Volume: 4 Issue: 7 Pages: 149-155

A Fuzzy Matrix Model for Problems Faced by Soybean Cultivators

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Article Info.
E-ISSN: 2583-6528
Impact Factor (SJIF): 6.876
Peer Reviewed Journal
Available online:
www.alladvancejournal.com

Received: 27/June/2025
Accepted: 26/July/2025

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Abstract

Context: Soyabean is currently one of the main largest cultivated crops in the whole Maharashtra region. The production of soyabean and profit after sales are affected by a number of different factors. It is very essential to study the problems faced by soyabean cultivators, since large numbers of investors are involving themselves in this field. In this paper, we are making an effort to pinpoint the many issues that soy farmers face and to establish the different groups of soyabean cultiva- tors based on the area's most negatively impacted by these issues. The present study highlights the problems of soyabean cultivators by Fuzzy Matrix Model in Mathematics.

Objective: To highlight the Impact of Fuzzy Matrix Model on Soy- bean farmers.

Methods: Survey and Fuzzy Matrix Model.

Results and Conclusions: The results from graph shows the group of respondents (based on cultivated area in acres) most nega- tively impacted.

The graph shows that those who grow soybeans on four to eight acres are the ones most impacted by these problems.

Significance: The Fuzzy Matrix Model is very useful for making decisions related to the problems faced by not only soybean cultivators but it can also be used while making decisions in other fields.

Keywords: Crops, Soyabean, RTD Matrix, ATD Matrix, CETD Matrix, Fuzzy Matrix.

1. Introduction

Nowdays Soyabean is the most popular crop among the farmers in Maharashtra since it need very less effort for production and currently soyabean oil giving very tough competation to other oils available in the market. Around 1100 BC, Chinese farmers domesticated the first soybeans, which came from South-east Asia. Soybeans were cultivated in the land of rising sun and some other nations. In 1765, a newcomer in British province of Georgia put Chinese soybean seed in the ground. Before the arrival of soybean seeds, soy sauce was well-liked in continental Europe and in American holdings of Great Britain. Soy nuts were not made available to farmers in Il and in corn belt states until 1851. Soybeans gained popularity in the 1870s as farmers started growing them for their pets feed. The hot, muggy summers that are typical of North Carolina were ideal for the plants. The American Department of Husbandry was testing soybeans as well as urging agriculturist to cultivate them for animal's food by the turn of century. George Washington Carver, an American druggist, found that soy seed are rich of oil and protein. Additionally, he recognized the superiority of soy seeds in keeping high-quality soil. For a three-year strat-egy, Mr. Carver urged cotton harvestors to "rotate" crops for two seasons so that peanuts, soybeans, sweet potatoes, or other plants would replenish the soil with minerals as well as nitrogen. In the third year, farmers would sow cotton. Lot of farmers were surprised and found that this change gives a much better cotton crop than they had seen earlier. Only 20 established soybean varieties were being employed by agriculturist at this era. Morse UN-derstand that the soybean crop had a lot of untapped potential. He collected soybeans in China for two years in 1929. He returned with over 10,000 types of soybeans to be studied by agricultural scientists. Morse recognized that farmers will be able to produce more be- cause to new and improved kinds. One day, Henry Ford brought a bag of soybeans to his research lab. "You guys are supposed to be smart," he said to the scientists after throw-ing them on the ground. With them, you should be able to accomplish something. Ford's lab scientists eventually created a soy-based plastic that was robust enough for the

ignition coil casings, light switch assemblies, window frames, accelerator pedals, horn buttons, and gearshift knobs. Additionally, they made an automobile's exterior out of "soybean plastic." Ford was using one bushel of soybeans for each automobile he produced by 1935. In America, soybean cultivation didn't truly take off until the 1940s.The internal revolution and World War II put a stop to the production of soybeans in China, which was central supply during that time. Market for soybeans rose significantly when the America entered in war due to the big rise in demands of plastics, lubricants, oils, and many other goods. As the diets of individ-uals enhanced, so the demand for meat consumption increased. Therefore meals containing Soybean once was the most popular and reasonably priced source of protein for livestock producers. 10 of millions of tons of soybean meal were fed yearly to chickens, cattle, turkeys, and hogs. The evolution of the soybean to oppose insecticides in 1990s was the major sci-entific research in agriculture. This made it possible for farmers to manage weeds without destroying soybean plants. Because they don't need steel tools to cultivate the crops, less fuel used, there would be less soil erosion and a higher yield per plant. The mechanism has made it possible for American farmers to fulfill the world's demand for food is at an all- time high. As the tactics used by the agricultural industry have a significant impact on its success. It is clear that during the cultivation period, the farmers have been dealing with a number of issues. The key issues, according to author Bung [4], were production, funding, and agricultural field maintenance. Generally speaking, soybean farmers are less wealthy and well-off, and they deal with a number of issues like underemployment, a lack of funding, and the participation of middlemen.

The study area namely Chh.Sambhajinagar and Nanded Districts is studied for this research of soybean Cultivation. Where chh.sambhajinagar is an urban and Nanded is rural district. Therefore, there is very much essential to study the problems of production and sales of Soybean, since large numbers of farmers are involving themselves in this field. Based on the findings, anyone may quickly learn about the history of soybean farmers and make a reasonable choice that will benefit them. Among other things, the farmers' biggest issues is financial indebtedness to others, and no guarantee in soybean yield due to imbalance of seasoning issues. However, frequent climate variations in the farming area are the primary cause of decreased soybean productivity. Fuzzy logic was firstly enlighten by Lotfi Zadeh [4], professor at University of California, Berkeley, in middle of the 1960s.Zadeh created fuzzy logic as a method of data processing; he established the concept of partial set membership in place of needing a data element to be either a member or non-member of a set. The membership function is made to lie across a range of actual values from 0.0 to 1.0 is the foundation of fuzzy set theory. (0.0,1.0) is a characteristic of the fuzzy set.

2. Material and Methods

2.1 Simple Fuzzy Matrix Model

Matrix containing components with values falling within fuzzy interval is called a fuzzy ma-trix. Fuzzy intervals include the unit interval [0, 1] and the interval [-1, 1]. The matrix representation is derived from the raw data. Values related to a live network are entries that correspond to the intersection of rows and columns. A raw time-dependent data matrix created from the raw data.

The raw data matrix should be divided into each element to create the Average Time De- pendent Data (ATD) Matrix (a_{ij}). This matrix displays data that is completely consistent, In the third step, the algorithm calculates the mean or average and the standard devia-tion (SD) of each column in the ATD matrix. Where $Mean = \frac{\sum X}{n}$ and standard Deviation

$$SD = \sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$$

Thus, the Referred Time Dependent Data Matrix is created from the ATD matrix. Be-cause its entries are 1, 0, and -1, this matrix is also sometimes referred to as the fuzzy matrix. By changing the parameter, these matrices can be combined to create the Com- bined Effective Time Dependent Data (CETD) matrix. The CETD matrix's row sum is determined, and conclusions are drawn from the row sums. All of these are represented by graphs, which are essential for presenting the data in the most straightforward way possible for everyone to understand.

2.2. Data Preparation

The researcher examined critically the problems faced by soybean cultivators to study these problems the data has been gathered from a total of 100 respondents in Chh.Sambhajinagar and Nanded District by meeting various persons and conducting interviews using the Google form and identified the study consisted from Small, Marginal and Large growers. The grow- ers having upto 2.5 acres were grouped as Small Size, the growers having up to 5 acres were grouped as Marginal Size and the growers having more than 5 acres were grouped as Large Size.T he issues faced by them are as follows:

P1-High Market Charges.
P2 - Price Instability.
P3-Role of Middle Man
P4-Lack of Market infrastructure.
P5 - Wastage while Cutting.
P6-Insufficient Storage Facility.
P7-Malpractice Selling Method.
P8-Inadequate Market Finance.
P9 - Delay in Collection Dues.
P10-Interest charged by Unorganized Sector.
P11-Labour problem.
P12-Lack of processing plant.
P13-Lack of Transport Facility.
P14-Lack of Education.
P15-Preferring the Distributers.
P16-Lack of Market Information.

The Respondents were divided into Ten Groups According to the Area in Acre as follows.

Table 1: Responce table

Area in Acre	No. of respondent
0-1	10
1-2	10
2-3	10
3-4	10
4-5	10
5-6	10
6-7	10
7-8	10
8-9	10
9-10	10

A 10 x 16 starting raw data matrix known as the Time Dependent Matrix (TD Matrix) was created by taking the ten categories mentioned above as rows and the number of respondents who suffered as a result of each of the sixteen issues as columns.

Table 2: Time Dependent Matrix

Area	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
0-1	9	8	6	7	7	8	4	5	6	3	5	6	2	5	3	6
1-2	10	8	7	9	5	4	7	2	5	3	6	6	5	8	9	4
2-3	8	8	9	10	6	4	9	5	3	6	6	6	7	8	9	7
3-4	8	8	7	9	10	5	6	4	7	2	3	8	5	4	8	9
4-5	10	8	9	6	7	8	5	6	8	4	8	7	7	7	8	9
5-6	7	7	8	9	6	7	6	5	8	4	9	10	5	7	6	6
6-7	9	9	8	7	6	7	8	8	9	10	8	4	6	8	9	9
7-8	8	6	8	9	9	7	8	4	6	5	9	8	7	7	8	8
8-9	8	7	7	8	9	7	8	5	9	10	7	8	4	2	8	9
9-10	9	5	4	6	6	9	9	8	7	6	4	10	8	9	8	9

Each element in the original raw data matrix has been multiplied by $\frac{1}{40}$ (width of corresponding class interval in guntha. 1 *guntha* = 1089*sq.feet*) to create the Average Time Dependent Matrix (ATD Matrix).

Table 3: Average Time Dependent Matrix

Area	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
0-1	0.225	0.200	0.150	0.175	0.175	0.200	0.100	0.125	0.150	0.075	0.125	0.150	0.050	0.125	0.075	0.150
1-2	0.250	0.200	0.175	0.225	0.125	0.100	0.175	0.050	0.125	0.075	0.150	0.150	0.125	0.200	0.225	0.100
2-3	0.200	0.200	0.225	0.250	0.150	0.100	0.225	0.125	0.075	0.150	0.150	0.150	0.175	0.200	0.225	0.175
3-4	0.200	0.200	0.175	0.225	0.250	0.125	0.150	0.100	0.175	0.050	0.075	0.200	0.125	0.100	0.200	0.225
4-5	0.250	0.200	0.225	0.150	0.175	0.200	0.125	0.150	0.200	0.100	0.200	0.175	0.175	0.175	0.200	0.225
5-6	0.175	0.175	0.200	0.225	0.150	0.175	0.150	0.125	0.200	0.100	0.225	0.250	0.125	0.175	0.150	0.150
6-7	0.225	0.225	0.200	0.175	0.150	0.175	0.200	0.200	0.225	0.250	0.200	0.100	0.150	0.200	0.225	0.225
7-8	0.200	0.150	0.200	0.225	0.225	0.175	0.200	0.100	0.150	0.125	0.225	0.200	0.175	0.175	0.200	0.200
8-9	0.200	0.175	0.175	0.200	0.225	0.175	0.200	0.125	0.225	0.250	0.175	0.200	0.100	0.050	0.200	0.225
9-10	0.225	0.125	0.100	0.150	0.150	0.225	0.225	0.200	0.175	0.150	0.100	0.250	0.200	0.225	0.200	0.225
μ_j	0.215	0.165	0.183	0.200	0.176	0.165	0.175	0.130	0.170	0.133	0.166	0.183	0.140	0.163	0.190	0.190

where the standard deviation of each column is (σ_j) and the average is (μ_j). The Refined Time Dependent Data matrix (RTD matrix) is created using the following formula by varing a parameter from the interval [0, 1]

" *if* $a_{ij} \leq (\mu_j - \alpha * \sigma_j)$ *then* $e_{ij} = -1$,
else if $a_{ij} \in (\mu_j - \alpha * \sigma_j, \mu_j + \alpha * \sigma_j)$ *then* $e_{ij} = 0$,
else if a_{ij} $(\mu_j + \alpha\, \sigma_j)$ *then* $e_{ij} = 1$, [5]
where a_{ij}*'s are the entries of ATD Matrix.* "

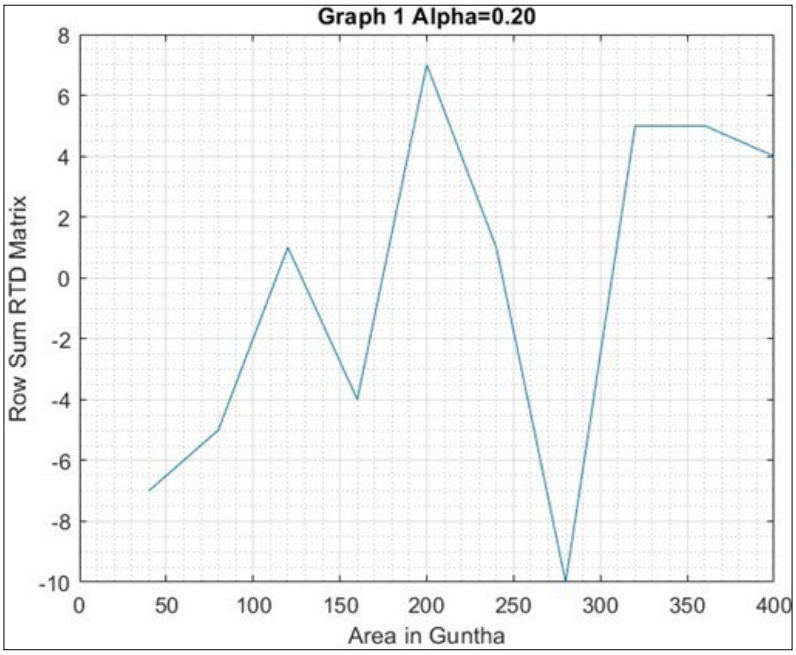
You can get any number of Refined Time Dependent Data Matrices by chang-ing the parameter $e_{ij} \in [0, 1]$.

2.3. Results

The following four matrices were obtained. The Graph and Row Sum of the RTD Matrix for $\alpha = 0.20, 0.40, 0.60, 0.80$. Is as follows:

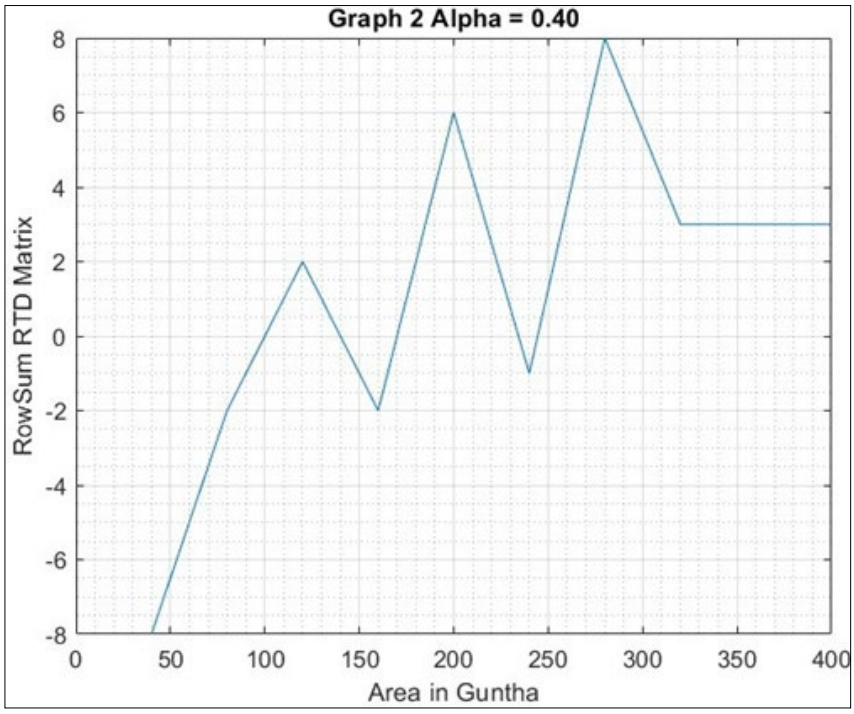
1. RTD Matrix α = 0.20

$$\begin{array}{cc} \text{RTD Matrix} & \text{Row Sum} \\ \begin{pmatrix} 1 & 1 & -1 & -1 & 1 & 1 & -1 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 \\ 1 & 1 & -1 & 1 & -1 & -1 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & 1 & 1 & -1 \\ -1 & 1 & 1 & 1 & -1 & -1 & 1 & 0 & -1 & 1 & -1 & -1 & 1 & 1 & 1 & -1 \\ -1 & 1 & -1 & 1 & 1 & -1 & -1 & -1 & 0 & -1 & -1 & 1 & -1 & -1 & 0 & 1 \\ 1 & 1 & 1 & -1 & 1 & 1 & -1 & 1 & 1 & -1 & 1 & -1 & 1 & 1 & 0 & 1 \\ -1 & 1 & 1 & 1 & -1 & 1 & -1 & 0 & 1 & -1 & 1 & 1 & -1 & 1 & -1 & -1 \\ 1 & 1 & 1 & -1 & -1 & 1 & 1 & 1 & 1 & 1 & 1 & -1 & 1 & 1 & 1 & 1 \\ -1 & -1 & 1 & 1 & 1 & 1 & 1 & -1 & -1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ -1 & 1 & -1 & 1 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 1 & -1 & -1 & 0 & 1 \\ 1 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & 0 & 1 & -1 & 1 & 1 & 1 & 0 & 1 \end{pmatrix} & \begin{matrix} = -7 \\ = -5 \\ = 1 \\ = -4 \\ = 7 \\ = 1 \\ = 10 \\ = 5 \\ = 5 \\ = 4 \end{matrix} \end{array}$$



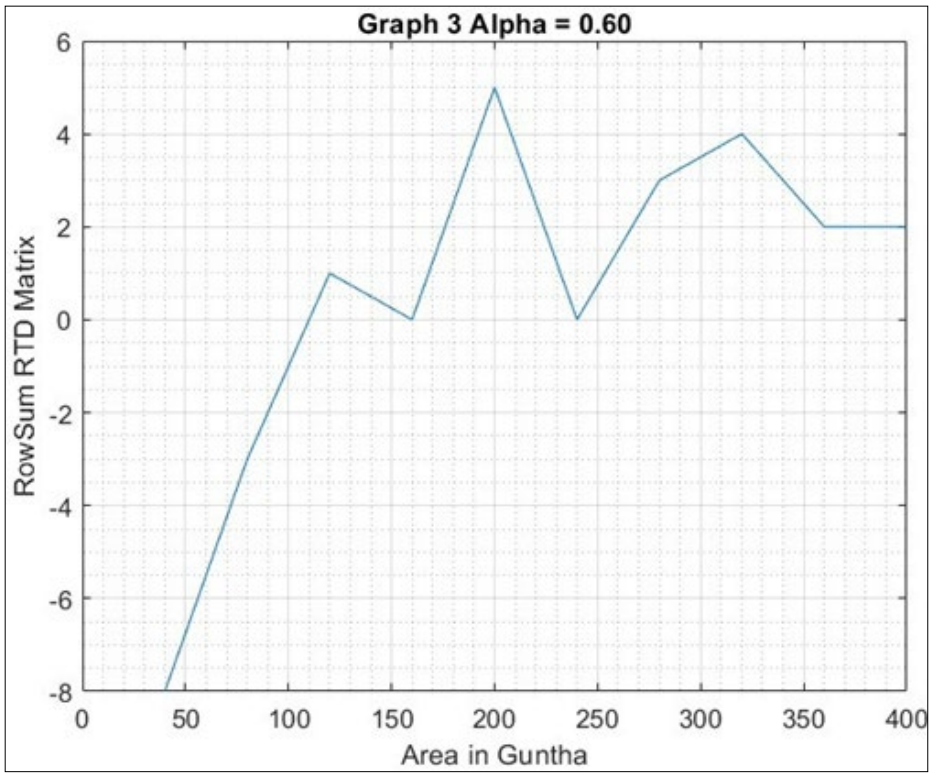
2. RTD Matrix α = 0.40

$$\begin{array}{cc} \text{RTD Matrix} & \text{Row Sum} \\ \begin{pmatrix} 1 & 1 & -1 & -1 & 0 & 1 & -1 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 \\ 1 & 1 & 0 & 1 & -1 & -1 & 0 & -1 & -1 & -1 & 0 & -1 & 0 & 1 & 1 & -1 \\ -1 & 1 & 1 & 1 & -1 & -1 & 1 & 0 & -1 & 0 & 0 & -1 & 1 & 1 & 1 & 0 \\ -1 & 1 & 0 & 1 & 1 & -1 & -1 & -1 & 0 & -1 & -1 & 1 & 0 & -1 & 0 & 1 \\ 1 & 1 & 1 & -1 & 0 & 1 & -1 & 1 & 1 & -1 & 1 & 0 & 1 & 0 & 0 & 1 \\ -1 & 0 & 1 & 1 & -1 & 0 & -1 & 0 & 1 & -1 & 1 & 1 & 0 & 0 & -1 & -1 \\ 1 & 1 & 1 & -1 & -1 & 0 & 1 & 1 & 1 & 1 & 1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & 1 & 1 & 1 & 0 & 1 & -1 & -1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 0 & 1 & -1 & -1 & 0 & 1 \\ 1 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & 0 & 0 & -1 & 1 & 1 & 1 & 0 & 1 \end{pmatrix} & \begin{matrix} = -8 \\ = -2 \\ = 2 \\ = -2 \\ = 6 \\ = -1 \\ = 8 \\ = 3 \\ = 3 \\ = 3 \end{matrix} \end{array}$$



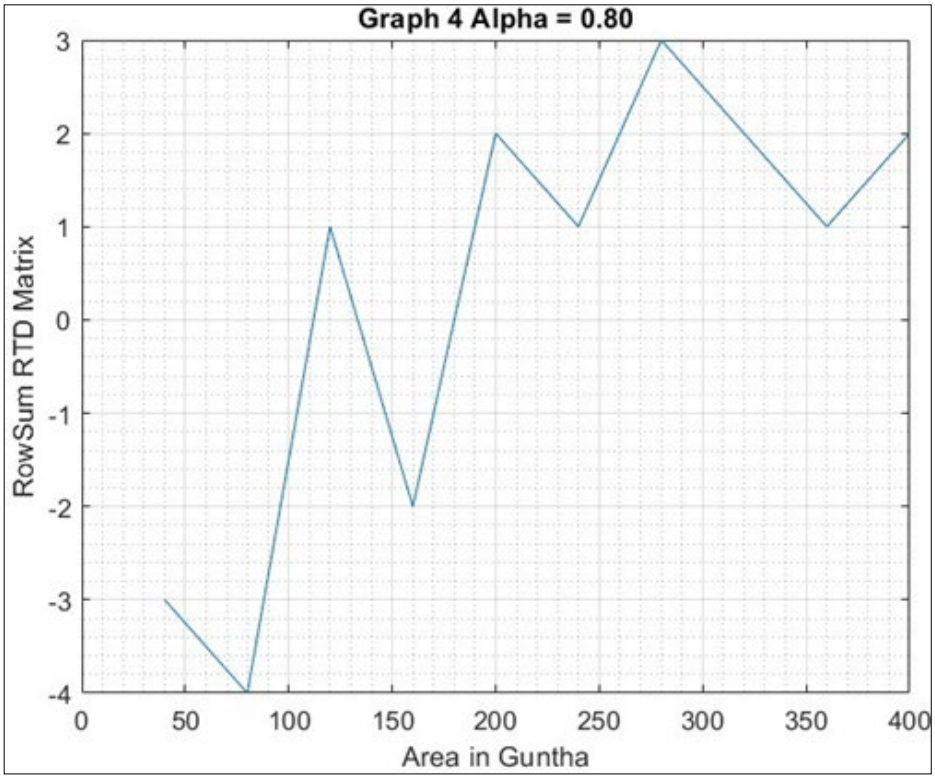
3. RTD Matrix α = 0.60

$$\begin{array}{c} \text{RTD Matrix} \\ \left(\begin{array}{cccccccccccccccc} 0 & 1 & -1 & -1 & 0 & 1 & -1 & 0 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 \\ 1 & 1 & 0 & 1 & -1 & -1 & 0 & -1 & -1 & -1 & 0 & -1 & 0 & 1 & 0 & -1 \\ -1 & 1 & 1 & 1 & -1 & -1 & 1 & 0 & -1 & 0 & 0 & -1 & 1 & 1 & 0 & 0 \\ -1 & 1 & 0 & 1 & 1 & -1 & 0 & 0 & 0 & -1 & -1 & 1 & 0 & -1 & 0 & 1 \\ 1 & 1 & 1 & -1 & 0 & 1 & -1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ -1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & -1 & -1 \\ 0 & 1 & 0 & -1 & -1 & 0 & 0 & 1 & 1 & 1 & 0 & -1 & 0 & 1 & 0 & 1 \\ -1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & -1 & -1 & 0 & 1 \\ 0 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & 0 & 0 & -1 & 1 & 1 & 1 & 0 & 1 \end{array}\right) \end{array} \begin{array}{c} \text{Row Sum} \\ \begin{array}{l} = -8 \\ = -3 \\ = 1 \\ = 0 \\ = 5 \\ = 0 \\ = 3 \\ = 4 \\ = 2 \\ = 2 \end{array} \end{array}$$



4. RTD Matrix α = 0.80

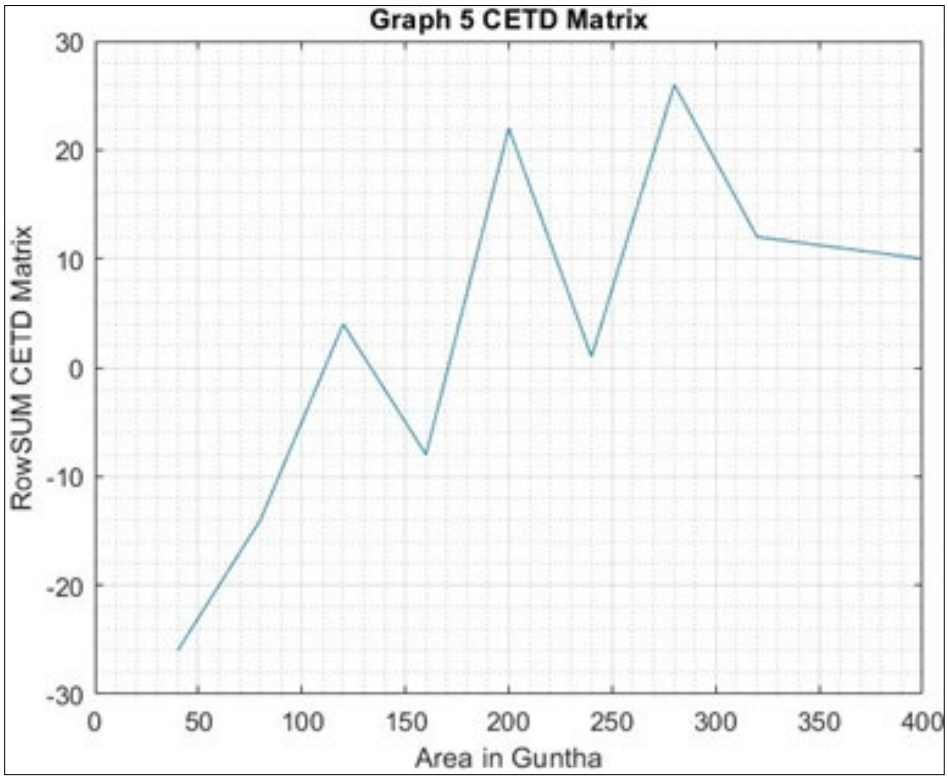
$$\begin{array}{c} \text{RTD Matrix} \\ \begin{pmatrix} 0 & 1 & -1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 & -1 & -1 & 0 & -1 & 0 \\ 1 & 1 & 0 & 0 & -1 & -1 & 0 & -1 & -1 & 0 & 0 & -1 & 0 & 0 & 0 & -1 \\ 0 & 1 & 1 & 1 & 0 & -1 & 1 & 0 & -1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & -1 & -1 & 0 & 0 & -1 & 0 & 0 \\ 1 & 1 & 1 & -1 & 0 & 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & -1 & -1 & 0 & 0 \\ 0 & -1 & -1 & -1 & 0 & 1 & 1 & 1 & 0 & 0 & -1 & 1 & 1 & 1 & 0 & 0 \end{pmatrix} \end{array} \quad \begin{array}{c} \text{Row Sum} \\ = -3 \\ = -4 \\ = 1 \\ = -2 \\ = 2 \\ = 1 \\ = 3 \\ = 2 \\ = 1 \\ = 2 \end{array}$$



Combined Effect Time Dependent Data Matrix (CETD Matrix), that provides the collective result of all these elements, is created by merging these four matrices as follows.

5. CETD Matrix

$$\begin{array}{c} \text{CETD Matrix} \\ \begin{pmatrix} 2 & 4 & -4 & -3 & 1 & 4 & -4 & 0 & -2 & -3 & -3 & -4 & -4 & -3 & -4 & -3 \\ 4 & 4 & -1 & 3 & -4 & -4 & 0 & -4 & -4 & -3 & -1 & -4 & -1 & 3 & 2 & -4 \\ -3 & 4 & 4 & 4 & -3 & -4 & 4 & 0 & -4 & 0 & -1 & -4 & 3 & 3 & 2 & -1 \\ -3 & 4 & -1 & 3 & 4 & -4 & -2 & -2 & 0 & -4 & -4 & 3 & -1 & -4 & 0 & 3 \\ 4 & 4 & 4 & -4 & 1 & 4 & -4 & 2 & 3 & -2 & 2 & 1 & 3 & 1 & 0 & 3 \\ -4 & 1 & 2 & 3 & -3 & 1 & -2 & 0 & 3 & -2 & 4 & 4 & -1 & 1 & -3 & -3 \\ 2 & 4 & 2 & -3 & -3 & 1 & 2 & 4 & 4 & 4 & 2 & -2 & 1 & 3 & 2 & 3 \\ -3 & -2 & 2 & 1 & 4 & 1 & 2 & -2 & -2 & 0 & 4 & 3 & 3 & 1 & 0 & 0 \\ -3 & 1 & -1 & 1 & 4 & 1 & 2 & 0 & 4 & 4 & 0 & 3 & -4 & -4 & 0 & 3 \\ 2 & -4 & -4 & -4 & -3 & 4 & 4 & 4 & 0 & 0 & -4 & 4 & 4 & 4 & 0 & 3 \end{pmatrix} \end{array} \quad \begin{array}{c} \text{Row Sum} \\ = -26 \\ = -14 \\ = 4 \\ = -8 \\ = 22 \\ = 1 \\ = 26 \\ = 12 \\ = 11 \\ = 10 \end{array}$$



The displayed graph shows the group of respondents (based on cultivated area in acres) most negatively impacted.

Conclusion

Respondents were asked for details such total holdings, area planted to soybeans, and the physical and financial productivity of soybean growers. The gathered data was tallied, pro- cessed, examined, and interpreted. The graph shows that those who grow soybeans on four to eight acres are the ones most impacted by these problems. The suggestions are put for- warded as under-

1. Contract farming arrangements can be provide to farmers with production support, such as field cultivation, land preparation and harvesting.
2. Plants for manufacturing and processing should be set up so that farmers may easily reach them.
3. The storage facility should be provided to increased soybean productivity.
4. Government should provide agricultural loans to farmers on easy-to-understand terms.

Acknowledgement

The BARTI-Pune/BANRF Fellowship-2022/2024-25/5640 financial support is greatly ap- preciated by the researcher.

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