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Fuzzy Quality Price for Green Raisin

S. R. Bhosale
P.D.V.P. Mahavidyalaya, Tasgaon, Maharashtra, India
M. S. Bapat
Willingdon College, Sangli, Maharashtra, India

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. Tasgaon region of Maharashtra state is well known for raisin production and marketing. The problem of price determination for green raisin is given and the solution to the problem is obtained by using fuzzy quality index.

Keywords: *Fuzzy sets; Quality index; Fuzzy Quality, Raisin*

1. Introduction

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. 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. Also market information is an important part in the marketing system. Accurate, adequate and timely availability of market information facilitates both the buyers and sellers. The market authorities declare 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 [5] various indices are introduced for the proper valuation of the produced to be sold. We apply this procedure for determining the price index for green raisin in Tasgaon Raisin 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 green raisin.

2. Price Indices

A price offered for a particular commodity for a specific period is called a price index. 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 $x_1, x_2, ..., x_n$ be the n blocks arrived in the market for sell. Let $w_1, w_2, ..., w_n$ 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 $r_1, r_2, ..., r_n$ be the prices(per unit) offered for these blocks.

2.1. 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 $r_u = \max\{r_1, r_2, r_3, ..., r_n\}$.
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.

2.2. 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.

2.3. 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

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

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

2.4. 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 $x_1, x_2, ..., x_n$ are n blocks with $w_1, w_2, ..., w_n$ are weights then weighted mean price is given by

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

2.5. Interval Weighted Price (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 $Q_I = (r_{u-t}, r_u], Q_{II} = [r_{i+t}, r_{u-t}], Q_{III} = [r_l, r_{i+t})$. 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,

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

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

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

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}

3. Fuzzy Sets

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 $\{x \in X \mid A(x) \geq \alpha\}$ 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 $A(x) = 1, \text{for some } x \in X$, 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,

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] A(x) is monotonic decreasing on [b, d] A(x) = 1, a $\leq$ x $\leq$ b

3.1. 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.

3.2. 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 $P: X \to [0,100]$ where X is set of different blocks of produce under consideration and $P(x_i) = p_i \ \ (i = 1,2,...,n)$ means quality of block x_i is p_i percent. We use the fuzzy quality function Q [5] given by $Q: [0,100] \to [0,1]$

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

Fuzzy quality Price (r_f) for the block x_i is given by $r_f = (Q \circ P)(x_i) r_u$.

4. Problem Definition

The study is carried out in the Tasgaon Market of Sangli district of Maharashtra State. This is a place where the green raisin is produced largely and is well known worldwide for its quality and taste. In this regulated market 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. There is ambiguity and uncertainty in defining the quality of yellow raisin on which the price is principally based. Therefore it is necessary to study the fuzzy quality price. For specific period of green raisin market table 1 below depict the primary data of different blocks of green raisin. Each block contains different number of boxes and each box contains 15 kg of green raisin. For specific period in Tasgaon Raisin Market (M.S.) table 1 below depict the primary data of blocks of raisin.

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.	17	255	229	58395
2.	28	420	240	100800
3.	19	285	220	62700
4.	21	315	257	80995
5.	29	435	253	110055
6.	20	300	257	77100
7.	31	465	251	116715
8.	62	930	263	244590
9.	31	465	262	123225
10.	31	465	248	115320
11.	56	840	260	218400
12.	19	285	250	71250
13.	30	450	252	113400
14.	42	630	235	148050
15.	21	315	260	81900
16.	34	510	265	135150
17.	31	465	256	119040
18.	76	1140	261	297540
19.	34	510	260	132600

20.	46	690	256	176640
21.	26	390	235	91650
22.	33	495	247	122265
23.	10	150	230	34500
24.	28	420	241	101220
25.	45	675	210	141750
26.	26	390	272	106080
27.	48	720	256	184320
28.	35	525	234	1221855
29.	36	540	255	137700
30.	24	360	220	79200
31.	55	825	220	181500
32.	32	480	230	110400
33.	27	405	242	98010
34.	24	360	254	91440
35.	47	705	250	176250
36.	55	825	240	198000
37.	35	525	235	123375
38.	18	270	249	67230
39.	43	645	228	147060
40.	25	375	240	90000
41.	26	390	244	95160
42.	33	495	243	120285
43.	21	315	229	72135
44.	19	285	246	70110
45.	20	300	237	71100
46.	44	640	234	149760
47.	55	825	220	181500
48.	30	450	214	96300
49.	49	735	230	169050
50.	70	1050	231	242550
51.	30	450	210	94500
52.	25	375	225	84375
53.	18	270	217	58590
54.	35	525	213	111825
55.	36	540	227	122580
56.	44	640	236	151040
57.	40	600	214	128400
58.	18	270	220	59400
59.	25	375	220	82500
60.	421	6315	228	1439820
61.	24	360	220	79200
62.	22	330	240	79200
63.	13	195	234	45630
64.	21	315	215	67725
65.	12	180	233	41940
66.	42	630	232	146160
67.	28	420	220	92400
68.	15	225	205	46125
69.	27	405	230	93150
70.	15	225	234	52650
71.	5	75	205	15375
72.	36	540	210	113400
73.	13	195	210	40950
$n = 73$	$\sum b_n = 2682$	$\sum w_n = 40230$		$\sum w_n r_n = 8211375$

Table: 1 (primary data of 13blocks of raisin)

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

- Price Interval(I_r) = [205, 272]
- Average Price(r_a) = 283.50
- Mean Price (r_m) =236.28
- Weighted Mean Price = 204.110
- Interval weighted Price

The interval [205, 272] is subdivided into three sub-price intervals according to the qualities of the raisin box Q_I = (251, 272], Q_{II} = [228, 250], Q_{III} = [205, 227).

Therefore, for these qualities the weighted prices are given by $r_w(Q_I) = 258.89838$, $r_w(Q_{II}) = 236.41, r_w(Q_{III}) = 217.143$.

- Fuzzy Quality Price

(1) In present model we assume that for 50% quality of green raisin producer will get minimum price r_l. Further we assume that there is no block of green raisin having quality less than 50%.Therefore for $x = 50\%$ and $Q(x) = r_l = 205$ and $r_u = 272$ Q is defined by

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

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

$$205 = \left[1 - \frac{(50-100)^2}{2(100-\beta)^2} \right] 272 \ \ for \ 50 \le x \le 100$$

$$\therefore \beta = 28.72 \approx 29.$$

For $\beta = 29$ the fuzzy quality price is given in the table 2 below

Sr. No	Quality of Box $x_i(\%s)$ $P(x_i) = x_i\%$	Fuzzy Quality Price $(r_f)Rs.$
1	50	205
2	60	228
3	70	248
4	80	261
5	90	269
6	100	272

5. 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 to obtain a grade index for green raisin is given. With some modifications this model can be used to determine a grade for any other agricultural produce. We have applied present model to study the prices of green raisin.

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