



Economic impact of E-tendering system on arecanut growers: evidence from Karnataka

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Abstract

The study analyzed the economic impact of the E-tendering system on arecanut growers in Karnataka, India. Two major APMCs having E-tendering for arecanut viz., Shivamogga and Bheemasamudra and APMC Davanagere, a non E-tendering market was selected for impact assessment of E-tendering on prices and arrivals of arecanut. From each APMC having E- tendering, 50 farmers were randomly chosen, making the total sample size 100 for assessing the impact of E-tendering on economic parameters. Primary data were collected through a pre-tested interview schedule from the sample farmers and secondary data were sourced from the official Krishimaratavahini website for the period of 12 years from 2007-2019. The difference-in-difference (DID) regression analysis was employed. The results of DID revealed that arecanut prices increased by ₹2,020.18 and ₹6,332.55 per quintal in APMC Shivamogga and Bheemasamudra, respectively, compared to APMC Davangere. Furthermore, the quantity of arecanut traded by farmers rose by 23.15 and 25.02 percent, while income per quintal increased by 44.16 and 44.55 percent in Shivamogga and Bheemasamudra, respectively.

Key words: E-tendering, Impact, Unified market platform, Arecanut, APMC

Introduction

Realizing the importance of efficient marketing, the Government of Karnataka introduced several reforms to the Agricultural Produce Marketing (Regulation and Development) Act, 1966. Karnataka is considered a forerunner among Indian states in reforming agricultural markets (Bisena and Kumar, 2018). One of the key initiatives was the implementation of an E-tendering system in 2009 under the Mandi Modernisation Programme (MMP), replacing the closed tendering system to ensure better prices for farmers. This system was further strengthened in 2014 with the introduction of the Unified Market Platform (UMP), developed by the Government of Karnataka in collaboration with the National Commodity and Derivative Exchange (NCDEX). Additionally, Rashtriya E-Market Services Private Limited (ReMS) was established as a joint venture company to provide E-marketing services (Aggarwal *et al.*, 2016).

The Unified Market Platform integrates APMC markets across the state into a single

online platform, allowing licensed traders to participate in the trading of notified agricultural commodities (Pavithra *et al.*, 2018). E-tendering was introduced to address bottlenecks in the traditional agricultural marketing system. Before its implementation, transactions in Karnataka were conducted through either open auction or closed tender systems (Aggarwal *et al.*, 2016). These traditional methods often led to collusion among traders and commission agents, depriving farmers of fair prices (Chengappa *et al.*, 2012). They also created opportunities for market malpractices such as alteration of quotes, data entry errors, and delays in finalization (Pavithra *et al.*, 2018). Furthermore, farmers frequently encountered delays in receiving timely payments after sales (Rampure 2015).

The E-tendering system under UMP offers several advantages over traditional methods. By computerizing the entire process, it ensures competitive pricing, reduces transaction time, and enhances transparency (Chand 2016). A schematic representation of the E-tendering process is illustrated in Fig. 1. By the end of the

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financial year 2019–20, approximately 162 main and 354 sub-APMCs were unified under a single platform, with more than 92 commodities brought under the E-tendering system (ReMS, 2020).

Arecanut in Karnataka is traded through this e-tendering process. The state alone accounts for 70.33% of the country's arecanut production (6.0 lakh tonnes) from an area of 2.79 lakh hectares (Anonymous, GoI, 2019). Among the districts, Shivamogga ranks first in both area (21.06%) and production (21.30%), followed by Davanagere, Dakshina Kannada, Tumkuru, Uttara Kannada, Chitradurga, Chikkamagaluru, and Udupi. Together, these districts contribute 91.16% of the total area and 93.30% of the total arecanut production in Karnataka (Anonymous, GoK, 2013). Arecanut growers in the state are highly price-responsive in terms of area under cultivation (Patil *et al.*, 2014). A 1% increase in expected price leads to a 4.14% increase in the area under arecanut cultivation (Patil *et al.*, 2014). Moreover, Aggarwal *et al.* 2016 reported that 42.90% of arecanut produced in the state is marketed through APMC markets. However, many growers still face challenges in marketing and struggle to realize the expected returns from the crop (Shambhavi 2016).

Therefore, understanding the prevailing arecanut marketing system in Karnataka and its associated challenges is essential. While the e-tendering system has the potential to address several inefficiencies, empirical studies evaluating its effectiveness—particularly in the context of arecanut—remain limited. Against this backdrop, the present study was undertaken to assess the economic impact of the e-tendering system on arecanut marketing in Karnataka. The study aims to evaluate the influence of the e-tendering system on the arecanut market by examining changes in price levels, economic parameters, and transaction efficiency. Specifically, it focuses on determining whether the implementation of the e-tendering system has significantly increased arecanut prices, and whether it has brought about notable differences

in marketing cost, the quantity traded by farmers, and income accrued per quintal when comparing the pre and post e-tendering periods. Furthermore, the study assesses whether the e-tendering system has contributed to a significant reduction in transaction time.

Materials and Methods

The present study was conducted in the year 2020-21 by selecting the two major APMCs of Karnataka viz., APMC, Shivamogga of Shivamogga district and APMC, Bheemasamudra of Chitradurga district during the agricultural year 2019-20. These APMCs were selected for being the two major markets in the state with e-tendering facilities. Shivamogga district was chosen to represent the traditional belts of arecanut while Bheemasamudra of Chitradurga district was selected to represent the non-traditional belts of arecanut in Karnataka. For the purpose of assessing the impact of e-tendering system on arecanut prices, APMC of Davangere district was selected as the non e-market or control market for the reason that it has not yet adopted e-tendering of Arecanut. Further, APMC of Davangere served as control because of its proximity to the selected e-markets and trading of similar grades of arecanut.

Primary data from 100 farmers trading in APMC Shivamogga and Bheemasamudra were obtained using a pre-tested interview schedule to assess the economic impact of e-tendering on arecanut growers. Secondary data on monthly modal prices of arecanut in Shivamogga and Bheemasamudra APMCs for the last 12 years (2007-2019) were collected from the official website of Krishi-marata vahini to elicit the impact of e-tendering system on arecanut prices.

The impact of e-tendering on arecanut prices was assessed using the Difference-in-Difference (DID) model—an econometric tool used to estimate the effects of policy interventions that do not affect all individuals uniformly or simultaneously (Lechner, 2011). This model was employed to evaluate the effect of the e-tendering system on arecanut prices by

considering APMCs with e-tendering as the treatment group and APMCs without e-tendering as the control group. For the impact assessment, monthly modal prices of the major arecanut grades Saraku and Rashi were analyzed. The collected price series were deflated using the GDP deflator to eliminate the effects of inflation. The deflated prices were then subjected to the DID method to isolate and identify the true effect of the treatment (e-tendering) and the influence of time.

Treatment factor was included in the model using dummy variable which takes zero value to represent control market i.e., non e-market (APMC, Davanagere) and '1' to represent the treatment market i.e., (APMC Bheema samudra / Shivamogga). Time factor was also included using dummy variable which takes zero value to represent pre e-tendering period and '1' to represent post e-tendering period. The regression model built was of the form:

$$Y = \beta_0 + \beta_1 * [Time] + \beta_2 * [Treatment] + \beta_3 * [Time * Treatment] + \varepsilon$$

$$Y = \beta_0 + \beta_1 * D_1 + \beta_2 * D_2 + \beta_3 * D_1 D_2 + \varepsilon$$

Where, Y = Real price in Rupees

β_0 = Intercept

β_1 = Slope coefficient of time dummy variable

β_2 = Slope coefficient of treatment dummy variable

β_3 = Slope coefficient of the interaction of D_1 and D_2 variables

D_1 = Dummy variable for time (Assumes '0' to represent pre-e-tendering and '1' for post-e-tendering period)

D_2 = Dummy variable for treatment (Assumes '0' to represent non-e-market and '1' for e-market)

$D_1 D_2$ = Interaction of time and treatment dummy variables

ε = Stochastic error term

The impact of time and treatment (implementation of e-tendering) were captured by the respective slope coefficients β_1 and β_2 . The impact of e-tendering on arecanut prices was captured by the coefficient of interaction between time and treatment dummy variables, β_3 .

One of the key assumptions for DID estimation is that the outcome variable in both the treatment and control groups follows a parallel trend in the pre treatment period. Graphical representation of the arecanut prices in the e-market and non e-market during the pre e-tendering period shows that, prices follow a parallel trend and does not violate the assumption (Fig. 2 and Fig. 3).

Further, a placebo test was carried out to check for the parallel trend assumption (Table 1). In the present study, statistically non-significant coefficient of interaction implies that the arecanut prices across the e-market and non e-market follow a parallel trend during the pre e-tendering period.

Economic impact of e-tendering system and its impact on transaction time was measured using various economic parameters such as marketing cost, quantity traded, and income accrued per quintal of arecanut. Whereas, impact on transaction time was measured using time taken for bid announcement, and time taken for payment. Impact of e-tendering on each economic



parameters and transaction time were found out using paired t-test.

Results and Discussion

Impact of e-tendering system on arecanut prices

When we had a look at impact of e-tendering system on arecanut prices we could elicit that, in case of APMC, Shivamogga the difference in difference model was found significant with an adjusted R^2 of 0.923 with significant f-statistic (Table 2). The coefficient of the interaction term between time and treatment captured the impact of e-tendering on arecanut prices. During the post e-tendering period, arecanut prices in APMC, Shivamogga increased by Rs. 2020.18 qt.⁻¹ exclusively because of e-tendering in comparison with the control market (Davangere APMC) (Table 3). The probable reason could be, increased competition and transparency in e-tendering system. The model was also found significant for APMC, Bheemasamudra with an adjusted R^2 of 0.905 and with significant f-statistic (Table 4). During the post e-tendering period, arecanut prices in APMC, Bheemasamudra increased by Rs. 6332.55 qt.⁻¹ (Table 5). The anticipated speculative gains by the private traders and large farmers could be the reason for increased price realization due to e-tendering in APMC, Bheemasamudra compared to APMC, Shivamogga. Arecanut growers in the Bheemasamudra region are known for their profit orientation and economic stability, which relieves them from immediate financial obligations. Apart from this, majority of the commission agents tend to collect produce directly from the farmers and hold it until the market price rises. Reddy, 2017 reported similar results from his study on the impact of e-markets in Karnataka. Further, the results were in congruence with the findings of Shambhavi, 2016, Girish, 2017, Chandana, 2018, Pavithra *et al.*, 2018, Tyngkan, 2018 and Vivek *et al.*, 2021.

During pre e-tendering period, the real price of Rashi variety was found to be Rs.

13874.38 in the non e-market (APMC, Davangere) and Rs. 12036.62 in APMC, Shivamogga. However, the real price of Rashi variety increased to Rs. 27419.38 and Rs. 27601.89 in Davangere and Shivamogga APMCs, respectively during the post e-tendering period (Table 3). The real price of Rashi variety which was Rs. 12891.96 in Bheemasamudra APMC during the pre e-tendering period rose to Rs. 32769.60 during the post e-tendering period (Table 5). Hence we accept the hypothesis that there is a significant increase in the price of arecanut after the implementation of the e-tendering system

Influence of static factors such as long-term policies and attitude of the farmers are captured in intercept, $\beta(0)$ with a value of Rs. 13874.38 qt.⁻¹ (Table 2). The ever-increasing demand for arecanut based products like Paan, Gutka and Supari along with the relative profitability of arecanut in comparison to paddy, maize and sugarcane has lured many farmers to take up arecanut cultivation. As arecanut possesses longer shelf life, majority of the arecanut farmers store it until they realise remunerative price. The factors mentioned above influences arecanut price, which was captured in the intercept.

The slope coefficient of time, β_1 (Rs. 13545.09 qt.⁻¹) captured dynamic factors such as short-term policies, export and import policies, demand, supply etc. (Table 2). Intermittent rainfall coupled with pests and diseases in the Malnad region triggered mismatch between demand and supply of arecanut. High import tariff and subsequent ban on arecanut imports have reduced the import of low quality arecanut from the South Asian countries and increased the demand for local arecanut, thereby boosting its price. All these factors bear a significant effect on arecanut prices and being captured in time element.

Economic impact of e-tendering system on arecanut growers

The impact of e-tendering system on

**Table 1. Placebo Test for violation of parallel trend assumption between arecanut prices in e-market and non e-market**

Particulars (1)	APMC, Shivamogga		APMC, Bheemasamudra	
	Coefficients (2)	P-value (3)	Coefficients (4)	P-value (5)
Intercept (β_0)	14097.11	0.000	14097.10	0.000
Time (year) (β_1)	-55.68	0.849	-55.68	0.873
Treatment (β_2)	-1763.54	0.353	-4602.93	0.058
Interaction (β_3)	-18.56	0.964	905.13	0.089
R ²	0.59		0.65	
Adj. R ²	0.34		0.42	
F value	1.75 ^{NS}		2.42 ^{NS}	

Table 2. Results of difference in difference model in APMC, Shivamogga

Particulars (1)	Coefficients (2)	P-value (3)
Intercept (β^0)	14097.11	14097.10
Time (year) (β^1)	-55.68	-55.68
Treatment (β^2)	-1763.54	-4602.93
Interaction (β^3)	-18.56	905.13
Adjusted R ²	0.59	0.65
F value	0.34	0.42
Number of observations	1.75 ^{NS}	2.42 ^{NS}
Overall model	$Y = 13874.38 + 13545.09 \cdot D_1 - 1837.76 \cdot D_2 + 2020.18 \cdot D_1 D_2$	

Dependent variable = Real price in Rs/quintal

** Significant at 1% level of significance

*Significant at 10% level of significance

Table 3. Impact of e-tendering on arecanut prices (Rashi) using difference in difference model in APMC, Shivamogga

Scenario (1)	Model equation (2)	Impact (Rs/quintal) (3)
Post e-tendering, e-market (D ₁ =1 and D ₂ =1)	$Y_4 = 13874.38 + 13545.09 \cdot D_1 - 1837.76 \cdot D_2 + 2020.18 \cdot D_1 D_2$	27601.89
Post e-tendering, non e-market (D ₁ =1 and D ₂ =0)	$Y_2 = 13874.38 + 13545.09 \cdot D_1$	27419.38
Pre e-tendering, e-market (D ₁ =0 and D ₂ =1)	$Y_3 = 13874.38 - 1837.76 \cdot D_2$	12036.62
Pre e-tendering, non e-market (D ₁ =0 and D ₂ =0)	$Y_1 = 13874.38$	13874.38
Impact of e-tendering	β_3	2020.18



economic parameters and transaction time were portrayed in Table 6. Paired t-test was performed to assess whether e-tendering has made significant impact on above mentioned factors or not. The economic indicators/parameters exhibited significant difference on implementation of e-tendering system.

(a) Marketing cost

As depicted in Table 6, marketing cost per quintal of arecanut increased by 34.97 per cent (Rs. 233.70 to Rs. 315.42) in APMC, Shivamogga and 35.56 per cent (Rs. 232.80 to Rs. 315.58) in APMC, Bheemasamudra during the post e-tendering period. The increase in marketing cost is not solely attributed to the implementation of e-tendering. However, e-tendering has made the traders quality conscious. Hence, to meet the quality requirements, farmers might have spent more towards grading of the produce, resulting in the increased marketing cost.

(b) Quantity traded/transacted

With regard to the quantity of arecanut traded by farmers, there has been an increase of 23.15 per cent (32.40 to 39.90 quintals) and 25.02 per cent (42.52 to 53.16 quintals) in APMCs, Shivamogga and Bheemasamudra, respectively (Table 6). The enhanced transparency of the e-tendering system, coupled with the competitive price discovery it facilitates, has motivated farmers to channel a larger share of their produce through the e-tendering platform rather than relying on non-electronic markets and alternative modes of sale. Further, wider adoption of improved cultivation practices by the farmers has increased the productivity of arecanut in the region. Pavithra *et al.*, 2018 reported similar results in their study on the effectiveness and challenges of e-tendering system with a focus on pigeon pea.

(c) Average income/price

At the same time, income accrued per quintal of arecanut has increased from Rs. 24230 to Rs. 34930 revealing an increase of 44.16 per

cent in APMC, Shivamogga. Similar is the trend in APMC, Bheemasamudra, where the income accrued per quintal of arecanut increased from Rs. 24250 to Rs. 35050 indicating an increase of 44.55 per cent (Table 6). The implementation of e-tendering has enhanced market competition and ensured competitive prices for farmers through fair and transparent marketing practices. Similar results were reported by Bachaspati(2), Tyngkan(25) and Geethavani (9). Though e-tendering's role may be pivotal but it cannot be a sole reason for price rise as it has happened over time. To decipher the impact of e-tendering system on arecanut prices, difference in difference model was used and the results indicated that rise in price due to e-tendering system was Rs. 2020.18 and Rs. 6332.55 per quintal, in APMCs, Shivamogga and Bheemasamudra, respectively (Table 3 and 5).

We thus accept the hypothesis that there is a significant difference in the economic parameters such as marketing cost, quantity traded by farmer and income accrued per quintal during the pre and post e-tendering period.

The impact of e-tendering system on transaction time were depicted in Table 7. E-tendering had significantly reduced the transaction time and it had been one of the key features of the system. Time taken for bid announcement has significantly reduced by 35.34 per cent (6.96 to 4.50 hours) in APMC, Shivamogga and 35.90 per cent (7.02 to 4.50 hours) in APMC, Bheemasamudra after the implementation of e-tendering (Table 7). Prior to the implementation of the e-tendering, bidding starts at 10.00 am and may go up to 5.00 pm for the declaration of winning bid. After the implementation of e-tendering, bidding process used to start at 10.00 am and the winning bid announces at 2.30 pm saving 2.50 hours for the farmers. Further, the time taken to effect payment has reduced by 60.00 per cent and 57.63 per cent in APMCs Shivamogga and Bheemasamudra, respectively (Table 7). During the pre e-tendering period, payment was made to the

farmers within two to three days after accepting the bid. Whereas, after the implementation of e-tendering, payment was credited directly to the farmers' bank account within 24 hours after the acceptance of the bid. We thus accept the

hypothesis that the e-tendering system has significantly reduced the transaction time. The findings were in conformity with that of Chengappa *et al*, 2012, Shalendra, 2013 and Pavithra *et al.*, 2018.

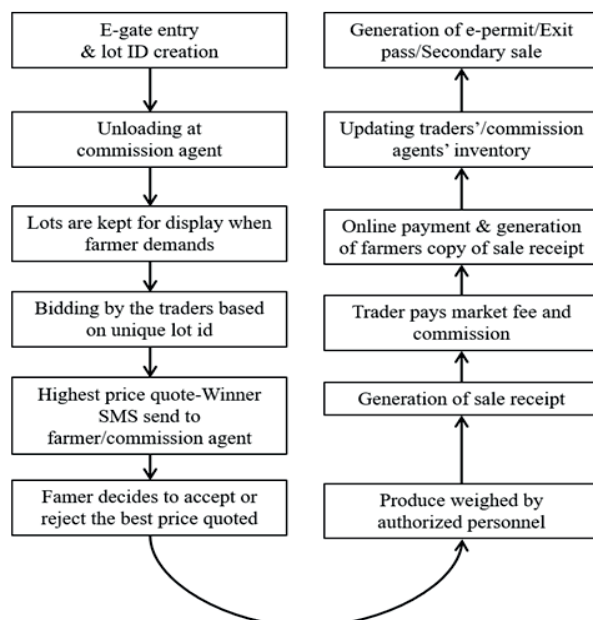


Fig.1. Mechanism of e-tendering

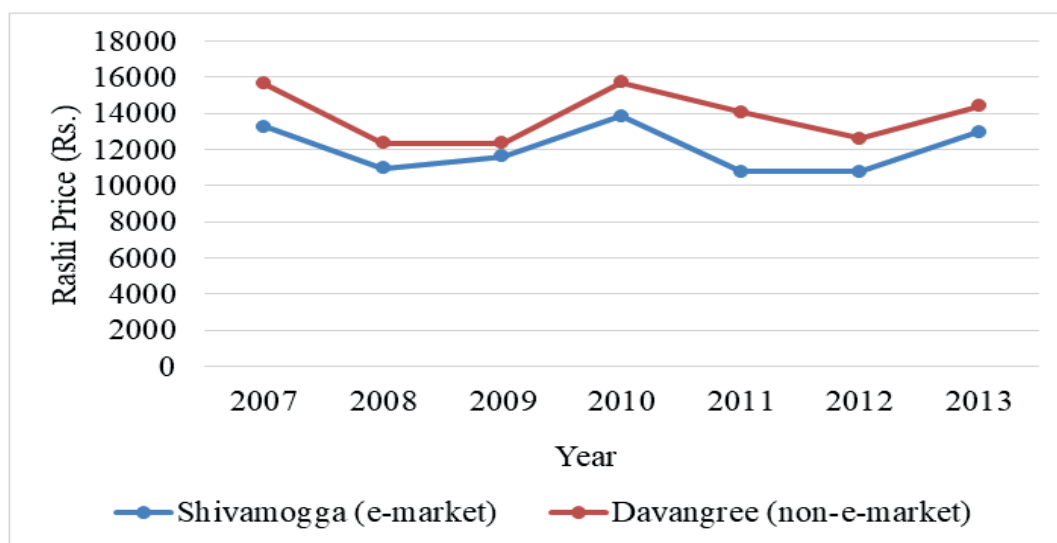


Fig. 2. Test for violation of parallel trend assumption between arecanut prices in Shivamogga and Davangree APMCS

**Table 4. Results of difference in difference model in APMC, Bheemasamudra**

Particulars (1)	Coefficients (2)	P-value (3)
Intercept (β^0)	13874.38**	0.000
Time (year) (β^1)	13545.09**	0.000
Treatment (β^2)	-982.415	0.520
Interaction (β^3)	6332.55**	0.008
Adjusted R ²	0.905	
F value	80.69**	
Number of observations	26	
Overall model	Y= 13874.38 + 13545.09*D ₁ - 982.415*D ₂ + 6332.55*D ₁ D ₂	

Dependent variable = Real price in Rs/quintal

** Significant at 1% level of significance

Table 5. Impact of e-tendering on arecanut prices (Rashi) using difference in difference model in APMC, Bheemasamudra

Scenario (1)	Model equation (2)	Impact (Rs/quintal) (3)
Post e-tendering, e-market (D ₁ =1 and D ₂ =1)	$Y_4 = 13874.38 + 13545.09*D_1 - 982.415*D_2 + 6332.55*D_1D_2$	32769.605
Post e-tendering, non e-market (D ₁ =1 and D ₂ =0)	$Y_2 = 13874.38 + 13545.09*D_1$	27419.47
Pre e-tendering, e-market (D ₁ =0 and D ₂ =1)	$Y_3 = 13874.38 - 982.415*D_2$	12891.96
Pre e-tendering, non e-market (D ₁ =0 and D ₂ =0)	$Y_1 = 13874.38$	13874.38
Impact of e-tendering	β_3	6332.55

Table 6. Economic impact of e-tendering system on arecanut growers**n=100**

Sl. No. (1)	Economic Indicators (2)	APMC, Shivamogga				APMC, Bheemasamudra			
		Mean		Percent change (5)	t-statistic (6)	Mean		Percent change (9)	t-statistic (10)
		Before 3	After 4			Before 7	After 8		
1.	Marketing cost (Rs./qtl)	233.70	315.42	34.97	-20.91**	232.80	315.58	35.56	-21.30**
2.	Quantity traded (Qtl/farmer)	32.40	39.90	23.15	-13.70**	42.52	53.16	25.02	11.87**
3.	Income accrued per quintal (Rs.)	24230	34930	44.16	-81.72**	24250	35050	44.54	-89.72**

** Significant at 1% level of significance

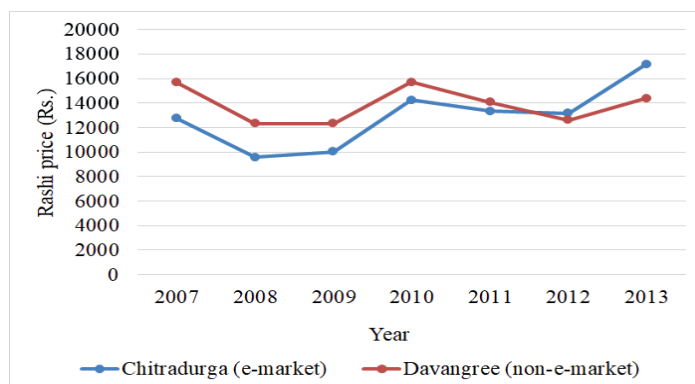


Fig. 3. Test for violation of parallel trend assumption between arecanut prices in Bheemasamudra and Davangere APMCS

Table 7. Impact of e-tendering system on transaction time in the selected APMCS

n=100

Sl. No. (1)	Indicators (2)	APMC, Shivamogga				APMC, Bheemasamudra			
		Mean		Percent change (5)	t-statistic (6)	Mean		Percent change (9)	t-statistic (10)
		Before (3)	After (4)			Before (7)	After (8)		
1.	Time taken for bid announcement (Hours)	6.96	4.50	-35.34	87.87**	7.02	4.50	-35.90	41.62**
2.	Time taken for payment (Hours)	60	24	-60.00	21.30**	56.64	24.00	-57.63	19.83**

** Significant at 1% level of significance

Policy Implications and Conclusion

The most anticipated impact of e-tendering system is on price of the commodity dealt and transparency in the transactions. Accordingly, the exclusive impact of e-tendering on arecanut prices was Rs. 2020.18qt.⁻¹ and Rs. 6332.55qt.⁻¹ in APMCs Shivamogga and Bheemasamudra, respectively. Better price realization could be achieved only when the farmers get involved in the tendering process instead of entrusting commission agents to do the job. Capacity building programs for the farmers need to be conducted and facilities for on-farm grading needs to be provided so as to make them capable of realizing the full potential of e-tendering system.

Time taken for bid announcement as well as time taken to effect payment has reduced significantly after the implementation of the e-tendering

system. Further, the quantity of arecanut traded and income accrued per quintal of arecanut has also increased. Hence, it is highly advisable to implement this system in place of traditional closed tendering system. This reduces the transaction costs of the farmers, which will significantly add to their income and lessen the drudgery.

The system of e-tendering needs to be extended to other non e-markets in the state and also for other notified commodities after ensuring adequate infrastructure facilities. Thereby it would enable the integration of agricultural markets in the state and law of one price would prevail. Further, this successful marketing model which relies on technological advancement can be implemented in other developing countries with suitable modifications.



Authors' Contribution: The study was conceptualized and designed by Sahana, S. Data collection, tabulation and the manuscript was prepared by Vivek, M.C., Kiran Kumar R. Patil helped in performing suitable statistical analysis of the data. The article was reviewed and approved by all authors.

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