Journal of Mathematical Problems, Equations and Statistics

E-ISSN: 2709-9407
P-ISSN: 2709-9393
JMPES 2023; 4(2): 22-26

www.mathematicaljournal.com
Received: 18-08-2023
Accepted: 20-09-2023

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Progress and potential of horticulture crops in India: An mathematical analysis

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Abstract
Agriculture is the dominant sector of the Indian Economy. Horticulture has emerged as an indispensable part of agriculture, offering a wide range of choices to the farmers for crop diversification and much needed nutrition to the people. The term 'Horticulture' is derived from the Latin words 'Hortus' means garden and 'culture' means cultivation. It also provides ample opportunities for sustaining a large number of agro-industries which generate substantial employment opportunities. The objective of the paper is to analyze the Issues, Challenges, and Scope of Supply Chain Management in Fruits and Vegetables in India**.** The trend analysis reveals wide variation in the growth performance of fruits and vegetables across states. The productivity growth at all India level is low, which needs to be addressed. The major concerns of the sector are improving the productivity through research and development, enhancing the share of value-added products, geographical diversification of exports and enhancing the infrastructure including cold storage and rural roads.

Keywords: Substantial, employment, opportunities

Introduction
"Horticulture is a science and technology of production, processing and merchandising of fruits, vegetables, flowers, spices plantations, medicinal and aromatic".
India is one of the largest, low-cost producers of fruits and vegetables in the world. Agriculture is the dominant sector of the Indian Economy. Horticulture is the practice of producing, improving, and utilizing horticulture crops such as fruits, vegetables, and flowers. Horticulture crops perform a crucial role in the enhancement of the Indian economy by creating jobs, producing raw materials for food industries, and gaining high profits for foreign investors. India's horticulture sector has proven to be more profitable and productive than the agricultural sector and has emerged as a rapidly growing industry. According to the Agricultural and Processed Food Products Export Development Authority (APEDA), India ranks second in fruits and vegetable production in the world after China. In addition, India leads the world in the production of ginger and okra, along with banana, papaya, mango and guava. The country has diverse topography and climate, which ensures availability of fruits and vegetables in every season. In 2021-22, the total horticulture production was around 341.63 million tones, with fruit production at around 107.10 million tones and vegetable production at around 204.61 million tones. India's horticulture output is likely to reach a record 350.87 million tones in the current crop year (July 2022-June 2023) as production of fruits, vegetables, spices and plantation crops increased significantly.

Methodology
Simple Growth Rate and Compound Growth Rate have been estimated using the following:

Simple Growth Rate $G = \frac{(y_t - y_0)}{y_0} * 100$

Compound Growth Rate $R = \left[\left\{\frac{y_t}{y_0}\right\}^{\frac{1}{n}} - 1\right] * 100$

Projection based on Simple Growth Rate

$y_t = y_0(1 + ng)$,

Where y_0 is an initial year
y_t is the projection year
n is number of years from base year and g is simple proportionate growth rate

Results and Discussion

India has diverse topography and climate, which is highly favorable for growing a large number of horticultural crops such as fruits, vegetables, root tuber, ornamental, aromatic plants, medicinal herbs, spices and plantation crops like Coconut, arecanut, cashew and coca. Table-I present the production of Fruits, Vegetables, foodgrains and human population since 2000-01 to 2021-22. It is seen that Fruits production has been increased from 43001 thousand tones 2000-01 to 102924 thousand tones in 2021-22. Similarly, Vegetables production has also been increased to 199882 thousand tones in 2021-22 from 88622 thousand tones in 2000-01. Foodgrains production has been increased from 212.85 M tones 2000-01 to 315.72 M tones in 2021-22. Growth rate per annum has also been worked out.

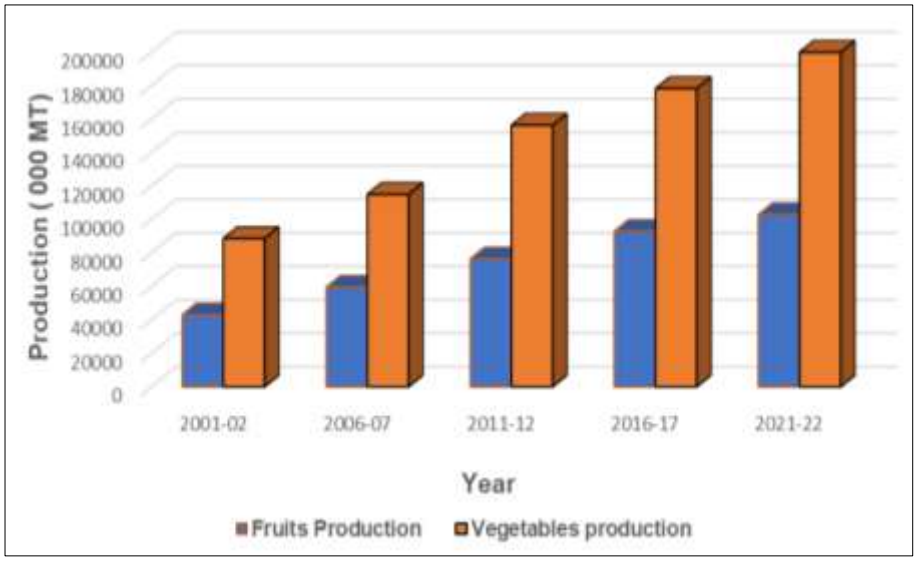

Fig 1: Foods and vegetables production

The State-wise break up of Area sown and production of Fruits is presented in Table-2. It could be seen that Andhra Pradesh is the highest Fruits producing state with17.72% of the total production in the country. Andhra Pradesh along with Maharashtra (11.63%), Uttar Pradesh (10.36%), Madhya Pradesh (8.34%) and Gujrat (7.70%) produce more than 55% Fruits production in the country.

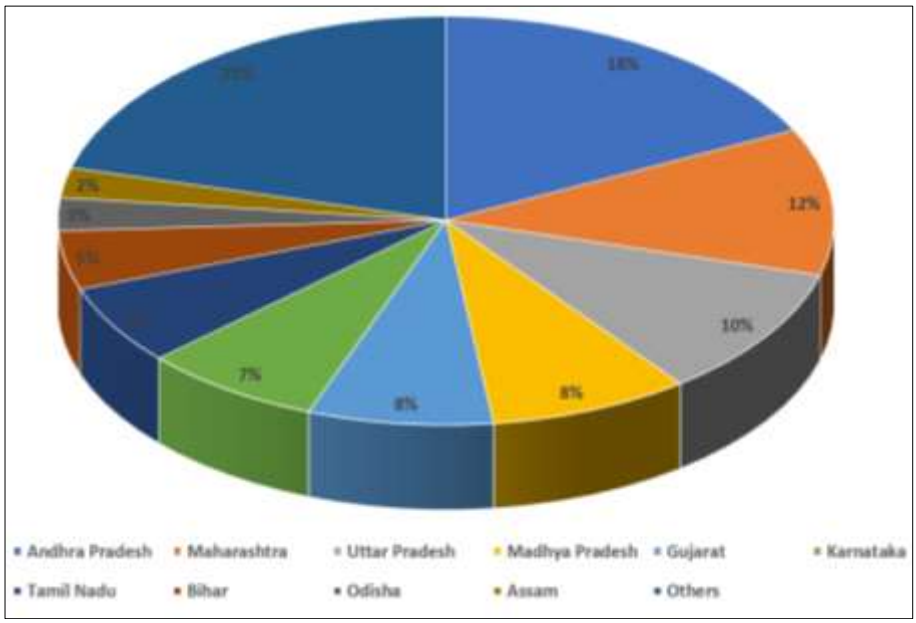

Fig 2: % Age of Fruits production of major states

The State-wise Area sown and production of Vegetables is depicted in Table - 3. It could be observed that Uttar Pradesh (14.62%) is the highest Vegetables producing state in the country followed by West Bengal, Madhya Pradesh, Bihar, Maharashtra and Gujarat. Theses six states together produce around 64% vegetables in the country.

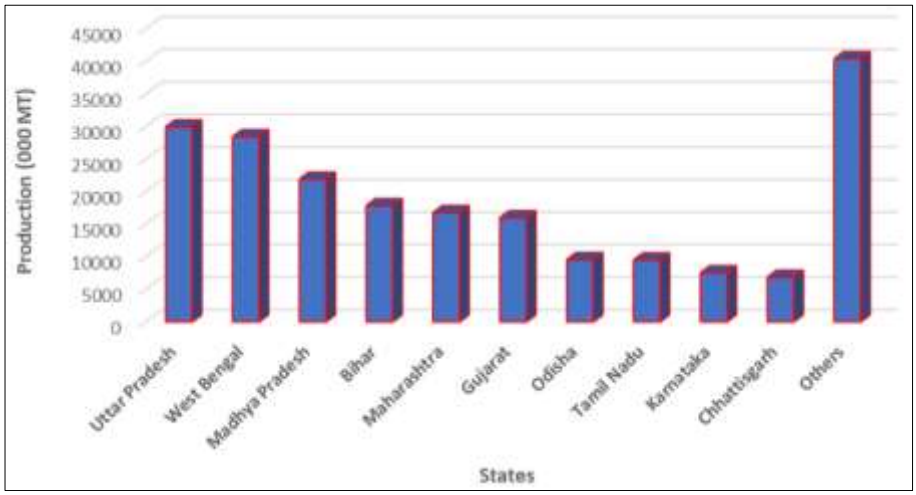

Fig 3: Major Vegetables Producing States

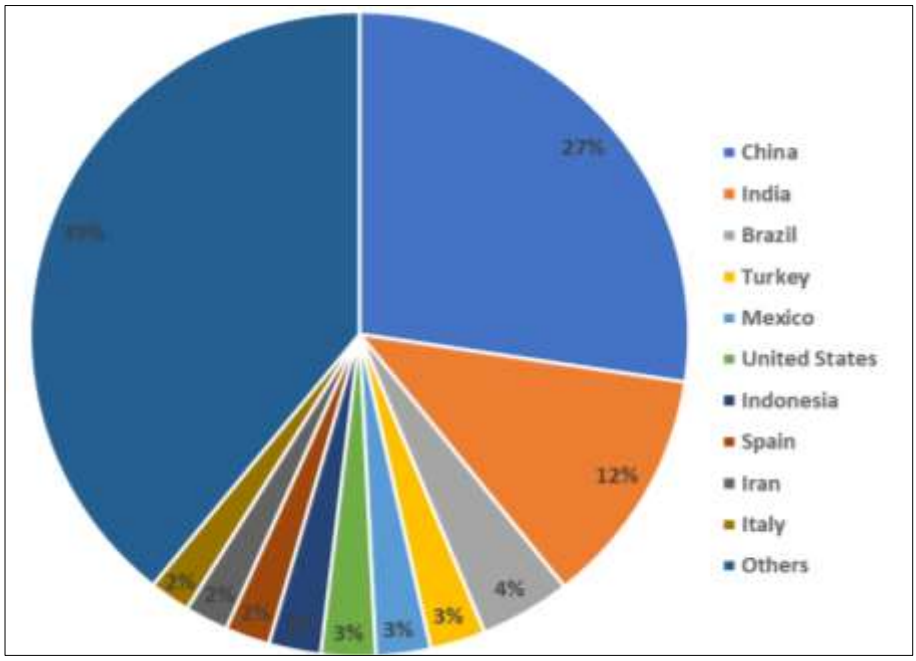

Fig 4: Major Fruits Producing County

Table 1: All India Fruits and Vegetables Production

Year	Fruits Production 000 MT	Vegetable Production 000 MT	Food grains production M Tones
2001-02	43001	88622	212.85
2002-03	45203	84815	174.77
2003-04	45942	88334	213.19
2004-05	50988	101246	198.36
2005-06	55356	111399	208.60
2006-07	59563	114993	217.28
2007-08	65587	128449	230.78
2008-09	68466	129077	234.47
2009-10	71516	133738	218.11
2010-11	74878	146554	244.50
2011-12	76424	156325	259.29
2012-13	81285	162187	257.13
2013-14	88977	162897	265.04
2014-15	86602	169478	252.02
2015-16	90183	169064	251.54
2016-17	92918	178172	275.11
2017-18	97358	184394	285.01
2018-19	97967	183170	285.21
2019-20	102088	188284	297.5
2020-21	102481	200445	310.74
2021-22	102924	199882	315.72
Growth rate (% per Annum)	6.64	5.98	2.30

Table 2: Area and Production of Fruits in Major States (2021-22)

States	Area 000 ha	Area % age share	Cumulative % share	Production 000 MT	Production %age share	Cumulative % share
Andhra Pradesh	788.22	11.18	11.18	18999.02	17.72	17.72
Maharashtra	831.18	11.79	22.97	12466.98	11.63	29.34
Uttar Pradesh	505.13	7.17	30.14	11113.86	10.36	39.70
Madhya Pradesh	432.24	6.13	36.27	8939.47	8.34	48.04
Gujarat	432.52	6.14	42.40	8260.78	7.70	55.74
Karnataka	416.22	5.90	48.31	8016.25	7.47	63.22
Tamil Nadu	323.61	4.59	52.90	6761.93	6.31	69.52
Bihar	363.77	5.16	58.06	4986.74	4.65	74.17
Odisha	366.66	5.20	63.26	2782.6	2.59	76.77
Assam	163.54	2.32	65.58	2539.77	2.37	79.14
Others	2426.33	34.42	100	22374.11	20.86	100
ALL INDIA	7049.42	100		107241.51	100	

Table 3: Area and Production of Vegetables in Major States (2021-22

States	Area 000ha	Production 000 MT	Area % age share	Cumulative % share	Production %age share	Cumulative % share
Uttar Pradesh	1326.92	29940.09	11.69	11.69	14.62	14.62
West Bengal	1530.88	28433.88	13.49	25.18	13.88	28.50
Madhya Pradesh	1136.94	21922.93	10.02	35.20	10.70	39.20
Bihar	904.56	17856.10	7.97	43.17	8.72	47.92
Maharashtra	1171.50	16790.28	10.32	53.50	8.20	56.12
Gujarat	808.11	15994.82	7.12	60.62	7.81	63.92
Odisha	679.04	9577.65	5.98	66.60	4.68	68.60
Tamil Nadu	381.61	9507.29	3.36	69.97	4.64	73.24
=Karnataka	485.83	7544.45	4.28	74.25	3.68	76.92
Chhattisgarh	490.05	6855.95	4.32	78.57	3.35	80.27
Others	2432.24	40411.68	21.43	100	19.73	100
ALL INDIA	11347.68	204835.12	100		100	

Table 4: Major Fruits Producing Countries Globally (2020)

	Production (000 MT)	% age share	Cumulative %age Share
China	242794	27.37	27.37
India	105971	11.95	39.32
Brazil	39759	4.48	43.80
Turkey	24153	2.72	46.52
Mexico	23838	2.69	49.21
United States	23748	2.68	51.89
Indonesia	22744	2.56	54.45
Spain	19471	2.20	56.65
Iran	18964	2.14	58.79
Italy	17828	2.01	60.80
Others	347759	39.20	100
TOTAL	887027	100	

India is the second largest producer of the fruits and vegetables in the world with first rank in the production of Banana, Mango, Lime & Lemon, Papaya and Okra. Its horticulture production has increased by 30 per cent in the last five years. Table - 4 presents the major Fruits producing countries in the world. It is seen, that China is the highest producing country with 27.37% share followed by India (11.95%), Brazil (4.48%), Turkey (2.72%). Mexico (2.69%) and United States (2.68%). These Countries together accounting more than 51% of global fruits production.

Table 5: Projected Production for Fruits and Vegetables

	2025-26	2030-31
Fruits (000 MT)	114494	127806
Vegetables (000 MT)	223355	249662

Table - 5 presents the projected production for Fruits and Vegetables for 2025-26 and 2030-31. It is seen that the production for fruits has been estimated of the order of 114494 thousand tones in 2025-26 and 127806 thousand tones in 2030-31. The Vegetable production will be 223355 thousand tones and 249662 thousand tones in 2025-26 and 2030-31 respectively.

Conclusions

The trend analysis reveals wide variation in the growth performance of fruits and vegetables across states. Generally, the productivity growth at all India level is low, which needs to be addressed. The major concerns of the sector are improving the productivity through research and development, enhancing the share of value-added products, geographical diversification of exports and enhancing the infrastructure including cold storage and rural roads.

Way Ahead

- Proper utilization of latest Science and Technology-led advancement
- Improvement in quality seeds & plants

- Price stabilization and minimizing the gap between the retail price and wholesale price.
- Imparting the education related to horticulture to upscale youth knowledge regarding various government schemes and modern equipment and machinery.
- Adoption of efficient post-harvest management and practices to enhance the value of fruits in the long run
- Establishing a better long-distance transportation network to ensure smooth and hindrance-free transportation of fresh horticultural produce.

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