



Exploring the Horticultural Sector in Arunachal Pradesh, India: Status and Prospects

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The horticultural industry in Arunachal Pradesh, a state renowned for its abundant biodiversity and unique agroclimatic conditions, is examined in this research. In this area, horticulture features a variety of crops, including citrus, kiwi, spices, and medicinal plants, and is positioned as a crucial area for addressing food security and economic sustainability. The study looks at developments in productivity, production, and cultivation from 2014 to 2024, providing information on how changes in crop focus and land usage affect the dynamics of the industry. Issues with market access, infrastructure limitations, and shrinking crop regions continue to be obstacles despite its potential. In order to meet changing market demands and environmental concerns, this article examines the strategic significance of horticulture revitalization through an analysis of important growth measures.

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1. INTRODUCTION

Northeast India is home to the state of Arunachal Pradesh, often called the “Land of the Rising Sun”, and the Orchid State of India. It is the largest state in the east, covering an area of 83,743 square kilometres. These states share borders with Assam and Nagaland and Bhutan shares borders with China and Myanmar. Located between the Patkoi range and the foothills of the Himalayas, Arunachal Pradesh has a unique landscape, flora and fauna. Aqueducts and canals, which are tributaries of the Brahmaputra River, also pass through here (Lama 2016, Tiwari et al. 2022, Avasthe et al. 2013). The state has great potential for the development of crops, fruits, vegetables, spices, flowers and pharmaceuticals. Horticulture is widely marketed for its valuable food and is an important means of survival contributing to livestock income and economic growth. Sustainability and environmental protection are additional benefits of horticultural diversification. The increasing demand for horticultural produce worldwide provides many opportunities for business growth. Despite Arunachal Pradesh's natural resources, its development potential is yet to be tapped. The transformation of civilization poses a threat to the environment and with population growth outpacing food production, concerns about food security are intensifying (Wangchu et al. 2024, Singh 2015, Asati and Yadav 2004, Handique et al. 2022).

Agriculture is believed to be a way to reduce the impact of civilizational change while improving the health and natural balance of the country. Arunachal Pradesh is the second largest fruit producer in the east after Assam. The state government has encouraged horticulture as an alternative to animal husbandry. Although it requires more investment, horticulture – especially fruit crops such as citrus, apple and kiwi – is considered more profitable than other forms of agricultural training. The businesses benefit the pastors and their livelihoods by creating employment, increasing exports and ensuring food security. Although plant-based products have been successful for many years, there are still problems such as poor access and poor communication. The objective of this study is to assess the spread of rice cultivation in Arunachal Pradesh, its contribution to the thrift

policy of the state and the reasons behind its development (Melo and Das, Mishra et al.).

2. CONCEPT OF HORTICULTURE CROP IN ARUNACHAL PRADESH

The production of fruits, vegetables, spices, flowers, plantation crops, and aromatic & medicinal plants in Arunachal Pradesh is referred to as horticulture. A wide range of horticultural crops can be grown in the state because to its distinctive terrain, which is marked by a variety of climatic zones and an abundance of natural resources. In Arunachal Pradesh, horticulture is vital to the state's agricultural economy since it creates jobs, improves food security, and helps local farmers make money (Wangchu et al. 2024).

2.1 AGRO-climate Zones

The diverse temperature and elevation of Arunachal Pradesh enable the production of a broad variety of crops, ranging from temperate crops in higher elevations to Sub-tropical fruits in lower elevations (Wangchu et al. 2024).

2.2 Fruit Cultivation

Arunachal Pradesh's horticulture heavily relies on fruit production. Citrus fruits like oranges and lemons, as well as exotic fruits like kiwis, which have become more and more popular in recent years, are produced in great quantities throughout the state. The practice of growing apples & kiwi commercially at higher elevations is also becoming more popular (Wangchu et al. 2024).

2.3 Production of Vegetables

The vegetable market is smaller, it still includes leafy greens, cauliflower, peas, and cabbage. Although there is room for expansion and commercialization, vegetables are primarily farmed for local use in kitchen gardens and on small farms (Wangchu et al. 2024).

2.4 Aromatic Plants and Spices

Arunachal Pradesh is well-known for growing spices, especially ginger, which is a significant cash crop there. An additional common spice is turmeric (Wangchu et al. 2024).

2.5 Objectives of the Study

- To study the trends in area under cultivation of major horticultural crops in Arunachal Pradesh from 2014-2015 to 2023-2024.
- To study the trends in production and productivity of major horticultural crops in Arunachal Pradesh from 2014-2015 to 2023-2024.

2.6 Tools of Analysis

- To find the Compound annual growth rate and Average.

2.7 Period of the Study

- The study period was from 2014-15 to 2023-24 (agricultural year).

3. MAJOR FRUIT CROPS IN ARUNACHAL PRADESH

According to data for 2024, Arunachal Pradesh's horticulture landscape features a wide variety of important fruit crops. Of these, citrus fruits are the most widely grown, with an area of 12.79 thousand hectares and a significant yield of 58.93 thousand metric tons. In the state's cooler parts, apples are the most popular crop, with a cultivated area of 3.57 thousand hectares and a yield of 6.79 thousand metric tons. Growing in importance in niche markets, the kiwi is a relatively new yet important crop that covers 2.43 thousand hectares and yields 7.05 thousand metric tons. Key roles are also played by pineapple and banana, which are grown on 3.23 and 3.63 thousand hectares of land, respectively, and yield 20.52 and 14.49 thousand metric tons.

Cultivated on a lower scale, however, crops such as papaya and litchi have minimal production levels of 0.60 and 0.08 thousand metric tons, respectively. Merely 0.01 thousand metric tons of mangos are produced over a very small area, making mango cultivation practically inconsequential. While highlighting the potential for diversification and higher production through targeted initiatives in underutilized crops like papaya and litchi, this data also highlights the state's reliance on a few fruit products.

4. MAJOR VEGETABLE CROPS IN ARUNACHAL PRADESH

The table highlights key vegetable crops grown in Arunachal Pradesh, focusing on their cultivation areas and production levels. Potato stands out as the most important crop, grown on

the largest area and producing the highest yield. Cabbage follows closely with a significant share in both cultivation and production. Tomatoes and brinjal also contribute notably, though their cultivation areas and outputs are relatively smaller. Other vegetables such as chili, pea, carrot, cucumber, bottle gourd, and pumpkin are cultivated on a smaller scale. Among these, pumpkin has a noteworthy yield despite being grown in a limited area. In contrast, bottle gourd has the smallest presence in terms of both cultivation area and production. This overview showcases the diversity of vegetable farming in the region while highlighting the varying importance of different crops in terms of their contribution to agricultural production.

5. MAJOR SPICES IN ARUNACHAL PRADESH

Arunachal Pradesh's significant spice production and cultivation are detailed in the table. Ginger, cardamom, turmeric, black pepper, and dried red chilies are the five main spices that are highlighted. Despite having the highest cultivated area (6,740 hectares), cardamom only produces 1,720 metric tons. The largest producer, ginger, is cultivated on 3,780 hectares and yields a noteworthy 18,430 metric tons. 1,470 metric tons of turmeric are produced from 540 hectares of cultivation. The areas used to grow dried red chilies and black pepper are far smaller—50 hectares for black pepper and 10 hectares for dried red chilies—resulting in extremely low production levels of 10 and 20 metric tons, respectively.

6. AREA UNDER HORTICULTURE CROPS IN ARUNACHAL PRADESH

The table shows changes in fruits, vegetables, plantation crops, aromatics & medicinal plants, flowers, and spices, as well as data on the area under horticultural crops in Arunachal Pradesh from 2014–2015 to 2023–2024 (Ministry of Agriculture and Farmers Welfare 2014-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

The acreage and output values are expressed in thousand hectares ('000 Ha) and thousand metric tons ('000 MT), respectively. Despite a discernible decrease from 90 thousand hectares in 2014–2015 to 30.09 thousand hectares in 2021–2022, fruits continue to occupy the largest area (Ministry of Agriculture and Farmers Welfare

2024-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

The number of vegetables has fluctuated little, beginning at 1.7 thousand hectares in 2014–2015 and progressively increasing to 2.62 thousand hectares by 2018–2019, where it will

remain until 2023–2024. The slight but steady growth in plantation crops—especially in 2020–2021 with 2.67 thousand hectares—indicates a growing interest in this market (Ministry of Agriculture and Farmers Welfare 2014-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Table 1. Major fruit crops in Arunachal Pradesh, 2024

Major Fruit Crops in Arunachal Pradesh, 2024			
Area in '000 Ha			
Sl. No.	Fruits	Area	Production in '000 MT
1	Citrus	12.79	58.93
2	Apple	3.57	6.79
3	Kiwi	2.43	7.05
4	Pineapple	3.23	20.52
5	Litchi	0.10	0.08
6	Papaya	0.15	0.60
7	Mango	0.00	0.01
8	Banana	3.63	14.49

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

Table 2. Major vegetables crops in Arunachal Pradesh

Major Vegetables Crops in Arunachal Pradesh			
Area in '000 Ha			
Sl. No.	Vegetables	Area	Production in '000 MT
1	Tomato	0.15	0.88
2	Potato	0.45	6.07
3	Chili	0.24	0.37
4	Cabbage	0.35	5.03
5	Pea	0.06	0.12
6	Brinjal	0.24	0.81
7	Carrot	0.04	0.45
8	Cucumber	0.04	0.12
9	Bottle Gourd	0.00	0.03
10	Pumpkin	0.10	0.71

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

Table 3. Major spices in Arunachal Pradesh

Major Spices in Arunachal Pradesh			
Production in '000 MT		Area in '000 Ha	
Sl. No.	Spices	Area	Production
1	Ginger	3.78	18.43
2	Cardamom	6.74	1.72
3	Turmeric	0.54	1.47
4	Black Papper	0.05	0.01
5	Red Chillies (Dried)	0.01	0.02

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024)

Table 4. Area under horticulture crops in Arunachal Pradesh

Area under Horticulture crops in Arunachal Pradesh								Area in '000 Ha
Production in '000 MT								
Sl. No.	Years	Fruits	Vegetables	Plantation	Aromatics & Medicinal	Flowers	Spices	Total
1	2014-2015	90	1.7	0.02	1.86	109.18	10	212.76
2	2015-2016	66.21	4	1.09	0.46	0.02	11.44	83.22
3	2016-2017	48.71	1.75	0.07	0.46	0.02	11.44	62.45
4	2017-2018	48.13	2.58	0.06	0.25	0	7.48	58.5
5	2018-2019	48.14	2.62	0.07	0.24	0	12.1	63.17
6	2019-2020	48.14	2.62	0.07	0.24	0	15.62	66.68
7	2020-2021	48.14	2.62	2.67	0.24	0	13.86	67.54
8	2021-2022	30.09	2.62	1.6	0.24	0	12.33	46.88
9	2022-2023	30.09	2.62	0.89	0.24	0	11.21	45.05
10	2023-2024	30.09	2.62	1.8	0.24	0	9.53	44.28
Average		48.77	2.58	0.83	0.45	10.92	11.5	75.05
CAGR		-0.1	0.04	0.57	-0.18	-0.66	0	-0.15

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

Due to less focus on these crops, aromatics and medicinal crops saw a sharp decline from 1.86 thousand hectares in 2014–2015 to just 0.24 thousand hectares after that. Following 2014–2015, the flower segment saw a dramatic drop from a noteworthy 109.18 thousand MT to zero in the following years, signifying a total departure from large-scale flower farming. Though they have decreased during the past two years, spices have remained consistent, ranging between 10 and 15.62 thousand MT (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

7. PRODUCTION OF HORTICULTURE CROPS IN ARUNACHAL PRADESH

With an emphasis on the contributions of fruits, vegetables, plantation crops, aromatics & medicinal plants, flowers, as well as spices, the table shows the production of horticultural crops in Arunachal Pradesh from 2014–2015 to 2023–2024. The area is represented in thousand hectares ('000 Ha), while the data is evaluated in thousand metric tons ('000 MT) (Ministry of

Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

With 331.4 thousand MT, fruits constituted the mainstay of production during the 2014–2015 period, making a substantial contribution to the total of 387.73 thousand MT. Fruit production, however, drastically decreased from 306.27 thousand MT in 2015–2016 to 124.38 thousand MT in 2016–2017. It then stabilized at about 125 thousand MT before rising to 138.16 thousand MT starting in 2021–2022 (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Changes in crop focus, cultivation methods, or even market conditions may be the cause of the reduction. The trend for vegetables was likewise erratic, beginning at 41 thousand MT in 2014–2015 and falling to about 14.42 thousand MT in 2016–2017 (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

After that, there was a recovery, and starting in 2018–2019, vegetable production stabilized at about 17,000 MT. The growing tendency in veggies can be a sign that horticulture is placing more emphasis on variety. Plantation crop production started out small, at 0.01 thousand MT in 2014–2015, but it grew significantly, peaking at 11.76 thousand MT in 2020–2021. Despite a subsequent minor decline in production, overall increase remained significant, indicating a recent strategic focus on plantation crop. Aromatics and medicinal crops saw a steep reduction in focus or viability, as seen by their sharp decline from 5.15 thousand MT in 2014–2015 to just 0.16 thousand MT in subsequent years. The production of flowers also fell precipitously, from 10.17 thousand MT in 2014–2015 to almost nothing in the following years (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

With a production of 74.44 thousand MT in 2014–2015, the spices segment played a major

role at first, but in many years after that, it drastically declined to zero. A small recovery was indicated by its 2023–2024 rebound of 7.46 thousand MT. With a Compound Annual Growth Rate (CAGR) of -0.08 and an average total production of 194.61 thousand MT across all crops, horticulture production has been trending downward over time (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24). This negative growth was caused in part by the dramatic reduction in aromatics and flowers, as well as the severe decline in fruits and spices. Vegetables and plantation crops, on the other hand, offered some stability and had been growing or staying relatively constant in recent years. Due to market needs, climate conditions, or agricultural policy, this data suggests a change in the state's agricultural strategy, maybe emphasizing some crops while lowering emphasis on others (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Table 5. Production of Horticulture crops in Arunachal Pradesh

Production of Horticulture crops in Arunachal Pradesh								
								Area in '000 Ha
Production in '000 MT								
Sl. No.	Years	Fruits	Vegetables	Plantation	Aromatics & Medicinal	Flowers	Spices	Total
1	2014-2015	331.4	41	0.01	5.15	10.17	74.44	387.73
2	2015-2016	306.27	33.01	8.33	0.99	0.01	0.08	348.62
3	2016-2017	124.38	14.42	0.1	0.99	0.01	0.08	139.91
4	2017-2018	125.7	16.6	0.14	0.16	0	0	142.61
5	2018-2019	125.84	17.39	0.21	0.16	0	0	143.6
6	2019-2020	125.84	17.39	0.21	0.16	0	0	143.6
7	2020-2021	125.84	17.41	11.76	0.16	0	0	155.18
8	2021-2022	138.16	17.41	7.05	0.16	0	0	162.78
9	2022-2023	138.16	17.34	3.89	0.16	0	0	159.55
10	2023-2024	138.16	17.34	6.88	0.16	0	0	162.54
Average		167.98	20.93	3.86	0.83	1.02	7.46	194.61
CAGR		-0.08	-0.08	0.92	-0.29	-0.56	-0.64	-0.08

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

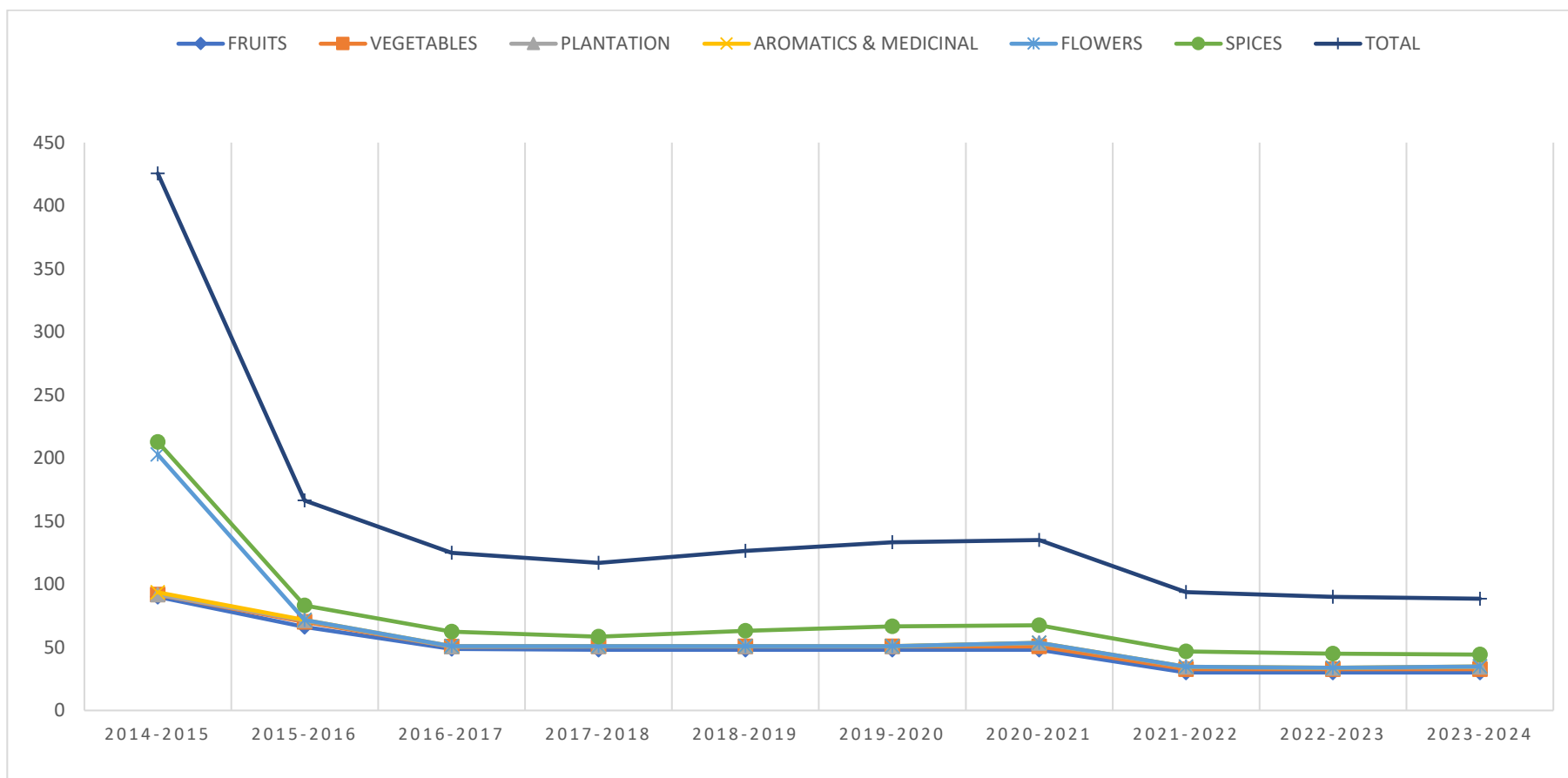


Fig. 1. Area under horticulture crops from 2014-2024

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

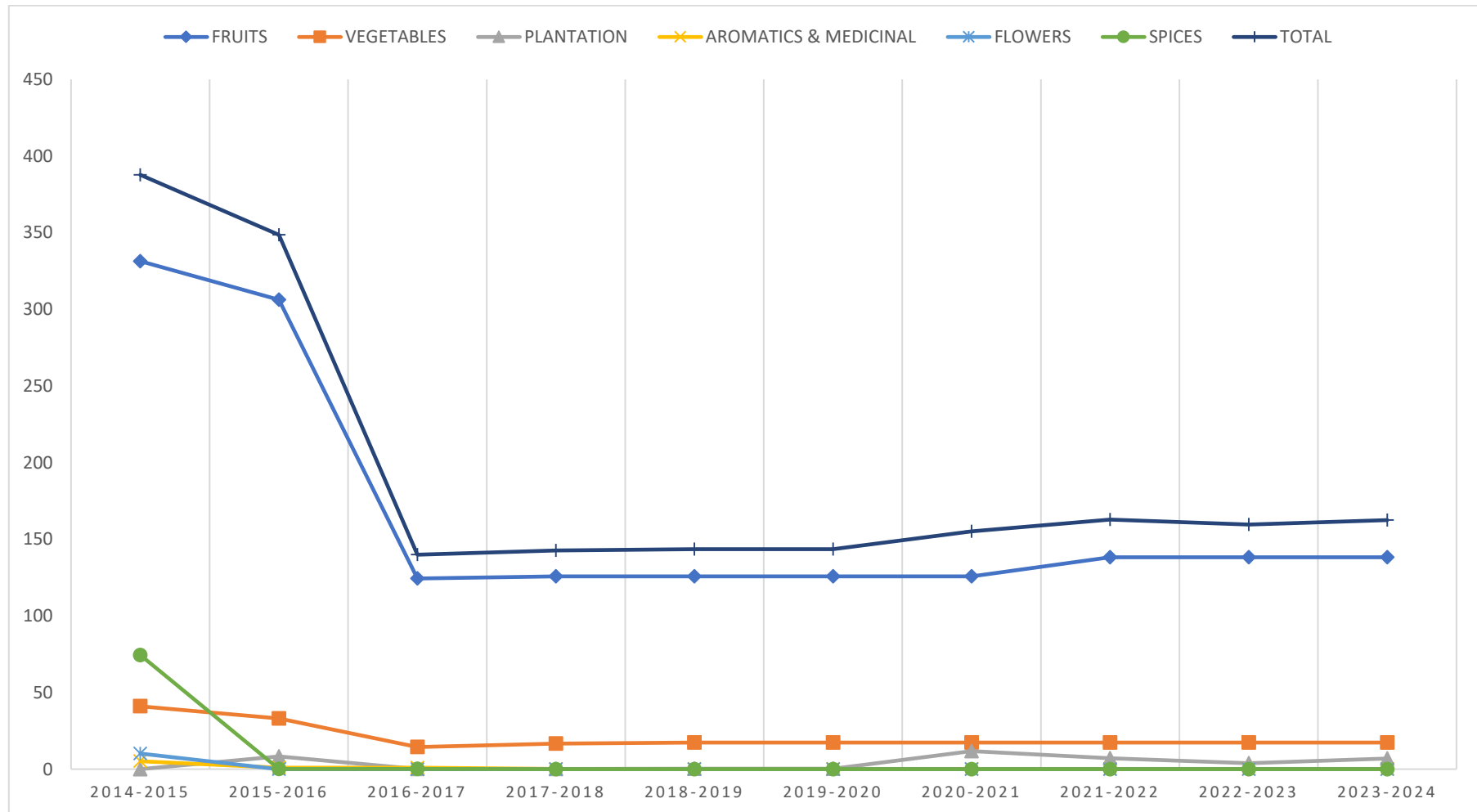


Fig. 2. Production of horticulture crops from 2014-2024

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

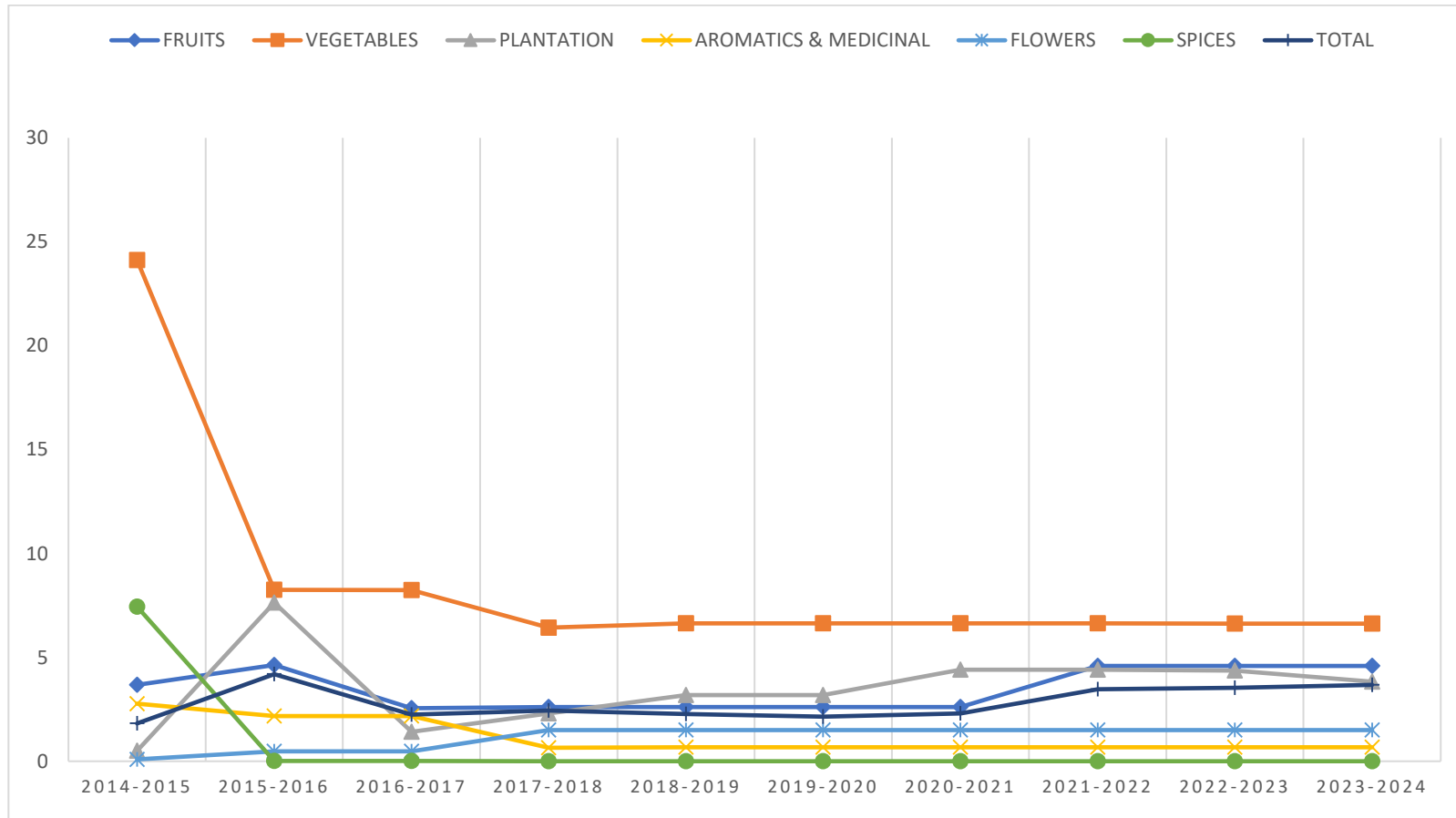


Fig. 3. Productivity of horticulture crops from 2014-2024

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

Table 6. Productivity of horticulture crops in Arunachal Pradesh

Productivity of Horticulture crops in Arunachal Pradesh								Area in '000 Ha
Production in '000 MT								
Sl. No.	Years	Fruits	Vegetables	Plantation	Aromatics & Medicinal	Flowers	Spices	Total
1	2014-2015	3.68	24.12	0.5	2.77	0.09	7.44	1.82
2	2015-2016	4.63	8.25	7.63	2.18	0.47	0.01	4.19
3	2016-2017	2.55	8.23	1.41	2.18	0.47	0.01	2.24
4	2017-2018	2.61	6.43	2.3	0.65	1.5	0	2.44
5	2018-2019	2.61	6.64	3.18	0.67	1.5	0	2.27
6	2019-2020	2.61	6.64	3.18	0.67	1.5	0	2.15
7	2020-2021	2.61	6.64	4.41	0.67	1.5	0	2.3
8	2021-2022	4.59	6.64	4.41	0.67	1.5	0	3.47
9	2022-2023	4.59	6.62	4.36	0.67	1.5	0	3.54
10	2023-2024	4.59	6.62	3.83	0.67	1.5	0	3.67
Average		3.51	8.68	3.52	1.18	1.15	0.75	2.81
CAGR		0.02	-0.12	0.23	-0.13	0.32	-0.63	0.07

Source: Data for 2014-2015 to 2023-2024 are taken from Ministry of Agriculture & Farmers Welfare Government of India (2024).

8. PRODUCTIVITY OF HORTICULTURE CROPS IN ARUNACHAL PRADESH

The productivity of Arunachal Pradesh's horticultural crops from 2014–2015 to 2023–2024 is shown in the table, which offers information on the following important categories: fruits, vegetables, plantation crops, aromatics & medicinal plants, flowers, and spices. The unit of measurement used to express the productivity data is Thousand metric tons per thousand hectares ('000 MT per '000 Ha). Vegetable productivity peaked in 2014–2015 at 24.12 '000 MT per '000 Ha, which helped to achieve the highest overall productivity of 1.82 '000 MT per '000 Ha. Vegetable productivity fell sharply over time, peaking at 8.25 '000 MT per 1,000 Ha in 2015–2016 and then levelling off at 6.6 '000 MT per 1,000 Ha in subsequent years. This drop points to either a fall in the emphasis on intensive vegetable growing or a decline in yield efficiency (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Fruits also fluctuated, peaking at 4.63 '000 MT per '000 Ha in 2015-2016 after beginning at 3.68 '000 MT per '000 Ha in 2014-2015. In the following years, they stabilized at 2.61 '000 MT per '000 Ha. Over the past three years, there has been a rebound, which is indicative of an attempt to increase fruit cultivation efficiency (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Productivity of plantation crops increased significantly, especially in 2015-2016, when it increased from 0.5 '000 MT per '000 Ha to 7.63 '000 MT per '000 Ha. In the following years, this tendency persisted, with variations ranging from 3.18 to 4.41 '000 MT per '000 Ha (Ministry of Agriculture and Farmers Welfare 2214-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

Beginning at 2.77 '000 MT per '000 Ha in 2014-2015 and falling to 0.67 '000 MT per '000 Ha in subsequent years, aromatics and medicinal

crops had a significant reduction, suggesting a lack of attention or declining yields. After a brief reduction, flower productivity stayed mostly constant, but spices saw a steep drop from 7.44 '000 MT per '000 Ha to zero for the majority of the time. At a Compound Annual Growth Rate (CAGR) of 0.07, the average total productivity was 2.81 '000 MT per '000 Ha. These patterns, which reflect changes in cultivation techniques or market and environmental conditions, underscore the difficulties Arunachal Pradesh faces in sustaining consistent and effective output across a variety of horticulture crops (Ministry of Agriculture and Farmers Welfare 2014-15, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-24).

9. CONCLUSION

Arunachal Pradesh has huge potential for horticulture development due to its unique geographical location and natural resources. Often referred to as the 'Orchid State of India' due to its unique climate and biodiversity, the state is set to become a leader in food production. Despite agricultural challenges and lack of infrastructure and trade, the state's horticulture sector is stable and profitable in terms of agriculture, especially for fruits like citrus, apple and kiwi. As global demand for its products increases, the horticulture industry has the potential to strengthen the economy, ensure food security and promote sustainable development. Arunachal Pradesh can realise its untapped potential by promoting horticulture as a way to reduce environmental degradation and address housing problems. The horticulture sector in Arunachal Pradesh has changed significantly between 2014 and 2024. The area under cultivation has decreased, and the yield of fruits and flowers has decreased. The state's total crop production has decreased, but some good crop like rice have been produced. This decline indicates the need for planning to arrest the decline and increasing the capacity of important crops like spices and vegetables.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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