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## PERFORMANCE AND STABILITY ANALYSIS OF CITRUS FRUITS EXPORTS FROM INDIA

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### ABSTRACT

India ranks first in the world in terms of lime/lemon production and ranks 2<sup>nd</sup> in orange production. India has the 26th rank in exports of lime/lemon, and Orange secured the 58th rank in the world's exporting countries. In this connection, the study on "Performance and Stability Analysis of Citrus Fruits Exports from India" was undertaken with the main objectives to assess the growth trend, instability, and sources of growth and variability. The secondary data on quantity and value of lime/lemon and orange exports from India was collected for 21 years from the year 2001 to 2021. It was analysed using compound growth rate, coefficient of variation, Cuddy Della Vella index, and Hazell's decomposition analysis. It was discovered that Period-I (26.88%) had a greater overall growth tendency in lime/lemon export quantity than Period-II (-1.61%) and Period-III (5.62%). Regarding oranges, Period-II (18.71%) has a greater growth rate than Period-I (-6.79%) and Period-III (6.43%). While the highest instability in terms of export quantity (37.86%) was found in lime/lemon and the highest instability in terms of export value (78.88%) was found in orange during the entire period from 2001 to 2022. According to the risk assessment, none of the countries fell into the highly desirable category of high growth rate and low risk in terms of export quantity and value. None of the countries in terms of both quantity and value of lime/lemon and orange exports reported under this category. Since no major importers were found under the most desirable category, efforts should be more concentrated towards the countries falling under the less desirable category, which have high growth, like Nepal in lime/lemon, whereas Nepal and UAE in orange. Results of decomposition analysis revealed that in the case of lime/lemon among all components, the share of the mean export price was the highest change in the variance of the export value. In the case of orange, mean export quantity showed the highest change in variance of export value.

**Key words :** Coefficient of variation, Compound growth rate, Cuddy Della Vella Index, Hazell's decomposition analysis, Instability.

### Introduction

India is the world's fruit and vegetable basket. Citrus fruits are consumable fruits that are members of the Rutaceae family and genus Citrus. Citrus fruits such as oranges, grapes, lemons, limes and pomelo are significant. These fruits have luscious pulp. These are among the healthiest fruits and nutritional powerhouses. Due to the numerous health and therapeutic advantages of citrus fruits, many specialists advise consuming the

India accounted for 17.05 per cent of the global lime/lemon production in 2021, with 20,814 MT produced

globally. Mexico (14.34%) and China (12.36%) were the other two largest producers. In 2021, the world produced 75,556.49 MT of oranges, with India accounting for 13.59 per cent of the total. China (9.99%) and Brazil (21.46%) were the other two largest producers [Food & Agricultural Organisation (FAO), 2023].

In India, total area under lime/lemon cultivation was 327.28 ha with annual production of 3548.39 metric tonnes and orange cultivation was 476.51 ha with annual production of 6219.38 metric tonnes during the year 2020-21 (Ministry of Agriculture and Farmer Welfare, Govt. of India, 2022). In India, lime/lemon is cultivated in the

states of Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Madhya Pradesh; these states are the larger producers of lime/lemon in India, and orange is cultivated in the states of Madhya Pradesh, Punjab, Maharashtra, Rajasthan and Haryana; these states are the larger producers of orange in India (Agricultural and Processed Food Products Export Development Authority, 2022).

Total export of lime/lemon was 36.67 million metric tonnes, with export value accounting for 41,954 million US dollars during the years 2020-21. Among all exporting countries, Spain has the first rank in terms of export, and India has the 26th rank in the world. Total export of orange was 66.68 million metric tonnes, with export value accounting for 60,521 million US dollars during the years 20-21. Among all exporting countries, Spain has the first rank in terms of export, and India has the 58th rank in the world (UN Comtrade, as reported by the Importing Countries, 2022). The major destinations of India's limes and lemons were Nepal, UAE, and Bhutan, Bangladesh emerged as the largest export market for orange followed by Nepal, Bhutan and UAE. (Agricultural and Processed Food Products Export Development Authority, 2022).

### Objective

- To study the growth pattern in lime/lemon and orange export from India
- To study the instability indices of lime/lemon and orange export from India
- To estimate the sources of growth and variability in lime/lemon and orange

### Materials and Methods

The data pertaining to the objectives of the study were collected from the Agricultural and Processed Food Products Export Development Authority website (Apeda.gov.in), the Export-Import Data of India website (indiastate.com), and the Food and Agriculture Organization website (faostat.org). The export of two commodities of lime/lemon and orange was selected considering the availability of data as per HS (Harmonized System) code. The study used secondary data to measure the export performance and stability of lime/lemon and orange from 2001-02 to 2021-22, which in turn shall be split into three periods, viz., Period-I (2001-02 to 2010-11), Period-II (2011-12 to 2021-22) and Period-III (2001-02 to 2021-22). The total number of the 21 years is considered. As per the WCO (World Customs Organization), there is a change in HS code of lime/lemon data after the year 2002. The HS code for the years 2001-2002 was 08053000, whereas after 2002 the HS

code for the lime/lemon data is 08055000.

### Compound Growth Rate

Growth rate measures past performance of economic variables and trends over time. To measure growth dynamics, a hypothetical function is postulated to describe and estimate the series of economic variables. The compound growth rates (CGRs) was calculated by using the exponential function of the following specification:

$$Y_t = a b^t u_t \quad (1)$$

Where,  $Y_t$  = Dependent variable (export quantity/export value, etc.)

$a$  = Intercept;

$b$  = Regression coefficient,

$t$  = Time element which takes the value 1, 2, 3...n,

$u_t$  = Error term

By taking logarithms of both the sides, the equation takes the form,

$$\text{Log } Y_t = \text{Log } a + t \text{ log } b \quad (2)$$

The value of log b was computed using the formula

$$\text{Log } b = \frac{(\sum t \text{ Log } Y - (\sum t \cdot \sum \text{Log } Y / N))}{\sum t^2 - \left(\frac{\sum t^2}{N}\right)} \quad (3)$$

Where,  $N$  = Number of years.

Subsequently, the compound growth rate (%) was computed by using the formulation.

$$\text{Compound growth rate}(r) = [(\text{Antilog of log } b) - 1] \times 100 \quad (4)$$

Student 't' test was used to determine the significance of the growth rates obtained for which the following formulation was employed,

$$t = \text{Log } b / \text{SE}(\text{Log } b) \quad (5)$$

$$\text{SE}(\text{Log } b) = \sqrt{\frac{\sum(Y - \bar{Y})^2 - \text{Log } b * (\sum(Y * t) - \sum(Y) * \bar{t})}{(N - 2)\sum(t - \bar{t})^2}} \quad (6)$$

The calculated 't' values, from equation (6) were compared with the table 't' values and the significance was tested for different significant probability levels.

### Instability Indices

To measure the instability index, Cuddy-Della Valle (1978) index was used.

$$I_x = CV \sqrt{(1 - \bar{R}^2)} \quad (7)$$

$$CV(\%) = S/\bar{X} * 100 \quad (8)$$

Where, Ix = Instability index;

CV = Coefficient of variation;

$\bar{R}^2$  = Adjusted coefficient of multiple determination;

$\bar{X}$  = Mean value;

S = Standard deviation.

### Decomposition Analysis

Hazell's (1984) decomposition model was used to analyze the impact of export quantity and unit value on export value, using a linear equation.

$$Z_t = a + bt + ut \quad (9)$$

Where,  $Z_t$  = Dependent variable (Export quantity/Export unit value);

a = Intercept;

b = Parameter to be estimated;

t = Time (in years);

ut = Error term with usual assumptions.

After detrending, the residuals (ut) was centred on the mean export quantity, mean export unit value and mean export price ( $\bar{Z}$ ).

$$Z = ut + z \quad (10)$$

The study calculates detrended export value, calculates coefficient of variation and decomposes variance into quantity, price and co-variance to identify sources of instability in lime/lemon and orange exports.

$$V(EV) = V(Y) + Y^2 V(A) + 2 AY Cov(A, Y) - Cov(A, Y)^2 + R \quad (11)$$

Where,

V(EV) = Export value variance;

A = Mean export quantity;

Y = Mean export price;

V(Y) = Export price variance;

V(A) = Export quantity variance;

Cov (A, Y) = Export quantity – export price co-variance;

$Cov(A, Y)^2$  = Higher order co-variance between export quantity and export price;

R = Residual.

The above equation is the mean export quantity and export price of co-variance between export quantity and export price. Clearly, a change in any one of these components would lead to a change in V (EV) between

two periods of time.

Methods of decomposition of the changes in variance of export value is carried out by constructing a method to partition the changes in variance of export value V(EV) between the first and the second periods into its constituent parts.

The variance of export value, V(EV) can be expressed as,

$$V(EV) = \bar{A}^2 V(Y) + \bar{Y}^2 V(A) + 2\bar{A}\bar{Y} Cov(A, Y) - Cov(A, Y)^2 + R \quad (12)$$

The variance of export value in the first period is,

$$V(EV_1) = \bar{A}_1^2 V(Y_1) + \bar{Y}_1^2 V(A_1) + 2\bar{A}_1\bar{Y}_1 Cov(A_1, Y_1) - Cov(A_1, Y_1)^2 + R_1 \quad (13)$$

and in the second period is,

$$V(EV_2) = \bar{A}_2^2 V(Y_2) + \bar{Y}_2^2 V(A_2) + 2\bar{A}_2\bar{Y}_2 Cov(A_2, Y_2) - Cov(A_2, Y_2)^2 + R_2 \quad (14)$$

Each variable in the second period can be expressed as its counterpart in the first period plus the change in the variable between the two periods, i.e.

$$\bar{A}_2 = \bar{A}_1 + \Delta\bar{A} \quad (15)$$

$$\bar{Y}_2 = \bar{Y}_1 + \Delta\bar{Y} \quad (16)$$

$$V(A_2) = V(A_1) + \Delta V(A) \quad (17)$$

$$V(Y_2) = V(Y_1) + \Delta V(Y) \quad (18)$$

$$Cov(A_2, Y_2) = Cov(A_1, Y_1) + \Delta Cov(A_1, Y_1) \quad (19)$$

Eq. can, therefore, be rewritten as

$$\begin{aligned} V(EV_2) = & \{\bar{A}_1 + \Delta\bar{A}\}^2 \{V(Y_1) + \Delta V(Y)\} \\ & + \{\bar{Y}_1 + \Delta\bar{Y}\}^2 \{V(A_1) + \Delta V(A)\} + 2\{\bar{A}_1 \\ & + \Delta\bar{A}\} \{\bar{Y}_1 + \Delta\bar{Y}\} \{Cov(A_1, Y_1) + \Delta Cov(A, Y)\} \\ & - \{Cov(A_1, Y_1) + \Delta Cov(A, Y)\}^2 + \{R_1 + \Delta R\} \end{aligned} \quad (20)$$

Which can be expressed as

$$\begin{aligned} V(EV_2) = & \bar{A}_1^2 V(Y_1) + \Delta\bar{A}^2 V(Y_1) + 2\bar{A}_1\Delta\bar{A} V(Y_1) \quad (21) \\ & + 2\bar{A}_1\Delta\bar{A}\Delta V(Y) + \bar{Y}_1^2 V(A_1) + \Delta\bar{Y}^2 V(A_1) \\ & + 2\bar{Y}_1\Delta\bar{Y} V(A_1) + \bar{Y}_1^2 \Delta = V((A) \\ & + \Delta\bar{Y}^2 \Delta V(A) + 2\bar{Y}_1\Delta\bar{Y}\Delta V(A) + 2\bar{A}_1\bar{Y}_1 Cov(A_1, Y_1) \end{aligned}$$

**Table 1 :** Components of change in the variance of export value.

Change in mean export price	$\Delta \bar{Y}$	$2\bar{A}_1\Delta\bar{Y} \text{cov}(A_1, Y_1) + \{2\bar{Y}_1\Delta\bar{Y}\Delta(\Delta\bar{Y})^2\}V(A_1)$
Change in mean export quantity	$\Delta \bar{A}$	$2\bar{Y}_1\Delta\bar{A} \text{cov}(A_1, Y_1) + \{2\bar{A}_1\Delta\bar{A}\Delta(\Delta\bar{A})^2\}V(Y_1)$
Change in export price variance	$\Delta V(Y)$	$\bar{A}_1^2\Delta V(Y)$
Change in export quantity variance	$\Delta V(A)$	$\bar{Y}_1^2\Delta V(A)$
Interaction between changes in mean export price and mean export quantity	$\Delta \bar{A} \Delta \bar{Y}$	$2\Delta \bar{A} \Delta \bar{Y} \text{cov}(A_1, Y_1)$
Change in export quantity-export price covariance	$\Delta \text{cov}(A, Y)$	$\{2\bar{A}_1\bar{Y}_1 - 2 \text{cov}(A_1, Y_1)\}\Delta \text{cov}(A, Y)\Delta\{\Delta \text{cov}(A, Y)\}^2$
Interaction between changes in mean export quantity and export price variance	$\Delta \bar{A}\Delta V(Y)$	$\{2\bar{A}_1\Delta\bar{A}\Delta(\Delta\bar{A})^2\}\Delta(Y)$
Interaction between changes in export price and export quantity variance	$\Delta \bar{Y}\Delta V(A)$	$\{2\bar{Y}_1\Delta\bar{Y}\Delta(\Delta\bar{Y})^2\}\Delta V(A)$
Interaction between changes in mean export quantity and export price and changes in export quantity export price covariance	$\Delta \bar{A} \Delta \bar{Y}$ $\Delta \text{cov}(A, Y)$	$(2\bar{A}_1\Delta\bar{Y}\Delta 2\bar{Y}_1\Delta\bar{A}\Delta 2\Delta\bar{A}\Delta\bar{Y})\Delta \text{cov}(A, Y)$
Change in residual	$\Delta R$	$\Delta V(A Y) - \text{Sum of the other components}$

$$\begin{aligned}
 &+ 2\bar{A}_1\bar{Y} \text{cov}(A_1, Y_1) + 2\bar{Y}_1\Delta\bar{A} \text{cov}(A_1, Y_1) + 2\Delta\bar{A}\Delta\bar{Y} \text{cov}(A_1, Y_1) \\
 &+ 2\bar{A}_1\bar{Y}_1\Delta \text{cov}(A, Y) + 2\bar{A}_1\Delta\bar{Y}\Delta \text{cov}(A, Y) + 2\bar{Y}\Delta\bar{A}\Delta \text{cov}(A, Y) \\
 &\quad + 2\Delta\bar{A}\Delta\bar{Y}\Delta \text{cov}(A, Y) - \{\text{cov}(A_1, Y_1)\}^2 - \{\Delta \text{cov}(A, Y)\}^2 \\
 &\quad - 2 \text{cov}(A_1, Y_1) \Delta \text{cov}(A, Y) + R_1 + \Delta R
 \end{aligned}$$

The change in variance of export value,  $\Delta V (EV)$  is then obtained by

$$\begin{aligned}
 \Delta V (EV) &= V (EV_2) - V (EV_1) \tag{22} \\
 &= \bar{A}^2V(Y_1) + 2\bar{A}_1\Delta\bar{A}V(Y_1) + \bar{A}_1^2\Delta V(Y) + \bar{A}^2\Delta V(Y) \\
 &= 2\bar{A}_1\Delta\bar{A}\Delta V(Y) + \bar{Y}^2\Delta V(A_1) + 2\bar{Y}_1\Delta\bar{Y}V(A_1) + \bar{Y}_1^2\Delta V(A) \\
 &\quad + \bar{Y}^2\Delta V(A) + 2\bar{Y}_1\Delta\bar{Y}V(A) + 2\bar{A}_1\Delta\bar{Y} \text{cov}(A_1, Y_1) \\
 &\quad + 2\bar{Y}_1\Delta\bar{Y} \text{cov}(A, Y) + 2\bar{Y}_1\Delta\bar{A}\Delta \text{cov}(A, Y) \\
 &\quad + 2\Delta\bar{A}\Delta\bar{Y}\Delta \text{cov}(A, Y) - \{\Delta \text{cov}(A, Y)\}^2 \\
 &\quad - 2 \text{cov}(A_1, Y_1) \Delta \text{cov}(A, Y) + \Delta R
 \end{aligned}$$

### Results and Discussion

#### Trend analysis in Export of Lime/Lemon and orange

The study calculates commodity-wise growth rates

(CGR) for orange and lime/lemon prices and quantities over three periods (2001-02 to 2010-11), (2011-12 to 2021-22), and (2001-02 to 2021-22), using exponential functions and individual outcomes for orange and lime/lemon. The following are the growth rate ranges provided by Das *et al.* (2016):

Low growth rate = between 0 to 5

Medium growth rate = greater than 5 and up to 10

High growth rate = greater than 10

#### Market-wise growth rates of lime/lemon

It can be observed from the results in Table 2 that the CGR of the Maldives during Period-I was found to be the highest positive in case of both export quantity (55.19%) and export value (56.85%) significant at the 1 percent level of significance, followed by Nepal (47.54%), UAE (36.19%), and other countries (29.44%) in terms of export quantity. Oman was the only one country in which a negative and significant growth rate was found in the case of export quantity (-28.50%) and export value (-25.43%) during Period-I. The reason for decreasing export may be due to the unavailability of requisite infrastructure facilities in production areas (Kashish *et al.*, 2017). In terms of value earned by lime/lemon export, The Maldives was observed to be the highest in growth

**Table 2 :** Market-wise growth rates of lime/lemon export from India.

S. no.	Export Market	Study Period					
		Period-I (2001-02 to 2010-11)		Period-II (2011-12 to 2021-22)		Period-III (2001-02 to 2021-22)	
		CGR (%)	SE	CGR (%)	SE	CGR (%)	SE
1	<b>United Arab Emirates</b>						
	Export Quantity	36.19***	0.4523	-9.32***	0.1729	3.85	0.7286
	Export Value	34.66***	0.3816	0.22	0.2430	14.26***	0.5532
2	<b>Nepal</b>						
	Export Quantity	47.54***	0.7849	16.84***	0.4649	19.21***	0.7635
	Export Value	55.55***	0.6543	15.09***	0.3725	28.13***	0.6911
3	<b>Saudi Arabia</b>						
	Export Quantity	17.60**	0.6133	-15.89*	0.6607	-1.32	0.8046
	Export Value	25.13***	0.6374	-12.46	0.7618	5.52	0.8820
4	<b>Oman</b>						
	Export Quantity	-28.50***	1.2168	32.07**	1.1834	-6.60**	1.5215
	Export Value	-25.43***	1.2651	44.84**	1.1031	1.52	1.5530
5	<b>Maldives</b>						
	Export Quantity	55.19***	0.7365	-28.54***	0.3938	2.23	1.3428
	Export Value	56.85***	0.6163	-21.65**	0.5330	15.33	1.2638
6	<b>Other Countries</b>						
	Export Quantity	29.44***	0.4678	12.42**	0.6337	9.67***	0.6555
	Export Value	25.42***	0.3361	24.11***	0.5373	21.48***	0.4401
7	<b>Overall export market</b>						
	Export Quantity	26.88***	0.2461	-1.61	0.1616	5.62**	0.4678
	Export Value	25.98***	0.2525	3.52	0.1911	13.83***	0.3759

Note: 1. \*, \*\* and \*\*\* indicate significance at 10 %, 5 % and 1% levels, respectively.

2. CGR- compound growth rate 3. SE- standard error.

4. Export quantity (tonnes) and export value (rs. lakh).

(56.85%) significant at 1 percent level of significance, followed by Nepal (55.55%), UAE (34.66%), and other countries (25.42%) during Period-I. Generally, growth in value is due to growth in quantity. A similar trend was also reported by Gondalia *et al.* (2017) in their study on the export of lime/lemon from India during the years 2007-08 to 2017-18.

The annual CGR of Oman during Period II were found to be the highest in the case of both export quantity (32.07%) as well as export value (44.84%), significant at the 1 and 5 percent level of significance, respectively, followed by Nepal (16.84%) and other countries (12.42%) in terms of export quantity. The Maldives, which was highest in Period-I showed a significantly declining growth trend during Period-II due to tough competition faced by Indian exporters in the international market and also may

be due to a significant increase in domestic production of lime and lemon (Kavita *et al.*, 2015). In the overall export market, the CGR was found to be negative in the case of export quantity (-1.61%), while in the case of export value (3.52%), it was found positive and non-significant during Period II.

During Period III, the CGR of Saudi Arabia and Oman both registered negative growth trends in the case of export quantity while positive growth trends in the case of export value. Among all the countries in Period III, Nepal observed the highest and most significant growth trends in the case of export quantity (19.21%) and export value (28.13%) at the 1 per cent level of significance, followed by other countries (9.67%) and UAE (3.85%) in terms of export quantity. In the overall export market, the compound growth rate of both export quantity (5.62%)

**Table 3.** Market-wise growth rates of orange export from India

S. no.	Export Market	Study Period					
		Period-I (2001-02 to 2010-11)		Period-II (2011-12 to 2021-22)		Period-III (2001-02 to 2021-22)	
		CGR (%)	SE	CGR (%)	SE	CGR (%)	SE
1	<b>Bangladesh</b>						
	Export Quantity	-7.79*	0.3004	18.00***	0.4573	5.46***	0.5372
	Export Value	-5.59*	0.2287	27.43	0.5359	13.28***	0.6188
2	<b>Nepal</b>						
	Export Quantity	23.06*	0.8923	27.82***	0.5261	20.33***	0.7044
	Export Value	21.38**	0.6747	25.63***	0.4367	28.46***	0.5509
3	<b>United Arab Emirates</b>						
	Export Quantity	-1.88	1.9704	45.74*	1.5972	27.47**	1.8024
	Export Value	-5.32	1.7443	49.49*	1.3448	34.86***	1.6647
4	<b>Oman</b>						
	Export Quantity	4.51	0.9555	-10.59	2.0171	1.52***	1.5559
	Export Value	-1.09	0.8204	10.34	1.4033	10.13***	1.1283
5	<b>Other Countries</b>						
	Export Quantity	3.55	1.3640	4.05	1.1490	4.59	1.1873
	Export Value	0.67	1.3716	16.58	0.9373	11.74*	1.1257
6	<b>Overall export market</b>						
	Export Quantity	-6.79	0.2950	18.71***	0.4219	6.43***	0.5162
	Export Value	-5.06***	0.1935	27.07***	0.4933	14.00***	0.5877

Note: 1. \*, \*\* and \*\*\* indicate significance at 10 %, 5 % and 1% levels, respectively.

2. CGR - compound growth rate 3. SE- standard error.4. export quantity (tonnes) and export value (rs. lakh).

and export value (13.83%) was found to be positive and significant at the 5 and 1 per cent level of significance, respectively, during Period III. A similar trend was reported by Kashish *et al.* (2017) in their study on production and trade performance of fruits in India during the years 1980-81 to 2013-14.

### Market-wise growth rates of orange

It can be observed from Table 3 that in Period-I, Nepal observed the highest CGR in the case of both export quantity (23.06%) and export value (21.38%), significant at 10 and 5 percent level of significance, respectively, followed by Oman (4.51%) and other countries (3.55%) in terms of export quantity. Among all the countries in Period-I, Bangladesh showed negative growth trends in terms of both export quantity (-7.79%) and export value (-5.59%), which were significant at the 10 percent level of significance. UAE and Oman showed non-significant growth trend in Period-I. Whereas in the case of the overall export market, the compound growth

rate was found to be non-significant in export quantity (-6.81%) and significant (-5.06%) for export value at the 10 percent level of significance. A similar trend was reported by Bharodia (2021) in their study on the export performance of fruits in India during the years 2000-01 to 2020-2021.

In UAE, during Period-II, highest positive growth trends was found in case of both export quantity (45.74%) and export value (49.49%) significant at 10 per cent level of significance. UAE has signed a Free Trade Agreement (FTA) under the Comprehensive Economic Partnership Agreement (CEPA) with India, which has opened duty-free access of Indian exporters to the UAE market. This will boost the export of citrus fruits and other agricultural and non-agricultural produce from India to the UAE. Bangladesh and Nepal showed positive and significant growth trend in case of export quantity during Period-II. For overall export market, the compound growth rate of both export quantity (18.71%) and export value (27.07%) were found to be positive and significant at 1 per cent

**Table 4 :** Market-wise instability analysis of lime/lemon export from India.

S. no.	Export Market	Study Period					
		Period-I (2001-02 to 2010-11)		Period-II (2011-12 to 2021-22)		Period-III (2001-02 to 2021-22)	
		CV (%)	CDV(%)	CV (%)	CDV(%)	CV (%)	CDV (%)
1	<b>United Arab Emirates</b>						
	Export Quantity	72.57	28.06	36.91	17.17	55.86	57.10*
	Export Value	79.02	35.47	22.85	24.08*	60.74	34.54
2	<b>Nepal</b>						
	Export Quantity	70.38	27.19	63.80	45.83	90.67	54.54
	Export Value	92.15	40.28	67.85	46.28	113.30	64.67
3	<b>Saudi Arabia</b>						
	Export Quantity	73.05	56.30	76.82	68.26	73.12	75.01*
	Export Value	86.50	57.04	88.83	89.12*	95.83	93.96*
4	<b>Oman</b>						
	Export Quantity	122.55	71.64	106.09	81.16	145.69	128.26
	Export Value	121.10	76.16	115.73	85.32	115.34	118.33*
5	<b>Maldives</b>						
	Export Quantity	113.77	62.47	125.06	80.59	118.08	121.13*
	Export Value	127.93	69.72	85.48	68.74	114.59	111.29*
6	<b>Other Countries</b>						
	Export Quantity	72.46	36.57	58.59	44.98	68.65	50.61
	Export Value	70.65	35.97	77.33	48.39	120.86	73.61
7	<b>Overall export market</b>						
	Export Quantity	64.70	23.10	16.15	15.88*	41.95	37.86
	Export Value	72.63	34.08	20.46	18.49*	61.25	24.34

Note: 1. CV- coefficient of variation (%), CDVI - cuddy della vella index (%),

2. \*- non significant

3. export quantity (tonnes) and export value (rs. lakh)

level of significance. The similar trend was also observed by Kadu *et.al.* (2021) in their study on export performance of orange from Indian during the year 2009-10 to 2018-2019.

In Period-III, UAE observed to be the highest positive growth trends in case of both export quantity (27.47%) as well as export value (34.86%) significant at 5 and 1 per cent level of significance, followed by Nepal (20.33%), other countries (4.59%) and Oman (1.52%) in terms of export quantity. In terms of value earned by orange export to UAE observed highest growth rate (34.86%) significant at 1 per cent level of significance, followed by Nepal (28.46%), Bangladesh (13.28%). In overall export market, the compound growth rate of both export quantity (6.43%) and export value (14.00%) were found positive and significant at 1 per cent level of

significance during the Period-III. The similar trend was observed by Shivagangavva *et al.* (2022) in their study on growth performance and export destination of Indian fruits during the year 2001-02 to 2015-16.

The growth rate of export in terms of quantity and value were found high, positive, and highly significant in Period -II (which are considered post -NHM Period) as compared to Period-I (which are considered pre-NHM Period) regimes (Table 3). This was may be due to impact of NHM. Because, after the NHM Period increase in production and productivity of horticultural crops, effective international export policy, better infrastructure facilities of storage, *etc.* So, the growth rate in terms of export quantity and export value were found increased during post-NHM over the pre-NHM.

### **Instability analysis in Export of Lime/Lemon and orange**

The study analyzes changes in export quantity and value of lime/lemon and orange in different Indian countries using the Cuddy Della Valle Index and coefficient of variation. The index de-trends the data series, providing direction. However, the coefficient of variation has limitations. The present study divides the CDV values into three categories Low instability (between 0 to 15); Medium instability (15 to 30); High instability (greater than 30) which represent the different range of instability (Sihmar, 2014).

The Cuddy-Della Valle index, calculated based on compound growth rate, is non-significant in countries with non-significant compound growth rates. In such cases, a coefficient of variation can be used instead, indicating no trend in the data (Tarpara *et al.*, 2018).

#### **Market-wise instability of lime/lemon**

During Period-I, the instability ranged in export quantity (23.10% to 71.64%) and export value (34.08% to 76.16%). The study observed that instability in the lime/lemon export of UAE and Nepal remained medium and Saudi Arabia, Oman, Maldives and other countries (export quantity) showed to be the higher range of instability. Both Saudi Arabia and Oman (export quantity and export value) remained more unstable market. In the overall export market, the instability range was medium in case of export quantity and high range. The result are in the line of Mokashi *et al.* (2014) in their study on export of Indian grapes during the year 1985-86 to 2010-11.

During the Period-II, the instability in export quantity (15.88% to 81.16%) and export value (18.49% to 89.12%). The pattern of instability of all countries was high in both export quantity and export value except UAE. UAE observed a declining trend in both export quantity and export value as compared to Period-I. The trend for instability in lime/lemon export in Nepal (export quantity) registered as an unstable country which, were noticed under medium unstable market during previous Period. The probable reason for the highest instability observed in Oman may be due to the fact that Oman has its own lime/lemon production. The variability of its own lime/lemon production directly reflected in India's lime/lemon export. In overall export market, the instability showed declining trend in Period-II as compared to Period-I.

During the Period-III, the instability in export quantity (37.86% to 128.26%) and export value (24.34 % to 118.33%). When compared with Period-I, export market becomes more unstable in Period-III. The pattern of

instability in Period-III, for all the countries showed to be the highest instability in case of both export quantity and export value. In overall export market the instability was at high range in case of export quantity and medium range in case of export value for all the countries. It was found that there was not a single country under the low instability category which is the most undesirable situation in Period-III (Table 4). The above finding is in line with Devi *et al.* (2019) on their study on performance and stability analysis of mango and mango pulp export from India during the year 1987-88 to 2016-17.

#### **Market-wise instability of orange**

During the Period-I, the instability in export quantity (32.58 % to 186.66 %) and export value (23.82% to 157.42 %). The higher range of instability in both export quantity and export value was found in Nepal, UAE, Oman and other countries. In terms of export value, Bangladesh is the only market which showed medium range of instability. It was found that, Oman, UAE and other countries were the highly unstable market for export of orange. Overall export market, the instability showed that high measures in case of export quantity and medium measures in case of export value. The similar instability trend was reported by Bharodia (2021) on their study on export of fresh fruit from India during the year 2000-01 to 2020-21.

During the Period-II, the instability in export quantity (31.67 % to 103.85 %) and export value (29.20 % to 89.39 %). The pattern of instability of all countries shows to high instability in both export quantity and export value except Nepal. UAE observed a declining trend in both export quantity and export value as compared to Period-I. The trend of instability in orange export in UAE and Oman in terms of export quantity as well as export value registered to be highly unstable.

During the Period-III, the instability in export quantity (59.33% to 123.81%) and export value (63.78% to 124.92%). As compared with Period-I and Period-II, export market becomes more unstable in Period-III. All countries showed to be the high range of instability in case of both export quantity as well as export value. In Overall export market, the instability was at high range for both, export quantity and export value. The reasons for high instability might be inconsistent domestic production, consumption and international demand. The above finding is in line with Geetha and Srivastava (2018) on their study on export of maize from India during the year 1981-82 to 2016-17.

The WTO's establishment led to high instability in lime/lemon and orange exports due to increased competition and trade liberalization, resulting in higher



**Table 5 :** Market-wise instability analysis of orange export from India.

S. no.	Export Market	Study Period					
		Period-I (2001-02 to 2010-11)		Period-II (2011-12 to 2021-22)		Period-III (2001-02 to 2021-22)	
		CV (%)	CDV(%)	CV (%)	CDV(%)	CV (%)	CDV (%)
1	<b>Bangladesh</b>						
	Export Quantity	39.32	34.27	69.69	43.43	74.80	60.96
	Export Value	31.71	27.68	86.55	46.10*	121.21	82.77
2	<b>Nepal</b>						
	Export Quantity	57.30	49.43	68.56	31.67	108.15	59.75
	Export Value	65.92	53.33	68.30	29.20	123.20	63.78
3	<b>Oman</b>						
	Export Quantity	67.51	70.90*	83.90	83.19*	94.36	84.49
	Export Value	60.93	64.39*	94.86	89.39*	126.71	105.26
4	<b>United Arab Emirates</b>						
	Export Quantity	175.98	186.66*	105.95	90.39	157.61	123.81
	Export Value	148.97	157.42*	103.44	87.64	164.14	124.92
5	<b>Other Countries</b>						
	Export Quantity	97.23	102.21*	99.03	103.85*	99.52	101.49*
	Export Value	141.26	143.93*	86.66	86.54*	109.23	103.63
6	<b>Overall export market</b>						
	Export Quantity	36.31	32.58*	68.16	40.17	76.91	59.33
	Export Value	27.61	23.82	83.02	42.24	119.59	78.88

Note: 1. CV- coefficient of variation (%), CDVI - cuddly della vella index (%),

2. \*- non significant

3. Export quantity (tonnes) and export value (rs. lakh)

availability of quality products at lower prices, thereby boosting international trade. This is in the line with Vasavada *et al.* (2021) in their study on export performance and direction of trade of major vegetable products from India during the year 1996-97 to 2019-20.

### **Risk assessment of Indian lime/lemon and orange export**

The study identifies four export categories: 1) high growth rate and low risk, 2) low growth rate and low risk, 3) low growth rate and high risk 4) high growth rate and high risk. The high growth rate and low risk category is highly preferable due to its higher growth rate over instability index. The study found no countries in the lime/lemon and orange export categories, suggesting a need for more efforts to shift countries from less desirable categories to those with high growth. While high growth rate and high risk category is preferable based on the greater ness of growth rate over instability index. Low

growth rate and low risk category is less preferable. Low growth rate and high risk category is not preferable at all. In both lime/lemon and orange most of the countries came under this category in terms of export quantity and export value. Strategies to increase growth rate and reduce instability are required to overcome this unusual situation.

### **Sources of Growth and Variability in Lime/Lemon and Orange Exports**

#### **Components of change in average export value in lime/lemon**

The study examined the changes in lime/lemon export value based on changes in mean export quantity and mean export unit value. The results showed that the increase in mean export quantity was the most significant contributor, accounting for 38.0% of the average export value during Period-I. The changes in the covariance between the mean export quantity and mean export price

**Table 6 :** Growth rate v/s instability of lime/lemon exports.

S. no.	Criteria	Export Quantity(MT)	Export Value(Rs. Lakh)
1	High growth rate and low risk	-	-
2	High growth rate and high risk	Nepal	UAE, Nepal, Maldives, other countries
3	Low growth rate and low risk	-	-
4	Low growth rate and high risk	UAE, Saudi Arabia, Oman, Maldives and other	Saudi Arabia, Oman

**Table 7 :** Growth rate v/s instability of orange exports.

S. no.	Criteria	Export Quantity(MT)	Export Value(Rs. Lakh)
1	High growth rate and low risk	-	-
2	High growth rate and high risk	Nepal, UAE	Bangladesh, Nepal, UAE, Oman, Maldives, other countries
3	Low growth rate and low risk	-	-
4	Low growth rate and high risk	Bangladesh, Oman, other countries	-

**Table 8 :** Decomposition analysis of the components of change in average export value of lime/lemon (In percent).

Period	Change in mean export quantity	Change in mean export price	Change in mean export quantity and mean export price covariance	Interaction between changes in mean export quantity and mean export price covariance	Residual	Total
Period-I (2001-02 to 2010-11)	38.00	30.51	20.79	0.74	9.96	100
Period-II (2011-12 to 2021-22)	88.49	229.45	-223.39	6.32	-0.87	100

accounted for 20.79 per cent increase in the mean export value. However, the interaction effect only benefited the export value to a small extent (0.74%) from both mean export quantity and price.

In Period-II, the variation in average export value was primarily due to changes in mean export price (229.45%), change in mean export quantity (84.49%), interaction between changes in quantity and price (6.32%) and change in export quantity-export price covariance (-223.39%). The contribution of residuals in average export values are 9.96 per cent and -0.87 per cent for Period-I and Period-II, respectively. The findings are line with Krishnadas (2010) in his study on chilli in Dharwad.

#### **Components of change in variance of export value in lime/lemon**

The change in the variability of export price accounted for 128.38 per cent in the variance of export value. The change in the covariance between mean export quantity and export price was -133.48 per cent showing the variability effect of both the mean export quantity and

mean export price. Due to change in co-variance, there was increased the instability of export value variance (0.06%) to a certain extent.

The effect of interaction term was also important in determining the stability of the export value and when added together contributed -267.02 per cent of the increase in the variance of total export value. The interaction term arise in part from the change in mean export price and export quantity covariance had induced a change in the behavior of the exporters, which affected the mean or variance of the export quantity and led to the instability of export value. Change in residuals contributed 314.77 per cent for the increment in variance of export.

Thus, it may be concluded that in case of lime/lemon, the change in mean export value was mainly contributed by change in mean export quantity, interaction between changes in mean export quantity and export price and changes in export quantity-export price covariance, change in export quantity-export price covariance and

**Table 9** : Decomposition analysis of the components of change in variance of export value of lime/lemon (In percent).

Change in mean export price	$\Delta \bar{Y}$	128.38
Change in mean export quantity	$\Delta \bar{A}$	26.52
Change in export price variance	$\Delta V(Y)$	0.06
Change in export quantity variance	$\Delta V(A)$	23.46
Interaction between changes in mean export price and mean export quantity	$\Delta \bar{A} \Delta \bar{Y}$	7.20
Change in export quantity-export price covariance	$\Delta cov(AY)$	-133.48
Interaction between changes in mean export quantity and export price variance	$\Delta \bar{A} \Delta V(Y)$	0.04
Interaction between changes in export price and export quantity variance	$\Delta \bar{Y} \Delta V(A)$	0.07
Interaction between changes in mean export quantity and export price and changes in export quantity-export price covariance	$\Delta \bar{A} \Delta \bar{Y}$ $\Delta cov(A)$	-267.02
Change in residual	$\Delta R$	314.77
<b>Total</b>		<b>100</b>

**Table 10** : Decomposition analysis of the components of change in average export value of orange (In percent).

Period	Change in mean export quantity	Change in mean export price	Change in mean export quantity and mean export price covariance	Interaction between changes in mean export quantity and mean export price covariance	Residual	Total
<b>Period-I (2001-02 to 2010-11)</b>	152.59	59.69	-95.97	2.97	-19.28	100
<b>Period-II (2011-12 to 2021-22)</b>	79.62	15.04	1.89	1.23	6.00	100

change in residual *etc.* On the contrary, the negative change in export quantity–export price covariance, and interaction between changes in mean export quantity and export price and changes in export quantity-export price covariance for the reduction in variance of export. Similar findings were attributed by Vedprakash (2018) in his study on agricultural production in India.

#### **Components of change in average export value in orange**

During Period-I, the change in mean export quantity (152.59%) was the most significant contributor, followed by change in mean export price (59.69%). This was expected due to higher growth rates in export quantity. The covariance between mean export quantity and price decreased by 95.97 per cent, possibly due to variations in export quantity and price variance.

The study found that the export value was influenced by both mean export quantity and price by 2.97% in

Period-I. The highest variation in average export value was due to changes in mean export quantity (79.62%) in Period-II, followed by changes in mean export price (15.04%) and the interaction between changes (1.23%). The covariance between changes in export quantity and price had a smaller positive effect (1.89%). The contribution of residuals in average export values are -19.28 and 6.00 per cent for Period-I and Period-II, respectively. The findings are line with Joshi *et al.* (2015) in his study on export of black paper from India.

#### **Components of change in variance of export value in orange**

The variability of export quantity significantly influenced the variance of export value, accounting for 66.27% of the variance. The covariance between mean export quantity and export price decreased by -0.25%, indicating a stabilizing effect among other change components.

**Table 11** : Decomposition analysis of the components of change in variance of export value of orange (in percent).

Change in mean export price	$\Delta \bar{Y}$	0.28
Change in mean export quantity	$\Delta \bar{A}$	66.27
Change in export price variance	$\Delta V(Y)$	0.00
Change in export quantity variance	$\Delta V(A)$	0.81
Interaction between changes in mean export price and mean export quantity	$\Delta \bar{A} \Delta \bar{Y}$	-2.42
Change in export quantity-export price covariance	$\Delta \text{cov}(AY)$	-0.25
Interaction between changes in mean export quantity and export price variance	$\Delta \bar{A} \Delta V(Y)$	0.01
Interaction between changes in export price and export quantity variance	$\Delta \bar{Y} \Delta V(A)$	0.01
Interaction between changes in mean export quantity and export price and changes in export quantity-export price covariance	$\Delta \bar{A} \Delta \bar{Y}$ $\Delta \text{cov}(A)$	-1.79
Change in residual	$\Delta R$	37.08
<b>Total</b>		100

The effect of interaction term was also important in determining the stability of the export value and when added together contributed -1.79 per cent of the increase in the variance of total export value. The interaction term arise from the change in mean export price and export quantity covariance and had induced a change in the behavior of the exporters, which affected the mean or variance of the export quantity and led to the instability of export value. Change in residuals contributed positively (37.08%) for the increment in variance of export.

The change in mean export value for orange is primarily influenced by the change in mean export quantity. Conversely, the negative change in export quantity-export price covariance and the interaction between changes in mean export quantity and export price contribute to the reduction in export variance. Similar findings were attributed by Devi (2019) in her study on decomposition analysis for the components change in the variance of export value of fresh mango and mango pulp.

### Conclusion

The study reveals that all countries experienced growth rates in export quantity and value of lime/lemon and orange, except Oman during Period-I. Oman experienced negative growth rates due to unavailability of infrastructure facilities in production areas. In contrast, Nepal and Bangladesh experienced positive growth rates in orange exports during Period-II. However, the overall trend in fresh lime/lemon export was lower in Period-II, indicating a lower quantity and increased export value. The main hurdle to lime/lemon export was quality, which

could have been maintained if quality had been maintained. The overall trend in fresh orange export was higher in Period-II, indicating a higher quantity and increased export value. This could be attributed to the impact of the National Horticultural Mission, effective international export policy, and better storage infrastructure. During Period-I, UAE and Nepal had medium stable markets for lime/lemon, while no single nation registered in medium stable markets during Period-III. Bangladesh had a medium instability index for orange exports in Period-I, while Nepal showed medium instability in export value. The analysis of growth rates in lime/lemon and orange exports reveals no standard in quality and international market demand. Stability in exports is higher for both exports. More efforts to improve quantity through scientific pre-harvest and post-harvest packages and government provision of cold storage and infrastructure facilities are needed to stabilize exports.

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