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Application of Fuzzy Quality Index for Price Determination of Yellow Raisin

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Abstract: In this paper we have discussed various price indices for agricultural produce and discussed their utility. The concept of fuzzy set is used to obtain Fuzzy quality price index. Various price indices are obtained for yellow raisin using the data collected from the agricultural market committee at Sangli (Maharashtra) which is one of the major marketing centre for yellow raisin.

Keywords: Fuzzy sets; Quality index; Fuzzy Quality, Yellow Raisin.

I. INTRODUCTION

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 costs, and benefits all the sections of the society. In India the marketing of agricultural produce has been promoted through regulated markets for the benefit of producers most of whom are illiterate or unaware of modern marketing activities. Most of the state governments have enacted legislations to generate local agricultural committees. The purpose of the state regulations is to protect farmer's interests and to avoid the exploitation from intermediaries and organized traders. Also these local agricultural committees assure better price and timely payments for their produce. An important part in marketing process is buying and selling activity. The producer or farmer wants to sell farm produce or processed farm produce at a satisfactory price. The prices of the agricultural produce vary from place to place, time to time and also with the quality and quantity. Therefore selling process becomes complicated and the role of market information and its analysis and conclusion becomes important. There are many methods of buying and selling. For the benefit of farmers the most of the market committees prefer open auction method and roster bid open auction method. In this system open auction starts from a point in the market at a notified time and advances sequentially from one shop to next shop. The auction is supervised by a clerk or a person nominated by market committee. Market information is an important part in the marketing system. Accurate, adequate and timely availability of market information facilitates both the buyers and sellers. For agricultural products the prices fluctuates more rapidly than those of the products of other sectors. A farmer is required to decide when, where and how to sell his farm produce. Price information helps him to take these decisions. The market authorities declares the prices, arrivals and changes in the market on daily basis. Normally the prices of the produce are declared in the form of price intervals i. e. maximum price to minimum price. From this information it becomes difficult for a farmer to guess about the possible price he will get in the market for his produce. The price of the produce mainly depends on the quality of the produce. In the paper [ ] various indices are introduced for the proper valuation of the produced to be sold. We apply this procedure for determining the price index for yellow raisin in Sangli district market committee. Also another type of price index called as fuzzy quality price index is obtained which depends on the quality of produce. In the next section we introduce various price indices and then apply these methods for determining price indices for yellow raisin.

II. PRELIMINARIES

Price Indices: A price 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 *price*

Let $x_1, x_2, \ldots\ldots\ldots, x_n$ be the n blocks arrived in the market for sell. Let $w_1, w_2, \ldots\ldots w_n$ be the weights (in units) of these blocks respectively. The unit may be different for different commodities. For example for grains it may be in quintals and for raisins it may be in kilograms. Let $r_1, r_2, \ldots\ldots r_n$ be the prices (per unit) 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

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range i.e. minimum rate to maximum rate. We call this as price interval and denote it by I_r. Thus $I_r = [r_1, r_u]$, where $r_1 = \min\{r_1, r_2, r_3 \ldots r_n\}$ and $r_u = \max\{r_1, r_2, r_3 \ldots r_n\}$.

This information is often confusing and does not give proper idea to the farmer about the price of his produce. He wishes maximum price for his block but most of the times ends in getting much lower price.

Average Price (r_a): If maximum and minimum values of the prices are available then arithmetic mean of the two values is the average price (r_a). Thus,

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

Most of the times the farmer gets the price for his block near about this value. But still exact value is still away from this.

Mean price (r_m): Since n different blocks gets n different prices it is natural to take their mean. Hence the mean price is introduced as

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

The mean price is a good estimation of prices. But the weights of the blocks are not taken in to consideration. Therefore a high prices for some blocks with comparatively smaller weights may give confusing results. Hence the weighted mean price is introduced.

Weighted Mean Price (r_w): Since price interval or value of average price does not indicate the exact behavior of market, weighted price is introduced. If $x_1, x_2, \ldots\ldots\ldots, x_n$ are n blocks with $w_1, w_2, \ldots\ldots w_n$ are weights then weighted mean price is given by

$$r_w = \frac{r_1 w_1 + r_2 w_2 + \ldots + r_n w_n}{w_1 + w_2 + \ldots + w_n}$$

Interval Weighted Price $r_w(Q)$*:* Usually prices 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 prices can be determined according to quality of produce.

We divide the price interval in three parts according to the quality I, II, III and denote it by $Q_1 = (r_{u-t}, r_u], Q_{II} = [r_{i+t}, r_{u+t}], Q_{III} = [r_l, r_{i+t})$. Q_I, Q_{II}, Q_{III} are the price intervals for the produce of quality I, II and III respectively. Then for the different intervals Q_I, Q_{II} and Q_{III} the weighted mean prices are given by,

$$r_w(Q_I) = \frac{r_{i1} + r_{i2} + \ldots\ldots + r_{i\alpha}}{w_{i1} + w_{i2} + \ldots\ldots + w_{i\alpha}}$$

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

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

where α, β and γ are the number of blocks whose price lies in the respective price intervals Q_I, Q_{II} and Q_{III}.

Fuzzy Set: Fuzzy sets was introduced by L. A. Zadeh in 1965. Fuzzy sets can describe imprecise and linguistics concepts in a better way so fuzzy set theory can been used to model imprecisely defined systems. The fuzzy sets allows the grade of membership for x which takes values from a unit interval [0,1].Fuzzy sets allows us to express vague concepts expressed in natural language.

A fuzzy subset A of a set X is a function $A : X \to I$ where I is the real interval $[0, 1]$. If $\alpha \in I$ then the set $\{x \in X | A(x) \geq \alpha\}$ 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 $A_{0+} = \{x \in X | A(x) > 0\}$. If $A(x) = 1$, then A is called normal fuzzy set. 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 $A(x)$ is monotonic increasing on [c,a] and A(x) is monotonic decreasing on [b, d]. A(x) = 1, $a \leq x \leq b$

Standard operations on fuzzy set: For three fuzzy subsets A, B and C in the universe 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.

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. For convenience this measure is in percentage. Then accordingly its fuzzy quality value is obtained. The price of the block x_i is then obtained by multiplying the highest price r_u by this fuzzy quality value $Q \circ P(x)$. We define a percentage function

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$P : X \rightarrow [0,100]$where X is set of different blocks of produce under consideration and $P(x_i) = P_i (i = 1, 2, \ldots, n)$ means quality of block x_i is P_i percent.

We use the fuzzy quality function Q[5] given by $Q : [0,100] \rightarrow [0,1]$.

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

Fuzzy quality Price (r_f) for the block x_i is given by

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

III. APPLICATION

In the regulated market run by Sangli District Market Committee, the individual farmers bring their agricultural produce according to some standards (weight or size). Market committee follows the roster method of open auction system. According to quality of agricultural produce producer gets the price. In this paper various price indices of are obtained and also fuzzy quality price based on quality is given. The study is carried out in market committee campus of Sangli district of Maharashtra. In this region yellow raisin is produced by processing some special quality of grapes. This is one of the famous market for buyers and sellers of yellow raisin which is well known worldwide for its quality and taste. There is ambiguity and uncertainty in defining the quality of yellow raisin on which the price is principally based. Therefore it is necessory to study the fuzzy quality price. For specific period of yellow raisin market in Sangli district (M.S.) table 1 below depict the primary data of different blocks of yellow raisin. Each block contains different number of boxes and each box contains 15 kg of yellow raisin

Table. I

Block labeling (x_n)	**Quantity of boxes** (b_n)	**Total quantity of raisin** $W_n=15(b_n)$	**Price per kg** (r_n) **Rs.**	**Total price** ($w_n r_n$) **Rs.**
1.	25	375	191	71625
2.	26	390	180	70200
3.	13	155	140	21700
4.	37	555	190	105450
5.	14	210	140	29400
6.	10	150	110	16500
7.	36	540	181	97740
8.	23	345	110	37950
9.	15	225	185	41625
10.	20	300	192	57600
11.	15	225	103	23175
12.	24	360	120	43200
13.	12	180	105	18900
14.	01	15	170	2550
15.	40	600	200	120000
16.	39	585	200	117000
$n = 16$	$\sum b_n = 350$	$\sum w_n = 5250$		$\sum W_n r_n = 880215$

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

1. Price Interval (I_r) = [103, 200]
2. Average Price(r_a) = 151.50
3. Mean Price (r_m) = 157.31
4. Weighted Mean Price (r_w)= 167.66
5. Interval weighted Price ($r_w(Q)$)

The interval [103, 200] is subdivided into three sub-price intervals according to the qualities of the raisin box

Q_I = (169, 200], Q_{II} = [136, 168], Q_{III} = [103, 135).

Therefore, for these qualities the weighted prices are given by $r_w(Q_I) = 190.7364, r_w(Q_{II}) = 140, r_w(Q_{III}) = 110.8928$.

6. Fuzzy Quality Price (r_f)

Calculation of β: In present model we assume that for 50% quality of yellow raisin producer will get minimum price r_i. Further we assume that there is no block of yellow raisin having quality less than 50%.

Therefore for $x = 50\%$ and $Q(x) = r_i = 103$ and $r_u = 200$. Q is defined by:

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

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

$$103 = \left[1 - \frac{(50-100)^2}{2(100-\beta)^2} \right] 200 \text{ for } 50 \le x \le 100$$

$$\therefore \beta = 49.24 \approx 49.$$

For $\beta = 49$ the fuzzy quality price is given in the table 2 below

Table II

S. N.	Quality of raisin block $x_i \quad P(x_i) = x_i\%$	Fuzzy Quality Price $(r_f)Rs.$
1	50	103
2	60	138
3	70	169
4	80	184
5	90	196
6	100	200

IV. CONCLUSION

Quality of product is one of the important factors affecting on market price of a produce. In present paper a method based on fuzzy quality function is used to obtain a grade index for yellow raisin. With some modifications this model can be used to determine a grade for any other agricultural produce.

The marketing committees declares prices of the agricultural produce in the form of a price interval. This may create confusion in sellers particularly unorganized farmers. The prices 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 quality. We have applied present model to determine the price of yellow raisin.

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