

Tomato Arrival and Price Prediction of Indian Agricultural Produce Market Committee (APMC)

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Abstract:

India is a heritage filled agriculture-dependent country. It's necessary to modernize our ancient agricultural practices by providing appropriate circumstances to the farmers. The agricultural transformation is often done via dynamic business proposition that could be a techno-economic method which can be accelerated easily. With the evident development in production technology, input supply, and infrastructure, we are able to see the upward trend in arrivals. The key constraints or factors that influence the prices within the market are due to the arrivals of the selective commodities and their competitive crops. The objectives of this paper is (i) To investigate the trend in arrivals of tomato in Kolar and Chintamani market, (ii) To estimate the trend in costs of tomato in Kolar and Chintamani market and (iii) To forecast the market-wise costs of tomato. The analysis reveals the fallouts of the findings: variations in the price level, the government necessity to create buffer stock schemes that may facilitate to stabilize the market value of tomatoes by getting hold suppliers who merchandise once harvests square measure masses, and marketing stocks of the merchandise onto the market once suppliers square measure low. These methods needed high finish technology and infrastructure. The problem of price variations and profit variations are often restrained by tomato retailers by having appropriate inventory management skills. Therefore, to avoid overstocking of tomatoes at a time within the store. This can be attributable to the biodegradable nature of tomato and overstocking of tomato causes spoilage predominantly due to lack of storage facilities. Hence precise cold storage should be constructed. The big data should be used to developing tools using artificial intelligence, machine learning to enhance planning and marketing services.

Keywords: Consumer Behaviour, Tomato, Price Prediction, Market Prediction

JEL Classification: Q10, Q11, Q12, Q13, Q14, Q18

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INTRODUCTION

Agricultural marketing plays a major role in moving of commodities from the farm producer to the consumer and stabilizing the price. The scheduled increase in agricultural production must be corresponding with variations in demand and supply for agric significantly regardless of the quantity of the marketable surplus generated with the farmers. Therefore, in relation to enhanced seed and fertilizer in contemporary agriculture, marketing was rightly regarded as an important input. Instability in price and earnings is common for agricultural products and they fluctuate more than the other industrial goods. Erratic and highly elastic production price leads to an instability in the agricultural commodity prices which thereby influences the income levels of the farmers. This results in the human and the political consequences in a large way. To feed the growing population surplus production in food grain is vital and India has achieved it. But the need for the self-sufficiency in the horticultural produce is equally important to maintain the health of the growing population. The vegetables, regarded as the protective foods, have short duration of growth but has high production and productivity. They can easily fit in diverse locations and systems of farming in addition to being profitable and a high employment generator. India is the world's **second**-largest vegetable producer, contributing around 7.18% to vegetable production worldwide and produces more than 40 types of vegetables belonging to different families. (Paarlberg, Robert 1997)

Tomato Global Scenario

Tomato, belonging to the Solanaceae family, is a major crop that is produced in India and the world with a global production of 152.9 million tons. Commonly referred to as the 'poor man's orange', it is highly nutritious as it has a wide range of essential nutrients. After potato and sweet potato, it is the third largest vegetable crop in the world. Since pre-historic times, tomatoes have been used as food by the people of Central and South America. The World production was 241.92 million tonnes of tomato from an area of 58.82 lakh hectares (FAO STAT) in 2017-18. China is the largest tomato producing country in the world, almost contributing for 24.6 % of world's tomato production. During 2017-18, China stood first with annual production of 59.63 million tonnes followed by India with 20.71 million tonnes, Turkey with 12.75 million tonnes, USA with 10.91 million tonnes, Egypt with 7.30 million tonnes and Iran (Islamic Republic of) with 6.18 million tonnes. These six countries contributed for around 73.16 % of world's tomatoes production.

Tomato Indian Scenario

Tomato has an important place in the country's vegetable production. Area under tomato in India was 8.08 lakh hectares accounting for 7.86% of the total vegetables crop acreage. Annual tomato production in India amounted to 19.69 million tonnes (NHB, 2016-17), 11.25 per cent of total vegetable production. However, the area under tomato has been increasing gradually as production fluctuated owing to weather-related factors. In India, Madhya Pradesh is the leading state that produces 31.02 lakh tonnes of tomato from an area of one lakh hectares. Karnataka is India's 2nd largest tomato producing state with 21.38 lakh tonnes of tomato from an area of 0.63 lakh hectares.

Tomato Karnataka Scenario

Tomato is produced throughout the year in Karnataka. The major tomato producing areas are Kolar, Chikballapur, Bangalore, Tumkur, Hassan, Haveri, and Davangere. In the state, the total area under tomato was 63.73 thousand hectares with a production base of 21.38 lakh tonnes in 2016-17 (Karnataka Stat, 2016-17). An analysis of arrivals and prices of tomatoes would assist to determine income, constraints and supply response. So, it is essential to analyze the wide fluctuations in prices of tomato and the relationship between arrivals and prices. Market integration describes the relationship between two spatially or temporarily separated markets. The process of determining prices are completely interdependent in an integrated market. The market integration research findings possibly suggest the manufacturers on how much, where and when to sell which will consecutively create an impact on their production policies and therefore the allocation of resources.

REVIEW OF LITERATURE:

Some of research works reveals spatial equilibrium model with endogenous prices is contracted and solve by quadratic mathematical programming method. Six scenarios involving the impacts from transportation costs, tariff, and North American Free Trade Agreement (NAFTA). Impacts on production, consumption, trade flows, prices, and net welfare. Credit to NAFTA, Mexico became the most tomato exporter to the USA. (Impacts on production, consumption, trade flows, prices, and net welfare. Due to NAFTA, Mexico became the main tomato exporter to the USA 2003). Price transmission in Tomatoes. It reveals explores the characteristics of spatial price movements for fresh vegetables special tomato. This is often very useful to policy considerations for fresh vegetables sector (Santeramo, Fabio Gaetano 2015). Results and projection of tomato price in SERBIA. It found that tomato is tremendously most essential vegetable crops in Serbia and average annual production of tomato has been about 174,000 tones. This study is analysis of the changes and thus the longer-term tendencies of the price parameters of tomato in Serbia with aim of forecaster the wheat and tomato price. (Ivanić, Dragan; Mutavdžić, Beba; Novković, Nebojša; Vukelić, Nataša 2015). Price transmission in tomato sector after the Arab Spring. It explains positive relationship with producer, wholesaler and retailer tomato prices. Throughout tremendous market measures that less price increases with supply chain price decline (Ahmed, Osama 2018). North America tomato market. It found endogenous prices are contracted and solve by quadratic mathematical programming method. Six scenarios involving the impacts from transportation costs, and tariff. Impacts on production, consumption, trade flows, prices, and net welfare. Recognition to NAFTA, Mexico became the most tomato exporter to the USA (NAFTA, Mexico became the main tomato exporter to the USA 2003). Influence of layer on behavior of greenhouse tomatoes in transition from conventional to biological growing greenhouse tomato production (Petkova, Valentina; Filipov, Stoyan; Kostadinov, Kostadin 2013). Rain in Spain falls and UK tomato prices soar. It reveals that heavy rains in Spain have prevented tomato growers from planting, delaying the 2011 tomato season, and raising the prospect of higher prices for both fresh and processed tomatoes (Glotz, Julia 2011). It reveals that consumers paid \$0.25/lb more for organic fresh tomatoes in the New York Philadelphia market. The organic premiums are estimated to be \$0.14/lb in the Chicago. Francisco markets and \$0.29/lb in the Antonio market. Furthermore, tomato prices consumers paid in 2004 varied by household characteristics, including income, age, and therefore the race and ethnicity of the top of the household (Chung L. Huang & Bing-Hwan Lin. 2007). Research explains the risk in investment in greenhouse tomato production in florida. And concludes behavior if prices and demand in production impacts the risk

availability this production. (Asci, Serhat; VanSickle, John J.; Cantliffe, Daniel J. 2014). It reveals that tomato prices glut in the U.S. due to whether, tomato growers in Florida developing their crop. In Florida the price farmers receive for a 25-pound box has fallen from \$30 to \$5 (Pleven, Liam, and Carolyn Cui. 2010). Tomato prices rocket as season ends prematurely. It reveals that wholesale price movement of several agricultural products worldwide includes tomato, onion and banana (Grocer 2014) research evaluated and recommended evidence rejecting the presence of unit roots at all seasonal frequencies for agriculture; and vegetables. (Aviralkumartiwari, Subhendu Dutta and Aruna Kumar Dash 2017). Paper shows agricultural price policy and stable price environment to farmers in case of pulses and suggests reviewing the pulses by making it sensitive to prevailing market prices. (Ashutosh Kr. Tripathi 2017) It found that Impact of prices influence the income of farmers towards cost of production like cultivation. This research reveals that how best utilized cost and projecting profits earned by farmers in Indian scenario. (Ashutosh Kumar Tripathi 2013). It depicts agro wellbeing practices. (P weligamage) and Competitive revenue price stageris in irrigation cost (P Weligamage).

The research offers information on how tomato prices would be in different months of the year. Such information provides farmers hints to the price behavior in order to make production decisions that are essential. The objectives of the study are to analyze the trend in arrivals of tomato in Kolar and Chintamani market, to estimate the trend in prices of tomato in Kolar and Chintamani market and to forecast the market –wise prices of tomato.

RESEARCH METHODOLOGY:

This section introduces the methodology used in the research which provides insights with on markets, data sources, nature and also the analytical methods applied for the assessments. The crop selected for the research was tomato. According to the Karnataka State Agricultural Marketing Board (KSAMB), Bangalore, Chikkaballapura, Chintamani, Kolar, Bagepalli and Srinivasapura are the main tomato markets in Karnataka. Because of the availability of continuous time series data for the study period, so I have selected Chintamani and Kolar markets were chosen. Data from secondary sources were acquired for the research. Data such as month, time of arrival, and the price of tomato were grouped from the Krishimaratavahini official website by the Karnataka State Agricultural Marketing Board (KSAMB) Bangalore. KSAMB receives the data from various markets across the state from the corresponding Agricultural Market Committees (APMC 'S). The Board and APMC 'S keep the website up to date by maintain the data of arrival and the prices of regulated agricultural commodities on a daily, weekly, monthly, annual basis. Arrival data refers to total arrivals in quintals during a market place during the month. The worth data used here denotes the month's modal price. Modal price is regarded as superior to the monthly average price, because it epitomizes the commodities marketed on a major percentage in a specific market at a particular month. For the markets under study, the monthly total arrivals and the modal prices date were composed from 2008 till 2018 (11 years). A brief description of statistical tools employed for this study was presented in this section. For studying the short-term, long-term and other periodic fluctuations in arrivals and price of tomato for each market, Time series analysis was employed; and for forecasting of arrivals and price, trend equation model was used.

RESULT AND DISCUSSION

Trend of tomato arrival and its price in carefully chosen markets of Karnataka

Time series analysis was employed to review the trends of tomato arrival, its pricing and its review in selected markets, linear models (linear in parameter) viz. linear model (straight line), were fitted to the total annual data of arrivals and average prices for the period of 5 years from 2015 to 2019.

To analyze any time series data, we have to check for data structure for their movements in graph. In current study movement of arrivals and prices are represented as below table 1 and graph 1.

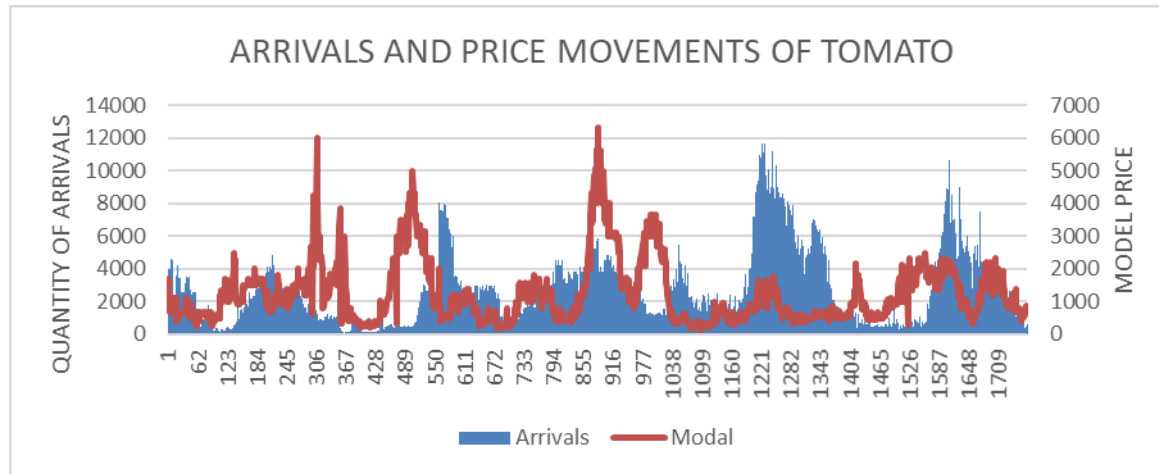
Table 1: The below table represents the sum of arrivals and average model price for Chintamani market from the year 2015 to 2019.

Months	2015		2016		2017		2018		2019	
	Sum of Arrivals	Avg of Modal	Sum of Arrivals	Avg of Modal	Sum of Arrivals	Avg of Modal	Sum of Arrivals	Avg of Modal	Sum of Arrivals	Avg of Modal
Jan	93994	864	5315	1541	30325	825	81697	388	21618	1185
Feb	76113	678	11510	376	44150	1400	44926	275	12547	512
Mar	24464	600	3535	302	66150	1297	40574	426	14929	817
Apr	6280	735	13015	1014	107410	614	32015	605	14115	1464
May	13870	1444	12960	2742	80905	640	66311	585	17760	1902
Jun	45435	1322	26575	3712	111563	2062	244785	974	84207	1766

Jul	84150	1558	78410	1969	124855	4763	256288	1283	219636	2046
Aug	103235	1007	187415	708	119400	2971	229826	638	160285	1122
Sep	62380	1124	93600	1035	77590	1278	138550	468	117255	932
Oct	53205	1567	73200	896	55005	2560	170118	575	88662	1790
Nov	32519	2447	79550	476	33149	2911	80713	624	65525	1199
Dec	24065	1588	38510	306	65215	904	33095	609	24916	775
Grand Total	619710	1244	623595	1261	915717	1849	1418898	622	841455	1302

Source:KSAMB &APMC'S

Graph 1: Indicates the arrivals and price movements of tomato from 2015-2019.



In the above graph we can say that movements of sum of arrivals and average model price are in trend structure. Graph movement indicates inverse relationship.

Analysis of trend in arrivals of tomato in Chintamani market.

To analyze the trend in arrivals of tomato inChintamanimarket, five models were fitted and estimates of the parameter of the fitted models are given in Table 4.1. The estimates of parameters of the Trend equation were found to be significant. The fitted trend equation is given below.

$Y = a + b \cdot x$, Where, Y = predicted values of arrivals at time point t , X = price, a and b = intercept and slope respectively.

RMSE and R^2 value were considered to check the adequacy of the fitted models. highest R^2 value (60 %) among the significant models. Hence, this model is adequately fitted compared to other models. Actual and predicted values of arrivals by the trend equation are shown in graph 2 and 3.

To analyze the arrival and price trend, firstly the we have to check the correlation between the arrivals and price. So for current study arrivals and price relation is 60 percent which represents that there is a relation between arrivals and prices in Chintamani market. The findings for current correlation study are represented as below.

Table 2: Arrival and price trends

Year	Jan ARR	Price	Price Trend
2015	93994	864.39	1062.98
2016	5315	1540.75	1011.84
2017	30325	825.17	960.70
2018	81697	388.28	909.57
2019	21618	1184.93	858.43
2020	57340		807.29

Source:Data Computation in Excel

To check the correlation between sum of arrivals and average model price we used regression technique, results are represented in below output.

Table 3: Correlation between sum of arrivals and average model

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.77469083					
R Square	0.600145883	60%				
Adjusted R Square	0.466861177					
Standard Error	28446.91668					
Observations	5					
ANOVA						
	df	SS	MS	F	Significance F	
Regression	1	3643736093	3643736093	4.502736295	0.123951245	
Residual	3	2427681206	809227068.7			
Total	4	6071417299				
	Coefficients	Standard Error	t stat	P -value	Lower 95%	
Intercept	113910.0628	34181.11257	3.332544034	0.044634514	5130.507375	
X Variable 1	-70.0739051	33.02311707	-2.121965196	0.123951245	-175.168202	
RESIDUAL OUTPUT						
Observation	Predicted	Residuals	Std Residuals			
1	53339.0834	40654.9166	1.650240503			
2	5943.693504	-628.6935041	-0.025519558			
3	56087.00938	-25762.00938	-1.045716358			
4	86702.05688	-5005.056881	-0.20316233			
5	30877.15684	-9259.156839	-0.375842258			

Source:Data Computation in Excel

Here it found the relation between sum of arrivals and average model price as **60** percent.

Table 4:Analysis of trend in arrivals of tomato in Kolar market

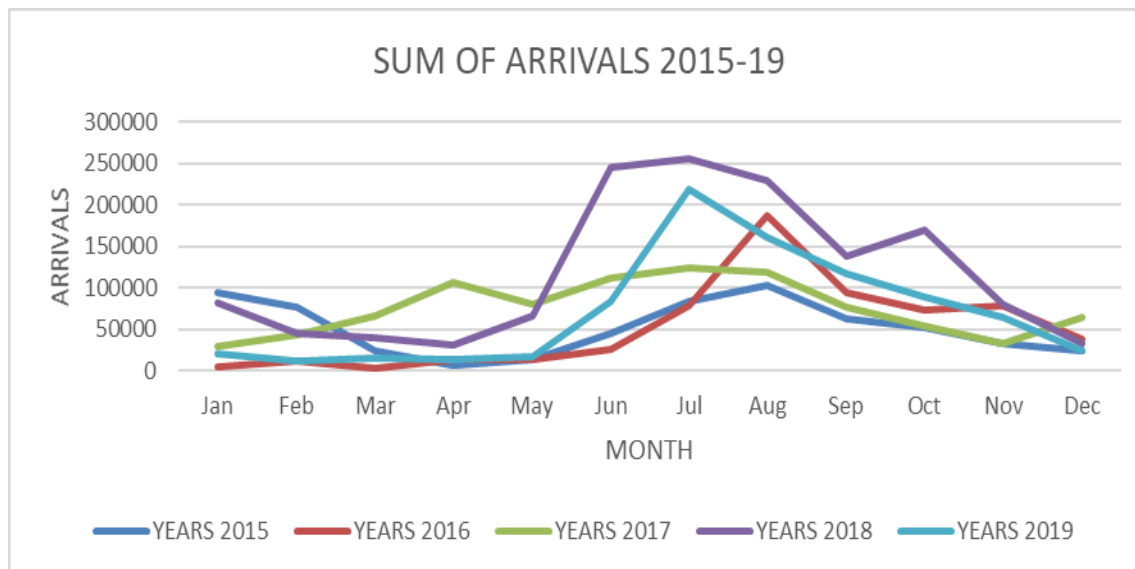
Sum of Arrivals Month	2015	2016	2017	2018	2019	Grand Total
Jan	93994	5315	30325	81697	21618	232949
Feb	76113	11510	44150	44926	12547	189246
Mar	24464	3535	66150	40574	14929	149652
Apr	6280	13015	107410	32015	14115	172832
May	13870	12960	80905	66311	17760	191806
Jun	45435	26575	111563	244785	84207	512565
Jul	84150	78410	124855	256288	219636	763339
Aug	103235	187415	119400	229826	160285	800161
Sep	62380	93600	77590	138550	117255	489375
Oct	53205	73200	55005	170118	88662	440190
Nov	32519	79550	33149	80713	65526	291456
Dec	24065	38510	65215	33095	24916	185801
Grand	619710	623595	915717	1418898	841455	4419375

Total						
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Source:KSAMB &APMC'S

This table represents sum of arrivals of tomato from the year 2015 - 2019 and their annual grand total.

Graph 2: Arrivals trend of Chintamani market.



In this graph y-axis represents sum of arrivals (in quintals) and x-axis represents months of respective years. It shows that in the month of July 2018(256288) accounts for height arrivals compare to rest of all other months from 2015 to 2019. Followed by July 2019 (219636), August 2016 (187415), July 2017 (124855) and August 2015 (103235) respectively.

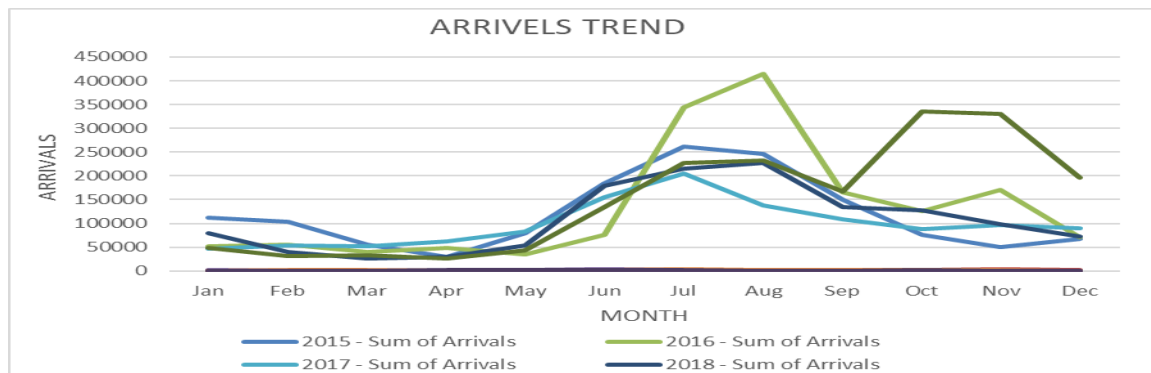
Table 5:The trend in arrivals of tomato in Kolar market

Sum of Arrivals Month	2015 Sum of Arrivals	2016 Sum of Arrivals	2017 Sum of Arrivals	2018 Sum of Arrivals	2019 Sum of Arrivals
Jan	111412	52005	46372	79821	48075
Feb	104112	55242	54138	40313	31033
Mar	54665	40751	51832	26055	32880
Apr	29245	49054	63080	29897	26500
May	79384	34548	83634	53209	42554
Jun	183583	76569	155826	178534	134009
Jul	262256	343436	204930	215663	227749
Aug	245537	415086	137364	227224	231932
Sep	149524	165268	107952	134424	167368
Oct	75458	126501	87793	127060	334885
Nov	49633	170403	97298	98792	330348
Dec	66877	70516	90183	72559	195718
Grand Total	1411686	1599379	1180402	1283551	1803051

Source:KSAMB &APMC'S

This table represents sum of arrivals of tomato from the year 2015 to 2019 and their annual grand total.

Graph 3: arrivals trend of Kolar market.



This graph indicates highest arrivals accounted for 415086 quintals in 2016 august followed by 262256 (July 2015), 334885 (October 2019), 215663 (July 2018) 204930 (July 2017) respectively.

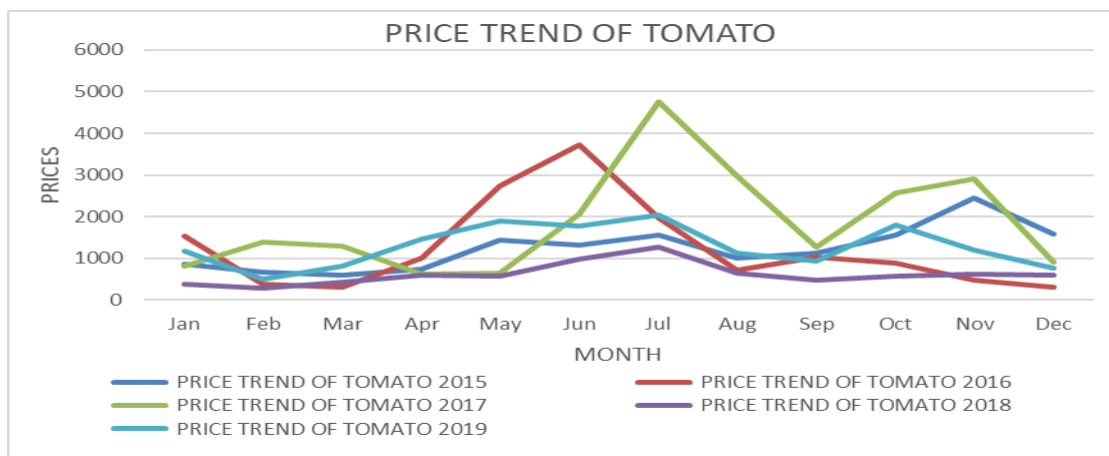
Table 6: To analyze the Chintamani market price trend of tomato.

Sum of Arrivals Month	2015	2016	2017	2018	2019
Jan	864	1541	825	388	1185
Feb	678	376	1400	275	512
Mar	600	302	1297	426	817
Apr	735	1014	614	605	1464
May	1444	2742	640	585	1902
Jun	1322	3712	2062	974	1766
Jul	1558	1969	4763	1283	2046
Aug	1007	708	2971	638	1122
Sep	1124	1035	1278	468	932
Oct	1567	896	2560	575	1790
Nov	2447	476	2911	624	1199
Dec	1588	306	904	609	775

Source:KSAMB &APMC'S

This table represents the average model price of tomato from the year 2015 to 2019 and their annual grand total.

Graph 4: Analyze the Chintamani market price trend of tomato in linear line graph.



This graph indicates highest average model price accounted for 4763 rupees per quintal in 2017julyfollowed by 3712 (June 2016), 2447(November 2015), 2046 (July 2019) and 1283 (July 2018) respectively.

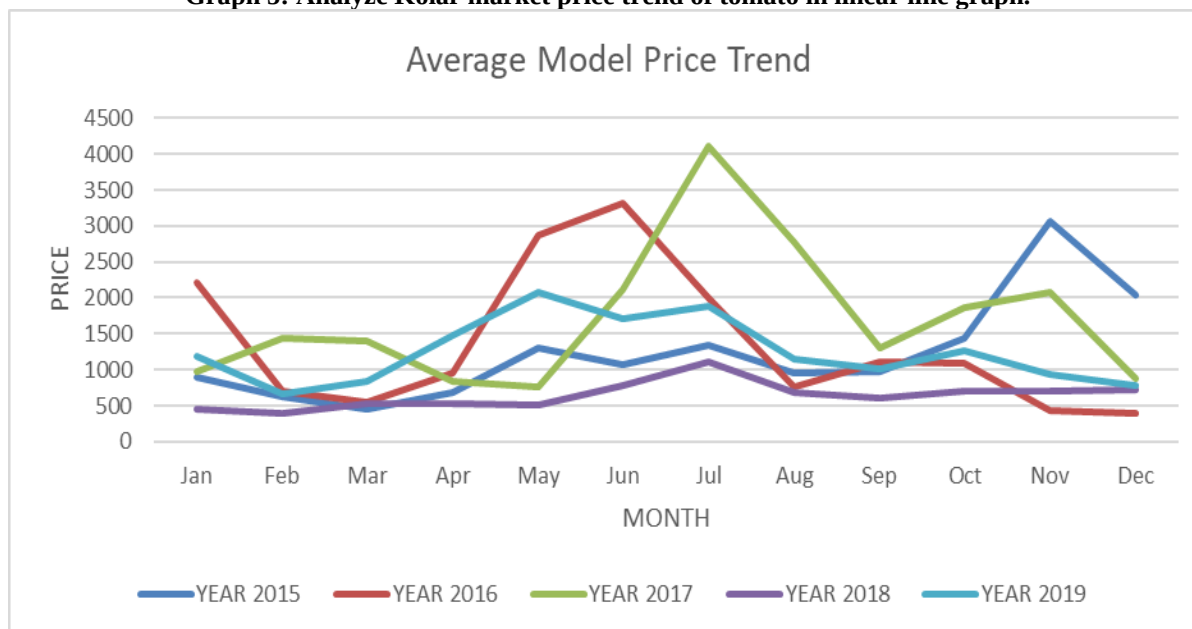
Table 7 :Analyze Kolar market price trend of tomato

Sum of Arrivals Month	2015	2016	2017	2018	2019
Jan	888	2207	975	460	1185
Feb	623	703	1443	388	656
Mar	447	549	1391	523	842
Apr	681	947	839	526	1483
May	1296	2875	758	516	2073
Jun	1062	3320	2120	789	1708
Jul	1346	1999	4115	1115	1884
Aug	955	760	2769	684	1156
Sep	984	1107	1312	597	1010
Oct	1441	1098	1866	710	1268
Nov	3056	437	2079	701	930
Dec	2041	402	884	722	771

Source:KSAMB &APMC'S

This table represents the average model price of tomato from the year 2015 to 2019 and their annual grand total.

Graph 5: Analyze Kolar market price trend of tomato in linear line graph.



This graph represents the average model price of tomato from the year 2015 to 2019 and their highest average model price accounts is 3056 in November 2015, 3320 in June 2016, 4115 in July 2017, 1115 in July 2018, 2073 in May 2019 respectively.

To forecast market –wise prices of tomato.

Table 8: Average model price trend of tomato (Price forecast Chintamani market).

Sum of Arrivals Month	2015	2016	2017	2018	2019	2020
Jan	864	1541	825	388	1185	807
Feb	678	376	1400	275	512	518
Mar	600	302	1297	426	817	856
Apr	735	1014	614	605	1464	1201
May	1444	2742	640	585	1902	1090
Jun	1322	3712	2062	974	1766	1412
Jul	1558	1969	4763	1283	2046	2411
Aug	1007	708	2971	638	1122	1337
Sep	1124	1035	1278	468	932	682
Oct	1567	896	2560	575	1790	1515
Nov	2447	476	2911	624	1199	827
Dec	1588	306	904	609	775	440

Source:KSAMB &APMC'S

In this table we got the forecasted average model price values for year 2020, where July months accounts for 2411 rupees for one quintal of tomato which is ranks highest average price in the year 2020 and in the month December 2020 accounts for 440 rupees per quintal of tomatoes which is least average model price. And its graph is represented below.

Graph 8: Analyze Chintamani market price forecast trend of tomato in linear line graph.

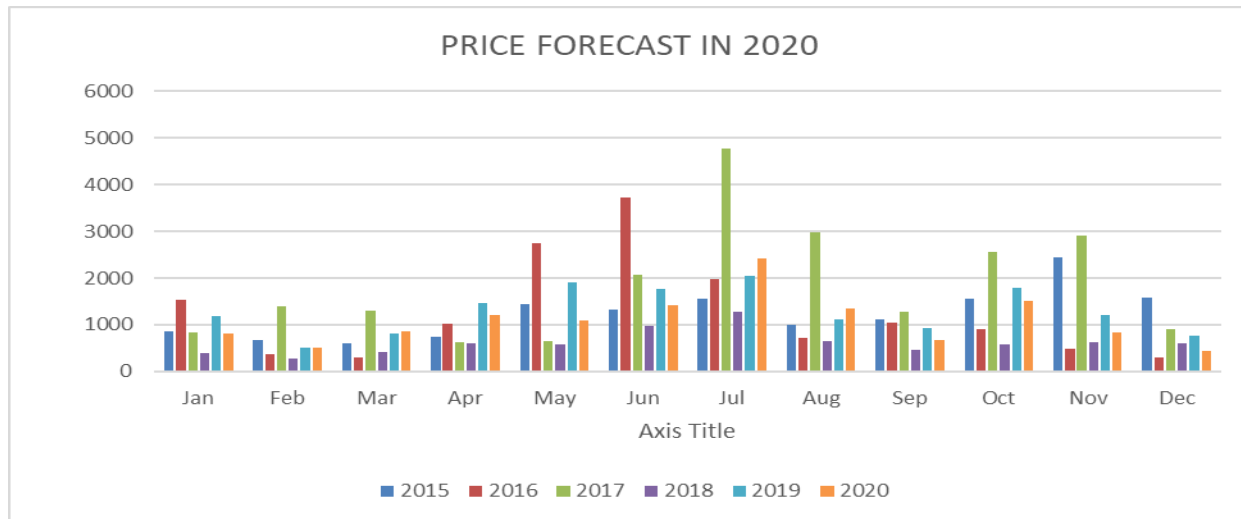


Table 9: Average model price trend of tomato (Price forecast Kolar market).

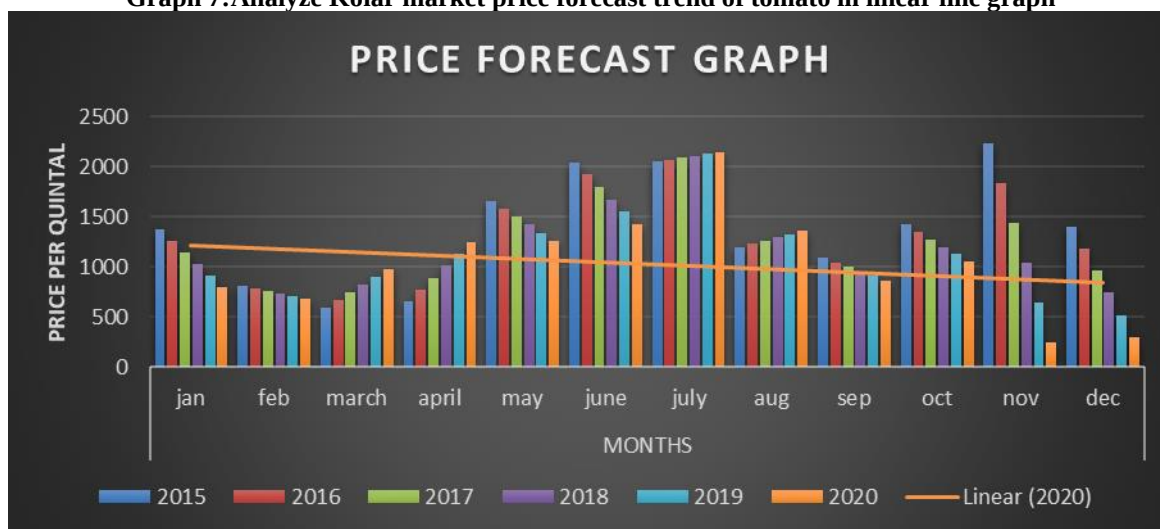
Sum of Arrivals Month	2015	2016	2017	2018	2019	2020
Jan	1374	1258	1143	1028	912	797
Feb	812	787	762	737	713	688
Mar	597	674	750	827	903	980
Apr	658	777	895	1014	1132	1250

May	1665	1584	1504	1423	1343	1262
Jun	2048	1924	1800	1676	1552	1428
Jul	2054	2073	2092	2111	2130	2149
Aug	1200	1232	1265	1297	1330	1362
Sep	1093	1048	1002	956	911	865
Oct	1423	1350	1277	1203	1130	1057
Nov	2238	1839	1440	1042	643	244
Dec	1408	1186	964	742	520	298

Source:KSAMB &APMC'S

The above table represents the price trend of tomato in the year 2020. In this table we got the forecasted average model price values for year 2020, where July months accounts for 2149 rupees for one quintal of tomato which is ranks highest average price in the year 2020 and in the month December 2020 accounts for 298 rupees per quintal of tomatoes which is least average model price. And its graph is represented below.

Graph 7:Analyze Kolar market price forecast trend of tomato in linear line graph



The graph 7 indicates the price forecast trend of tomato in Kolar market in which July month accounts for highest price forecast trend and December month accounts for least value over the year.

CONCLUSIONS

Time series analysis was employed to study the trend in arrivals of tomato. To examine the trend of tomato arrivals followed by the prices of tomato in selected markets, linear models (linear in parameter) viz. linear model (straight line), were fitted to the total annual data of arrivals and average prices for the period of 5 years from 2015 to 2019. To analyze any time series data, we have to check for data structure for their movements in graph. In current study movement of arrivals and prices are represented as in table 4 & 5 and graph 3 & 4. To analyze the trend of tomato arrivals and also the prices of tomato in selected markets, linear models viz. linear model (straight line), Quadratic model, Cubic model and Exponential model, and nonlinear model i.e., sigmoid model were fitted. RMSE and R^2 values were considered to check the adequacy of the fitted models. Among the fitted model's exponential model, quadratic model, quadratic model and sigmoid models are best fitted to prices for Kolar and Chintamani markets respectively. The linear model was best fitted among the fitted models for prices of cotton in all the four selected markets. For forecasting of tomato prices in all the selected markets, the Holt Winter's exponential model and ARIMA models were fitted. The estimates of Holt Winter's model were found to be significant for all the selected markets hence forecasting of prices was done by this method. From the best fitted model forecasting was done for 12 months ahead.

Linear and nonlinear models viz. linear, quadratic, cubic, exponential and sigmoid were some of the models fitted to evaluate the trend in arrivals and prices of tomato. This study, 5 years monthly arrivals and prices data were collected. For arrivals of tomato, both linear and nonlinear models were best fitted whereas for prices of tomato only linear model was best fitted. The results of this study indicate that there was a huge variation over the different years in the prices of tomato in all the markets. For forecasting of tomato prices, Holt's winter model and ARIMA model were considered in that estimates of Holt Winter's

model were significant in for Kolar and Chikballapure the markets. Best fitted Holt Winter's models selected for different markets. Hence, Holt Winter's models are best to forecast the tomato prices in selected markets.

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