

Fuzzy Matrix Model for Analyzing Problems in Agriculture Sector

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Abstract - India is the largest producer of mango in the world and Alphonso mangoes is main product in the Konkan region, Maharashtra. The production of mangoes and profit after sales affected by number of different factors. There is very much essential to study the marketing problems faced by Alphonso mango cultivators, since large numbers of investors are involving themselves in this field. In this article, the author attempted to identify the various problems encountered by the mango cultivators and to establish the different group of mango cultivators based on number of trees worst affected by such problems. The present study highlights the marketing problems of mango cultivators in Sindhudurg and Ratnagiri Districts (Konkan Region) by Mathematical Fuzzy Matrix Model.

Key Words: Fuzzy Matrix, ATD Matrix, RTD Matrix, CETD Matrix, Alphonso Mangos

1. INTRODUCTION

The Indian 'Alphonso' (Hapus-Mango) is the most popular fruit in the world - known as the 'King of all fruits'. The Alphonso mango [5] is a foreign fruit that came to India through Goa along with Alfonso De Albuquerque in 1600's. From Goa, the Alphonso mango travelled to different places like Sindhudurg, Ratnagiri, other Konkan region and southern side of India as well. As we know, the success of agriculture is highly influenced by the strategies adopted by the agriculture. It is quite obvious that the farmers have been facing a variety of problems during the time of cultivation.

The author Bung[4] pointed the major problem included production, finance, and maintenance of field of agriculture. In general, the mango growers are economically and socially weaker people and faced by various problems such as under employment, lack of financial resources and involvement of intermediaries. Since the mango cultivation is a seasonal one, it is obvious that they have been unemployed for about six months throughout a year.

The study area namely Sindhudurg and Ratnagiri Districts is very famous for Mango Cultivation. Particularly the blocks around the Sindhudurg and Ratnagiri Districts are contributing the maximum quantity of mango to the Indian Market. Therefore, there is very much essential to study the problems of production and sales of mangos, since large numbers of farmers are involving themselves in this field. Based on the findings, anyone can easily understand the background of the mango growers and also take an appropriate decision for the benefit of growers. The most serious problems faced by the cultivators among other things are financial indebtedness to others, and no guarantee in mango yield due to imbalance of seasoning issues. But the main reason for lower production of mango is frequent climatically changes in the area of cultivation.

Lotfi Zadeh[9] a professor at the University of California at Berkeley, first presented fuzzy logic in the mid-1960's. Zadeh developed fuzzy logic as a way of processing data, instead of requiring a data element to be either a member or non-member of a set, he introduced the idea of partial set membership. The fuzzy set theory is based on making the membership function lie over a range of real numbers from 0.0 to 1.0. The fuzzy set is characterized by (0.0, 0, 1.0).

2. MATERIALS AND METHODS

2.1 Simple Fuzzy Matrix Model:

A fuzzy matrix is a matrix with element having values in the fuzzy interval. The unit interval [0, 1] and the interval [-1, 1] are called fuzzy intervals. The raw data gives the matrix representation. Entries corresponding to the intersection of rows and columns are values corresponding to a live network. The raw data, as it is transformed into a raw time dependent data matrix.

Using the raw data matrix, convert it into the Average Time Dependent Data (ATD) Matrix (a_{ij}) by dividing each entry of the raw data matrix. This matrix represents a data which is totally uniform,

At the third stage, the average or mean and the standard deviation (SD) of every column in the ATD matrix, are determined by the formula $Mean = \frac{\sum x}{n}$ and $SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$.

The ATD matrix is thus, converted into the Referred Time Dependent Data Matrix. This matrix is also at times termed as the fuzzy matrix as the entries are 1, 0 & -1. One can combine these matrices by varying the parameter $\alpha \in [0,1]$, so that the Combined Effective Time Dependent Data (CETD) matrix is obtained.

The row sum is found out for the CETD matrix and conclusion are derived based on the row sums. All these are represented by graphs and graphs play a vital role in exhibiting the data by the simplest means that can be ever understood by a everyone.

2.2 Data Preparation

The author examined critically the mango marketing problems prevailing in the study area of sample mango cultivators. By meeting different peoples and conducting interviews based on the questionnaires prepared data have been collected from the total of 100 respondents identified in the study consisted from Small, Marginal and Large growers. The growers having up to 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.

The list of marketing problems encountered by them are as follows:

- Y₁ - Price Instability.
- Y₂ - Lack of Market Information
- Y₃ - Inadequate Market Finance
- Y₄ - Lack of Transport Facility
- Y₅ - Competition from Exporters
- Y₆ - Insufficient Storage Facility.
- Y₇ - Malpractice Selling Method
- Y₈ - Preferring the Distributers
- Y₉ - Delay in Collection Dues
- Y₁₀ - Interest charged by Unorganized Sector
- Y₁₁ -Labour problem
- Y₁₂ -Lack of processing plant

Based on their number of trees the respondents were grouped into five categories as detailed below:

Table -1: Plantation Info

| No. of Trees | Number of respondents |
|--------------|-----------------------|
| 1-50 | 10 |
| 51-100 | 10 |
| 101-150 | 10 |
| 151-200 | 10 |
| 201-250 | 10 |
| 251-300 | 10 |
| 301-350 | 10 |
| 351-400 | 10 |
| 401-450 | 10 |
| 451-500 | 10 |

By taking the above ten categories as rows and the number of respondents suffering due to each of the twelve problems as columns, a 10 x 12 initial raw data matrix called Time Dependent Matrix (TD Matrix) was formed.

| No. of Trees | Y ₁ | Y ₂ | Y ₃ | Y ₄ | Y ₅ | Y ₆ | Y ₇ | Y ₈ | Y ₉ | Y ₁₀ | Y ₁₁ | Y ₁₂ |
|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|
| 1-50 | 10 | 7 | 8 | 5 | 4 | 6 | 9 | 3 | 4 | 2 | 8 | 5 |
| 51-100 | 9 | 6 | 7 | 7 | 8 | 7 | 8 | 3 | 3 | 3 | 9 | 4 |
| 101-150 | 10 | 8 | 7 | 6 | 7 | 6 | 9 | 4 | 5 | 4 | 8 | 5 |
| 151-200 | 9 | 7 | 8 | 9 | 7 | 8 | 6 | 5 | 6 | 6 | 9 | 7 |
| 201-250 | 9 | 8 | 7 | 10 | 9 | 8 | 8 | 6 | 7 | 7 | 8 | 8 |
| 251-300 | 8 | 8 | 5 | 9 | 7 | 6 | 8 | 6 | 6 | 6 | 7 | 7 |
| 301-350 | 7 | 5 | 7 | 6 | 8 | 4 | 4 | 6 | 6 | 5 | 8 | 8 |
| 351-400 | 9 | 10 | 5 | 8 | 4 | 6 | 7 | 5 | 5 | 6 | 8 | 9 |
| 401-450 | 9 | 9 | 6 | 7 | 5 | 7 | 6 | 5 | 5 | 6 | 9 | 9 |
| 451-500 | 8 | 8 | 8 | 6 | 6 | 5 | 6 | 6 | 7 | 6 | 10 | 9 |

The initial raw data matrix has been converted into Average Time Dependent Matrix (ATD Matrix) (a_{ij}) by dividing each entry with width of the respective class-interval.

Table -2: ATD Matrix

| No. of Trees | Y ₁ | Y ₂ | Y ₃ | Y ₄ | Y ₅ | Y ₆ | Y ₇ | Y ₈ | Y ₉ | Y ₁₀ | Y ₁₁ | Y ₁₂ |
|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|
| 1-50 | 0.20 | 0.14 | 0.16 | 0.10 | 0.08 | 0.12 | 0.18 | 0.06 | 0.08 | 0.04 | 0.16 | 0.10 |
| 51-100 | 0.18 | 0.12 | 0.14 | 0.14 | 0.16 | 0.14 | 0.16 | 0.06 | 0.06 | 0.06 | 0.18 | 0.08 |
| 101-150 | 0.20 | 0.16 | 0.14 | 0.12 | 0.14 | 0.12 | 0.18 | 0.08 | 0.10 | 0.08 | 0.16 | 0.10 |
| 151-200 | 0.18 | 0.14 | 0.16 | 0.18 | 0.14 | 0.16 | 0.12 | 0.10 | 0.12 | 0.12 | 0.18 | 0.14 |
| 201-250 | 0.18 | 0.16 | 0.14 | 0.20 | 0.18 | 0.16 | 0.16 | 0.12 | 0.14 | 0.14 | 0.16 | 0.16 |
| 251-300 | 0.16 | 0.16 | 0.10 | 0.18 | 0.14 | 0.12 | 0.16 | 0.12 | 0.12 | 0.12 | 0.14 | 0.14 |
| 301-350 | 0.14 | 0.10 | 0.14 | 0.12 | 0.16 | 0.08 | 0.08 | 0.12 | 0.12 | 0.10 | 0.16 | 0.16 |
| 351-400 | 0.18 | 0.20 | 0.10 | 0.16 | 0.08 | 0.12 | 0.14 | 0.10 | 0.10 | 0.12 | 0.16 | 0.18 |
| 401-450 | 0.18 | 0.18 | 0.12 | 0.14 | 0.10 | 0.14 | 0.12 | 0.10 | 0.10 | 0.12 | 0.18 | 0.18 |
| 451-500 | 0.16 | 0.16 | 0.16 | 0.12 | 0.12 | 0.10 | 0.12 | 0.12 | 0.14 | 0.12 | 0.20 | 0.18 |

The average (μ_j) and standard deviation (σ_j) of every column were worked out as follows:

| | | | | | | |
|---------|----------|----------|----------|----------|----------|----------|
| Average | 0.176 | 0.152 | 0.136 | 0.146 | 0.13 | 0.126 |
| S.D. | 0.018379 | 0.028597 | 0.022706 | 0.032728 | 0.034319 | 0.025033 |

| | | | | | | |
|---------|----------|----------|----------|----------|----------|----------|
| Average | 0.142 | 0.098 | 0.108 | 0.102 | 0.168 | 0.142 |
| S.D. | 0.031903 | 0.023944 | 0.025298 | 0.031903 | 0.016865 | 0.037059 |

Using the average μ_j of each j^{th} column and σ_j the S.D of each j^{th} column, a parameter α from the interval [0, 1] is chosen and the Refined Time Dependent Data matrix (RTD matrix) e_{ij} is formed using the formula:

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 $a_{ij} \in (\mu_j + \alpha * \sigma_j)$ then

$$e_{ij} = 1,$$

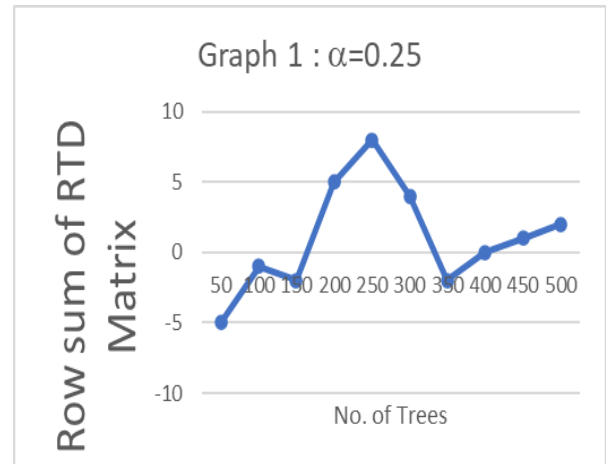
where, a_{ij} 's are the entries of the ATD matrix.

By varying the parameter $e_{ij} \in [0,1]$, any number of Refined Time Dependent Data Matrices can be obtained.

2.3 Results:

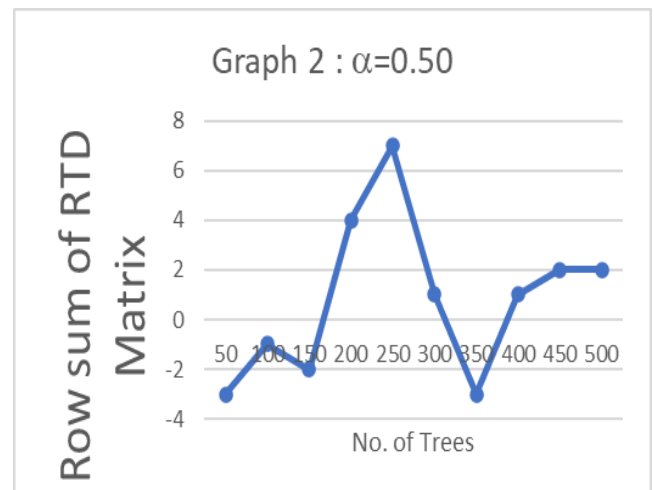
Three of such matrices obtained were as follows:

| | |
|---|--|
| <p>RTD Matrix for $\alpha = 0.25$</p> $\begin{pmatrix} 1 & -1 & 1 & -1 & -1 & 0 & 1 & -1 & -1 & -1 & -1 & -1 \\ 0 & -1 & 0 & 0 & 1 & 1 & 1 & -1 & -1 & -1 & 1 & -1 \\ 1 & 1 & 0 & -1 & 1 & 0 & 1 & -1 & -1 & -1 & -1 & -1 \\ 0 & -1 & 1 & 1 & 1 & 1 & -1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & -1 & 1 \\ -1 & 1 & -1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & -1 & 0 \\ -1 & -1 & 0 & -1 & 1 & -1 & -1 & 1 & 1 & 0 & -1 & 1 \\ 0 & 1 & -1 & 1 & -1 & 0 & 0 & 0 & -1 & 1 & -1 & 1 \\ 0 & 1 & -1 & 0 & -1 & 1 & -1 & 0 & -1 & 1 & 1 & 1 \\ -1 & 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & 1 & 1 \end{pmatrix}$ | <p>Row Sum Matrix</p> $\begin{pmatrix} -5 \\ -1 \\ -2 \\ 5 \\ 8 \\ 4 \\ -2 \\ 0 \\ 1 \\ 2 \end{pmatrix}$ |
|---|--|



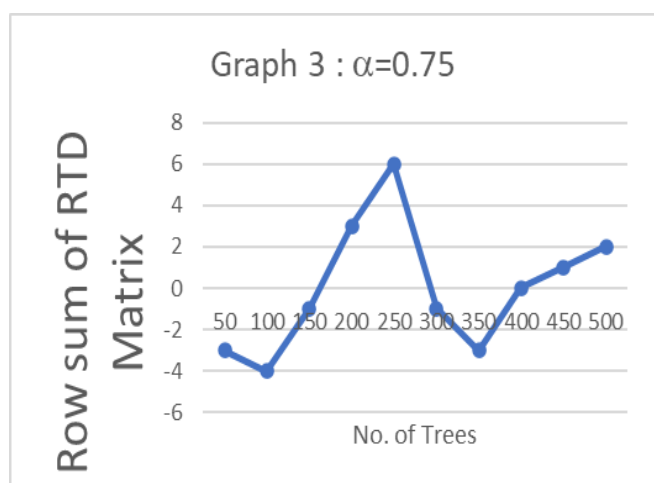
Graph 1: Row sum of RTD Matrix at $\alpha=0.25$

| | |
|--|--|
| <p>RTD Matrix for $\alpha = 0.50$</p> $\begin{pmatrix} 1 & 0 & 1 & -1 & -1 & 0 & 1 & -1 & -1 & -1 & 0 & -1 \\ 0 & -1 & 0 & 0 & 1 & 1 & 1 & -1 & -1 & -1 & 1 & -1 \\ 1 & 0 & 0 & -1 & 0 & 0 & 1 & -1 & 0 & -1 & 0 & -1 \\ 0 & 0 & 1 & 1 & 0 & 1 & -1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\ -1 & 0 & -1 & 1 & 0 & 0 & 1 & 1 & 0 & 1 & -1 & 0 \\ -1 & -1 & 0 & -1 & 1 & -1 & -1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & -1 & 0 & -1 & 1 & -1 & 0 & 0 & 1 & 1 & 1 \\ -1 & 0 & 1 & -1 & 0 & -1 & -1 & 1 & 1 & 1 & 1 & 1 \end{pmatrix}$ | <p>Row Sum Matrix</p> $\begin{pmatrix} -3 \\ -1 \\ -2 \\ 4 \\ 7 \\ 1 \\ -3 \\ 1 \\ 2 \\ 2 \end{pmatrix}$ |
|--|--|



Graph 2: Row sum of RTD Matrix at $\alpha=0.50$

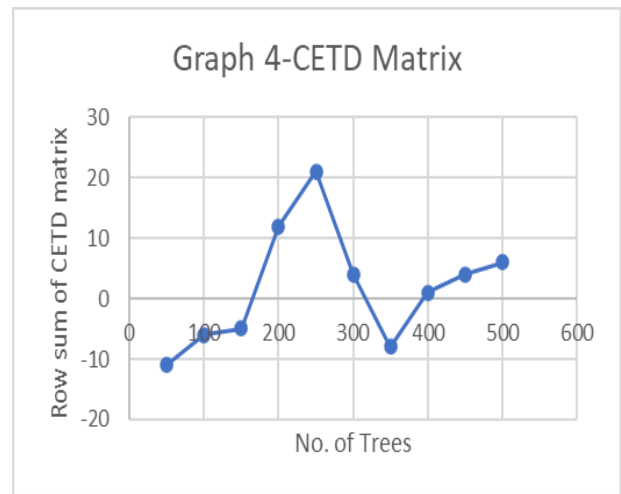
| | |
|---|---|
| <p>RTD Matrix for $\alpha = 0.75$</p> $\begin{pmatrix} 1 & 0 & 1 & -1 & -1 & 0 & 1 & -1 & -1 & -1 & 0 & -1 \\ 0 & -1 & 0 & 0 & 1 & 0 & 0 & -1 & -1 & -1 & 0 & -1 \\ 1 & 0 & 0 & -1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & -1 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ -1 & 0 & -1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \\ -1 & -1 & 0 & -1 & 1 & -1 & -1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -1 & 0 & 1 & -1 & 0 & -1 & 0 & 1 & 1 & 0 & 1 & 1 \end{pmatrix}$ | <p>Row Sum Matrix</p> $\begin{pmatrix} -3 \\ -4 \\ -1 \\ 3 \\ 6 \\ -1 \\ -3 \\ 0 \\ 1 \\ 2 \end{pmatrix}$ |
|---|---|



Graph 3: Row sum of RTD Matrix at $\alpha=0.75$

By combining all these three matrices, the Combined Effect Time Dependent Data Matrix (CETD Matrix), which gives the cumulative effect of all these entries, was obtained as follows:

| CETD Matrix | Row Sum Matrix |
|--|---|
| $\begin{pmatrix} 3 & -1 & 3 & -3 & -3 & 0 & 3 & -3 & -3 & -3 & -1 & -3 \\ 0 & -3 & 0 & 0 & 3 & 2 & 2 & -3 & -3 & -3 & 2 & -3 \\ 3 & 1 & 0 & -3 & 1 & 0 & 3 & -3 & -1 & -2 & -1 & -3 \\ 0 & -1 & 3 & 3 & 1 & 3 & -2 & 0 & 1 & 2 & 2 & 0 \\ 0 & 1 & 0 & 3 & 3 & 3 & 2 & 3 & 3 & 3 & -1 & 1 \\ -3 & 1 & -3 & 3 & 1 & 0 & 2 & 3 & 1 & 2 & -3 & 0 \\ -3 & -3 & 0 & -3 & 3 & -3 & -3 & 3 & 1 & 0 & -1 & 1 \\ 0 & 3 & -3 & 1 & -3 & 0 & 0 & 0 & -1 & 2 & -1 & 3 \\ 0 & 3 & -2 & 0 & -3 & 2 & -2 & 0 & -1 & 2 & 2 & 3 \\ -3 & 1 & 3 & -3 & -1 & -3 & -2 & 3 & 3 & 2 & 3 & 3 \end{pmatrix}$ | $\begin{pmatrix} -11 \\ -6 \\ -5 \\ 12 \\ 21 \\ 4 \\ -8 \\ 1 \\ 4 \\ 6 \end{pmatrix}$ |



Graph 4: Row sum of CETD Matrix

The graph as shown Fig. -1 below exhibited the group of respondents (based on number of trees) worst affected.

3. Conclusion

The information such as total holding, area under mango, physical and revenue productivity obtained from mango cultivators were enquired from the respondents. Data so collected was processed, tabulated, analyzed and interpreted. From the graph it is observed that the mango cultivators ranging trees between 200 and 300 are worst affected by such marketing problems. The suggestions are put forwarded as under-

- Agricultural loans should be provided on soft and simple terms and conditions to all farmers.
- The storage facility will also provide positively to enhance mango productivity.
- Processing and manufacturing plants should be installed for easy access of the farmers.

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