International Journal of Engineering & Technology, 7 (4.10) (2018) 624-628

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Identification of Social Problems of Farmers Using Fuzzy Mathematics

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Abstract

In this article the reasons behind farmers suicide in Cauvery Delta Zone in Tamil Nadu a state in India were collected and analyzed through fuzzy sets and fuzzy logic. A fuzzy model was developed to identify the factor which causes the excessive stress on farmers to commit suicide. Finally some valuable suggestions towards the welfare of farmers also provided.

Keywords: *Fuzzification ; Fuzzy Logic; Social Problems of Farmers ; Suicidal Tendency Measure and Weight score*

1. Introduction

India is an agricultural country. Farmers of India are the pillars of support to raise the economic position of their country. But this was the proudest position of famers about hundred years back. Now, in India farmers committing suicide is a frequent and common social problem which is very unpleasant. There are many reasons behind the farmers suicide. Few among them are water Scarcity in summer or on other seasons, failure of crops, increase in cost of production, stress and indebtedness. Due to many such causes more farmers suicidal attempts were happened all over India. Based on the media and newspaper report [3,5] and the pilot survey report there were totally more than 150 farmers who have committed suicide in between December 2016 to February 2017 in the Cauvery Delta Zone. This made farmers to protest on road using macabre elements to highlight the problems of farmers suicide in the states of Tamil Nadu. As an added fuel many industries, Government orders and public contracts forced the farmers to hand over their farm lands for their well beings, which will deprive the source of lives of the fellow farmers which will result in farmers suicide. If this stage is continued then for daily food need people should depend on other countries.

By considering the at most importance of this issue, in this article a survey was done in the Cauvery Delta Zone in Tamil Nadu which is one of the states of India. Based on the data collected a fuzzy model was developed to identify the most stressed factor of the farmers which lead to suicide**.** The model was developed based on fuzzy sets and fuzzy logic [1,2 & 4] which were developed and studied by Lofti A. Zadeh [6,7 & 8] , because most of the factors involved in this survey contains uncertainties. This article would definitely help the people or ENGO'S who are interested in helping the poor farmers from committing suicide and to uplift their economical position.

2. Preliminaries

Definition 2.1 [4] : *Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1. By contrast, in Boolean logic, the truth values of variables may only be the integer values 0 or 1. Fuzzy logic has been employed to handle the concept of partial truth, where the truth value may range between completely true and completely false.*

Definition 2.2 [6] : *If X is a collection of objects denoted generically by x, then a fuzzy set A in X is a set of ordered pair A = {x, $\mu_A(x)/\ x \in X\}$ $\mu_A(x)$ is called the membership function (generalized characteristic function) which maps X to the membership space M. A single pair (x, $\mu(x)$) is called a fuzzy singleton. Thus the whole set can be viewed as the union of its constituent singletons.*

3. Identification of Social Problems of Farmers Using Fuzzy Mathematics

3.1. Algorithm

1. Data collection through the suitable Questionnaire which will reflect the resource availability, mental strength, economic back ground etc., of farmers.
2. 7 point scaling were done by farmers from -3 to 3.
3. A_{ij} values were calculated.
4. Pairwise difference in A_{ij} for each questions were computed and ranked.
5. Fuzzification of suicidal tendency measure were done.

6. Based on the fuzzified values the extreme factors of farmers stress can be identified.

3.2. Primary and Secondary Information

From this Cauvery Delta Zone randomly 50 farmers families (i.e.25 affected due to the death of the farmer and 25 non affected families) were selected for the survey. All these farmers have less than 7 acres of land. As per land holding status of farmers have been classified in four categories namely 'marginal Farmers' (having less than 1 hectare of land), 'small Farmers' (having 1 hectare to below 2 hectares of land), 'Medium Farmers' (having 2 acre to below10 acre of land) and 'large farmers' (having more than 10 acres). The study included the collection of affected farmers from different newspapers, who were reported to have committed suicide. In case of affected farmers families the survey was conducted among their relatives, from their interviews on newspaper and TV channels and also from some investigations. Some personal interviews of non-affected farmer's families were conducted and some questionnaires were asked to collect appropriate information. This survey was conducted from December 2016 to February 2017.The secondary information such as the state and the central government aids and the welfare schemes to farmers have been collected from government circular websites.

In a study of suicide among farmers in Cauvery delta zone, India, the following cases were examined.

1. The fundamental factors leading to misery finally bring them to commit suicide.

2. The needs of farmers that pushed them into debt snare.

3. The important role of systematic, institutional and organization planning , involved in activation, irrigation, harvesting etc.

4. Land storage status of farmers who have committed suicide

3.3. The factors included in the questionnaire

The authors asked some purposeful questions to collect the information like habits, health problems of farmers and various hazards, additional incomes, reason for liking farming were collected by direct investigations from senior farmers in the Cauvery Delta Zone. Additionally the economic position of their families were also obtained.

Table 1: Distribution of questions in the questionnaire according to the basic parameters

Q.no	Description	Basic factor / parameter
Q1	Importance regarding irrigation system (Cauvery delta and bore well)	Resource Availability
Q2	Importance regarding seeds, pesticides, fertilizers	Resource Availability
Q3	Importance regarding harassment of recovery of loan and indebtedness	Stress Indicator and Economic
Q4	Changing crop pattern crop failure	Economic
Q5	Habits alcoholism and prevalence of various addictions gambling	Stress Indicator
Q6	Importance regarding government programme and policy	Stress indicator
Q7	Importance regarding psychosocial factors: 1) Family stress 2) Marriage problem of adult daughter 3) Chronic illness with family 4) Depressions due to social and economic status.	Stress Indicator and Stress
Q8	Importance of remunerative price	Infrastructure
Q9	Importance regarding transport and storage facilities	Infrastructure
Q10	Importance regarding changes of weather and climates	Infrastructure and Natural Calamities

3.3. Data Analysis

Using qualitative and quantitative investigation methods such as descriptive statistics, correlations and regression the data was analyzed**.**

3.4. Description about Scale And Interpretation

The farmers answered the questions from 1 to 10 to the tune of the range from -3 to 3 at 7 point scales. Negative score indicates that the farmer was affected by that score.

3.5. Procedure for Ranking the Questions According To Their Importance As Indicated By Their Weighted Score.

In this table the affected farmer's families (A member of the family committed suicide) were represented. They registered their opinion for the ten questionnaires in the 7 point scale from -3 to 3.

Table 2: Non controlled/ affected farmers

Score	Q1(c_1)	Q2 (c_2)	Q3(c_3)	Q4 (c_4)	Q5(c_5)
-3(r_1)	11	0	13	5	5
-2(r_2)	9	0	8	9	6
-1(r_3)	3	0	4	11	0
0(r_4)	0	0	0	0	0
1(r_5)	0	3	0	0	5
2(r_6)	0	15	0	0	8
3(r_7)	2	7	0	0	1
Total	25	25	25	25	25

Table 3: Non controlled/ affected farmers

Score	Q6 (c_6)	Q7 (c_7)	Q8 (c_8)	Q9 (c_9)	Q10 (c_{10})
-3(r_1)	4	5	0	9	7
-2(r_2)	13	8	0	5	9
-1(r_3)	0	0	0	3	3
0(r_4)	0	0	0	0	0
1(r_5)	3	8	4	0	0
2(r_6)	5	4	14	8	3
3(r_7)	0	0	7	0	3
Total	25	25	25	25	25

In tables 4 and 5 the values $A_{ij} = \sum_{i=1}^{10}\sum_{j=1}^{7} c_i r_j$ was calculated and then all these values were added question wise for the values in tables 2 and 3.

Table 4: Non controlled/ affected farmers

Score	Q1(c_1)	Q2 (c_2)	Q3(c_3)	Q4 (c_4)	Q5(c_5)
-3(r_1)	-33	0	-39	-15	-15
-2(r_2)	-18	0	-16	-18	-12
-1(r_3)	-3	0	-4	-11	0
0(r_4)	0	0	0	0	0
1(r_5)	0	3	0	0	5
2(r_6)	0	30	0	0	16
3(r_7)	6	21	0	0	3
Total	-48	54	-59	-44	-3

Table 5: Non controlled/ affected farmers

Score	Q6 (c_6)	Q7 (c_7)	Q8 (c_8)	Q9 (c_9)	Q10 (c_{10})
-3(r_1)	-12	-15	0	-27	-21
-2(r_2)	-26	-16	0	-10	-18
-1(r_3)	0	0	0	-3	-3
0(r_4)	0	0	0	0	0
1(r_5)	3	8	4	0	0
2(r_6)	10	8	28	16	6
3(r_7)	0	0	21	0	9

Total	-25	-15	53	-24	-27

The non-affected farmers gave their score in the 7 point scale from -3 to 3 for each question in questionnaire. The table 6 and 7 reflect this.

Table 6: Controlled / Non affected farmers

Score	Q1(c_1)	Q2 (c_2)	Q3(c_3)	Q4 (c_4)	Q5(c_5)
-3(r_1)	0	0	7	0	6
-2(r_2)	0	2	5	2	9
-1(r_3)	7	3	4	3	2
0(r_4)	0	0	0	0	0
1(r_5)	3	6	0	5	2
2(r_6)	13	13	9	6	6
3(r_7)	2	1	0	9	0
Total	25	25	25	25	25

Table 7: Controlled/ Non affected farmers

Score	Q6 (c_6)	Q7 (c_7)	Q8 (c_8)	Q9 (c_9)	Q10 (c_{10})
-3(r_1)	0	0	0	0	9
-2(r_2)	6	5	0	6	8
-1(r_3)	7	0	0	5	0
0(r_4)	0	0	0	0	0
1(r_5)	2	2	13	0	5
2(r_6)	5	13	8	8	0
3(r_7)	5	5	4	6	3
Total	25	25	25	25	25

In table 8 and 9 the values $A_{ij} = \sum_{i=1}^{10}\sum_{j=1}^{7} c_i r_j$ was calculated and then all these values were added question wise for the values in the tables 6 and 7.

Table 8: Controlled/ Non affected farmers

Score	Q1(c_1)	Q2 (c_2)	Q3(c_3)	Q4 (c_4)	Q5(c_5)
-3(r_1)	0	0	-21	0	-18
-2(r_2)	0	-4	-10	-4	-18
-1(r_3)	-7	-3	-4	-3	-2
0(r_4)	0	0	0	0	0
1(r_5)	3	6	0	5	2
2(r_6)	26	26	18	12	12
3(r_7)	6	3	0	27	0
Total	28	28	-17	37	-24

Table 9: Controlled/ Non affected farmers

Score	Q6 (c_6)	Q7 (c_7)	Q8 (c_8)	Q9 (c_9)	Q10 (c_{10})
-3(r_1)	0	0	0	0	-27
-2(r_2)	-12	-10	0	-12	-16
-1(r_3)	-7	0	0	-5	0
0(r_4)	0	0	0	0	0
1(r_5)	2	2	13	0	5
2(r_6)	10	26	16	16	0
3(r_7)	15	15	12	18	9
Total	8	33	41	17	-29

Table 10:Pairwise Differences

Q.no	(A)	(B)	D = A – B	Rank
Q1	28	-48	76	2
Q2	28	54	-26	9
Q3	-17	-59	-42	10
Q4	37	-44	81	1
Q5	-24	-3	-21	8
Q6	8	-25	33	5
Q7	33	-15	48	3
Q8	41	53	-12	7
Q9	17	-24	41	4
Q10	-29	-27	-2	6

In table 10 the differences between the affected (A) and non-affected farmers (B) for each question by using the formula D = A – B were calculated, sorted and the factors were ranked

If the difference is negative, it would indicate that the corresponding factors are not reasons for stress. The positive differences indicate that the corresponding factors must be the reasons for more stress. The first five questions (rank wise) in the above table will be considered because they cause excessive stress.

6. The Fuzziness of Suicidal Tendency Measure

For this, the universal set would be U = {All Farmers in and around Cauvery Delta Zone}. Now a days all farmers felt abundance frustration due to many reasons. Most important is the fact that 'frustration' is not a two valued metric. A logic variable say 'frustration', which can takes values as follows. If frustration is TRUE then the associated traditional logic value is 1. If frustration is FALSE then the associated traditional logic value is 0. But this is not possible, because there is an uncertainty in the measurement of frustration. . To overcome this uncertainty the level of frustration was defined as extremely frustrated, moderately frustrated, and lowly frustrated. Consider the function F: U → [0, 1] where U is the universal set defined as U = {All Farmers In Cauvery Delta Zone}.

Here a three valued fuzzy logic for the above mentioned fuzzy sets is defined as follows:

G ={extremely frustrated} ={Farmers having highly great trouble} = {x | F(x) > g}

M = {moderately frustrated} = {Farmers having moderate trouble} = {x | m < F(x) ≤ g}

L = {lowly frustrated} = {Farmers having slightly least trouble} = {x | F(x) ≤ m}

According to this three level of frustration, the strength of suicidal inclination to the level of frustration can be associated.

3.7. Fuzzification

Thus every member of the universe will have some grade suffering, a value between 0 and 1 associated with them.. Closer the value of F(x) to 1, higher would be the tendency to commit suicide.

In tables 11 and 12, the opinions of 50 farmers were converted into 0 to 1 range for the first five questionnaire and then F(x) was calculated by using F(x) = 1-average.

Table 11: Fuzzy score (0-1) of top 5 causes for distress of affected farmers

S.No	Affected/Non controlled Farmers Name	Average distress score F(x)=1-average
1	Selva Kumar	0.86
2	Chakra Varthi	0.94
3	Govindan	0.94
4	Chinna Durai	0.82
5	Aravind	0.94
6	Durai Raj	0.78
7	Muthu Govunder	0.74
8	Veera Mani	0.54
9	Mariya Kannu	0.94
10	Chinna Samy	0.76
11	Adhiyan	0.76
12	Shanmuga Vel	0.8
13	Ponnu Samy	0.92
14	Panneer Selvam	0.9

15	Kannan	0.74
16	Kamakshi	0.72
17	Karuna Nidhi	0.64
18	Vijaya Ragavan	0.78
19	Radha Krishnan	0.8
20	Natarajan	0.76
21	Govindan	0.58
22	Raja Rathinam	0.8
23	Jaya Kumar	0.72
24	Jagadhammbal	0.76
25	Rathinam	0.6

Table 12: Fuzzy score (0-1) of top 5 causes for distress of non affected farmers

S.No	Non Affected/ controlled Farmers Name	Average distress score F(x)=1-average
1	Sree Rangan	0.38
2	Kannammal	0.4
3	Rathinammal	0.26
4	Radhamani	0.38
5	Venkat Raman	0.52
6	Illan Zelian	0.4
7	Ravi	0.38
8	Shanthi	0.42
9	Dhanda Pani	0.4
10	Perumal	0.38
11	Sudhakar	0.28
12	Jaya Raman	0.42
13	Kuppu Samy	0.52
14	Thangavel	0.38
15	Jagan Nadhan	0.38
16	Narayannan	0.42
17	Krishnan	0.4
18	Illango	0.3
19	Kaliannan	0.26
20	Chinna Muthu	0.24
21	Moorthi	0.4
22	Kavetti Naidu	0.26
23	Marri Muthu	0.42
24	Sundaram	0.22
25	Balan	0.24

From the table 11 and12, the maximum respondents are in 0.8 and 0.4 This shows that these are the extreme critical values. Hence the fuzzification was defined as follows.

If $F(x) \geq 0.80$ then $G(x) = 1$ and $M(x) = L(x) = 0$.
If $0.50 \leq F(x) < 0.80$ then $G(x) = (F(x) – 0.5)/0.3$,
$M(x) = 1 – G(x)$ and $L(x) = 0$
If $0.40 < F(x) < 0.50$ then $G(x) = 0$, $M(x) = (F(x) – 0.4)/0.1$ and $L(x) = 1 – M(x)$
If $F(x) < 0.40$ then $G(x) = 0$, $M(x) = 0$ and $L(x) = 1$

Using the above Fuzzification definition, the values F(x), G(x), and L(x) for Non – Controlled/ Affected Farmers and for non affected /controlled farmers were calculated and compared.

Table 13: Values of F(x), G(x), and L(x) For Non – Controlled/ Affected Farmers

S.No	Affected/Non controlled Farmers Name	F(x)	G(x)	M(x)	L(x)
1	Selva Kumar	0.86	1	0	0
2	Chakra Varthi	0.94	1	0	0
3	Govindan	0.94	1	0	0
4	Chinna Durai	0.82	1	0	0
5	Aravind	0.94	1	0	0
6	Durai Raj	0.78	0.93	0	0.07
7	Muthu Govunder	0.74	0.8	0	0.2
8	Veera Mani	0.54	0.13	0	0.87
9	Mariya Kannu	0.94	1	0	0
10	Chinna Samy	0.76	0.87	0	0.13
11	Adhiyan	0.76	0.87	0	0.13
12	Shanmuga Vel	0.8	1	0	0
13	Ponnu Samy	0.92	1	0	0
14	Panneer Selvam	0.9	1	0	0
15	Kannan	0.74	0.8	0	0.2
16	Kamakshi	0.72	0.73	0	0.27
17	Karuna Nidhi	0.64	0.46	0	0.53
18	Vijaya Ragavan	0.78	0.93	0	0.07
19	Radha Krishnan	0.8	1	0	0
20	Natarajan	0.76	0.87	0	0.13
21	Govindan	0.58	0.26	0	0.73
22	Raja Rathinam	0.8	1	0	0
23	Jaya Kumar	0.72	0.73	0	0.27
24	Jagadhammbal	0.76	0.87	0	0.13
25	Rathinam	0.6	0.33	0	0.6

Table 14: Values of F(x), G(x), and L(x) For Controlled/ Non Affected Farmers

S.No	Non Affected / controlled Farmers Name	F(x)	G(x)	M(x)	L(x)
1	Sree Rangan	0.38	0	0	1
2	Kannammal	0.4	0	0	1
3	Rathinammal	0.26	0	0	1
4	Radhamani	0.38	0	0	1
5	Venkat Raman	0.52	0.07	0.93	0
6	Illan Zelian	0.4	0	0	1
7	Ravi	0.38	0	0	1
8	Shanthi	0.42	0	0.2	0.8
9	Dhanda Pani	0.4	0	0	1
10	Perumal	0.38	0	0	1
11	Sudhakar	0.28	0	0	1
12	Jaya Raman	0.42	0	0.2	0.8
13	Kuppu Samy	0.52	0.07	0.93	0
14	Thangavel	0.38	0	0	1
15	Jagan Nadhan	0.38	0	0	1
16	Narayannan	0.42	0	0.2	0.8
17	Krishnan	0.4	0	0	1
18	Illango	0.3	0	0	1
19	Kaliannan	0.26	0	0	1
20	Chinna Muthu	0.24	0	0	1
21	Moorthi	0.4	0	0	1
22	Kavetti Naidu	0.26	0	0	1
23	Marri Muthu	0.42	0	0.2	0.8
24	Sundaram	0.22	0	0	1
25	Balan	0.24	0	0	1

Table 15 : Comparison of affected and non-affected farmers

Farmers	Greatly Frustrated G(x)	LowlyFrustrated L(x)	Moderately Frustrated M(x)
Controlled	0	8	17
Non controlled	17	0	8
Grand total	17	8	25

4. Findings

From the above table it is clear that highly frustrated farmers who has committed suicide (17 out of 25 that is 68%) and their family could not be saved and the moderately frustrated farmers who have committed suicide (8 out of 25 that is 32%) their family could be saved.

5. Conclusion

According to the study of questionnaire, it is found that the factors which causes the excessive stress are Q4-Crop failure, Q1-Irrigation system, Q7-Psychosocial factors, and Q3-Indebtedness. In this project the authors tried to measure the psychological, social and financial impact of above factors in terms of degree of frustration with the help of fuzzy mathematics. To overcome water scarcity new technology can be implemented to do rain water harvesting. The Government can give compensation amount to the affected Small farmers. They can be encouraged to know

about the additional sources of income like breeding cows, goats etc. The Government can try to provide the loan facility to avail the new technology.

Our food and food practices are great medicines for so many diseases. The loss of farmers are not only affect the need of food but also it will create a great impact on Health, dresses, economical position of our country etc. Hence the government can encourage the farmers to avoid spending more money on buying hybrid seeds, fertilizers and pesticides. They can do farming by natural agricultural methods like natural seeds etc. They can breed good country cow and bull in their farms which will help them completely to reduce money spending on fertilizers and pesticides which prevent farmers from indebtedness. Also the government can cancel the contracts which will deprive the lands from the farmers. It can also reduce the cost of production, fix the best price for their production and encourage them to sell the products directly to customers.

Acknowledgement

The authors would like to express their sincere gratitude and thanks to the referees for the betterment of this paper.

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