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Growth and Instability in Oilseed Prices – A Case of Amreli Market in Gujarat

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ABSTRACT

The growth and instability in oilseed prices in Amreli district of Gujarat have been estimated for the period from 1995-96 to 2016-17 using various statistical methods. The instability index suggested by Cuddy and Della was employed. Commensurate with the objectives of study, time series data on prices of major oilseed crops *viz* grown in the district were collected and compiled. The findings emerged from the study revealed a high level of instability in case of the sesamum black and white, but it showed moderate instability in the price of castor and bunch type as well as semi spreading varieties of groundnut. The results of correlation analysis indicated integration between oilseed prices. Higher association was noticed between the prices of the two varieties of the same crop. It was also observed that price of castor is closely related with groundnut than the sesamum whereas the lowest association was observed between prices of groundnut bunch type and sesamum white. Research and policy support is needed for raising productivity in the rain-fed areas and also for insulating the crop sector from year-to-year variations in price. The study has suggested that development of assured storage facility, market integration, market price forecast, agricultural practices, farmer-friendly insurance schemes and better weather forecasting would provide a sound shield to growth and price instability in the district.

Key words: Cuddy della valle index, Growth, Instability, Oilseeds, Prices.

INTRODUCTION

India produces a variety of crops belonging to cereals, pulses, oilseeds, fruits and vegetables, condiments, sugar, fibres, narcotics *etc*. India ranks first in production of castor, sesamum, safflower and nigerseed; second in groundnut and rapeseed and mustard, third in linseed and fifth in soybean and sunflower in the world. Notwithstanding this fact, the productivities of oilseed crops in India are lower than other oilseeds producing countries of the world except in case of castor. The demand for oilseeds in India is rising at a faster rate and will be doubled by 2020 AD resulting in rising gap between domestic supply and consumption.

Indian agriculture has made considerable progress, particularly in respect of food crops such as wheat and rice in irrigated areas; however, performance has not been so good in case of other crops particularly oilseeds, pulses, and coarse cereals. Therefore, after achieving self-sufficiency in food grains, the government is focusing attention on these agricultural commodities. The oilseed sector has been an important area of concern and interventions for Indian policy makers in the post-reforms period when India became one of the largest importers of edible oils in the world, importing about half of domestic requirement in the 1990s.

The State of Gujarat plays a prominent role in oilseed production in India. Oilseeds are important next only to food grains in terms of area, production and value in the state. Oilseeds area and production in the state constitute about 10.8 per cent and 14.5 per cent, respectively in India. Oilseeds crops occupy 2.72 lakh hectares of land in Amreli district. Among the oilseeds, groundnut is the most important crop produced in the district. In the district of Amreli, groundnut and sesamum occupy first and second rank among the oilseed crops with respect to sowing area respectively. Castor occupies third position with respect to sowing area in the district, while rest of the oilseeds occupy negligible sowing area.

Prices of agricultural commodities play an important role in rural economy. Livelihood of the small and marginal farmers and farm labours mostly depend on prices of different crops. Prices of the oilseed crops play a key role since it occupies second largest sowing area after cotton in the district. Prices mainly depend on supply although many determinants fluctuate the prices of different crops. It is necessary to analyze the relationship and direction between different prices of oilseed crops to know its behaviour.

This study is an attempt to know the price behaviour of oilseed crops of Amreli district by growth and instability analysis with the following objectives.

1. To compare different price series of oilseed crops using summary statistics
2. To find the relationship between the pair of prices of major oilseed crops and their significance.
3. To examine the growth and instability in selected oilseed prices.

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METERIALS AND METHODS

Oilseed crops are the backbone of the farmers, traders and agro processors in Amreli district since oilseed crops occupied second largest position after cotton in agriculture sector. Agricultural Produce Market Committee, Amreli is one of the popular market yards in Saurashtra region of Gujarat State.

The present study was based on the time series data on prices of major oilseed crops grown in the district, which includes groundnut (Bunch and Semi spreading), sesamum (Black and White) and castor. These crops were selected based on their higher arrivals in the APMC, Amreli. Time series monthly data on all the four selected crops were collected for the period from 1995-96 to 2016-17 from the APMC, Amreli.

Arithmetic mean, Standard deviation, Range and Co-efficient of variation were worked out to compare different price series of oilseed crops using following formulae.

$$\bar{X} = \frac{\sum_{i=1}^{N} Xi}{N}$$

Where,

N is the number of observations and Xi is the value of ith observation. The range is calculated as the difference between the largest and smallest data value.

$$R = \text{Maximum} - \text{Minimum}$$

The standard deviation of the sample is:

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{N - 1}}$$

Co-efficient of variation is the ratio of standard deviation to the mean which expressed in percentage CV% = (S.D./ Mean)*100. Time series data often contain the trend also. To overcome this problem, the instability index suggested by Cuddy and Della was employed. Cuddy-Della index is most commonly used measures of instability of time series data and is universally acceptable. The indices were originally developed by John Cuddy and Della Valle for measuring the instability in time series data (Cuddy and Della Valle, 1978). This index is a better measure compared to coefficient of variation, as it is inherently adjusted for trend, often observed in time series data. This measure included as a component of instability all cyclical fluctuations present in the time series data, whether regular or irregular, as well as any component which could be defined as „white noise . The original formulation of the index is given as follows:

$$C.D.V.I. = C.V. \% \sqrt{(1 - R^2)}$$

Where,

CV is the coefficient of variation in per cent; R^2 is the coefficient of determination. The ranges of C.D.V.I. (Rakesh Sihmar, 2014) are given as follows;

Low C.D.V.I. : $0 < C.D.V.I. \leq 15$
Medium C.D.V.I. : $15 < C.D.V.I. \leq 30$
High C.D.V.I. : $30 < C.D.V.I.$

In time series literature, instability in the data is measured by Cuddy Della Valle Instability index because this index accommodate trend present in the data which is not done by the commonly used instability measure *i.e.* Coefficient of Variation (CV). The latter measures instability around mean but the former measures instability around the trend. Since time series data contain trend, it should be detrended in order to measure instability in a statistically sound manner. So CDVI was utilized to measure instability

Correlation coefficient

The Pearson product-moment correlation coefficient, also known as r, R, or Pearson's r, is a measure of the strength and direction of the linear relationship between two variables that is defined as the covariance of the variables divided by the product of their standard deviations. This is the best known and most commonly used type of correlation coefficient; when the term "correlation coefficient" is used without further qualification, it usually refers to the Pearson product-moment correlation coefficient.

To find the relationship between the pair of price of different oilseed crops, Pearson's correlation coefficient have been workout between the all possible pair of prices and make correlation matrix.

Correlation coefficient 'r' is calculated through the following formula:

$$r = \frac{n \sum x - \sum x \sum y}{\sqrt{[n \sum x - (\sum x)^2]\,[n \sum y^2 - (\sum y)^2]}}$$

Where,

x and y are values of variables (here prices of two different oilseed crops) and n is size of the sample.

The value of correlation coefficient can be interpreted in the following manner:

If 'r' is equal to 1, then there is perfect positive correlation between two values;

If 'r' is equal to -1, then there is perfect negative correlation between two values;

If 'r' is equal to zero, then there is no correlation between the two values.

To test the null hypothesis, Ho: $\rho = 0$ against the alternative hypothesis H1: $\rho \neq 0$ for the sample data ($n \leq 30$), Student's t-test is used using following formula with p value 0.05 and n-2 d.f.

$$t = (r\sqrt{n-2})/(\sqrt{1-r^2})$$

Where,

r is the sample correlation coefficient,

n is the sample size

Growth rates

The compound annual growth rate (CAGR) is a useful measure of growth over multiple time periods. It can be thought of as the growth rate that gets you from the initial value to the ending value if you assume that the value has been compounding over the time period.

To calculate compound annual growth rate, divide the value of the variable at the end of the period in question by

its value at the beginning of that period, raise the result to the power of one divided by the period length and subtract one from the subsequent result.
This can be written as follows:

$$CAGR = \left[\frac{\text{Ending value}}{\text{Beginning value}}\right]^{\left[\frac{1}{\#\text{ of years.}}\right]} - 1$$

Where
# indicates no. of years.

To test whether difference between C.G.R. of two time period of same commodity, we can use two sample (before introduction of Bt cotton and after introduction of Bt cotton) 't' test given by Fisher to test null hypothesis : Ho : $\bar{x} = \bar{y}$; against Ha : $\bar{x} \neq \bar{y}$ by using following formula.

Calculate Fisher's 't' with $n_1 + n_2 - 2$ d.f.

$$t = \frac{(\bar{X} - \mu_1) - (\bar{Y} - \mu_2)}{S_{(\bar{x} - \bar{y})}}$$

$$S_{(\bar{x} - \bar{y})} = \sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

Where,
S^2_p = Pooled Variance

RESULTS AND DISCUSSION

According to objectives of the present research work, the results and discussion is divided into three heads as follows.

Summary statistics

The descriptive statistics of price series of all the major oilseed crops *viz*., groundnut semi spreading, groundnut bunch type, sesamum white, sesamum black and castor are presented in Table 1. It indicates that the highest mean value of price observed for sesamum black (Rs.6056/Qtl.), followed by sesamum white (Rs.4919/Qtl.), whereas lowest was observed for the castor crop (Rs.2204/Qtl.). Similar trend was noticed in case Range and Standard Deviation of price. According to Coefficient of Variation, the highest variation was observed in price series of black sesamum *i.e.* 65.18 per cent while, lowest variation was observed in the price series of semi spreading groundnut (45.99%). Overall, the range, standard deviation and C.V. indicated the wide variation in the price level for all the major oilseed crops. The high C.D.V.I. were observed for sesamum black and white, while for the groundnut semi spreading, groundnut bunch type and castor, showed medium C.D.V.I.

Correlation coefficient

Mitra *et al*. (2017) reported that all possible pair wise correlations between the prices of two zones of India were significant at 5 per cent level of significance. Positive sign indicates that all the price series moves towards the same direction. The results presented in Table 2 revealed that the highest correlation was observed between prices of groundnut semi-spreading and groundnut bunch type, followed by prices of sesamum white and sesamum black indicating high association between the prices of two varieties of the same crop. It was also observed that price of castor is closely related with groundnut than the sesamum. Lowest association was observed between prices of groundnut bunch type and sesamum white.

Test of significance

The results of test of significance shown in Table 2 which indicated that calculated values of student's 't' were highly significant in case of all the pairs of prices of oilseed crops.

Fig 1 showed that the price of castor was closely related with the prices of bunch type groundnut bunch type and semi spreading groundnut. It was observed that the prices of the varieties of the same crop were highly associated as compared to the varieties of other crops. Prices of the sesamum white and sesamum black were highly fluctuated

	Groundnut (semi spreading)	Groundnut (bunch)	Sesamum (white)	Sesamum (black)	castor
Groundnut (semi spreading)	1	0.99	0.82	0.89	0.93
Groundnut (bunch)	0.99	1	0.79	0.88	0.91
Sesamum (white)	0.82	0.79	1	0.96	0.83
Sesamum (black)	0.89	0.88	0.96	1	0.89
castor	0.93	0.91	0.83	0.89	1

Table 1: Summary statistics of price series of oilseeds.

Statistic	Oilseed crops (Price Rs/qtl)				
	Groundnut semi spreading	Groundnut bunch type	Sesamum white	Sesamum black	Castor
Mean	2442	2402	4919	6056	2204
Range	3443	3254	11224	12632	3098
S.D.	1123	1119	2996	3948	1053
C.V.%	45.99	46.59	60.90	65.18	47.76
C.D.V.I.	23.54	24.75	45.25	40.05	26.95

than the prices of groundnut bunch, groundnut semi spreading and castor. High level of price was observed for the sesamum black and sesamum white in the year 2013-14.

Compound growth rate

The annual compound growth rates for the overall period 1995-96 to 2016-17 were calculated. In addition to that the growth rate before the introduction Bt. Cotton and after introduction of Bt cotton were also computed and the results are presented in the Table 3. The highest annual compound growth rate was observed for sesamum black followed by castor, whereas the lowest was observed for sesamum white. Interestingly, the compound growth rates of prices of all the selected oilseeds were higher after introduction of Bt cotton than before the introduction of Bt cotton for all the crops. This could be attributed mainly to the shift of acreage from oilseed crops to Bt cotton which resulted into reduction in supply of oilseeds and thus increase in its prices. Negative C.G.R. was observed for sesamum crop before introduction of Bt cotton, but positive and high C.G.R. was observed for this crop after introduction of Bt cotton. Ultimately, the factor 'Introduction of Bt cotton' influenced positively on prices of oilseed crops. Urmi Pattanayak and Minati Mallick (2017) studied the trend and variation in production and procurement of Rice and Wheat across major states in India. They used simple growth rate in their trend analysis.

To test whether difference between C.G.R. before introduction and after introduction of Bt cotton is significant or not, two samples Fisher's 't' test was used to test null hypothesis : Ho : $\bar{x} = \bar{y}$; against Ha : $\bar{x} = \bar{y}$. The results given in Table 3 indicated that difference is significant at p value 0.05, indicating significantly higher C.G.R. after introduction of Bt cotton (2001-02). Thus the null hypothesis was not accepted.

Instability index

The results presented in Table 4 revealed that higher C.D.V.I.$_s$ were observed for sesamum black and white crops, while medium C.D.V.I.$_s$ were observed for groundnut semi spreading, groundnut bunch type and castor crops. Relatively higher instability was noticed in the price of sesamum after introduction of Bt cotton but a reverse trend was observed for groundnut and castor. On the whole, it can be concluded that the instability in the prices of both

Table 2: Test of significance of correlation coefficient.

Correlation between	Value of correlation coefficient	Calculted 't'value
Groundnut (Semi Spreading) and groundnut (Bunch)	0.99	43.91**
Groundnut (Semi Spreading) and sesamum (White)	0.82	6.46**
Groundnut (Semi Spreading) and sesemum (Black)	0.89	8.66**
Groundnut (Semi Spreading) and castor	0.93	10.91**
Groundnut (Bunch) and sesamum (White)	0.79	5.84**
Groundnut (Bunch) and sesemum (Black)	0.88	8.33**
Groundnut (Bunch) and castor	0.91	9.69**
Sesamum (White) and sesemum (Black)	0.96	15.17**
Sesamum (White) and castor	0.83	6.62**
Sesemum (Black) and castor	0.89	8.52**

(Note: Table values of 't' with n-2 d.f., at p value 0.05 and 0.01 are 2.086 and 2.845, respectively).

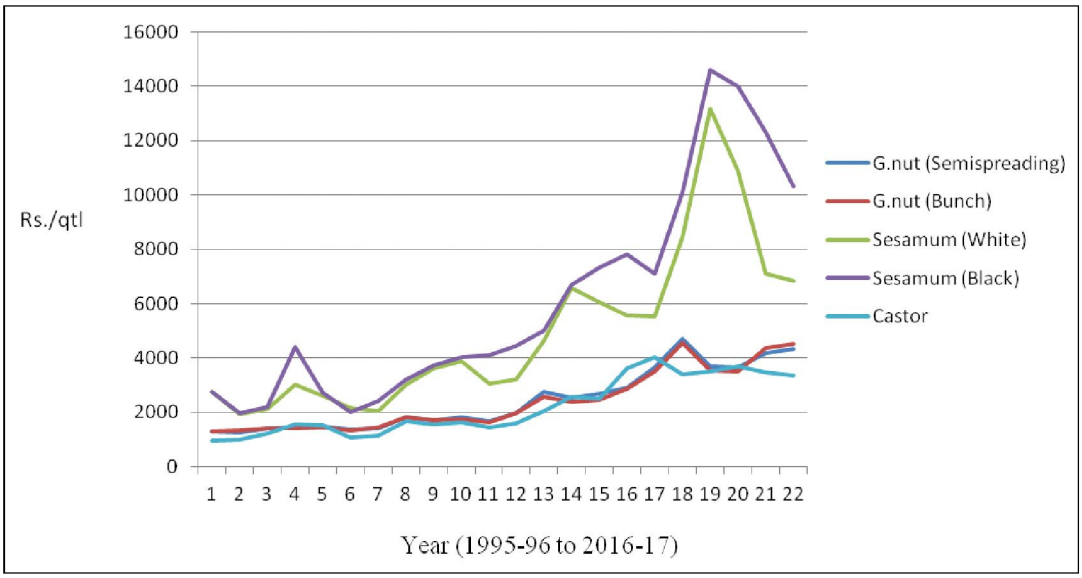

Fig 1: Price series of oilseed crops.

Table 3: Compound growth rate of prices.

Oilseed crop	C.G.R. % (1995-96 to 2016-17)	C.G.R.%		Calculated 't'value
		Before introduction of Bt. cotton	After introduction of Bt. cotton	
Groundnut (Semi spreading)	5.56	1.18	5.89	2.65*
Groundnut (Bunch)	5.85	1.57	6.31	2.55*
Sesamum (White)	4.25	-4.05	5.59	2.38*
Sesamum (Black)	6.21	-1.91	8.15	2.40*
Castor	5.92	2.86	4.78	2.60*

Table 't' value is 2.10 at p value 0.05 and 18 (n_1+n_2-2) d.f.

Table 4: Cuddy dela vale index (C.D.V.I.).

Oilseed crop	C.D.V.I.% (1995-96 to 2016-17)	C.D.V.I.%		Calculated 't' value
		Before introduction of Bt. cotton	After introduction of Bt. cotton	
Groundnut (Semi spreading)	23.54	4.42	13.40	0.056^{NS}
Groundnut (Bunch)	24.75	3.15	13.50	0.58^{NS}
Sesamum (White)	45.25	17.02	31.39	0.020^{NS}
Sesamum (Black)	40.05	31.93	21.32	0.007^{NS}
Castor	26.95	18.89	16.86	0.035^{NS}

Table 't' value is 2.10 at p value 0.05 and 18 (n_1+n_2-2) d.f.

the varieties of groundnut were comparatively lower in both the periods as compared to all other oilseeds under study.

To test null hypothesis: Ho: C.D.V.I.(1^{st} sample)= C.D.V.I.(2^{nd} sample); against Ha: C.D.V.I.(1^{st} sample) ≠ C.D.V.I.(2^{nd} sample) Fisher's 't' test was used which showed that before and after introduction of Bt cotton, no significant difference was observed in C.D.V.I.%.

CONCIUSION AND POLICY SUGGESTIONS

It is concluded that all the price series were positive highly correlated with each other, among which price of the castor was highly associated with price of groundnut than the price of sesamum. Price series of sesamum white and black were highly fluctuated than the price series of groundnut semi spreading and bunch and castor. Highly risky crop according to price for the stock holders and merchants is sesamum than groundnut and castor. High variation was observed in compound growth rate of sesamum varieties than groundnut varieties and castor. Significantly higher compound growth rates were observed for all the oilseed crops after introduction of Bt cotton in the district. These results may help to the stock holders, oilseed merchants and policy makers of the district.

The current status of oilseed crops has been analyzed for the past two decades which highlights the role of policy, technology and their interactions in shaping it. The role of technological inputs, policy environment and price systems in giving direction to the oilseeds economy cannot be over-emphasized. The potential sources of growth and their related constraints throw light on the possible future directions in oilseeds economy for sustaining its growth and stability in oilseed prices. Enlarging the scope of research and technology diffusion and institutional intervention beyond the farm gate is the way forward in re-energizing the oilseed crop sector. Special emphasis may be given to the following suggestions.

- Strengthen the oilseed crop seed chain, particularly in groundnut and sesamum to match the variety specific demand for higher yield, which will further decrease the per unit cost of cultivation.
- Provide market integration so that there will not be any price fluctuations in the oilseed market.
- Market information about the monthly and quarterly prices of oilseed should be easily available to the farmers in each market yard, so that they can sell their produce at right time and right place.
- Implement market reforms and policies, such as contract farming and public private partnership in production and processing, to ensure a competitive market for oilseeds and edible oil along with adequate protective measures to avoid unfair competition from the international markets.
- Improving local capacities and the social, economic and environmental sustainability of agriculture through delivery of technology and services and strengthening of institutions shall bring in the desired growth in the oilseed crop economy. This growth will be of immense benefit to the country as oilseeds are grown mainly in the disadvantaged regions.

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