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REVEALED COMPARATIVE ADVANTAGE (RCA) AND ITS APPLICATION TO EVALUATE INDIA'S PERFORMANCE OF FRESH MANGOES, MANGOSTEEN & GUAVAS DURING THE PERIOD 1991-2020: AN ANALYSIS WITH RESPECT TO TRADE

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ABSTRACT
The international market for fresh fruits and vegetables is truly humongous. And, with countries in Asia experiencing significant addition in the purchasing power of their middle classes, the demand for these, as well as for a host of other agricultural products, is sure to rise exponentially in the future too. From India's point of view, what makes the prospect even more attractive is the fact, that there aren't too many countries with the production capacity to meet this ever-expanding demand. Fresh Mangoes, Mangosteens & Guavas represent a particularly promising sub-segment in the larger fresh fruits & vegetables space. In this paper, an attempt has been made to study the production and export performance of India for these products during the period 1991-2020. Data available in the public domain depicts India as a very large producer of most of the tropical fruits, but proportionately not such a large exporter. This dichotomy has baffled many experts and policy makers for quite some time. In this working paper, an attempt has been made not just to trace the trajectory of India as a producer and as an exporter, but also to analyze the factors that have a bearing on the production of these commodities in India, and export of the same from India. As analytical tools to aid the study, statistical measures such as CAGR, RCA, RSCA, time series method (TSM), correlation & regression, standard deviation, mean and coefficient of deviation have been used in this study to derive meaning out of the various disparate data elements. Finally, this study also tries to identify the areas of weaknesses that require urgent remedial steps. And, the study also makes a few key recommendations to improve India's performance as a producer and exporter of the two commodities.

Keywords: *CAGR, Productivity, Production, Export, Revealed Comparative Advantage (RCA), Revealed symmetric comparative advantage (RSCA), forecasting, constraints*

Introduction

In so far as the origin of the 'king of fruits'[1] is concerned, there are various conjectures. While some believe it originated in the Indo-Burmese[2] plains, others believe that it originated right here in India[3,] around 4000 years

[1] http://nhb.gov.in/report_files/mango/mango.htm
[2] https://indiaagronet.com/indiaagronet/crop%20info/Mango.htm#1
[3] https://dpi.wi.gov/sites/default/files/imce/school-nutrition/pdf/fact-sheet-mango.pdf

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ago. Guava on the other hand is believed to have originated in tropical America[4], where it grows as a wild fruit, even today. According to some accounts, it was introduced in India in the 17th Century.

Interestingly, as far as the question of origin of guavas is concerned, there are fascinating hints in linguistics. Etymologically speaking, the word 'guava' is believed to have come from Spanish word 'guaya', a variant of 'guayaba'[5]. The Spanish 'guyaba' in turn is believed to have come from Arawakan (West Indies) 'guayabo'. The world 'guajava', found in Tupi[6] language, is believed by some linguists to be the real source behind the Spanish 'guayaba'.

In India, mangoes are grown mainly in tropical and subtropical regions, which is basically the whole of India except for the mountains and the deserts. Indian mangoes are harvested around February/early March, when the cold weather begins to make way for the summer. Every year, the crop faces the risk of severe damage from frost bites, a very real possibility during the cold winters that grip north and north-west India every year.

Like mango, Guava too is grown in tropical as well as sub-tropical regions. Compared to many other tropical fruits, guava is much more resistant to drought, and is also suitable for a host of soil types. This partly explains why it is grown on such a large scale, in so many different countries of the world, and in so many different states in India. In India, Uttar Pradesh, Bihar, West Bengal, Maharashtra, Chhattisgarh, Tamil Nadu, Karnataka, Madhya Pradesh, Gujarat and Andhra Pradesh are the leading producers of the fruit. Allahabad Safeda, Lucknow-49, Chittidar, Nagpur Seedless, Banglore, Dharwar, Akra Mridula, Arka Amulya, Harijha, Hafshi, Allahabad Surkha CISH-G1, CISH-G2, CISH-G3 etc. (NHB Database-2009) are the main varieties of guava cultivated in India.

Table 1: Production of GUAVA in India

Production ('000 Tonnes)			
		2021-22	
Sr No.	State	Production	Share (%)
1	Uttar Pradesh	983.59	21.78
2	Madhya Pradesh	776.75	17.2
3	Bihar	434.41	9.62
4	Andhra Pradesh	335.11	7.42
5	Haryana	271.18	6
6	Punjab	219.85	4.87
7	West Bengal	203.56	4.51
8	Chattisgarh	187.04	4.14
9	Gujarat	175.33	3.88
10	Karnataka	167.48	3.71
	Total production	3754.3	

*Source: National Horticulture Board (NHB), *2021-22 (1st Adv. Estimate)*

Mango cultivation is extensively practiced in well over 90 countries. Asia's share in total global output of the fruit amounts to almost 77%, tropical America pitches in with a 13% share, and the African region contributes around 9% (FAOSTAT 2007) to the combined global output.

India is home to nearly 1,000 cultivars or varieties of mango. However, out of these, only around 30 are used extensively in commercial farming (Anon., 2003). In line with the trend of regional diversity in all kinds of agricultural produce, every major geographic region of India has its own varieties, ones that are grown mostly in those regions alone. The following table gives the names of the important commercial varieties and the provinces in India where they are grown on a large scale.

Table 2: States of India and the mango cultivars grown there

States	Varieties
Andhra Pradesh	Banganapalli, Suvarnarekha, Neelum and Totapuri
Bihar	Chausa, Kishen Bhog, Dashehari, Fazli, Himsagar, Zardalu, Gulabkhas, Langra and Bombay Green

[4] http://nhb.gov.in/model-project-reports/Horticulture%20Crops/Guava/Guava1.htm#:~:text=Guava%20is%20mostly%20grown%20under,days%20by%20the%20ring%20method.&text=Drip%20irrigation%20has%20proved%20to%20be%20very%20beneficial%20for%20guava.
[5] https://hort.purdue.edu/newcrop/morton/guava.html
[6] https://www.collinsdictionary.com/dictionary/english/tupi

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Gujarat	Kesar, Alphonso, Rajapuri, Jamadar, Totapuri, Neelum, Dashehari and Langra
Haryana	Chausa, Dashehari, Langra and Fazli
Himachal Pradesh	Chausa, Dashehari and Langra
Karnataka	Alphonso, Totapuri, Banganapalli, Pairi, Neelum and Mulgoa
Madhya Pradesh	Dashehari, Fazli, Langra, Neelum, Alphonso and Bombay Green
Maharashtra	Alphonso, Kesar and Pairi
Punjab	Chausa, Dashehari and Malda
Rajasthan	Bombay Green, Chausa, Dashehari and Langra
Tamil Nadu	Alphonso, Totapuri, Banganapalli and Neelum
Uttar Pradesh	Bombay Green, Chausa, Dashehari and Langra
West Bengal	Gulabkhas, Kishenbhog, Alphonso, Bombay Green, Himsagar, Dashehari, Fazli, Langra and Neelum

Source: agriexchange.apeda.gov.in

Again, just as the soil and climatic conditions in some countries are more suited to cultivation of specific types of crops, and just as individual states of India enjoy comparative advantage in cultivation of specific crops, within the individual states too, there are regions that are better suited for mango cultivation. Hence, within the mango growing states, there is a much greater concentration of mango cultivation in those parts that are better suited to cultivation of mango, than the other regions of the same state. Table below shows regions within each of the major mango growing states of India, and the regions in those states that have much more intense cultivation of the fruit.

Table 3: Concentrated pockets of mango in mango growing states

State	Districts
Andhra Pradesh	Krishna, Vizianagaram, WestGodavari, Visakahapatnam, East Godavari, SrikakamKhammam, Nalgonada, Karimnagar, Warangal, Mahaboobnagar, Chittoor, Cuddapah, Nellore, Prakasam
Karnataka	Kolar, Bangalore, Tumkur, Chitradurga, Mysore, Hassan, Mandya, Chickmagalur
Gujarat	Valsad, Navsari, Surat, Vadodara, Bharuch Junagadh, Amreli, Bhavnagar,
Uttar Pradesh	Lucknow, Sultanpur, Sitapur, Unnao, Hardoi, Barabanki, Faizabad, Saharanpur, Bulandshahar, Meerut, Muzaffarnagar, Bijnor, Moradabad, Deoria, Basti, Maharajganj, Kabir Nagar, Gorakhpur, Kushi Nagar
Maharashtra	Ratnagiri, Sindhudurg, Raigarh, Satara, Sangli, Kolhapur, Latur, Nasik, Beed, Akola, Jalna, Ahmednagar, Buldhana, Osmanabad
Tamil Nadu	Teni , Dharmapuri, Salem, Tirunelveli.

Source: agriexchange.apeda.gov.in

Most of the Indian mango cultivars have specific eco-geographical requirements for optimum growth and fruiting/yield. Perhaps that is one of the reasons why there is such a strong geographical identification associated with almost every variety of mango.

Mango fruits mature in 3–4 months. During this period, beginning with the stage of being just a whitish green flower, the crop metamorphoses into a green fruit with a very tangy taste. With the passage of time, the color of the fruit changes from dark green, either to light green, or to yellow, or to a reddish tinge at time of full maturity. Just as different varieties have different tastes and texture, there is wide difference in the cropping/maturity cycle too. For example, Alphonso, a cultivar native to western region, is an early season variety, and comes to the market by mid-February or latest by March. And, having arrived in the market by Feb/March, this cultivar, Alphonso, rules the market all the way up to April/May.

On the other hand, mango cultivars like Chausa, Dashehari and Langra, that are grown in norther states enter the market in April, and their season lasts until July/August. Harvesting normally starts after the first few newly ripened fruits drop to the ground. These varieties appear in the market early in May, and form the mainstay of the fruit market until August/September.

Table 4: Arrival Pattern of main mango Varieties in the market:

S.No.	States	Season of availability	Important cultivars
1	Andhra Pradesh	Mid Feb. - mid July	Banganpalli, Totapuri, Suvarnrekha,Neelum
2	Gujarat	April - July	Alphonso, Kesar,Rajapuri
3	Karnataka	April – July	Banganpalli, Totapuri,Neelum,Alphonso,Pairi
4	Maharashtra	March – July	Alphonso, Kesar,Pairi

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5	Uttar Pradesh	May - August	Bombay Green, Dashehri,Langra,Chausa,Amrapali

Source: Indian Horticulture Database, 2006

Production of Mangoes, Mangosteens and Guavas – World & India:

In general, the total acreage dedicated to the production of fruits and vegetables has been growing consistently over the years. This is not to say that there are no fluctuations. Depending upon the seasonal variations in prices being offered by the market, or upon other factors like timely availability of inputs, the total land dedicated to orchard, or for that matter any type of farming, does change from one cropping season to the next. However, when we take the average over a longer period of time, these fluctuations get evened out, and the decisions of the farmers, over such longer durations, tend to be governed by more lasting factors, such as long-term prices, long-term demand, availability of key inputs over the long-term etc.

Depending upon changing tastes of consumers, prices of individual varieties fluctuate in the short to medium term. But, in view of factors such as demographics and pace of economic development in countries like India, not only is the total number of consumers in the market rising, the disposable income of those consumers is rising at an even faster pace. As a result, the total size of the market for fresh fruits & vegetables has been undergoing a period of dramatic expansion. And, as we know, the supply side of the market, being programmed to respond to forces of demand and supply, responds to such secular increase in demand by seeking to increase production. This translates, at one level, into greater reliance on technology, at another level, it also manifests into increased acreage.

Thus, overall, the seasonal fluctuations in acreage notwithstanding, in so far as the overall fruits & vegetables category is concerned, the total area under cultivation has been expanding consistently.

Table 5: Various Crops, Acreage and Production in India

Crops	2019-20		2020-21		2021-22	
	(Final)		(Final Estimate)		Estimated	
Fruits	Acreage	Production	Acreage	Production	Acreage	Production
Grapes	150	3,181	155	3,358	162	3,490
Guava	292	4,361	308	4,582	307	4,516
Jackfruit	187	1,739	188	1,893	187	1,877
Litchi	97	726	98	720	98	724
Mango	2,294	20,317	2,317	20,386	2,339	20,336
Papaya	142	5,780	146	5,540	149	5,744
Pomegranate	283	3,186	288	3,271	282	3,216
Watermelon	116	3,157	119	3,254	120	3,225
Total - Fruits	6,774	1,02,080	6,930	1,02,481	6,967	1,02,924
Vegetables	10,310	1,88,284	10,859	2,00,445	11,065	1,99,882
Medicinal	641	734	653	825	650	767
Flowers	323	3,000	322	2,980	267	2,886
Plantation	4,143	16,116	4,255	16,629	4,271	15,852
Spices	4,291	10,137	4,457	11,117	4,344	10,816
Total	26,482	3,20,471	27,476	3,34,603	27,563	3,33,251

Source: https://agricoop.nic.in

Useful information derived from the table above:

- Around 1.11% of the total acreage used for horticulture is used to grow guavas
- Around 8.49% of the total acreage used for horticulture is used to grow mangoes.
- Mangoes consume around 33.57% of the total land dedicated to cultivation of fruits.
- Fruits constitute around 25.28% of the total land area utilized by the horticulture sector.
- Fruits & vegetables taken together, consume around 65.42% of the total land area under horticulture.

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Among the countries that have a sizeable mango cultivation economy, India has the richest collection of mango cultivars. As shown in table 2 above, almost all states in India have their own varieties, which grow best only in the climatic conditions found in the respective states. Mango cultivation is pretty wide spread in India. But, the major mango growing states are U.P, Bihar, Andhra Pradesh, Orissa, West Bengal, Maharashtra, Gujarat, Karnataka, Kerala and Tamil Nadu (NHB Database-2009).

Table 6: Major Mango and Guava growing countries of the world

Country	Production (Tons)	Acreage (in Hectares)	Yield (Kg/Hectare)
India	18.779.000	2.237.000	8.394,7
China	4.771.038	586.027	8.141,3
Thailand	3.432.129	410.694	8.356,9
Mexico	2.197.313	206.423	10.644,7
Indonesia	2.184.399	167.785	13.019
Pakistan	1.606.091	167.743	9.574,7
Brazil	1.417.149	78.961	17.947,5
Egypt	1.277.008	113.055	11.295,4
Bangladesh	1.161.685	153.088	7.588,3
Nigeria	917.617	133.572	6.869,8
Philippines	827.075	195.958	4.220,7

(Source: www.atlasbig.com)

A careful examination of the information contained in Tables 1, 2, 3, 4, 5 & 6 reveals that India has a very large and diversified production capacity for mangoes and guavas. And, unlike many other mango growing countries, India is also home to a large number of cultivars of the fruit. However, as one can see from Table 7, 8 & 9, when seen in the light of its total production, India has not been able to place as much part of its total production into the world market, as it should have, given the exportable volume that comes into India's inventory each year. Not just that, as seen from the table below, even the consistency of performance has been missing from India's export performance in world market for mangoes and mango-based products.

Table 7: India's Mango Export In Last 5 Years

Mango Export	2015-16	2016-17	2017-18	2018-19	2019-20
(US$ million)	50	67	59	60	56
Growth (%)	-	34	-12	2	-7

(Source: Agriexchange-APEDA)

Out of 10 million tonnes, only around 40,000 tonnes of the mangoes grown in India are exported, accounting for about 0.4% of production. Other major producers of mango are China, Mexico, Thailand, Indonesia, Pakistan, Philippines, Nigeria, Brazil, Peru, Australia, South Africa, Malaysia and Venezuela (R.N. Hegde, 2006).

Export of Mangoes, Mangosteens & Guavas from India:

As has been noted in table 2, 3 and 4, India is home to a large number of mango cultivars. However, due to various reasons, India has so far not been able to build a stable market for all of her cultivars in major mango importing nations. Out of the reasons that have held back India's progress thus far, some, such as logistical reasons, are internal to India, while some, such as tastes & preferences of the consumers in foreign countries, are external. Among the varieties that are exported from India, Alphonso, Kesar, Bangarpalli, Totapari, and Chausa have found the highest traction among overseas consumers.

It must be noted that, when it comes to exporting, mangoes are exported either in the form of fresh fruits, or in the form of pulp, or as slices of the fruit. Another form in which mango is exported is in the form of processed food such as jelly, cream, frozen mango, mango cream etc. As can be seen from table 8 below, major export destinations for India's mangoes are UAE (~51%), Bangladesh (~19%), UK (~8%), Saudi Arabia (~6%). United States on the other hand, accounts for just over 1% of the total exports of the fruit from India.

Table 8: India's Export of Mango to top 10 Countries

	2009-10		2010-11		2011-12		Qty growth in % over 2010-11	% share in 2011-12
	Qty	Value	Qty	Value	Qty	Value		
United Arab Emirates	25,608.15	10,382.97	25,725.00	10,066.87	22,013.88	10,736.68	-14.43	51.19
Bangladesh	33,549.90	3,295.82	23,049.69	1,859.43	27,599.48	4,058.91	19.74	19.35

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United Kingdom	2,958.65	1,746.88	2,723.54	1,453.81	2,532.42	1,641.64	-7.02	7.83
Saudi Arabia	3,147.13	1,345.40	1,592.18	617.99	2,388.63	1,169.70	50.02	5.58
Nepal	4,058.15	378.63	1,991.26	209.58	3,925.74	671.42	97.15	3.2
Kuwait	804.15	520.09	580.29	377.79	731.24	539.7	26.01	2.57
Singapore	367.58	190.28	387.81	206.04	599.27	358.11	54.53	1.71
Qatar	659.02	512.78	374.97	199.05	816.1	328.76	117.64	1.57
Bahrain	1,238.49	402.33	980.66	355.42	623.69	289.95	-36.4	1.38
United States	175.4	256.58	136.7	193.94	353.18	221.29	158.36	1.06
Total Mango Export	74,460.63	20,053.96	59,220.78	16,292.13	63,441.27	20,974.29	7.13	100

Source: DGCIS, Government of India

Constraints in Production and Export of Mangoes, Mangosteens & Guavas:

India continues to be an absent, or at best a marginal player in most of the leading export markets for fresh fruits. This fact can also be noticed in table 8 above, where one can see that in markets like USA, Japan, EU, Australia, South Korea etc, India has a very small share of the market for fresh fruits. Those markets are currently served by growers from elsewhere. There are a host of reasons behind India's lackluster performance in these markets.

The list of problems starts from the farm itself. Indian farmers do not have access to high quality farming techniques that could play a critical role, not just in enhancing the productivity of the farms, but also in improving the quality of the output. In the absence of access to high quality seeds / saplings, Indian farmers often suffer either due to lower yield or in the form of a yield of inferior quality, or quite often both. In addition, they also face other problems such as lack of access to scientific methods of irrigation, provisioning of plant nutrients, climate control, weed & pest control and lack of timely access to credit to enable the farmers hire staff and machinery to complete the harvesting in a scientific and timely manner.

Among other reasons, one could count factors like weak linkages with buyers/ consumers in importing countries, inadequate transport infrastructure within India to efficiently source the fruits from the farms, especially in the hinterland, and bring those to ports in a cost-competitive manner, lack of adequate storage and refrigeration facilities, both during transit as well as at the point of origin, cumbersome export related paperwork, lack of awareness about the quality standards expected in the leading markets, lack of infrastructure to perform procedures like irradiation, that are required by the customs authorities in markets like USA and EU etc.

Another very important reason that is hampering India's ability to convert its massive production into export numbers, is the lack of adequate food processing capability within India. Without an efficient food processing industry, India is always under pressure to find buyers at the earliest, since not being able to do so results in wilting of the fruit. Often, due to the extreme urgency to find buyers, Indian exporters are not able to properly negotiate for prices. In addition, it is through food processing that raw fruits are converted to high value commodities like jams, jellies, cream, wine, ice cream etc. As a result of India's inability to convert its fruits into high value processed foods, very often other countries import the same fruit, process it and then export it as high value goods.

In this age of internet-enabled, hyper-connected world, farmers in advanced countries have started the practice of entering into forward contracts with buyers to ensure remunerative prices for their products. It not only eliminates pricing related uncertainties, but also helps the farmer plan his expenses keeping in mind the prices that he/she is going to get. In India such advanced synchronization with the markets does not exist at the level of the farm. As a result, Indian farmer is always at the mercy of the vagaries of the market.

Review of Literature:

For this research paper, various research journals, papers and articles were reviewed. The inputs generated by this literature review forms the scaffolding on which the entire logical edifice of this paper has been constructed. Some of the most important works that the authors of this paper reviewed in this context are as follows:

1. Negi, (2000): The author states that in India, mangoes are grown in tropical and subtropical regions, ranging from areas like Konkan that are very near to the sea level, to areas that rise to an altitude of 1500 meters. However, the cultivation is practiced on a commercial scale largely in areas situated at up to 600 meters of altitude. These are areas, where, at least during the flowering to maturity period of the crop, the temperature rarely goes below 0ºC. In fact, in these areas, during the entire cultivation season, the temperature hovers around 27ºC-30ºC mark, the ideal heat band required for proper growth of the crop.

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2. Anitha Gomathi Krishnan, Tapan Kumar Nailwal, Alok Shukla, Ramesh Chandra Pant (2009): The authors have highlighted the universal appeal of Mango (Mangifera indica L.). They have also underscored the appeal of the fruit, from a nutritional as well as from a commercial point of view, especially for the tropical and subtropical areas of the world.
3. G.P. Gandhi (2006): Mr. Gandhi has highlighted the role of improving standards of infrastructure, and of incorporation of superior technology at all levels of the value chain. He says that it is because of such improvements that today the Indian mangoes can be transported in a much more efficient manner to large parts of the globe. He also notes that due to this improving ease of sourcing from India, importers are in a position to stagger their orders over a longer period of time, thus enabling them to serve their consumers over a much longer period of time, as well as achieving superior utilization of their financial resources.
4. PFID-FV[7] Report (2001): As per this report, India is by far the largest producer of mangoes in the world. Mexico and Brazil are the largest producers in the Americas. Thailand, Pakistan and the Philippines are the largest Asian producers (after India). Nigeria is Africa's largest mango producer. In the US, mangoes are grown in Florida, Hawaii and California.
5. G.M. Naidu, G.R. Naidu (2010): Here, the authors have noted that India is the leading producer of mangoes in the world, accounting for more than 50 percent of global mango production. For the majority of farmers in India, mangoes, in addition to being a popular fruit, are also an important cash crop. India's mangoes are unique in taste and aroma, and, with more than one thousand varieties, India offers a product diversity like no other country. The authors have also highlighted the problem posed by lack of adequate storage and processing facilities in India. They have underscored the fact that due to the lack of this type of infrastructure, nearly 15 percent of India's mango production is lost due to wastage.
6. Edward A. Evans (2008) found that mango is cultivated in over 90 countries. While only a small fraction of the total mango production enters international trade (less than 4%), the volume traded has risen substantially over the last decade. Among the factors responsible for increased mango production, trade, and consumption are lower prices, year-round availability, fewer trade barriers, longer shelf life, and consumer interest. Although not a major mango producer, United States has developed most of the popular cultivars traded on the international market, and is also the single largest importer of the fruit.
7. R. N. Hegde (2006): In this work, the author has analyzed the role of qualitative parameters that have a huge bearing on the success of fresh fruits in international market. The author has noted that parameters such as appearance (size, shape, pattern, gloss, color and texture), kinesthetics (touch and feel), and sensory parameters (smell, aromas and other subjective features) play a big role in determining the response of the customers towards the fruits. Author has also said that given the fragility of the fruit and its very short shelf-life, it is imperative to have efficient infrastructure in areas such as handling, packaging, storage and transportation of the fruit. In addition, the author has also acknowledged the critical role of a well-trained human resource base in this context. As per the author, on top of all of these, there is another factor, namely a high-caliber infrastructure for multidisciplinary research, aimed at enhancing the quality of the produce. Only integrated and concerted efforts of Governments, growers, suppliers, shippers, transporters and exporters can bring about satisfactory results.
8. World Bank (2006): In this report, world bank has noted that Indian mangoes account for 40% of the global mango production. The report also highlights the fact that most of the mangoes grown in India are mainly consumed in the country's domestic market. The report therefore notes that given India's vast production of the fruit, any additional quantity diverted from domestic consumption to export markets, would result in massive income gains for the farmers.
9. Tharanathan et al. (2006): Here, the author notes that mango is not just any other fruit in India. Apart from its colossal gastronomical impact on the country, it is also a major source of income for Indian farmers. The author also acknowledges the impact of India's diverse soil and climatic zones in helping sustain more than a thousand cultivars of the fruit. The author has also catalogued the important role being played by major mango producing states such as UP, Bihar, Maharashtra, Madhya Pradesh, Bengal, Gujarat, Andhra Pradesh, Odisha and Tamil Nadu.
10. Pitam Chandra & Abhijit Kar (2006) have said that with changing global demography and rising levels of disposable income in almost all the major developing countries, trade in fruits, vegetables and other high value agricultural commodities has steadily gained traction, especially over the last couple of decades. On one hand, while factors such as rising income levels, and awareness about food sources with higher nutritional values, have provided the boost to the demand side of the trade, factors like improving logistics,

[7] Partnership for Food Industry Development – Fruits & Vegetables - https://pdf.usaid.gov/pdf_docs/pdabw682.pdf

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falling trade barriers, willingness among consumers to pay a little more for superior quality food, and higher margins in the export trade, have provided the short in the arm to the supply side of the equation.

11. Bhaskar N. Patil & A. J. Nirban (2010): The authors state that in so far as the export of fresh fruits & vegetables from India is concerned, mango is the main crop among fruits, and onion occupies the first position among vegetables. Among countries/regions, Gulf Countries and Bangladesh are important export destinations for Indian fresh fruits, where mango is a major constituent, and vegetables, where onions, tomatoes and potatoes are the main constituents. The authors have also noted that apart from traditional markets like the Gulf Countries and Bangladesh, of late, Indian fruits like grapes, mangoes, and vegetables like eggplant, have been gaining market share in non-traditional markets like the U.K., The Netherlands, France and Germany.
12. Mattoo et al. (2007) have highlighted the fact that out of the total production of mangoes in India, only about one percent goes to the international markets. This is primarily due to huge domestic demand. But, other factors such as lack of strong linkages with international supply chain, high transport costs, large wastage within India, unavailability of processing capacity, and very often, lower than expected quality of Indian mangoes, also weigh down the prospects of India's farm exports in an equally big way.

Methodology:

Research methodology is an important aspect of research. It is research methodology that determines how data would be collected, and subsequently how the data thus collected would be analyzed using quantitative and qualitative methods. Furthermore, it is research methodology that guides a researcher on how to go about the task of checking the veracity and accuracy of the findings that emerge from the research.

Research Design:

In this research paper, exploratory and descriptive research design has been used. Overall, the structure of this research has been designed keeping in mind the need to facilitate an analytical investigation into India's performance as a major producer & exporter of fresh fruits in general, and mangoes, mangosteens & guavas in particular.

This research, among other things, is also aimed at exploring the issues that are hampering the production and export of these fruits from India. The research has been designed in such a way that wherever there is a need to understand the meaning of certain pieces of data, or the relationship that exists between certain data elements, descriptive approach was adopted. And, whenever there was a need, e.g. to explore certain phenomenon such as rising or falling exports during a certain period, the researchers had the freedom to deploy exploratory research techniques.

Data Collection:

The study is largely based on secondary data. But, care has been taken to select only such data that is very reliable data. Accordingly, for the purpose of sourcing data for this research, the authors have depended upon various trustworthy sources such as highly reputed research journals, newspapers, government reports, authentic databases etc. Some information has also been obtained by using the RTI route.

Some data has also been taken from the websites of global organizations of repute such as World Food Program, Food & Agricultural Organization etc. Among Indian organizations, institutions such as National Horticulture Board (NHB), Agricultural and Processed Food Products Export Development Authority of India (APEDA), Ministry of Food Processing Industry, (MOFPI), Ministry of Agriculture, Government of India etc. have been extensively relied upon as credible sources of information for this research.

Additional secondary data has been sourced from agencies such as Central Food Technological Research Institute (CFTRI), Indian Institute of Foreign Trade (IIFT), Ministry of Commerce & Industry, Indian Institute of Horticulture Research (IIHR) Bangalore, Indian Institute of Vegetables Research, Varanasi (U.P.), Directorate of Economics & Statistics, Ministry of Agriculture etc.

Databases of various Government agencies used as a source in this research:

- Database of Indian Horticulture (Year-1993 to 2021)

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- Database of National Horticulture Board (NHB), Ministry of Agriculture, Government of India
- Year Book (2007-08 to 2020-21) of Food and Agriculture Organization (FAO), United Nations;
- Agricultural Research Data Book (2008 to 2021) published by Indian Council of Agricultural Research New Delhi;
- Export Statistics Book (1991-92, 2020-21) of Agricultural & Processed Food Products Export Development Authority of India etc.

Government Annual Reports Used as a source in this research:

- Annual Report (1996-97 to 2020-21) of Ministry of Food Processing Industry, Government of India
- Annual Report of Reserve Bank of India (2007 to 2021)

Statistical tools & techniques used in the Study:

In this research, various kinds of statistical tools & technique have been used for analyzing the data. For example, in order to calculate the per yield per acre/hectare, the total production of the fruits in a specific year was divided by total acreage dedicated to the fruit concerned.

In addition, since the research required certain percentage figures, the researchers used simple percentage formula to extract information such as percent share of respective fruits and vegetables in parameters such as total area under cultivation, total production, total exports & imports etc. Other statistical tools & techniques, such as correlation & regression, revealed comparative advantage (RCA) etc have also been used wherever they needed to be deployed. Similarly, in order to measure fluctuations in a variable over time, statistical tools such as standard deviation, coefficient of variation have been used in this paper. A brief description of the various statistical tools & techniques used in this study is as follows:

1. Compounded Annual Growth Rate (CAGR):

The Compounded Annual Growth Rate (CAGR) has been used in this paper to calculate rate of growth of parameters such as production, value addition, export and import over a reasonably long period of time. The formula used to calculate the CAGR is as follows:

$$CAGR = \left(\frac{EV}{BV}\right)^{\frac{1}{n}} - 1 \times 100$$

Where:

EV = Ending value

BV = Beginning value

n = Number of years

2. Revealed Comparative Advantage Ratio (RCA):

Adam Smith was perhaps the first economist who sought to explain international trade through the concept of relative advantage. Since then, this simple concept underwent multiple rearticulations. In the subsequent years, other great economists like Ricardo also provided an explanation of the international trade using the paradigm of comparative advantage. As of today, there are two established approaches to analysis of comparative advantage: the Ricardian approach and the Heckscher and Ohlin (H-O) approach. Ricardo was of the view that it is the difference in absolute production cost, rather than in comparative cost, that provides the principal traction to international trade. On the other hand, in H-O theory, it is the difference in factor prices across countries, that is argued to be the primary driver of international trade.

Overall, almost all leading classical theories of international trade agree that a country's standing in international trade is determined, among other things, primarily by the competitiveness of its economy vis-a-vis other countries. And, these theories also argue that comparative advantage in international trade is based upon pre-trade relative prices. Such a line of argument leads to the conclusion that a country would enjoy comparative advantage in particular goods as long as the relative prices of those goods in the domestic market of that country are lower than the relative prices of those goods in the world market.

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A corollary of these theories says that since comparative advantage is a function of pre-trade relative prices, and, since these pre-trade relative prices in turn are a function of the relative costs of production, study of relative costs of production between nations is just as valid a way to track comparative advantage of nations.

Therefore, traditionally, while trying to measure comparative advantage, researchers have often relied upon pre-trade relative costs. However, there is a serious problem with a heavy dependence on this particular piece of statistics. Observable data on relative prices and/or costs are very difficult to get hold of. In fact, there is no reliable publisher of such an information. It was this paucity of data, that in 1965, forced renowned Hungarian Economist, Béla Alexander Balassa to come up with an alternative way to measure the relative advantage of countries in various products or even entire industries. This new method was called the Revealed Comparative Advantage (RCA) index.

Balassa was not only the inventor of this concept, he was also the first to come up with an empirical RCA index computation in 1965. Instead of relying upon pre-trade relative prices, Balassa used post-trade data to calculate the RCA index. It must be noted that this index does not determine the sources of comparative advantage. Instead, it is basically a number that tells us whether a country has Revealed Comparative Advantage or not.

For a given product 'h', any country, say India, would be considered to be enjoying a favorable RCA when the ratio between India's exports of products 'h' to India's cumulative exports (t) is higher in value than the value of the same ratio, calculated the world as a whole. Mathematically speaking, this condition is expressed as follows:

$$Rih = (Xih/Xit)/(Xwh/Xwt)$$

Where:

- Rih = Revealed Comparative Advantage Ratio for India in product ‘h’
- Xih = India’s exports of product ‘h’; Xit = Total exports of India
- Xwh = World exports of product ‘h’; Xwt = Total world export

If the RCA value of a commodity is greater than one, it indicates that the country concerned has a comparative advantage in the international trade of that commodity. On the other hand, if the RCA index yields a value that is less than one, it indicates that the country concerned does not enjoy any comparative advantage in the international trade of that commodity. The RCA index, a statistical tool, has been extensively employed to understand dynamics of international trade such as changes in trading patterns (Ferto and Hubbard 2003, Batra and Khan 2005, Kannan 2010). Since its appearance in 1965, concept has been updated a few times. But, the basic concept has not changed.

Problem with RCA and its resolution through Revealed Symmetric Comparative Advantage (RSCA):

RCA, in the its original form, suffers from one major problem. Because of the way it is expressed in mathematical terms, it can have any value, ranging from negative infinitity to positive infinity. As a result, it suffers from the problem of lacking symmetry around any fixed number. This problem was ultimately removed through an amendment to the original method of computing RCA. This change was suggested by Laursen and Engedal in 1995. The modified RCA index was called Symmetric-RCA or RSCA.

Whereas the value of the RCA index could be anything, the value of RSCA index always sways between +1 and -1. This feature of RSCA endows it with the property of being symmetric around zero. In the context of RSCA framework, the closer a country is to an RSCA index value of +1, the higher would be its comparative advantage. On the other hand, the closer a country inches towards an RSCA value of -1, the lesser would be its comparative advantage. Mathematically, it can be expressed as follows:

$$RSCA = (RCA-1) / (RCA+1)$$

Forecasting:

Forecasting is nothing else but a structured way to estimate the future by using scientific methods, including mathematical tools and logical foundations. The result obtained from the process of forecasting is known as forecast or simply projection. As a tool, forecasting is used to gain a glimpse into the future. It is extensively employed by all kinds of organizations to figure out how well prepared they are to face the challenges expected in the future. Whether it is companies, social sector organizations such as NGOs, multi-lateral organizations such as World Bank and IMF or even countries, all are known to employ this technique to help improve the quality of their decision making.

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Since it is a method to look into the broad outlines of the future, it is also quite helpful as a tool to enable countries / firms reorient their approach if the picture of the future that emerges from the forecasting exercise is not in line with their expectations. Although forecasting can never be an 100% accurate, yet, in a world that is full of uncertainties at every step, even a reasonably accurate depiction of future can mean the difference between success and failure for companies / countries struggling to distinguish themselves from their competitors.

3. Time Series Analysis:

The first step if we want to estimate the future, is always about a careful, data-drive study of the past. In this context, statistical data that is collected at regular intervals of time over sufficiently long durations, plays an extremely useful role. This kind of data is generally referred to as 'time series'. Thus, when we observe numerical data at different points of time, the set of observations is known as time series.

4. Least Squares Method:

This method is extensively used in practice. Application of this method involves fitting of a trend line to the data in such a manner that the following two conditions are satisfied:

$$(1) \text{ ---- } \Sigma(Y - Yc) = 0$$

i.e., the sum of deviations of the actual value of Y from the computed values of Y is zero.

$$(2) \text{ ----- } \Sigma (Y-Yc)^2 \text{ is least,}$$

i.e., when the sum of the squares of the deviations of the actual and computed values is least. That is why this method is called the method of least squares. The line obtained by this method is known as the 'best fit'.

The method of least squares can be used either to fit a straight trend line or a parabolic trend line. The following equation represents the straight trend line:

$$Yc = a + bX$$

Here, Yc denotes the trend (computed) values that are distinct from the actual values 'Y'. And, 'a' is the Y intercept or the value of the Y variable when X= 0. Similarly, 'b' represents slope of the line or the amount of change in Y variable that is associated with a change of one unit in X variable. The X variable in time series represents time.

In order to determine the value of the constants a and b, the following two normal equations are to be solved:

$$\Sigma Y = Na + b\Sigma X \text{ …… (i)}$$

$$\Sigma XY = a\Sigma X + b\Sigma X \text{……(ii)}$$

Where N represents number of years (months or any other time period) for which data is given. The time variable is measured as a deviation from its mean. Since $\Sigma X = 0$, the two equations mentioned-above would take the form:

$$\Sigma Y = Na, \ \Sigma XY = b\Sigma X^2$$

5. Correlation & Regression:

Concept of correlation & regression is perhaps the most commonly used technique for investigating the relationship between two quantitative variables. Regression is used to delineate the relationship in the form of an equation. Concept of regression can be visualized in many ways such as in the form of a scatter diagram. When the set of values generated from the regression equation are plotted on graph, the closer the points lie to a straight line, the stronger the linear relationship between two variables.

Correlation on the other hand is used to measure the strength of the relationship between a pair of variables. Correlation between two variables is expressed through what is known as the correlation coefficient. It basically quantifies the strength of the relationship between any two variables. In algebraic notation, if we have two variables x and y, and the data takes the form of n pairs (i.e. [x1, y1], [x2, y2], [x3, y3] ... [xn, yn]), then the correlation coefficient is given by the following equation:

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$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Here, 'r' is the correlation coefficient, also known as Pearson's correlation coefficient. This variable 'r' would always have a value ranging between +1 and -1. A value close to +1 indicates a strong positive relationship, which means, when one variable increases, the other too follows suit. On the other hand, a value close to -1 indicates a strong negative relationship, which means, when one variable decreases, the other increases. A value close to 0 indicates no mathematically describable relationship. In this context, it must be noted that in this context, when we say a mathematical relationship, we mean a linear relationship. However, one should be cognizant of the fact that variables could also have a non-linear relationship between them.

Notes on calculations:

Since this research is being conducted on past data, and, since the gap between the first year of interest to this research i.e. 1991, and today i.e. 2022 is almost 31 years, there was a need to be mindful of the currency conversion rates. As we know, Dollar-Rupee conversion rates have been dynamic ever since India adopted the system of market determined value of Rupee. As a result, whenever a past data on production and export needed to be converted into monetary value, the authors of this paper had to find out the average value of Dollar-Rupee conversion for that year.

This rate, even though it may or may not be the same as the extant rate on the day of the transaction, yet, since it is an average for the whole year, it is still the best value that could have been opted for, given our need to minimize the extent of statistical operations without sacrificing the rigor of the same.

It must also be noted that the topic of this paper includes mangosteens too. However, mangosteens are not grown in any significant quantity in India. In fact, it is grown mostly in South-East Asia. However, during the course of this study, the authors discovered, that in most of the databases, the data for mangoes and guavas is clubbed with the data for mangosteens. Therefore, the authors too decided to go along with the name in vogue, namely mangoes, mangosteens and guavas. But, it does not distort the accuracy of the results obtained from various statistical operations performed in this paper. That is because, the share of mangoes and guavas in the total value of the output of these three fruits is so high, and that of the mangosteens is so miniscule, that the statistical impact of the presence or absence of mangosteens is at best extremely marginal. And, since it was very difficult to sift the numbers for mangosteens from the numbers for mangoes and guavas, the authors decided to retain the numbers as they have been presented in the various databases.

When it comes to CAGR, it was observed that if either the beginning or the ending value is zero, the calculation of CAGR becomes meaningless. Hence, in this paper, wherever there was a situation like this, the nearest non-zero value was selected.

Importance of the Study:

This is an exercise with mainly academic objectives. But, it has also yielded certain very important insights that may help policy makers make superior policies in future. This study is based on the production and export numbers for fresh mangoes, mangosteens & guavas. Looking at the data that was collected as part of this study, it was clear that whether it is production or exports, the numbers have been consistently rising, leading to creation of powerful tailwinds for the agriculture sectors as a whole. Exports play an important role in the economy of any country with India being no exception to this general phenomenon. This study not only validates the fact that overall, India has good potential to emerge as an exporting powerhouse for fruits & vegetables in general, and for mangoes & guavas in particular. This study also highlights and explores the problems faced by the entire value chain of these crops, and tries to identify possible solutions.

Objectives of the Study:

1. To examine the production, productivity, and export numbers for fresh mangoes, mangosteens & guavas.
2. To evaluate India's performance as an exporter of these crops.
3. To identify the major factors affecting the production and export of these commodities.
4. To provide possible solutions for addressing issues plaguing the production and export of the fruits.

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Scope of the Study:

The horticulture sector encompasses a wide range of commodities, including fruits, vegetables, potatoes, tubers, ornamentals and medicinal & aromatic crops. However, in this study, only mangoes, mangosteens and guavas have been considered, and the time period considered for study is from 1991 to 2020. Basically, the study considers production (state wise, crop wise) and export & import of these fruits. The study has been conducted in context of India with the global numbers acting as points of reference to anchor the study.

Limitations of the Study:

i. For the study, only 30 years have been taken i.e. from 1991 to 2020.
ii. For the study, data that has been taken, relates mostly to production and export & import of mangoes, mangosteens & guavas as a single category. Wherever separately available, data for mangoes and guavas was considered individually. But, during the course of this research, it was discovered that the data that is available in the public domain, mostly treats these three products as part of a unified category called 'Mangoes, Mangosteens & Guavas'.
iii. Overall, the production quantity of mangosteens, when compared to that of mangoes and guavas is quite small. Therefore, in view of the very large difference between the quantity, of production as well as of exports, of mangoes & guavas on one hand, and for mangosteens on the other, the statistical difference created due to presence of mangosteen in the consolidated numbers is very small.

Analysis and Interpretation:

India - Compound Annual Growth Rate (CAGR) for Mangoes, Mangosteens & Guavas:

Table 8 presents the CAGR of production and exports for mango, mangosteen & guava for the period 1991-2020. For the sake of ease of understanding, and in order to enable better comparison across different periods of time, the entire 30-year period between 1991 to 2020 has been divided into six blocks, each of 5 years. For the first 5-year slot between 1991-95, the CAGR of for production of mangoes & guavas was 4.68%, and for export, the CAGR was 0.15%. During the 2nd 5-year period, i.e. between 1996-2000, the CAGR for production dipped to -0.81%, indicating a fall in production during this period. During the same period, the CAGR for exports was 7.96%. And, the decadal CAGR for the period 1991-2000 was 1.84% for production and 5.45% for exports.

Similarly, for the 5-year period from 2001-2005, CAGR for production was 3.30%, whereas for exports it was 36.94%. For the subsequent 5-year period (2006-2010), CAGR for production was 3.48% and for exports it was 0.28%. And, the decadal (2001-2010) CAGR for production was 4.1% whereas for exports it was 18.87%.

Similarly, the table below also lists down the 5-year (2011-15 & 2016-20) and 10-year (2011-20) CAGR for production as well as for exports. For the period 2011-15, the CAGR for production was 4.04% and for exports it was negative 5.38%. For the period 2016-20, the CAGR number for production was 5.83% and for exports it was negative (-) 7.92%. And, for the decade (2011-20), the production CAGR was 5.00% and for exports it was negative (-) 5.66%. For the full 30-year period from 1991-2020, the CAGR for production is 3.53% and for exports is 5.87%.

Table 8: Compound Annual Growth Rate of Mango, & Guava - 1991-2020:

	Production	Export
Year	Quantity (Tonnes)	Quantity (Tonnes)
1991	87,52,134.00	23,105.00
1992	92,23,256.00	25,850.00
1993	1,01,10,000.00	23,405.00
1994	1,09,90,000.00	27,320.00
1995	1,10,00,000.00	23,275.00
5-Year CAGR	4.68	0.15
1996	1,09,37,183.00	26,780.00
1997	1,10,00,000.00	44,862.00
1998	1,02,30,000.00	47,149.00
1999	97,81,700.00	37,822.00
2000	1,05,03,500.00	39,274.00
5-Year CAGR	-0.81	7.96
10-Year CAGR (1991-2000)	1.84	5.45
2001	1,00,56,800.00	46,232.00
2002	1,00,20,200.00	41,577.00
2003	1,27,33,200.00	1,79,179.00
2004	1,14,90,000.00	1,56,222.00
2005	1,18,29,700.00	2,22,622.00

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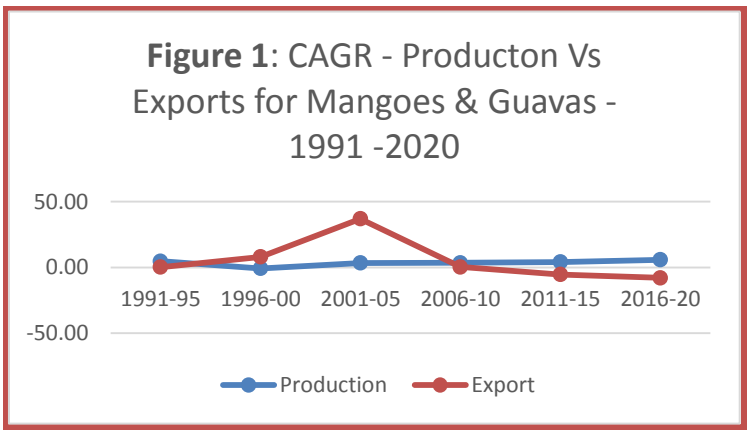
5-Year CAGR	3.30	36.94
2006	1,26,63,100.00	2,56,874.00
2007	1,37,34,000.00	2,40,858.00
2008	1,39,97,000.00	2,74,854.00
2009	1,27,50,000.00	2,86,775.00
2010	1,50,26,700.00	2,60,484.00
5-Year CAGR	3.48	0.28
10-Year CAGR (2001-2010)	4.10	18.87
2011	1,51,88,000.00	2,29,192.00
2012	1,61,96,000.00	2,14,640.00
2013	1,80,02,000.00	2,63,918.00
2014	1,84,31,330.00	2,10,668.00
2015	1,85,27,000.00	1,73,814.00
5-Year CAGR	4.05	-5.38
2016	1,86,43,000.00	1,93,383.00
2017	2,33,32,000.00	1,72,441.00
2018	2,49,66,000.00	1,53,284.00
2019	2,56,31,000.00	1,47,242.00
2020	2,47,48,000.00	1,28,018.00
5-Year CAGR	5.83	-7.92
10-Year CAGR (2011-2020)	5.00	-5.66
CAGR for the period (1991-2020)	3.53	5.87

Data Source: FAOSTAT & National Horticulture Board Database

In order to better visualize the performance of India in production and export of mangoes, mangosteens and guavas, one could also plot a separate graph of the CAGR for the two parameters i.e. production and export during the period 1991-2020, with the whole period divided into six equal intervals of 5-years.



Data Source: FAOSTAT & National Horticulture Board Database

Interpreting Figure 1:

Even if one were to ignore the annual numbers, even on a five yearly basis, neither production, nor the export of the fruits has managed to post consistently good growth (CAGR) numbers. In fact, both production and export of these commodities have often posted negative growth, indicating inconsistent performance. Between the two parameters, i.e. between production and export, it is production that has posted a steadier performance than exports, that have been far choppier with more frequent peaks and troughs, indicating a very uneven performance. This basically means that there is a great demand to develop measures to generate production and export performance numbers that are more evenly distributed across time.

Productivity of Mango, Mangosteen & Guava in India & World

Table 9 & Figure 2 depict India's & World's productivity (yield per acre/hectare) when it comes to cultivation of mango, mangosteen & guava during the period 1991-2020. For the sake of ease of presentation and comprehension, this period of 30 years has been broken down into six blocks, each of 5-years duration. As can be seen from the data in the table, when compared to the productivity of the rest of the world, productivity of India has been fluctuating rather wildly. This can also be noticed from the fact that during this period, India's productivity swung from as low as 5.52% to as high as 9.31%.

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Table 9: India & World Productivity of Mangoes & Guava during 1991-2020

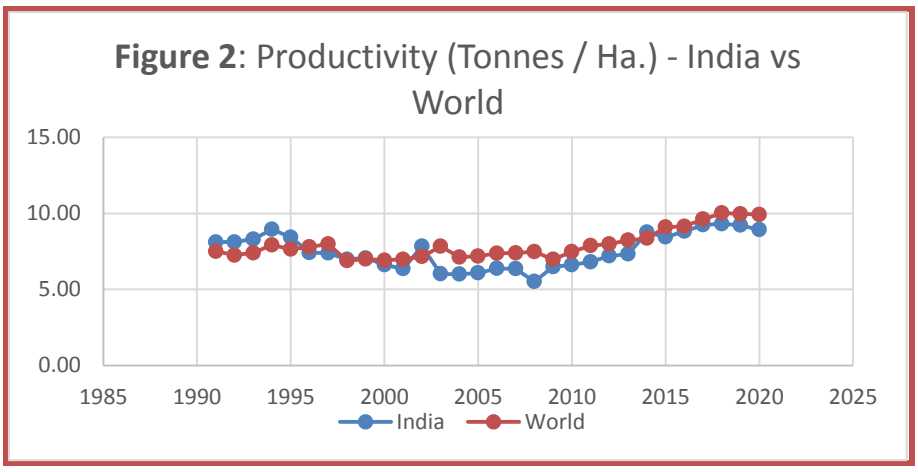
Productivity			Productivity			Productivity		
Year	India	World	Year	India	World	Year	India	World
1991	8.12	7.51	1996	7.42	7.79	2001	6.36	6.98
1992	8.11	7.25	1997	7.39	7.99	2002	7.85	7.16
1993	8.31	7.40	1998	6.98	6.89	2003	6.03	7.83
1994	8.95	7.93	1999	7.06	7.00	2004	6.00	7.13
1995	8.43	7.64	2000	6.62	6.92	2005	6.09	7.18
5-Year Average			5-Year Average			5-Year Average		
1991-95	8.38	7.55	1996-00	7.09	7.32	2001-05	6.46	7.26
Productivity			Productivity			Productivity		
Year	India	World	Year	India	World	Year	India	World
2006	6.38	7.38	2011	6.81	7.88	2016	8.82	9.15
2007	6.36	7.39	2012	7.20	7.99	2017	9.24	9.62
2008	5.52	7.48	2013	7.33	8.23	2018	9.31	10.02
2009	6.50	6.97	2014	8.76	8.35	2019	9.22	9.97
2010	6.61	7.49	2015	8.44	9.09	2020	8.92	9.93
5-Year Average			5-Year Average			5-Year Average		
2006-10	6.27	7.34	2011-15	7.71	8.31	2016-20	9.10	9.74

Data Source: FAOSTAT & National Horticulture Board Database

In fact, if we look at all the six 5-year blocks of data in the table above, 2nd, 3rd and 4th 5-year blocks witnessed a fall in productivity, not just vis-à-vis the first 5-year block, but also in a 'block-on-block' basis, i.e., in the sense that every successive block of 5-years witnessed a decline in productivity compared to the preceding 5-year period. This fall was arrested only in the 5th block, but there too, the rise in productivity happened only with respect to the productivity level in previous three 5-year blocks, not with respect to numbers in the first five-year block. This means that even in the 5th block, the productivity on was lower than the productivity seen at the beginning of the 1st block of 5-years (1991-1995).

The real turn-around happened in the sixth five-year block. During this period, i.e. during the sixth five-year block, the trend of rising productivity sustained its momentum, not just in a 'block-on-block' context, but, more importantly, in the overall context. This time, the increase was not just with respect to the figures in the three previous 5-year blocks. Instead, this time, i.e. between 2016-2020, the productivity figure that was reported was even better than the highest previous figure, witnessed during the first 5-five year period , i.e. between 1991-1995.

When it comes to comparing the productivity numbers for India and the world, the best way is to look at the representation of those numbers in the form of a graph, like the one shown below.



Data Source: FAOSTAT & National Horticulture Board Database

So, as can be seen from the figure above, the extent to which productivity values for India and for the world differ from each other is not so high. This point can also be seen if we compare the two sets of data using standard deviation and coefficient of variation as a measure, as has been shown in the table below:

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Table 10: India & World Productivity Trend of Mango, Mangosteen & Guava for the period 1991-2020:

Productivity								
For India					For World			
Year	Productivity	Mean	Variance	(variance)^2	Productivity	Mean	variance	(variance)^2
1991	8.12	7.50	0.615	0.378	7.51	7.92	-0.41	0.17
1992	8.11	7.50	0.607	0.369	7.25	7.92	-0.67	0.45
1993	8.31	7.50	0.806	0.649	7.40	7.92	-0.52	0.27
1994	8.95	7.50	1.448	2.096	7.93	7.92	0.01	0.00
1995	8.43	7.50	0.922	0.850	7.64	7.92	-0.28	0.08
1996	7.42	7.50	-0.083	0.007	7.79	7.92	-0.13	0.02
1997	7.39	7.50	-0.115	0.013	7.99	7.92	0.07	0.01
1998	6.98	7.50	-0.527	0.278	6.89	7.92	-1.03	1.06
1999	7.06	7.50	-0.440	0.194	7.00	7.92	-0.92	0.84
2000	6.62	7.50	-0.883	0.780	6.92	7.92	-1.00	1.00
2001	6.36	7.50	-1.146	1.314	6.98	7.92	-0.94	0.88
2002	7.85	7.50	0.341	0.116	7.16	7.92	-0.76	0.57
2003	6.03	7.50	-1.478	2.185	7.83	7.92	-0.09	0.01
2004	6.00	7.50	-1.501	2.252	7.13	7.92	-0.79	0.62
2005	6.09	7.50	-1.418	2.011	7.18	7.92	-0.74	0.54
2006	6.38	7.50	-1.127	1.271	7.38	7.92	-0.54	0.29
2007	6.36	7.50	-1.145	1.311	7.39	7.92	-0.53	0.28
2008	5.52	7.50	-1.982	3.930	7.48	7.92	-0.44	0.19
2009	6.50	7.50	-1.006	1.011	6.97	7.92	-0.95	0.90
2010	6.61	7.50	-0.892	0.796	7.49	7.92	-0.43	0.18
2011	6.81	7.50	-0.693	0.481	7.88	7.92	-0.04	0.00
2012	7.20	7.50	-0.303	0.092	7.99	7.92	0.07	0.00
2013	7.33	7.50	-0.179	0.032	8.23	7.92	0.31	0.10
2014	8.76	7.50	1.251	1.566	8.35	7.92	0.44	0.19
2015	8.44	7.50	0.935	0.875	9.09	7.92	1.18	1.38
2016	8.82	7.50	1.314	1.727	9.15	7.92	1.23	1.51
2017	9.24	7.50	1.741	3.030	9.62	7.92	1.70	2.88
2018	9.31	7.50	1.807	3.264	10.02	7.92	2.10	4.40
2019	9.22	7.50	1.714	2.938	9.97	7.92	2.05	4.22
2020	8.92	7.50	1.419	2.015	9.93	7.92	2.01	4.04
Sum of (Variance)^2 for India				37.83	Sum of (Variance)^2 for the world			27.07
Standard Deviation for India				1.142	Standard deviation for the world			0.97
Coefficient of variation for India				0.152	Coefficient of variation for World			0.122

Data Source: FAOSTAT & National Horticulture Board Database

Figure : India & World Productivity Trend of Mango, Mangosteen & Guava for the period 1991-2011

The information that is provided by table 10 through numbers can also be visualized through a graph, as shown below.

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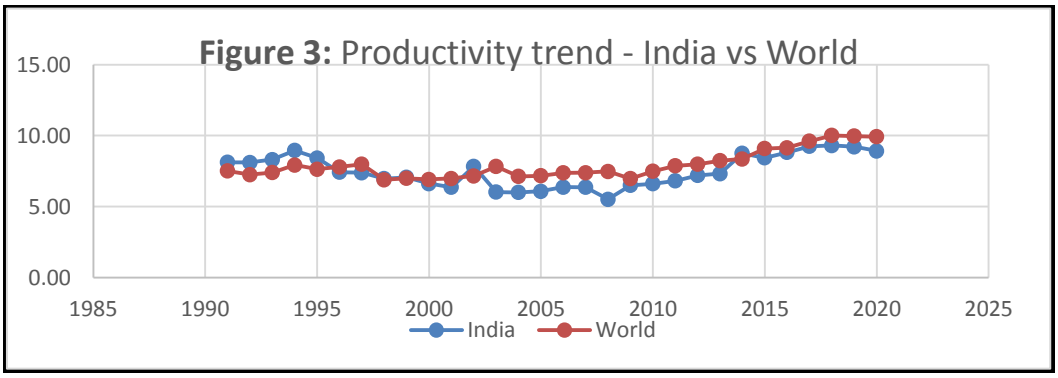

Data Source: FAOSTAT & National Horticulture Board Database

By applying statistical techniques like standard deviation and coefficient of variation, as has been shown in table 10, one could know that overall, India has a greater variation than the world, when it comes to productivity of her land for the cultivation of these two crops.

On the other hand, through the graph, one can visualize minute details like in which year was the deviation greater, in which year was the variation minimal, and one can also have an idea about the likely future trend.

India's Foreign Trade (Export & Import) in Mango, Mangosteen & Guava:

Table 11 shows figures for export and import of mango, mangosteen & guava during the period 1991-2020. During this period, India's exports of these commodities witnessed a growth of 5.87% in quantity terms, and 7.78% in terms of monetary value. Similarly, the CAGR for trade balance too grew at the rate of 7.76%. On the other hand, during the same period, CAGR for quantity imported was 18.53%, and the CAGR for import value during the same period was 15.60%.

So, if one were to draw one's conclusions based purely upon these numbers, one would conclude that imports grew at a much faster pace than exports. That is definitely true. But, one also has to keep in mind a few statistical nuances, such as the fact that imports were starting from a very low base of nearly zero. This low base is creating the statistical bias known as base-effect. So, even though imports were growing faster than exports, in practical terms, because of the vast quantitative difference between the two parameters, the effect of this mismatch was negligible.

Table 11: Export & Import of Mangoes & Guavas by India during 1991-2020

Year	Import (Tonnes)	Import Value - US$	Import price / Ton	Export Quantity (Tonnes)	Export - US$	Export Earnings (US$/Ton)	Trade Balance
1991	0	0.00	0.00	23,105.00	1,45,39,000.00	629.26	1,45,39,000.00
1992	0	0.00	0.00	25,850.00	1,74,76,000.00	676.05	1,74,76,000.00
1993	0	0.00	0.00	23,405.00	1,47,05,000.00	628.28	1,47,05,000.00
1994	4	9,000.00	2,250.00	27,320.00	1,51,41,000.00	554.21	1,51,32,000.00
1995	0	0.00	0.00	23,275.00	1,23,53,000.00	530.74	1,23,53,000.00
1996	18	33,000.00	1,833.33	26,780.00	1,34,02,000.00	500.45	1,33,69,000.00
1997	13	7,000.00	538.46	44,862.00	2,05,88,000.00	458.92	2,05,81,000.00
1998	0	0.00	0.00	47,149.00	2,00,04,000.00	424.27	2,00,04,000.00
1999	7	8,000.00	1,142.86	37,822.00	1,80,23,000.00	476.52	1,80,15,000.00
2000	29	34,000.00	1,172.41	39,274.00	1,65,23,000.00	420.71	1,64,89,000.00
2001	19	20,000.00	1,052.63	46,232.00	1,90,73,000.00	412.55	1,90,53,000.00
2002	59	42,000.00	711.86	41,577.00	1,92,73,000.00	463.55	1,92,31,000.00
2003	49	52,000.00	1,061.22	1,79,179.00	8,53,07,000.00	476.10	8,52,55,000.00
2004	6	6,000.00	1,000.00	1,56,222.00	9,31,00,000.00	595.95	9,30,94,000.00
2005	100	94,000.00	940.00	2,22,622.00	12,27,10,000.00	551.20	12,26,16,000.00
2006	109	1,00,000.00	917.43	2,56,874.00	15,71,98,000.00	611.97	15,70,98,000.00
2007	104	80,000.00	769.23	2,40,858.00	16,36,22,000.00	679.33	16,35,42,000.00
2008	171	1,30,000.00	760.23	2,74,854.00	22,49,79,000.00	818.54	22,48,49,000.00
2009	297	1,59,000.00	535.35	2,86,775.00	21,05,56,000.00	734.22	21,03,97,000.00
2010	132	93,000.00	704.55	2,60,484.00	22,86,54,000.00	877.80	22,85,61,000.00

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2011	631	5,63,000.00	892.23	2,29,192.00	20,13,56,000.00	878.55	20,07,93,000.00
2012	777	7,21,000.00	927.93	2,14,640.00	16,68,94,000.00	777.55	16,61,73,000.00
2013	653	7,37,000.00	1,128.64	2,63,918.00	20,43,10,000.00	774.14	20,35,73,000.00
2014	1036	10,80,000.00	1,042.47	2,10,668.00	19,61,36,000.00	931.02	19,50,56,000.00
2015	751	11,54,000.00	1,536.62	1,73,814.00	18,36,16,000.00	1,056.39	18,24,62,000.00
2016	524	8,06,000.00	1,538.17	1,93,383.00	20,25,65,000.00	1,047.48	20,17,59,000.00
2017	493	8,22,000.00	1,667.34	1,72,441.00	18,21,66,000.00	1,056.40	18,13,44,000.00
2018	645	11,09,000.00	1,719.38	1,53,284.00	15,97,32,000.00	1,042.07	15,86,23,000.00
2019	911	17,18,000.00	1,885.84	1,47,242.00	15,14,06,000.00	1,028.28	14,96,88,000.00
2020	656	6,97,000.00	1,062.50	1,28,018.00	13,74,59,000.00	1,073.75	13,67,62,000.00
	CAGR for Import Quantity					18.53	
	CAGR for Import Value					15.60	
	CAGR for Export Quantity					5.87	
	CAGR for Export Value					7.78	
	CAGR for Trade Balance					7.76	

Revealed Comparative Advantage (RCA) & Revealed Symmetric Comparative Advantage (RSCA) Ratio for Mango, Mangosteen & Guava:

The RCA and RSCA enjoyed by India in the international trade involving mango, mangosteen & guava can be seen in table 12. Figure 4 conveys the same message in a more visual manner. What is noticeable in the data for the period1991-2020, is the fact that during this whole period, the RCA enjoyed by India in mangoes, mangosteens & guavas has always been consistently more than one (RCA>1), the benchmark value below which a country does not enjoy any competitive advantage in the product under consideration.

However, another trend that is not so positive from the point of view of India's prospects of emerging as a mango export power house, lies in the fact that over this period (1991 – 2020), RCA value has not only been fluctuating wildly, it has also been going down consistently. For this period, India started with a very high RCA of 14.89 in 1991. In the subsequent year, i.e. in 1992, it climbed even higher to reach 16.54. Then, from 1993 till 2002, India saw a consistent decline in its RCA. Subsequently, during the period 2003-2010, India saw its RCA return to the double-digit territory. However, during this period too, there were lots of fluctuations from one year to the next. In 2011, India again returned to single-digit RCA. Not just that, since then her RCA has been falling continuously to reach a lowly figure of 1.93 in 2020.

Table 12: India's RCA & RSCA Ratio for Mangoes & Guavas during 1991-2020

Year	Xih =Export Value - US$ million	Xit = Total exports of India in US$ million	Xwh = World exports of product h (in US$ million)	Xwt = Total world export (in US$ millions)	Rih = RCA for India in product h
1991	14.54	22,940.00	191.71	45,04,930.00	14.89
1992	17.48	25,490.00	210.91	50,89,590.00	16.54
1993	14.71	27,470.00	264.06	49,25,250.00	9.98
1994	15.14	32,360.00	267.39	54,76,510.00	9.58
1995	12.35	39,070.00	291.45	64,90,170.00	7.04
1996	13.40	40,800.00	352.65	67,85,370.00	6.32
1997	20.59	44,460.00	358.54	70,47,230.00	9.10
1998	20.00	46,430.00	381.08	69,70,430.00	7.88
1999	18.02	52,540.00	378.76	72,31,500.00	6.55
2000	16.52	60,880.00	385.65	80,32,680.00	5.65
2001	19.07	60,960.00	416.14	77,81,990.00	5.85
2002	19.27	73,450.00	389.09	81,72,330.00	5.51
2003	85.31	90,840.00	564.25	94,62,660.00	15.75
2004	93.10	1,26,650.00	577.78	1,14,93,710.00	14.62
2005	122.71	1,60,840.00	621.84	1,30,65,700.00	16.03
2006	157.20	1,99,970.00	755.18	1,50,58,640.00	15.68
2007	163.62	2,53,080.00	913.45	1,75,09,110.00	12.39
2008	224.98	2,88,900.00	996.17	2,00,00,600.00	15.64

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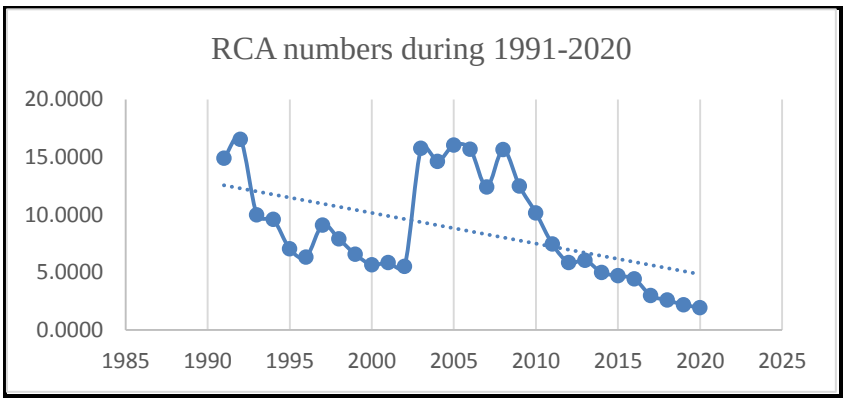
2009	210.56	2,73,750.00	995.08	1,61,24,800.00	12.46
2010	228.65	3,75,350.00	1,156.04	1,92,43,640.00	10.14
2011	201.36	4,47,380.00	1,371.52	2,26,81,800.00	7.44
2012	166.89	4,48,400.00	1,464.01	2,30,09,870.00	5.85
2013	204.31	4,72,180.00	1,689.74	2,35,91,380.00	6.04
2014	196.14	4,68,350.00	2,012.36	2,39,58,190.00	4.99
2015	183.62	4,16,790.00	2,001.14	2,13,04,880.00	4.69
2016	202.57	4,39,640.00	2,182.77	2,08,96,160.00	4.41
2017	182.17	4,98,260.00	2,824.86	2,30,00,930.00	2.98
2018	159.73	5,38,640.00	2,896.27	2,51,85,950.00	2.58
2019	151.41	5,29,240.00	3,248.29	2,47,33,870.00	2.18
2020	137.46	4,99,100.00	3,195.84	2,23,61,520.00	1.93

Figure 4: RCA enjoyed by India Mangoes & Guavas for the period 1991-2020



Interpreting Figure 4:

Figure 4 is a visual representation of something that is otherwise noticeable in table 12 also. It shows how India's RCA levels have been on a roller-coaster ride since 1991, the point of time from which this study begins. Trendline in the figure also shows that there have been periods when RCA values have shot up considerably above the long-term average, denoted by the trend line. But, it also shows that there have been equally large periods when the RCA has been considerably lower than the long-term average.

However, the most troubling part lies in the abysmally low levels of RCA since 2017, when it reached 2.98. In 2020, RCA figures further nosedived to just 1.93, only marginally more than the watershed point of 1. It is a cause of great concern which demands deeper analysis. India needs to figure out what is causing such drastic fall in her RCA.

Investigating the relationship between domestic inflation in India and the RCA enjoyed for Mango, Mangosteen & Guava:

Year	Inflation Rate (%)	Inflation in fraction = I	RCA	Correlation bet. Inflation & RCA
1991	13.87%	0.1387	14.8934	0.2815
1992	11.79%	0.1179	16.5449	0.2056
1993	6.33%	0.0633	9.9847	0.1136
1994	10.25%	0.1025	9.5833	0.1166
1995	10.22%	0.1022	7.0407	0.1046
1996	8.98%	0.0898	6.3204	0.1196
1997	7.16%	0.0716	9.1018	0.1359
1998	13.23%	0.1323	7.8807	0.1143
1999	4.67%	0.0467	6.5495	0.1612
2000	4.01%	0.0401	5.6530	0.1253
2001	3.78%	0.0378	5.8509	0.1357
2002	4.30%	0.0430	5.5113	0.1143
2003	3.81%	0.0381	15.7489	0.0909
2004	3.77%	0.0377	14.6232	0.1887

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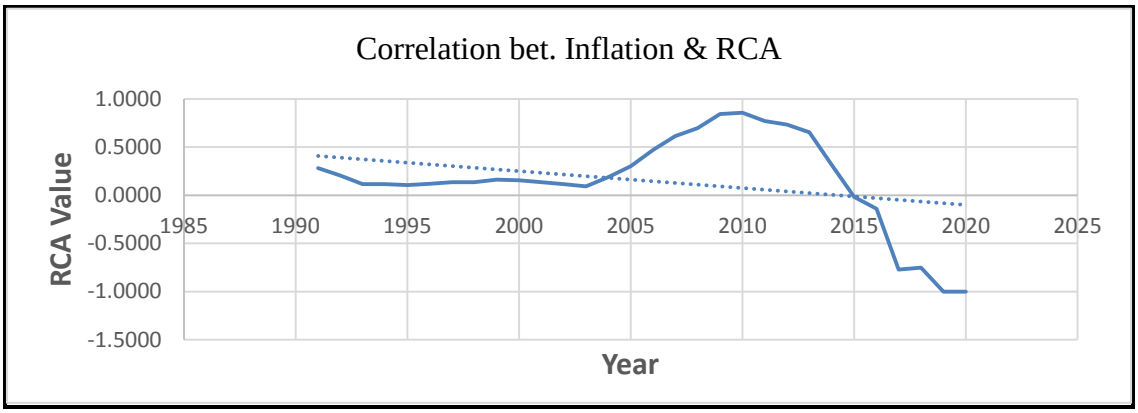
2005	4.25%	0.0425	16.0303	0.3016
2006	5.80%	0.0580	15.6753	0.4709
2007	6.37%	0.0637	12.3927	0.6142
2008	8.35%	0.0835	15.6352	0.6982
2009	10.88%	0.1088	12.4638	0.8435
2010	11.99%	0.1199	10.1405	0.8565
2011	8.91%	0.0891	7.4433	0.7691
2012	9.48%	0.0948	5.8498	0.7329
2013	10.02%	0.1002	6.0411	0.6520
2014	6.67%	0.0667	4.9858	0.3135
2015	4.91%	0.0491	4.6902	-0.0162
2016	4.95%	0.0495	4.4109	-0.1416
2017	3.33%	0.0333	2.9769	-0.7734
2018	3.94%	0.0394	2.5788	-0.7517
2019	3.73%	0.0373	2.1784	-1.0000
2020	6.62%	0.0662	1.9271	-1.0000

Figure 5: Visualizing the correlation between domestic inflation in India and the RCA enjoyed by India in international trade of mangoes, mangosteens and guavas:



Interpreting figure 5:

Figure 5 shows that for most part of the duration covered by this study, i.e. 1991 to 2020, the correlation between domestic inflation in India, and the RCA value enjoyed by her in the international trade involving mangoes, mangosteens & guavas, was positive. But, the degree of correlation was rarely very strong. In fact, throughout 1991-2006, the correlation between these two variables never touched +0.5. This basically indicated the relative weakness of the correlation between these two variables.

Things started to change in 2007, when for the first time, the correlation between the two variables crossed the critical mark of +0.5 to reach a level of 0.6142. From that point onwards and stretching all the way up to 2013, the strength of correlation between the two variables never went below +0.5, thus indicating a strong positive correlation.

From 2014, things started taking a different turn all over again. During that year, after a long gap, the coefficient of correlation dived below the critical +0.5 mark to reach a level of 0.3135. But, what makes the turn even more interesting is the fact that after 2014, the coefficient of correlation experienced further depletion of strength to reach the negative territory. Not just that, the strength of the correlation in the negative direction increased over the successive years to reach the level of negative 1 in 2019. That level of further sustained even in 2020.

The negative correlation between domestic inflation in India and the RCA for mangoes, mangosteens and guavas is quite interesting, but also quite logical. It basically means that the more the inflation in India becomes stronger, the lesser would be India's competitiveness in the international trade of the fruits that are the subject of this investigation. The corollary of this would be diametrically opposite case of rising competitiveness in response to falling domestic inflation regime in India.

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The fact that India's RCA has been falling dramatically since 2014, means that even though the headline inflation number (CPI/PPI/WPI) may not have been too high for most of this period, something else was driving the fall in RCA witnessed during this period. The falling RCA number in an atmosphere of relatively benign inflation regime, points to the possibility, that the cost drivers that really matter to the farmers of mango, mangosteens and guavas, must have experienced serious bouts of inflation, even though the same was not adequately represented in the official inflation numbers such as WPI, PPI and WPI. It means that in the larger CPI/PPI/WPI basket, the weightage of items relevant to the farmers and exporters of mangoes, mangosteens and guavas may not have been very high. Perhaps that is why, a rise in the cost of those items, did not result in a big spurt in the overall CPI/WPI/PPI numbers. But, in so far as the fruits under investigation are concerned, it seems the rise in inflation was quite substantial for them.

This is however, just a surmise based upon the weak data points emerging from the correlation between domestic inflation in India and the RCA enjoyed by India in the export market of mangoes, mangosteens and guavas. In order to validate this conclusion, a much deeper investigation would be required.

Key findings reflected through relevant numbers:

Before we dive into the analysis of the results that have emerged out of this study, it is worthwhile to take a look at some of the key numbers that have been yielded by the computations done as part of this research:

- For the period 1991-2020, CAGR for production of mangoes, mangosteens and guavas in India was 3.53%.
- For the same period, CAGR for exports was 5.87%.
- Mean productivity (tonnes per acre) of India during 1991-2020 was 7.5, while the mean productivity of the world as a whole during the same period was 7.92.
- India's productivity was however much more volatile. This is indicated by a higher standard deviation of 1.142, which is considerably higher than the standard deviation (0.97) seen in the mean productivity numbers for the world as a whole.
- The volatility in the India's mean productivity is also confirmed by another set of numbers, namely the coefficient of variation between India's mean productivity and the mean productivity of the world at large.
- The Coefficient of variation for India was found to be 0.152 while the value of the same parameter for the world as a whole was 0.122.

It is also quite educative to look at some of other the most relevant numbers related to the foreign trade in mangoes, mangosteens and guavas done by India during 1991-2020:

- CAGR for import Quantity was observed to be 18.53. On the other hand, CAGR for import in dollar value terms, was found to be 15.60.
- In terms of tonnes of goods exported, CAGR of Indian exports, was 5.87. However, when exports of India were compounded in dollar value terms, the CAGR was found to be equal to 7.78.
- When it comes to the net revenue earned by India through the foreign trade in these three crops, i.e. when it comes to CAGR for the growth in trade surplus, the number was found to be equal to 7.76.
- Mean RCA enjoyed by India during 1991-2020 was 8.69. But, like productivity (yield per acre) numbers, RCA numbers too were very unstable. From a high of around 15.5 in 1992, RCA enjoyed by India in the international trade of these fruits collapsed to just 1.93 in 2020.
- When the nature of the relationship between domestic inflation in India, and the RCA enjoyed by India, was sought to be understood through the values of the coefficient of correlation for the period 1991-2020, the result was a mixed picture. However, the correlation numbers indicate that from 2014 onwards, India has witnessed a negative correlation between these two variables. During 2019 and 2020, the value of the coefficient of correlation reached a perfect -1.

Conclusion and Suggestions:

In the hyper-competitive world of globalization era, every sector of a nation's economy has to strive to be at its very best, if the nation concerned has to compete with other nations in the global market place. In the modern era, through the economic success of countries in east and south-east Asia, the world, especially the developing world, has realized, that the way to transform national economies, is to carve out greater and greater share in the world trade, as well as to strive to move up the value chain. Therefore, ipso facto, it has also been realized, that the best way to achieve the twin goals of poverty eradication and expansion of the national economic pie, is to participate vigorously in global trade.

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Since 1991, when India embraced an industrial & economic policy regime characterized by the three properties of liberalization, privatization and globalization (LPG), the industrial and commercial landscape of India has been altered drastically. In many cases, this transformation has been beyond even the wildest imaginations of the people, who, in 1991, showed the willingness to invest their political capital to initiate a historic shift in India's economic policy stance from license-permit raj, to the era of an open architecture economy. From being a closed and an almost autarchic economy till then, India decided to break the shackles imposed on her industrial dreams by the pernicious but ubiquitous heavy-handed State interventions in the economic machinery of the nation.

The resultant freedom that the spirit of Indian industriousness experienced, started translating itself in the form of significantly superior performance levels in almost all walks of India's national economy, including in the sphere of foreign trade. As far as mangoes, mangosteens and guavas are concerned, the spirit of exploration of global markets unleashed by the economic reforms of 1991, saw both the production and export of these commodities see unprecedented growth.

From 87,52,134 tonnes in 1991, India saw the total production of these fruits reach historic high of 2,47,48,000 tonnes in 2020. Similarly, in exports, whereas India exported a total of just 23,105 tonnes in 1991, in 2020 India exported a total of 1,28,018 tonnes of the fruits, a growth of more than 500% during this period. When measured in millions of USD, India's exports of mangoes, mangosteens and guavas, from being just USD 14.54 million in 1991, touched a never-before seen high of 137.46 million dollars. This represents a growth of more than 900% during the period under consideration i.e. during 1991-2020.

Speaking of agriculture as a sector of Indian economy, it too has been massively affected by the process of economic reforms initiated in 1991. India saw a quantum jump in production as well as in exports. Horticulture, floriculture, dairy, fisheries, aquaculture, animal husbandry, forestry, food processing, and all the other sub-sectors of Indian agriculture have contributed to the surge in India's rise as a major player in global agriculture. And, for most of India's agricultural production and exports, it is possible to trace the turning point to the events of 1991. Therefore, whether or not the reforms of 1991 were a factor in the rise of Indian agriculture since then, is largely an exercise without much material weight. The evidence is simple quite strong for it to be refuted.

But the story has not always been evenly spaced out, and neither has its trajectory been always desirable. Till about 1970, agriculture contributed around 42%8 to India's GDP. By 1991, when the nation undertook the process of economic reforms, share of agriculture in India's GDP had declined to 27.7%[9]. But, the decline did not stop there. Barring the last couple of years, agriculture in India has seen its share of GDP go down consistently, year after year. The table below suffices to summarize this story:

Year	% of GDP
1960	41.74
1970	40.29
1980	34.41
1990	27.58
2000	21.61
2010	17.03
2011	17.19
2012	16.85
2013	17.15
2014	16.79
2015	16.17
2016	16.36
2017	16.56
2018	16.03
2019	16.73
2020	18.23

Source: World Development Indicators | DataBank (worldbank.org)

[8] Share of Agriculture Sector in GDP (pib.gov.in)
[9] World Development Indicators | DataBank (worldbank.org)

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Therefore, based upon the available data, we can see two completely different processes in action. Whereas on one hand, we are witnessing a secular decline in share of agriculture in India's GDP, on the other hand, we are also witnessing India's overall share, both in global GDP, as well as in global agriculture output and trade, rise consistently. This can mean only two things. It could mean that rate of growth in other sectors of Indian economy has been much faster than that of agriculture. This logical conclusion is also empirically supported by all kinds of data. The other possible inference that could be drawn from this trend would be centered around the idea of agriculture in the rest of the world growing at an even slower pace than what has been witnessed in India during this period.

While, on an aggregate level, a relatively sluggish rate of growth in their agriculture may not be such a big source of concern for most of the rich countries, India with its vastness of rural population, can just not afford to let this situation perpetuate itself. While it is true that agriculture alone may not be able to fully eradicate rural poverty in India. Yet, it is also true that without a buoyant agriculture, India would never be able to achieve this goal in any significant manner. An efficient agriculture is therefore believed to hold the key to sustained rural prosperity in India. Therefore, all issues relating to agriculture must be adequately studied, and data driven ways to address the problems facing each of the sub-sectors of Indian agriculture must be identified and implemented.

This study, a multi-parametric, structured analysis of India's performance in production and export of mangoes, mangosteens and guavas, has revealed certain very useful pointers which provide insights into the health of Indian agriculture at large. It has also shone spotlight on some of the most critical problems that need urgent attention. The study has revealed that India, though having registered impressive growth over the years, is nowhere close to achieving its true potential as a global agricultural powerhouse.

Data thrown up by this study, and gathered during the process of doing background research for this study, suggests that India needs to urgently implement measures to prevent the massive post-harvest wastage that is rampant in agriculture. build massive capabilities in areas such as food processing, reduce the logistical cost, and substantially bring down the 'time-to-market' number. Among them, with respect to the issue of post-harvest management of crops, it is worthwhile to note, that at an all-India level, as per an estimation done by The Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana, Indian farmers lose around `92,651 crores[10] every year due to wastage on account of poor post-harvest management techniques. Other estimates, such as the one done by Financial Express in 2019, have estimated that India loses around 16%[11] of its gross agricultural output to wastage. This is clearly an alarming number. Worse still, the wastage is even higher for high value, and highly perishable crops like fruits and vegetables. For fruits & vegetables, it is estimated that India loses around 40% of its total produce to wastage. Overall, this figure clearly demonstrates how far India still needs to go, even to reap the low-hanging fruits like reduction of wastage.

Among the various kinds of fruits and vegetables produced by India, mangoes, mangosteens & guavas are considered especially lucrative in view of their high demand in international market. Although India has done well in the export of these fruits, however, in order to properly contextualize the performance of India in the value chain of these crops, one also needs to evaluate India's export performance vis-à-vis the vast untapped potential for exports represented by India's total production of these crops. Considering the fact that while international market for these fruits was in excess of US$ 2.6 billion during 2021, India was only able to export fruits worth around US$ 185 million, registering a market share of just around 14%, When contrasted against more than 40%, which is what India's share in global production of these fruits is, an export market share of just 14% is definitely an underperformance.

Data for international trade in fruits & vegetables, when looked in conjunction with the underlying factors powering this trade, indicates the possibility of sustained growth in demand for these products in the world market. It is therefore a golden opportunity for India to be ready to exploit the opportunities that would be presented by the expected expansion in the global trade of these products. But, as has been seen in the course of this study, there are multiple factors that are holding India back. So, first of all, India would need to plug the loopholes plaguing its horticulture sector in particular, and the larger agriculture sector in general.

India also has to be mindful of the fact that competition from countries/regions such as China, USA, South-East Asia and Latin America is only going to intensify in the years to come. Every country wants to corner the biggest share of this market. India therefore would need to be at the top of her game, if she wishes to translate her potential into

[10] Wastage of Agricultural Produce (pib.gov.in)
[11] India wastes up to 16% of its agricultural produce; fruits, vegetables squandered the most | The Financial Express

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reality. Multiple reports have indicated that going forward, the best way to derive the maximum benefit from the agriculture sector would be to go for more and more value addition. This would include things like going in for export of cut-fruits, for trade in processed foods, building adequate cold-chains in order to supply the fruits in the off-season when the prices are high. In the context of international trade in fresh fruits & vegetables, data being generated from almost all the sources, is unequivocally pointing in this direction. So, it is no longer just a theoretical possibility. Data, in a way, is therefore reminding India of the direction her agriculture sector needs to take.

Apart from setting up value preservation and value enhancement pieces of infrastructure such as cold chains and food processing industries, India would also need to actively scout for opportunities to get into favorable free trade agreements with countries / regions that are ready for such partnerships. This would obviously mean a certain degree of give and take. India would therefore need to be open-minded about allowing imports of agricultural goods from such partnering countries. This may disturb the market access that is currently available exclusively to local producers. But, by diverting her production capacities, from low value crops like grains where India does not enjoy the competitive advantage, into high value ones such as tropical fruits, where India has distinct advantages, India would not only be able to prevent large scale displacement of her domestic farmers from the market, she would also be able to goad them into production and trade of commodities that present possibilities of much higher margins over much larger time horizons.

And, India would also need to be cognizant of the fact, that going forward, the dependence of the agriculture sector on force multiplier services such as agricultural R&D, innovations in products & packaging, would increase by orders of magnitude. Therefore, along with work in the on-field areas, India would also need to strengthen off-field, but related infrastructure such as institutional network to meet the credit, marketing and insurance related needs of agriculture and allied sectors, institutions dedicated to R&D in agriculture etc. If all these points are adequately addressed, Indian agriculture would be able to see the kind of transformation that was seen by the likes of IT sector and pharma sector from mid-1990s onwards.

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