# 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.**

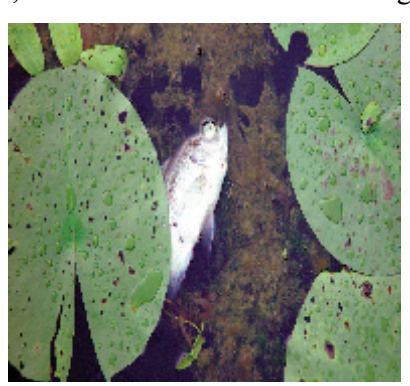
High levels of endosulfan were detected in human breast milk of younger mothers in Sub Saharan Africa. Residues were also detected in fat and blood samples from children living nearby farms in Spain. Blood, human milk and urine samples were also be contaminated. Alarmigly high levels of endosulfan residues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

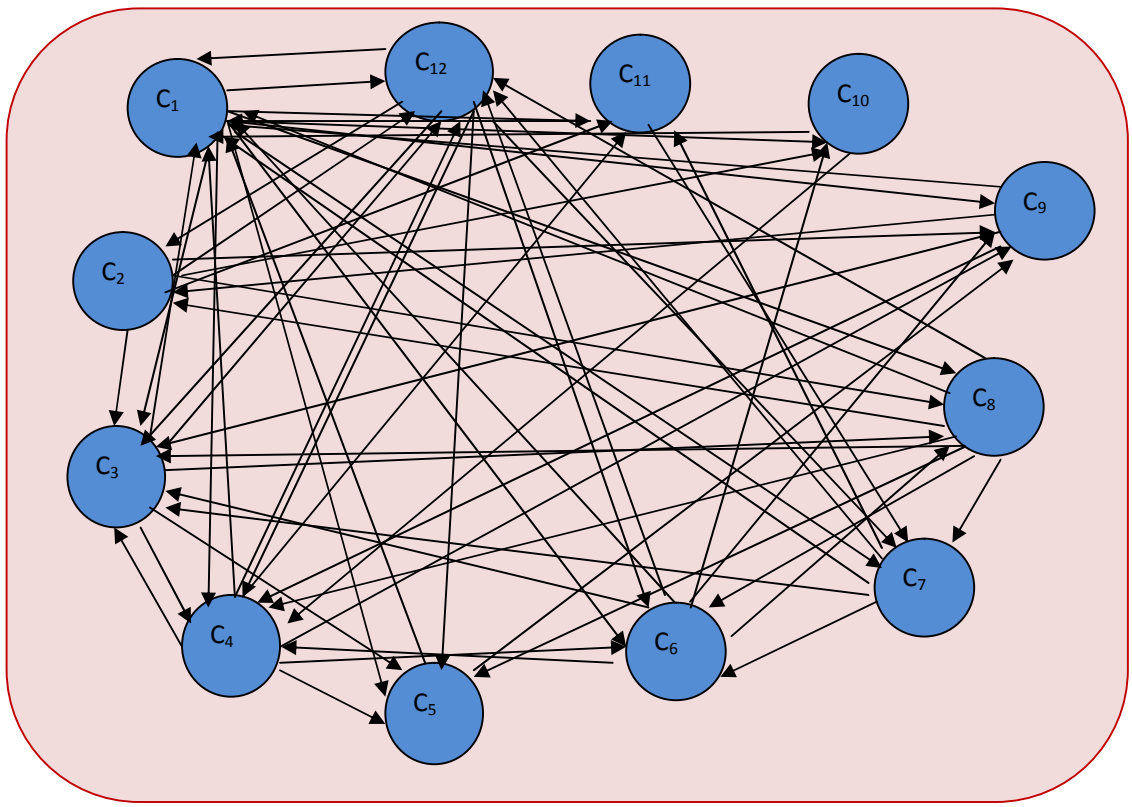
**$C_{12}$ - Long term exposure to Endosulfan causing cancer, kidney, skin diseases, neuro behavioral problems and infertility**

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.

$C_1^6M$ =↪ ( 1 0 1 1 0 0 0 1 1 1 0 1 ) ↪( 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 )↪ ( 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 )↪ (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)

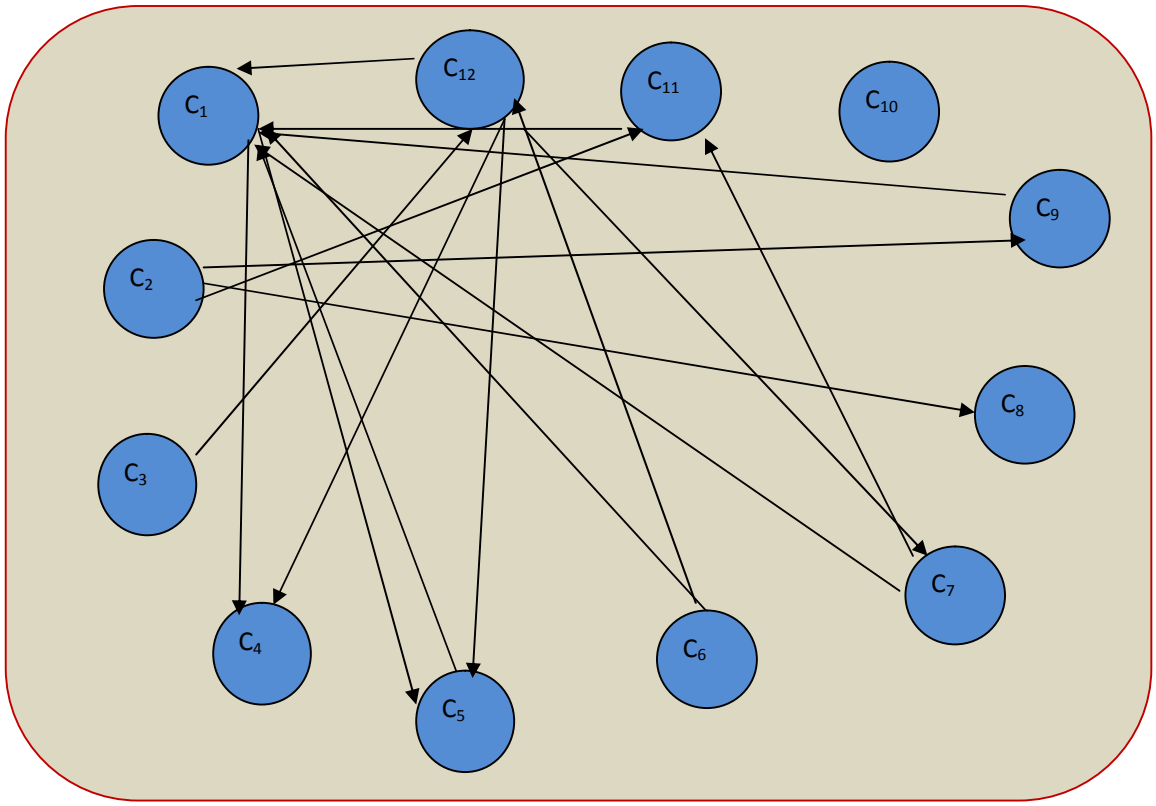
### 4.4.1: Implementation of FCM model to the study

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.

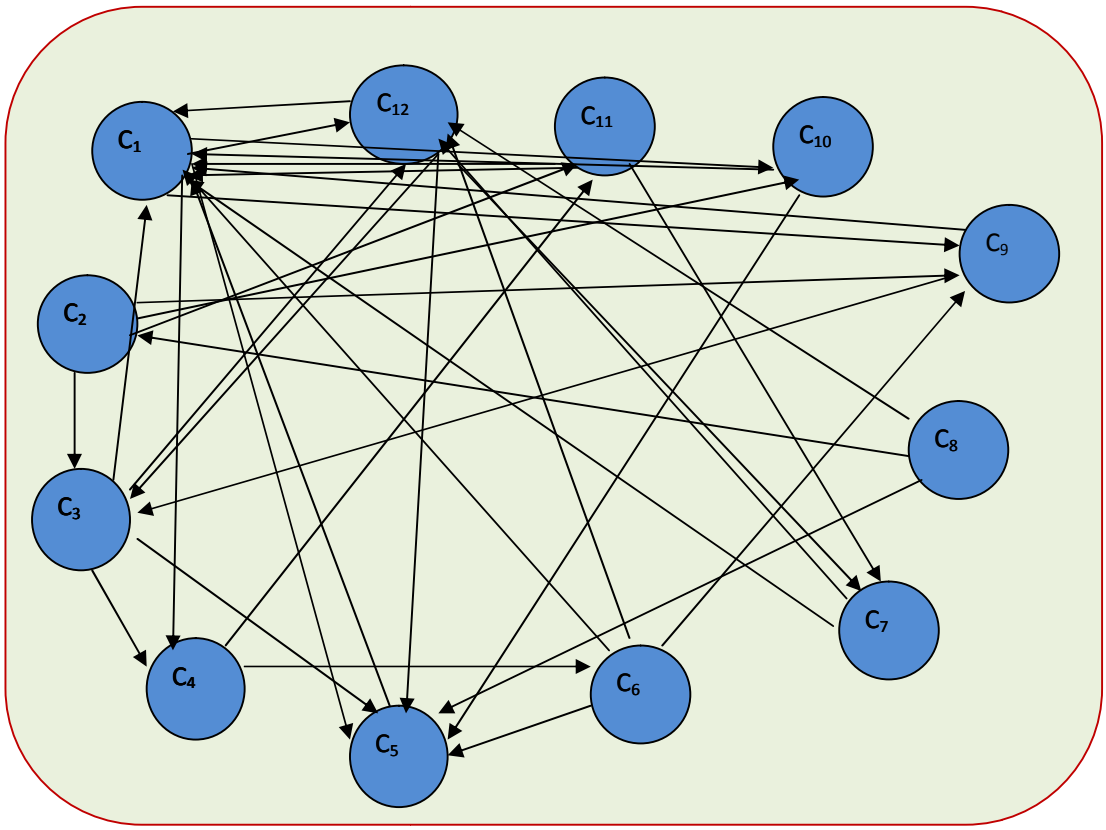



The related connection matrix denoted by A for the above directed graph is given below

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

### 4.4.3 Analysis of the second expert's view

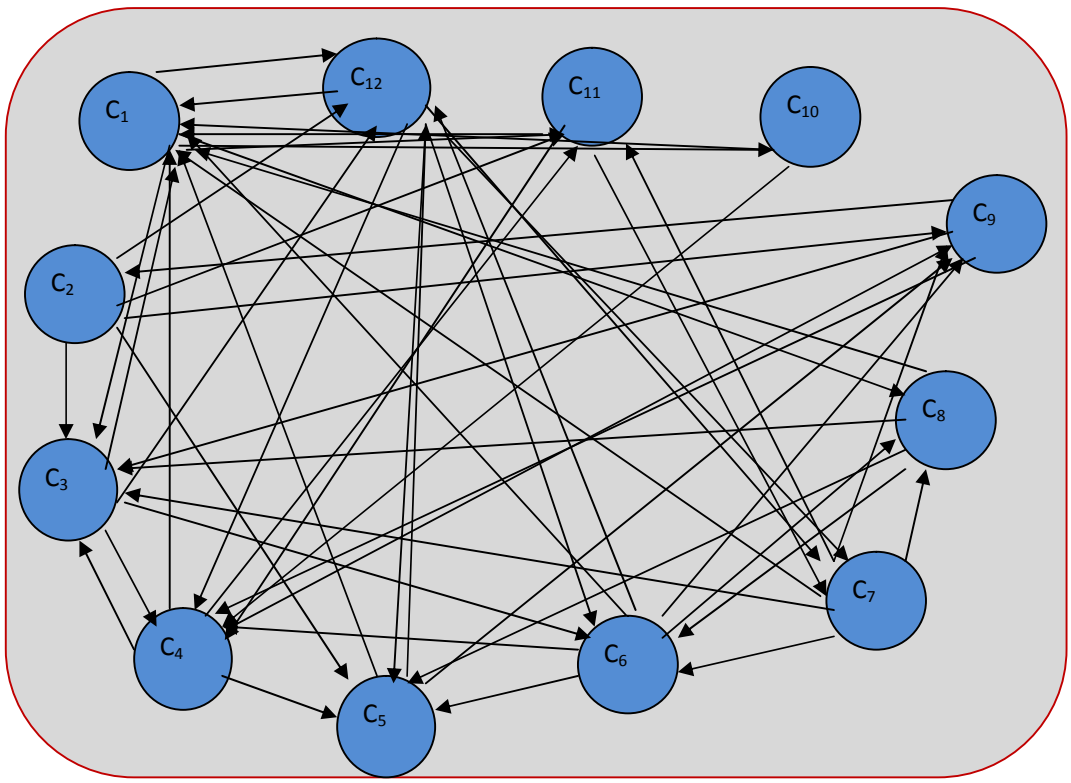
The second experts opinion is arrived through responses from an NGO for the connections between the concepts considered in section 4.2.The related graph and the matrix are given by an NGO




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

### 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.

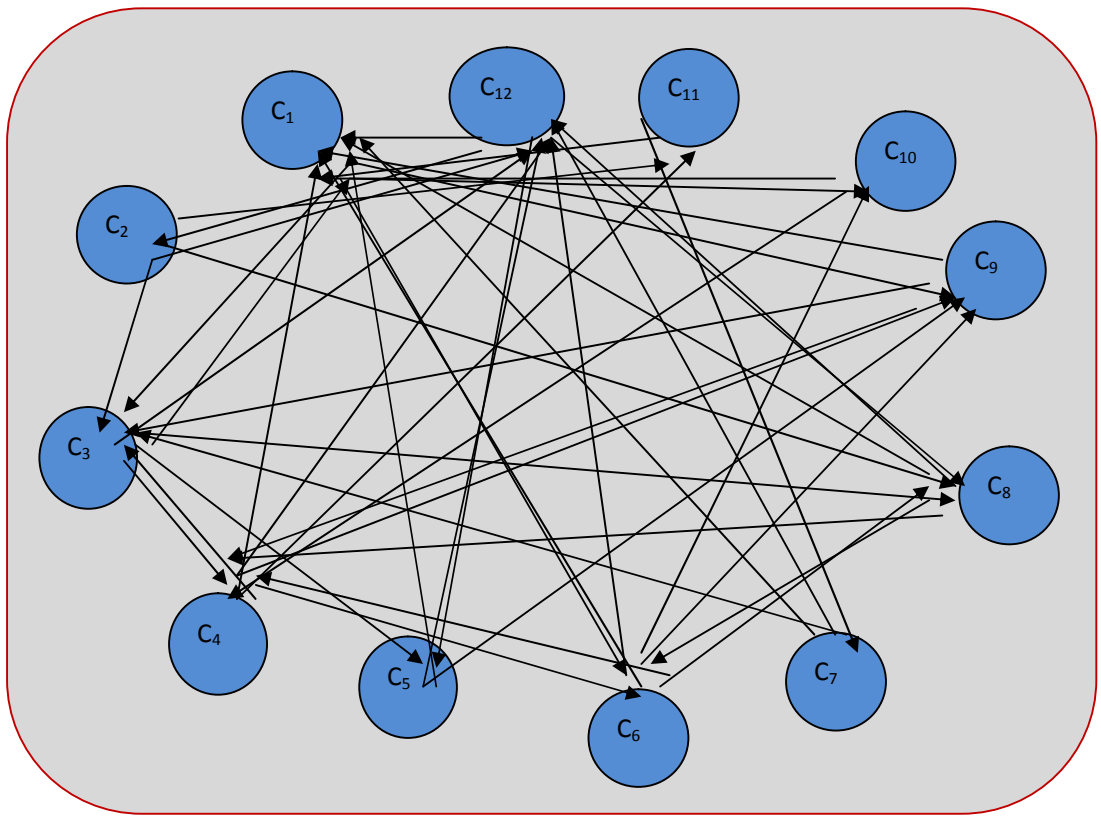



$$C = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} & C_{12} \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0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

### 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 )=$P_2$

$P_2$S= (16 4 13 10 11 8 2 6 12 5 5 14 ) ↪(1 1 1 1 1 1 0 1 1 1 1 1) =$P_3$

$P_3$S= (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)=$P_4$

$P_4$S=(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

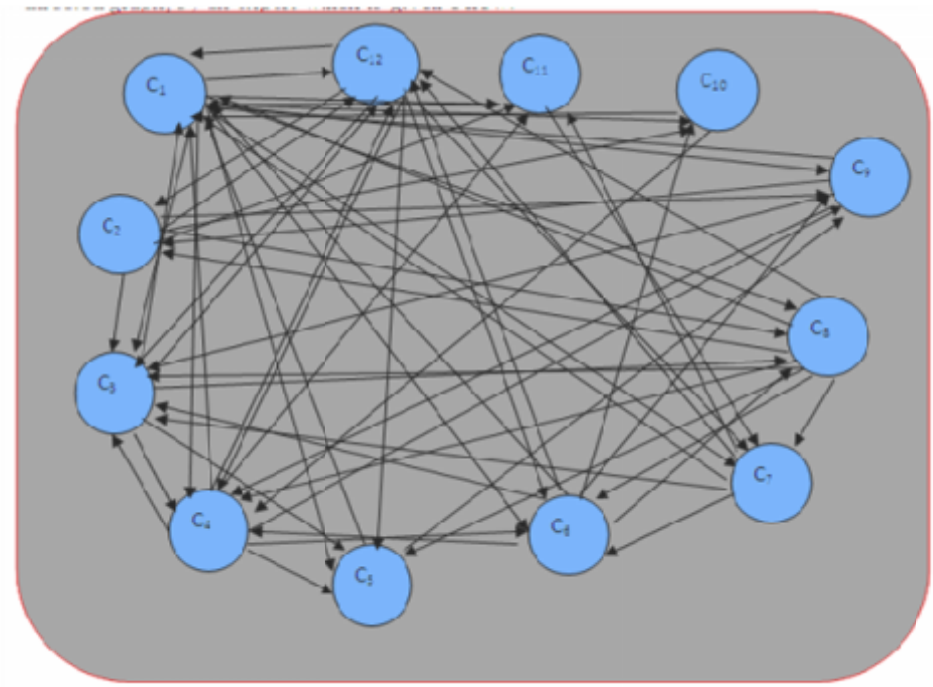
$C_6$ – Residual effect of Endouslfna in land

## 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)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 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 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 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 $Q_2'$

$Q_2$M =(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)= $Q_2'$

$Q_2'$= (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 $P_2$

$P_1^9$M= (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 $R_3$.

$Q_2^1M \approx$

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

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

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

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

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

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

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

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

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

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

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

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

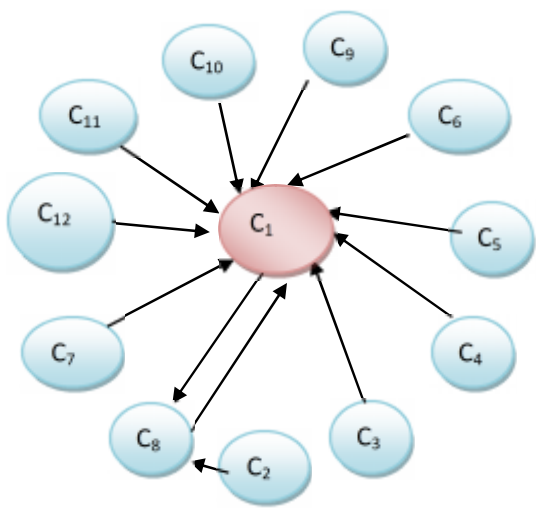
Here $R_3$=(0 0 1 1 1 1 1 1 1 1 1 1)= $Q_2$. Hence the fixed point is (0 0 1 1 1 1 1 1 1 1 1 1)

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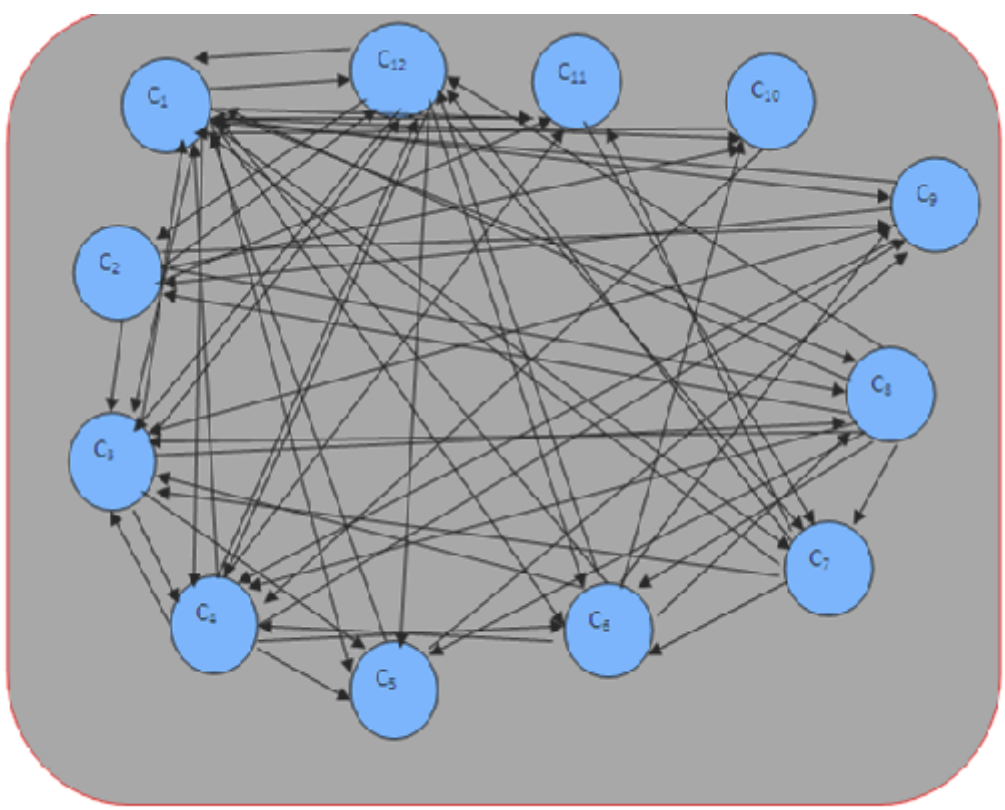
## 4.6 Analysis of the reasons for various effects of Endosulfan in agriculture using MFCMs

### 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) ↪ (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 1 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 )

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

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

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

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

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

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

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.

$R_3$M is calculated and threshold as $R_3^I$

$R_3$M=(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.