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FUZZY QUALITY INDEX

S.R. Bhosale
P. D. V. P Mahavidyalaya, Tasgaon. 416312. Maharashtra, India.

M. S. Bapat*
Willingdon College, Sangli 416415, Maharashtra, India.

S. N. Yadav
ADCET, Ashta 416401, Maharashtra, India.

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ABSTRACT

In this paper various methods for determining the price of the agricultural produce are discussed. Depending on the quality, fuzzy quality price is introduced. This method is used to obtain the fuzzy index price of processed agricultural produce viz. currant.

Keywords: *Fuzzy sets; Quality index; Fuzzy Quality.*

1. INTRODUCTION

One of the most crucial problems in many decision-making methods is the precise evaluation of the pertinent data. Very often in real-life decision-making applications data are imprecise and fuzzy. A decision maker may encounter difficulty in quantifying and processing linguistic statements. Therefore it is desirable to develop decision-making methods which use fuzzy data. It is equally important to evaluate the performance of the fuzzy decision-making method. Hence, the development of useful fuzzy decision-making methods is really the need of the hour.

Agricultural marketing in a broader sense is concerned with the marketing of farm products produced by farmers. The study of the agricultural marketing system is necessary to understand the complexities involved and the identification of crucial problems for providing efficient services in the transfer of farm products to consumers. An efficient marketing system minimizes cost of marketing and benefits all the sections of the society. The expectations from the system vary from group to group and generally the objectives are in conflict. Therefore fuzzy logic which is a tool to study complexities and resolves the conflicting situations can be a very useful tool. It tries to provide the maximum share to the producer and required quality to consumers at the lowest possible price.

Indian agriculture has attained a good degree of commercialization due to increase in production and sustainable surpluses. Agricultural marketing system plays a crucial role in economic and social development by providing production incentives and distributing the benefits of growth. But still there are many problems in marketing of agricultural produce in India. The seasonal glut of the agricultural produce and consequent slump in prices at the time of harvest, scarcity during lean period, low productivity, erratic rainfall, scarcity of quality seeds, non-implementation of production technology by farmers, exploitation of producers by middlemen and big trading companies, lack of knowledge about grading and storage are some of the major hurdles in marketing of agricultural produce.

There is a large variation in the quality of agricultural products, which makes their grading and standardization somewhat difficult. In this paper various methods are discussed for determining the price of the agricultural produce. Depending on the quality, fuzzy quality price is introduced. This model of pricing can be applied to any agricultural produce having similar marketing facilities. This helps in determining the expected price based on the quality and available previous information.

Corresponding Author: M. S. Bapat*
Willingdon College, Sangli 416415, Maharashtra, India.

2. PRELIMINARIES

Fuzzy Set

A fuzzy subset A of a set X is a function $A: X \to I$. If $\alpha \in I$ then the set $\{x \in X \mid A(x) \geq \alpha\}$ is called α -level cut or in short α -cut and is denoted by A_α . The strict α -level cut of A is the Support of A is the set $A_{0+} = \{x \in X \mid A(x) > 0\}$. If $A(x) = 1$, for some $x \in X$, then *A* is called normal fuzzy set.

Fuzzy number

A fuzzy number is a fuzzy set A: R $\to$ L which satisfies at least the following three properties,

i) A is upper semi-continuous

ii) A(x) = 0 outside some interval [c, d]

iii) There are real numbers a, b, c and d such that c $\leq$ a $\leq$ b $\leq$ d for which

1. A(x) is monotonic increasing on [c, a]
2. A(x) is monotonic decreasing on [b, d]
3. A(x) = 1, a $\leq$ x $\leq$ b

Triangular fuzzy number

A fuzzy number *A* on $R \in (-\infty, +\infty]$ is defined to be a fuzzy triangular number if their memberships function *A*: *R* $\to$ [0, 1] is equal to

$$A(x) = \begin{cases} \frac{1}{m-l}x - \frac{l}{m-l}, & x \in [l,m] \\ \frac{1}{m-u}x - \frac{u}{m-u}, & x \in [m,u] \\ 0 & \text{otherwise} \end{cases}$$

where, l $\leq$ m $\leq$ u, and l and u stands for the lower and upper values of the support of the fuzzy number *A*, respectively, and m for the model value.

Standard operations on fuzzy set

Define three fuzzy subsets A, B and C in the universe X. For given x $\in$ X, we have the following operations.

1. *Union*: (A $\cup$ B) (x) = A(x) $\vee$ B(x). ($\vee$ = max (or sup.))
2. *Intersection*: (A $\cap$ B) (x) = A(x) $\wedge$ B(x). ($\wedge$ = min (or inf.))
3. *Complement:* A^c (x) = 1 – A (x).

The operations 1 through 3 are generalization of the corresponding classical set theoretic operations.

3. PRICE INDEX

In India, the organized marketing of agricultural commodities has been promoted through a network of regulated markets. Exporters, processors and retail chain operators cannot procure directly from the farmers as the produce is required to be channelized through regulated markets and licensed traders. In the process, there is an enormous increase in the cost of marketing and farmers end up getting a low price for their produce. In these regulated markets the individuals bring their commodity according to some standards (weight or size). According to quality of agricultural produce producer gets the price i.e. the price of the agricultural produce depends on the quality of the produce. The market value of the produce also depends on the past information of the prices of the produce i.e. the rates in previous days, weeks or months.

Price Indices

A rate offered for a particular commodity on a particular day is a price index. We define the following terms

- Let X be an *agricultural commodity* to be sold in the market.
- A commodity of a single farmer with similar quality is called a *block*.
- Different blocks *weigh* differently.
- Each block gets different *rate*

Let $x_1, x_2, ..., x_n$ be the n blocks. Let $w_1, w_2, ..., w_n$ be the weights. Let $r_1, r_2, ..., r_n$ be the prices offered for these blocks.

Price Interval (I_r)

It is a normal practice that prices declared by the market committees are in the form of range i.e. minimum rate to maximum rate. We call this as price interval and denote it by I_r. Thus $I_r = [r_l, r_u]$, where $r_l = \min\{r_1, r_2, r_3, ..., r_n\}$ and $r_u = \max\{r_1, r_2, r_3, ..., r_n\}$.

Average Price (r_a)

If maximum and minimum values of the rates are available then arithmetic mean of the two values is the average rate r_a .Thus,

$$r_a = \frac{(r_l + r_u)}{2}.$$

Mean price (r_m)

$$r_m = \frac{(r_l + r_2 + ... + r_n)}{n}.$$

Weighted Mean Price (r_w)

Since rate interval or value of average rate does not indicate the exact behavior of market, weighted rate value is introduced. If $x_1, x_2, ..., x_n$ are n blocks with $w_1, w_2, ..., w_n$ are weights then weighted rate value is given by

$$r_w = \frac{r_l w_1 + r_2 w_2 + ... + r_n w_n}{w_1 + w_2 + ... + w_n}.$$

Interval Weighted Price $r_w(Q)$

Usually rates of agricultural produce are decided by the quality of the produce. It is convenient to divide the produce in three or four parts and then rate can be determined according to quality of produce.

We divide the rate interval in three parts according to the quality I, II, III and denote it by $Q_I = (r_{u-t}, r_u], Q_{II} = [r_{i+t}, r_{u-t}], Q_{III} = [r_l, r_{i+t})$. Quality I is good quality, quality II is medium quality and quality III is the poor quality of the produce.

Then for the different qualities Q_I, Q_{II} and Q_{III} the weighted mean prices are given by,

$$r_w(Q_I) = \frac{r_{i_1} w_{i_1} + r_{i_2} w_{i_2} + ... + r_{i_\alpha} w_{i_\alpha}}{w_{i_1} + w_{i_2} + ... + w_{i_\alpha}},$$

$$r_w(Q_{II}) = \frac{r_{j_1} w_{j_1} + r_{j_2} w_{j_2} + ... + r_{j_\beta} w_{j_\beta}}{w_{j_1} + w_{j_2} + ... + w_{j_\beta}},$$

$$r_w(Q_{III}) = \frac{r_{k_1} w_{k_1} + r_{k_2} w_{k_2} + ... + r_{k_\gamma} w_{k_\gamma}}{w_{k_1} + w_{k_2} + ... + w_{k_\gamma}}.$$

4. FUZZY QUALITY PRICE (r_f)

In this method a fuzzy quality function is designed depending on the quality of produce. The quality of particular block x_i is determined according to some measure. If this measure is in percentage then accordingly its fuzzy quality value is obtained. The value of the block x_i is then obtained by multiplying the highest rate r_u by this fuzzy quality value $Q(x)$. We define a percentage function $P: X \to [0,100]$ where X is set of different blocks of produce under consideration and $P(x_i) = p_i \quad (i = 1, 2, ..., n)$ means quality of the block x_i is p_i percent.

We define the fuzzy quality Q by the function $Q:[0,100]\to[0,1]$ by

$$Q(x)=\begin{cases}\dfrac{x^2}{2\beta^2}\ for\ 0\le x\le\beta\\ 1-\dfrac{(x-100)^2}{2(100-\beta)^2}\ for\beta\le x\le 100\end{cases}$$

where β is a parameter which depends on quality of the produce and the past information about the prices. Fuzzy quality Price r_f for the block x_i is given by

$$r_f=(Q\circ P)(x_i)r_u.$$

5. APPLICATION

The present paper describes currant as a produce for quality based price. In Tasgaon (Sangli district) the grapes are cultivated largely and processed to produce currant. The currant is well known worldwide for its quality and taste. The data is collected from the Tasgaon Agriculture Market Committee. There is ambiguity in determining the price of currant which is principally based on quality. It is important to study the price based on quality of currant.

For specific period in Tasgaon Currant Market of Sangli District (M.S.) table 1 below depict the sample of primary data of different blocks of currant. Each block contains different number of boxes. Each box contains 15 kg of current.

Table-1

Block labeling (x_n)	**Quantity of boxes** $\mathbf{b_n}$	**Quantity of current in kg.** $w_n=15\times b_n$	**Price per kg** $(r_n)Rs.$	**Total price** $(w_n r_{n.})Rs.$
1	11	165	81	13365
2	20	300	100	30000
3	21	315	85	27775
4	16	240	90	21600
5	7	105	60	6300
6	9	135	70	6450
7	13	195	75	14625
8	25	375	84	31500
9	23	345	89	27705
10	30	450	80	36000
11	38	570	96	54720
12	34	510	78	39780
13	16	240	100	24000
$n=13$	$\sum b_n=263$	$\sum w_n=3945$	$\sum r_n=1088$	$\sum w_n r_n=335820$

For the primary data in table 1 the following results were observed.

i. Price Interval I_r = [60, 100]
ii. Average Price r_a = 80
iii. Mean Price r_m = 83.69
iv. Weighted Mean Price r_w = 85.13
v. Interval weighted Price
The interval [60, 100] is subdivided into three sub-price intervals according to the qualities of the currant box Q_I = (88, 100], Q_{II} = [73, 88], Q_{III} = [60, 73).

Therefore, for these qualities the weighted prices are given by $r_w(Q_I)=91.46$, $r_w(Q_{II})=80.619$, $r_w(Q_{III})=65.625$.

vi. Fuzzy Quality Price

Calculation of parameter β

In present model we assume that for 50% quality of currant producer will get minimum price r_l . Further we assume that there is no block of currant having quality less than 50%.

Therefore for $x = 50$ and $r_l = 60.$ The function Q is defined by

$$Q(x) = \begin{cases} \dfrac{x^2}{2\beta^2} \; for \; 0 \le x \le \beta \\ 1 - \dfrac{(x-100)^2}{2(100-\beta)^2} \; for \beta \le x \le 100 \end{cases}$$

$$\therefore \mathrm{r}_l = \left[1 - \frac{(x-100)^2}{2(100-\beta)^2} \right] r_u \;\; for \; 50 \le x \le 100$$

$$60 = \left[1 - \frac{(50-100)^2}{2(100-\beta)^2} \right] 100 \;\; for \; 50 \le x \le 100$$

$$\therefore \beta = 44.10 \doteq 44.$$

For $\beta = 44$ the fuzzy quality price is given in the table 2 below

Table-2

Sr. No	**Quality of Currant** $x_i(\%s) \;\; P(x_i) = x_i\%$	**Fuzzy Quality Price** $(r_f)Rs.$
1	50	60
2	60	74.40
3	70	85.60
4	80	93.60
5	90	98.41
6	100	100

CONCLUSION

Quality of product is one of the important factors affecting on market price of a produce. Effective time management and updated market information is necessary for better quality and expected price. Scientific knowledge of currant agriculture is useful to produce a better quality of currant. This results in getting better price in the market.

In present paper a method based on fuzzy decision model to obtain a grade index for currant is given. With some modifications this model can be used to determine a grade for any other agricultural produce.

Presently the marketing of agricultural commodities is promoted through a regulated local or district level market committees. These institutions declares price of the commodities in the form of a price interval. This may create confusion in sellers particularly unorganized farmers. The rates of the produce depend on the quality. Most of the sellers are not aware of this fact and therefore they do not get the expected price for their produce. A fuzzy model developed in this paper can be applied to determine a proper price based on grade index. We have applied present model to study the rates of currant based on their qualities as well to determine rates of currant in worldwide famous Tasgaon currant marker in Sangli district (M. S.).

REFERENCES

1. J., L. A. Zadeh and B. R. Gaines, [1984], Fuzzy sets and Decision Analysis. North-Holland, New York.
2. Zimmermann, H. Bapat M.S. and Yadav S.N. (2009)**,** "*Fuzzy Sets in Sugarcane Industry Decision. International Journal of Tropical Agriculture* ", Vol. 27, NO. 1-2 pp 247-250.
3. Bellman, R. E. and L. A. Zadeh [1970], "Decision making in a Fuzzy environment. Management science, 17(4), pp.141- 164.
4. George J.Klir/Bo Yuan, Fuzzy sets & Fuzzy logic; prentice, Hall of India Private limited, New Delhi-110 001, 2002.
5. H.M. Nielsen, W. Paul, Modelling image processing parameters and consumer aspects for tomato quality grading, IFAC Mathematical and control Appl. Agric. Horticulture (1997) 141-146.
6. Krishi Utpan Bazaar Samiti, Market Yard Vishrambag, Sangli (M.S.) India.
7. Krishi Utpan Bazaar Samiti, Tasgaon, Sangli (M.S.) India.

8. N. Perrot[a,*] , I. Ioannou[b], I. Allais[c] , C. Curt[c] , J. Hossenlopp[c] , G. Trystram[c] , Fuzzy concepts applied to product quality control: A review, Fuzzy sets and systems 157(2006) 1145-1154.
9. R. Srinivasan, Case Studues in MARKETING the Indian context, Fifth edition (2014), PHI India.
10. Zimmermann, H. J. [1987], Fuzzy sets, Decision Making, and Expert systems. Kluwer, Boston.

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