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A CASE STUDY :

Agricultural market intelligence – A case study of maize crop price forecasting

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SUMMARY : The majority of the rural producers are unable to understand and interpret the market and price behavior to their advantages. Hence, market information and intelligence are crucial to enable farmers and traders to make informed decisions about what to grow, when to sell, and where to sell.The price forecasts are made by analyzing the prices of Agricultural Commodities concerned over 15 years using advanced statistical tools like ARIMA, ARCH, GARCH models, comparing the same with prices of futures markets and national and international reports of trade surveys besides conducting state level trade surveys. Under the project price forecasts were made for maize crop twice during *Kharif* and *Rabi* seasons for 3 years / 6 seasons from *Kharif* 2014 to *Rabi* 2016-17. Thus, a total 12 price forecasts with more than 90 per cent precision were developed and disseminated through various means like university website, university magazine, Vyavasayam, SMS to contact farmers, pamphlets, farmers trainings and meetings, etc.

KEY WORDS :
Maize crop, ARIMA, ARCH, GARCH

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BACKGROUND AND OBJECTIVES

Market intelligence (MI) is the process of collecting, analyzing, interpreting, and disseminating information relevant to marketing decisions. MI for agriculture emphasizes the interdependence and interrelatedness of all aspects of agribusiness, namely: from farm input supply to the growing, assembling, storage, processing, distribution and ultimate consumption of the product. The most important marketing information input needed by a farmer in the current scenario is the price intelligence. Efficient market intelligence is essential for the development of the agricultural sector as a whole. In as much as it provides outlets and incentives for increased production, MI contributes greatly to the commercialization of subsistence farmers. Failure to develop the MI is likely to negate most of the efforts of the government to increase agricultural production. It is expected that future agricultural growth would largely accrue from improvements in productivity of diversified farming systems with regional specialization and sustainable

management of natural resources, especially land and water. Effective linkages of production systems with marketing, agro-processing and other value added activities would play an increasingly important role in the diversification of agriculture. Marketing excellence is the result of correct marketing decisions and all correct marketing decisions come from Market Intelligence (MI).

The Centre will collect details on prices of major commodities at domestic and international markets, analyze and forecast future domestic and export prices. The Centre transmits the forecast prices prevailing in other states and in the forthcoming months to the regulated markets and farmers. The Centre by providing this information helps the farmers to plan the cropping pattern and the right time and right market to sell their produce. This centrefunctions by networking with the Regional Agricultural Research Stations at zonal level and also the DAATT Centres at district level, thus covering the entire Telangana State.

Maize is one of the important coarse cereal crops grown in different agro-climatic conditions of India. Maize ranks third next to Wheat and Rice in the world with respect to area, while its productivity surpasses all other cereal crops. Maize is grown in 70 countries of the world. The major Maize growing countries are USA, China, Brazil, Mexico, Indonesia, India, France and Argentina. In some parts of the world, Maize is used as food grain for human consumption. It is being used for manufacturing industrial products like starch, syrup, alcohol, acetic and lactic acids, glucose, paper, rayon, plastic, textile, adhesive, dyes, synthetic materials, rubber etc. In USA more than 90 per cent of the people use Maize oil for consumption purpose and around 25% of Crop land area is occupied by Maize. India is at 6^{th} position in Maize production and 15^{th} position in its productivity in the World. In India Maize is grown all over the country. In India the major producing states are Karnataka, Andhra Pradesh, Madhya Pradesh, Bihar, Rajasthan, Tamil Nadu, Telangana and Uttar Pradesh. In 2015-16 Karnataka is the largest Maize producing state in India with a production of 3.01 million tonnes and Andhra Pradesh is next to the Karnataka in case of production with a production of 2.76 million tonnes. In case of area Karnataka stands first and Andhra Pradesh ranks fifth next to Rajasthan, Madhya Pradesh and Maharashtra with an area of 0.78 million hectares. Maize is a traditional crop of Telangana state. In India maize stands fifth in area and second in terms of production and productivity .The area, production and productivity of Maize in Telangana are increasing.

Review of literature :

Meyler *et al.* (1998) drew a framework for ARIMA time series models for forecasting Irish inflation. Prajneshu and Venugopalan (1998) applied this model as well as other parametric statistical modeling techniques, like polynomial function fitting, and nonlinear mechanistic growth modeling for describing trends in marine fish production data of the country. Singh *et al.* (2007) applied statistical models for forecasting rice production in India. Singh (2013) developed forecasts of international tourism demand for Bhutan by selecting appropriate model both ARIMA as well as exponential smoothing. Paul *et al.* (2014) applied models for livestock and dairy production in India under time series framework.

RESOURCES AND METHODS

The major sources of price data on selected commodities include the official records of Directorate of Economics and Statistics, Government of Telangana, and the official websites of marketing departments of both Andhra Pradesh and Telangana states.

The monthly average price data of selected commodities in selected markets from April 2002 to 2007 December was obtained from Directorate of Economics and Statistics, Government of Telangana. The same data from 2008 January onwards was collected from websiteshttp://agrimarketing.telangana.gov.in/indexnew.jsp. Very few data gaps for the commodities in the selected markets were filled with the data from the nearby another major market of selected commodity in the state.

The price forecasts are made by analyzing the prices of Agricultural Commodities concerned over 15-20 years using advanced statistical tools like ARIMA, ARCH, GARCH models, comparing the same with prices of futures markets and national and international reports of trade surveys besides conducting state level trade surveys. Thus, these forecasts are made by way of thinking globally and acting locally.

ARIMA:

It is one of widely used time series models. ARIMA model was chosen rather than the others such as Average

Moving, Average Naïve, due to its flexibility that it can represent several different types of time series, *i.e.* pure autoregressive (AR), pure moving average (MA) and combined AR and MA (ARMA) series. The ARIMA model is denoted by ARIMA (p,d,q), where "p" stands for the order of the auto regressive process, "d" is the order of the data stationary and "q" is the order of the moving average process. In ARIMA model, the future value of a variable is assumed to be a linear function of several past observations and random errors.

SARIMA:

When seasonality is considered in ARIMA model it becomes SARIMA model. Seasonal ARIMA models are usually denoted ARIMA (p,d,q) $(P,D,Q)_m$, where m refers to the number of periods in each season, and the uppercase P, D, Q refer to the autoregressive, differencing and moving average terms for the seasonal part of the ARIMA model.

ARCH:

Autoregressive conditional heteroscedasticity (ARCH) is the condition that one or more data points in a series for which the variance of the current error term or innovation is a function of the actual sizes of the previous time periods' error terms: often the variance is related to the squares of the previous innovations. In econometrics, ARCH models are used to characterize and model time series. ARCH models are commonly employed in modeling financial time series that exhibit time-varying volatility clustering*i.e.* periods of swings interspersed with periods of relative calm. ARCH-type models are sometimes considered to be in the family of stochastic volatility models, although this is strictly incorrect since at time t the volatility is completely pre-determined given previous values.

GARCH:

If an autoregressive moving average model (ARMA model) is assumed for the error variance, the model is called a generalized autoregressive conditional heteroscedasticity (GARCH) model.

OBSERVATIONS AND ANALYSIS

The monthly average data from 2002 to 2016 were showed in Table 1. Results show that maize prices increasing year by year high prices are present at June

Table 1: Monthly average prices of maize

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Monthly average for overall years
January		540	510	508	550	690	648	819	852	915	1233	1338	1205	1258	1350	886.86
February		515	500	515	557	725	667	710	850	918	1125	1263	1150	1296	1440	873.64
March		547	504	500	567	734	710	779	846	942	1105	1307	1212	1288	1420	890.07
April	547	534	540	508	532	721	670	676	849	1026	1228	1252	1293	1290	1370	869.07
May	558	545	550	515	533	676	672	841	845	998	1080	1254	1288	1310	1350	867.67
June	569	553	552	516	517	732	774	854	873	1039	1041	1536	1294	1310	1420	905.33
July	604	575	560	549	550	741	830	876	884	1029	1233	1419	1305	1310	1400	924.33
August	608	560	575	575	597	735	873	853	902	1002	1091	1508	1310	1310	1450	929.93
September	569	514	592	562	630	718	856	879	930	1004	1371	1307	1221	1320	1350	921.53
October	504	505	505	531	591	719	828	844	901	984	1247	1154	1290	1320	1380	886.87
November	519	510	536	539	655	695	826	849	883	1002	1280	1149	1278	1325	1450	899.73
December	517	505	540	550	670	703	834	863	894	1008	1344	1140	1320	1325	1400	907.53
Year wise average	555	533.583	538.667	530.667	579.083	715.75	765.667	820.25	875.75	988.917	1198.17	1302.25	1263.83	1305.17	1398.33	

2013 (Rs. 1536), monthly average for overall years is very high present in the month of July and Yearly average for overall months is very high present in the year 2016.

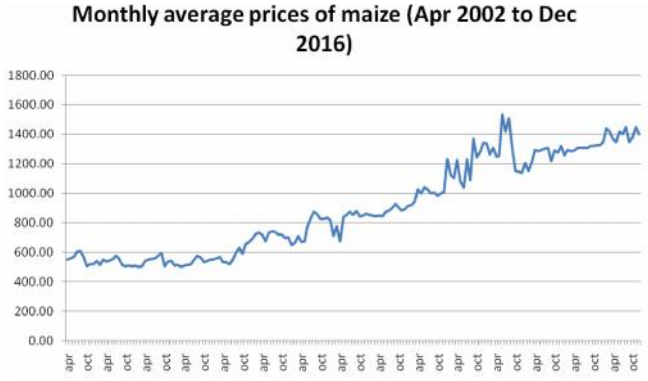

Fig. 1: Monthly average prices of maize

Price forecasts:

The main purpose of Network Project on Market Intelligence is to provide short term price forecasts to farmers for selected agricultural commodities for effective decision making with regard to production and marketing and make them to realize remunerative prices. Under the project price forecasts were made for maize crop twice during *Kharif* and *Rabi* seasons for 3 years / 6 seasons from *Kharif* 2014 to *Rabi* 2016-17. Thus, a total 12 price forecasts with more than 90 per cent precision were developed and disseminated through various means like university website, university magazine, *Vyavasayam*, SMS to contact farmers, pamphlets, farmers trainings and meetings, etc. The selected maize price forecasts made during *Kharif* and *Rabi* seasons of 2014-15 to 2016-17 years is presented in Table 2.

The econometric time series analytical model best fit for maize data during all 12 price forecasts was found to be ARIMA. Considering the farmers' and traders' expectations along with model price forecast, a final integrated price forecast was arrived at during pre-sowing and pre-harvesting scheduled months and the same were disseminated through different means to farmers and traders.

Forecast validity :

For any forecast validation is most important. Keeping that in view, the prices forecasted were validated by working out the percentage deviation and mean average percentage errors. Forecast validity of maize prices during pre-sowing and pre-harvesting months of both *Kharif* and *Rabi* seasons for the years 2014-15 to

Table 2 : Price forecasts of maize (in Rs.)

Forecast	Particulars	2014-15	2015-16	2016-17
Pre sowing Forecast	*Kharif*			
	Model Selected	ARIMA (110)	ARIMA (011)	ARIMA(212)
	Model Forecast	1250.35	1299.43	1337.06
	Farmer's Expectation	1350 - 1400	1200-1350	1350-1450
	Trader's Expectation	1250 - 1450	1200-1250	1250-1350
	Final range	1260 -1310	1290-1350	1250-1450
Pre harvest Forecast	Model Selected	ARIMA (110)	ARIMA (112)	ARIMA(211)
	Model Forecast	1245.23	1310.17	1389.89
	Farmer's Expectation	1200-1400	1250-1400	1350-1450
	Trader's Expectation	1200-1350	1200-1450	1250-1350
	Final range	1240-1310	1320-1390	1250-1450
Pre sowing Forecast	*Rabi*			
	Model Selected	ARIMA(111)	ARIMA(112)	ARIMA(211)
	Model Forecast	1265.69	1325.46	1402.32
	Farmer's Expectation	1250-1450	1200-1400	1300-1500
	Trader's Expectation	1200-1400	1250-1450	1250-1400
	Final range	1250-1330	1350-1400	1250-1450
Pre harvest Forecast	Model Selected	ARIMA(211)	ARIMA(112)	ARIMA(211)
	Model Forecast	1286.45	1334.46	1422.20
	Farmer's Expectation	1250-1420	1300-1450	1350 - 1500
	Trader's Expectation	1200-1350	1250-1350	1250 - 1400
	Final range	1200-1300	1300-1350	1250-1450

Table 3 : Forecast validity of maize

Season	Year and month	Month-wise Forecast price (Rs./q)	Actual price (Rs./q)	% deviation	MAPE%
Kharif Pre sowing	2014 May	1260 -1310	1100 -1380	-3.63	6.9
Kharif Pre harvest	2014 Sept	1240 - 1310	1100 -1380	-2.82	9.5
Rabi Pre sowing	2014 Sept	1250 - 1330	1000 -1300	-12.17	8.5
Rabi Pre harvest	2014 Dec	1200 -1300	1000 -1300	-8.70	5.6
Kharif Pre sowing	2015 May	1290 - 1350	1200-1400	-1.54	2
Kharif Pre harvest	2015 Sept	1320 -1390	1200-1400	-4.23	3.8
Rabi Pre sowing	2015 Sept	1350 -1400	1176-1443	-5.00	6.8
Rabi Pre harvest	2015 Dec	1300 - 1350	1176-1443	-1.18	6.8
Kharif Pre sowing	2016 May	1250-1400	1240-1449	1.45	7.3
Kharif Pre harvest	2016 Sept	1250-1400	1240-1449	1.45	3.4
Rabi Pre sowing	2016 Sept	1250-1450	1200-1450	-1.89	3.6
Rabi Pre harvest	2016 Dec	1250-1450	1200-1450	-1.89	3.3

2016-17 are presented in Table 3. It is evident from the table that the pre-harvest price forecasts are less deviated from actual prices than the pre-sowing price forecasts and the per cent deviation was reduced over years. Among the total 12 price forecasts made during the project period minimum deviation (-1.18%) was observed with *Rabi* pre-harvest 2015-16, while the maximum (-12.17%) was found with rabi pre-sowing 2014-15.

Conclusion :

Maize prices increasing year by year high prices are present at June 2013 (Rs. 1536), monthly average for overall years is very high present in the month of July and Yearly average for overall months is very high present in the year 2016. The econometric time series analytical model best fit for maize data during all 12 price forecasts was found to be ARIMA. Considering the farmers' and traders' expectations along with model price forecast, a final integrated price forecast was arrived at during pre-sowing and pre-harvesting scheduled months and the same were disseminated through different means to farmers and traders.the pre-harvest price forecasts are less deviated from actual prices than the pre-sowing price forecasts and the per cent deviation was reduced over years. Among the total 12 price forecasts made during the project period minimum deviation (-1.18%) was observed with rabi pre-harvest 2015-16, while the maximum (-12.17%) was found with *Rabi* pre-sowing 2014-15. Thus, a total 12 price forecasts with more than 90 per cent precision were developed and disseminated through various means like university website, university magazine, Vyavasayam, SMS to contact farmers, pamphlets, farmers trainings and meetings, etc.

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