An analysis of the growth of China’s fruit and vegetable sector (1990-2024)

World Vegetable Center

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Cover picture: A farmer harvesting Chinese violet (*Telosma cordata*) flower buds in Zengcheng, China (Photo: T Deng).
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An analysis of the growth of China's fruit and vegetable sector (1990-2024)

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Executive summary

This study analyzed the growth of China's fruit and vegetable sector since 1990, using publicly available statistics, a review of mostly Chinese academic literature, and primary data collected from two case studies. It was found that China's fruit production expanded by 302% from the mid-1990s to the early 2020s, and national vegetable production grew by 380%, expanding across all provinces, with some like Shandong, Henan, and Guangxi emerging as key production areas.

By 2023, China accounted for 53% of global vegetable production and 36% of global fruit production by value, based on FAO data. Among global vegetable production, China accounted for 93% of spinach production, 82% of cucumber and gherkin, 45% of green chili, and 36% of tomatoes worldwide.

From 1990 to 2023, China's average vegetable yield increased by 56%, while the cultivated area expanded by 246%. For fruit, the average yield increased by 264%, and the cultivated area grew by 180%. Protected cultivation expanded rapidly, reaching about 2.7 million hectares in 2023, producing around 230 million tonnes annually. Currently, protected cultivation accounts for 45% of vegetable production by value, with key crops including tomatoes, peppers, and cucumbers, though many other crops are also produced.

Fruit and vegetable production remains predominantly driven by smallholder family farms, which have organized into cooperatives and linked to markets. Agroenterprises have played a significant role in growth, as demonstrated by case studies of vegetables in Gaozhou and lychee in Guangzhou. Research organizations and private companies have also contributed notably, especially through the spread of modern technologies like improved crop varieties. In 2021, there were 4,108 licensed companies operating in the vegetable seed market, valued at US$2.2 billion.

Strategic and sustained policy support, particularly through the Vegetable Basket Project and the Green Channel policy, has been a key driver of this growth. The Vegetable Basket Project, which went through four phases, initially focused on expanding production through technology adoption, with instructions to local governments to ensure sufficient vegetable supplies. It then shifted to market development, improving price information systems, upgrading wholesale markets, developing cold chains, and enhancing links between producers and markets. Subsequently, the focus moved to food safety and product quality, areas that remain priorities today. The Green Channel policy greatly facilitated inter-regional trade of fresh produce by removing obstacles like checkpoints and tolls for vehicles; other policies, such as zero tax on agricultural production and trade, also played crucial roles.

China's fruit and vegetable exports have grown since joining the World Trade Organization in 2001, but remain modest—around 1% of total output by value—since most production is consumed domestically. Consumer demand for fruit surged sharply with rising income, with an average annual growth rate of 5.1%. Vegetable consumption has not increased, but the per capita average of roughly 300 grams per day exceeds the World Health Organization's recommendation of 240 grams per day, making China one of the few countries to surpass this guideline.

Major challenges include improving food safety, resource use efficiency, and minimizing environmental impacts, which will support further development of China's fruit and vegetable sector. Future research could explore long-term ecological effects and changing consumer behaviors to better inform policies and practices.

1 Introduction

Fruit and vegetables are essential and irreplaceable components of a healthy diet, and low consumption is a global health issue linked to approximately three million deaths worldwide (Afshin et al., 2019). Lack of fruit and vegetables is a primary dietary risk factor, alongside high sodium intake and low consumption of whole grains. They are vital for health as a key source of vitamins, minerals, dietary fiber and phytonutrients like antioxidants, that help protect people from diseases. It has been estimated that over half of the world's population have diets lacking micronutrients (Passarelli et al., 2024).

In approximately half of all countries, fruit and vegetable availability cannot meet consumption levels recommended by the World Health Organization (Mason-D'Croz et al., 2019). WHO suggests that adults consume around 400 grams of fruit and vegetables per day (146 kg/year), but recent studies also propose significantly higher amounts, of 500 grams per day (Willet et al., 2019) or even 610 grams per day (Afshin et al., 2019). However, no country but China produces sufficient fruit and vegetables to satisfy these recommendations.

China has developed its fruit and vegetable sector at a rapid pace since 1990. Current vegetable availability in the country is 515 kg per capita, which is 3.4 times the global average (FAOSTAT, 2025). China accounts for an estimated 53% of global vegetable production and 36% of global fruit production, despite making up only 20% of the world's population, as this report shows. Additionally, China uses only 1.7% of the global cropland but accounts for 7.8% of global fertilizer use (Wang et al., 2021). However, the significant growth of China's fruit and vegetable sector is relatively under-documented and under-analyzed in English-language academic literature, whereas a deeper understanding of the achievements and drivers could provide valuable lessons for other countries that aim to enhance fruit and vegetable production as a means of improving food security, nutrition, and rural livelihoods.

This study provides a comprehensive description and analysis of the development of the fruit and vegetable sector in China. It provides a comprehensive overview of production trends for fruit and vegetables, examining national and regional patterns, and identifying provinces that have emerged as key production hubs. National trends are contextualized internationally using FAO data. This study then explores factors that have contributed to this growth, including policies, protected cultivation, the role of research, and the development of domestic and international markets. Finally, the study presents two case studies to illustrate successful local initiatives. Analysis draws on an extensive review of literature, secondary data from statistics offices, and insights from interviews with public and private sector experts.

2 Data sources

This study uses secondary data from official Chinese sources to analyze trends in fruit and vegetable production at national, regional, and provincial levels, and FAO data to analyze the contribution of China to global fruit and vegetable production, complemented with two case studies.

Chinese official statistics

Fruit and vegetable production data (1990-2024) were sourced from the China Agriculture Yearbook, China Rural Statistical Yearbook, and the National Bureau of Statistics of China website. The National Bureau of Statistics includes edible fungi (fresh and dry) and taro in vegetable production data, but excludes potato, sweet potato and cassava. Fruit production refers to orchard fruits until 2003, but expanded to melons afterwards, with data adjusted to include melons before 2003.

Regional statistics adhere to the methodology used in the China Agriculture Yearbook and China Rural Statistical Yearbook. Data are disaggregated by province and economic region. Four regions are defined: (a) Northeastern: Liaoning, Jilin, Heilongjiang; (b) Eastern: Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan; (c) Central: Shanxi, Henan, Anhui, Hubei, Jiangxi, Hunan; (d) Western: Chongqing, Sichuan, Shaanxi, Yunnan, Guizhou, Guangxi, Gansu, Qinghai, Ningxia, Tibet, Xinjiang, Inner Mongolia.

Import and export data were derived from China Rural Statistical Yearbook 2023. Customs data were renamed 'Vegetables' to 'Vegetables and edible fungi', and renamed 'Fresh and dried fruits and nuts' to 'Dried and fresh melons, fruits, and nuts' in 2021. Per capita consumption data were obtained from the China Statistical Yearbook, using the category 'Vegetables and edible fungi' for vegetable consumption and 'Fresh melons and fruits' for fruit consumption.

Data on production costs and net profits were sourced from the Compilation of National Agricultural Product Cost and Benefit Data. Vegetable production costs correspond to the item 'Average expenses and labor use for vegetables in large and medium cities.' For orchard fruits, we used 'Expenses and labor use for apples' as there are no aggregate data for all fruit crops. Values were expressed in Chinese Yuan (RMB) per mu (a mu being 1/15th of a hectare or 666.7 m^2). Agricultural input data were sourced from the National Bureau of Statistics of China website. Data regarding rural per capita disposable income were drawn from national and provincial annual figures released by the National Bureau of Statistics, supplemented by data from provincial statistical yearbooks.

FAO data

Data were downloaded from FAOSTAT (https://www.fao.org/faostat/) on 6 April 2025 from the production domain 'Value of agricultural production; elements: Gross production value in current, thousand US$, and Gross production value in constant 2014-2016, thousand US$'. The constant series was used to analyze trends, while the current series was used to analyze 2023 production. The time series spans the period from 1990 to 2023, the latest year available in the database. Population data were downloaded to calculate per capita production. FAO's definition of fruit and vegetables slightly differs from that of China's National Bureau of Statistics, however. FAO includes melons in the vegetable category, whereas the National Bureau of Statistics includes them as a fruit, and FAO does not include taro in vegetables, while Chinese data do. However, both include edible fungi in the vegetable category.

Case studies

Data were collected for case studies on the vegetable sector in Gaozhou and the lychee sector in Guangzhou - two examples of successful local vegetable and fruit production. The aim was to identify factors from the diverse perspectives of various stakeholders involved. Data were gathered from field research in Gaozhou city, and Zengcheng and Conghua districts of Guangzhou city, using a qualitative methodology that combined document analysis and interviews. Analysis also involved reviewing local government policy documents to systematically record and categorize specific measures that promoted the growth of the vegetable and fruit sectors, enhanced by in-depth interviews with smallholder producers, farmer organizations, enterprises, and village officials.

3 Fruit and vegetable production

Growth in vegetable production

National and regional trends

China's vegetable sector has experienced rapid growth since the mid-1990s, as shown in Figure 1A. Vegetable production grew from 166 million tonnes (t) in 1994 to 800 million t in 2022, which represents a 382% expansion over 28 years, or an average annual growth of 5.8%. Table 1 shows the distribution of vegetable production across China's four regions. The Eastern region increased vegetable output from 119.1 million t in 1995 to 294.8 million t in 2022, an increase of 148%. Key agricultural provinces such as Shandong and Jiangsu were significant contributors. For example, Shandong's 2022 output of 90.5 million t constituted 11% of the national total. The central region also saw rapid growth, with production growing from 68.2 million t in 1995 to 219.5 million t in 2022—a 222% rise. Provinces like Henan and Hubei demonstrated particularly strong growth. The Western region recorded the fastest growth with vegetable production increasing from 48.6 million t in 1995 to 252.5 million t in 2022, representing a 419% increase. In contrast, growth was slower in the Northeast region, with production increasing from 21.4 million t in 1995 to 33.3 million t in 2022, a modest rise of 56%.

Table 1: Vegetable production in China by region, 1995-2022, in million tonnes

Region	1995	2000	2005	2010	2015	2020	2021	2022
Eastern	119.07	213.60	261.30	279.72	328.46	278.73	286.60	294.76
Central	68.18	119.50	149.15	170.41	206.81	206.77	213.28	219.45
Western	48.61	84.82	114.65	156.16	202.50	232.64	243.55	252.46
Northeastern	21.37	39.19	39.41	44.71	47.50	30.99	32.06	33.30

Source: China Agriculture Yearbook, China Rural Statistical Yearbook, National Bureau of Statistics of China website

Provincial trends

All provinces experienced substantial growth in vegetable production (Table 2). Shandong is the largest vegetable-producing province, accounting for the largest vegetable planting area, volume, and export volume and value (Zeng, 2023). Vegetable production in Shandong grew from 37.0 million t in 1995 to 90.5 million t in 2022, a 145% increase. Production from Henan province in the Central region also expanded rapidly from 16.6 million t in 1995 to 78.5 million t in 2022, an increase of 372%. The Sichuan-Chongqing area also saw substantial growth, expanding from 13.9 million t in 1995 to 74.7 million t in 2022, a 438% increase, establishing it as the main vegetable-producing province in the Western region. Most provinces experienced significant growth; however, the spatial concentration of vegetable production has increased and is driven by economic factors rather than environmental conditions (Ji et al., 2018). Major municipalities have seen a decline in vegetable production, with Beijing's vegetable output declining from 3.9 million t in 1995 to 2.0 million t in 2022, a reduction of 49%. And Shanghai's production, while exhibiting fluctuations, showed modest overall growth, rising from 2.4 million t in 1995 to 2.6 million t in 2022, an increase of 6.3%.

Main types of vegetables produced

China cultivates a wide diversity of vegetables, with the main ones (by planting area and output volume) being chili pepper, tomato, cucumber, eggplant, and Chinese cabbage. Regarding chili, in 2018, China accounted for 38.7% of the global area under chili and contributed 49.5% of the world's chili production (Wang et al., 2021). As one of the most extensively planted vegetables in the country, chili is cultivated across diverse regions (Zou and Zhu, 2022). The Chinese chili sector experienced rapid growth spurred by the emergence of protected

cultivation in the 1990s. By 2000, the national chili planting area reached 1.3 million ha, expanding to 2.1 million ha by 2015, and has consistently remained above 2.1 million ha (Zou et al., 2025).

Tomato is another major staple vegetable in China, consistently ranking fourth in planting area among all vegetables (Liu, 2024). The tomato planting area has expanded from 0.47 million ha in 1990 to 0.96 million ha in 2010 and then to 1.2 million ha in 2022, supported by large-scale adoption of modern techniques like mechanized planting and precision fertilization/irrigation (Huo, 2016). Total output reached 69.7 million t in 2022 (Liu, 2024), but China's average yield remains approximately 50% lower than other major producing countries (Jiang et al., 2024).

Table 2: Vegetable production by province in China, 1995-2022, in million tonnes

Province	1995	2000	2005	2010	2015	2020	2021	2022
Shandong	36.95	72.57	86.07	90.31	102.73	84.35	88.01	90.46
Henan	16.61	39.82	58.80	66.24	74.57	76.12	76.07	78.45
Jiangsu	16.00	33.11	36.05	42.34	55.96	57.28	58.57	59.75
Hebei	21.48	44.54	64.68	70.74	82.44	51.98	52.84	54.07
Sichuan	13.90	23.13	27.14	34.08	42.41	48.13	50.39	51.99
Hubei	16.63	27.17	29.17	31.32	38.52	41.19	43.00	44.08
Hunan	11.35	17.80	23.99	31.23	39.97	41.10	42.69	43.57
Guangxi	13.02	16.13	21.31	21.29	27.86	38.31	40.48	42.37
Guangdong	17.04	22.15	25.96	27.19	34.39	37.07	38.56	39.99
Guizhou	3.61	5.95	8.40	12.02	17.32	29.91	32.80	33.56
Yunnan	4.06	5.85	9.71	12.55	18.74	25.08	27.49	28.58
Anhui	10.07	14.49	16.71	21.37	27.14	23.31	24.45	25.38
Chongqing	-	8.02	8.90	13.10	17.80	20.93	21.84	22.72
Shaanxi	3.63	5.57	8.70	13.84	18.23	19.58	20.13	20.82
Liaoning	12.68	17.57	19.55	26.68	29.33	19.60	19.90	20.55
Zhejiang	8.23	13.59	17.65	17.89	18.07	19.45	19.34	19.77
Jiangxi	8.09	11.01	11.46	11.15	13.59	16.43	17.31	17.87
Fujian	7.33	11.00	14.03	15.63	19.04	16.30	16.87	17.53
Gansu	3.28	5.01	8.67	12.36	18.23	14.79	16.55	17.37
Xinjiang	2.70	5.29	8.62	17.34	19.34	17.15	16.20	17.32
Inner Mongolia	3.08	7.60	10.09	13.51	14.45	10.75	9.94	10.13
Shanxi	5.43	9.20	9.02	9.09	13.02	8.61	9.76	10.10
Heilongjiang	3.38	13.26	11.54	7.24	9.57	6.74	7.25	7.60
Hainan	1.33	2.67	3.12	4.42	5.72	5.73	5.89	6.05
Ningxia	0.88	1.50	1.84	4.07	5.76	5.66	5.33	5.28
Jilin	5.31	8.36	8.33	10.79	8.60	4.65	4.91	5.15
Shanghai	2.44	3.77	4.09	3.98	3.64	2.53	2.49	2.60
Tianjin	4.34	5.31	5.43	4.19	4.42	2.66	2.39	2.56
Beijing	3.92	4.89	4.24	3.03	2.05	1.38	1.66	1.99
Qinghai	0.38	0.60	0.84	1.42	1.66	1.51	1.50	1.52
Xizang	0.09	0.17	0.43	0.58	0.70	0.84	0.90	0.82

Source: China Agriculture Yearbook, China Rural Statistical Yearbook, National Bureau of Statistics of China website
Note: Data for Chongqing and Sichuan were shown together, as they were not separate provinces before 1997.

Growth in fruit production

National and regional trends

Figure 1B shows a linear expansion of China's fruit sector since 1995. Fruit production was 81.2 million t in 1996, 121.1 million t in 2000, and 327.4 million t in 2023.

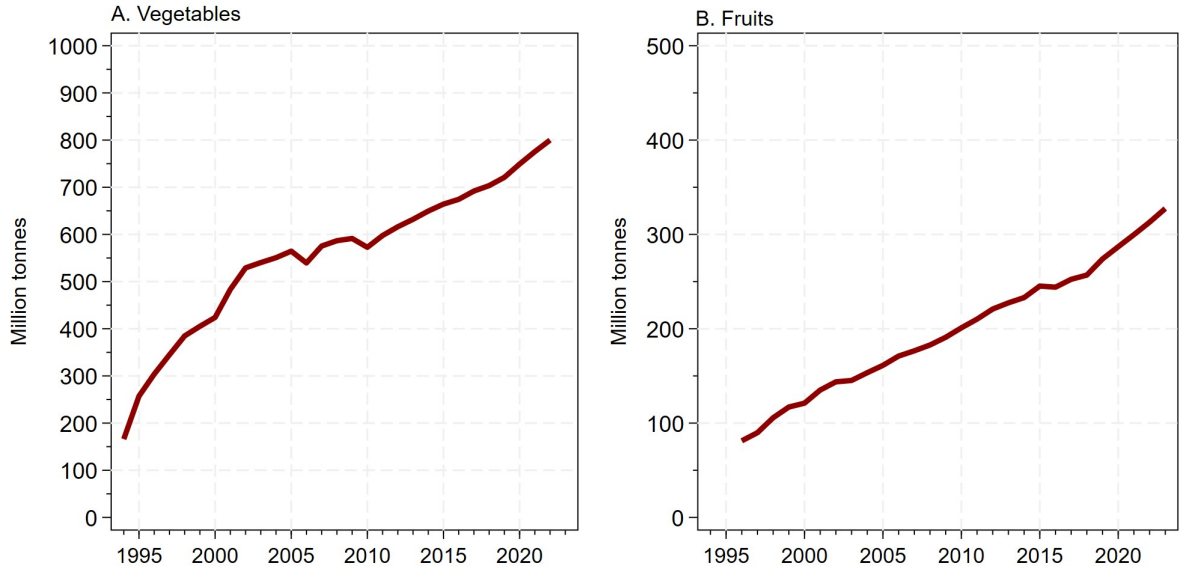


Figure 1: Vegetable (A) and fruit (B) production in China, 1996-2023, in million tonnes. *Source: China Agriculture Yearbook, China Rural Statistical Yearbook, and the website of the National Bureau of Statistics of China*

Fruit production increased in all of China's four major economic regions (Table 3). In the Eastern region, a major fruit production zone, output expanded from 50.2 million t in 1997 to 158.6 million t in 2022, an increase of 215.8%. The Central region also demonstrated rapid growth, with production rising from 16.6 million t in 1997 to 66.2 million t in 2022 (a 298.7% increase). Provinces such as Henan played a key role in this expansion. Fruit production in the Western region grew from 13.1 million t in 1997 to 42.3 million t in 2022 (a 223.4% rise), gradually strengthening its position within the national fruit sector. Finally, in the Northeastern region, output increased from 12.5 million t in 1997 to 45.9 million t in 2022, representing a 267.5% increase.

Provincial trends

Among provinces, Guangxi has emerged as the leading fruit producer in terms of total fruit output in 2022 (Mo et al., 2024). Its production grew from 4.1 million t in 1997 to 34.0 million t in 2022—a growth of 728.0%. Shandong, a traditional powerhouse in fruit production, saw its output grow from 16.2 million t in 1997 to 31.0 million t in 2022 (a 91.0% increase), consistently maintaining high production. Shaanxi also experienced rapid development in its fruit sector, with production increasing from 3.3 million t in 1997 to 22.4 million t in 2022 (a 585.3% increase). Xinjiang also recorded significant growth, with fruit production rising from 2.1 million t in 1997 to 16.7 million t in 2022 (a 696.7% increase). In contrast, municipalities like Tianjin and Shanghai, constrained by geography and other factors, exhibited lower fruit production volumes and relatively minor changes. Tianjin's output increased slightly from 0.5 million t in 1997 to 0.6 million t in 2022. Fruit production in Shanghai even declined from 0.5 million t in 1997 to 0.3 million t in 2022, a decrease of 38.5%.

Table 3: Fruit production in China by region, 1997-2022, in million tonnes

Region	1997	2000	2005	2010	2015	2020	2021	2022
Eastern	50.23	61.61	82.02	106.58	131.91	145.63	151.66	158.60
Central	16.61	23.97	30.97	43.56	59.83	59.78	63.33	66.22
Western	13.07	19.11	23.84	30.22	35.15	38.45	40.76	42.27
Northeastern	12.48	16.44	24.37	33.64	46.86	43.06	43.96	45.87

Source: China Agriculture Yearbook, China Rural Statistical Yearbook, and the website of the National Bureau of Statistics of China

Table 4: Fruit production in China by province, 1997-2022, in million tonnes

Province	1997	2000	2005	2010	2015	2020	2021	2022
Guangxi	4.11	5.26	7.67	10.94	17.20	27.86	31.21	34.03
Shandong	16.22	20.82	25.47	27.94	32.19	29.39	30.33	30.96
Henan province	8.53	14.58	18.42	23.94	26.65	25.63	24.55	25.42
Shaanxi	3.27	5.68	9.06	14.77	19.31	20.71	21.41	22.41
Guangdong	4.95	7.37	9.46	12.36	16.49	18.83	19.58	20.28
Xinjiang	2.10	3.03	5.12	10.29	16.35	16.60	16.60	16.73
Hebei	7.71	10.19	13.98	16.12	21.17	14.24	14.45	15.34
Sichuan	2.67	3.22	5.27	7.23	9.34	12.21	12.91	13.81
Yunnan	1.09	1.11	1.70	3.98	7.27	9.62	11.43	12.89
Hunan	4.62	3.82	5.19	7.88	9.81	11.51	11.94	12.08
Hubei	4.20	6.06	5.67	7.79	9.66	10.67	11.19	11.43
Shanxi	2.00	3.19	3.14	4.75	8.43	9.10	9.75	10.03
Jiangsu	3.78	1.76	6.06	7.39	9.15	9.74	9.69	10.02
Gansu	1.59	2.26	2.81	4.89	6.79	7.79	8.84	9.66
Liaoning	3.00	3.44	4.51	7.33	8.82	8.51	8.56	8.80
Fujian	3.94	4.18	5.59	6.43	8.37	7.65	8.10	8.65
Anhui	3.82	6.40	7.12	8.05	10.30	7.42	7.78	7.98
Jiangxi	1.98	2.26	3.25	4.68	6.63	7.13	7.45	7.49
Zhejiang	3.84	3.73	5.78	7.01	7.41	7.55	7.23	7.05
Guizhou	0.77	0.58	0.96	1.24	2.25	5.48	6.54	6.99
Chongqing	0.85	1.01	1.55	2.38	3.76	5.15	5.53	5.93
Hainan	0.78	1.42	2.20	3.75	4.06	4.96	5.26	5.64
Ningxia	0.31	0.47	0.70	2.29	2.99	2.05	2.63	2.72
Heilongjiang	1.74	3.39	3.53	2.80	2.13	1.70	1.84	1.89
Inner Mongolia	0.82	1.83	1.79	2.78	2.97	2.39	1.91	1.76
Jilin	1.50	2.00	2.35	2.18	2.09	1.47	1.64	1.66
Tianjin	0.46	0.28	0.68	0.60	0.63	0.56	0.49	0.58
Beijing	0.73	1.00	1.12	1.15	0.88	0.54	0.49	0.38
Shanghai	0.52	0.72	1.01	1.02	0.62	0.44	0.33	0.32
Xizang	0.46	0.01	0.01	0.02	0.01	0.02	0.03	0.03
Qinghai	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.03

Source: China Agriculture Yearbook, China Rural Statistical Yearbook, National Bureau of Statistics of China website

4 China's role in global fruit and vegetable production

Based on FAO data, global production of vegetables in value, at farm gate prices, was US$646.0 billion in 2023, and that of fruit was US$619.8 billion. Of this, China accounted for 53% of global vegetable production and 36% of fruit production (Figure 2).

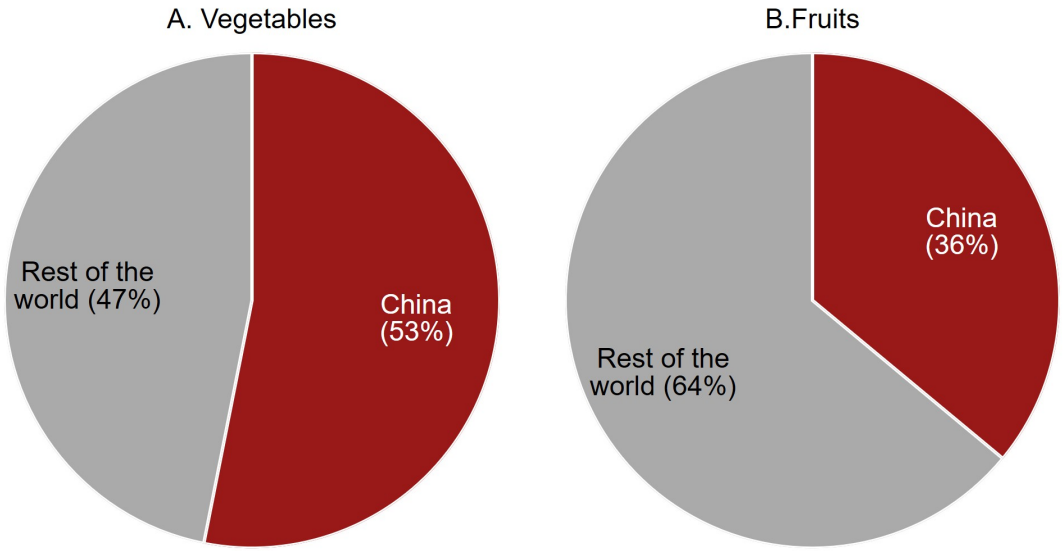


Figure 2: China's share in global vegetable (A) and fruit (B) production in 2023.
Source: FAOSTAT (2025): Gross value of production (US$).

Regarding specific vegetables, China produces 93% of the world's spinach, 87% of the world's asparagus, and 82% of the world's cucumbers and gherkins (Figure 3). In terms of fruit, it produces 75% of the world's pears, 65% of the world's peaches and nectarines, and 55% of the world's plums (Figure 4).

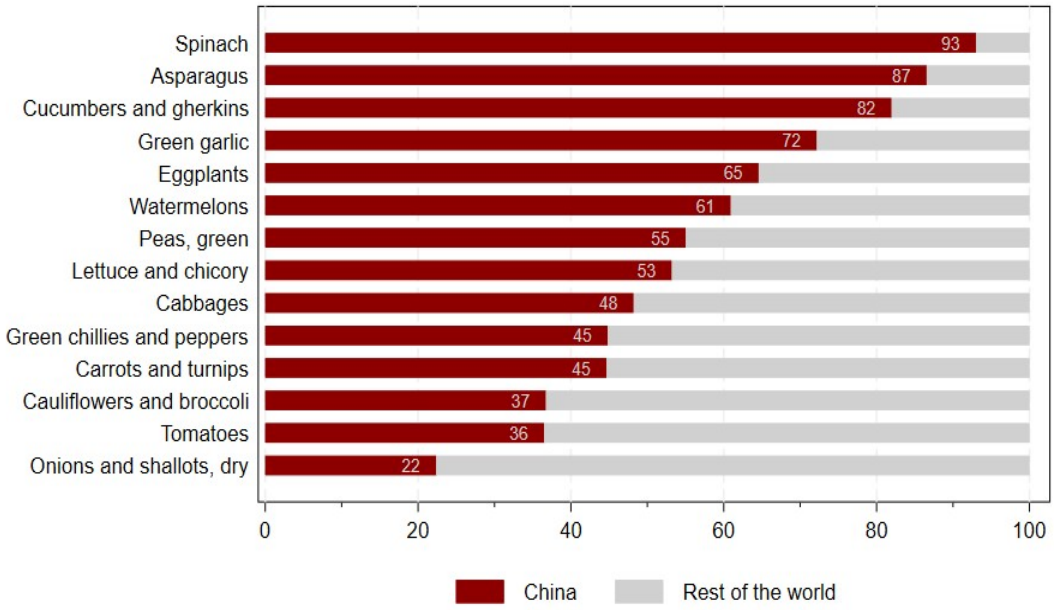


Figure 3: China's share of global vegetable production, 2023. *Source: FAOSTAT (2025): Gross Production Value (constant 2014-2016, in thousand International $)*

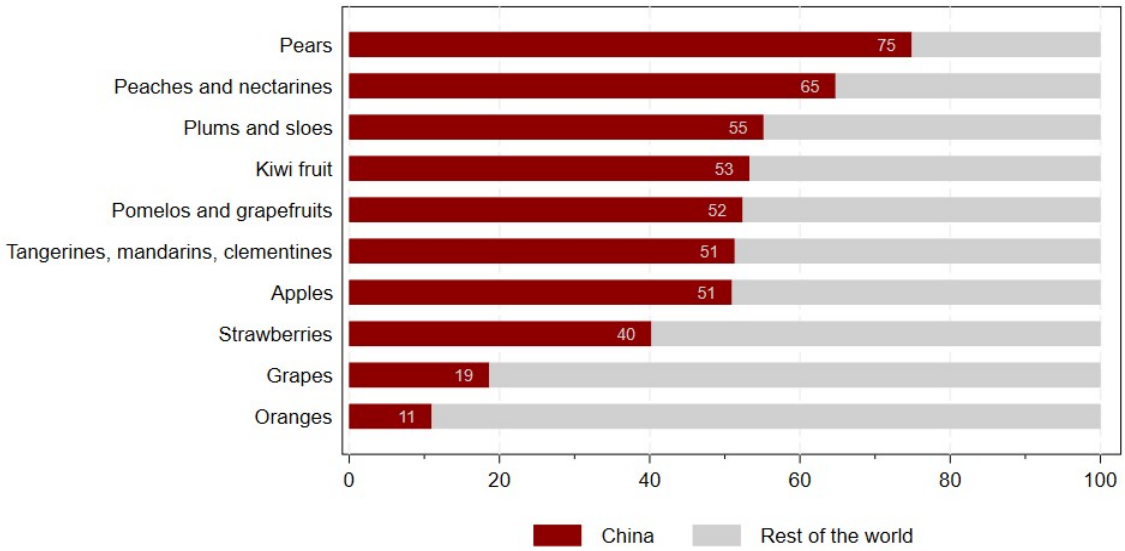


Figure 4: China's share in global vegetable production, 2023. *Source: FAOSTAT (2025): Gross Production Value (constant 2014-2016, in thousand International $)*

Global vegetable production increased from approximately US$200 billion in 1990 to US$580 billion in 2023, as shown in Figure 5A. China accounted for a large share of this increase as its vegetable production increased from US$50 billion in 1990 to US$300 billion in 2023. Similarly, for fruit, China accounts for most growth in global output (Figure 5B).

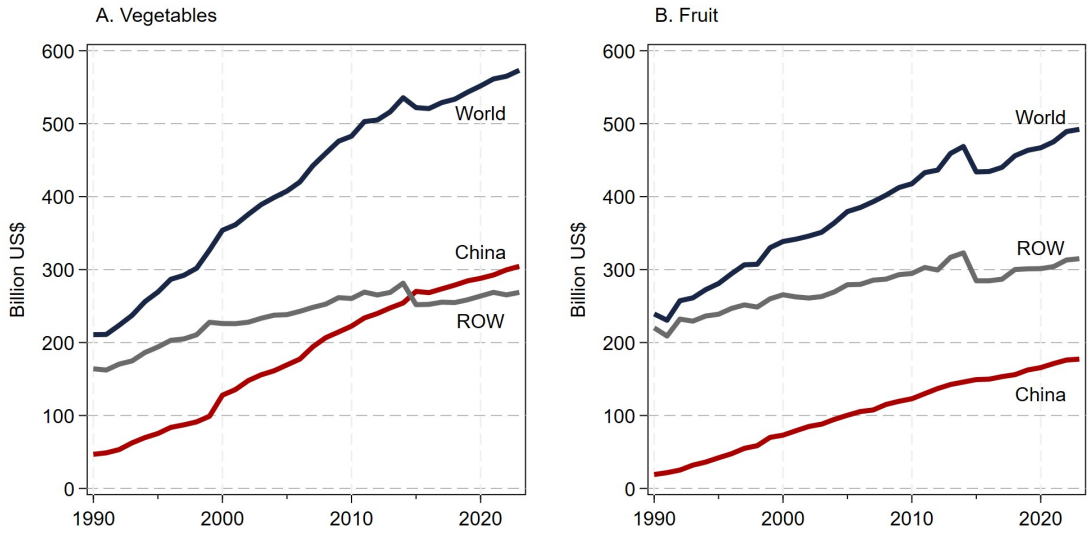


Figure 5 China's growth in global vegetable (A) and fruit (B) production by value, 1990-2023.
Source: FAOSTAT (2025): Gross Value of Production in constant 2014-2016 US dollars. Note: ROW=Rest of the World

Figure 6 illustrates the growth of China's vegetable production in kilograms per person for vegetables (left) and fruit (right). The data indicate availability rather than consumption, with the difference being exports, food loss and waste, and processing. The WHO recommends that adults consume about 240 grams of vegetables and

160 grams of fruit daily, totaling 88 kg of vegetables and 58 kg of fruit annually. China's vegetable production surpasses this amount by 5.6 times, while its fruit production exceeds it by 2.4 times, which shows that China produces more than enough fruit and vegetables to feed its own population. Another important observation from these data is that the per capita production of vegetables has been stagnant since 1990 in the rest of the world, as the growth in global production is solely driven by production growth in China.

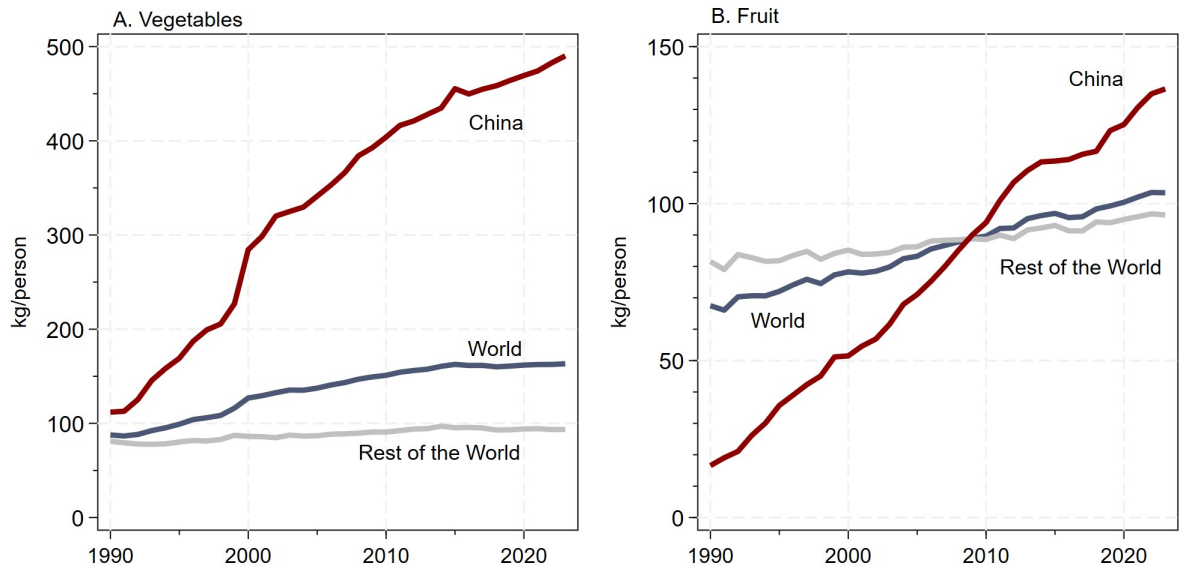


Figure 6: Growth in gross vegetable and fruit production per capita, 1990-2023.
Source: FAOSTAT (2025): Crops and livestock products, based on production (in tonnes) and area harvested (hectares)

Finally, the source of production growth is analyzed. An increase in production can be achieved through area expansion or an increase in productivity (crop yield). The data show that both have contributed to the increased production of vegetables (Figure 7) and fruit (Figure 8), with mean vegetable yields increasing by about 50% and the vegetable area expanding by about 240%. These growth rates contrast with the growth in vegetable production in the rest of the world, which observed virtually no gains in mean crop yields.

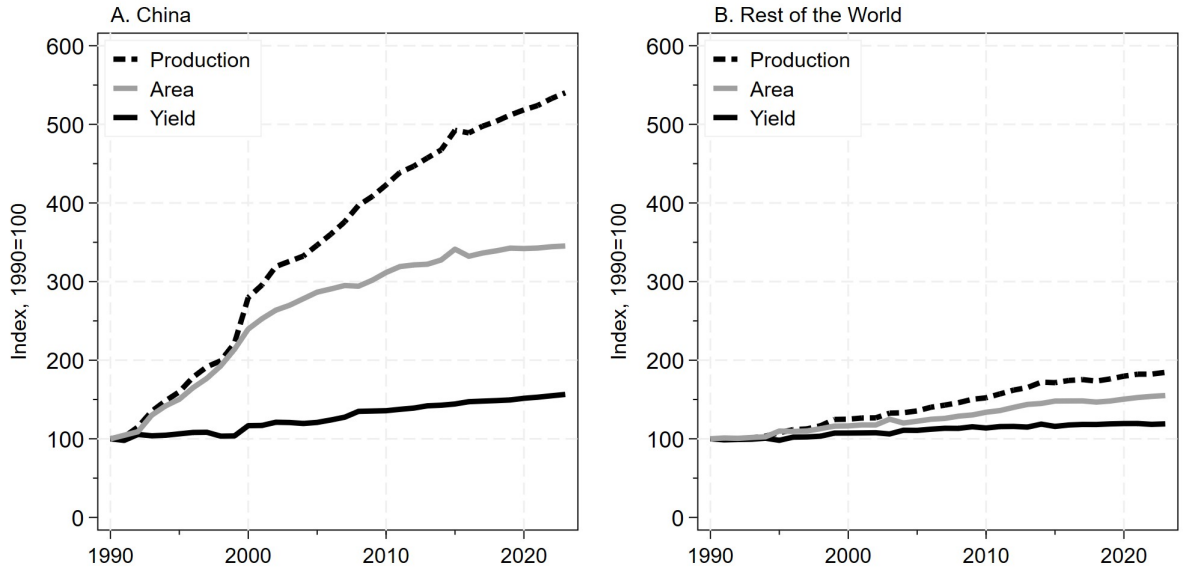


Figure 7: China's growth in vegetable production, area, and yield, 1990-2023, index 1990=100.
Source: FAOSTAT (2025): Crops and livestock products, based on production (in tonnes) and area harvested (hectares)

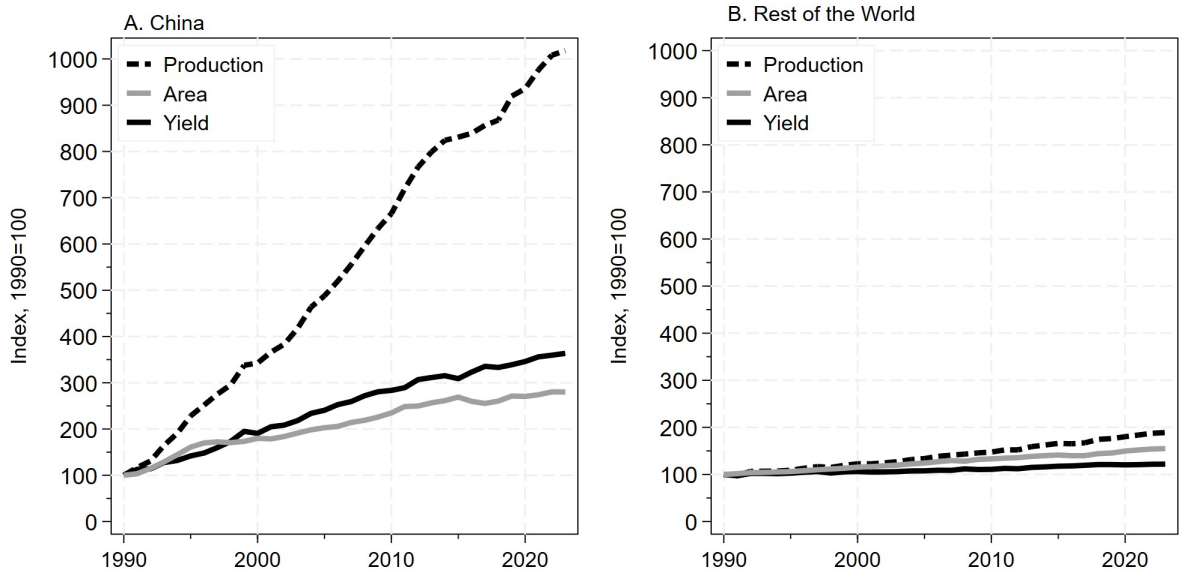


Figure 8: China's growth in fruit production, area, and yield, 1990-2023, index 1990=100. *Source: FAOSTAT (2025): Crops and livestock products, based on production (tonnes) and area harvested (hectares)*

5 Drivers of fruit and vegetable production

Policy support

Two key government initiatives, the "Vegetable Basket Project" and the "Green Channel" policy for fresh agricultural product transport, have been instrumental in propelling the development of China's vegetable and fruit sector. These policies, implemented in stages, have profoundly influenced the sector by ensuring a stable agricultural supply, fostering structural optimization, and enhancing market circulation efficiency (Wen and Long, 2012; Huang, 2011; Shang, 2016; Tang, 2025).

Vegetable Basket Project, 1988-present

Initiated in 1988, the Vegetable Basket Project is a comprehensive government strategy aimed at improving production, supply, and marketing channels for non-staple foods to meet the needs of urban populations (Wang and Han, 1994). The project has evolved through four distinct phases (Chen, 2022).

Phase 1 (1988-1994): With the growth of urban and rural incomes and increasing demand for non-staple foods, significant supply shortages emerged. This phase primarily aimed to increase production through the use of new varieties and technologies, and establishing production bases for meat, eggs, milk, aquatic foods, and vegetables, to ensure market supply. The City Mayor Responsibility System was introduced to tackle urban supply shortages (Li, 1994; Wen, 2012), and made local government at all levels, especially prefecture government, responsible for the local supply of vegetables, meat, eggs, dairy products, and aquatic products (fruit supply was not yet a policy priority during this period). Local government had to coordinate and oversee tasks including production development, market linkages, transportation, market regulation, safety and quality, and ensuring stable supply and prices. National vegetable production during this phase surged from 166.0 million t in 1994 to 257.2 million t in 1995.

Phase 2 (1995-1999): After supply issues had been alleviated, phase 2 focused on market development, particularly infrastructure construction and operational efficiency. Driven by rising urban household incomes, consumer demand for fruit transitioned from occasional to daily during this period, prompting policy adjustments. This period saw notable achievements in structural optimization across broad non-staple foods and quality enhancement within the vegetable and fruit sector (Yu, 2014). The 1997 State Council Notice on Further Strengthening Vegetable Basket Work formally listed fruit alongside vegetables as key components of the program. A price information network connecting 33 wholesale markets across 28 major cities and production areas was introduced in 1995, which boosted market transparency and efficiency. In 1996, the State Council initiated a pilot program for wholesale market construction, and by late 1997, the number of agricultural wholesale markets had grown to approximately 4,000 nationwide, which helped link producers to wholesale markets and retailers. By 1999, supply and demand for fresh agricultural foods, now explicitly including fruit, reached a basic equilibrium, facilitating a strategic shift from quantity expansion to quality improvement (Chen, 2022).

Phase 3 (2000-2009): China's accession to the World Trade Organization (WTO) in 2001 increased international competition in the food and agricultural market. At the same time, income growth stimulated domestic consumer demand for quality foods. In response, this phase saw a policy shift towards food safety and sustainable development. In 2001, the Ministry of Agriculture launched the Pollution-Free Agricultural Products Action Plan, establishing extensive pollution-free production bases to safeguard consumer health ('safety on the tip of the tongue') (Xie and Qi, 2021). Measures promoting production standards, product traceability systems, and ecological agriculture increased the availability of high-quality and more environmentally friendly

food products. Vegetable production continued to grow, surpassing 590.0 million t in 2009, a 46% increase from 1999.

Phase 4 (2010-present): In response to accelerated urbanization and evolving consumer preferences, this phase continued its focus on food safety while emphasizing coordinated development and systematic improvement of production capacity, market systems, quality assurance, and emergency preparedness (Ministry of Agriculture, 2012). As of 2023, the national vegetable planting area exceeded 22.9 million ha, with quality and safety inspection pass rates consistently above 99%.

Green Channel policy, 1995-present

The Green Channel policy was designed to facilitate the movement of fresh agricultural products within the country, which was critically important for the vegetable and fruit sector (Ma and Sun, 2016; Zhai, 2014). Launched jointly in 1995 by the State Council's Office for Correcting Unhealthy Tendencies, the Ministry of Transport, and the Ministry of Public Security, it aimed to support the Vegetable Basket Project by ensuring a stable supply of vegetables to cities and improving agricultural product logistics (Xu and Wang, 2018). Its core provision facilitated the easy passage of fresh produce transported across the country—specifically 'no detention of vehicles, no unloading of goods, no fines'—and reduced or waived toll fees for vehicles legally transporting full loads of fresh produce like vegetables and fruits (Anon, 2010).

Initially, the policy covered four primary vegetable transport routes (e.g. Shouguang to Beijing, Hainan to Shanghai) totaling 11,000 km across 18 provinces (Chen et al., 2011). This was expanded in 2005 with the creation of the 'Five Vertical and Two Horizontal' national green channel networks. This network spans 27,000 km, covering major inter-provincial routes and enhancing cross-regional product flow (Anon, 2010). This expansion coincided with a regional specialization in fruit and vegetable production, with the Green Channel acting as a vital link connecting producers and consumers across the country.

In 2010, the State Council extended the Green Channel policy to all toll roads. Standards for legal full-load transport were clarified, and items like potatoes, sweet potatoes, and fresh maize were added to the list of eligible products (Zhang and Wu, 2011). It has been estimated that the policy reduced toll fees by nearly 13 billion yuan in 2010 alone (representing about 29% of the total costs of transporting goods via national or regional transport arteries). Recent efforts by the Ministry of Transport have focused on standardizing policy execution and increasing transparency.

Southern Vegetables to Northern Markets project

At 34° North latitude, the harsh winter draws an invisible vegetable and fruit dividing line. From November to April each year, greenhouses in northern China enter a hibernation period due to insufficient sunlight, while southern provinces such as Guangxi and Yunnan maintain daily average temperatures of 15-25°C, earning them the reputation of natural winter vegetable greenhouses. As a result, the south has become the main production area for China's winter and spring vegetables.

In the early days, individual vendors spontaneously organized the transportation of southern vegetables to northern markets, but on a small scale. To meet the growing demand for fresh vegetables during winter, the Ministry of Commerce launched the Southern Vegetables to Northern Markets project in 2010. Hainan, Guangxi, and Yunnan were designated as main production areas for the project. Funds were invested to support infrastructure construction, such as cold-chain logistics and information platforms. With improvements in transportation and rising living standards, the variety and scale of the project expanded. More than 100 types of vegetables are now transported to 30 provinces across the country, forming the primary supply for

winter and spring vegetables in northern China, and also exported to Southeast Asian countries (Wu, 2018; Wang et al., 2013; Lü, 2012).

Other policies

Other supportive fiscal policies include comprehensive agricultural input subsidies, seed subsidies, and agricultural machinery purchase subsidies (Gong and Li, 2022) to reduce production factor costs, while land use policies for protected cultivation (Zhou, 2010) ensure adequate land access for large-scale cultivation. Full-chain agricultural product traceability systems have been established to strengthen quality and safety monitoring (Wang and Zhang, 2025; Yang et al., 2023). Industrial upgrading is supported by agricultural industrial parks (Wang and Wang, 2023; Cui, 2021; Tan et al., 2022) that promote full-value-chain integration. In 2025, the policy scope of the "new round of large-scale equipment renewal and consumer goods trade-in" was extended to encompass protected cultivation, further stimulating modernization within the sector.

Tax incentives also provide significant support. Under regulations like the Provisional Regulations on Value-Added Tax (VAT) and specific notices from the Ministry of Finance and State Administration of Taxation, agricultural producers are exempt from VAT on sales of their self-produced products. Similarly, businesses engaged in vegetable wholesale and retail are exempt from VAT (Zhang, 2012). These exemptions reduce the tax burden on producers and sellers and keep market prices low.

The public sector has intensified efforts to cultivate public brands for fruit and vegetables through policy coordination. In Shouguang city for example, the government addressed challenges in traditional agriculture such as limited varietal diversity, inconsistent quality standards and lack of branding, by integrating agricultural markets through policy guidance and establishing a regional public brand management system for ‘Shouguang vegetables’ (Li and Zhang, 2023), with strict brand access, systems for traceability, quality testing, logistics and storage capacity verification, and public approval processes.

Protected cultivation

Protected cultivation refers to the use of structures like greenhouses and plastic tunnels, as well as advanced production equipment and technologies to control temperature, light, water, soil, air, and nutrients. This optimizes crop growth conditions, enabling high efficiency and high-quality production, and has been very important to China's vegetable and fruit sector (Wang et al., 2020). Protected cultivation in China supports the year-round production of over 30 vegetables, with tomato, cucumber, and pepper being the dominant crops (Miao, 2018). Greenhouse vegetable production in China, while improving yields and ensuring year-round supply, may also lead to higher greenhouse gas emissions and nitrogen losses compared to open-field systems.

China established five major zones for protected vegetable production: the subtropical rainy zone of the Yangtze River basin, the temperate arid and high-altitude cold zones of the Northwest and Qinghai-Tibet Plateau, the temperate zone of the Northeast, the warm-temperate zone encompassing the Huang-Huai-Hai plain and Bohai rim, and the tropical rainy zone of South China. Provinces like Shandong, Henan and Jiangsu are leading in terms of output from protected cultivation (Miao, 2018).

Historically, vegetables from protected cultivation were perceived as luxury goods, supplying a niche market. The launch of the ‘Vegetable Basket’ project in 1988 greatly increased vegetable demand, and protected cultivation became a common method of production (Nie et al., 2024). It developed rapidly during the 1990s, when new designs of covered structures emerged. By 2018, China's total protected cultivation area reached 1.9 million ha, nearly double that of 2011. However, lower-cost plastic tunnels with limited resilience remained the dominant structure type, while solar greenhouses and multi-span greenhouses constituted only 30% and 3% of the area, respectively, at that time. However, by 2023, the area under protected cultivation grew to

approximately 2.7 million ha, representing 85% of the global total, and that produced 230 million t annually, and vegetables occupy about 80% of the area used (Ao, 2023). Currently, under the impetus of the rural revitalization strategy, protected cultivation is evolving towards lower consumption of energy, water and fertilizers while targeting higher yields and higher efficiency.

Vegetables from protected cultivation generate significantly higher returns per unit area than open-field cultivation, with yields 5-7 times higher, driving a shift from open-field to protected production. The high profitability attracts substantial investment in capital, labor, and technology, encouraging upgrades to greenhouses, irrigation and climate control systems to boost efficiency and quality. Vegetables from protected agriculture now account for over 45% of total vegetable output by value (Zhang and Ma, 2017).

The large-scale development of protected cultivation has been supported by upgrades to infrastructure and public services. A national cold chain logistics network featuring "four horizontal and four vertical" backbone corridors has been established, supported by 86 national cold chain logistics bases covering all 31 provinces (including autonomous regions, municipalities, and the Xinjiang Production and Construction Corps). In addition, the central government initiated a two-year "build first, subsidize later" program in 2022, which supported 27,000 farmer cooperatives, family farms, and collective economic organizations in the construction of cold storage and preservation facilities. This initiative added over 12 million t of cold storage capacity (Qiao, 2022), significantly boosting the use of cold chains for fruit and vegetables (reaching 20%) and markedly reducing spoilage rates (by 10%) (Hong, 2018).

Growing consumer demand

Increasing consumer demand has been a key driver for the expansion of the fruit and vegetable sector, stimulated by income growth, population growth, and urbanization. However, China's dietary patterns have changed in recent decades, with people eating more animal-based foods and processed foods, marking a new phase in the country’s nutrition transition (Du et al., 2002).

In terms of per capita consumption, there has been a rapid increase in fruit consumption since the 1990s, but no substantial increase in vegetable consumption. Fruit consumption increased for both urban and rural populations (Figure 9). The mean daily per capita intake rose from 41.7 g in 1990 to 166.4 g in 2020—a more than threefold increase over 30 years, primarily driven by improving living standards. A significant urban-rural disparity existed in fruit consumption during the 1990s, with urban residents consuming (112.7 g/day) nearly seven times more fruit than rural residents (16.1 g/day), reflecting differences in purchasing power. Over time, rural fruit consumption has grown to narrow this gap. Fruit consumption was only 1.4 times higher in urban areas than in rural areas in 2020. Overall, the average fruit consumption in 2020 aligns with the WHO-recommended amount of about 160 g.

Per capita vegetable consumption briefly declined in both urban and rural areas from 1990 to 1995 but then stabilized at slightly above 300 g/day (Figure 10). Urban residents consume more vegetables than their rural counterparts, with the gap being more pronounced during the 2000s compared to the 1990s. Nonetheless, the mean per capita vegetable consumption for both rural and urban residents is significantly above the WHO-recommended amount of 240 g/day.

In terms of regional differences, there is a strong contrast between rural and urban fruit consumption in all regions, with urban residents consuming three times more (Figure 11). For vegetables, urban residents eat more than rural residents in Eastern and Western regions, with no difference in means for other regions, and declining vegetable consumption in the Northeastern region, both for urban and rural residents.

Three structural shifts are evident on the consumption side. First, urban and rural residents increasingly demand safe and organic vegetables and fruit (Wang, 2023; Zhang, 2023; Zhang, 2025; Xie, 2020). Second, there is a growing demand for imported fruit, particularly high-end options like durian and cherries (Liu and Tian, 2025; Cheng, 2024; Zheng, 2023), contributing to a more diverse fresh fruit consumption. Third, new sales channels have emerged, including community group buying and fresh food e-commerce platforms (Yang et al., 2025; Sun, 2025), fundamentally reshaping purchasing models. These trends create a dynamic interplay where demand pulls supply, and supply creates demand. This feedback loop compels the sector to focus on quality enhancement.

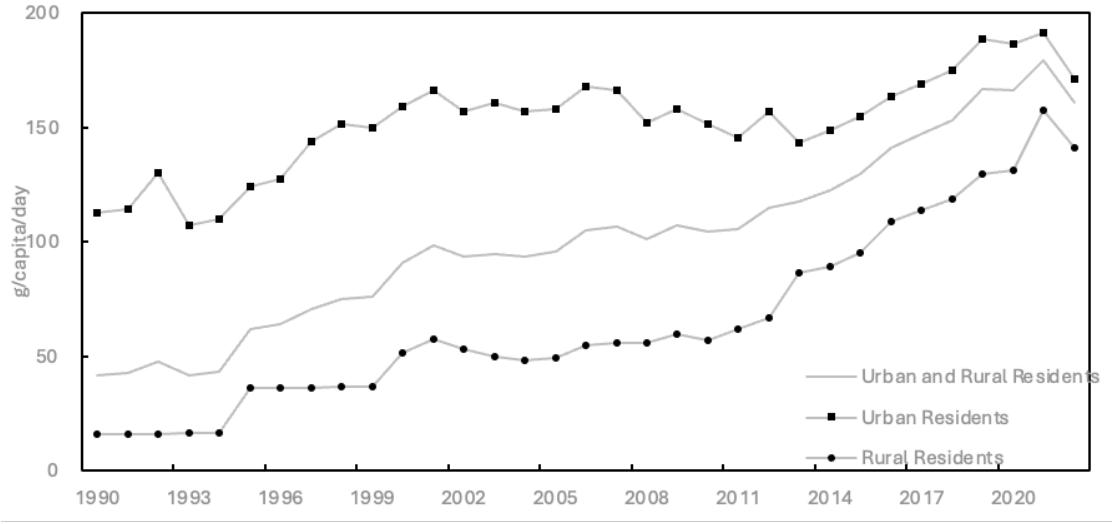


Figure 9: Mean fruit consumption in China, 1990–2020, g/capita/day.
Note: Data adjusted for dining out. Source: National Bureau of Statistics of China website

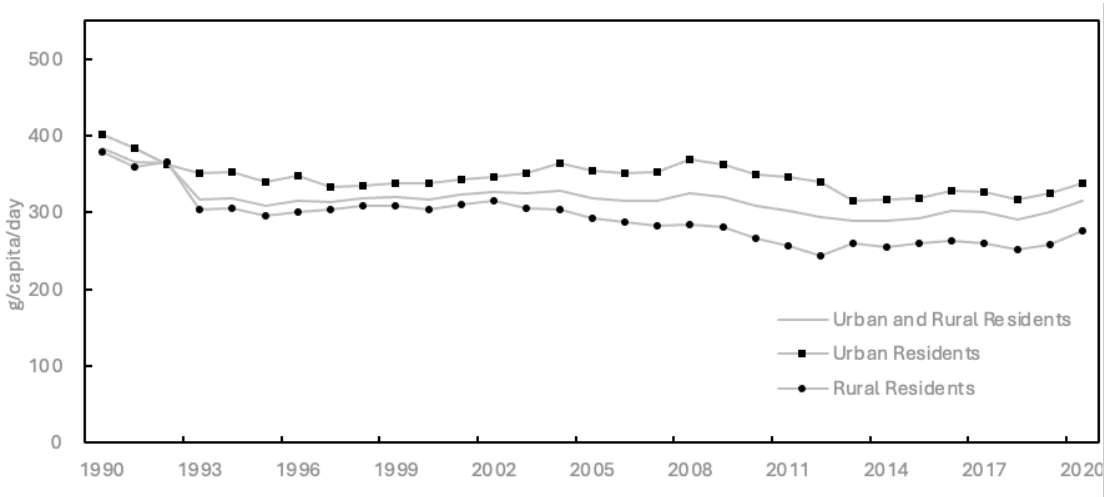


Figure 10: Mean vegetable consumption in China, 1990–2020, in g/capita/day.
Note: Data adjusted for dining out. Source: National Bureau of Statistics of China website

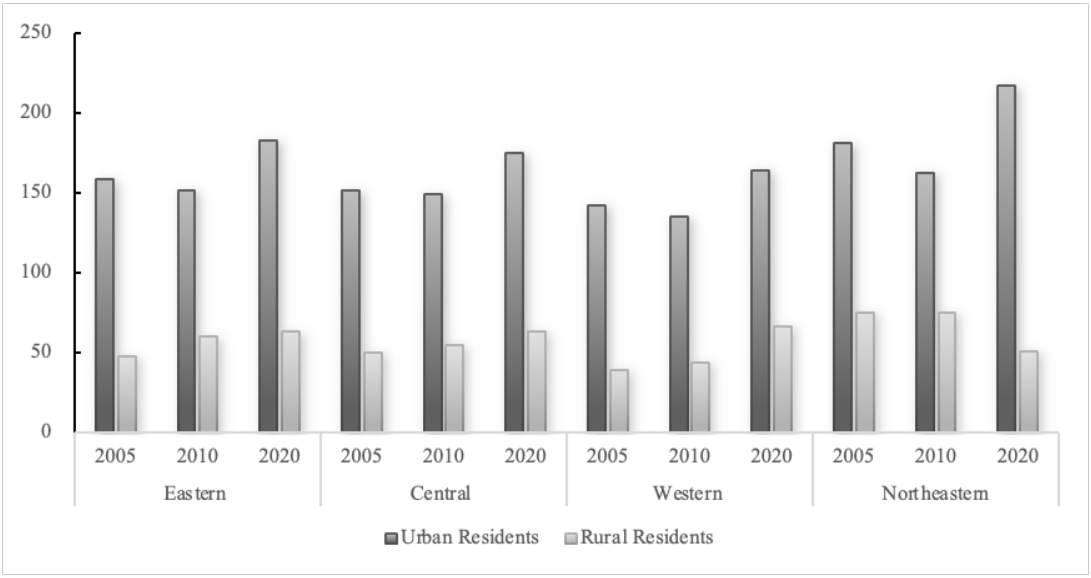


Figure 11: Fruit consumption in China by region, in g/capita/day. Source*: National Bureau of Statistics of China website*

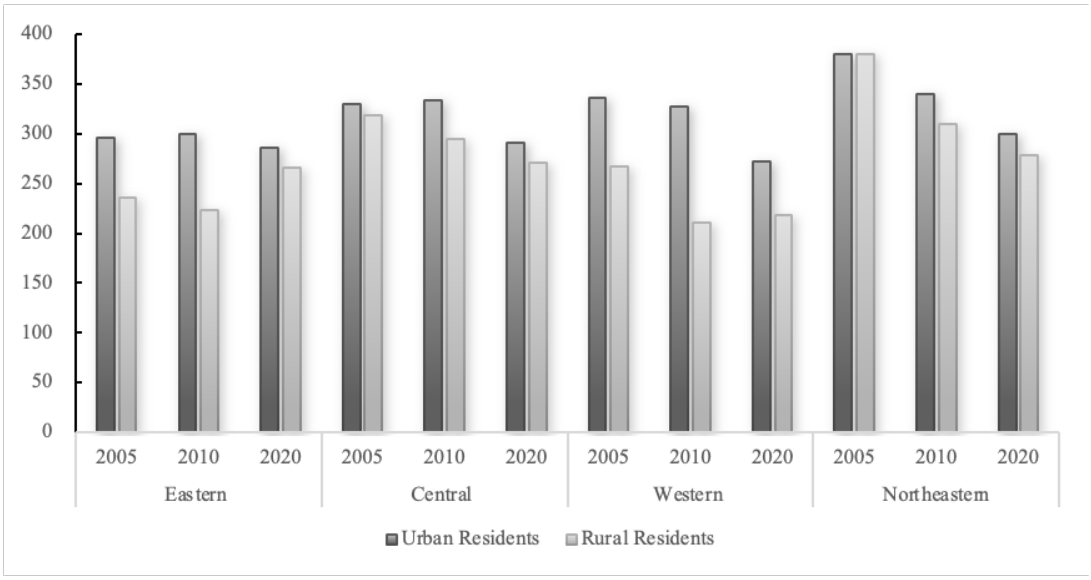


Figure 12: Vegetable consumption in China by region, in g/capita/day. Source*: National Bureau of Statistics of China website*

Export growth

In 1990, China exported 1.0 million t of vegetables and edible fungi and 0.2 million t dried/fresh melons, fruits and nuts (Table 5). By 1995, this had grown to 1.6 million t of vegetables/fungi and 0.4 million t of fruits/nuts. China's entry into the WTO in 2001 created new impetus, and by 2005, the country exported 5.2 million t of vegetables/fungi and 2 million t of fruits/nuts, reaching 9.3 million t of vegetables/fungi and 3.3 million t of fruits/nuts by 2022. While this is a high volume, exports are just 1.2% of domestic vegetable production of 800 million t and 1.0% of fruit production of 327 million t.

In 2021, China's vegetable export was valued at US$10.1 billion, making it the world's largest exporter of vegetables. The Regional Comprehensive Economic Partnership (RCEP), a free trade agreement among 15

countries in the Asia-Pacific region, including ASEAN member states plus Australia, China, Japan, New Zealand, and South Korea, has become a key market (Zheng and Li, 2024). In 2021, exports to RCEP nations accounted for 53.9% of China's total vegetable export value. Key RCEP destinations include Vietnam, Japan, Malaysia, South Korea, Indonesia, Thailand, and the Philippines. Beyond RCEP, Russia and USA are also significant importers of Chinese vegetables. The 'Belt and Road' initiative has further deepened trade cooperation with participating countries, expanding export opportunities. RCEP countries also account for 50% of China's fruit exports (Sun and Li, 2024), with Vietnam and Thailand accounting for about 50% of all exports to RCEP countries.

Within the framework of China's "dual circulation" strategy, imports and exports are both considered as important. Fruit and vegetable exports broaden market horizons for domestic producers, alleviate supply-demand pressures within China, and enhance the international profile and competitiveness of Chinese producers. Products like Shandong vegetables and Shaanxi apples exemplify how stable quality and output can create a profitable export market. Export activities also catalyze coordinated development across the entire value chain—from cultivation and harvesting to processing, transport, and sales—creating employment, boosting farmer incomes, invigorating the rural economy, and thus reinforcing the domestic cycle through interaction with the international cycle. Fruit and vegetable imports, on the other hand, diversify choices for Chinese consumers, satisfying demands for a wider variety of products. Popular imported items like durian and cherries cater to consumer preferences for high-quality, diverse fruit options. This influx also encourages the domestic sector to accelerate upgrading, improving product quality and diversity. Furthermore, imports strengthen agricultural exchange and cooperation with other nations, help the domestic sector adapt to international standards, and enhance the overall competitiveness of the sector.

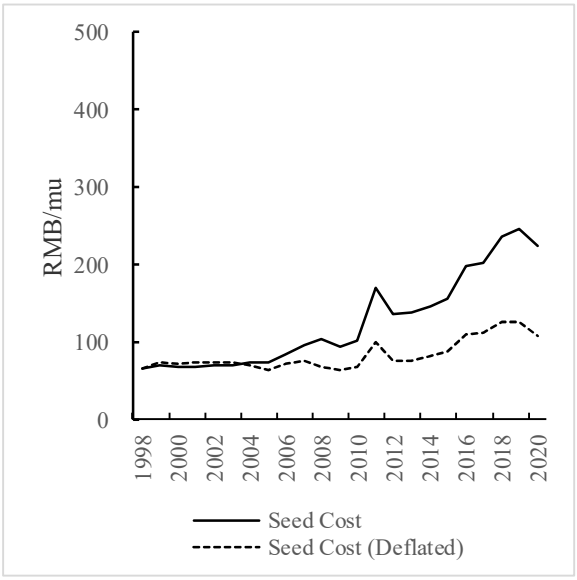
Table 5: China's fruit and vegetable exports, 1990-2022, in million tonnes

Year	Fruit	Vegetables
1990	0.23	0.98
1995	0.40	1.58
2000	0.82	2.45
2005	2.00	5.20
2010	3.00	6.55
2015	2.87	8.33
2020	3.87	10.17
2021	3.61	8.99
2022	3.34	9.34

Source: China Rural Statistical Yearbook 2023

Farm input use

The fourth driver of fruit and vegetable production is increased use of inputs such as improved seeds, fertilizers and pesticides. Figure 13 shows the average input use in vegetable production from 1998 to 2020. Seed expenditures increased 66% in real prices (adjusted for price inflation). Fertilizer expenditures increased 54%, and pesticide expenditures increased by 71%. Lastly, expenditures on agricultural film (plastics used for mulching and protected cultivation) peaked at 176.7 yuan/mu in 2016 and then declined to 165.2 yuan/mu by 2020.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400
300
200
100
0
RMB/mu
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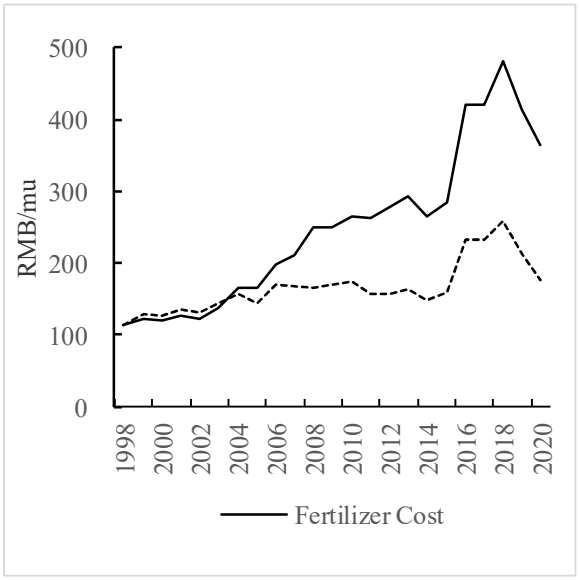
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Seed Cost
Seed Cost (Deflated)


500
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RMB/mu
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2000
2002
2004
2006
2008
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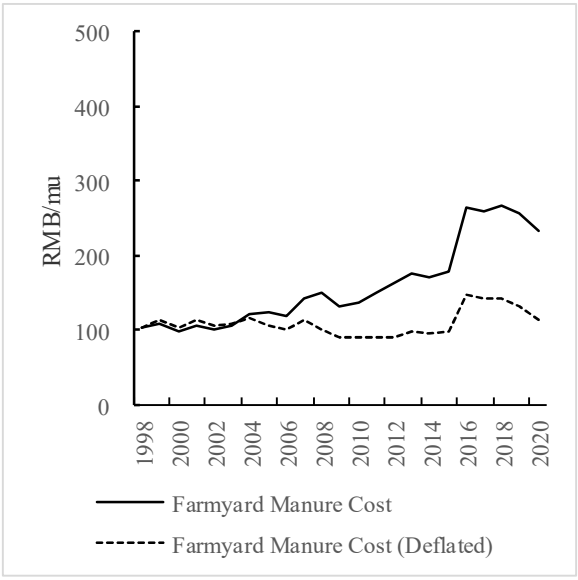
2020
Fertilizer Cost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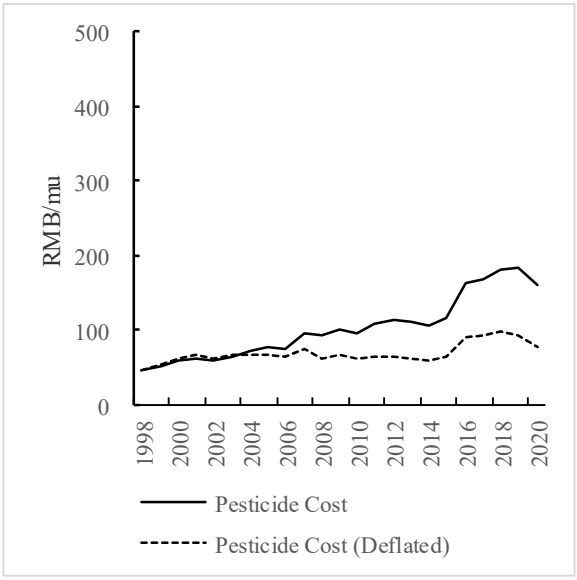
Farmyard Manure Cost
Farmyard Manure Cost (Deflated)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Pesticide Cost
Pesticide Cost (Deflated)

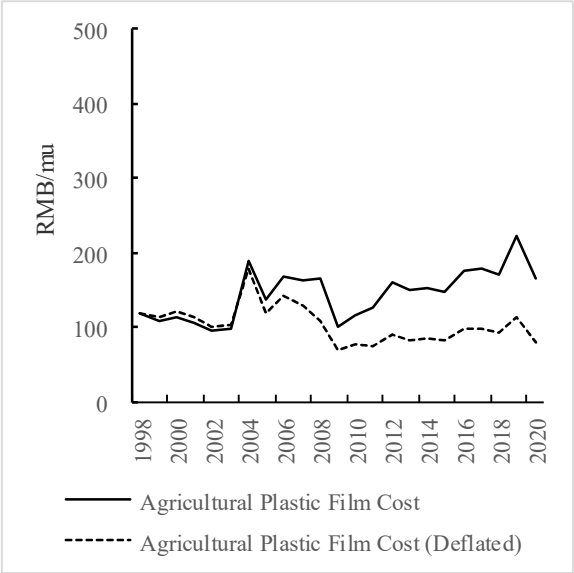
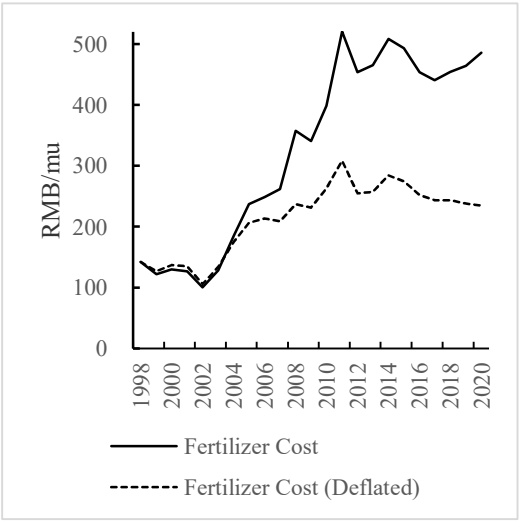
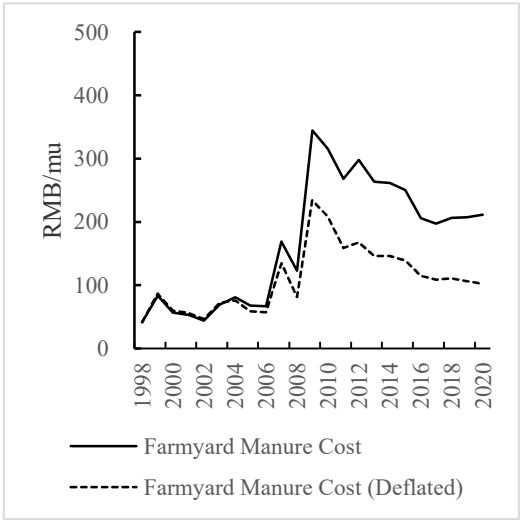


Figure 13: Farm input costs in vegetable production, in RMB/mu.
Source: Compilation of National Agricultural Product Cost and Benefit Data, National Bureau of Statistics of China website

Figure 14 shows farm expenditures in fruit (apple) production from 1998 to 2020. Expenditures on fertilizers increased by 65% in real terms. Expenditures on manure increased by 29%, and pesticide expenditures increased by 138%.





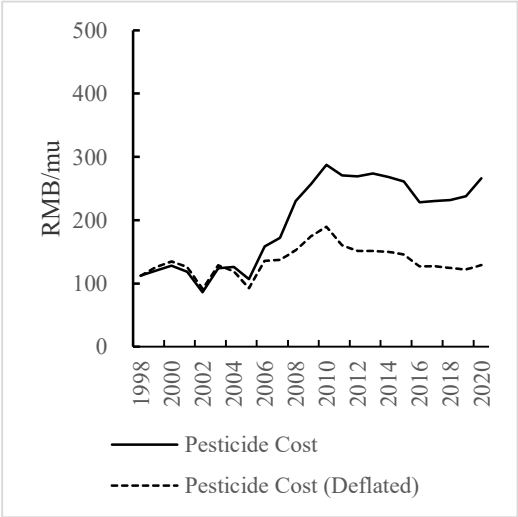


Figure 14: Farm input costs in apple production, in RMB/mu.
Source: Compilation of National Agricultural Product Cost and Benefit Data, National Bureau of Statistics of China website

Studies show that vegetable and fruit production make up over 30% of chemical fertilizer use in Chinese agriculture (Hou et al., 2017). Average fertilizer application rates rose from 32.8 kg/mu (492 kg/ha) in 1998 to a peak of 61.1 kg/mu (916.2 kg/ha) in 2018. Although rates declined to 45.2 kg/mu (678 kg/ha) by 2022, they still remain well above the internationally accepted safety threshold of 225 kg/ha. Comparative data indicate that China's vegetable fertilizer application rates are higher than those of Japan (+192 kg/ha), the US (+445.5 kg/ha), and the EU (+471 kg/ha) (Kang and Guo, 2024). There remains much scope for reducing mineral fertilizer use in vegetable production. A 12-year study conducted across 54 sites shows that integrating soil-crop system management practices with more efficient fertilizer products can reduce nitrogen use by 38%, cut greenhouse gas emissions by 28%, and boost yields by 17%, providing a promising strategy for sustainable intensification of vegetable systems (Wang et al., 2021). Regarding fruit production, fertilizer use in major apple-growing regions peaked at 65.1 kg/mu (976.7 kg/ha) in 2010 before gradually declining. Excessive fertilizer use damages soil structure, speeds up nutrient depletion, causes severe soil compaction, and contributes to secondary soil salinization (Lü, 2024).

The extensive use of agricultural films in vegetable production poses another environmental challenge. Average usage peaked at 18.8 kg/mu (281.9 kg/ha) in 2014 before decreasing to 12.6 kg/mu (189.5 kg/ha) by 2022. Although the national average recovery rate for agricultural film reportedly exceeds 80%, inadequate disposal practices persist in some areas, with farmers sometimes simply piling collected film at field edges or plowing film fragments into the soil. This contributes to so-called "white pollution"—environmental contamination caused by plastic and nylon waste (Xu et al., 2023). Accumulated film fragments disrupt soil structure, hinder root growth, and worsen issues like soil compaction and secondary salinization (Wu, 2024; Shen et al., 2023).

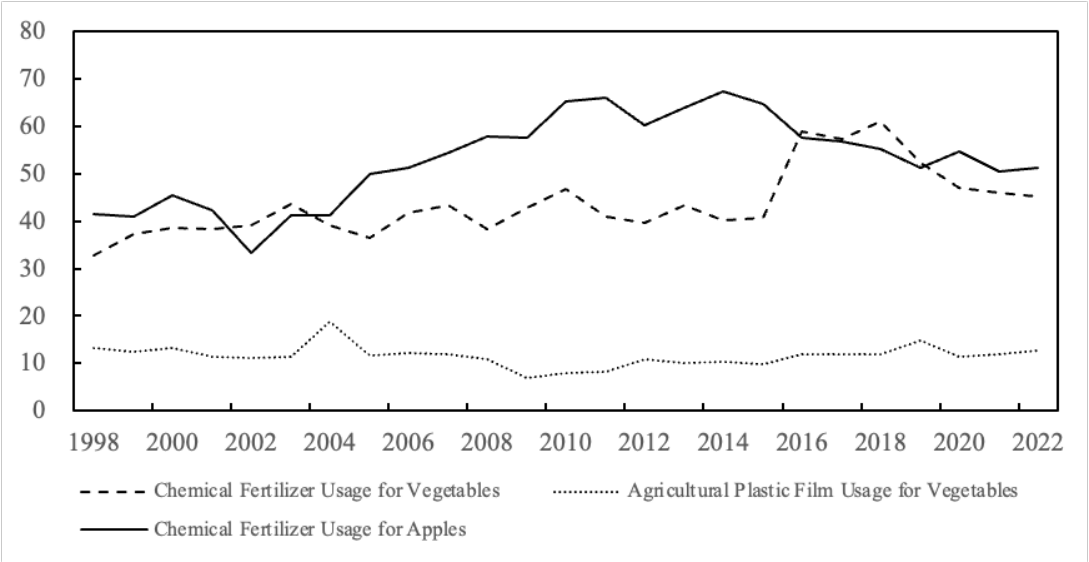


Figure 15: Use of chemical fertilizers and agricultural plastic film in fruit and vegetable production in China, in kg/mu.

Source*: Compilation of National Agricultural Product Cost and Benefit Data*

On the positive side, increased public awareness regarding food safety and environmental protection drives increased consumer demand for organic and environmentally friendly produce, particularly organic fruits and vegetables. The market for organic agriculture has grown in China, surpassing 100 billion RMB in 2019 (Zhou, 2024). According to the China National Certification and Accreditation Administration (2024), organic vegetable production reached 1.23 million t (4.9% of total organic crops), and organic fruit production reached 1.30 million t (5.2% of total organic crops) in 2023. New technologies like precision agriculture and smart greenhouses also have the potential to reduce farm input use by enhancing input use efficiency (Wei, 2021).

Government commitment to green agriculture is also intensifying. Policies like the 'Action Plan for Zero Growth in Fertilizer Use by 2020' and updated pesticide management regulations encourage reduced chemical input use and promote environmentally sound practices such as biological control and crop rotation/fallowing (Wei, 2021). The 'National Rural Revitalization Strategy' furthermore provides financial, technical, and service support for the green transition, facilitating industrial upgrades and sustainable practices (Zhao et al., 2025). Furthermore, the Ministry of Agriculture and Rural Affairs issued 'Guiding Opinions on Accelerating the Comprehensive Green Transformation of Agricultural Development' in December 2024. This guidance emphasizes fertilizer reduction through the application of science (including soil testing and formulated fertilization), advancing safe pest control methods, and promoting the responsible use and disposal/recycling of agricultural film, including the deployment of high-efficiency recovery machinery.

6 Research organizations and the private sector

Research organizations and sector associations

A collaborative innovation system of research institutions and social organizations underpins the development of China's vegetable and fruit sector.

Research organizations, including universities and agricultural extension centers, have contributed to the development of improved varieties. Noteworthy is the progress in Chinese cabbage breeding driven by multiple institutions. The Beijing Academy of Agriculture and Forestry Sciences Vegetable Research Center has collected, characterized, and identified genes from Chinese cabbage germplasm, leading to numerous varieties, some of which have become dominant cultivars in key production areas. Additionally, the Chinese Academy of Agricultural Sciences Institute of Vegetables and Flowers spearheaded efforts to sequence the complete cabbage genome. The Shandong Academy of Agricultural Sciences Vegetable Research Institute contributed research on using hybrid vigor and enhancing hybrid breeding techniques (Zhang et al., 2025).

Public research organizations have robust collaborations with the private sector, facilitating technology transfer through integrated breeding, propagation, promotion, and service models. An example is the Haiken Nanfan Seed Sector Innovation Research Institute, which established dedicated teams for vegetable and tropical fruit innovation, launching breeding projects on germplasm introduction, evaluation and utilization (Guo and Wang, 2024). Research efforts are also customized to regional needs, such as the Pingnan Comprehensive Experimental Station (part of Fujian's modern agriculture system) that developed techniques for protected multi-cropping of celery in southern high-altitude areas (Li, 2025), while the CAAS Institute of Vegetables and Flowers formulated environmentally friendly pest control strategies for melon pests in southern regions (Wang et al., 2017).

Sectoral organizations, such as the China Vegetable Association, the China Fruit Marketing Association, and various provincial and municipal counterparts, promote sector upgrades through science and technology services. The Guangdong Vegetable Sector Association, for example, regularly organizes academic seminars to discuss the provincial sector's status, breeding advancements, pest management, fertilization techniques, and seed business management (Report, 2011). The Shouguang Vegetable Association and the Shouguang Talent Development Group established a ‘New Farmer’ Talent Service Center featuring a database of 3,000 technicians, standardizing the deployment of technical expertise to vegetable parks nationwide.

In production standardization, many associations develop group standards, such as the Guangdong Plant Protection Society's technical regulations for green Choi Sum production, and the Yantan District Fruit and Vegetable Association's standards for watermelon cultivation, aimed at enhancing consistency in regional product quality. Regarding sector services, the Shouguang Vegetable Association (considered the ‘hometown of Chinese vegetables’) established a resource-sharing platform for its members, covering aspects such as ‘modern agricultural industrial park’ construction and agricultural input e-commerce, thereby optimizing the local sector ecosystem.

Producers

Within the vegetable and fruit production chain, the private sector encompasses diverse actors, including smallholder farmers, farmer cooperatives, and agricultural enterprises. As agricultural market reforms have deepened, the private sector has emerged as the central driving force behind the sector's development.

China's agricultural landscape is often characterized as a ‘large country with small farms,’ where smallholder family-based operations remain the sector's backbone (Mu and Kong, 2024). Data from the Third National Agricultural Census (People’s Republic of China 2024) show that smallholders constitute over 98% of agricultural operating entities, employ 90% of the agricultural workforce, and manage 70% of the total cultivated land. As of 2024, an estimated 210 million farm households operate on less than 10 mu (approx. 0.67 ha) of land (Li and Chen, 2025).

However, smallholders face significant operational challenges. Their limited scale hinders their ability to track market dynamics accurately and weakens their bargaining power in market transactions. As a result, they incur higher costs when purchasing inputs. The small scale of operations hinders their ability to adapt to modern agricultural production methods. Furthermore, smallholders typically have lower resilience to natural risks and often rely heavily on pesticides and fertilizers (Gui and Qian, 2023). Demographic change also poses a challenge as the farming population is aging (Liu et al., 2023). Consequently, their income streams are often limited, making capital accumulation solely through farming difficult.

Developing various forms of moderately scaled operations and nurturing new types of agricultural entities have been key strategies for modernizing Chinese agriculture (Wang, 2020). Policies encourage the expansion of family farms to create more efficiently managed units and economies of scale (Huang, 2025). Farmer cooperatives, in turn, function as resource integration platforms. The "Cooperative + Farmer Household" model typically involves cooperatives managing operations institutionally and at scale, providing individual farmer households with comprehensive or specific services, such as land preparation, pest control, input procurement, machinery sharing, harvesting, and marketing, often under formal agreements (Liu, 2025).

Agricultural enterprises have been instrumental in connecting smallholders to modern agriculture, with family farms and cooperatives acting as crucial intermediaries (Wang et al., 2025). By establishing close partnerships, enterprises drive the scale, specialization, and branding of agricultural products, thereby enhancing farmers' cultivation practices and market competitiveness for mutual benefit (Ma et al., 2014). Contract farming is a common model where enterprises sign production and sales agreements with farmers, often operating through a "Company + Cooperative + Base + Farmer Household" structure. The company provides technical support, market intelligence, and sales channels, while farmers produce according to specified standards, benefiting from guaranteed purchase prices. This creates stable benefit-sharing mechanisms and boosts farmer incomes (Jiang, 2019).

The income of farmers is an indicator of the sector's performance (Hu et al., 2016). At a macro level, the per capita disposable income of China's rural residents has generally trended upwards. The national average rural per capita disposable income rose from 2,282 yuan in 2000 to 18,931 yuan in 2021 (Table 6). The rural per capita disposable income in major vegetable and fruit-producing provinces, such as Shandong and Henan, is well above the national average and has experienced significant growth.

Average net profit from vegetables per mu of land showed an overall upward trend from 1,112 yuan in 2000 to 4,131 yuan in 2020 and 3,669 yuan in 2021, with variations influenced by market supply, demand dynamics, changes in production costs, and advances in cultivation technology. Periods of rapid growth in net vegetable profits (2004-2007, 2010, and 2018-2020) coincide with increases in rural disposable income per capita. This suggests that the economic performance of the vegetable sector contributes significantly to farmers' income growth. Factors such as market oversupply can depress prices and profits, but technologies like protected agriculture and new varieties boost yields and lower costs, thereby increasing profitability.

Table 6: Rural disposable income and net profit from vegetable production

Year	Rural disposable income (RMB/capita)			Net profit from vegetable production (RMB/mu)
	National	Shandong	Henan	
2000	2282	2663	1986	1112
2001	2407	2810	2098	1380
2002	2529	2955	2216	1181
2003	2690	3159	2236	1341
2004	3027	3519	2553	1563
2005	3370	3946	2871	1607
2006	3731	4387	3261	1510
2007	4327	5009	3852	2227
2008	4999	5671	4454	1882
2009	5435	6154	4807	2088
2010	6272	7034	5524	2777
2011	7394	8395	6604	2558
2012	8389	9506	7525	2455
2013	9430	10687	8475	2852
2014	10489	11882	9416	2070
2015	11422	12930	9966	2188
2016	12363	13954	10853	2151
2017	13432	15118	11697	2127
2018	14617	16297	12719	2688
2019	16021	17775	13831	3125
2020	17131	18753	15164	4131
2021	18931	20794	16108	3669

Source: Compilation of National Agricultural Product Cost and Benefit Data, National Bureau of Statistics of China website

Seed sector

The seed sector is crucial in driving fruit and vegetable development, built on a synergistic network between public sector policy support, private sector companies, and research organizations. The introduction of new varieties has enhanced the sector's competitiveness, with China's vegetable seed market valued at 15.5 billion yuan (US$2.2 billion) in 2019 (Wang et al., 2021). With fruit trees, 1,060 new varieties were registered between 2017 and 2024 (Wang et al., 2024), and improved varieties have been estimated to contribute 30-35% to yield increases (Zhang, 2009). The government has targeted policies to foster the seed sector. Practical examples include government support for establishing the Shouguang Vegetable Seed sector group and associated trial and demonstration sites in Shandong province (Zhong and Kong, 2012).

Talent development is another government priority. Policies encourage collaboration between university researchers and seed enterprises (Zhao and Zhang, 2022), creating a sector-university-research ecosystem for talent growth and technological innovation, enhancing human capital. Researchers share advanced knowledge with companies, while enterprises provide practical platforms, bridging theory and practice to cultivate versatile professionals crucial for the seed sector's advancement.

In 2021, 4,108 licensed companies operated in the vegetable seed market nationwide (Bin et al., 2024). Chinese seed companies have expanded their operations in domestic and international markets. For instance, Anhui Jianghuai Horticulture has introduced melon and watermelon varieties to markets in Southeast Asia, South Asia, and South America (Dai et al., 2015).

7 Case studies

This section looks at two agricultural development models in China: the Gaozhou vegetable sector and the Guangzhou lychee sector. These cases demonstrate how specific regions leveraged unique advantages, interventions, and collaborative frameworks to grow their fruit and vegetable sectors.

Gaozhou vegetable sector

Gaozhou city in southwestern Guangdong province has established itself as a major winter vegetable supplier for markets in northern China. This model is built upon its advantageous climatic conditions, large-scale off-season production capacity, and well-developed infrastructure. Gaozhou benefits from a humid subtropical monsoon climate (average annual temperature of 23°C, annual precipitation of 1560 mm) with warm winters and significant diurnal temperature variations, creating a natural greenhouse effect. This enables vegetable production during winter months when supplies are scarce in northern regions, establishing Gaozhou as a crucial national 'vegetable basket.'

Gaozhou city cultivated vegetables on an area exceeding 13,000 ha in 2024. It benefited from the Green Channel policy's 'South-to-North Vegetable Transport', allowing it to transport vegetables to distant markets. The policy exempts vehicles carrying fresh produce from road tolls, which is crucial for large-scale logistical operations, allowing Gaozhou to reduce the cost of shipping vegetables to distant markets. Production sites such as Fenjie Town, specializing in beans, scallions and garlic sprouts, use high-intensity cropping systems like rice-rice-vegetable-vegetable or vegetable-rice-rice-vegetable to achieve land utilization rates over 90% and produce 2-3 vegetable harvests annually. The sector is supported by robust infrastructure, including a 100,000 m^2 trading hall, cold storage facilities (40,000 m^3 capacity), ice factories (500 t daily capacity), and logistics networks. This infrastructure allows communities to do grading, packaging, and cold chain transportation of approximately 67,000 t of northbound vegetables.

The Gaozhou vegetable sector benefited from comprehensive government support, market entity collaboration, value chain integration, and robust quality and risk management systems. Technical support services provided by the government enhanced production efficiency and standardization. The local government provided subsidies to replace mineral fertilizers with organic fertilizers and for agricultural machinery purchases, and provided intensive technical support by technicians.

The sector is based on cooperatives and 'Village-Strengthening Companies', which are innovative organizational models linking smallholder farmers to larger markets while strengthening the sector's organization and reducing risk. For instance, the Maonong Planting Professional Cooperative provides seedlings, inputs, technology, standards, and purchasing to its farmers and offers them guaranteed minimum prices to stabilize their incomes. Also, the Tubingdong Vegetable Base in Xuefu Village (90+ households, 13.3 ha of scallions/garlic sprouts) centralizes seed procurement (selling it to below wholesale costs for farmers) and handles unified purchasing and sales. The model balances food security (rice cultivation) with high-value cash crops (scallions), improving land use efficiency and stimulating income growth for farmers and the cooperative.

The clustering of farms in cooperatives spurred the growth of upstream and downstream industries, like packaging, refrigeration, e-commerce, and logistics (e.g. Fenjie Town hosts four packaging plants, two ice factories, and nine large cold storage facilities). The central trading market handles over 1 million kg daily, including local produce and that of neighboring regions (Hainan, Guangxi, Yunnan). National buyers maintain purchasing stations to ship produce to northern China. Efforts are underway to expand e-commerce to reduce

reliance on physical wholesale markets. Stringent quality control systems are in place to ensure product safety. A traceability platform combined with random inspection controls pesticide residues.

Guangzhou lychee sector

Zengcheng and Conghua districts of Guangzhou city transformed their traditional lychee production into a high-value, globally competitive specialty industry. Located in the South Asian tropical monsoon zone, these districts are ideal for lychee cultivation. Both have a long history of lychee farming. In 2024, Zengcheng (13,440 ha, producing 27,700 t) and Conghua (20,000 ha, producing 31,000 t) accounted for over 70% of Guangzhou's lychee output.

Guangzhou's lychee sector is highly competitive thanks to innovation in variety development, organizational reform, branding, and value chain extension. This success is driven by strong collaboration among government, businesses, research institutions, and farmers. A partnership of 12 public research organizations, including South China Agricultural University, established a national lychee germplasm repository that conserves over 600 varieties. This has led to the development of late-maturing varieties like *Jingang Hongnuo* and *Xianjinfeng*, which extend the harvest season from 45 to 90 days, allowing for a more staggered market supply.

The Lychee Sector Technology Enhancement Project, with a total investment of 120 million yuan, promoted more than 20 new technologies such as dwarf dense planting for mechanization, integrated water and fertilizer management, and drone-based plant protection, resulting in a 25% increase in yield. Additionally, the 'Guangzhou Lychee Sector High-Quality Development Three-Year Action Plan' offered subsidies for standardized orchard construction, cold chain infrastructure, and technical support for farmers.

As a result of the support, farmers became more organized and connected to processing and distribution sectors, establishing an industrial development model of shared risks and benefits. Companies signed purchase agreements with farmers while providing inputs and interest-free loans. Three national processing companies (e.g., Haisheng Group, specializing in freeze-drying, and Shunchangyuan, producing lychee wine) helped build an industrial cluster of lychee associations to coordinate market orders and avoid price competition.

Lychee production is supported by five provincial-level agricultural industrial parks equipped with intelligent sorting lines (400 t/day/line), controlled atmosphere storage (120,000 m^3 total), and cold chain logistics centers (enabling 24-hour delivery within the Pearl River Delta and 48-hour delivery across the nation). The annual fruit processing capacity is about 146,000 t, yielding. The sector has developed over 20 value-added products, such as dried lychees, lychee wine, and lychee honey.

Branding strategies and diversified market channels added value and increased market influence. Two lychee varieties, *Zengcheng Gualü* and *Conghua*, received national geographical indication certification trademarks. Products were sold through e-commerce enterprise brands (Li Xiao Ji, Conghua Youxuan) operating flagship stores on major platforms (JD.com, Tmall), helping to generate over 1.5 billion yuan in e-commerce sales in 2024. The sector also used a multi-channel sales approach, including offline wholesale markets, e-commerce, and other outlets. Agrotourism was incorporated into the model through events like the "Gualü Lychee Cultural Festival" and offering "Customized Lychee Picking Tours," which attract 800,000 tourists annually.

Finally, a quality control and green development system was put into place. It established a comprehensive 'branch-to-tongue' quality control mechanism. This includes local quality standards (e.g., sugar content ≥18 degrees, edible rate ≥80%) and an agricultural product quality and safety traceability platform that covers 300,000 growers. Organic fertilizers and green pest and disease control are actively promoted.

8 Conclusions

This report documented and analyzed the transformation of China's fruit and vegetable sector from 1990 to 2024. Predominantly using data and literature from China, the study described this development, identified the key drivers of its success, and described the role of the public and private sectors in this transformation. China's fruit production expanded by 302%, and its vegetable production grew by 380%. Vegetable production expanded across all of China's provinces, with Shandong, Henan, and Guangxi provinces emerging as key production sites. By 2023, China accounted for 53% of global vegetable and 36% of global fruit production, by value, based on FAO data, including 93% of global spinach production, 82% of global cucumber and gherkin production, 45% of green chili, and 36% of tomato production. China's vegetable yields also increased by about 50%, while the cultivated area under vegetables increased by 250%.

Key drivers of this success include strategic and sustained policy support, notably the Vegetable Basket Project and the Green Channel policy. The Vegetable Basket Project underwent four distinct phases. The initial focus was on expanding production with technologies and clear instructions to local government to ensure a sufficient supply of vegetables (alongside other essentials like meat, eggs, dairy, and aquatic products). The project then focused on market development, creating better price information systems, upgrading wholesale markets, developing cold chains, and improving links between producers and markets. Next, the focus shifted to food safety and product quality, which remain relevant today. The Green Channel policy was equally instrumental in facilitating inter-regional trade of fresh produce by removing obstacles such as checkpoints and toll fees for vehicles transporting fresh produce. Other policies, such as zero value-added tax on agricultural production and trade, have also been instrumental.

Another key driver is the synergistic interplay between the public sector, private companies, and research organizations. Government initiatives provided essential frameworks, infrastructure (notably in cold chain logistics), and support for public branding. The private sector, including smallholder producers and increasingly sophisticated cooperatives and enterprises, improved production and market integration. Research organizations and the seed sector played a pivotal role in innovation, variety development, and the dissemination of advanced production methods. A key factor has been the rapid spread of protected agriculture, which accounts for about 45% of China's current vegetable output by value.

Case studies of the Gaozhou vegetable and Guangzhou lychee sectors further highlighted how comprehensive and targeted strategies contributed to the development of the fruit and vegetable industry, with organizing farmers into cooperatives and connecting them to markets and processors playing key roles.

In summary, China's fruit and vegetable sector presents a compelling story of agricultural modernization, driven by policy, innovation and market dynamics. This has yielded substantial benefits, and the sector now stands at a juncture where balancing continued productivity with environmental stewardship and ensuring equitable dietary improvements are paramount. Insights from this analysis underscore the complexity of such transformations and highlight the importance of integrated and adaptive strategies for sustainable horticulture development globally.

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