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RESEARCH ARTICLE

PRODUCTION AND EXPORT OF ONION: ECONOMETRIC ASNALYSIS

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ABSTRACT

India is the second largest producer of onions in the world after China. It enjoys 19% share of the global onion production. The annual average production is 12 lakh tones. The study has been undertaken to understand the effect of Area and Yield on Production of Onion and to study export trends of Onion. The production of onion has significantly increased over the past 30 years (1980-2012) but there has been lots of fluctuations specially from 1995 onwards indicating that production of onion is not steady year over year but sometimes increases and decreases. Such fluctuations may arise due to dependency of agricultural crops on rainfall and monsoons. Excess rainfall or less rainfall hampers the production of crops among other factors.

INTRODUCTION

The onion (*Allium cepa*) is used as a vegetable and is the most widely cultivated species of the genus *Allium*. *A. cepa* is exclusively known from cultivation and its wild original form is not known. Onion is produced and consumed not only in India but also throughout the world. Onion is classified as a vegetable and has special qualities which add taste and flavor to food. It is used extensively in Indian cuisine and culinary preparations both in cooked and raw form. Onion possesses very good nutritive and medicinal values. Onion is consumed by all classes of people-poor and rich and hence assumes a place of an essential item. India is the second largest producer of onions in the world after China. It enjoys 19% share of the global onion production. The annual average production is 12 lakh tones. The major Onion producing states are Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Tamil Nadu. Maharashtra ranks first in Onion production with a share of 32.20% of the total Indian aproduction. However, in terms of productivity, Gujarat ranks first with an area share of 22.9%. In Maharashtra Onion cultivation is primarily centered in Nashik, Pune, Ahmednagar, Satara, Sholapur and Dhulia. These regions are endowed with well drained, non-crusting soil required for onion cultivation. The production is taken in three seasons, i.e. Kharif (May-July to Oct-Dec.) Late-Kharif (Aug-Sep. to Jan-Mar) and Rabi (Oct-Nov. to April-June). Though onion is produced in three seasons, those produced in rabi season are only suitable for storage as the variety grown in this season has higher TSS, dry matter and more number of outer dried intact scales.

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The major varieties found in India are Agrifound Dark Red, Agrifound Light Red, NHRDF Red, Agrifound White, Agrifound Rose and Agrifound Red, Pusa Ratnar, Pusa Red, Pusa White Round. There is a lot of demand of Indian Onion in the world. India exported 1.64 million tonnes of Fresh Onion to the world for a total value of rs 1929.29 crores during the year 2012-13 (APEDA). The major importing countries are Malaysia, Bangladesh, United Arab Emirates, Sri Lanka, Indonesia, Singapore and Kuwait as on 2012 (APEDA)

Objectives

The study has been undertaken with the following Objectives:

- To understand the effect of Area and Yield on Production of Onion.
- To study export trends of Onion

Literature review

John (2011) in her study stated that the probable reasons for rise in Onion Prices was mainly due to failure in production of the Kharif Crop due to spread of fungal diseases like Purple Anthracnose and Purple Blotch among the Kharif onion saplings. Also erratic monsoons that caused water logging in the flat crop beds resulted in spread of these fungal infections among the saplings. The humid climate that prevailed from August worsened the situation. Though fungicides are generally effective against these fungal diseases, the heavy downpour made spraying ineffective. The end result was an unprecedented fall in the yield of Onion. Sharma *et al* (2011) in their study did a time series analysis of production of Onion and found that the trends in area and production of onions revealed that there is significant increase in onion production resulting in a rise in market arrivals. However, due to unseasonal rains, production of onions declined by about 20% in three major growing states during 2009-10 and 2010-11. To some extent, this reduction in production was offset by marginally higher production in other states like Rajasthan. The magnitude of decline in production did not affect arrivals in the market very much. The astronomical increase in the prices of onions was a result of hoarding of the stocks in anticipation of a rise in the price and higher retailer mark-ups. Rise in prices was also partly due to reduction in MEP and consequent increase in exports during November 2010. Moreover, the crop situation was not predicted accurately and thus information on loss in production was not anticipated by market intelligence.

Tuteja (2013) in her study found that the wholesale price of onion in growing states was around Rs 45-50 per kg. However, retail prices in different places are Rs 70-80 per kg. The huge gap of Rs 25-30 per kg in wholesale and consumer prices implies a margin of more than 50%. After deducting cost of logistics, 10-15%, the difference in cost price and selling price is still high. A huge markup is taking place in the retail chain and traders are cornering huge profits. It seems that government agencies like NAFED are unable to efficiently monitor price rise regularly in the domestic market. Also, it did not take timely remedial action when there is a probability of a major shortfall in supply. So far, the government does not have any effective regulatory cell to monitor and foresee such abrupt increase in prices of essential foodstuffs with inelastic demand.

MATERIALS AND METHODS

The data has been collected from Secondary Sources which are various Government databases like NAFED, National Horticultural Board etc. The data has been analyzed using econometric tools. The econometric tools used are Ordinary least Square Method as well as Various tests to check the sationarity of the data. Descriptive statistics have been used to analyze the Wholesale and Retail Prices of Onion

RESULTS AND DISCUSSION

Data analysis

Table 1.

Year	Production	Area	Yield/hectare	Export	% of prod exported
1980-81	2500000	0.25	9961	193,658.00	7.74632
1981-82	2650000	0.25	10562	169,771.00	6.406453
1982-83	2430000	0.24	10330	181,313.00	7.46144
1983-84	2700000	0.27	9982	181,510.00	6.722593
1984-85	3100000	0.28	11139	274,803.00	8.864613
1985-86	2860000	0.28	10202	207,709.00	7.262552
1986-87	2530000	0.26	9659	265,845.00	10.50771
1987-88	2700000	0.27	9857	141,325.00	5.234259
1988-89	3350000	0.32	10620	228,174.00	6.811164
1989-90	3070000	0.3	10176	360,227.00	11.73378
1990-91	3230000	0.3	10686	289,380.00	8.959133
1991-92	3580000	0.32	11088	406,135.00	11.34455
1992-93	3490000	0.32	10791	395,685.00	11.33768
1993-94	4010000	0.37	10902	448,874.00	11.19387
1994-95	4040000	0.38	10661	496,881.00	12.29903
1995-96	4080000	0.4	10316	434,655.00	10.65331
1996-97	4180000	0.4	10348	512,879.00	12.26983
1997-98	3620000	0.4	9091	446,820.00	12.34309
1998-99	5330000	0.47	11391	298,427.00	5.599006
1999-00	4900000	0.49	9932	318,230.00	6.49449
2000-01	4550000	0.42	10786	330,207.00	7.257297
2001-02	4830000	0.45	10686	506,924.00	10.49532
2002-03	4210000	0.42	9912	545,211.00	12.95038
2003-04	5920000	0.5	11784	840,717.00	14.2013
2004-05	6430000	0.55	11718	941,448.00	14.64149
2005-06	8680000	0.66	13118	778,134.00	8.964677
2006-07	8890000	0.7	12655	1,161,062.00	13.06031
2007-08	9140000	0.7	12974	1,101,404.00	12.05037
2008-09	13480000	0.83	16260	1,783,820.00	13.23309
2009-10	12160000	0.76	16079	1,873,002.00	15.40298
2010-11	15120000	1.06	14210	1,340,771.00	8.867533
2011-12	15390000	1.03	14898	1,552,904.00	10.09034

Source: Department of Agriculture and Cooperation (Horticulture Division, NAFED

Graph 1 indicates that production of onion has significantly increased over the past 30 years (1980-2012). It can also be seen that the graph(blue line) is not a smooth line but has lots

(Area-Million Tones , Production-Million Tones, Yield- Kg/hectares, Export-million tones)

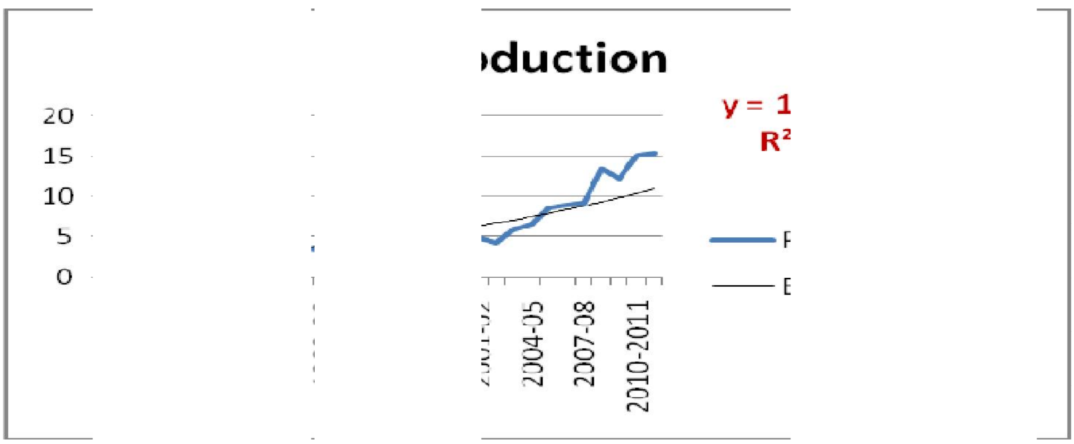


Figure 1. Trend in production anf export in India

of fluctuations specially from 1995 onwards indicating that production of onion is not steady year over year but sometimes increases and decreases. Such fluctuations may arise due to dependency of agricultural crops on rainfall and monsoons. Excess rainfall or less rainfall hampers the production of crops among other factors. The Exponential or the fitted trend line is drawn in the Graph and is found to be sloping upwards, and the exponent of 'e' is our growth estimate which is found to be 5.5% (i.e; 0.055*100). This process of calculating Growth rate is called the Chart Method Growth . Growth estimate helps us to know the yearly rate of Growth of a certain variable (production in this case). This rate can also help us forecast production for years to come

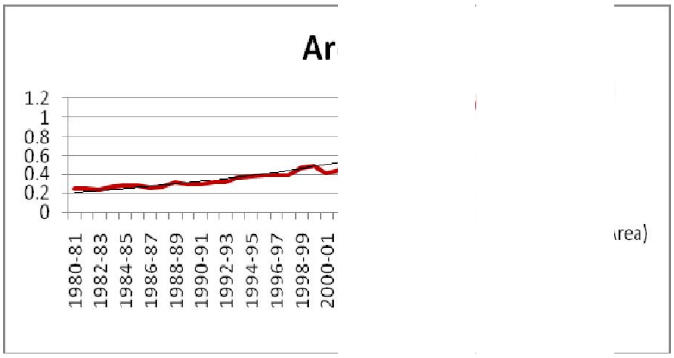


Figure 2. Trend in area of onion

Area under Onion Cultivation: Like the production graph we see that area under onion cultivation has gone up over the past 30 years, but even this graph is not a smooth rising line but comprises of fluctuations. So the question arises as to why there are such fluctuations in cultivation area? The increase or decline in production of Onion maybe due to the fact that cultivation of a crop largely depends upon the price it fetches and when production increases the prices go down , thus leading to losses for the farmers. Under these circumstances farmers decide to produce less of the crop in the next year which again leads to a deficit of supply, leading to a rise in price. This induces farmers to produce more the next year. The growth estimate is found to be 4.3%.

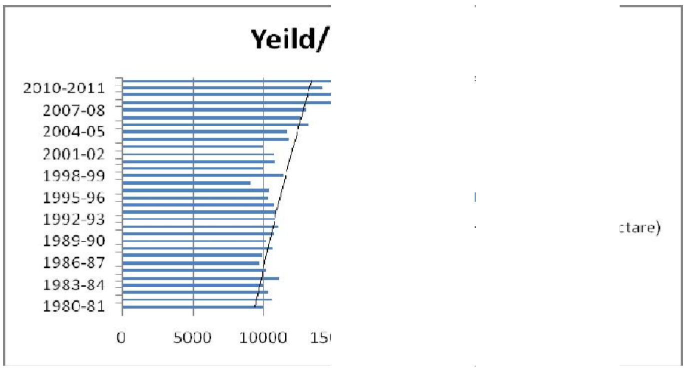
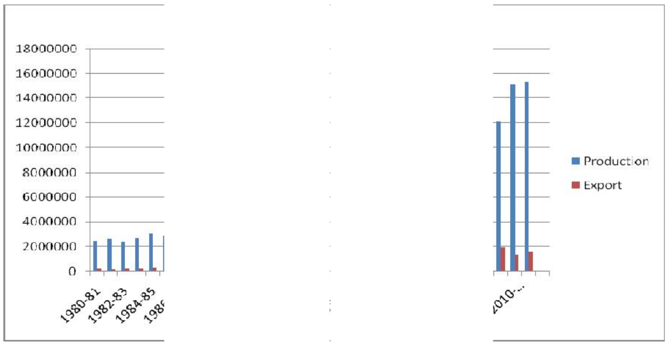


Figure 3. Yield per hectare of onion

The above bar diagram shows that the yield / hectare of onions has increased over the past 30 years. The yield was highest during the year 2008 to 2009 (16260 kg/hectare) and lowest in the year 1997-98 (9091 kg/hectare). Thus the difference between the highest and the lowest yield is 7169. From the value of the exponential we can see that growth estimate rate of the yield over the past thirty years is 1.1%. Also evident from the chart is that there has not been a substantial increase of yield over the past thirty years. Thus we can infer that there is still scope for improvement in the yield through use of better variety seeds, better technologies and proper fertilizers. Also, farmers need to be educated about correct proportion of fertilizers and pesticides to be used or else more or less of it will only ruin the crop leading to fall in production

The blue bars represents the Export of Onion In the past 30 years . From the graph it is seen that export for onions has been the highest in the year 2008-2009 to 2009-10 with almost 1800000 (million tones) of onion being exported. The fitted trend line (denoted by the black line) is also upward rising and the growth estimate was calculated to be 7.1%. The growth estimate represents the year on year growth of a variable if it grows at a steady pace without any fluctuations

Graph 5



The above bar diagram represents total onion production (blue bar) and the amount exported (red bar) out of the total production. Percentage wise the amount of export varies from 6% to 15% of total production in the past 30 years. This however is a very small amount compared to the total production. Therefore the reason that very high amount of exports lead to high domestic prices due to lack of supply in the domestic market is not a very realistic reason behind the onion price inflation. Another method of calculating the annual growth rate is the Compound annual growth .The Compound Annual growth rate is defined as the year-over-year growth rate over a specified period of time. The compound annual growth rate is calculated by taking the nth root of total percentage growth rate, where n is the number of years in the period being considered which can be written. as :

$$CAGR = \left(\frac{\text{Ending Value}}{\text{Beginning Value}}\right)^{\left(\frac{1}{\#\text{ of years}}\right)} - 1$$

The compound annual growth rate of Production of Onion was found to be 5.84% from the period 1980 to 2012 and the CAGR of total onion exports were found to be 4.17% , and the CAGR for yield was 1.27%. The CAGR formula and the chart method of finding growth are different largely because CAGR uses only the start and end periods in its calculations, where the curve fitting uses all of the data.

-tab	1%	5%	10%
PRODUCTION	3.752946	2.998064	2.638752
AREA and YEILD	3.670170	2.963972	2.621007

the sample correlogram. In the given time Series data it was found that the Autocorrelation Coefficients were exponentially Falling (ACF starts at very high value and decline slowly) indicating that the series is non stationary but after first differencing the ACF at 11 lag hovers around zero (the solid vertical line represents the Zero Axis) indicating that the series has become stationary. Another way to check the stationarity of the data is to check the *Q-statistic* (developed by Box and Pearce) and the Augmented Dicky Fuller Statistic. In both these test for stationary we do hypothesis testing in case of Q stat our null hypothesis is set at H_0 : The series is stationary against the alternative hypothesis H_1 : The series is non stationary. But it should be noted that in case of Q statistic the null hypothesis is accepted if the p-value is set to be above 0.05 otherwise we reject it. SO in the above table we see that the p-value at Q stat at level is 0.000 thus we reject or null

Stationarity test for the time series data

VARIABLES	ACF(Level)	ACF(1st Differencing)	Qstat (Level)	Qstat 1stDifferencing)	ADF (Level)	ADF (1st Differencing)
PRODUCTION (Y) (Dependent)	Exponentially Falling (ACF starts at very high value and decline slowly)	After 1st differencing the ACF at 11 lag hovers around the zero	65.943 (0.000)	24.754 (0.10)	$t_{cal=}$ 2.135960 (p=0.9998)	$t_{cal=}$ -1.903961 (P=0.0000)
AREA (Independent)	Exponentially Falling (ACF starts at very high value and decline slowly)	After 1st differencing the ACF at 11 lag hovers around the zero	73.178 (0.000)	13.933 (0.237)	$t_{cal=}$ 3.924140 (p=1.0000)	$t_{cal=}$ -7.901435 (p=0.000)
YEILD (Independent)	Exponentially Falling (ACF starts at very high value and decline slowly)	After 1st differencing the ACF at 11 lag hovers around the zero	53.943 (0.000)	15.636 (0.155)	$t_{cal=}$ -1.166276 (p=0.6761)	$t_{cal=}$ -7.749565 (p=0.0000)

The above table represents various tests done to check whether the Time series data of Onion is stationary or not. There are various methods that can be used to check the stationarity of a data. Now the question arises as to why the stationarity of time series is so important? Because if a time series is nonstationary, we can study its behavior only for the time period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalize it to other time period. Therefore, for the purpose of forecasting, such (non stationary) time series maybe of little practical value (Damodar and Gujararti). One such simple test of stationarity is based on the so-called Autocorrelation function (ACF). The ACF at lag *k,* is denoted by ρ_k and is defined as :

$$\rho k = \gamma k \;/\; \gamma 0$$

= covariance at lag *k* / variance

If we plot ρk against *K* the graph we obtain is known as the population Correlogram, but in practice we can only compute the Sample Autocorrelation Function, $\widehat{\rho k}.$ where

$\widehat{\rho k} = \widehat{\gamma k} \;/\; \widehat{\gamma 0}$ where $\widehat{\gamma k} = \sum (Y_t - \bar{Y})\frac{Y_{t+k} - \bar{Y}}{n}$ and $\widehat{\gamma 0} = \sum \frac{[(Y_t] - \bar{Y})^2}{n}$. Therefore if we plot $\widehat{\rho k}$ against k we get

hypothesis and accept our alternative hypothesis. But after first differencing the p-value of the Q-stat ahs increased and is above 0.05 for all the variables thus in this case we accept our null hypothesis which means that the series has become stationary after first differencing. Now in case of the Augmented Dickey Fuller Test we check the value of the absolute value of the calculated t statistic and our H_0 is set as the Series has a unit Root (in other words the series is non stationary) against our H_1 : There is no Unit Root (or in other words the series is stationary). From the above table we see that the calculated t value at level (without differencing) has been found to be statistically insignificant as the p-value is greater than 0.05, but after first differencing the p-value has been found to be significant thus we can reject the null hypothesis and accept our alternative hypothesis. Therefore from the various test for stationary we have found that a Macroeconomic data is non stationary in nature but becomes stationary after the first differencing.

Estimation of data by running regression by using the ordinary least square method

Ordinary least square method

Let us consider an two variable linear regression model which can be written as

$$Yi = \beta_1 + \beta_2 X_i + U_i$$

Where Yi = Dependent variable

β_1 = Intercept Term

β_2 = Slope coefficient of X_i

U_i = Error term

And our estimated equation is $\widehat{Y_i} = \widehat{\beta_1} + \widehat{\beta_2}\, X_i$

Therefore applying the regression model in our data we get :

$\widehat{PRODUCTION}$ =-7.080311+12.29518 * $\widehat{AREA}$ +0.000616* $\widehat{YEILD}$

S.E	(0.499678)	(0.488188)	(0.000597)
Þ-Value	(0.0000)	(0.0000)	(0.00000)

R2 =0.993810

d-wd Stat=0.84890

We have regressed Production with area and yield using Ordinary least square method and have obtained the above given results. From the given results we see that even though all the slope coefficients have been found to be statistically significant (p-value = 0.000) and also the set of data has found to be a very good fit with 99% variation in production in onion being explained by area and yield, but the Darwin –Watson(d-stat) value has been found to be very low at 0.849 thus indicating the presence of autocorrelation. Thus we can say that the situation exemplifies the problem of spurious, or nonsense regression which arises when the data is Non stationary

$$\Delta Y_t = \beta_1 + \beta_2 \,\Delta X_{2t} + \beta_3 \,\Delta X_{3t} + u_t$$

$\Delta Y_t = (Y_1 t - Y_1(t-1))$ (Dependent Variables)

$\Delta X_{2t} = (X_{2t} - X_{2t-1})$

$\Delta X_{3t} = (X_{3t} - X_{3t-1})$

ΔPRODUCTION$_t$=-0.001462 +0.0529 $\Delta XArea_{2t}$ +0.1 $\Delta Yeild_{3t}$

(0.050815)	(0.000048)	(0.71605
(0.9772)	(0.0000)	(0.00000)

R^2=0.948920 d-.wd stat= 2.44

F-stat 260.0822 (0.0000)

After taking 1st differencing of each Variables at 11 lag periods and running Regression

Now in the same given set of data we have again run a regression but in this case we have taken the first differences of all the variables to make it stationary. From the above set of calculations we see that after the 1st differencing process when we run a regression using Ordinary Least square method the value of Darwin-watson (d-stat) has increased and is much more closer to two indicating presence of weak autocorrelation. The estimated slope coefficients of Area and Yield were found to be significant at 99% level of significance which means that as the total area under onion cultivation goes up by 1% on an average, production of onion would go up by 5%. Also if the yield per hectare increases by 1% on an average, production would increase by 13 %. Both of these variables have a positive relationship with the production of onion. The value of R^2 of 0.95 means that about 95% of the variation in Production of Onion is explained by area and yield and the remaining 5 % is unexplained. The high R^2 value indicates that the sample regression line fits the data very well.

Conclusion

Analyzing the Time series data through means of econometric tools and descriptive statistics the study found that the production of Onion is positively related to its yield per hectare and area, thus efforts must be taken to increase the yield by using modern technologies and better quality seeds, fertilizers etc. Also farmers must be educated on the importance of produci ng a certain crop so that they do not erratically change the cropping pattern from one crop to another thereby leading to a fall of production which leads to rise in prices. Such regulation must be made by the various Government agricultural agencies. The study undertaken also showed that there has been a substantial increase in Onion Production over the past 30 years, even though the production is not steady but is prone to fluctuations. Thus we can say that rise in prices due to lack of production is only a small factor that causes the prices to surge up. The share of Export on the total onion production varied between 5 to 15% which was not that a large amount to cause scarcity in a country which is the 2nd largest producer of onion.

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