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The changing structure of agricultural marketing in India: a state-level analysis of e-NAM

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Abstract The government of India launched e-NAM to remove inefficiency and enhance transparency in the agricultural marketing system and ensure fair prices to farmers for their produce. This paper examines the (i) extent of APMC markets covered by e-NAM across the states, and stakeholders' participation in e-NAM; (b) pattern of trade, its concentration, and determinants; (c) benefits of e-NAM to farmers; and (d) constraints in e-NAM trading. The evidence shows no significant price advantage for most commodities across the states on the implementation of e-NAM. This indicates the need for strengthening quality assaying and accelerating the issuance of unified licenses to promote inter-market trading and achieve better price discovery.

Keywords Trade performance and concentration, stakeholder's participation, effect on farmers price, constraints in e-NAM trading

JEL Codes Q11, Q13, Q180

A series of policy measures taken by the Government of India has resulted in self-sufficiency in foodgrain production. However, an ineffective marketing system remains a cause of concern (Chand 2016). Hence, the Government of India launched an electronic-National Agriculture Market (e-NAM) — a pan-India online trading portal on 14 April 2016 — to improve price discovery in real-time by eliminating the information asymmetry between buyers and sellers. It connects surplus production regions with deficit regions through an online platform, which may lead to better market competition, and thus better prices for farmers for their produce. It also provides an option for buyers to access products across markets.

Nonetheless, our understanding of the effects of e-NAM on farmers' prices is limited. Kumar et al. (2020) find no price advantage in e-NAM over Agmarknet markets. Bachaspati and Pathak (2018) even reported a decline in the prices after the introduction of e-NAM in Chattisgarh. Reddy and Mehjabeen (2019) and Bhattacharya and Chowdhury (2020) noted a positive effect of e-NAM on commodity prices. Kumar and Pant (2020) and Rao et al. (2020) have reported that e-NAM has helped better price realization. On the other hand, Sekhar and Bhatt (2018), Reddy (2018) and Levi et al. (2020) provide mixed evidence of e-NAM. The evidence in most of these studies is either based on a few commodities from a small number of states and the inference cannot be generalized. There is an information gap on a holistic view of e-NAM in terms of size of the trade, its pattern and price effects. Against this backdrop, this paper examines the following questions: (i) to what extent APMC markets are connected with e-NAM across? (ii) what is the pattern of trade, concentration, and its determinants? (iii) whether e-NAM has benefitted farmers? and (d) what are the constraints in e-NAM trading?

Data and method

We utilize both secondary and primary data. The secondary data on daily e-NAM transactions (i.e, minimum, modal and maximum prices, and quantity

traded) were collected from the e-NAM portal (https://enam.gov.in) for July 2019 to June 2021, yielding a total of 6.4 lakh observations. State-level data on regulated markets, cultivators, gross cropped area, crop production, gross value added in the agriculture, and monthly commodity prices published by different government agencies were compiled. To study the perceptions of stakeholders about e-NAM and operational constraints, twelve focused group (FGD) discussions involving farmers, traders, and mandi officials were conducted at the APMCs of Chennai, Dindigul, Vellore, and Madurai districts of Tamil Nadu during February - March 2020.

We use Herfindahl-Hirschman Index (HHI) to measure the crop-group-wise concentration of e-NAM trade across states to capture the relative size of dominance by each state. The HHI is calculated as the squared sum of all the states' percentage share of trade (OECD 2018). It ranges between 0 and 10,000. A value of HHI less than 1500 indicates less concentration, 1500 to 2500 moderate concentration, and more than 2500 high concentration (Kranenburg 2017, Willingham and Green 2019).

We consider the value of trade as the performance of the state in e-NAM. The trade value of each state was normalized by dividing trade value by their respective state agricultural gross value added (AgGVA) to nullify the scale effect. It is hypothesized that if more markets are linked with e-NAM, more are the transactions in e-NAM. It is assumed that the proportion of farmers and traders' participation in e-NAM would expand the trade. The unified license (UL) for the traders— a pre-requisite for inter-market transactions — is an important factor influencing the volume of trade. It is expected that incentives such as cash awards for best-performing farmers, traders and e-markets would enhance e-NAM trade. It is plausible that the nature of commodities traded such as food grains and cash crops vastly determine the value of trade. With this background, an empirical panel regression model was fitted to analyze the determinants of e-NAM trade. A panel of 15 states was constructed and the fixed effect model was estimated:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 D_{1it} + \beta_7 D_{2it} + \varepsilon_{it}$$

where Y is the dependent variable, Xs and Ds are explanatory variables, βs are parameters, ε is an error term with zero mean and constant variance. Y is defined as the proportion of e-NAM trade value in total state AgGVA of i^{th} state in t^{th} year. X_1 is the percentage share of e-markets in the total regulated markets. X_2 is farmers' participation (%), which is measured as the proportion of registered farmers in e-NAM total cultivators in a state. X_3 is the trader's concentration (total number of traders per unit of gross cropped area (GCA)). X_4 is the proportion of traders who received the unified license. X4 is the share of non-food commodities trade value in the total trade. The policy dummy, D_1 is defined as the states which have given some form of monetary incentives as one and otherwise zero. D_2, a year dummy, was introduced to control time-invariant unobserved individual characteristics that can be correlated with observed variables.

The linking of agricultural markets across the country is expected to affect the farmers' price realization in many ways. For instance, e-tendering would result in more transparency, and even intra-market transactions would reduce the cartelization of traders. Also, e-trading by increasing the number of buyers is expected to enhance competitiveness. For this purpose, we used commodity-wise daily modal prices to derive monthly prices and aggregated monthly prices at the state level. We consider Agmarknet prices for comparing with e-NAM prices. Agmarknet covers more than 350 commodities across 3200 markets. It may be noted that Agmarknet covers e-NAM as well as non-e-NAM markets. The non-availability of data on exclusive non-eNAM market prices at the state level deprives the accuracy of our estimates on the price difference. However, the direction of bias could be identified. For instance, the negative (positive) price difference of e-NAM over non-e-NAM markets indicates an underestimation (overestimation) of the difference. Shapiro-Wilk normality test of price series indicated a violation of the normal distribution. Hence, we applied a non-parametric test (also called a distribution-free test). As we are interested in the paired monthly price differences, we choose Wilcoxon signed-rank test, a non-parametric test equivalent to the parametric paired t-test (Siegel and Castellan 1988).

Results and discussion

Pattern and growth in key characteristics of e-NAM

Linking all the markets with e-NAM and active

participation of stakeholders in e-NAM trading are the important factors in the success of e-NAM (Table 1). The performance on this count indicates substantial growth in the registration of Farmer Producer Organizations (FPOs) (144%) and the issuance of unified licenses (UL) (121%) in the past two years. A reasonable increase in linking of markets (71%) and traders' registration (40%) was also observed. However, the increase in farmers' participation, was very low (3%). Uttar Pradesh, Madhya Pradesh, Haryana and Telangana recorded a more than 60% increase in farmers' registration. Rajasthan recorded a good share in the markets, trader's registration, and issuance of UL. Active participation of FPOs was found in Maharashtra.

At the all-India level, only about 9% of the APMC markets were linked with e-NAM in July 2019 but their coverage is increased to 15% in June 2021 (Figure 1). The high coverage states (Himachal Pradesh, Rajasthan, and Gujarat) also could cover only about 30% of the total APMC markets. It implies that a majority of the markets are functioning in offline mode. From the FGD we find that those who are not comfortable with digitalization prefer to go for offline mode, and e-NAM is the last resort for them. Hence, expediting the mandi linking is essential to ensure greater participation of stakeholders in e-NAM. Farmers' e-NAM participation rate is the highest in Haryana (90%) and followed by Telangana (58%) as against the national average of about 13%.

Overall, about 86 traders per lakh hectare of GCA have registered for e-NAM at the all-India level. Uttarakhand has the highest intensity of the number of registered traders. In most other states it is less than 100. Unified

Table 1 State-wise e-NAM profile (as of June 2021)

States	Mandis		Farmers (in lakhs)		Traders		Unified licenses		FPOs	
	No.	%	No.	%	No.	%	No.	%	No.	%
Uttar Pradesh	125	12.5	33	19.3	34,758	20.1	110	0.2	223	11.9
Madhya Pradesh	80	8	30	17.7	21,555	12.5	393	0.7	80	4.3
Haryana	81	8.1	27	15.9	12,482	7.2	28	0	230	12.3
Telangana	57	5.7	18	10.7	5,709	3.3	5,709	9.7	55	2.9
Andhra Pradesh	33	3.3	14	8.4	3,365	2	3,365	5.7	170	9.1
Rajasthan	144	14.4	14	8.4	37,348	21.6	37,348	63.7	160	8.5
Maharashtra	118	11.8	12	7.1	20,073	11.6	0	0	257	13.7
Gujarat	122	12.2	9	5.1	9,325	5.4	105	0.2	86	4.6
Tamil Nadu	63	6.3	3	1.7	3,621	2.1	327	0.6	106	5.6
Jharkhand	19	1.9	2	1.3	2,064	1.2	39	0.1	75	4
Punjab	37	3.7	2	1.3	2,346	1.4	1	0	6	0.3
Odisha	41	4.1	2	1.2	5,848	3.4	5,848	10	159	8.5
Chhattisgarh	14	1.4	1	0.8	3,099	1.8	34	0.1	22	1.2
Himachal Pradesh	19	1.9	1	0.7	1,968	1.1	0	0	50	2.7
Uttrakhand	16	1.6	1	0.3	4,691	2.7	4,691	8	43	2.3
West Bengal	18	1.8	0	0.2	3,191	1.8	7	0	150	8
Puducherry	2	0.2	0	0.1	160	0.1	0	0	2	0.1
Chandigarh	1	0.1	0	0	80	0	0	0	0	0
Jammu & Kashmir	2	0.2	0	0	56	0	0	0		0
Karnataka	2	0.2	0	0	597	0.3	597	1	0	0
Kerala	6	0.6	0	0	217	0.1	35	0.1	3	0.2
All India	1,000	100	171	100	1,72,553	100	58,637	100	1,877	100
Growth* (%)	70.9		3.3		39.8		121.3			144.4

Source Compiled from the e-NAM portal
Note *indicates change over from July 2019 to June 2021

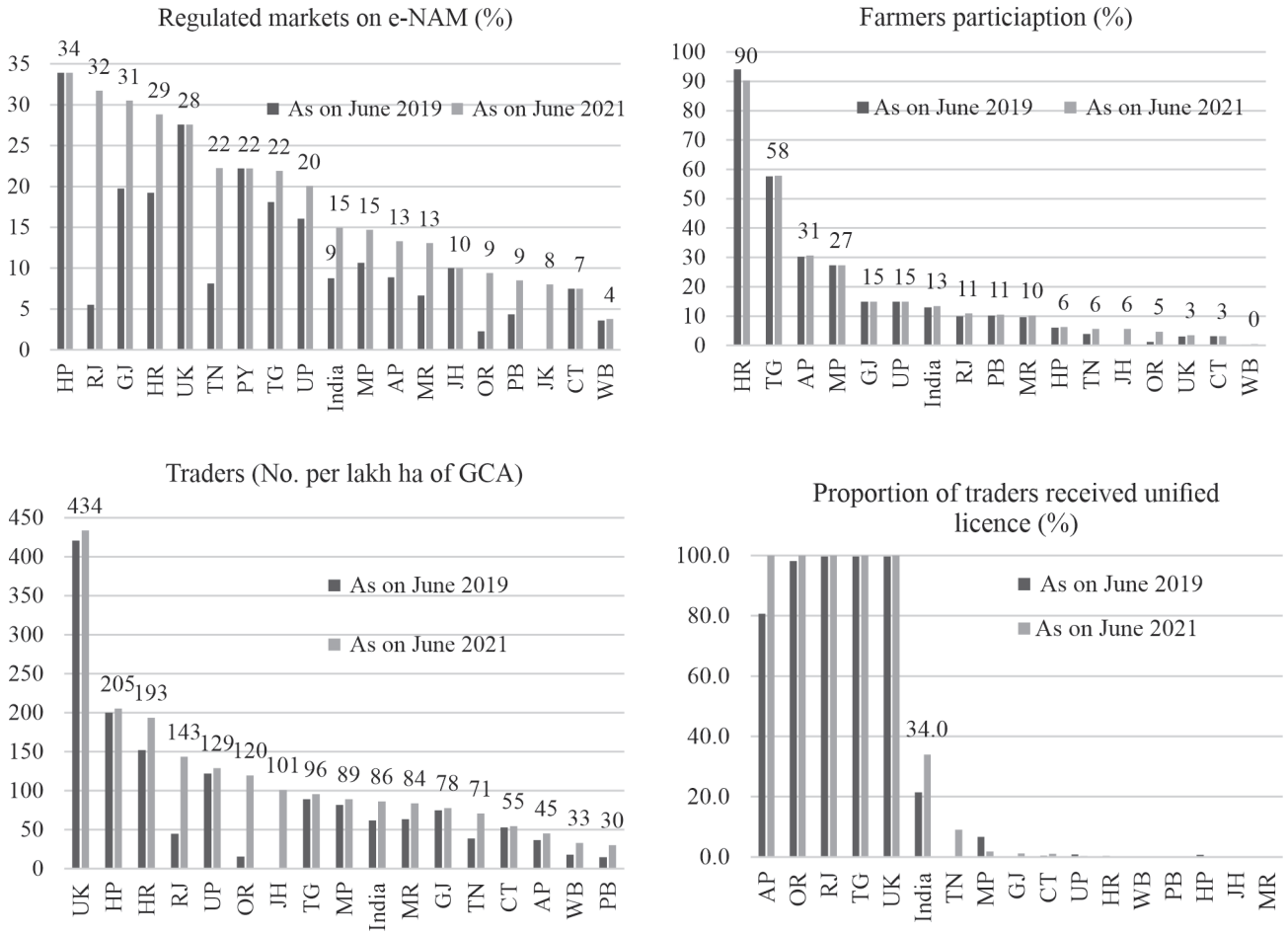

Figure 1 Regulated markets coverage and stakeholders' participation in e-NAM

Source Same as in Table 1

licenses essential inter-market trading is issued to only one-third of the traders. Also, high disparities were found in the issuance of UL among states. Five states issued UL to all traders, while in other states its issuance rate is very low or negligible.

Trade pattern and concentration in e-NAM

More than 175 commodities with a trading volume of 8.69 million tons in 2019-20 were traded through e-NAM, which is much smaller compared to their production (Tables 2 and 3). And , the year-on-year growth in 2020-21 was also very low (3.6%). Trade in cereals registered a decline of 19%, while the volume of pulses trade remained almost unchanged. The e-NAM trade in oilseeds, fruits, and vegetables is very low. Farmers expressed their concern about the uncertainty of sales in online trade and the spoilage of products if unsold. Vegetables and fruits consolidated their share in total trade. The HHI indicates that trade in pulses and oilseeds is highly concentrated in a few states. However, we find an upward trend in the concentration of four crop groups in 2020-21. The trade concentration in pulses and vegetables declined, which indicates the increasing participation of states in e-NAM.

The trade value increased by 14% between 2019-20 to 2020-2021. Although the cereals have the largest volume share the other commodity groups (comprising spices and dry fruits) have a larger value share The trade value of oilseeds more than doubled and it increased 1.7 times in the case of fruits. Cereals share rather declined about 11 percentage points, while that of oilseeds it increased to the same extent. Fruits and vegetables share also increased marginally. Overall, the trade concentration was moderate or high in all the commodities, except vegetables.

Table 2 State-wise and crop-wise trade concentration (Volume basis) in e-NAM

States	Cereals	Pulses	Oilseeds	Vegetables	Fruits	Others	All
			2019-20				
Total (million t)	4.69	0.93	0.36	0.88	0.11	1.72	8.69
Share (%)	54.0	10.7	4.2	10.1	1.3	19.8	100.0
			Share in total trade (%)				
Haryana	36.49	0.61	2.38	7.59	5.57	45.09	29.61
Rajasthan	5.02	11.35	45.01	0.07	0.01	5.03	6.80
Andhra Pradesh	0.05	0.38	18.37	35.86	28.58	25.42	9.84
Maharashtra	2.57	27.89	0.06	8.07	19.12	0.58	5.56
Punjab	9.85	0.08	0.08	14.91	9.73	11.32	9.19
Telangana	9.75	5.58	16.36	0.70	0.35	9.13	8.42
Madhya Pradesh	11.76	48.24	3.25	0.52	0.48	0.69	11.85
Uttar Pradesh	12.03	3.14	4.62	18.05	12.88	1.16	9.24
Odisha	8.42	0.11	2.21	0.00	0.00	0.16	4.68
Tamil Nadu	0.11	0.02	0.30	0.49	0.62	0.53	0.24
Himachal Pradesh	0.00	0.01	0.00	3.53	13.24	0.06	0.54
Others	3.95	2.57	7.36	10.22	9.41	0.83	4.03
HHI	1925	3282	2728	2075	1739	2919	1471
			2020-21				
Total (million t)	3.81	0.93	1.00	1.03	0.50	1.73	9.00
Share (%)	42.3	10.3	11.1	11.4	5.6	19.2	100.0
			Share in total trade (%)				
Haryana	48.54	1.68	19.39	7.85	2.13	37.07	31.03
Rajasthan	14.95	26.46	56.55	18.40	13.13	11.86	20.47
Andhra Pradesh	0.04	1.12	9.84	27.25	14.43	23.96	9.75
Maharashtra	3.64	31.09	0.27	8.25	56.04	0.65	8.96
Punjab	10.71	0.25	0.25	10.08	2.89	11.94	8.20
Telangana	5.67	7.85	9.33	1.23	1.47	9.82	6.36
Madhya Pradesh	5.08	23.23	0.75	0.81	0.07	0.24	4.77
Uttar Pradesh	3.80	1.39	0.74	10.84	0.87	0.61	3.24
Odisha	4.82	0.15	0.92	0.95	0.02	0.20	2.31
Tamil Nadu	0.17	0.03	0.03	6.70	1.41	3.06	1.51
Himachal Pradesh	0.00	0.01	0.00	2.37	5.84	0.07	0.61
Others	2.58	6.73	1.93	5.26	1.70	0.49	2.79
HHI	2810	2320	3763	1511	3576	2338	1714
Growth (%) *	-18.8	-0.5	178.0	17.5	338.4	0.8	3.6

Source Same as in Table 1; *Note* *indicates change over from July 2019 to June 2021

The progress of the e-NAM was assessed by comparing the trade with the total production and agriculture gross value added (AgGVA) (Table 4). The e-NAM trade accounts for 3% of the paddy and a half percent of wheat output, and about 2% of the total foodgrains production in 2019-20. Acuite (2021) also reported that about 5.84% of total foodgrains and oilseeds were traded through e-NAM in 2017-18. The figures are more or less the same for 2020-21. The value of trade also indicates a very low share (1.8%). Haryana (15%) and Rajasthan (7%) have a larger share. These findings indicate that although e-NAM commenced well, it

Table 3 State-wise and crop-group wise trade concentration (ad valorem basis) in e-NAM

States	Cereals	Pulses	Oilseeds	Vegetables	Fruits	Others	All
			2019-20				
Total (Rs Crores)	10,093	3,987	1,621	1,116	248	10,823	27,888
Share (%)	36.2	14.3	5.8	4.0	0.9	38.8	100.0
			Share in total trade (%)				
Haryana	45.5	0.6	2.1	9.9	10.1	36.1	31.2
Rajasthan	4.2	13.2	40.8	0.1	0.0	5.2	7.8
Andhra Pradesh	0.0	0.4	20.2	27.8	17.6	39.1	17.7
Maharashtra	7.6	6.1	18.4	0.9	0.6	7.5	7.7
Punjab	11.9	0.1	0.1	11.3	5.2	9.4	8.5
Telangana	2.1	26.9	0.1	14.0	19.7	0.5	5.5
Madhya Pradesh	10.3	46.5	2.8	1.5	0.6	0.5	10.8
Uttar Pradesh	9.9	3.1	4.7	15.1	7.8	0.5	5.2
Odisha	0.1	0.0	0.4	0.7	0.3	0.5	0.3
Tamil Nadu	5.4	0.2	4.0	0.0	0.0	0.1	2.3
Himachal Pradesh	0.0	0.0	0.0	7.4	30.4	0.1	0.6
Others	3.0	2.8	6.3	11.2	7.8	0.7	2.6
HHI	2531	3119	2507	1607	1874	3001	1660
			2019-20				
Total (Rs Crores)	8,073	4,785	5,402	1,423	669	11,557	31,909
Share (%)	25.3	15.0	16.9	4.5	2.1	36.2	100.0
			Share in total trade (%)				
Haryana	57.5	1.8	19.6	6.9	4.7	30.0	29.4
Rajasthan	11.2	28.4	56.2	20.2	32.3	12.1	22.5
Andhra Pradesh	0.0	1.2	9.2	24.6	22.2	34.5	15.8
Maharashtra	4.2	8.9	10.0	1.4	2.0	9.3	7.5
Punjab	12.1	0.3	0.3	7.7	2.0	10.1	7.2
Telangana	2.7	29.2	0.2	10.0	9.9	0.5	6.0
Madhya Pradesh	4.1	21.0	0.7	2.8	0.2	0.2	4.5
Uttar Pradesh	2.8	1.4	0.6	8.3	0.8	0.2	1.5
Odisha	0.1	0.0	0.1	7.2	1.4	2.7	1.4
Tamil Nadu	3.3	0.2	1.6	0.1	0.0	0.1	1.2
Himachal Pradesh	0.0	0.0	0.0	4.4	20.9	0.1	0.7
Others	1.9	7.6	1.5	6.5	3.5	0.3	2.4
HHI	3644	2246	3737	1412	2118	2427	1798
Growth (%)*	-20.0	20.0	233.3	27.5	169.5	6.8	14.4

Source Same as in Table 1
Note *indicates change over from July 2019 to June 2021

needs to go far away to realize its objectives.

The e-tendering or e-trading?

The e-tendering is a process involving online transactions between buyers and sellers within a market. While in the case of e-trading, the transactions are dispersed across buyers and sellers in different markets. Since the purpose of e-NAM is to connect the farmers and traders across markets through an online portal, we assess the share of inter-market trade in the total trade (Figure 2). Due to data accessibility constraints, this analysis is confined to the period of

Table 4 e-NAM trade as a share of production and value

States	Paddy (m t)		Wheat (m t)		Foodgrains (m t)		AgGVA in 2018-19 (Rs '000 crores)	Total e-NAM trade value 2020-21 (Rs crores)	Share of e-NAM trade in AgGVA of 2018-19 (%)
	Production	e-NAM trade	Production	e-NAM trade	Production	e-NAM trade			
				2019-20					
Haryana	4.82	1.69	11.88	0.00	17.86	1.72	62.9	9,381.6	14.9
Madhya Pradesh	4.78	0.11	19.61	0.30	33.52	1.00	221.1	1,430.1	0.6
Uttar Pradesh	15.52	0.29	33.82	0.22	56.17	0.59	233.7	476.4	0.2
Telangana	7.43	0.28	0.01	0.00	11.13	0.51	49.0	2,407.6	4.9
Punjab	11.78	0.44	17.62	0.00	29.86	0.46	76.5	2,294.1	3.0
Tamil Nadu	7.17	0.38	0.00	0.00	11.27	0.40	83.3	378.0	0.5
Maharashtra	2.90	0.01	1.79	0.03	12.82	0.38	133.5	1,902.6	1.4
Rajasthan	0.48	0.01	10.92	0.12	23.23	0.34	102.1	7,194.8	7.0
Chhattisgarh	6.77	0.11	0.12	0.00	7.50	0.13	35.4	203.9	0.6
Gujarat	1.98	0.00	3.33	0.03	8.15	0.04	111.7	106.7	0.1
Others	41.54	0.03	3.09	0.01	63.45	0.05	627.7	6,133.6	1.0
All-India	118.9	3.34	107.9	0.7	297.5	5.63	1,736.9	31,909	1.8
All-India share of trade in total production (%)		2.82		0.66		1.89			
				2020-21					
All-India e-NAM trade quantity, 2020-21 (mt)		2.73		0.52		4.74			
Share of trade in total production of 2019-20 (%)		2.30		0.48		1.59			

Source Same as in Table 1.

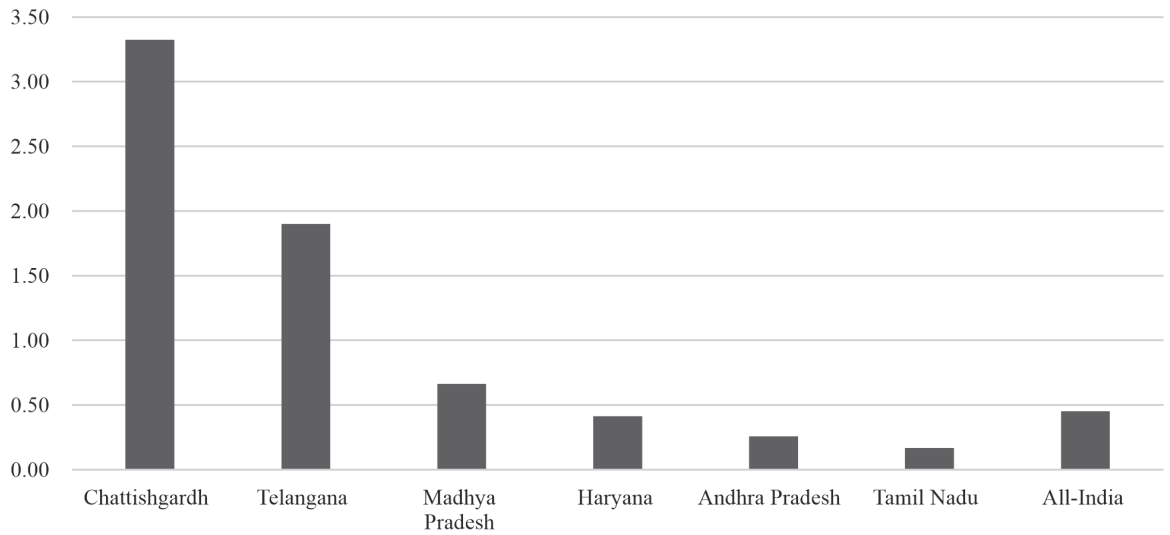

Figure 2 Inter-market trade value share in total trade during Jan 2018 to Dec 2019 (%)

Jan 2018 to Dec 2019. The value of trade shows that almost 99.5% of it happens through e-tendering, which indicates that the offline transactions that happened in APMC markets are just digitalized, ensuring transparency. But, to reap the full benefit of e-NAM, a substantial amount of inter-market transactions needs to occur to increase trade competitiveness and ensure better prices to farmers.

Determinant of e-NAM trade performance

We assessed determinants of e-NAM trade using the least square dummy variable (LSDV) regression. Farmers' participation, the share of non-foodgrains in total trade, and incentives appear as important factors positively influencing the value of trade. Farmers' participation is directly related to the value of trade, and on average each additional farmer would enhance trade value by 0.11%. The nature of commodities being traded also influences the value of trade. On average a one-percent increase in the share of non-foodgrains leads to a 0.025% increase in the value of trade. Further, the states that provide monetary incentives to stakeholders for participating in e-NAM trade, realize an average 2.3% higher trade through e-NAM. The infrastructure and buyer-related factors show neither coverage by e-NAM coverage nor traders' intensity and their licenses have a significant effect on the value of trade. As of now, intra-market trading is the most common phenomenon, while Unified license is an essential requirement for inter-market trading. Also, given the size of farmers' participation, the existing trader density is enough for handling the products. The differential intercept time dummy is also not significant.

The effect of e-NAM on farmers' price

Overall, it is observed that e-NAM prices are relatively lower compared to the Agmarknet prices. However, exceptions are also noticed. For instance, paddy prices are higher in e-NAM markets of Punjab and Haryana than their corresponding Agmarknet prices. It is plausible that most of their non-basmati paddy is procured by the Food Corporation of India (FCI) and the basmati paddy could have been traded in the e-NAM. Thus, we have dropped these two states from the price difference analysis. Groundnut in Tamil Nadu and Arhar in Karnataka are the other exceptions, where e-NAM prices are reported to have outpaced the Agmarknet prices. Additionally, it is also observed that farmers have not realized MSP for most crops in most of the states.

Out of 35 Wilcoxon price difference tests conducted across states for eight commodities, eight tests produced insignificant results indicating prices are more or less equal in both the markets at the state level. And, four tests supported the hypothesis of positive and significant effect of e-NAM on farmers' prices (in case of paddy in Uttar Pradesh (Rs 31/Qtl), Arhar in Karnataka (Rs 333/ Qtl), groundnut in Tamil Nadu (Rs1580 / Qtl), and soybean in Rajasthan (Rs59/Qtl). Two-thirds of the tests supported the hypothesis that e-NAM prices are lower than Agmarknet prices.

Table 5 Determinants of e-NAM trade performance

Dependent Variable: Proportion of e-NAM Trade value in state agricultural GVA (%)			
Variables	Coefficients	Standard Error	P-value
Intercept	-1.804	0.891	0.055
The proportion of regulated markets on e-NAM (%)	-0.036	0.056	0.530
Farmers' participation (%)	0.114	0.016	0.000
Traders per GCA (No./lakh ha)	0.008	0.006	0.164
Proportion of traders received unified licence (%)	-0.017	0.010	0.117
Share of non-foodgrains in the total value of trade (%)	0.025	0.013	0.062
Policy incentives (If incentives =1; Otherwise=0)	2.317	0.939	0.022
Time dummy (2019-20 =0 and 2020-21=1)	0.235	0.713	0.745
R Square	0.82		
Adjusted R Square	0.76		
Number of observations	30		

Table 6 Results of Wilcoxon signed-rank test of the price difference between e-NAM and Agmarknet markets

Crops	Major States	No. of paired observations	e-NAM price difference over Agmarknet		Z-statistic	P-value
			Number of negative signs	Average price difference (Rs/Qtl)		
Paddy	Uttar Pradesh	24	8	31	1.91	0.056
	Chhattisgarh	21	12	-37	-1.83	0.068
	Telangana	22	21	-112	-4.07	0.000
	Tamil Nadu	22	13	-145	-1.51	0.131
	West Bengal	20	20	-234	-3.92	0.000
Wheat	Chhattisgarh	24	13	50	0.23	0.819
	Rajasthan	24	20	-51	-3.66	0.000
	Madhya Pradesh	24	22	-51	-3.37	0.001
	Uttar Pradesh	24	22	-58	-3.51	0.000
Maize	Tamil Nadu	22	10	16	0.71	0.475
	Andhra Pradesh	21	9	-5	0.47	0.639
	Madhya Pradesh	24	15	-23	-1.11	0.265
	Maharashtra	24	16	-60	-1.91	0.056
	Telangana	23	17	-799	-3.20	0.001
Arhar	Karnataka	18	1	333	3.68	0.000
	Telangana	24	12	34	-0.11	0.909
	Maharashtra	24	23	-236	-4.26	0.000
	Uttar Pradesh	13	8	-288	-1.78	0.075
	Gujarat	18	12	-334	-1.89	0.058
Groundnut	Tamil Nadu	23	3	1580	3.77	0.000
	Andhra Pradesh	21	8	44	0.92	0.357
	Rajasthan	24	18	-139	-1.91	0.056
	Gujarat	17	16	-690	-3.57	0.000
	Maharashtra	21	13	-729	-1.62	0.106
Mustard	Haryana	15	8	-10	-0.51	0.609
	Rajasthan	24	20	-185	-3.77	0.002
	Madhya Pradesh	24	22	-370	-3.74	0.000
	Uttar Pradesh	24	24	-469	-4.29	0.000
	Gujarat	14	12	-589	-2.73	0.006
Soybean	Rajasthan	18	17	59	-2.19	0.029
	Chandigarh	24	15	-107	-1.20	0.230
	Madhya Pradesh	24	17	-194	-2.37	0.018
	Maharashtra	23	21	-216	-3.80	0.000
	Telangana	24	17	-681	-3.59	0.000
Copra	Tamil Nadu	22	22	-1135	-4.11	0.000

e-NAM trading process

Based on the focused group discussion with mandi officials, traders, and farmers in Tamil Nadu, we discuss the e-NAM trading process and constraints in its adoption. The farmers need to bring their products to the market. At the gate, registration, weighing will be done and a lot number will be generated. For farmers' registration, identifying proof and bank account details are required. Farmers need to register only one time in any market and this ID can be used for future transactions. However, there is no unique ID for farmers to trade across markets, hence, they need to do registration in each market separately.

Traders and commission agents also essentially need to do registration to do trading in e-NAM. For the traders, the registration is done at two levels APMC level -(--trading can only be done at a particular APMC) and state-level (--trading can be done across the states). The APMC level registration is approved by APMC, while, for state-level registration (unified license) the application will be approved by State Agricultural Marketing Board. Finally, the unified license with a unique ID will be provided by Nagarjuna Fertilizers and Chemicals Ltd (NFCL), Hyderabad, the strategic partner and the service provider for eNAM (SFAC 2021). In Tamil Nadu, farmers need to pay neither a registration fee nor a mandi fee. While traders need to pay license fees and mandi fees at the rate of one percent of the value of trade.

After the lot number is generated, a sample will be collected for quality assaying. Then, the complete details like commodity name, and varieties, quantity along quality parameters will be uploaded in the online portal. For each market, the opening and closing times for bidding will be varying. After the closing time of bidding, the system will identify the bid winner based on the highest bid for each lot and SMS also will be sent to the farmers for price confirmation. If the price is agreed upon, a sale agreement report will be generated and given to both farmers and traders. The trader needs to deposit the amount in the concerned APMC account, either online or at the bank, and lift the product from the APMC. From the APMC account, the mandi officials will transfer the money to the farmer's account on the same day, in some occasions, the delay is also reported maximum of three days. If the farmer is not satisfied with the price, he can reject the sale. After rejection, the farmer has two options. First, he can store the product at the APMC godown and sell it in the coming days and there is no storage cost for farmers for 15 days, after that Rs 0.4/qtl per day is charged. Second, farmers can take back the product for selling other outlets or storing it at their homes.

Stakeholders' perception and constraints in e-NAM trading

Farmers

The majority perceived that e-NAM reduced their marketing costs. Because, online trading eliminated 2% commission charged by the traders and other hidden charges, also ensured proper weighment. They believed e-NAM prices are more or less equal to other marketing outlets, but the absence of other charges benefitted them for participation in e-NAM. However, farmers also reported some of the constraints in e-NAM compared to their traditional market outlets, like waiting at the APMC till the product is being sold and delay in receipt of payment (2-3 days), and apprehension about non-sale in online and subsequent cost of return transportation charges. In the traditional market, the product is being sold at the farm gate or commission mandi, the product is sold immediately and the amount is also settled right away after adjusting advance if any taken. Some of the farmers are not much aware of the e-NAM process and price confirmation also through personal contact of e-mandi officials not through SMS, as reported in the e-NAM trade process.

Traders

Traders are not in favour of online trading, as they are facing difficulties in coping up with digitalization, and also it affects their income. They contend that e-NAM made them dependent on someone well-versed with digital transactions for their transactions-mostly their relatives or staff at the internet cafe. Some traders reported that they have been forced to buy a computer or laptop, as the mobile e-NAM app is not as convenient as the desktop app. For instance, all the lot they cannot see in mobile app simultaneously and lot details will be visible in reverse order of serial number. They perceive, it makes the bidding process very confusing and cumbersome. But Mandi officials describe that lot order reversal is essential to make aware of buyers the

total number of lots and assuring bidding for all lots rather than only initial lots. Traders reported that mismatch in traded quantity is one of the major hurdles in e-NAM. In offline trade, the lots are traded one by one and according to the need, traders purchased quantity. While in online trade, simultaneous bidding causes difficulty, either winning the lots more than demand or nil, both are troublesome to traders. Traders also reported that during the bidding process, there are no options in the system for save, reviewing the bids which make them bidding a nightmare. On the other hand, they also face monetary losses, one of the main losses for traders is the commission from farmers. Additionally, they need to pay a mandi fee in e-NAM, while outside e-NAM transactions are also supposed to report and deposit mandi fees at the respective APMCs, but in general, the transactions are underreported or unreported.

e-Mandi officials

The e-NAM officials the gross-root level implementation agents are finding it a tough time to transition from offline trading to online mode. The time for commodity arrival to trading is very short. Specifically, that is all the operations like lot number generation, quality assaying, uploading the lot details in the portal need to be carried out within 3-4 hours. Some of the officials reported that during the peak harvesting seasons of paddy daily 100 -150 farmers will visit the APMC market and the limited staff compels them to skip quality testing and grading will be done based on the inspection. Kumar et al. (2020) also reported the skipping of quality testing during peak marketing seasons in their study. It makes the reliability of the grading system highly questionable. Subsequently, buyers lose confidence in the grading system and they examine the lot physically before bidding the prices. NABARD (2018) study also noted that neither farmers nor traders are trusting the quality assaying. It has serious implications for inter-market trading, as the traders located in other places would not participate or need to employ the agent to verify the quality of the product. Eventually, the very purpose of online marketing is defeated. Also, this inefficiency in the system increases the transaction cost of buyers. Further, it is also observed that the difference in the bag size complicates the bidding process and hinders inter-market trading. For instance, paddy is packed in varying quantities in the different areas say 60 kg, 75 kg, 80 kg, and prices are quoted per bag rather than quintal.

Conclusions and implications

We analyzed the e-NAM performance and progress and its effect on farmers' prices. The e-NAM, still need to go long way to achieve set targets. Only about 15% of the APMC markets are linked and farmers' participation rate also wobbling around 13%. The major commodities traded are cereals which account for nearly 40% of total volume and 25% of the value of trade in 2020-21. The trade concentration analysis also indicated a moderate to the high concentration of trade in the majority of the commodities, highlighting only certain states are actively participating in e-NAM. Monetary incentives and farmers' participation rates are the major factors that influence the value of trade. We find the e-NAM prices are significantly lower than the Agmarketnet prices in most commodities in the majority of the states. And, only a very few states recorded the higher prices in some commodities. A very little amount of total products is being traded through e-NAM. Also, inter-marketing trade is negligible which could be one of the reasons for not increasing the competition and achieving better price realization. Reddy and Mehjabeen (2019) also reported no significant increase in competition as the flip side of e-NAM. The benefit of online trading could be realized not only by linking more markets but also by the active participation of buyers across the markets. But our analysis pointed out that in general, trading through e-NAM is very low and inter-market trading is negligible. Therefore, we suggest the following strategies to promote both intra-market and inter-market trading.

- A unified license is the pre-requisite for inter-market trading, hence, acceleration of the speed of license issue is the pressing priority.
- Although infrastructure is available, there is a lack of skilled manpower and training for establishing standard quality assaying labs. Hence, addressing these issues and building confidence in quality testing and grading system among the buyers is an essential need to improve the efficiency of the system.
- Development of a uniform price quote system like price per unit of a product like Rs/qtl or Rs/kg rather than Rs/bag would ease the bidding process.

- The technical glitches in the online system need to be addressed to attract more traders. For example, save and review options need to be provided as it is very essential especially power and internet interruptions. More user-friendly options like a drop-down menu to choose the particular lots for bidding rather than scrolling down the lots.
- Also, the bid winners' list in a day for all the lots listed is based on the order of highest bid-wise rather than a serial number of the lots. But the option should be given to e-mandi officials to print the result as per their convenient ordering. Because, when SMS service for price finalization is failed, the e-mandi officials face difficulties in declaring the results.
- During the survey and previous study (Kumar et al. 2019), farmers reported that lack of awareness is the major reason for the low participation of farmers. Hence, a large-scale awareness campaign needs to be done to bring more farmers into e-NAM.

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