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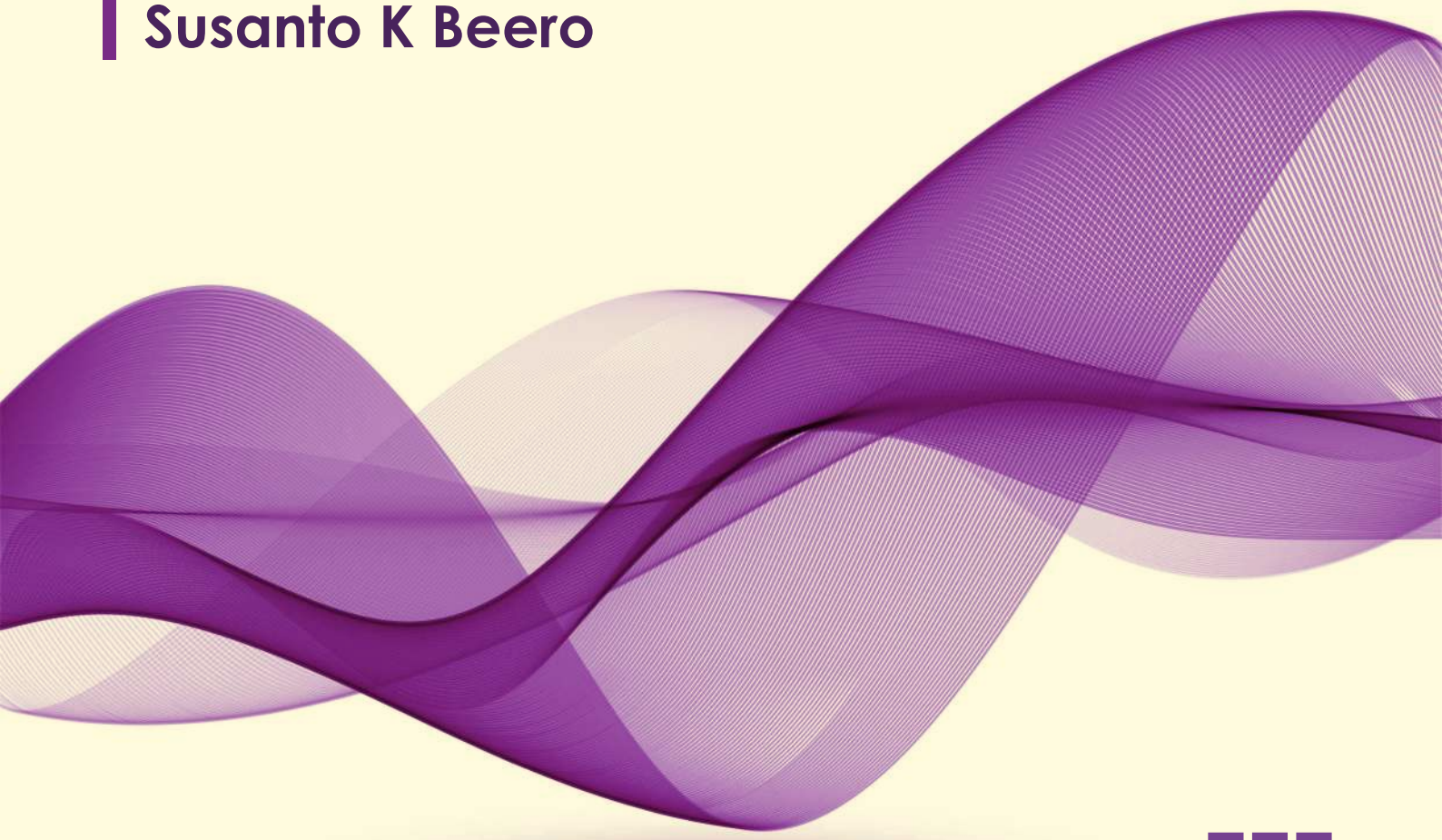

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Abstract

Endemic market failures with infrastructural bottlenecks compounded by excessive regulation and vested interests stifle agricultural markets and farm incomes in developing countries. Electronic market is the new initiative of the central government to overcome these problems. This paper examines the performance of these markets through analysing primary data from 856 farm households in six states along with secondary data. It argues that adequate physical infrastructure is crucial even for the functioning of the electronic market and that other related policy measures are needed to have a significant improvement in agricultural marketing. The results indicate that farmers obtained a 3.75 percent higher prices in these markets vis-a-vis the prices received before selling to these markets. This is significant as it comes in the background of plummeting prices by 8.34 per cent in the manual transactions. One measure of successful electronic market is higher price realization in manual transactions and this has not happened due to the miniscule share of eNAM transactions. On the whole, the exclusion of resource poor and illiterate farmers, lack of related infrastructure including short-term credit in regulated markets and insignificant penetration of electronic market transactions do not inspire confidence on its ability to help overcome market failures.

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1. Introduction

Decades of policy neglect of marketing has been giving way to concerted efforts in the last few years to refurbish the system in ways more than one (GoI 2016; Vijayshankar and Krishnamurthy 2012; Chand 2016; Rao et al 2017). At the heart of the agricultural marketing system in India is the Agricultural Produce Marketing and Regulation Act of the sixties (Acharya 2004). Endemic food shortages during those times drove policy towards tighter regulation so much so that even inter-state movement of agricultural produce are severely restricted. These regulations coupled with the rudimentary infrastructure served the nation reasonably well in the run upto achieving self-sufficiency in food production by enabling farmers market their outputs (Purohit et al 2017). More than five-time increase in foodgrain production during the intervening period and still higher production of fruits and vegetables, coupled with changing consumption patterns, have made the system so obsolete that several changes are due in the country for a long time. Besides, excessive regulation encouraged rent seeking (Lele 1971; Minten et al 2012; Reardon and Gulati 2008). Research shows that variation in prices of agricultural commodities both within and among states is very high in India even in comparison to other developing countries, despite the adoption of new information and communication technologies as well as putting in place better infrastructure (Chatterjee and Kapur 2017). This speaks poorly of the price discovery process in the background of poor marketing and related infrastructure.

The politically sensitive nature of reforms compounded by the resistance of vested interests of disparate intermediaries in the scattered value chains delayed their arrival in agricultural marketing. A quarter century after the onset of full-fledged reforms, the central government started moving towards reforms with the draft model APMC Act 2003, relaxation of foreign direct investment in retailing, creation of national agricultural market and further reforms with the proposed the draft model acts called Agricultural Produce and Livestock Marketing (Promotion and Facilitation) Act, 2017 and Agricultural produce and Livestock Contract Farming and Services (Promotion and Facilitation) Act, 2018. Among these measures, the creation of national agricultural market through electronic platform is expected to be game changer, though not a panacea (Chand 2016). This is a difficult job and would need policy tweaking at several levels. The humongous nature of this task can be gauged from the fact that the geographically scattered markets are divided into as many as 2477 principal regulated markets and governed separately by disparate agricultural produce market committees or as popularly called APMCs with different tax structure. In essence, we have thousands of markets for agricultural commodities in India (GoI 2016). The positive response for the introduction of e-tendering system in 2006 and unified online agricultural market platform in 2014 have acted as precursors to this measure (Dey 2016; GoI 2017; Bisen and Kumar 2018). The latest available data show that 360 out of the 585 proposed *Mandis* have been conducting online trading in the country.

We look briefly at the experience of the Karnataka model as there are no available studies on eNAM directly. The e-market system in Karnataka has not only increased farm income but also shown positive impact on arrivals, prices and in discovery of prices. The system has been effective in enhancing the trade competitiveness by integrating different markets across the state. The system also has the potential of integrating with concepts like warehousing, grading, electronic payment, electronic weighment, packaging, branding and pledge financing and achieved the basic objective of a Single Integrated Market (Chengappa et al 2012; Shalendra 2013). The introduction of e-trading system in the selected regulated agricultural markets of Karnataka has improved the marketing efficiency through competitive and transparent bidding mechanism, and by minimization of manipulations in trading practices (Athawale 2014).

The positive impact of e-market in the name of Rashtriya e Marketing Services (ReMS) in Karnataka on farmers as well as on traders was documented in various studies (Chand 2016). It increased competition among traders, reduced scope for collusion, and increased number of bids per lot from about six to eleven. There was also a 46% higher increase in average prices in e-markets between 2007 and 2015 compared to physical markets. And also there was a significant reduction in price variability and an increase in average market arrivals (Reddy, 2016 and 2018). According to the government's think tank NITI Aayog report, farmers in Karnataka have realised a 13 percent of income in real terms in the year 2015-16 from the sale of agricultural commodities through the e-trading interface Unified Market Platform (UMP) (GoI 2017). Qualitative studies found that ReMS helped farmers in Karnataka generating higher revenues, increasing the number of bids, increasing competition among traders and reducing scope for collusion (Agarwal et al 2017). However, the jury is still out in regard to the functioning of ReMS in Karnataka and associated impacts (Agarwal et al., 2017). As there are no empirical studies so far on eNAM, scholars have tried to juxtapose experiences in ReMS to the effective functioning of eNAM and assert that this can play crucial role (Chand 2016; Dey 2016; Agarwal et al 2017; GoI 2017; Bisen and Kumar 2018).

Against this background, this paper examines the functioning of electronic *Mandis* in the country with special focus on the extent of price impact, bottlenecks in the functioning of eNAM and factors determining positive price impact and satisfaction with eNAM. The paper is organised into five Sections. The next Section explains the conceptual framework, while Section 3 elucidates data and analytical tools. Analysis of price trends in pre and post-eNAM scenarios are compared in section 4. Section 5 examines infrastructural facilities and perceived problems in electronic regulated market yards. Section 6 analyses determinants of price impacts and satisfaction with eNAM. The last section concludes with major findings and policy implications.

2. Conceptual Framework- Rationale for Electronic Market

Recent work in institutional economics moved the paradigm of farm decision making beyond neoclassical assumptions about perfect and complete markets, absence of transaction costs, and full information available to all participants (Hoff et al 1993; Timmer 1997). History of agricultural markets in developing countries shows shifts in policies from efforts to address these failures by putting in place mechanisms to correct incomplete institutional and physical infrastructure through various policies, to 'getting prices right' and later 'get institutions right' (Barrett and Mutambatsere 2005). Enabling smallholders to reach effective markets that can

ensure better prices by overcoming market failures in developing countries has attracted huge body of research from the nineties (de Janvry et al 1991).

The explanation for differential market participation and choice of markets can be traced to the existence of proportional transaction costs (per unit costs of accessing transportation and imperfect information) and fixed transaction costs (costs associated with search, negotiation and bargaining, and screening, enforcement and supervision) (Key et al 2000). Failure to participate in markets results from high transport costs as found from study of coarse grain markets in SSA (Goetz, 1992), and in food crop growers in Kenya (Omamo 1998a & b), and coffee producers in Uganda (Fafchamps and Vargas-Hill 2005).

Information on its own does not help mitigate the situation for farmers in reaching distant markets for fetching higher prices and can only enable them better bargaining with local traders as found in Uganda (Svensson and Yanagizawa 2009) and Ghana (Zanello et al 2014) and India (Mitra et al 2018). Also, neither SMS-based information in India (Fafchamps and Minten 2012) nor mobile phone usage in West Africa does not result in higher prices. Combining market failure literature with intra-household allocation and decision making literature, Lee and Bellemare (2013) found that intra-household allocation of mobiles with either the farmer or his spouse enables a 5-8% increase in producer prices for cash crop in the Philippines.

Empirical evidence demonstrates that the key issues to higher market participation for farmers in developing countries are- improving facilities in markets and reducing travel time (Shilpi and Umali-Deininger 2008), promoting competition and consolidation in markets (Minten et al 2012), promoting farmer access to markets and competition among players (Mitra et al 2018), and transport and information (Negi et al 2018). Besides, developing country farmers face market failures in responding to the rising quality consciousness with rising incomes as the existing marketing infrastructure does not support external verification with trust in the system and information about crop quality attributes are not circulated (Fafchamps et al 2008). Further, high transport costs, lack of reliable price information and quality verification mechanism result in intermediaries exploiting farmers producing non-food crops (Goyal 2010). Despite providing critical services, their removal can lead to significant efficiency gains (Goyal 2010; Besley and Burgess 2000; Minten et al 2012).

Market failures dampen price realisation for farmers in developing countries and new institutions in marketing are expected to address these failures (Williamson 1985; Key et al 2000). New institutional economics posits that new institutions emerge as a response to missing markets in an environment of pervasive risk, incomplete markets and information asymmetry (Bardhan 1989). Organizational structure of firms are chosen in part to minimize transaction costs (Williamson, 1975). Contracts between agribusiness firms have evolved and popularised in this background since the nineties and promoted by governments as well as international organisations (Key and Runsten 1999; Barrett et al 2012). Emergence of demand driven value chains with more power to the retail end of the value chain represents further developments in this regard. Modern value chains represent an opportunity for the smallholders in developing countries to overcome market failures and reduce transaction costs, apart from acting as a hedge against price risks (Reardon et al 2009; Rao et al., 2018). This is hypothesised to help the resource poor farmers in developing countries to participate in markets and rework their production decision as price signals effectively get transmitted from these demand driven value chains. The latest in the emerging

institutions is the state-run electronic national markets for agricultural produce in India. The lack of integration across markets (Roy et al 2018), inefficiencies leading to sub-optimal play of market forces (Chand 2012 and 2016), need for transparency by reducing the scope for collusion (Minten et al 2012), and need for single licensing system of the buyers across different states in the country are some of the other country-specific factors that justify harnessing of information and communication technologies to foster a national market.

3. Data and Methods

The study harnessed both secondary and primary data. The secondary data on prices, market arrivals and bids/offers collected by various e-NAM *Mandis* available with the Department of Marketing, Ministry of Agriculture and Farmers Welfare of Government of India are used to analyze the market trends before and after the introduction of e-NAM. The electronic *Mandis* initially got a head start in six states viz., Uttar Pradesh, Madhya Pradesh, Haryana, Maharashtra, Telangana and Gujarat. Therefore, this study has focused on these states and collected primary data from about 5% of these 341 markets- in about 21 *Mandis*. The Agro-Economic Research Centres of the respective states conducted the primary data collection and analysis. Researchers from the respective Agro-Economic Research Centre (AERC) have visited the *Mandis* selected and made a list of farmers and *Mandi*-registered traders and commission agents. Then a sample of 100 farmers, 25 traders and 25 commission agents is selected randomly for survey in each state making the total sample to be of 856 farm households and 150 each of traders and commission agents from 338 villages in 23 districts across six states. A structured questionnaire is used for data collection. The data collected pertain to the major commodities traded in these markets. Determinants of farmer satisfaction with the electronic markets and higher price differential relative to physical market transactions are analysed using logit and tobit models, respectively.

4. Characteristics of the Sampled Farm Households and Price Discovery

The educational and land size categories of these farm households are representative of the typical farming situations in India on the whole with some exceptions in some states (Table 1 and Figure 1). The participants are highly educated with 28% of them completing higher education and another 30 per cent of them having studied upto high school. Only ten per cent of the illiterates could sell in electronic market. Most of the respondents have obtained high school or higher education in all the states selected except Telangana. Among the sample respondents across states, the participating farmers in Gujarat are better educated with 42 per cent in higher education followed by 42% high school educated farmers in Haryana. It is heartening to note that largest proportion viz., 35% illiterate farmers from Telangana participated in eNAM.

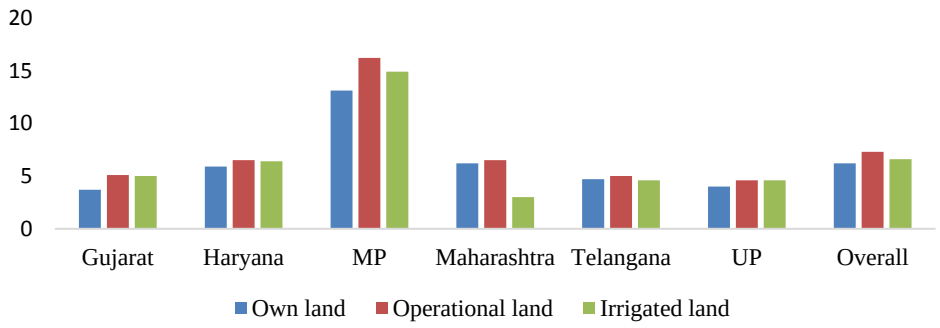
The share of smallholders among those selling to eNAM form representative proportion in Gujarat (81%), Uttar Pradesh (70%), and Telangana (65%), while they form miniscule proportion in Madhya Pradesh (24%), Maharashtra (39%), and Haryana (47%). On the whole, our study shows that smallholders constitute 55% among those selling to these electronic agricultural markets. On a positive note, four per cent of those selling in Uttar Pradesh are landless labourers that have leased-in land.

Table 1: Educational and land holding size category profile of sample households

Category	Gujarat	Haryana	MP	Maharashtra	Telangana	UP	Overall
Education							
Illiterate	3.8	4.9	4.0	12.0	35.0	8.0	9.9
Primary	3.8	11.3	7.3	10.0	14.0	13.2	10.4
Secondary	17.0	21.1	26.0	20.0	17.0	26.4	22.4
High School	34.0	41.6	33.3	29.0	16.0	24.0	29.5
Higher education	41.5	21.1	29.3	29.0	18.0	28.4	27.8
Overall	100	100	100	100	100	100	100.0
Size category of farmers							
Landless	0.9	-	0.7	-	-	4.0	1.4
Marginal	49.1	24.0	5.3	15.0	35.0	39.6	28.6
Small	31.1	23.3	18.0	24.0	30.0	25.6	24.9
Medium	12.3	36.7	25.3	42.0	25.0	22.4	26.8
Large	6.6	16.0	50.7	19.0	10.0	8.4	18.3
Overall	100	100	100	100	100	100	100.0

However, the major concern is that mostly farmers with irrigated land (90%) are eNAM participants (Figure 1). The entire operational land is irrigated in all states except in Maharashtra and Madhya Pradesh where only 46% and 92% of the participating-farmers land is irrigated. The second aspect to be noted from Figure 2 is that the average land owned is 6.2 acres as a whole and much higher in MP with 13.1 acres and relatively lower in Gujarat (3.7 acres) and UP (4.0 acres).

Figure 1: Average own land, operational land and irrigated land of sampled households in acres



Price discovery in eNAM vis-à-vis Manual *Mandis*: The prices of the participating farmers are analysed to examine whether the stated objective of enabling higher price discovery through electronic market is achieved or not. The prices received before and after participating in electronic markets are controlled for inflation as they relate to different years by dividing with consumer price indices in respective states. Then, the crop specific differences in average real prices received by individual farmers are combined for the purpose by using weights of the monetary value of total transactions of the sampled households (Table 2). The prices of the 14 agricultural commodities before and after the e-NAM implementation shows that the

participation in electronic market transactions enabled higher price discovery by 3.75 per cent for the participating farmers as shown in the fifth column of Table 2.

Table 2: Primary survey based pre and post e-NAM price comparison for sampled households

Commodity	Weights	Price before eNAM in INR (Current prices)	Price after eNAM in INR (Current prices)	Price difference in real terms (%)
Paddy	0.48	1840	2180	8.460
Wheat	0.07	1599	1602	-0.300
Sorghum	0.01	1865	1913	0.070
Pearl millet	0.00	1297	1301	0.010
Maize	0.06	1252	1219	-0.230
Pigeon pea	0.00	4175	4533	0.030
Bengal gram	0.07	4417	4432	-0.040
Green gram	0.00	4707	4578	0.003
Lentil	0.02	4046	3214	-0.320
Black gram	0.06	4915	2830	-2.440
Ground nut	0.00	3825	4483	0.040
Cotton	0.05	4247	5128	0.870
Fruits	0.02	478	507	0.190
Vegetables	0.14	768	642	-2.720
Others	0.03	1879	1967	0.130
		2160	2211	3.750

Source: Calculated from field survey data. Note: The price difference in real terms in the last column is arrived at by dividing deflated value of prices before eNAM with the deflated values of the post-eNAM prices and multiplying with 100.

The price advantage of 3.75 per cent shown in Table 2 is based on the prices received by the farmers for the same crop before and after eNAM situations. Though this gives the price difference realized by the same person for the same agricultural produce, it needs to be noted that there is a difference in the time horizon. While the pre-eNAM situation refers to the price received in 2016-17, the latter is for the year 2017-18. Several factors might be responsible for this price difference in a different year. Ideally, both prices received by the participant farmers should have been compared with non-participants in both before and after scenarios. Since our sample does not afford this comparison, we generate another counterfactual with the price movements in the physical transactions for these commodities by harnessing price data in the same *mandis* (Table 3).

The prices of agricultural commodities plummeted by 8.34 per cent in the corresponding period in the manual transactions in the *mandis* as can be seen from Table 3. The comparison of positive price impact realized in eNAM with the general movement of prices in the same *mandis* for the corresponding periods show that eNAM was instrumental in helping farmers get a 3.75 percent higher price over pre-adoption scenario in the background of plummeting prices. This higher price in the electronic market is expected as it spreads the market area to the entire country and consequently helps better play of market forces with higher clearing prices. Higher prices in this study context of overall declining prices are particularly important as this positive impact is achieved in the gloomy scenario of depressing prices nationally and internationally.

Table 3: Variations in Agricultural Prices in Physical Transactions of *Mandis* in 2017-18 vis-à-vis 2016-17

Crop	Weights	Prices in 2016-17 (Current prices)	Prices in 2017-18 (Current prices)	Price difference in real terms
Paddy	0.164	1684	1789	2.59
Wheat	0.359	1819	1526	-17.14
Sorghum	0.001	2023	1873	-8.26
Pearl millet	0.001	1780	1275	-25.95
Maize	0.005	1462	1215	-14.73
Pigeon pea	0.038	5798	3117	-44.23
Bengal gram	0.126	7634	4887	-35.89
Green gram	0.008	4892	4336	-11.47
Lentil	0.015	5494	3696	-32.00
Black gram	0.019	5755	2850	-49.87
Groundnut	0.005	4233	2913	-31.17
Cotton	0.022	5195	4857	5.67
Fruits	0.050	3269	3504	-8.29
Vegetables	0.098	897	1343	6.27
Others	0.089	2838	2963	48.16
Overall	0.999			-8.34

Source: DES, Ministry of Agriculture and Farmers Welfare

5. Infrastructural Facilities and Perceived Problems in Regulated Markets (*Mandis*)

The perceptions of the stakeholders in regard to markets are as important as the measurable outcomes like prices received. Here, we look at the perceived satisfaction levels and bottlenecks in selling through the electronic agricultural markets. It is to be noted that many of these same bottlenecks hamper effective functioning of agricultural markets in India. Nearly two-fifths (44%) of the participant-farmers among the sampled households are satisfied with the performance of eNAM. The proportion is much higher in Telangana (89%), Gujarat (81.5%), and Haryana 79.3%). Most of the farmers selling in eNAM (66%) view quality testing as transparent, 47% of them feel that this rating as liberal and 22% of them actually received quality testing report. The real problem, however, is in regard to the availability of facilities in the regulated markets as expressed by the participating-farmers (Table 4).

Table 4: Percentage of farmers reporting facilities available in regulated markets across states

	Percentage of farmers reporting availability of facilities						
Facility	Gujarat	Haryana	MP	Maharashtra	Telangana	UP	Overall
Weighing	80	100	100	100	100	95	97
Bid management	31	84	100	100	100	18	66
Cleaning	13	95	0	8	100	80	56
Assaying	4	75	15	86	100	18	45
e-auction	4	75	3	99	100	14	43
Grading	20	29	0	67	50	28	30
Grain storage	41	38	3	74	50	0.4	26
Drying	5	16	0	1	100	8	18
Sorting	7	31	0	7	50	15	18
Soil testing	67	-	-	-	50	-	12
Cold storage	3	-	-	-	-	-	0.20

Source: Field surveys

The infrastructural facilities are poor in the *mandis* with a lot of variation across Indian states (Table 4). On the whole, cold storage facilities are non-existent in the *mandis*. Relatively small proportion of farmers expressed satisfaction with the soil testing (12%), sorting (18%), drying (18%), grain storage (26%) and grading (30%). There is much to be desired in terms of facilities like e-auction, assaying, cleaning and bid management that are found to be satisfactory by 43%, 45%, 56% and 66% of participating farmers. The satisfaction level with the facilities in the *mandis* is relatively better in Telangana and Haryana; of average level in Gujarat and Maharashtra; and poor in Uttar Pradesh and Madhya Pradesh. The crucial requirement for participating in eNAM is the availability of assaying and e-auction facilities and the availability of these facilities is negligible in Gujarat, MP and UP. Shalendra and Jairath (2016) and Roy et al (2018) also identified these bottlenecks as the major challenges to electronic agricultural markets. On other hand, lack of facilities like cold storage, drying, sorting, grading, and grain storage facilities hinder even the manual transactions in the *mandis*, as Aggarwal et al (2017) concluded from their survey of *Mandis.*

Table 5: Perceived serious problems in eNAM across states

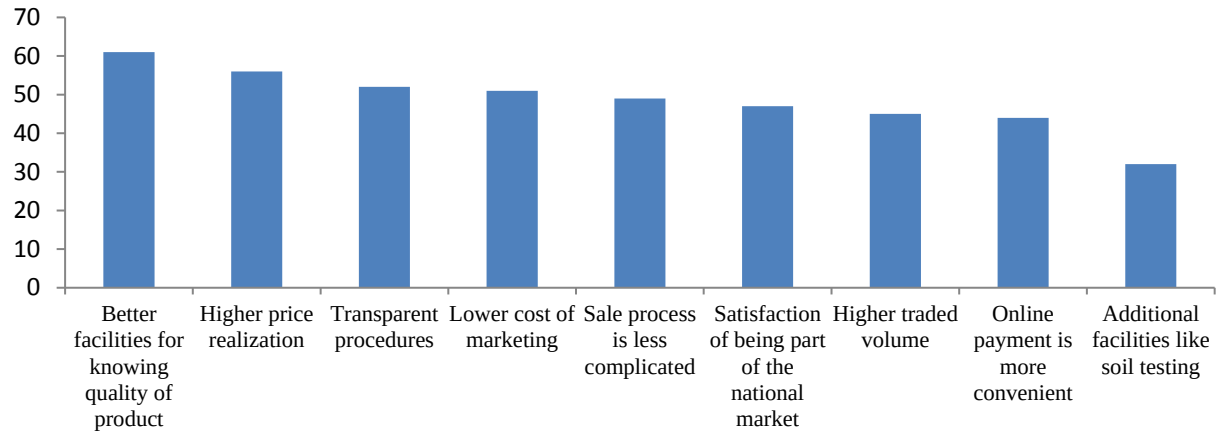
Problem	Percentage of farmers reporting problems in						
	Gujarat	Haryana	MP	Maharashtra	Telangana	UP	Overall
Labour problem for loading / unloading	76	39	45	16	89	49	48
No soil testing laboratory	100	36	61	55	97	24	47
No trained manpower to help with electronic transactions	74	19	61	21	86	36	46
Delay in online payment	50	25	92	17	86	19	41
Discovering prices is cumbersome	50	25	87	18	70	15	40
Online payment process is difficult	50	30	94	15	57	19	40
No refrigeration facilities	67	57	15	50	97	24	40
Not enough computers	62	35	21	25	97	31	38
Poor net connectivity	71	36	23	25	96	21	37
Sale process is complicated than before	79	22	81	16	50	16	36
Collusion among traders/trade malpractices	50	43	77	3	55	14	36
Frequent power failures	0	42	0	20	83	31	35
Cleaning facilities are not adequate	48	46	56	16	91	22	35
Poor road network for transportation	71	32	43	12	44	35	33
Sorting facilities are not adequate	60	49	40	15	22	28	33
Grading facilities are not adequate	60	50	29	18	80	12	31
Quality parameters are stringent	67	21	54	26	100	12	31
No guidance or help desk	84	25	66	2	17	7	29
Electronic system does not work/works occasionally	70	33	24	18	68	22	28
Higher cost than pre e-NAM	40	36	61	63	66	8	28
Weighing facilities are not adequate	53	25	30	11	77	10	24
Lower price than pre e-NAM	0	31	-	14	65	8	21
Market is far away	-	35	8	3	54	21	21
Higher *mandi* fees than before	43	5	5	27	-	28	15

Source: Field surveys

The participating farmers in eNAM expressed non-availability of trained manpower to handle online transactions (46%), delay in online payment (40%), lack of sufficient computers (38%), poor net connectivity (37%) and frequent power failures (35%), lack of help desk (29%) and occasional non-functioning of e-auctioning (28%) as the major problems in selling through electronic market. Large proportion of them (40%) also opined that online payment process is difficult and that the sale process is complicated than before (36%). Apart from these online transaction specific problems, there are problems that make selling in *mandi* a difficult thing. Some of them are- poor road connectivity (54%), labour problem for loading/unloading (48%), collusion among traders (36%), inadequate sorting facilities (33%), grading facilities (31%), stringent quality parameters (31%). Several scholars documented these shortcomings in the

effective functioning of *mandis* in India (Minten et al 2012; Aggarwal et al 2017). They also feel the need for a soil testing laboratory (47%) in the *mandi* for guiding them in crop production decisions. Other studies also reported similar perceived needs of the farming community to improve soil conditions (Singh et al 2018).

Figure 2: Perceived advantages in selling through eNAM



Source: Field surveys

When we look at the advantage of e-NAM, more than 50 per cent stakeholders from across states reported availability of better facilities for knowing quality of product (61%), higher price realization (56%), transparent procedures (52%) and lower cost of marketing (51%). Among the states selected, highest per cent of farmers from Telangana have realized advantages of e-NAM (Figure 2). The participant farmers also mentioned other advantages like easy sale process, convenient payment and so on.

6. Determinants of satisfaction and price differentials in eNAM: The econometric analysis for identifying factors leading to satisfaction with eNAM (Fourth column in Table 6) indicates that significant determinants are bidding facilities, e-auction facilities, testing of quality, overall rating of e-NAM, ease of selling, ease of online payment, cleaning facilities and price for wheat and pulses. The positive and significant level at overall rate of e-NAM shows that e-NAM is performing well. Among these variables, cumbersome sale process, difficulty and delays in online payments and lack of cleaning and sanitation facilities inconvenience the farmer-participants. As the online sale process gets standardized and farmers get used, these problems might be sorted out with concerted efforts of authorities. Significantly, they are happy with the bidding, e-auction, and receiving report of quality testing of produce.

Table 6: Factors determining price differences and satisfaction with eNAM: Tobit and logit regression results

Variables	Tobit for price difference		Logit for satisfaction (e-NAM better than manual mandi = 1)	
	Coefficient	Std. Error	Coefficient	Std. Error
Education in number of years	-1.54***	0.39	-	-
Educated or not (Literate = 1)	-	-	0.91	0.71
Actual land owned in acres	-0.3	0.26	-0.03	0.04
Farm size category (Small = 1)	-2.26	1.74	-	-
Irrigated area - 100% irrigated or less (Yes = 1)	9.16**	4.37	-0.45	0.68
Availability of assaying facilities (Yes=1)	4.61	4.07	-0.22	0.63
Availability of bidding facility (Yes=1)	-8.39	5.38	1.9***	0.70
Availability of e-auction facility (Yes=1)	-6.35	4.48	1.5**	0.62
Quality testing parameters (Transparent=1)	6.59**	2.93	-	-
Received a report on testing of quality (Yes=1)	-	-	1.61***	0.56
Rate e-NAM overall (satisfactory=1)	1.3	3.23	3.76***	0.47
Higher mandi fees than before (Yes=1)	-8.39**	4.17	-	-
No guidance or help desk (No=1)	-	-	-0.74	0.57
Electronic system does not work (Yes=1)	-	-	-0.6	0.53
Cumbersome sale process (Yes=1)	12.76***	3.50	-1.14**	0.54
Price discovery complicated than before (Yes=1)	-1.58	3.32	-	-
Poor net connectivity (Yes=1)	-6.88**	2.99	-	-
Grading facilities are not adequate (Yes=1)	-3.85	3.77	-	-
Quality parameters are stringent (Yes=1)	-8.6**	3.83	-	-
Online payment process is difficult (Yes=1)	-	-	-1.41**	0.55
No trained manpower to help (Yes=1)	-	-	-0.36	0.44
Cleaning facilities are not adequate (Yes=1)	-	-	-1.37**	0.61
No refrigeration facilities (Yes=1)	-	-	-0.92	0.59
Northern region	19.39***	7.08	-0.57	0.77
Western region	-7.7	5.61	0.53	0.69
Southern region	-5.97	7.41	-0.93	1.00
Paddy dummy	5.48	4.76	-0.91	0.70
Wheat dummy	-4.98	5.25	-1.48**	0.74
Pulses dummy	0.14	5.93	-4.22***	1.30
Vegetables dummy	-7.35	8.29	-0.71	0.83
Constant	28.96***	10.30	0.87	1.70
Sigma	24.03	1.03	-	-
Log likelihood	-1443.5		-99.84	
Number of observations	437		537	
LR chi2(22)	168.89		514.44	
Prob > chi2	0.0000		0.0000	
Pseudo R2	0.0553		0.7204	
Left censored observations at pdiff_perc2<=0	143			
Uncensored observations	294			
Right censored observations	0			

Source: Authors' analysis using field survey data

The Tobit model regression analysis was performed by considering price differences as the dependent variable and other determinants as independent variables to examine what are factors responsible for positive price differences (relative to price received by the same farmer for the same crop in regulated market before introduction of eNAM) in crops when farmers sell their crops after the introduction of e-NAM. In other words what helps farmers to get better price for their crops? The variables such as irrigation, satisfaction with quality testing, ease of sale process and geographical location in northern region are positively significant (Column 2 of Table 6). This implies that farmers with fully irrigated farms and those located in *mandis* in Haryana get

higher prices in eNAM. Quality testing to the satisfaction of users is also found to be significant in resulting in getting positive price difference. The farmers form Haryana have received higher price and benefited in selling their crops in e-NAM (Sekhar and Bhatt 2018). The finding that farmers having irrigated farms alone are benefitting is a concern. Several studies show that farmers with better resources especially irrigation could participate and reap higher profits (Rao et al 2018; Reardon et al 2009). The negatively significant variables such as higher *Mandi* fees, poor net connectivity, and stringent quality parameters show that those factors stand in the way of obtaining higher prices by farmers in eNAM relative to manual and spot transactions.

7. Conclusions and policy implications

The scattered nature of agricultural markets across the length and breadth of the country in large numbers, higher variations in price realization for farmers relative to even other developing countries, and obsolete marketing system necessitate changes in the policy framework for agricultural marketing. This paper examined the functioning of this market by harnessing primary data from 856 households in six states and employed descriptive as well as binary variable regressions.

The participation in electronic markets seems to be conditioned by education, as majority of the participants completed high school and even acquired higher education. The analysis shows that the participating farmer households in electronic markets received a 3.75 per cent higher price by selling in electronic markets compared to the pre-adoption scenario. Another counterfactual scenario through the analysis of price data of manual transactions for the select commodities before and after the adoption scenarios shows that prices have declined for all the agricultural commodities by 8.34%. Juxtaposing the treatment and counterfactual scenarios, this study concludes that selling in the electronic market has the potential to enable higher prices to farmers through increasing competition and thwarting inefficiencies. Though the 3.75 percent higher price seems smaller, this is significant in the background of plummeting prices in the markets in general.

The findings of our study show the pathetic stage of infrastructure with non-existent facilities for cold storage and very poor facilities for soil testing, sorting, drying, grain storage, and grading. The large proportion of participant-farmers informed that there are no assaying facilities (55%) and e-auction facilities (57%). Serious problems in eNAM functioning include- lack of trained manpower to handle online transactions, delay in online payment, lack of sufficient number of computers, poor net connectivity, and frequent power failures, lack of help desk and occasional non-functioning of e-auctioning. It was the lack of infrastructure and its poor quality that stifles its functioning. The importance of infrastructure build-up is also highlighted by several scholars in agricultural marketing as the crucial pre-requisite for the effective functioning of the electronic marketing (Chand 2016; Dey 2016; Agarwal et al 2017; Bisen and Kumar 2018). Roy et al (2017) also concluded that markets for commodities in India lack integration and that serious large-scale investments are required for the functioning of eNAM comprising warehousing, cold storages, refrigerated vans, laboratories, grading facilities and certification mechanisms among others. Our findings show that 54% of the farmers felt that road connectivity is a serious problem in selling in the *mandi*. This requires serious attention not only for electronic marketing, but also for agricultural marketing in general. Several studies highlighted the importance of transportation (Negi et al 2018). It is here that the role of new institutions and

incentives might play a big role. A special purpose vehicle for this purpose might be a good idea considering the experience of the Karnataka model.

Further examination of the underlying factors for satisfaction with eNAM revealed that the availability of e-auction and bidding facilities and provision of quality testing report are positively correlated with satisfaction levels. Conversely, cumbersome price discovery process, difficulty and delays in online payment and lack of cleaning facilities proved dampeners for farmers' happiness with the electronic marketing. Another significant set of findings indicates that availability of irrigation facility, good and transparent quality testing, farmers being located in northern region and price discovery process are positively associated with better price realization relative to before adoption scenario. On the other hand, higher *mandi* fees, poor net connectivity, and stringent quality parameters stifle price realization significantly.

The results of the study showed that participating farmers in the electronic market receive higher prices and only two-fifths of them are happy and satisfied. The performance of this intervention is poor in states of central and north India, where infrastructure in general and marketing infrastructure in particular are relatively under-developed. Extending the eNAM to all the market yards in the country, developing standards, net connectivity, bidding facilities, transparent testing facilities, and ease of online payment system will go a long way in establishing eNAM as the preferred marketing option for the farm households, though it is by no means a panacea as Chand (2016) asserts. The rise of online market from government side will act as a countervailing force to the steadily picking up private investments, some of which can be monopolistic in nature. It is equally important to realize that regulated markets form only one-third of agricultural marketing and that many other players have been engaged in this trade.

To conclude, adequate physical infrastructure is crucial even for the functioning of the electronic market and other related policy measures are needed to have a significant improvement in agricultural marketing. The successful electronic market marketing should lead to higher price realization in manual transactions and this has not happened due to the miniscule share of eNAM transactions. On the whole, the exclusion of resource poor and illiterate farmers, lack of related infrastructure including short-term credit in regulated markets and insignificant penetration of electronic market transactions do not inspire confidence on its ability to help overcome market failures. Future research might focus on the impacts with effective counterfactual methods and in a medium-term panel approaches.

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