



Impact of development of National Agriculture Market (e-NAM) on farmers

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ABSTRACT

In developing countries like India, a well-functioning agricultural sector is crucial for economic growth and livable incomes. In an agricultural market system, prices can organize production efficiently by encouraging farmers to serve markets with excess demand and provide the levels of quality and varieties that consumers prefer. Though the state often plays a large role in market organization, the Government of India has been pressing for market reforms with State Governments to deal with market inefficiencies. One such major move has been to promote integrated markets across space and time in the country through the adoption of the National Agriculture Market Scheme (e-NAM). This paper examines the impact of the adoption of e-trading through e-NAM in regulated stand-alone wholesale APMC markets in Rajasthan on price realization by farmers in select commodities and its impact on market arrivals as a measure of market development. Difference-in-difference estimates indicate increase in farmers' prices or quantities, consistent with increased demand and supply, while survey evidence suggests areas for further efficiency gains. The survey was conducted in select e-NAM APMC markets in Rajasthan during March–May 2021 and 2022.

Keywords: Farmers, Market arrivals, National Agriculture Market, (e-NAM), Price realization

Agriculture and allied sector activities are critical to the Indian economy, with nearly 54.6% of the country's workforce dependent on this sector for sustenance (DAC&FW 2021). Growth in Indian agriculture has remained largely uneven, fluctuating across Plan periods despite the best effort of the planners. Agriculture marketing plays a crucial role in providing remunerative prices to farmers for their produce while subjecting the same farmer-entrepreneur to market risks such as price volatility, lack of demand and marketing credit.

Usually after harvest, small/marginal farmers dispose about 50% of their marketable surplus in distress sale to square off their debts (NCF 2006). Generally, agriculture transactions take place independent of the regulated wholesale markets, through mutual agreement between the farmers and the traders/agents. In the traditional method of price-setting in the Agricultural Produce Market Committee (APMC), traders and intermediaries often form cartels (NABARD 2018), which lowers farmers' prices and also leads to delayed payments.

The scheme of the digital National Agriculture Market (e-NAM) was introduced in 2016 as reform measures to promote virtual trading platforms by integrating stand-alone

physical APMC markets across states to foster transparent competitive quality-based bidding system for better price realization by farmers. There are multiple intended benefits of e-NAM for farmers such as higher price realization, convenience due to online payment, time saving for farmers, better facilities for assessing the quality of produce, fewer complications and transparency in the sale process (Shalendra and Paty 2018, Reddy 2019, Sekhar and Bhatt 2019).

As price realisation by farmers for their produce after harvest is crucial to the growth of the agriculture sector, it is important to study the impact of e-NAM, which has completed 6 years since its commissioning and has increased outreach, on price realisation and market arrival, which will help policy planners, scheme implementing agencies, APMC market managers, academicians and researchers to further work on improving this important scheme. This paper examines the impact of the development of e-trading through e-NAM in regulated wholesale APMC markets on price realization by farmers in select commodities and the impact on market arrivals as a measure of market development.

MATERIALS AND METHODS

Study area: Rajasthan, the largest state in India, is traditionally an agrarian society, with the agriculture sector contributing nearly 30% of the state's GDP. Further, it is one of the leading states which had implemented e-NAM in 144 APMC markets since April 2016 and is leading in adopting scientific instrument-based quality assaying for

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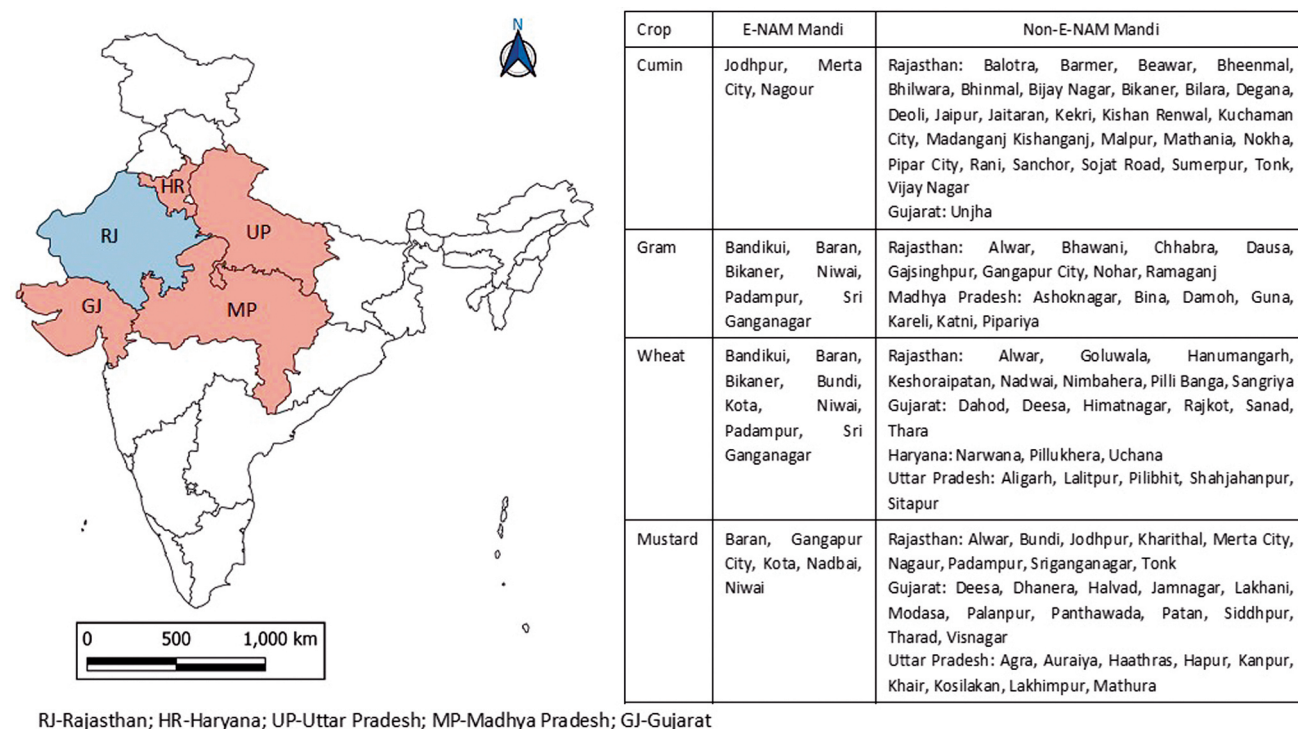


Fig 1 List of markets selected for the study.

the trade of agricultural commodities in e-NAM. During the COVID-19 pandemic period in May 2020, the state integrated the remaining 119 APMCs with an e-NAM platform through virtual remote mode. Rajasthan has been a major producer of wheat, gram, mustard and cumin, which had been selected for this study; wheat and gram is the major food crop, mustard is the major oilseed and cumin is the major spice for Indian food, which are traded in e-NAM.

As e-NAM progress in Rajasthan is concerned, the number of farmers and traders registered in the portal, as on 30 September 2022, a total number of 15 lakh farmers, 83,529 traders and 26,059 commission agents are registered on the e-NAM portal. Total trade of 1.05 crore (million tonnes) MT and 26.13 lakh coconut was recorded on the e-NAM portal for Rajasthan with a total trade value of ₹1705 crore. As regards with the inter-state trade of Rajasthan on e-NAM is concerned, a total of 6.0 quintals of trade (selling) from Rajasthan is recorded in coriander, wheat and garlic to Gujarat and Madhya Pradesh, while 26.0 quintal quantity of inter-state trade (buying) is recorded on e-NAM from state of Andhra Pradesh and Gujarat, Madhya Pradesh, and Uttar Pradesh.

The e-NAM markets in Rajasthan taken up for the study, have considerable e-trading volumes for selected commodities for the survey and have been e-trading for more than 4 years (starting between September 2016 and December 2017). The survey was conducted in during March–May 2021 and 2022.

In the Difference-in-Difference (DiD) analysis, these e-NAM markets will represent treatment markets. A similar number of markets in neighbouring geographical areas,

including nearby states, transacting through conventional physical bidding till 2021 in the same commodities, were selected from the AGMARKNET database as control markets (Fig 1).

While, market data (e-NAM and AGMARKNET) provide measures of prices and market arrival for the DiD analysis, further information from farmers was collected through a structured questionnaire/interview method and qualitatively analysed for inference relating to the research objective. In both the e-NAM and AGMARKNET data, the analysis focuses on the modal price (price at which maximum number of transactions happen), which is aggregated to monthly means for each market crop. The e-NAM data cover 2017 to 2021 while the AGMARKNET data extend back to 2010.

An average sample size of 30–40 farmers in each treatment market for select commodities was randomly chosen for the survey. Care was taken to choose farmers visiting e-NAM markets for transactions in such a way that they represented different areas around e-NAM markets.

Difference-in-difference (DiD) model: The analysis uses DiD to control for unobserved cross-market and cross-time variation. The DiD methodology is used preferably in an observational context, where exchangeability cannot be assumed between the treatment and control groups (in this case market data).

Because markets may differ for many reasons, which could be correlated with which markets convert to become e-NAM markets, a simple outcome comparison across e-NAM and non-e-NAM markets might be subject to omit variable bias. And because months might differ for many

reasons, a simple outcome comparison for a market before it adopts e-NAM versus after might be subject to omit variable bias. For these reasons, we employ a DiD strategy to estimate the effects on prices and arrivals. For each crop c , we estimated a separate regression as:

$$Y_{cmt} = \beta_c eNAM_{cmt} + \Gamma_{cm} + \Delta_{ct} + \varepsilon_{cmt} \quad (1)$$

Where, m , market and t , time period (month-year); Y , outcome of interest, either mean modal price or total arrivals; $eNAM$ is an indicator variable that takes value 1 in time period and markets where e-NAM has been activated and 0 otherwise. Γ , crop-market fixed effect that captures the fact that prices or arrivals may be systematically larger in some markets than others, even independently of e-NAM. Δ , crop-time fixed effect capturing price fluctuations that occurred nationwide over time both in e-NAM and non-e-NAM markets. Finally, ε , error term that captures other time-varying factors that affect the outcome but those are not correlated with when a market adopts e-NAM. Standard errors are clustered by market crop.

With these controls, the coefficient of interest (β_c) captures the evolution of prices and arrivals before versus after e-NAM implementation, relative to markets that did not receive e-NAM at the same period. The key assumption is parallel trends: in a hypothetical world in which e-NAM did not exist, prices in treated markets would on average grow exactly as they do in control markets. We know of no other market-specific events whose timing coincided with the introduction of e-NAM. Thus, immediate changes in outcomes upon the introduction of e-NAM are likely driven by e-NAM itself.

From a conceptual perspective, different signs of β_c are informative of the effects of e-NAM on farmer surplus. e-NAM is likely to induce a demand shock for farmers' crops. As the electronic platform enables more competition among traders, demand for farmers' crops may be higher. A demand shock alone generates the following prediction:

Mechanism A ($\beta_c^{\text{Price}} > 0$, $\beta_c^{\text{Quantity}} > 0$): e-NAM leads to a positive demand shock for crops in treated markets. Farmers sell more and earn higher prices.

But when a demand shock occurs, farmers may adjust to the higher prices by switching to e-NAM markets or by bringing more crops to their local e-NAM markets. This supply response, when combined with the initial demand shock, generates a slightly different prediction:

Mechanism B ($\beta_c^{\text{Price}} < 0$, $\beta_c^{\text{Quantity}} > 0$): e-NAM leads to a positive supply shock in the treated crop market, reducing prices and increasing quantity. This would occur if e-NAM enables farmers from other markets (with even lower prevailing prices) to sell in the treated market or if farmers in the treated markets bring more crops to the market.

In both cases, there is a positive demand shock that increases farmer welfare. Whether this translates into higher or lower prices depends on whether farmers re-optimize by bringing more crops to the e-NAM markets. In other words, either price or quantity increases at the mandi level are suggestive of farmer surplus, but via different

mechanisms. On the other hand, if prices and quantities both decrease, then e-NAM is unlikely to have increased demand and farmer surplus is lower. In the results, we show that patterns are consistent with mechanism A for two crops (wheat and mustard) and with mechanism B for two other crops (cumin and gram).

RESULTS AND DISCUSSION

Impact of e-NAM on price realization and market arrival: The DiD results for prices and market arrivals (quantities) are presented in Table 1, separately by crop. For wheat, there is a statistically significant increase of ₹224.2/quintal in prices with no significant change in quantity sold. This price increase is 33.2% over the mean modal price. We see similar patterns for mustard, where prices increase by ₹156.4/quintal and quantities increase by an average of 10169.0 quintals. These increases are 8.3 and 97% of the mean outcome, respectively. The prices increase for these crops, with zero or positive effects on quantities, suggest an increase in demand in response to e-NAM. For these two crops, the surplus to existing farmers goes up, though farmers in other markets may lose out as traders reallocate to e-NAM markets. Past studies have also reported an increase in the modal prices of commodities in similar digital markets as compared to physical markets (Reddy 2019, Levi *et al.* 2020).

The positive price effects are consistent with e-NAM enabling competition among traders, which leads to higher demand for farmers' crops. Patterns are slightly different for cumin and gram. For cumin, while the price change is statistically zero, quantity increases by an economically and statistically significant 6919.4 quintals per month. Similarly, while gram prices slightly decline by ₹229.4/quintal, arrivals increase by 2330 quintals (over an average of 2085 quintals in the sample). The large increase in quantity without price increases suggests that e-NAM led to a shift in the supply of crops at treated markets. This increase in supply could either be a direct migratory response to e-NAM if the app made it easier for farmers to sell in treated markets or a response of farmers to the higher prices in treated markets. In either case, the increase in quantity suggests that a subset of farmers were better off even if the price in treated markets did not increase. In particular, either farmer from other regions earned higher prices by shifting to the e-NAM mandis, or existing farmers grew more in response to the higher prices offered and competed down the price. The price and arrivals effects differ by commodities may reflect differential supply elasticities across commodities. If farmers are able to increase supply of cumin and gram faster than they can for wheat and mustard, then they may substitute more toward these crops, which generates a differential response in arrivals.

To ensure that the results speak to welfare gains for farmers rather than other traders, we next estimated the price realization and arrivals for harvest time periods. Generally, small and marginal farmers do not have the holding capacity to retain their harvest in the immediate post-harvest period

Table 1 The difference in price and market arrivals

Crop	Cumin	Gram	Wheat	Mustard	Cumin	Gram	Wheat	Mustard
	Modal Price				Arrivals			
<i>All months</i>								
e-NAM	41.99	-229.4**	224.2***	156.4***	6919.4***	2330.0**	-3138.8	10169.0**
	-387.7	-82.62	-77.08	-50.98	-1104.8	-981.2	-5063.4	-4972.4
Mean DV	12387.3	3915.1	1643.7	3275.5	450.4	2085	13292.7	5297
Clusters	31	22	30	36	31	22	30	36
N	2028	2359	3163	4122	2031	2397	3204	4132
<i>Harvest months</i>								
e-NAM	439.6	-309.1***	550.9***	274.9***	13586.0***	3995.7*	-11034.8	16262.7
	-342.7	-77.62	-177.5	-85.57	-1776.1	-2148.4	-9831.1	-11414.2
Mean DV	12214.1	3784.6	1653.5	3280.4	738.4	3973.5	34935.9	10991.4
Clusters	31	22	29	36	31	22	29	36
N	655	648	905	1154	655	661	922	1161

Mean DV, mean dependent variable; Clusters, number of markets; N, observation count; ***, Significant at 99% Confidence level (CL); **, Significant at 95% CL; *, Significant at 90% CL.

and sell their crops immediately after harvest. To study this, we estimate the DiD specification for a post-harvest period of 90 days (March–May) to understand the impact of e-NAM on prices and arrival of these four commodities. The effects of e-NAM on prices and arrivals are substantially larger in magnitude during harvest time (Table 1). Since farmer-trader (rather than trader-trader) transactions are more likely during harvest time, these results suggest that farmers are the beneficiaries of e-NAM treatment.

For the strongest results, the price increase for wheat and the arrivals increase for an event, a study analysis was conducted that estimates separate coefficients for each harvest year (Fig 2) which found that pre-trends were precise and flat, which supported the assumption of parallel trends between treatment and control markets. The effect of e-NAM is sudden and coincided with e-NAM's introduction, which lent more credence to these effects being causal.

Finally, estimated the heterogeneous effects by whether the transactions take place during the COVID-19 pandemic. The core result of higher prices for wheat and mustard were driven by pandemic periods (Table 2). This suggests that e-NAM increased prices exactly when farmers were undergoing economic distress. The positive effects on quantities for cumin and gram are roughly equal pre- and during COVID, so the movement of farmers across markets appears to have been unaffected.

Farmers and factors influencing price realization and e-NAM efficiency: The survey of farmers (n=390) helped identify critical factors for e-NAM implementation. Most of the farmers had attended at least primary school with almost half (47.8%) with education up to high school or 10+2. However, a large percentage of farmers' respondents (26.8%) were without any formal education. While, 45.3% were with an annual household income of ₹45,000–100,000,

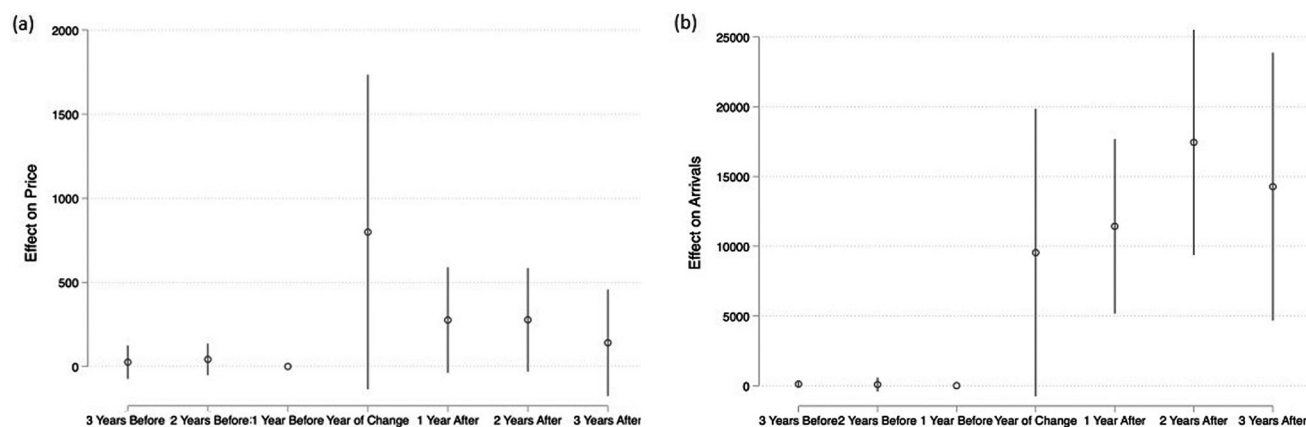


Fig 2 Event study estimates from price (a) wheat, and arrivals (b) cumin, regressions. The “Year of Change” is the year when e-NAM was introduced.

Table 2 The difference in price and arrivals during pre-COVID and COVID.

Crop	Cumin	Gram	Wheat	Mustard	Cumin	Gram	Wheat	Mustard
	Modal Price				Arrivals			
e-NAM Pre- COVID	418	-286.6***	139.3*	22.67	13639.9***	3591.9	-14206.6	13750.1
	-370.6	-78.01	-81.15	-48.59	-1991.2	-2360.6	-10890.5	-8880.6
e-NAM during COVID	461.9	-334.9***	891.0***	524.3***	13530.5***	4431.4**	-8690.3	18628.3
	-376.1	-80.43	-241	-151.9	-2454.5	-2072.3	-11161.7	-14077
e-NAM Pre- COVID	417.5	-289.1**	114.6*	22.51	13640.4***	3580.7	-13932.7	13750.8
	-371.1	-78.26	-66.85	-48.6	-1993	-2363.6	-10738.5	-8885
e-NAM 2020	-11.32	-399.3***	101.6	332.3***	13932.0* **	2877.8	1179.2	12774.6
	-478.4	-89.5	-79.43	-110.9	-2634	-1807.6	-11895.4	-9739.1
e-NAM 2021	948.4**	-278.3***	1585.1***	716.7***	13117.8***	5994.2**	-17000.7	24496.9
	-405.1	-83.25	-273.2	-201.1	-2283.7	-2622.4	-15034.4	-18681.1
Mean DV	12214.1	3784.6	1653.5	3280.4	738.4	3973.5	34935.9	10991.4
Clusters	31	22	29	36	31	22	29	36
N	655	648	905	1154	655	661	922	1161

Mean DV, mean dependent variable; Clusters, number of markets; N, observation count; ***, Significant at 99% CL; **, Significant at 95% CL; *, Significant at 90% CL.

29.2% were in the annual household income bracket of ₹1–2 lakh. Although for the survey, only those farmers were included who had adopted e-NAM, still more than 76% of the farmers depend on the commission agents or traders for selling their crops in the market. More than 80% of respondent farmers stated that they regularly sell their produce at APMCs. A significant percentage (42.6%) of respondents sold their produce in a single lot.

There is a significant relationship between competitiveness and transparency of the bidding system to price realization by farmers (Table 3), possibly indicating that the more competitive and transparent the e-NAM bidding system is, the better is the price realization by farmers.

e-NAM provides a better alternative to farmers for price discovery as compared to the traditional physical bidding system. One of the major issue has been information asymmetry concerning farmers in a farmer-trader relationship. However, the finding from the survey suggests a strong correlation between the e-NAM information system

and price realization by farmers.

Farmers looking for price information through the e-NAM app before selling crops tend to get better bid prices for produce through e-NAM as compared to physical bidding (Table 3). Similarly, those farmers who are able to see quality parameters of produce through the e-NAM app., gain better price realization for higher quality produce. This strongly suggests the significance of advisory services provided e-NAM in improving the price realization of farmers.

Interestingly more than 78% of farmers still depend on traders and others for price information, while merely 35.8% depend on the e-NAM mobile app. It is essential that the farmer becomes independent from traders and others such as commission agents in getting information on price so that it will help the farmer to independently and judiciously take an entrepreneurial decision on where and to whom to sell his produce in agri-value chain.

Farmers' ability to monitor both qualities of produce and bid in progress in e-NAM platform for their produce, helps them to independently participate in e-NAM (Table 3).

Table 3 Spearman's rank correlation between competition and transparency in bidding to price realization.

Price realization	Better bid value for produce	Better price for higher quality produce	Participate in e-NAM trading independently
e-NAM provides competition in bidding	0.441***		
e-NAM provides transparent way of bidding	0.326***		
Farmer looks for price information before selling crop through e-NAM	0.524***	0.042	0.452***
Ability of farmer to see the quality parameters of produce in e-NAM	0.104	0.291***	0.516***
Farmers' ability to monitor bid in progress of his produce in e-NAM			

***, Significant at 99% CL.

Thus, the farmers need to be very well trained in operating e-NAM to be able to take judicious decisions, independent of commission agents or traders, to market their produce profitably. However, nearly 75% of farmers had reported that they had not received training even once, with more than 80% of farmers expressing their willingness for training.

It was found that the adoption of e-NAM increased price realisation for farmers for wheat and mustard with a positive or zero effect on quantity, and increased quantity sold for cumin and gram with negative or zero effects on prices. These results suggest that e-NAM amounted to a positive demand shock for wheat and mustard and a positive supply shock for cumin and gram. Studies have shown that farmers, especially small and marginal ones, tend to have low price negotiation power and lose out much to the middlemen and traders (Ranjan 2017). The findings from this study suggest that e-NAM has the potential to reduce information asymmetry between farmers and traders and the potential to reduce dependence on commission agents thus making the farmers less vulnerable in terms of price realisation for their produce. While, subset of farmers benefit in each case, the effects of e-NAM may therefore depend on the crop and on the ability of farmers from outside regions to shift to the treated market. However, for farmers to surely derive benefits through e-NAM, need-based training content, methodology, language and place of training for farmers need to be properly considered by Government, while scaling up the efforts and resources for training more farmers. The need for awareness creation and capacity building for e-NAM stakeholders has been highlighted in various studies (Yadav 2018, Meena *et al* 2019). To have a multiplier effect in training, the concept of Master Trainers and the Training of Trainers (ToT) process needs to be considered seriously. To further strengthen the training process, there is a need to develop self-learning computerized kiosks for e-NAM and provide each such kiosk at least at the village Panchayat level for free training of farmers to enhance outreach and inclusivity. In prominent places in e-NAM APMC Markets, there is a need to provide an electronic display of the bidding process and prices on the e-NAM platform to make

the information easily and openly available to farmers to reduce their dependence for the same on others including traders and commission agents. The government may also consider handholding of farmers in APMCs for trading on the e-NAM platform through a system of trained 'e-NAM Mitras' (e-NAM Friends) inside APMCs, who would guide and handhold farmers freely at every stage of e-NAM trading right from gate entry in the market.

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