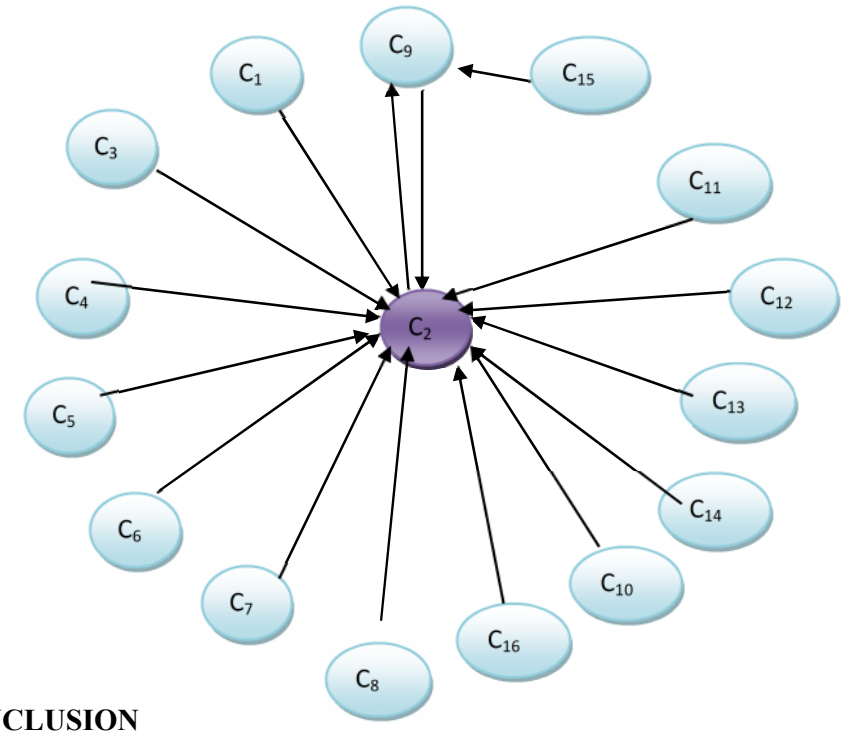
(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M= (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 0)

Here R_3=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)= S_4 . Hence the fixed point is =(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1) . Here the triggering pattern is $C_2 \rightarrow C_9 \rightarrow C_2 \rightarrow C_2$.

A C++ Computer Program (Appendix III(l) is used to find out the triggering patterns when other attributes are kept in ON state. The following table gives the triggering patterns for each concept.

Number	Attribute on State	Triggering Pattern
Concept 1	C_1: (1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	$C_1 \rightarrow C_2 \rightarrow C_2$
Concept 2	C_2: (0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)	$C_2 \rightarrow C_9 \rightarrow C_2 \rightarrow C_2$
Concept 3	C_3: (0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)	$C_3 \rightarrow C_2 \rightarrow C_2$
Concept 4	C_4: (0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)	$C_4 \rightarrow C_2 \rightarrow C_2$
Concept 5	C_5: (0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)	$C_5 \rightarrow C_2 \rightarrow C_2$
Concept 6	C_6: (0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)	$C_6 \rightarrow C_2 \rightarrow C_2$
Concept 7	C_7: (0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)	$C_7 \rightarrow C_2 \rightarrow C_2$
Concept 8	C_8: (0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)	$C_8 \rightarrow C_2 \rightarrow C_2$
Concept 9	C_9: (0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)	$C_9 \rightarrow C_2 \rightarrow C_2$
Concept 10	C_{10}: (0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)	$C_{10} \rightarrow C_2 \rightarrow C_2$
Concept 11	C_{11}: (0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)	$C_{11} \rightarrow C_2 \rightarrow C_2$
Concept 12	C_{12}: (0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)	$C_{12} \rightarrow C_2 \rightarrow C_2$
Concept 13	C_{13}: (0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)	$C_{13} \rightarrow C_2 \rightarrow C_2$
Concept 14	C_{14}: (0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)	$C_{14} \rightarrow C_2 \rightarrow C_2$
Concept 15	C_{15}: (0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)	$C_{15} \rightarrow C_9 \rightarrow C_2 \rightarrow C_2$
Concept 16	C_{16}: (0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)	$C_{16} \rightarrow C_2 \rightarrow C_2$

Merging of all these graphs on a single graph , the following graph is obtained.



5.5.4 CONCLUSION

All the concepts except C_{15} have direct impact to the same fixed point. **(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)** which is the vector corresponding to the concept C_2. Hence, the interrelationships between the attributes reveal that C_2-*"Use lower risk alternative pest control practices.*" is the terminal node.The triggering pattern $C_2 \rightarrow C_9 \rightarrow C_2 \rightarrow C_2$ implies that C_9-*Give awareness about the ill effects of Endosulfan* plays the role of intermediary node. The limiting point corresponding to C_2(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1) highlights that attribute C_1, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{14}. C_{16} which seem to be the major measures to stop the usage of Endosulfan in agriculture.Hence the conclusion arrived in this model is that the major measures to stop the usage of Endosulfan are:

C_1 –Prohibition or restriction of production, use, import and export

C_2 – Ues lower risk alternative pest control practices

C_3 –strengthen agricultural chemical control act.

C_4 –Adopt organic, ecological and natural agriculture.

C_5- Voluntary cancellation and phase out of all existing Endosulfan

C_6 – Provide online information service for non chemical pest management.

C_7 –Use crop rotation, inter cropping, field sanitation and mechanical methods.

C_8-Use insecticides derived from natural plants extracts, natural soaps, neem, lemon grass

C_9-Give awareness about the ill effects of Endosulfan

C_{10}-Give severe punishment for using Endosulfan

C_{11}-Support of Govt. and research Institutions

C_{12}-Involve NGO organizations.

C_{14}- Give free organic pesticides to farmers.

C_{16}-Award the informer on Endosulfan.

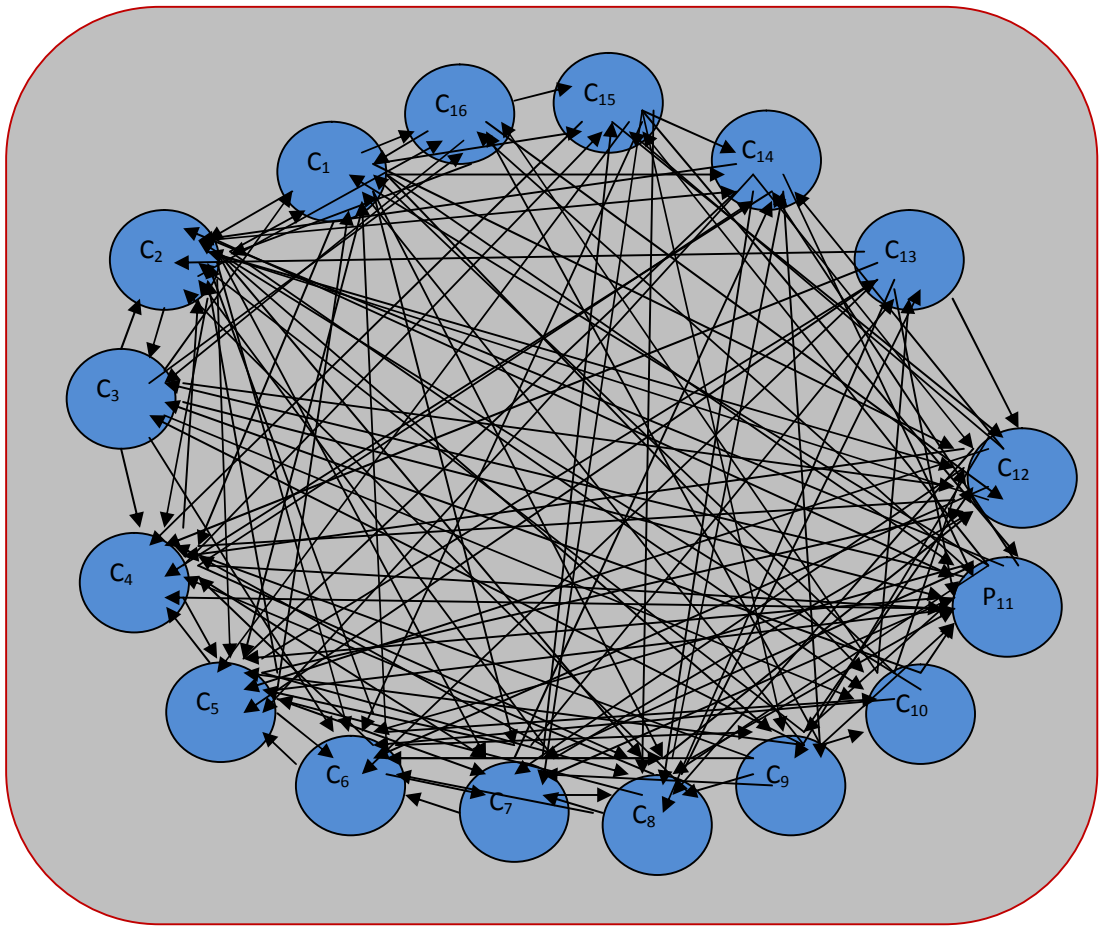
2. The triggering pattern shows that C_2 and C_9 are related. ie, Giving awareness about the ill effects of Endosulfan to the farmers will result in the usage of lower risk alternative pest control practices.

5.6 Analysis of The Measures To Elminate The Use Of Endosulfan In Agriculture By Maximum Fuzzy Cognitive Maps (MFCM)

5.6.1 Implementation of MFCM model to the study

MFCM is an advancement of FCM. It follows the foundation of FCM. It has a slight modification only in algorithm approache. The following steps to be adopted to derive an optimistic solution to the problem to an unsupervised data by MFCM model is explained in Chapter III.

The following represent the connection graph of the above 16 concepts and its connection matrix as in section 5.2.



M=

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1
C_2	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1
C_3	1	1	0	1	0	1	0	0	0	1	1	1	0	0	0	1
C_4	0	1	0	0	1	0	1	1	0	0	1	1	0	1	1	0
C_5	0	1	0	1	0	1	1	1	0	0	1	1	1	1	0	0
C_6	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0
C_7	0	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0
C_8	0	1	0	1	1	1	1	0	0	0	1	1	1	1	0	0
C_9	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1
C_{10}	1	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1
C_{11}	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1
C_{12}	0	1	0	1	1	1	1	1	1	0	0	0	0	1	1	0
C_{13}	0	1	0	1	1	1	0	1	0	0	1	1	0	0	0	0
C_{14}	0	1	0	1	1	0	0	1	1	0	1	1	0	0	0	0
C_{15}	0	0	0	1	1	1	1	1	1	0	1	1	0	1	0	0
C_{16}	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0

From the above matrix M the row having maximum number of 1s occurring first is C_2 here. Now call C_2 as R_1.

Let R_1=(1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1)

Each component in R_1 vector is taken separately and the product of it with M is calculated and thresholded.

$R_1 \circ M \approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 1 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 1 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1)=R_2

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M↪ (1 1 1 0 0 1 0 0 0 1 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 0 1 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 1 0 0 1 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M↪ (0 1 0 1 1 0 0 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M↪ (0 1 0 1 1 0 0 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M↪ (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 1)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M↪ (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 1)

The vector having maximum number of 1s is taken as R_2

R_2= (1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1) ≠ R_2

Product R_2M is calculated and threshold as $R_2 \circ$

R_2M==(1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1)M= (6 12 5 10 10 10 9 9 4 5 9 10 4 8 5 6)

↪ (1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)= $R_2 \circ$

Each component in R_2 ◦ vector is taken separately and the product of it with M is calculated and threshold R_2M is obtained.

$R_2 \circ M \approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 1 0 1 0 1)=R_3

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 1 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 1 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M↪ (1 1 1 0 0 1 0 0 0 1 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 1)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M↪ (0 1 0 1 1 1 1 1 1 0 0 1 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M↪ (0 1 0 1 1 1 0 1 0 0 1 1 1 0 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0)M↪ (0 1 0 1 1 0 0 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M↪ (0 0 0 1 1 1 1 1 1 0 1 1 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1)M↪ (1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 1)

The vector having maximum number of 1's is taken as R_3

R_3=(1 1 1 1 1 1 1 1 1 1 1 1 0 1 0 1) $\neq R_2$ Thus the iteration is continued

Product R_3M is calculated and threshold as $R_3 \circ$

R_3M= (7 14 5 13 12 11 10 12 6 5 12 14 4 9 6 6)=(1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1)= $R_3 \circ$

Each component of $R_3 \circ$ vector is taken separately and product of it with M is calculated and threshold.

$R_3 \circ M \approx$

(1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 0 1 1 0 1 1 1 0 1 1 1)

(0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 0 1 0 1)=R_4

(0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 1 1 0 1 0 0 0 1 1 1 0 0 0 1)

(0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 0 1 1 0 0 1 1 0 1 1 0)

(0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0)M↪ (1 1 0 1 1 1 1 1 1 1 0 0 0 0 0 0)

(0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 1 0)

(0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0)M↪ (0 1 0 1 1 1 1 1 0 0 1 1 1 1 0 0)

(0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1)

(0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0)M↪ (1 1 1 0 0 1 0 0 0 1 1 1 1 0 0 1)

(0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0)M↪ (1 1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 1 1)

(0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0)M↪ (0 1 0 1 1 1 1 1 1 0 0 1 0 1 1 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0)M↪ (0 1 0 1 1 0 0 1 1 0 1 1 0 1 0 0)

(0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1)M↪ (1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1)

The vector having maximum number of 1s is taken as R_4

R_4= (1 1 1 1 1 1 1 1 1 1 1 1 0 1 0 1)=R_3

When the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated and the calculation gets terminated.

A computer program C++ (Appendix III (m)) isalso framed to work the follwoing method.

5.6.3 CONCLUSION

In MFCM model we arrive at a fixed point (1 1 1 1 1 1 1 1 1 1 1 1 0 1 0 1) The above fixed point vector nothing but the second row of the casual connection matrix M after thresholding. That is, "Use lower risk alternative pest control practices". We can conclude that this factor as the most impactful factor in this study even though many attributes present. The other interdependent attributes having impact on the

estimation of the measures to stop the usage Endosulfan in agriculture are C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9 C_{10}, C_{11}, $C_{12,}$ C_{14} and C_{16} which are the places in which 1 is present in the fixed point .This is the same fixed point we have arrived in section 5.5, while working with the IFCM model. We have have performed 16 trials and got various fixed points in IFCM where as in MFCM model there is only 1 trial giving the same fixed point. This model consumes less time and focuses only on a particular fixed point unlike getting various fixed points leading to vagueness. Hence this model is much suitable to work for the unsupervised data to find the most impactful factors. But in IFCM model the impact of each concept on other concepts can also be found which is an advantage of IFCM.