## Onion price forecasting in Hubli market of Northern Karnataka using ARIMA technique

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(Recevied: February, 2014 ; Accepted: April, 2015)

Abstract: The present study is an attempt to forecast the prices of onion at Hubli market of Northern Karnataka, as the arrivals of Onion were found to be maximum in this market. The time series data on monthly price of onion required for the study was collected from the registers maintained in the Hubli APMC from year 1996-97 to 2010-11. The ARIMA model forecasted prices revealed an increase in the prices of onion in the future years and also demand for onion. Hence, farmers need to plan the production process in such a way that good price for the produce could be expected. ARIMA model is an extrapolation method that requires only historical time series data on the variable under study. The Box-Jenkins model provides a verified approach for identifying and filtering most appropriate variations for the series being analyzed, for diagnosing the accuracy and the reliability of the models that have been estimated and lastly, for forecasting the price.

Keywords: Akike Information Coefficient, Auto-Correlation Function, Swarz Information Coefficient

#### Introduction

Auto Regressive Integrated Moving Average (ARIMA) models are extensively used to study market fluctuations particularly of agricultural commodities. The main advantage of this class of models lies in its ability to quantify random variations present in any economic time series. Hence the data on prices of onion in the selected markets were subjected to ARIMA analysis to quantify the variation and also to predict the future prices of onion.

Since ARIMA model used only stationary series, there was also a need to change the non-stationary series into stationary series by applying appropriate order of differencing to the series. Thereafter, the autocorrelation and partial autocorrelation coefficients of the working series were computed and confirmed the absence of trend component in the series. An examination of such tables revealed that this is justified by the autocorrelation function of the series dropping to zero after second or third lag. The present study is an attempt to study the forecasting of prices of onion at Hubli taluk of Dharwad district.

## Material and methods

The Hubli regulated market is one of the most important and terminal markets in North Karnataka. The Hubli market was chosen for the present study as it is one of the largest markets for arrivals of onion in North Karnataka. The time series data on monthly price of onion required for the study was collected from the registers maintained in the Hubli APMC from the year 1996-97 to 2010-11. This market maintains data on daily, monthly and yearly prices of agricultural commodities. The data on prices refers to modal prices in a month. Modal price was considered superior to the monthly average price as it represented the major proportion of the commodity marketed during the month in a particular market.

A mixed Auto Regressive Integrated Moving Average model developed by Box and Jenkins (1976) was employed for analysis of the data, which involved selection of appropriate model, estimation of parameters, diagnostic checking and finally forecasting the prices.

## **Results and discussion**

Identification of the model was concerned with deciding the appropriate values of (p,d,q) (P,D,Q). It was done by observing Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) values. The Auto Correlation Function helps in choosing the appropriate values for ordering of moving average terms (MA) and Partial Auto-Correlation Function for those autoregressive terms (AR). The number of non-zero coefficients in ACF determines order of MA terms and the number of non-zero coefficients in PACF plots determines order of AR terms. Based on the Akike Information Coefficient and Swarz Baysian Criteria, the model (1,1,1) (2,1,1) was found to fit the series suitably. The results of these coefficients are given in Table 1.

ARIMA model was estimated after transforming the variables under study into stationary series through computation of either seasonal or non-seasonal or both, order of differencing. The attainment of stationary series could be through computation of auto-correlation and partial auto-correlation functions which are provided in the Table 2. A careful examination of ACF and PACF upto 36 lags revealed the presence of seasonality in the data. However, the series was found to be stationary, since the coefficient dropped to zero after the second lag. Each individual coefficient of ACF and PACF were tested for their significance using 't' test. Further, the absence of peak at first values clearly indicated suitability of the choice of non-seasonal difference d=1 to

Table1.	Residual ana	lysis of month	ly	prices of	onion in	ı Hubli m	arket
Model		Akike		-		Swar7	

WIGUEI	AKIKC	Swarz
	Information	Baysian Criteria
	Coefficient	Criteria
(1,1,1) (2,1,1)	2183.901	2196.373

Table 2. Auto correlation function and partial auto correlation function of onion prices in Hubli market

Lags	Prices						
-	ACF	Standard error	PACF				
1	-0.069	0.077	0.069				
2	-0.050	0.076	-0.056				
3	-0.201	0.076	-0.195				
4	0.070	0.076	0.099				
5	0.091	0.076	0.064				
6	0.027	0.076	-0.019				
7	0.022	0.075	0.063				
8	0.032	0.075	-0.014				
9	0.086	0.075	0.085				
10	0.057	0.075	0.057				
11	0.021	0.074	0.001				
12	-0.049	0.074	-0.016				
13	-0.024	0.074	-0.008				
14	-0.016	0.074	-0.037				
15	-0.043	0.073	-0.067				
16	-0.035	0.073	-0.043				
17	-0.002	0.073	-0.005				
18	-0.028	0.073	-0.056				
19	-0.014	0.072	0.018				
20	-0.055	0.072	-0.049				
21	-0.034	0.072	-0.034				
22	-0.040	0.072	-0.028				
23	-0.033	0.071	-0.038				
24	-0.030	0.071	-0.021				
25	-0.014	0.071	0.002				
26	0.025	0.071	0.028				
27	-0.014	0.07	-0.010				
28	-0.030	0.07	-0.017				
29	-0.016	0.07	0.015				
30	-0.004	0.07	-0.007				
31	0.001	0.069	-0.004				
32	-0.003	0.069	0.005				
33	0.002	0.069	0.000				
34	0.000	0.069	-0.002				
35	0.094	0.068	0.091				
36	-0.022	0.068	-0.052				

ACF- Auto Correlation Function, PACF- Partial Auto Correlation Function, The standard error at each lag for PACF - 0.077

accomplish stationary series. Hence based on ACF and PACF many models were tested. Finally model (1,1,1) (2,1,1) was identified as the best model for forecasting of prices of onion in Hubli market.

Having tentatively identified the model, next the parameters which minimize the sum of squares of error were estimated through iteration process. The parameters of the tentatively identified model were estimated and are presented in the Table 3. The standard error values of MA1.1 was significant and the other values were non-significant. Here the standard error of seasonal and nonseasonal autoregressive both at first lag and second lag were non-significant, whereas the standard error of moving average were

Table 3. Conditional least square estimate of onion prices in Hubli market

Parameter		Prices						
	Estimate	Standard Error	t value	P value				
MA1.1	0.665	0.098	6.811	0.000				
AR1.1	0.223	0.128	1.748	0.082				
MA2.1	0.996	1.548	0.643	0.521				
AR2.1	0.015	0.090	0.171	0.864				
AR2.2	0.073	0.086	0.846	0.399				

MA – Moving average, AR – Auto-regressive

statistically significant. The estimated models were then subjected to diagnostic checking to validate the adequacy of the estimated model prior to carrying out forecasting.

The residual of estimated models were examined for testing the randomness of series and analyzed to determine the adequacy. Model verification is concerned with checking of the residuals of the model to see if they contain any systematic pattern, which can still be removed to improve the chosen ARIMA model. Seasonality was found and the forecast consideration was best.

The residual of the estimated models was random in all cases since none of the coefficients were significantly different from zero which also supported by the non-significance of Box-Pierce 'Q' statistics. These entire joint statistics approved that, all the tentatively identified and estimated models were appropriate for forecasting the onion prices of the selected market. Manasa (2010) arrived at similar conclusions regarding validation of ARIMA modeling in her study on the pigeon pea price. The values of these statistics are shown in Table 1. The model (1,1,1) (2,1,1) was found to be the best model for prices in Hubli market, since the statistic of AIC and Q statistics was found to be non-significant.

The principal objective of ARIMA model for a variable is to generate post sample period forecast for the variable price. Both Ex-ante and Ex-post forecasting were done and it was compared with actual values of observations. The forecasting was done upto 2013. The results of ex- ante and ex-post forecast of prices of onion in the market are shown in the Table 4. The forecasts depicted in Fig. 1 indicate that there are narrow



Fig. 1. Ex-ante and Ex-post forecast of monthly prices of onion in Hubli market

# Onion price forecasting in Hubli market.....

Table 4. Ex-ante and Ex-post forecast of monthly prices of onion in Hubli market

Actual     Predicted     Actual     Predicted     Actual     Predicted       101-1906     230     .     Jan-2001     500     430     Hap     50     449       Preh-1996     270     .     Mar-2001     350     211     Mar-2006     300     344       Apre-1996     280     .     Apre-2001     250     278     May-2006     280     .     372     Apre-2006     280     .     373       Jun-1996     380     .     Jar-2001     350     452     Jar-2006     380     .     379       Aug-1996     350     .     Aug-2001     550     505     Nov-2006     380     441     500     .     Nov-1996     300     .     Oct 2001     550     505     Nov-2006     370     372     Dac-1996     300     .     Dac-2001     480     Obt 200     125     Feh-2007     650     653     Apre-1997     325     .     Jar-2002     230     114     Jar-2007     530	Year	Price	e (₹/q)	Year	Pric	e (₹/q)	Year	Pric	e (₹/q )
Jan. 1996     350     .     Jan. 2001     500     430     Jan. 2006     350     469       Mar. 1996     240     .     Mar. 2010     350     211     Mar. 2006     300     344       Mar. 1996     240     .     May. 2001     250     272     Apr. 2006     280     353       May. 1996     380     .     Jan. 2001     350     452     Jan. 2006     350     377       Jal. 1996     360     .     Jan. 2001     350     459     Jan. 2006     360     399       Aug. 1996     350     .     Sep. 2001     500     R20     Sep. 2006     380     441       Sep. 1996     350     .     Dec. 2011     480     601     Dec. 2006     360     469       Nov. 1996     300     .     Dec. 2011     480     601     Dec. 2016     430     Apr. 1007     650     643       Mar. 1997     250     233     Apr. 2002     200     137     Mar. 2017     500     <		Actual	Predicted		Actual	Predicted		Actual	Predicted
Feb-196     270     .     Feb-2001     450     466     Feb-2006     300     214       Apr-1906     270     .     Apr-2001     280     372     Apr-2006     280     353       May-1996     380     .     Jun-2001     350     452     Jun-2006     350     377       Jun-1996     360     .     Jun-2001     350     452     Jun-2006     360     399       Aug-1996     350     .     Aug-2001     700     681     Aug-2006     380     481       Nov-1996     300     .     Oct-2001     550     688     Oct-2006     380     466       Nov-1996     300     .     Dec-2001     480     601     Dec-2006     720     653       Jun-1997     325     .     Jun-2002     280     137     Mar-2007     650     653       Jun-1997     250     233     Jun-2002     300     324     Jun-2007     880     545       Jun-1997     200 <td>Jan-1996</td> <td>350</td> <td></td> <td>Jan-2001</td> <td>500</td> <td>430</td> <td>Jan-2006</td> <td>350</td> <td>469</td>	Jan-1996	350		Jan-2001	500	430	Jan-2006	350	469
Mar. 1996     240     .     Mar. 2001     350     211     Mar. 2006     200     353       May. 1996     280     .     May. 2001     250     278     May. 2006     280     296       May. 1996     380     .     Jun. 2006     350     352     Jun. 2006     350     350     351     Jun. 2006     360     399       Aug. 1996     350     .     Sep. 2001     500     720     Sep. 2006     380     441       Sep. 1996     350     .     Occ. 2011     550     688     Oct. 2006     360     467       Nov. 1996     300     .     Nov. 2001     650     Nov. 2006     730     472       Jan. 1997     250     273     Mar. 2002     200     123     Mar. 2007     500     531       Jan. 1997     200     288     May. 2002     300     May. 2007     880     455       Jan. 1997     200     233     Jal. 2002     300     Jal. 2007     800     881 <	Feb-1996	270		Feb-2001	450	466	Feb-2006	360	324
Apr-1996     270     Apr-2001     280     372     Apr-2006     280     253       Jun-1996     380     -     Jun-2001     350     452     Jun-2006     360     377       Jun-1996     360     -     Jun-2001     350     459     Jun-2006     360     399       Aug-1996     350     -     Aug-2001     700     681     Aug-2006     380     481       Oct-1996     350     -     Cort.2001     550     Res     Oct-2006     380     461       Oct-1996     350     -     Dec-2001     480     601     Dec-2006     370     472       Dec-1997     300     248     Feb-2002     200     128     Feb-2007     650     653       Mar-1997     250     273     Mar-2002     200     179     Apr-2007     520     531       Mar-1997     200     283     Mar-2002     300     Mar-2007     850     545       Jun-1997     200     233 <td< td=""><td>Mar-1996</td><td>240</td><td></td><td>Mar-2001</td><td>350</td><td>211</td><td>Mar-2006</td><td>300</td><td>344</td></td<>	Mar-1996	240		Mar-2001	350	211	Mar-2006	300	344
May-1996     280     .     May-2001     250     278     May-2006     260     260     277       Jul-1996     360     .     Jul-2001     350     452     Jul-2006     360     399       Jul-1996     350     .     Aug-2001     700     681     Aug-2006     380     481       Sep-1996     350     .     Oct-2001     550     688     Oct-2006     360     467       Nov-1996     300     .     Dr-2001     650     S05     Nov-2006     720     692       Jan-1997     325     .     Jan-2002     200     127     Mar-2007     650     642       Mar-1997     200     273     Mar-2002     200     130     Mar-2007     500     55       Jul-1997     200     283     Mary-2002     300     304     Jul-2007     800     889       May-1997     200     233     Jul-2002     300     304     Jul-307     800     880       May-1997<	Apr-1996	270		Apr-2001	280	372	Apr-2006	280	353
Jun-1996     380     .     Jun-2001     350     452     Jun-2006     350     377       Jun-1996     350     .     Aug-2001     700     681     Aug-2006     380     481       Sep-1996     350     .     Sep-2001     550     582     Sep-2066     380     466       Oct-1996     300     .     Oct-2001     480     601     Dec-2006     370     672     692       Jan-1997     300     248     Feb-2007     650     653     Sep-201     500     481     Mar-2007     500     642       Mar-1997     250     273     Mar-2002     200     179     Apr-2007     500     642       Mar-1997     200     233     Jun-2002     300     Mar-2007     510     551       Jun-1997     200     233     Jun-2002     300     Jun-2007     876     655       Jun-1997     300     203     Sep-202     450     560     Aug-2007     1100     985	May-1996	280		May-2001	250	278	May-2006	280	296
Jul-1996     360     .     Jul-2001     350     Jul-2006     360     3499       Sep-1996     350     .     Sep-2001     500     720     Sep-2006     360     416       Oct-1996     300     .     Oct-2001     550     688     Oct-2006     360     467       Nov-1906     300     .     Nov-2001     650     S05     Nov-2006     720     692       Jan-1997     325     .     Jan-2002     250     141     Jan-2007     650     633       Apr-1997     200     218     Feb-2002     200     127     Mar-2007     500     563       Apr-1997     200     233     Jan-2002     300     May-2007     580     545       Jan-1997     200     233     Jan-2002     430     590     Aug-2007     1100     983       Sep-1997     300     235     Oct-2002     440     Apc-2007     1100     983       Aug-1997     900     733     Ne-2002	Jun-1996	380		Jun-2001	350	452	Jun-2006	350	377
Aug1996     350     .     Aug2001     700     681     Aug2006     380     481       Oct1996     300     .     Oct2001     550     688     Oct2006     360     467       Nov1996     350     .     Dec-9001     480     601     Dec-2006     370     650     632       Dec-1996     350     .     Dec-2001     480     601     Dec-2007     650     642       Mar1997     300     248     Feb-2002     200     128     Feb-2007     50     653       Apr-1997     200     273     Mar-2007     50     563       Apr-1997     200     288     May-2002     300     May-2007     810     889       Aug1997     200     233     Jul-2002     380     369     Jul-2007     810     889       Aug1997     300     203     Sep-2007     410     Nor-2007     710     1072       Oct-1997     300     235     Sep-2003     506	Jul-1996	360	•	Jul-2001	350	459	Jul-2006	360	399
Sep-1996     350     .     Sep-2001     500     720     Sep-2006     360     416       Nov-1996     300     .     Nov-2001     650     505     Nov-2006     370     372       Dec-1996     300     .     Nov-2001     650     505     Nov-2006     720     692       Jan-1997     325     .     Jan-2002     200     128     Feb-2077     650     633       Apr-1997     200     273     Mar-2007     500     561       Apr-1997     200     273     Mar-2007     580     561       Jan-1997     200     213     Jau-2002     300     Mar_2007     880     865       Jau-1997     200     213     Jau-2002     400     300     Aug-2007     1100     983       Sep-1997     300     233     Nov-2002     450     Aug-2007     1100     983       Sep-1997     900     733     Nov-2002     450     Aug-2007     1100     983     300	Aug-1996	350		Aug-2001	700	681	Aug-2006	380	481
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Feb-1997300248Feb-2002200128Feb-2007650642 $Apr-1997$ 250273 $Mar-2002$ 200179 $Apr-2007$ 520531 $May-1997$ 275283 $Apr-2002$ 200300 $May-2007$ 520531 $May-1997$ 200233 $May-2002$ 300304 $Hur-2007$ 890849 $May-1997$ 200233 $Jul-2002$ 380369 $Jul-2007$ 890889 $May-1997$ 200233 $Lay2002$ 430506 $Sep-2007$ 11001072 $Sep-1997$ 300203 $Sep-2002$ 430506 $Sep-2007$ 7101072 $Nov-1997$ 350303 $Nv-2002$ 600416 $Nv-2007$ 725510 $Dec-1997$ 900878 $Jan-2003$ 260127 $Ian-2008$ 310469 $Peb-1998$ 850855Feb-2003250193Feb-2008660511 $Mar-1998$ 350613 $Mar-2003$ 260166 $Mar-2008$ 330369 $Apr-1998$ 350355Feb-2003400258 $Apr-2008$ 330369 $Apr-1998$ 350361 $Jm-2003$ 480576 $Aug-2008$ 330466 $Jul-1998$ 700436 $Jul-2003$ 480576 $Aug-2008$ 730990 $Aug-1998$ 16501150 $Aug-2003$ 600688Nov-2008720 </td <td>Jan-1997</td> <td>325</td> <td></td> <td>Jan-2002</td> <td>250</td> <td>141</td> <td>Jan-2007</td> <td>650</td> <td>638</td>	Jan-1997	325		Jan-2002	250	141	Jan-2007	650	638
$\begin{split} \begin{tabular}{l l l l l l l l l l l l l l l l l l l $	Feb-1997	300	248	Feb-2002	200	128	Feb-2007	650	642
Apr-1997275283Apr-2002200179Apr-2007520531Jun-1997200233Jun-2002300304Jun-2007875655Jul-1997200233Jul-2002380369Jul-2007870655Jul-1997200203Jul-2002430590Aug-200711001072Sep-1997300203Sep-2002430596Sep-200711001072Nov-1997350303Nov-2002600416Nov-2007725510Dec-1997900703Dec-2002360511Dec-2007710741Jan-1998900878Jan-2003250127Jan-2008310469Apr-1998350613Mar-2003260166Mar-2008350345May-1998360317May-2003480467May-2008360345May-1998360317May-2003480576Aug-2008350466Jul-1998700436Jun-2003450487Jun-2008350466Jul-199816001710Aug-2003450487Jun-2008350345Aug-199816501150Aug-2003450487Jun-2008350356Sep-190816501150Aug-2003756Sep-2008757377Oct-19981600713Jan-2004<	Mar-1997	250	273	Mar-2002	200	237	Mar-2007	500	563
May-1997     200     288     May-2002     300     May-2007     580     545       Jun-1997     200     233     Jun-2002     380     369     Jun-2007     875     655       Jun-1997     200     193     Aug-2002     430     590     Aug-2007     1100     985       Sep-1997     300     223     Oct-2002     430     506     Sep-2007     170     1737       Nov-1997     900     703     Dec-2002     360     511     Dec-2007     510     741       Jan-1998     950     613     Mar-2003     250     193     Feb-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     360     383       Jun-1998     350     317     May-2003     485     506     Jul-2008     880     556       Jun-1998     950     668     Jul-2003     455     506     Jul-2008     880     556       Jun-1998     1500	Apr-1997	275	283	Apr-2002	200	179	Apr-2007	520	531
Jun-1997     250     303     Jun-2002     300     324     Jun-2007     875     655       Jul-1907     200     133     Aug-2002     430     590     Aug-2007     1100     985       Sep-1997     300     203     Sep-2002     430     506     Sep-2007     1100     1072       Oct-1997     350     303     Nov-2002     460     416     Nov-2007     725     510       Dec-1997     900     778     Jan-2003     260     127     Jan-2008     310     469       Feb-1998     850     855     Feb-2003     260     127     Jan-2008     350     354       Mar-1998     350     382     Apr-2003     400     258     Apr-2008     350     384       May-1998     360     317     May-2003     488     467     May-2008     330     466       Jul-1998     360     1150     Aug-2003     480     576     Aug-2008     720     990       Sep-1998 <td>May-1997</td> <td>200</td> <td>288</td> <td>May-2002</td> <td>200</td> <td>300</td> <td>May-2007</td> <td>580</td> <td>545</td>	May-1997	200	288	May-2002	200	300	May-2007	580	545
Jul-1997     200     233     Jul-2002     380     369     Jul-2007     890     889       Aug-1997     300     203     Sep-2002     430     590     Aug-2007     1100     1973       Oct-1997     300     253     Oct-2002     450     465     Oct-2007     725     510       Dec-1997     900     703     Dec-2002     360     511     Dec-2007     510     741       Jan-1998     850     855     Feb-2003     250     193     Feb-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     360     383       Jun-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     950     668     Jul-2003     455     506     Jul-2008     880     556       Jul-1998     1600     1710     Aug-2003     505     566     Sep-2008     505     737       Oct-1998 <td>Jun-1997</td> <td>250</td> <td>303</td> <td>Jun-2002</td> <td>300</td> <td>324</td> <td>Jun-2007</td> <td>875</td> <td>655</td>	Jun-1997	250	303	Jun-2002	300	324	Jun-2007	875	655
Aug.1997     200     193     Aug.2002     430     590     Aug.2007     1100     985       Sep-1997     300     253     Oct-2002     450     465     Oct-2007     479     737       Nov-1997     350     303     Nov-2002     600     416     Nov-2007     510     741       Jan-1988     900     878     Jan-2003     260     127     Jan-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     350     345       May-1998     350     382     Apr-2003     400     258     Apr-2008     350     345       May-1998     700     436     Jun-2003     480     566     Jul-2008     850     556       Jul-1998     700     436     Jun-2003     480     576     Aug-2008     720     980       ct-1998     1650     1150     Aug-2003     500     681     Mar-2008     550     737       ct-1998	Jul-1997	200	233	Jul-2002	380	369	Jul-2007	890	889
Sep-1997     300     203     Sep-2002     430     506     Sep-2007     1100     1072       Nov-1997     350     303     Nov-2002     600     416     Nov-2007     725     510       Dec-1997     900     703     Dec-2002     360     511     Dec-2007     510     741       Jan-1998     850     855     Feb-2003     250     193     Feb-2008     650     510       Mar-1998     350     382     Apr-2003     260     166     Mar-2008     330     569       Apr-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     480     487     Jun-2008     530     466       Jun-1998     700     1710     Sep-2003     465     Sep-2008     720     980       Sep-1998     1660     1710     Sep-2003     500     586     Oct-2008     720     488       Dec-1998     1850 </td <td>Aug-1997</td> <td>200</td> <td>193</td> <td>Aug-2002</td> <td>430</td> <td>590</td> <td>Aug-2007</td> <td>1100</td> <td>985</td>	Aug-1997	200	193	Aug-2002	430	590	Aug-2007	1100	985
Oct-1997     300     253     Oct-2002     450     465     Oct-2007     479     737       Dac-1997     350     303     Nov-2002     600     416     Nov-2007     510     741       Jan-1998     900     878     Jan-2003     260     127     Jan-2008     630     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     350     345       May-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     450     487     Jun-2008     530     466       Aug-1998     1650     1150     Aug-2003     450     566     Jul-2008     850     556       Aug-1998     1650     1150     Aug-2003     480     576     Aug-2008     720     488       Dec-1998     1350     1685     Dec-2003     600     688     Nov-2008     720     488       Dan-2004 </td <td>Sep-1997</td> <td>300</td> <td>203</td> <td>Sep-2002</td> <td>430</td> <td>506</td> <td>Sep-2007</td> <td>1100</td> <td>1072</td>	Sep-1997	300	203	Sep-2002	430	506	Sep-2007	1100	1072
Nov-1997     350     303     Nov-2002     600     416     Nov-2007     72.5     510       Dec:1997     900     703     Dec-2002     360     511     Dec-2007     510     741       Jan-1998     900     878     Jan-2003     260     127     Jan-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     350     345       May-1998     350     382     Apr-2003     480     487     Jun-2008     530     466       Jun-1998     700     436     Jun-2003     445     506     Jul-2008     880     556       Aug-1998     1650     1150     Aug-2003     480     576     Aug-2008     720     990       Sep-1998     1650     1522     Nov-2003     600     688     Nov-2008     700     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1998 <td>Oct-1997</td> <td>300</td> <td>253</td> <td>Oct-2002</td> <td>450</td> <td>465</td> <td>Oct-2007</td> <td>479</td> <td>737</td>	Oct-1997	300	253	Oct-2002	450	465	Oct-2007	479	737
Dec.1997     900     703     Dec-2002     360     511     Dec-2007     510     741       Jan-1998     850     855     Feb-2003     250     193     Feb-2008     310     469       Feb-1998     850     613     Mar-2003     260     166     Mar-2008     330     569       Apr-1998     350     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     450     487     Jun-2008     530     466       Jul-1998     700     436     Jun-2003     450     487     Jun-2008     530     466       Jul-1998     1650     1150     Aug-2003     450     506     Jul-2008     870     737       Oct-1998     1600     1710     Sep-2003     550     566     Sep-2008     570     737       Oct-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999 </td <td>Nov-1997</td> <td>350</td> <td>303</td> <td>Nov-2002</td> <td>600</td> <td>416</td> <td>Nov-2007</td> <td>725</td> <td>510</td>	Nov-1997	350	303	Nov-2002	600	416	Nov-2007	725	510
Jan-1998     900     878     Jan-2003     260     127     Jan-2008     310     469       Feb-1998     850     855     Feb-2003     250     193     Feb-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     350     345       May-1998     360     317     May-2003     480     258     Apr-2008     530     466       Jul-1998     950     668     Jul-2003     450     487     Jun-2008     880     556       Aug-1998     1650     1150     Aug-2003     450     566     Sep-2008     550     737       Oct-1998     1600     1710     Sep-2003     500     610     Dec-2008     470     488       Dec-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     700     621       Apr-1999 </td <td>Dec-1997</td> <td>900</td> <td>703</td> <td>Dec-2002</td> <td>360</td> <td>511</td> <td>Dec-2007</td> <td>510</td> <td>741</td>	Dec-1997	900	703	Dec-2002	360	511	Dec-2007	510	741
Feb-1998     850     855     Feb-2003     250     193     Feb-2008     650     510       Mar-1998     350     613     Mar-2003     260     166     Mar-2008     350     345       May-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     480     576     May-2008     530     466       Jul-1998     950     668     Jul-2003     485     506     Jul-2008     880     556       Arg-1998     1650     1150     Arg-2003     550     566     Sep-2008     550     737       Oct-1998     2000     1582     Oct-2003     700     586     Oct-2008     870     627       Jan-1999     600     743     Jan-2004     610     Dec-2008     870     627       Jan-1999     301     278     Mar-2004     402     563     Feb-2009     700     621       Apr-1999     301 <td>Jan-1998</td> <td>900</td> <td>878</td> <td>Jan-2003</td> <td>260</td> <td>127</td> <td>Jan-2008</td> <td>310</td> <td>469</td>	Jan-1998	900	878	Jan-2003	260	127	Jan-2008	310	469
Mar-1998     350     613     Mar-2003     260     166     Mar-2008     330     569       Apr-1998     350     382     Apr-2003     400     258     Apr-2008     360     345       May-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     450     487     Jun-2008     530     466       Jul-1998     1650     1150     Aug-2003     455     506     Jul-2008     820     990       Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     720     980       Oct-1998     1350     1685     Dec-2003     600     618     Nov-2008     720     488       Dec-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     415     535     Mar-2009     700     631       May-1999	Feb-1998	850	855	Feb-2003	250	193	Feb-2008	650	510
Apr-1998     350     382     Apr-2003     400     258     Apr-2008     350     345       May-1998     360     317     May-2003     388     467     May-2008     360     383       Jun-1998     700     436     Jun-2003     450     487     Jun-2008     880     556       Aug-1998     1650     1150     Aug-2003     480     576     Aug-2008     720     990       Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     720     488       Dec-1998     2000     1582     Oct-2003     700     586     Oct-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     350     543     Feb-2004     400     400     Apr-2009     550     706       May-1999     460     226     May-2004     430     432     May-2009     550     706       Jun-1999 </td <td>Mar-1998</td> <td>350</td> <td>613</td> <td>Mar-2003</td> <td>260</td> <td>166</td> <td>Mar-2008</td> <td>330</td> <td>569</td>	Mar-1998	350	613	Mar-2003	260	166	Mar-2008	330	569
$\begin{array}{llllllllllllllllllllllllllllllllllll$	Apr-1998	350	382	Apr-2003	400	258	Apr-2008	350	345
Jun-1998     700     436     Jun-2003     450     487     Jun-2008     530     466       Jul-1998     950     668     Jul-2003     465     506     Jul-2008     880     556       Aug-1998     1650     1150     Aug-2003     450     576     Aug-2008     720     990       Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     750     737       Oct-1998     2000     1582     Oct-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     301     278     Mar-2004     400     400     Apr-2009     700     631       May-1999     450     636     Jun-2004     430     432     May-2009     550     706       May-1999     450     636     Jun-2004     420     498     Jul-2009     650     666       Jul-1999 </td <td>May-1998</td> <td>360</td> <td>317</td> <td>May-2003</td> <td>388</td> <td>467</td> <td>May-2008</td> <td>360</td> <td>383</td>	May-1998	360	317	May-2003	388	467	May-2008	360	383
Jul-1998     950     668     Jul-2003     465     506     Jul-2008     880     556       Aug-1998     1650     1150     Aug-2003     480     576     Aug-2008     720     990       Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     550     737       Oct-1998     2000     1582     Oct-2003     700     586     Oct-2008     465     515       Nov-98     1850     2032     Nov-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     350     543     Feb-2004     620     563     Feb-2009     700     621       Apr-1999     460     226     Mar-2004     415     535     Mar-2009     550     706       May-1999     450     517     Jul-2004     450     432     Jun-2009     550     666       Jul-1909 </td <td>Jun-1998</td> <td>700</td> <td>436</td> <td>Jun-2003</td> <td>450</td> <td>487</td> <td>Jun-2008</td> <td>530</td> <td>466</td>	Jun-1998	700	436	Jun-2003	450	487	Jun-2008	530	466
Aug-1998     1650     1150     Aug-2003     480     576     Aug-2008     720     990       Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     550     737       Oct-1998     2000     1582     Oct-2003     700     586     Oct-2008     465     515       Nov-98     1850     2032     Nov-2003     600     688     Nov-2008     720     488       Dec-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     301     278     Mar-2004     415     535     Mar-2009     700     621       Apr-1999     460     226     May-204     430     432     May-2009     500     666       Jul-1999     450     517     Jul-2004     420     498     Jul-2009     700     698       Aug-1999<	Jul-1998	950	668	Jul-2003	465	506	Jul-2008	880	556
Sep-1998     1600     1710     Sep-2003     550     566     Sep-2008     550     737       Oct-1998     2000     1582     Oct-2003     700     586     Oct-2008     465     515       Nov-98     1850     2032     Nov-2003     600     688     Nov-2008     720     488       Dec-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     350     543     Feb-2004     620     563     Feb-2009     700     621       Apr-1999     301     278     Mar-2004     400     400     Apr-2009     550     706       May-1999     460     226     May-2004     432     May-2009     580     571       Jun-1999     450     636     Jun-2004     420     498     Jul-2009     700     698       Aug-1999     410 </td <td>Aug-1998</td> <td>1650</td> <td>1150</td> <td>Aug-2003</td> <td>480</td> <td>576</td> <td>Aug-2008</td> <td>720</td> <td>990</td>	Aug-1998	1650	1150	Aug-2003	480	576	Aug-2008	720	990
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Nov-98     1850     2032     Nov-2003     600     688     Nov-2008     720     488       Dec-1998     1350     1685     Dec-2003     600     610     Dec-2008     870     627       Jan-1999     600     743     Jan-2004     615     478     Jan-2009     805     739       Feb-1999     350     543     Feb-2004     620     563     Feb-2009     700     838       Mar-1999     301     278     Mar-2004     415     535     Mar-2009     550     706       May-1999     460     226     May-2004     430     432     May-2009     580     571       Jun-1999     450     636     Jun-2004     420     498     Jul-2009     700     698       Aug-1999     410     670     Aug-2004     520     632     Aug-2009     100     954       Ct-1999     400     503     Oct-2004     345     456     Oct-2009     1400     1118       Nov-2000	Oct-1998	2000	1582	Oct-2003	700	586	Oct-2008	465	515
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Jun-1999450636Jun-2004465532Jun-2009650666Jul-1999450517Jul-2004420498Jul-2009700698Aug-1999410670Aug-2004520632Aug-2009650812Sep-1999600413Sep-2004400499Sep-20091100954Oct-1999400503Oct-2004345456Oct-200914001118Nov-1999350366Nov-2004380366Nov-200912501422Dec-1999250296Dec-2004430340Dec-200915501371Jan-2000200189Jan-2005400277Jan-201011501459Feb-2000200126Mar-2005300315Apr-2010810821Mar-2000200218Apr-2005300315Apr-2010810821Jun-2000250290Jun-2005420425Jun-2010830870Jul-2000260251Jul-2005450474Jul-2010800847Aug-2000270320Aug-2005780608Aug-2010900967Sep-2000320349Sep-2005850759Sep-201015001252Oct-2000350362Nov-2005760889Nov-201015301288Nov-2000350362	May-1999	460	226	May-2004	430	432	May-2009	580	571
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$Dec_{2000} = 500 = 502 = 100^{-2003} - 700 = 607 = 100^{-2010} = 1500 = 1509 = 100^{-2010} = 1500 = 1509 = 100^{-2}0000 = 100^{-2}0000 = 100^{-2}000 = 100$	Nov-2000	350	367	Nov-2005	760	880	Nov. 2010	1500	1200
	Dec-2000	500	577	$Dec_{2005}$	600	646	$Dec_{2010}$	2200	1878

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Year	Pric	ce (₹/q)	Year	Price (₹/q)		Year	Price (₹/q)	
	Actual	Predicted		Actual	Predicted		Actual	Predicted
Jan-2011		2046	Jan-2012		2402	Jan-2013		2774
Feb-2011		2177	Feb-2012		2470	Feb-2013		2712
Mar-2011		1997	Mar-2012		2363	Mar-2013		2623
Apr-2011		2011	Apr-2012		2331	Apr-2013		2520
May-2011		2051	May-2012		2368	May-2013		2587
Jun-2011		2231	Jun-2012		2512	Jun-2013		2728
Jul-2011		2384	Jul-2012		2642	Jul-2013		2796
Aug-2011		2434	Aug-2012		2652	Aug-2013		2845
Sep-2011		2407	Sep-2012		2778	Sep-2013		3183
Oct-2011		2228	Oct-2012		2788	Oct-2013		3208
Nov-2011		2405	Nov-2012		2847	Nov-2013		3252
Dec-2011		2495	Dec-2012		2983	Dec-2013		3616

variations in between the actual and forecasted values of prices of onion in the Hubli market and the forecasted values of prices showed an increasing trend in the future months. The prices of onion in the market during 2011 will be high (₹ 2495/q) and less (₹ 1997/q) during the months of December and March, respectively. In 2012 the prices will be high in the month of December (₹ 2983/q) and less during the month of April (₹ 2331/q). Similarly, in 2013 the prices will be high in the month of December (₹ 3616/q) and less during the month of April (₹ 2520/q). Similar model was used by Almemaychu Amera (2002) and Punitha (2007) to forecast the prices and arrivals of agricultural commodities and drawn conclusions.

ARIMA model is an extrapolation method that requires only the historical time series data on the variable under study. The ARIMA model forecasted prices revealed an increase in the prices of onion in the future years and also demand for the crop. Hence, increase in the area of production of onion and their sale in the suitable markets can be planned suitably.

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