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RESEARCH ARTICLE

Prediction of Production of Crops using K-mean & Fuzzy Logic

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Abstract: ***Rainfall and crops production is playing a most important role for countries economic growth and development. Farmers to Finance minister waiting and worshiping for good rainfall to their God and Goddess because farmers are anxious regarding their bread and butter while Finance ministry is anxious regarding GDP growth of the countries as well as revenue generation. Finance ministry has also to plan and manage to store the yielded crops in better way and also to get ready to help farmers and their kin in bad situation with the help of disaster management like bad rainfall or heavy rainfall.***

Previously farmers predict the production on the basis of assumption of experience farmers without any help of computer as well as soft computing technology. But we had used the latest technology like "Prediction using K-means" based on last several decades of data as well as "Rule based prediction using fuzzy logic" for the "Chittorgarh" district of Rajasthan state in India. We had also compared the result of both the process.

There are number of algorithms for prediction purpose. But, we used K-means algorithm for prediction because predicted rainfall is based on last several decades of data year by year. On using K-means algorithm we got the more accurate or actual or probable prediction. Another prediction is done on the basis of rule base system using fuzzy logic by applying rule on land used for farming, rainfall and production with the help of inference engine.

Both predictions are done on the tool "MATLAB". Which is much more accurate than the prediction done by experienced farmers on the basis of assumption.

Keyword: Fuzzy, K-MEANS, Matlab, Prediction, Rainfall, Crop yield prediction.

I. Introduction

Agriculture in India has a significant history. Today, India is ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. [1]

Agriculture activity is a type of business with risk. The production of Crops depends various factors like on climatic, geographical, biological, political and economic factors.

Accurate information about the nature of historical yield of crop is important modeling input, which are helpful to farmers & Government organization for decision making process in establishing proper policies related to next production. The advances in computing and information storage have provided vast at most of data. The challenge has been to extract knowledge from this raw data, Data mining that can bridge the knowledge of the data to the crop yield estimation. This research aimed to data mining techniques and apply them to the various variables consisting in the database to establish if meaningful relationships can be found and using fuzzy logic to find the condition of crops on various condition of rainfalls.

1 Introduction to *K-means*

K-means is one of the simplest unsupervised learning algorithms that solve the well-known problem i.e. average mean. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed apriority. The main idea is to define k centres, one for each cluster. These centres should be placed in a cunning way because of different location causes different result [2].

1.1 K-means Algorithm.

Mean = (Sum of all N numbers) / N

Step1: Start

Step2: Take N inputs

Step3: [Initialize] Sum := 0

Step4: Repeat for i := 1 to N by 1

Sum := DATA[i] + Sum

[End of loop]

Step5: mean := Sum / N

Step6: Write: 'Mean of N number is mean'

Step7: Stop

2.1 Fuzzy logic

Fuzzy logic is a superset of Boolean (conventional) logic that handles the concept of partial truth, which is truth values between "completely true" and "completely false". Fuzzy logic is multivalued. It deals with degrees of membership and degrees of truth. Fuzzy logic uses the continuum of logical values between 0 (completely false) and 1 (completely true)

2.2 Fuzzy Set

The modeling of imprecise and qualitative knowledge, as well as the transmission and handling uncertainty of data at various stages are possible through the use of fuzzy sets [3].

Knowledge discovery in databases is mainly concerned with identifying interesting patterns and describing them in a concise and meaningful manner. Fuzzy sets depend on membership function which is mainly from human ideas so that decisions in agriculture can easily find by using fuzzy se

3 Data Collection & Classification

For the prediction of rainfall data have been collected from different sources by different methods. The information gathering process is done with three government department like Indian Meteorological Department, Statistical Institution and Agricultural department of chittorgarh (Rajasthan) [4].

3.1 Rainfall has been categorized as

Classification on the basis of light rain, moderate, rather heavy, heavy, very heavy [5]. Data collected here for this project is rainfall data of last several years' and total crops production in year. Where area is in hectare, production is in tones [6]

Rainfall data have been collected from different-different departments and crops data has been completed by official website of chittorgarh aggregation department. [7] The data has been download in excel format and of different crops i.e. Rabi crops and Kharif crops, but for this paper we have taken Kharif crops such as crops major crops because this research aims prediction of crops for chittorgarh district of rajasthan and major crops here is Jowar, Bajra, Maize and sugarcane. There are several applications of Data Mining techniques in the field of agriculture. Some of the data mining techniques are related to weather conditions and Short term forecasting of air pollution in the atmosphere [8]. Data mining techniques are applied to study sound recognition problems. [9]

DISTRICT-WISE AREA, PRODUCTION AND YIELD OF KHARIF CROPS

District: Chittorgarh (Area in Ha., Production in tonnes & Yield in Kg./Hac.)

1998-99			1999-00			2000-01			2001-02			2002-03			2003-04		
Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
1245	1522	1222	1069	1349	1262	857	803	937	732	913	1247	725	589	812	776	1283	1653
14400	9562	664	13384	9518	711	13690	6668	487	17452	11411	654	15896	7154	450	21742	8946	411
44	19	432	13	4	308	34	15	441	53	40	755	40	9	225	41	47	1146
142288	196542	1381	142896	198186	1387	156105	194824	1248	162294	293041	1806	156526	186039	1189	174714	374056	2141
17	4	235	4	2	500	7	1	143	3	9	3000	0	0	-	2	2	1000
157994	**207649**	**1314**	**157366**	**209059**	**1328**	**170693**	**202311**	**1185**	**180534**	**305414**	**1692**	**173187**	**193791**	**1119**	**197275**	**384334**	**1948**
459	608	1325	431	368	854	481	158	328	416	291	700	240	46	192	312	187	599
586	61	104	506	50	99	599	104	174	676	199	294	665	42	63	821	509	620
26335	9273	352	17017	5874	345	14538	3977	274	19836	9575	483	28185	9698	344	23518	9061	385
1	0	0	0	0	-	2	0	0	7	2	286	0	0	-	0	0	-
27138	9382	346	17667	5941	336	15407	4136	268	-	-	-	-	-	-	-	-	-
54519	**19324**	**354**	**35621**	**12233**	**343**	**31027**	**8375**	**270**	**20935**	**10067**	**481**	**29090**	**9786**	**336**	**24651**	**9757**	**396**
3698	876	237	3894	989	254	4500	1036	230	6675	2117	317	9126	1827	200	10610	3454	326
39501	48243	1221	39550	46103	1166	25799	23057	894	31292	44094	1409	38814	36389	938	36667	51247	1398
111380	163630	1469	116208	171477	1476	116606	58671	503	112640	107532	955	108518	81823	754	101837	151293	1486
9	13	1444	11	11	1000	43	11	256	9	5	556	8	1	125	13	8	615
154588	**212762**	**1376**	**159663**	**218580**	**1369**	**146948**	**82775**	**563**	**150616**	**153748**	**1021**	**156466**	**120040**	**767**	**149127**	**206002**	**1381**
2267	131848	58160	1605	83940	52299	1025	57304	55906	659	30954	46971	862	43675	50667	786	44811	57011
858	1161	1353	650	1097	1688	952	1503	1579	1090	600	550	1523	996	654	1519	3135	2064
859	255	297	17027	6353	373	18734	4550	243	7833	39213	5006	4902	696	142	5858	5756	983
676	775	1146	849	1456	1715	658	829	1260	704	10085	14325	552	242	438	-	-	-
0	0	-	0	0	-	0	0	-	-	-	-	-	-	-	-	-	-
0	0	-	0	0	-	0	0	-	17	17	1000	0	0	-	0	0	-

data of chittorgarh in excel format

Area	Production	Annual Rainfall Tota
–	–	–
14321	7754	1067
Name of Crops		Bajra
Area	Production	Annual Rainfall Tota
–	–	–
37	18	1067
Name of Crops		Maize
Area	Production	Annual Rainfall Tota
–	–	–
187533	187965	1067

Fig 2: Data imported in matlab

IV. Implementation of Prediction work

(a) K-means Based

To find the prediction of production we have created the GUI for K-means based by using K-means and GUI coding where k is the number of year which lie Between 1 to 15. Suppose we need to find the crop prediction for year 2015 then k=1 will predict the value on the basis of previous year data, similarly it will predict the rainfall and crop production for next year.

Steps to open K-means GUI:

(a) Open matlab in computer/laptop

(b) Open .m file of K-means code

(c) Run the .m file, after successful compilation GUI will appear like below.

(d) Choose name of crops for which prediction to be done from list of crops

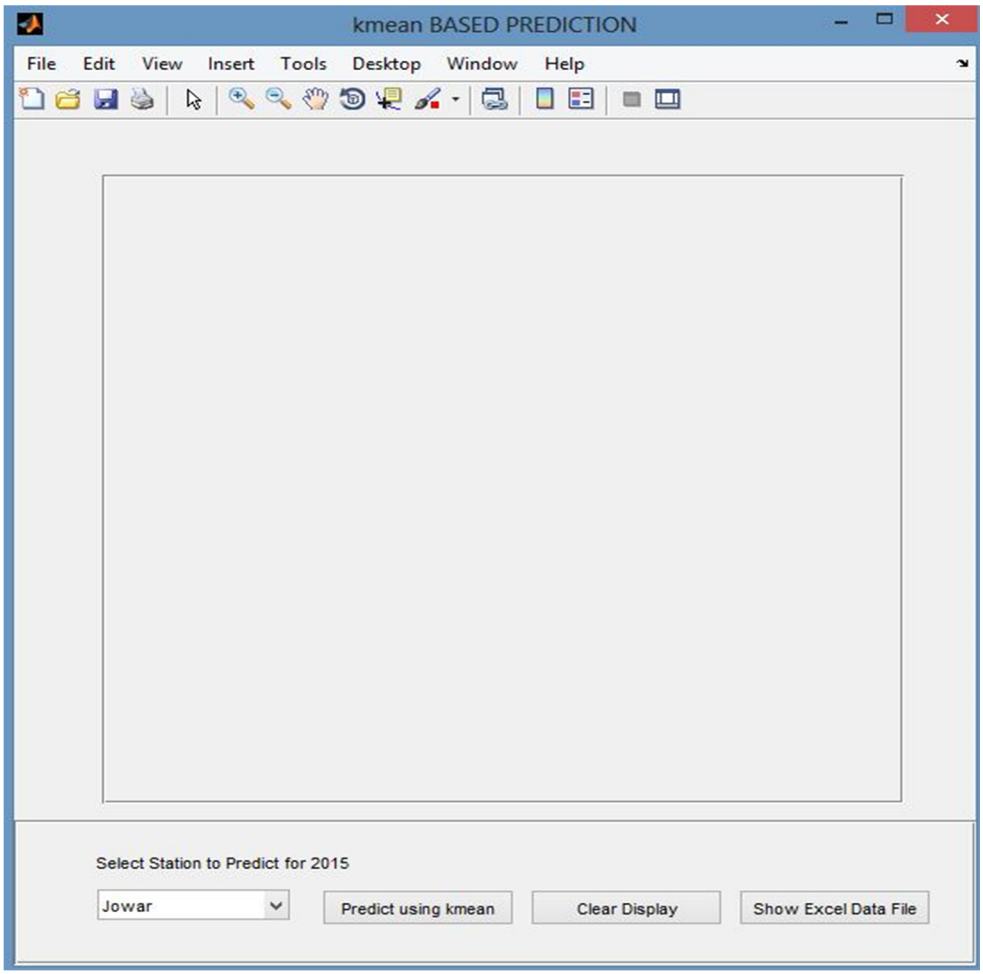

Fig 3: GUI-K-means

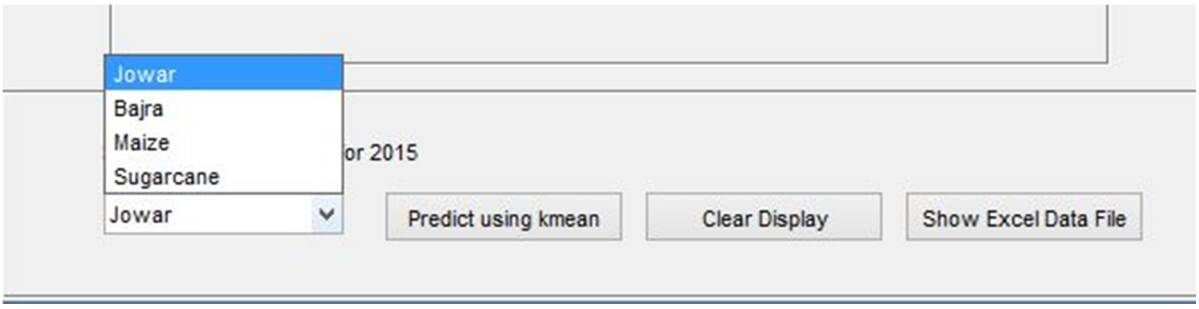

Fig 4: figure showing option among crops.

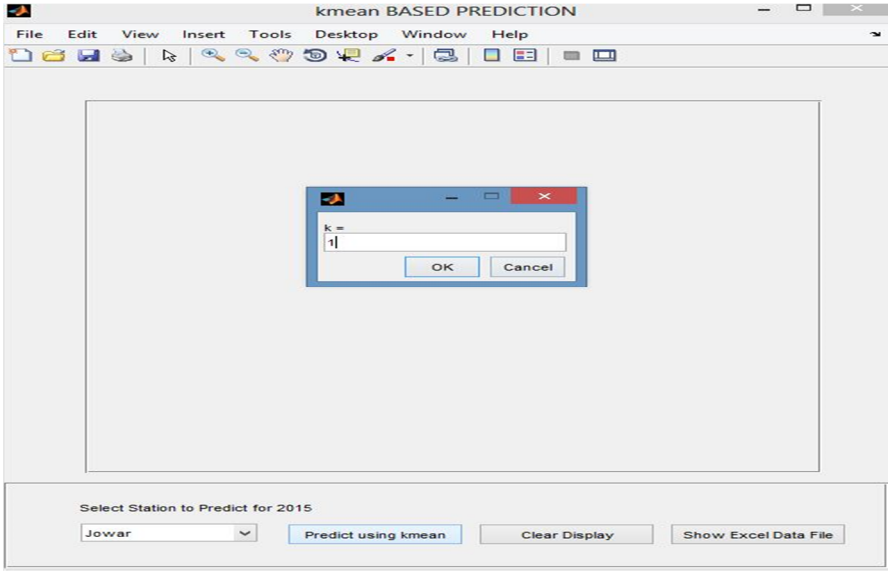

Fig 5: choose the value of k.

(f) Since data is collected is from 2000 to 2014 i.e. total data is 15 so the maximum value of k is 15.

(g) Previous year data file should be imported in code so that it can fetch data from previous year data and can be imported in matlab file for prediction.

```
% Load data from an excel file
% Get Workbook interface and open file
exlWkbk = exl.Workbooks;
exlFile = exlWkbk.Open(['F:\cropdata.xlsx']);
```

Fig 6: Importing excel data file

K is the value selected for year which values lie Between 1 to 15. Steps we have to do is open the matlab in your computer then import the data file (Ms-Excel) into workspace then import the .m file of GUI. Then run the code after successful compilation GUI will appear on screen then below select then select the station among which prediction is to be done, in GUI code data file is included in it, it is necessary to import data file so that prediction can be done from the previous data available in the data sheet. K-MEAN is applied for prediction of production [10].

In GUI click on prediction using K-means button and then mention the value of k from 1 to 15, then click on ok it will predict the production for next year.

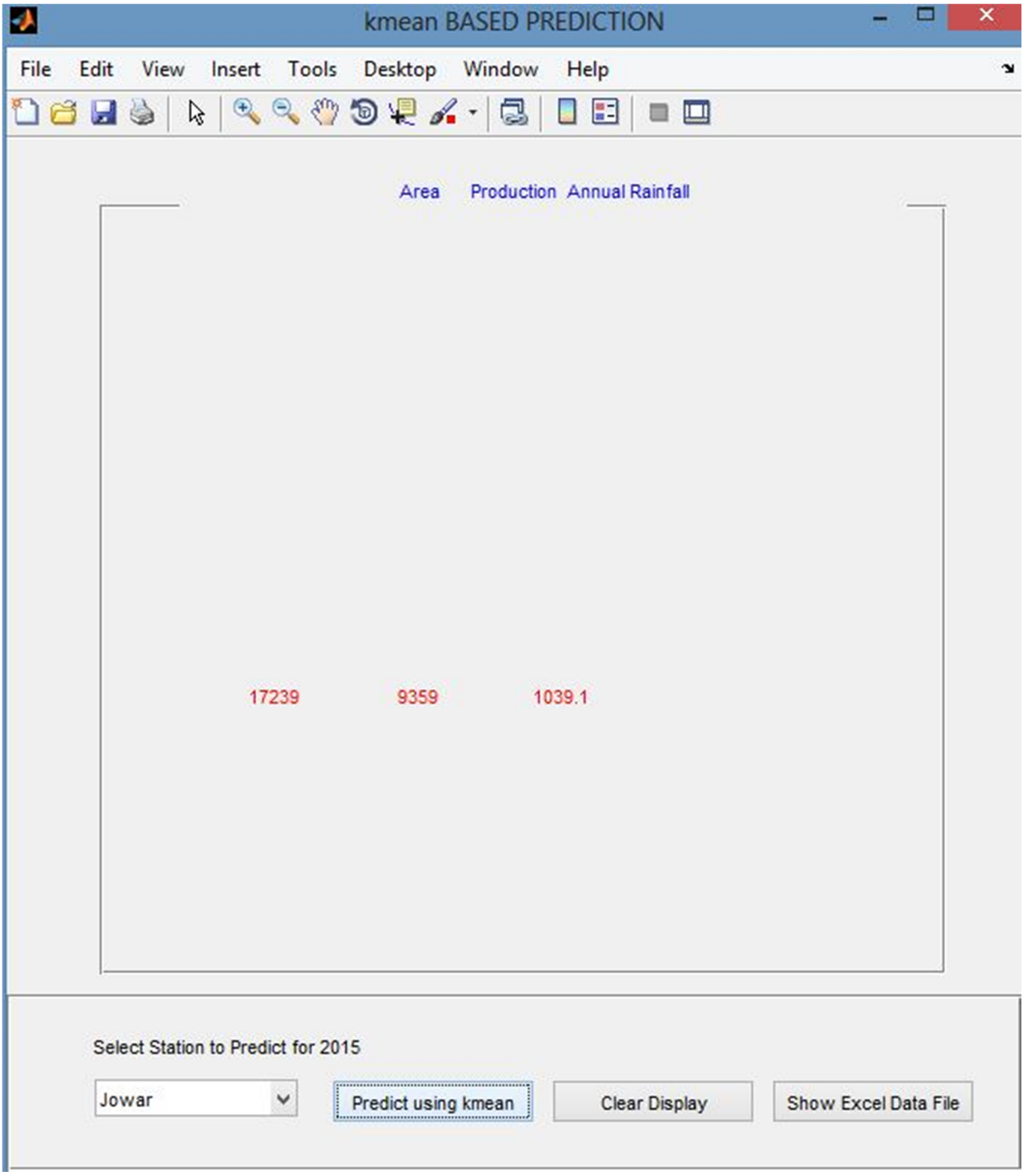

Fig 7: Output value of prediction of rainfall of entire year

When K=1 then Area is 17239 and production is 9359 and total annual rainfall will be 1039.1mm. This process works on the basis of average from data, prediction is done by last k year value, and average among the area, production, and annual rainfall, this can be find by applying formula [11].

$$\text{Prediction} = \frac{\text{Last K year Area, Production, and Annual rainfall}}{K}$$

(Where K is the number of year)

Example shown below to find the average based value using basic k-mean

(b)_Using Fuzzy inference system

Implementing into fuzzy can be only done in matalb by using Mamdani or sugeno model, Mamdani is the basic and easy so for this paper Mamdani model is selected. Open FIS (Fuzzy Inference system) by fuzzy command in matlab. Create the member function as much required and set the range of all member function. Fuzzy models can be said to represent a prudent and user-oriented sifting of data, qualitative observations and calibration of commonsense rules in an attempt to establish meaningful and useful relationships between system variables [12]

Steps to open fuzzy inference system

(a) Open matlab in computer/laptop
(b) Type fuzzy in command window
(c) FIS editor will appear on the screen, create FIS variables as per requirements
(d) Choose multiple of membership function required in the FIS variable.
(e) Set the range of membership function and types of it.

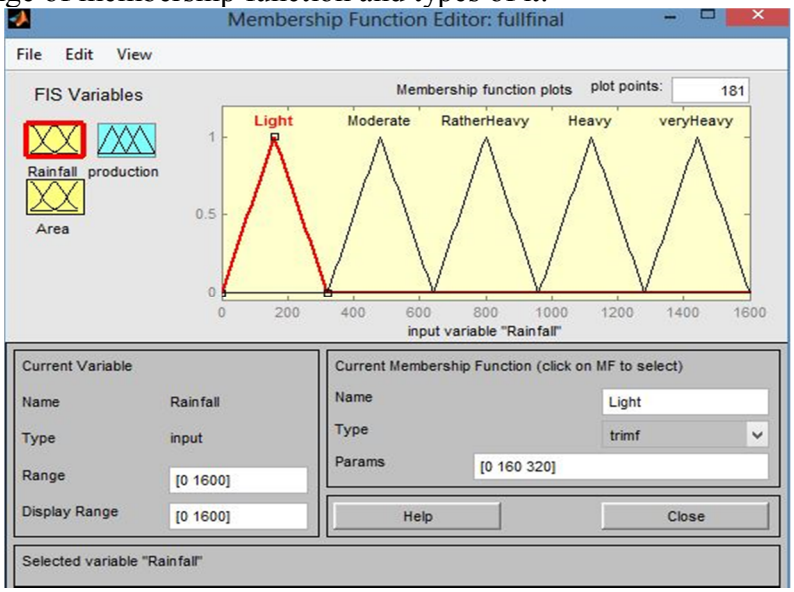

Fig 8: Membership function

overall output of this research depend upon the surface view of the fuzzy set and its membership function generated rule according to the requirement and condition, there can be multiple rules can be created in fuzzy system according to membership. Even there can be couple of FIS variable i.e. multiple input and multiple outputs. Other membership function can be added as shown in table

S. no	Variable Name	Terms Name	Range
1	Rainfall	Light rain	0 320
		Moderate rain	321 640
		Rather heavy	641 960
		Heavy	961 1281
		Very heavy	1281 1600
2	Area	Very less	0 4800
		Less	4801 9600
		Average	9601 14400
		Good	14401 19200
		Very good	19201 24000

V. Rule & Surface View

Here is how rules is created in rule editor. Below there are some examples showing how to create rule on the basis of variable editor and how to relate among them, here variables are rainfall and crop sowing area, and relation between them. The rules are as follows:-

1. If (Rainfall is Light) and (Area is VeryLess) then (production is VeryLow) (1)
2. If (Rainfall is Moderate) and (Area is VeryLess) then (production is Low) (1)
3. If (Rainfall is Moderate) and (Area is Less) then (production is Low) (1)
4. If (Rainfall is RatherHeavy) and (Area is Average) then (production is Average) (1)
5. If (Rainfall is Heavy) and (Area is Good) then (production is Good) (1)
6. If (Rainfall is Light) and (Area is Good) then (production is Average) (1)
7. If (Rainfall is Light) and (Area is Less) then (production is LessThanAverage) (1)
8. If (Rainfall is veryHeavy) and (Area is VeryGood) then (production is Average) (1)
9. If (Rainfall is Heavy) and (Area is VeryGood) then (production is VeryGood) (1)
10. If (Rainfall is RatherHeavy) and (Area is Average) then (production is LessThanAverage) (1)

11. If (Rainfall is veryHeavy) and (Area is VeryLess) then (production is LessThanAverage) (1)
12. If (Rainfall is Heavy) and (Area is Less) then (production is Low) (1)
13. If (Rainfall is Light) and (Area is VeryGood) then (production is VeryLow) (1)
14. If (Rainfall is veryHeavy) and (Area is Average) then (production is Low) (1)
15. If (Rainfall is veryHeavy) and (Area is Good) then (production is Average) (1)
16. If (Rainfall is RatherHeavy) and (Area is VeryGood) then (production is Average) (1)
17. If (Rainfall is Light) and (Area is VeryLess) then (production is VeryLow) (1)
18. If (Rainfall is Light) and (Area is Average) then (production is LessThanAverage) (1)
19. If (Rainfall is RatherHeavy) and (Area is Average) then (production is Average) (1)
20. If (Rainfall is Heavy) and (Area is Less) then (production is LessThanAverage) (1)

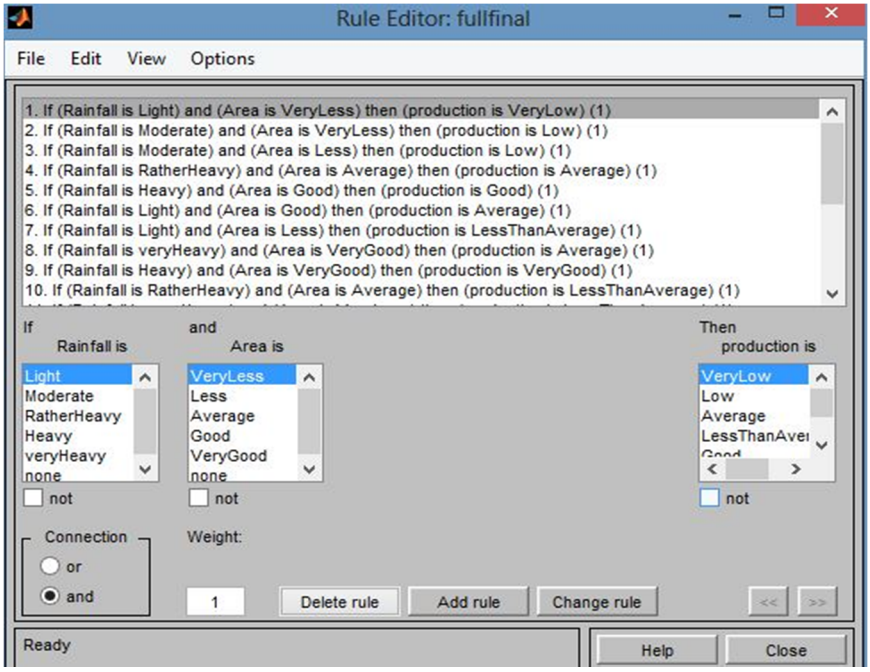

Fig 9: Rules created in Fuzzy Inference system

To view Rules & surface view of the output value follow the following steps:-

(i) Open Membership function editor

(ii) After MF editor appears, click on view menu to open rule viewer which will appear as shown in figure below

(iii) To view surface view click on view menu on rule viewer

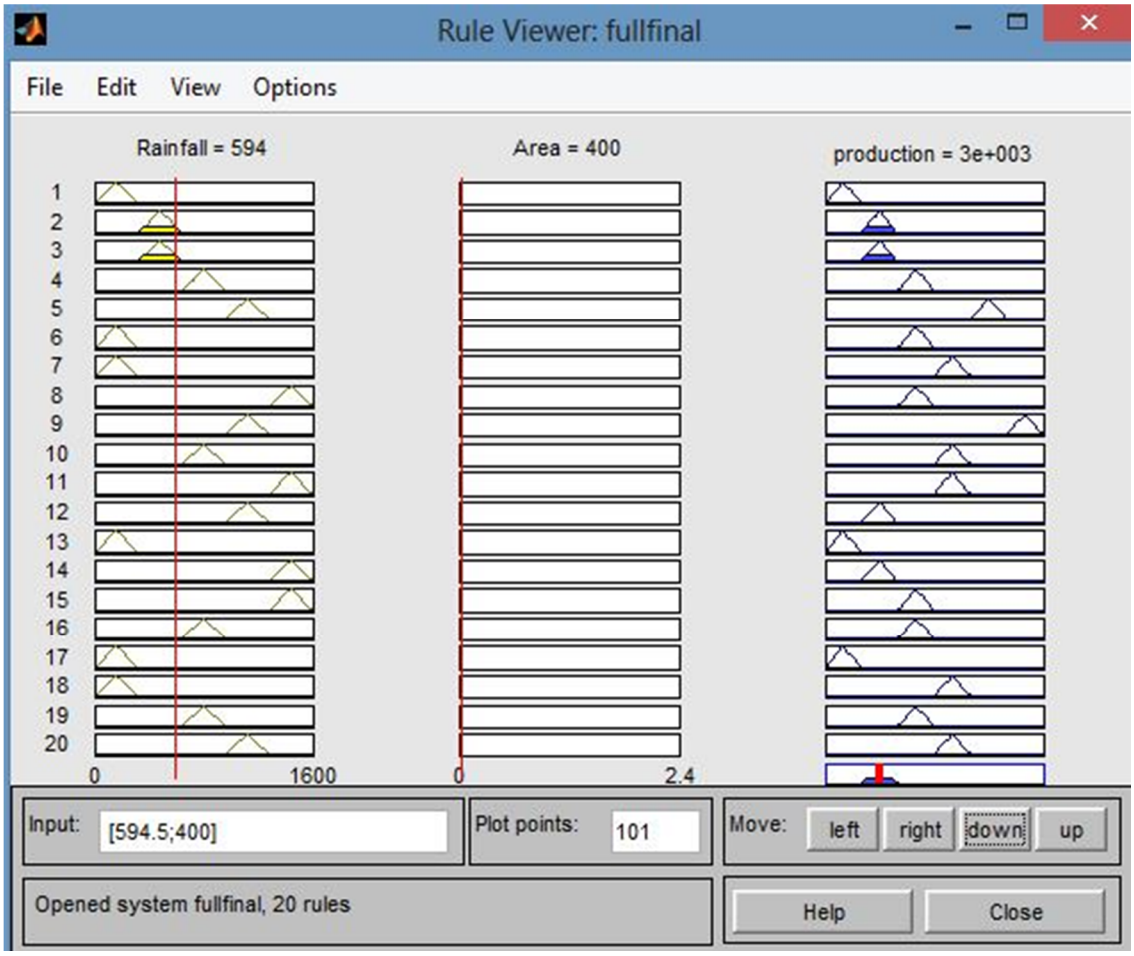

Fig 10: Rule Viewer

RESULT

Analysis for K-Mean

S. no	Year	Area	Rainfall	Production	Actual data
1	2015	16791.2	1015.06	8791.2	NIL
2	2014	16208.40	970.74	8457.40	9359
3	2013	14655	974.90	8904	6743
4	2012	15212.20	896.10	9691	8500
5	2011	15067.60	1036.90	8942.20	11600
6	2010	14609.80	990.70	9025	7754
7	2009	14325.20	1014.60	9147.80	7690
8	2008	15605.20	965.2	9141.80	8976

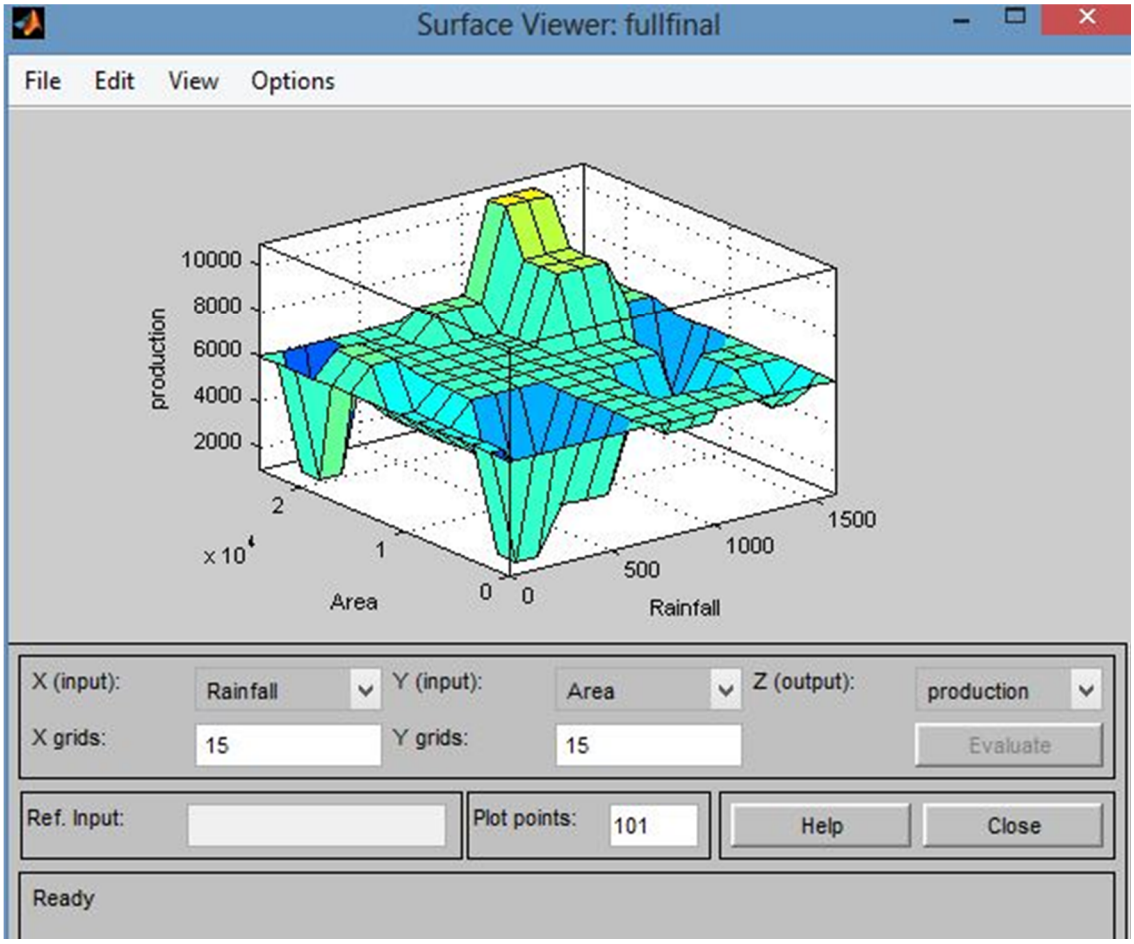

Fig 11: Surface view

VI. Conclusion

This research will help the farmers to know how much production will be done in next coming season and how much amount of rainfall will occur so that farmers can get awareness and they can manage themselves from their heavy loss. The tool used here can be used to predict crop production of any place simply uploading the data according to users.

VII. Future Work

With the improvement of computer technologies, especially those without any premises or humans subjective, fuzzy logic can be applied in many areas. In this paper some fuzzy logic were adopted in order to estimate crop production with existing data and their use in K-means & fuzzy logic. Still there are some technique have not yet applied to agriculture problem, such as Actual weather condition for exact date to know farmers to harvest and yield or commencement of seeds

and many more technologies to be employed for discovering important information from agricultural-related like soil identification, pest control and etc.

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