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IDRC-TTI Case Study
Matching game in tomato pricing at Madanapalle Tomato Mandi

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ABSTRACT

Three players/stakeholders namely seller/ farmer, mandi commissioning agent, and buyer were identified in a matching game. In each such matching game there exists only one seller (i=1) and many potential buyers (j=1,2,3,...,n). New pricing model was developed with the objectives of maximizing transparency, maximization of benefits to all players, and minimization of risks. This model has been tested at the field and found suitable to adapt the same. This model will create a win-win situation to all the three players.

Keywords: Matching game, pricing model, maximization

1. INTRODUCTION

Madanapalle is a town located in the Chittoor district of Andhra Pradesh. It is one of the biggest Revenue Divisions in India (it covers almost half of the Chittoor district). It is a fast-growing city at the center of an agricultural region noted for its fruits and vegetables, especially tomatoes. Madanapalle is a centre of vernacular culture. Madanapalle has pleasantly mild, to warm summers with average high temperatures of 30 to 35 degrees Celsius (86 F to 95 F). Temperatures do not exceed 40 degrees celsius (104 F)and winters are cold with temperatures between 7 to 15 degrees Celsius (44.6 F to 59 F). Usually summer lasts from March to June. This climate is ideal for tomato growing. One can find 125 or more villages in and around Madanapalle where tomato growing farmers are available. In Madanapalle, there exists a big mandi at which only tomatoes will be marketed. Four to seven lakh kilograms of tomatoes per day will be sold at this mandi depending on peak and non-peak season. Local demand will be only thiry five to forty thousand kilograms tomatoes per day. Pricing at mandi will be a primary issue in this study.

So a market design which concerns the creation of a venue for buyers and sellers, and a format for transactions is essential in this study. Earlier many researchers used game theory as a tool for market design particularily matching games (see [1],[2],[3],[4]and [5]) In the existing system there are three important players namely sellers/farmers, mandi commissioning agents, and buyers. Mandi commissioning agent will facilitate auction at mandi. Before the beginning of auction, buyers can look at micro level at the quality of tomatoes by overturning the one, two or three crate of tomatoes and this number will depend upon number of crates of tomatoes available for sale. Usually women labourers were hired by farmers for grading. After the completion of this process labeling(code) will be done by writing in a piece of paper with name of the farmer and number of crates available for sale. Many farmers expressed that auctioning at mandi seems to be biased towards mostly buyers. Hence the following system is proposed:

2. PROBLEM FORMATION

For each mandi agent and for each seller/farmer, a matching game is associated with several buyers. These buyers can buy from many sellers/farmers linked with different mandi commissioning agents. There are three disjoint sets of players.

(1) Mandi Commissioning agents

Let us denote mandi commissioning agents as MCA_i (i = 1,2,3,--,l)

(2) Farmers/sellers

Sellers can be identified as S_{ij} where i denotes the i^{th} mandi agent and j denotes the j^{th} farmer attached to the respective mandi commissioning agent. Here j = 1,2,3,---,m_i

(3) Buyers

Buyers can be defined by B_{ijk} where first subscript indicates the mandi commissioning agent, second subscript indicates the respective seller/farmer and third subscript indicates the buyer.

For each mandi commissioning agent there may be several farmers/sellers attached but each farmer will be attached to one and only one mandi commissioning agent. Buyers are free to buy from any farmer/s and also from any mandi commissioning agent/s.

Each mandi agent should invite farmers/sellers to enter the data of quoting the minimum price/crate for which they can sell, in a computer along with the number of crates available for sale. All farmers will enter the data independently and even mandi agent cannot access the data. The process of data entry by farmers/sellers will go parallel across mandi agents. However buyers may be common to different mandi agents. After looking at the quality of tomatoes at every farmer across all mandi agents, buyers will now enter the data of maximum price/crate for which they can buy. Fractional lots will not be allowed to buy.

Once the data entry is finished, buyer should reconfirm about the quoted price. After reconfirmation, one cannot change but can withdraw from the competition of buyers. Actual buyer will be selected by computer through finding maximum difference between the seller and a buyer. The matching will always be possible if and only if there exist at least one buyer entry into every seller under any mandi commissioning agent. In case of multiple optimal solutions at finding buyer in any matching game then auction can be held only for those participants who are at optimal level. Usually non disclosed entries will not have multiple optimal solutions as there will be heavy competition among buyers.

2.1 Buyer's selection

In the existing system buyer's selection will be through auction. In the proposed system buyer will be selected through finding the maximum of {Buyer's maximum quoted price – Seller's minimum quoted price}. If at least one of the buyer's maximum quoted price is higher than Seller's minimum quoted price then the bracketed expression given above will have positive value and the maximum will occur at the maximum difference in the two players quoted price. If all buyer's maximum quoted price is lower than the seller's minimum quoted price then the maximum will occur at the minimum difference in the two players quoted price. In this case all the player's benefits will get reduced.

This can occur due to either seller is too optimistic or seller is not tried to obtain latest information about the market prices in and around the region. Once buyer's selection is over the next challenging issue will be how to fix the price. In other words how much will seller and mandi commissioning agent get and the cost to buyer. This can be obtained through the following method:

2.2 Allocations to each stakeholder

The allocations for each stakeholder namely seller/farmer, mandi commissioning agent, and buyer will be calculated as follows:

Stakes for sellers S_{ij} =

$$
\begin{aligned}
&[0.96 * Max\{MxP_{ijk}, k = 1,2,3,--\} \\
&if \;\; Max\{MxP_{ijk}, k = 1,2,3,--\} < MnP_{ij} \\
&Otherwise \\
&MnP_{ij} \;\; if \; 1.04 * MnP_{ij} = \\
&Max\{MxP_{ijk}, k = 1,2,3,---\} \\
&MnP_{ij} + (0.96 * Max\{MxP_{ijk}, \\
&k = 1,2,3,---\} \\
&-1.04 * MnP_{ij}) / 3 \\
&\; if \; 1.04 * MnP_{ij} < 0.96 * \\
&Max\{MxP_{ijk}, k = 1,2,3,---\} \\
&MnP_{ij} - (1.04 * MnP_{ij} - 0.96 * \\
&Max\{MxP_{ijk}, k = 1,2,3,---\} / 2 \\
&\; if \; 1.04 * MnP_{ij} > 0.96 * \\
&Max\{MxP_{ijk}, k = 1,2,3,---\}]
\end{aligned}
$$

Cost of purchase for buyers B_{ijk}

$$[1.04 * Max\{MxP_{ijk}, k = 1,2,3,--\}$$
$$if \ \ Max\{MxP_{ijk}, k = 1,2,3,--\} < MnP_{ij}$$
$$Otherwise$$
$$Max\{MxP_{ijk}, k = 1,2,3,---\}$$
$$if\ 1.04 * MnP_{ij} = 0.96 * Max\{MxP_{ijk},$$
$$k = 1,2,3,---\}$$
$$Max\{MxP_{ijk}, k = 1,2,3,---\} - (0.96 *$$
$$Max\{MxP_{ijk}, k = 1,2,3,---\} - 1.04 * MnP_{ij}) / 3$$
$$if\ 1.04 * MnP_{ij} < 0.96 * Max\{MxP_{ijk},$$
$$k = 1,2,3,---\}$$

$$Max\{MxP_{ijk}, k = 1,2,3,---\} + (1.04 *$$
$$MnP_{ij} - 0.96 * Max\{MxP_{ijk}, k = 1,2,3,---\} / 2$$
$$if\ 1.04 * MnP_{ij} > 0.96 * Max\{MxP_{ijk},$$
$$k = 1,2,3,---\}]$$

Stakes for Mandi commissioning agents MCA_i

$$[0.08 * Max\{MxP_{ijk}, k = 1,2,3,--\} \ \ if \ \ Max\{MxP_{ijk},$$
$$k = 1,2,3,--\} < MnP_{ij}$$
$$Otherwise$$
$$0.04 * MnP_{ij} + 0.04 * Max\{MxP_{ijk}, k = 1,2,3,---\}$$
$$if\ 1.04 * MnP_{ij} > 0.96 * Max\{MxP_{ijk}, k = 1,2,3,---\}$$
$$0.04 * MnP_{ij} + 0.04 * Max\{MxP_{ijk}, k = 1,2,3,---\} +$$
$$(0.96 * Max\{MxP_{ijk}, k = 1,2,3,---\} - 1.04 * MnP_{ij}) / 3$$
$$if\ 1.04 * MnP_{ij} \le 0.96 * Max\{MxP_{ijk}, k = 1,2,3,---\}$$

If two or more buyers quoted the maximum price which happens to be optimum then the quick auction can be held only for those buyers. In that case agent will get only 4% commission from each of those buyers and sellers/farmers. This will ensure that mandi agent will not try to get the data and leaked the same. All the farmers will be able to enter the data and the competitive prices will be quoted as they verify from the other markets through mobile phones.

In the proposed system, we observe that the stakes of both mandi commissioning agents and farmers will be a win-win situation when compared to the existing system. For buyers too we can consider it as wining situation since more price if it is quoted then chances of getting the right kind/quality of tomatoes will be high and at the same time differential reduction in price will occur which leads to a winning situation.

3. VALIDATION OF MODEL

This model is to be tested like prices from buyers and sellers will be known through enquiry before auctioning and the actual stakes/purchasing prices from the players so obtained will be compared with that obtained in the proposed system.

The following table-I shows about the maximum of maximum quoted price of buyer and seller's minimum quoted price with allocations of each player in the auction system and proposed system

The table-I shows that proposed model will maximize the benefits to all the three players.

4. CONCLUSIONS

In the proposed pricing model, it is to be observed that the system will maximize its transparency as well as the benefits to all the three players. As farmers are more important players in the system, this transparency will enable them to improve the supply of tomatoes to the market. This system can be implemented on trial basis. This system seems to be sustainable. In order to claim the sustainability frequent feedback can be taken from all the three players. Once this proposed system is successful then information system can be developed to enable the buyers from any region can participate in the market without eliminating mandi agents through local representative. Sellers/farmers can also access the buyer's demand and take decision of supply tomatoes accordingly.

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Appendix

MnP	MxP	Seller Stakes		Buyer's payment		Agent's comsn	
		Auction	Proposed	Auction	Proposed	Auction	Proposed
360.00	350	331.2	336.00	358.8	364.00	27.6	28.00
270.00	260	230.4	249.60	249.6	270.40	19.2	20.80
210.00	200	220.8	192.00	239.2	208.00	18.4	16.00
100.00	380	345.6	186.93	374.4	293.07	28.8	106.13
300.00	290	259.2	278.40	280.8	301.60	21.6	23.20
420.00	400	384	384.00	416	416.00	32	32.00
340.00	290	278.4	278.40	301.6	301.60	23.2	23.20
320.00	320	326.4	307.20	353.6	332.80	27.2	25.60
325.00	0	278.4	0.00	301.6	0.00	23.2	0.00
280.00	270	278.4	259.20	301.6	280.80	23.2	21.60
180.00	165	187.2	158.40	202.8	171.60	15.6	13.20
350.00	330	292.8	316.80	317.2	343.20	24.4	26.40
290.00	285	249.6	273.60	270.4	296.40	20.8	22.80
170.00	165	153.6	158.40	166.4	171.60	12.8	13.20
240.00	250	249.6	235.20	270.4	254.80	20.8	19.60
290.00	290	259.2	278.40	280.8	301.60	21.6	23.20
250.00	250	211.2	240.00	228.8	260.00	17.6	20.00
350.00	340	288	326.40	312	353.60	24	27.20
250.00	230	259.2	220.80	280.8	239.20	21.6	18.40
270.00	240	240	230.40	260	249.60	20	19.20
250.00	220	220.8	211.20	239.2	228.80	18.4	17.60
300.00	270	297.6	259.20	322.4	280.80	24.8	21.60
310.00	280	288	268.80	312	291.20	24	22.40
300.00	250	278.4	240.00	301.6	260.00	23.2	20.00
270.00	250	240	240.00	260	260.00	20	20.00
290.00	260	259.2	249.60	280.8	270.40	21.6	20.80

Table-I