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Performance of fresh onions in India: An economic analysis

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Abstract
India is the second largest onion growing country in the world. Onion (Allium cepa L) is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables. The time series data has been collected for 20 years (1999 to 2019) and classified into First decade (1999 to 2008) and Second decade (2008 to 2019) for comparing decade performance. Compound growth rate, Coppock's Instability Index, Supply response analysis and Markov Chain analysis are the tools used for analyzing the data. Growth rate in first decade were higher which was statistically significant at 1 per cent while the export value recorded comparatively higher annual growth rates at 20.99 per cent in first decade which was statistically significant at 1 percent level. In supply response analysis, among the price and non price factors, lagged yield only positively influences farmer's decision on acreage allocation in current year. The direction of trade in Indian onion export shows that UAE and Nepal are the highest stable onion market with the probability of retention 0.52 and 0.45 respectively from 1999-2019.It shows that there is a need to create our onion demand and maintain good relations with other countries to retain the market share.

Keywords: Performance, fresh onions, economic analysis

Introduction

India is the second largest producer of fruits and vegetables in the world. The production of fruits and vegetables in 2019 is estimated to be 314.5 million tonnes. The production of fruits is estimated to be around 97.38 million tonnes and vegetables production is estimated 187.36 million tonnes in 2018 -19. Among vegetables, onion Production is estimated to be around 23.28 million tonnes. (Department of Agriculture Cooperation and Farmers welfare, Horticulture division)

India is the second largest onion growing country in the world. Onion (*Allium cepa* L) is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables. Onion is a seasonal crop with a harvesting period of Rabi (March -June), Kharif (October to December), Late kharif (January - March)

The major varieties found in India are Agri found Dark Red, Agri found Light Red, NHRDF Red, Agri found White, Agri found Rose and Agri found Red, Pusa Ratnar, Pusa Red, Pusa White Round. The major onion producing states area Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Telangana. Maharashtra ranks first in onion production with a share of 28.32%. There is a lot of demand of Indian onion in the world, the country has exported 2.18 million MT of fresh onion to the world for the worth of Rs. 3467.06 croresduring the year 2018-19 (APEDA).

Onion is important vegetables for a consumer. It is used almost daily in food preparations. It is not possible to make a fresh meal without onion. But the price of onions varies very frequently from Rs. 10 to Rs. 205 within a year. Farmers also not able to respond immediately for a price increase *i.e* to increase area under onion or yield. During period of low prices, only possibility is to increase storage of onion expecting high price in future. But infrastructure and cost of storage is another issue for farmers. Many farmers want to sell onion immediately to realize income from crop.

Hence this study was taken up with the following objectives: i) To find the growth and instability in area, production and productivity of onions in India and ii) To find out the supply response factors and export performance of onion in India.

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Review of literature

Immanuel raj *et al.*, (2014) [3] stated that erratic weather, volatile market price, lack of adequate storage and market infrastructure caused instability in production of onion, preventing the farmers in taking the optimal decision on allocation of area and raising farm productivity. Kamble and Tiwari (2018) [4] stated that in addition to poor storage facilities and lack of retention power of onion growers are the main cause for instability of onion in the market. To protect against such high fluctuations in price of onion, the producers can organize themselves into growers associations and plan to grown different varieties of onion which have different sowing and harvesting periods. Meena *et al.*, (2018) [7] conducted study in Bihar to measure the performance of onion for 40 years using secondary data from 1974 to 2014. In the first decade, onion gains the area at the compound growth rate of 1.7% per annum. Inthe second decade, performance of the onion in area and production was much better than first decade but onion lost the productivity at the compound growth rate of 0.3% per annum. In the third decade shows very poor performance and onion lost the area and production. Performance of onion was recorded much better and onion gained recorded area, production and productivity with highest growth rate in the fourth decade. During the whole study period best performance of onion was found in production followed by area and productivity.

Kusuma and Rudrapur (2016) [5] conducted a study on export performance of onion using Markov chain analysis. It was estimated during 2010-11 the major onion export destinations were Bangladesh (36.55%), Malaysia (21.03%) and other scon tributing about 16.47 per cent. There is need to improve the efficiency of production and quality in order to stabilize the markets. Kumar *et al.* (2009) study on performance of onion exports from India using Markov chain analysis. They found that Bangladesh account for highest share of onion exports followed by Malaysia, UAE and Singapore. They stated that the supply of onion exports could be increased by increasing production, reducing post-harvest losses and through policy support for giving adequate technology.

Methodology

The data used for this study which are collected from Agricultural and Processed Food Products Export Development Authority (Export quantity of onion), Season and Crop Report (Rainfall data), Agriculture statistics at a Glance 2019(Area, Production and Productivity of onion). Compound growth rate, Coppock's Instability Index, Supply response analysis and Markov Chain analysis are the tools used for analyzing the data as follows:

i) Compound Growth rate

It measures the growth performance of area, production, productivity and export for onion over the years. The time series data has been collected for20 years (1999 to 2019) and classified into First decade (1999 to 2008) and Second decade (2008 to 2019) for comparing decade performance. The growth rate was estimated using exponential trend model (Anjum, S. and Madhulika, 2018) [1].

Exponential trend model: $Y = ab^t e$

Where,
Y = Area/production/productivity/Export quantity
a = Intercept
b = Regression co-efficient

t = Time variable.
e = Error term

Take the logarithm, it becomes $\log y = \log a + t \log b + error$
From the estimated function the compound growth rate was worked out

From the estimated function: CGR (r %) = (Antilog of log b - 1)*100

ii) Coppock's Instability Index (CII)

To measure percentage variations from year to year, CII (Anjum, S. and Madhulika, 2018) [1] can be calculated by

$$\text{Formula CII} = \left[\text{Antilog}\left(\sqrt{\text{Vlog}}\right) - 1\right] * 100$$

$$V \log = \frac{\left[\sum \log \frac{x_{t+1}}{x^t} - M\right]^2}{N}$$

Where,
X_t=Area/Production/Yield/Exports
t =number of years.
M= Mean of the difference between Logs of X_{t+1}, X_t.
V log = logarithmic variance of the series.

iii) Supply Response Analysis

According to Gujarati (1995), a model is described as dynamic if the time path of the dependent variable is explained by its previous values. To know the responsiveness of the area [acreage] under the crop [Supply] to the changes in the prices in lagged year. (Dupdal and Patil, 2018) [2].

Acreage response (A*t) = $b_0 + b_1 P_{t-1} + b_2 Y_{t-1} + b_3 R_t + b_4 A_{t-1} + U$

Where

$A*_t$ = Area of onion crop in the current year (ha)
A_{t-1} =Area of onion crop lagged by one year (ha)
P_{t-1}= Farm harvest price of crop lagged by one year (Rs/qtl)
Y_{t-1}= Yield of onion crop lagged by one year
R_t = Rainfall during monsoon period in mm
U = Disturbance term

The long run elasticity (LRE) and short run elasticity (SRE) were calculated by using the following formula
1. SRE= [Coefficient of lagged price X (Average lagged price/Average area)]
2. Coefficient of adjustment (λ) = [1 – regression coefficient of lagged area]
3. LRE = [SRE/ λ]

iv) Markov Chain analysis

The direction of onion trade has been analyzed using Markov Chain Analysis (MCA) (Kumar, *et al.* 2006) [6]. The Fundamental element of MCA is to estimate of transitional probability matrix P and diagonal elements of the matrix measure the probability that the export share of a country will be retained

$$E_{jt} = \sum_{i=1} E_{it-1} P_{ij} + e_{jt}$$

Row elements indicate the probability of loss in trade on account of competing countries and column elements indicate

the probability of gain in trade from other competing countries.

Transitional probabilities P_{ij} which can be arranged in a (c*r) matrix: - properties.

$0 \leq P_{ij} \leq 1$

$\Sigma P_{ij} = 1$ for all 'i'

Results

i) Compound Growth Rate of onion performance in India from 1999-2019

The compound growth rate of area, production, productivity and exports of onion were calculated and shown in the Table 1. On comparing two decades performance of onion from 1999-2019,area, production, productivity and exports of onion in second decade (2008-19) 6.56%,5.06%, 1.04% and 4.22% were less when compared to the first decade (1999-2008) growth rate of 12.4%,7.53%, 4.59% and 20.99% respectively. This reduced level of area allocation and yield in second decade due to worst climatic condition in 2010 which ultimately leads to low export. Growth rate in first decade were higher which was statistically significant at 1 per cent while the export value recorded comparatively higher annual growth rates at 20.99 per cent which was statistically significant at 1 percent level of significance. In the second decade, the growth rate of export quantity(4.22%) was positive and significant at 10 per cent level and it shows lowest performance when compared to first decade. The supply of onion for exports could be increased through increased production and by way of reduction in post harvest losses.(Kumar *et al.,*2006) [6].

Table 1: Growth rates in area, production, productivity and export of onions in India

Period	Area	Production	Productivity	Export
1999-2008	12.4***	7.53 ***	4.59***	20.99 ***
2008-2019	6.56 ***	5.06 ***	1.04 **	4.22*

*** significant at 1 per cent level, ** significant at 5 per cent level,* significant at 10 per cent level. (Figures in parenthesis indicates standard error)
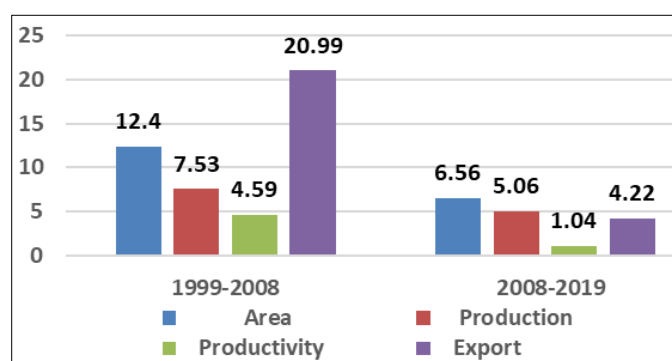

Fig 1: Growth rates in area, production, productivity and export of onions in India

ii) Coppock's Instability Index of area, production, productivity and export of onion

Fluctuations in crop performance depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs and other factors. Higher growth in production accompanied by low level of instability for any crop is desired for sustainable development of agriculture. To measure the instability level in onion performance by using Coppock's instability index.

Table 2 presents the results of estimated instability measures of area, production, productivity and exports of onion in India over the period of 1999-2019.It could be inferred that instability of area, production, productity and export performance declined in second decade (2008-2019) and highest instability found in first decade (1999-2008).

Table 2: Coppock's Instability Index of area, production, productivity and export of onion

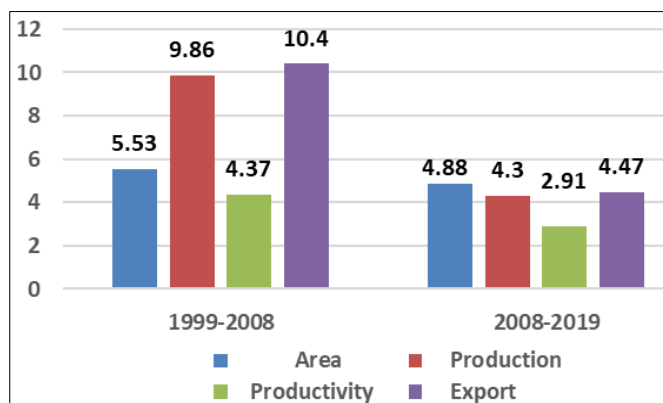| Period	Area	Production	Productivity	Export
1999-2008	5.53	9.86	4.37	10.4
2008-2019	4.88	4.3	2.91	4.47

Fig 2: Coppock's Instability Index of area, production, productivity and export of onion

Supply response analysis

It intends to examine and identify price and non-price factors which effects farmers' decision making process regarding area allocation in onion cultivation. The price factor like farm harvest price and non- price factors such as the area, yield of onion and rainfall under onion cultivation taken for analysis. One year lag used in acreage, yield and price assuming that the current year acreage, yield and price generally influence the decision about area allocation in the next year

Table 3: Results of acreage response of onion in India

Factors	Co-efficient	t-Value
Intercept	2044.34	196.92
Lagged yield	1.71**	0.05
Lagged price	-0.06*	-1.70
Lagged area	-0.04 ***	-2.85
Rainfall	-0.03 ***	-3.4
R^2	0.52	

It could be inferred from the Table 3, R^2 value 0.52 which shows that the variables included in the model accounts for 52 per cent of the variation in onion acreage.The regression co efficient of lagged yield shows that one per cent increase in previous year yield, there was an increase in the area allocated by current year by 1.71 per cent were found to be significant at 5% level.

The coefficient of lagged priceof onion (-)0.06 was significant at 10per cent level which implies that the price will have a negative effect on decision of the area allocation during the current year. The negative relation of rainfall (-) 0.03 also significant at one per cent level. This shows that previous year rainfall have a negative influence of area allocation during current year. The lagged area under crop 0.04 significant at one percent which implies negative impact on area allocation by farmers during current than previous year.

Table 4: Long run and short run elasticity of supply response function of Onion

Particulars	Elasticity
Short Run Elasticity	0.4017
Long Run Elasticity	0.386
Coefficient of Adjustment	1.04

The short run price elasticity is 0.4017 showing that a one percent increase in the lagged price of the onion crop induces the farmers to allocate the area under the onion crop by 0.4017 percent in current year. The value of coefficient of adjustment 1.04 explains that the discrepancy [disequilibrium] between actual change and desired change in the area can be eliminated to the extent of 1.04 units every year.

The long run price elasticity is 0.386 explains that the cumulative effect of changes in the price on the current year's acreage is such that if the lagged price is increased by one percent then the area under the crop in current year will be increased by 0.386 percent per year. Elasticity for onion crop found inelastic in both short run and long run. It means the price of onion has little effect on its consumption. Fall in their prices does not raise their consumption significantly and price rise causes only a small decrease in consumption since it is a vegetable that consumed daily.

iv) Markov chain analysis

The structural change in direction of trade are quantified using Markov chain analysis. The diagonal element of the transitional probability matrix measures the probability that the export share of the country will be retained. The elements of the transitional probability matrix shows the probability "P" that the share would shift from i^{th} country to j^{th} country. The row elements in the transitional probability matrix provide the information on the extent of loss in trade, on account of competing countries. The columns element indicates the probability of gains in volume of trade from other competing countries and the diagonal element indicates probability of retention of the previous year's trade volume by the respective country

Major importers of Indian onions are Bangladesh, Sri Lanka, Malaysia, UAE, Nepal, Saudi and Kuwait. Among these countries, UAE and Nepal are the highest stable onion market for Indian onion export with the probability of retention 0.52 and 0.45 respectively. Malaysia(0.36) and Kuwait (0.32) are moderately stable while Sri Lanka having lowest probability of retention(0.19). Bangladesh gain its major share from Saudi (27%) and retained its probability of share upto 28%. UAE and Sri Lanka gain its major share from Sri Lanka(28%) and Nepal (24%) respectively. Nepal lost is major share to UAE (33%) and Malaysia (22%). Saudi lost its major share upto 37 per cent to Malaysia. These trade direction shows the probability of retention in Indian onion export, loss and gain of respective countries.

Table 5: Direction of Trade in Indian Onion Export (1999-2019)

Countries	Bangladesh	Malaysia	UAE	Sri Lanka	Nepal	Saudi	Kuwait	others
Bangladesh	0.28	0.00	0.00	0.00	0.19	0.22	0.16	0.15
Malaysia	0.00	0.36	0.16	0.00	0.00	0.18	0.20	0.12
UAE	0.02	0.16	0.52	0.28	0.18	0.02	0.00	0.00
Sri Lanka	0.04	0.08	0.12	0.19	0.24	0.13	0.11	0.09
Nepal	0.00	0.22	0.33	0.00	0.45	0.00	0.06	0.00
Saudi	0.12	0.37	0.13	0.14	0.00	0.23	0.00	0.01
Kuwait	0.14	0.12	0.02	0.05	0.15	0.13	0.32	0.08
Others	0.03	0.17	0.02	0.16	0.11	0.21	0.05	0.25

Conclusion

Compound growth rate and Instability index shows that in first decade (1999-2008), the performance is higher than the following decade (2008-2019). Supply response function result shows that non price factor, lagged yield positively influences the farmers' decision on acreage allocation in the current year. Indian onion is largely demanded by Malaysia, UAE, Bangladesh, Sri Lanka, Nepal, Saudi and Kuwait. The trade direction of onion exports shows that there is a need to create Indian onion demand in other countries also. India has to maintain good trade relation with these countries and retain the market share.

Suggestions

- Government should implement trade policy for price stabilization and farmers' market since it is less price elastic.
- By selling directly to consumers, produce often needs less transport, less handling, less refrigeration and less time in storage. Contract farming is an effective measure of strengthening the distribution system. Through contract farming, the farmers gets benefited through provision of inputs and production services, access to credit, introduction of appropriate technology, skill transfer, guaranteed and fixed pricing structures; and access to reliable markets. On-farm storage structures make onions available throughout the year.
- Onion must be stored in scientific manner like modern cold storages and proper warehouse structures helps to avoid certain problems which arises during conventional storage of onion *viz.* loss in weight, sprouting and rotting of bulb.
- Awareness should be needed to promote use of dehydrated onions.
- Government should take measures to retain the higher market share in the country and to gain in exports.

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