

An Economic Analysis of Protected Cultivation in Haryana: A Comparative Study Between Open-Field and Protected Cultivation

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Abstract

Original Research Article

The increasing population and declining landholdings in India have created a significant challenge to the traditional agricultural model to meet the rising demand of foodgrains and vegetables. Over the past two decades, the growth in production and productivity of many crops has remained limited, making it difficult for traditional farming systems alone to satisfy future food requirements. In this context, the protected cultivation technology (Poly-house and net house) in agriculture may help to meet out the rising demand of vegetables. Therefore, this study evaluates the importance of protected cultivation as a sustainable alternative agriculture arrangement to fulfill the rising demand for vegetables. The study is analyzing the trends in the area and production of tomato, capsicum, and cucumber vegetable crops in Haryana between 2015-16 and 2024-25. The analysis reveals a declining trend in both area and production under open-field cultivation, while protected cultivation recorded consistent growth throughout the study period. The increasing adoption of protected cultivation reflects its growing importance in improving productivity, enhancing production efficiency, and supporting sustainable vegetable cultivation in Haryana.

Keywords: Vegetable Crops, Trend Analysis, Protected cultivation, Open-field Cultivation.

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1. INTRODUCTION

Rapid population growth is increasing pressure on land and natural resources for the adequate supply of food grain and vegetable. As the population continues to expand, the demand of foodgrains, fruits and vegetable are also increasing sharply. At the same time, the average size of landholdings is gradually declining in India. In this situation it is very difficult to fulfil the demand of foodgrains and vegetable and maintain the farmer's income by traditional cultivation. Therefore, the new agricultural arrangement of protected cultivation may be the new agriculture tool which can fulfil the demands of food grains and vegetables and sustain the farmer's income. Farmers can successfully diversify their traditional agricultural practices by adopting various levels of protected cultivation (i.e. polyhouse, greenhouse, net house etc.). In Horticulture cultivation, the technology of Protected Cultivation has become more popular, because it facilitates the controlled environmental conditions which further ensure maximum output with superior quality. The potential crops produced under protected cultivation are cucumber, capsicum, tomato, chilli, sweet pepper etc. There are many studies which show that the protected

cultivation has increased the production, productivity and farmers' income also (Kumar *et al.*, 2015; Duhan, 2016; Nordey *et al.*, 2017; Punera *et al.*, 2017; Kumari, 2019; Mehta *et al.*, 2020). Therefore, protected cultivation has expanded rapidly in India.

To facilitate horticultural activities in India, the Indian Government has introduced numerous schemes such as the National Horticulture Mission (NHM), Horticulture Mission for North East and Himalayan states (HMNEH), National Horticulture Board (NHB), Coconut Development Board (CDB) and Central Institute of Horticulture (CIH), Nagaland. The government of India has also initiated a Mission for Integrated Development of Horticulture (MIDH), a centrally sponsored scheme to ensure growth of horticulture sector. The Indian government is also providing subsidies up to 60 per cent of total project (except North East and Himalayan States, where the central government is providing up to 90 per cent).

The government of several states including Haryana has also tried to promote protected cultivation in the state. As a result, the state has witnessed a

significant expansion in polyhouse cultivation, with the highest adoption reported in Karnal district, followed by Rohtak and Mahendergarh (Kumar *et al.*, 2018). Vegetable cultivation under protected structures offers several advantages over open-field cultivation, including the production of high-quality vegetables during the off-season. This is largely achieved through the effective management of environmental conditions, as well as better control of pests and diseases (Sahu *et al.*, 2020). The use of protected cultivation extends the life span of agricultural operations and increases revenue even from vegetable production by an extent of 68 to 73 per cent, other thing being equal (Liao *et al.*, 2020).

Although several studies have examined the economics and profitability of protected cultivation in different parts of India, limited research has focused on the changing trends in area and production under open-field and protected cultivation in Haryana. Moreover, comparative evidence on the performance of major vegetable crops under the two cultivation systems remains inadequate. In view of this, the present study tries to analyze and compare the trends of area and production of tomato, capsicum and cucumber in open field and protected cultivation in Haryana.

1.1 Objectives of the Study

- To analyse the trend in area of vegetable crops under protected cultivation and open-field cultivation in Haryana.

- To analyse the trend in production of vegetable crops under protected cultivation and open-field cultivation in Haryana.

2. DATA SOURCE AND METHODOLOGY

The present study is based on secondary data collected from the Department of Horticulture, Haryana for the period 2015-16 to 2024-25. The analysis focuses on three major vegetable crops, namely tomato, capsicum, and cucumber, cultivated under both open-field and protected cultivation systems. Additional information was obtained from published research articles, government reports, and official publications related to horticulture and protected cultivation.

This study is descriptive and comparative in nature to analyse the trend of area and production of selected vegetable crops under open field and protected cultivation in Haryana. The percentage shares were calculated to analyse the relative contribution of each crop in the selected vegetable crops over time. The analysis is mainly in tabular form and using graphical methods.

3. RESULTS AND DISCUSSION

This section analyses the trends in area and production of tomato, capsicum and cucumber under protected and open-field cultivation in Haryana from 2015-16 to 2024-25 through tables and figures.

Table 3.1: Area under Selected Vegetable Crops in Haryana (in ha)

Year	Tomato	Tomato (%)	Capsicum	Capsicum (%)	Cucumber	Cucumber (%)	Total Area
	(1)	(2)	(3)	(4)	(5)	(6)	(1+3+5)
Open-field Cultivation							
2015-16	29027.5	62.05	3282	7.02	14471	30.93	46780.5
2016-17	28750	62.49	3911	8.50	13347	29.01	46008
2017-18	34605	61.83	4458	7.97	16901	30.20	55964
2018-19	30115	58.60	4430	8.62	16842	32.77	51387
2019-20	23922.6	55.78	4035	9.41	14931	34.81	42888.6
2020-21	21319	59.83	3657	10.26	10654	29.90	35630
2021-22	20890.5	61.43	3740.8	11.00	9375	27.57	34006.3
2022-23	22869.5	57.29	4345.5	10.89	12706	31.83	39921
2023-24	22183.6	62.33	4109.4	11.55	9298.6	26.13	35591.6
2024-25	22125	61.79	4121	11.51	9562	26.70	35808
Protected Cultivation							
2015-16	56.5	12.97	65	14.93	314	72.10	435.5
2016-17	121.7	19.58	112.8	18.15	387	62.27	621.5
2017-18	83	12.39	100.25	14.96	486.65	72.65	669.9
2018-19	58.3	9.52	71.8	11.73	482.2	78.75	612.3
2019-20	61.6	9.76	81.1	12.85	488.4	77.39	631.1
2020-21	43.4	4.56	113.7	11.94	794.8	83.50	951.9
2021-22	47.1	6.21	83.8	11.05	627.2	82.73	758.1
2022-23	110.8	7.06	207.1	13.19	1251.9	79.75	1569.8
2023-24	83.4	5.22	180.6	11.30	1334.4	83.48	1598.4
2024-25	241	13.07	220	11.93	1383	75.00	1844

Source: Department of Horticulture, Haryana.

Table 3.1 shows the decadal trend (2015-16 to 2024-25) of the area of selected vegetable crops such as tomato, capsicum and cucumber cultivated under open field and protected cultivation in Haryana. In open field cultivation, tomato was the most important crop throughout the study period and more than 50 per cent of the total cultivated area was occupied by tomato crops. However, the area decreased from about 29 thousand hectares in 2015-16 to nearly 22 thousand hectares in 2024-25. The share of capsicum increased gradually with time but the second most important crop was cucumber with some fluctuations each year.

On the other hand, protected cultivation had a much lower absolute area but clearly increased over the decade from 435.5 ha in 2015-16 to 1844 ha in 2024-25, with very significant growth since 2020-21. Cucumber was the most preferred crop for protected cultivation and always occupied more than 60 per cent of the protected

area. Its cultivated area increased from around 314 hectares in 2015-16 to about 1,383 hectares in 2024-25. Capsicum also showed a significant increase in area while tomato showed a relatively smaller area with some improvement in later years. Overall, the findings indicate that tomato was the most preferred crop in open field cultivation, while cucumber was the most preferred crop under protected cultivation. Further, the use of advanced technologies is found to be more in protected cultivation in Haryana.

Overall, the table presents two important structural shifts: (i) the area of open field vegetables cultivation is the largest, and the most important crop is the tomato, and (ii) protected cultivation occupies a relatively small area but it is expanding and becoming progressively oriented toward cucumber production systems.

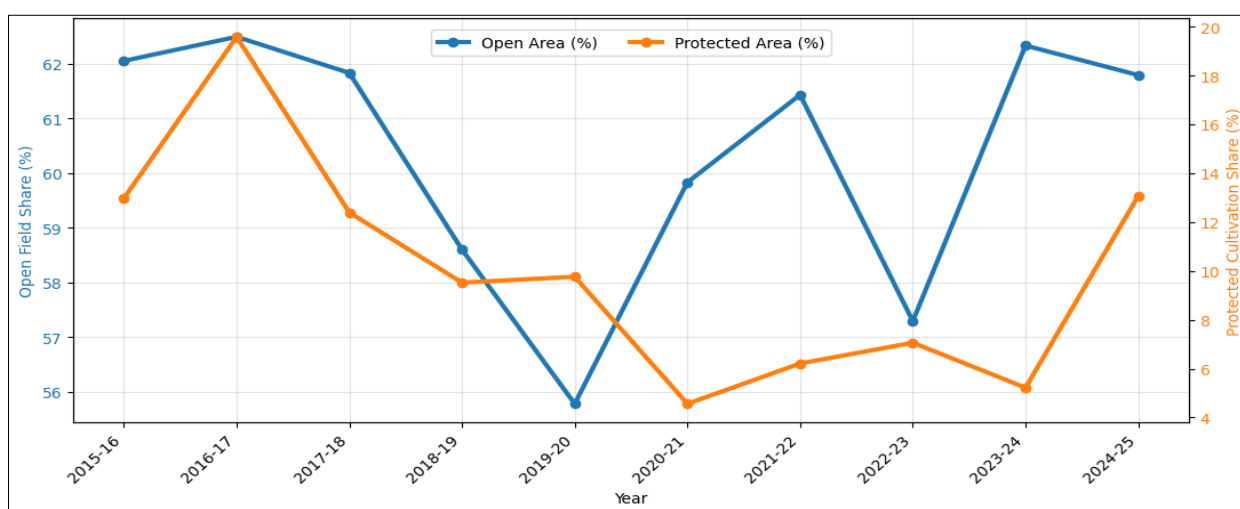


Figure 3.1: Trends in Tomato Area under Open-field and Protected Cultivation (in %)
 Source: Department of Horticulture, Haryana

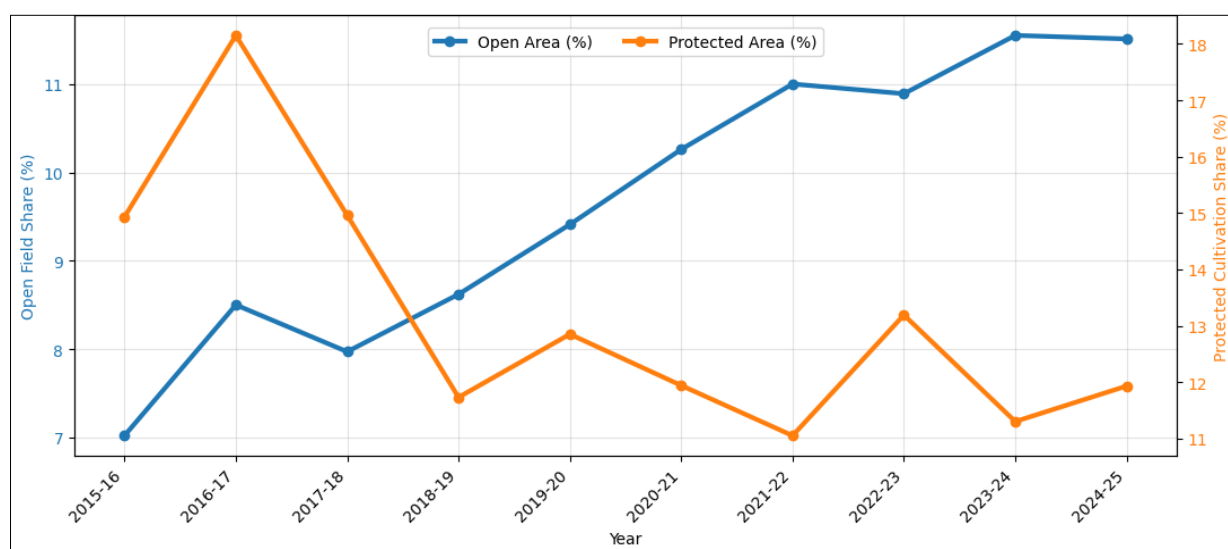


Figure 3.2: Trends in Capsicum Area under Open-field and Protected Cultivation (in %)
 Source: Department of Horticulture, Haryana

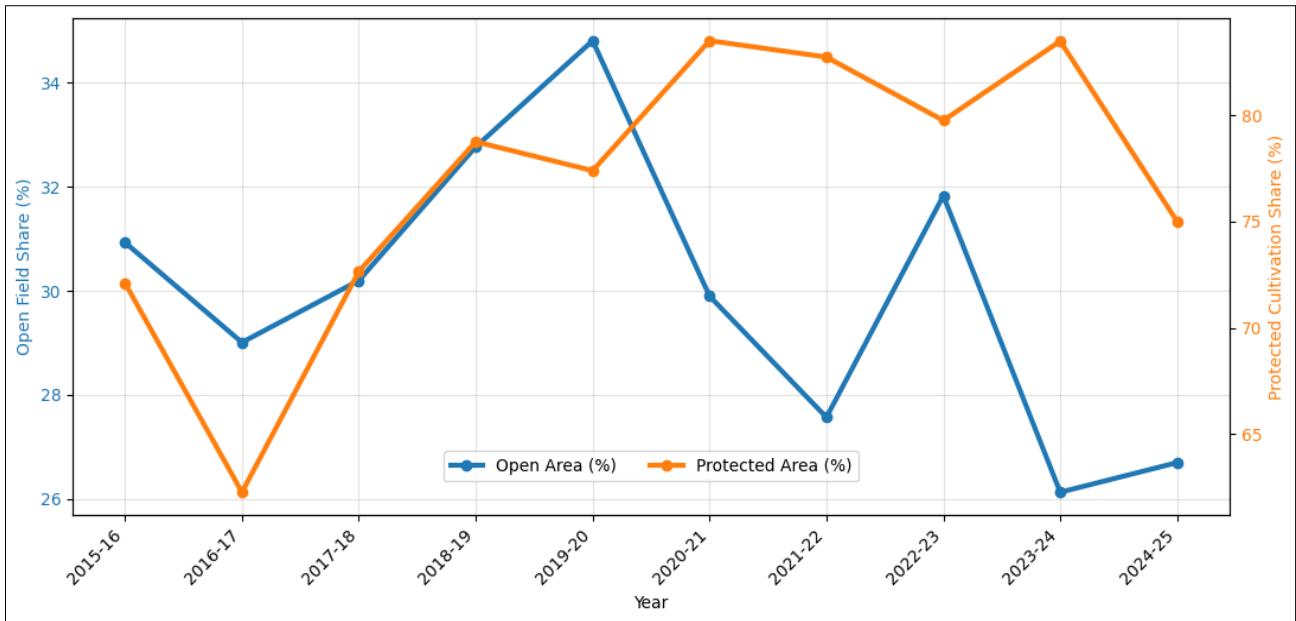


Figure 3.3: Trends in Cucumber Area under Open-field and Protected Cultivation (in %)

Source: Department of Horticulture, Haryana

Figures 3.1 to 3.3 highlight the shift in area of vegetables in open field and protected cultivation in Haryana. The area of tomato under open field cultivation decreased significantly from 2018-19 to 2020-21 and then increased slightly in later years while the protected cultivation of tomato increased during 2016-17 and again in 2024-25.

during the given period of study, and a great variation across years. Cucumber was also the most significant crop for protected cultivation, especially in 2020-21 and 2023-24, suggesting increased farmer preference for protected cucumber production. Overall, the figures indicate a more stable crop composition under open field cultivation and a more specialized cultivation under protected cultivation.

The share of protected area for capsicum showed a gradual positive trend in open field cultivation

Table 3.2: Total Area under Selected Vegetable Crops (in ha)

Year	Open-field Cultivation	Open-field Cultivation (%)	Protected Cultivation	Protected Cultivation (%)	Total Cultivated Area
	(1)	(2)	(3)	(4)	
2015-16	46780.5	99.08	435.5	0.92	47216
2016-17	46008	98.67	621.5	1.33	46629.5
2017-18	55964	98.82	669.9	1.18	56633.9
2018-19	51387	98.82	612.3	1.18	51999.3
2019-20	42888.6	98.55	631.1	1.45	43519.7
2020-21	35630	97.40	951.9	2.60	36581.9
2021-22	34006.3	97.82	758.1	2.18	34764.4
2022-23	39921	96.22	1569.8	3.78	41490.8
2023-24	35591.6	95.70	1598.4	4.30	37190
2024-25	35808	95.10	1844	4.90	37652

Source: Department of Horticulture, Haryana

Table 3.2 presents the trend of total area under vegetable cultivation in Haryana from 2015-16 to 2024-25. During this period, most of the vegetable area (over 95 per cent) was under open-field cultivation, whereas protected cultivation had a small but steadily increasing share. The total area under cultivation, over the decade has been fluctuating from a high of 56,633.9 ha in 2017-18 to a low of 34,764.4 ha in 2021-22, followed by some recovery during 2022-23 to 2024-25. The absolute open-

field area also reflects a rise-fall-stabilisation pattern but the proportion of the area is declining slightly from 99.08 per cent in 2015-16 to 95.1 per cent in 2024-25. Protected cultivation, on the other hand, has a definite upward trend, jumping from 435.5 ha (0.92 per cent) in 2015-16 to 1,844 ha (4.90 per cent) in 2024-25, especially after 2021-22. Overall, the table indicates that the open field system remains the major production system for vegetables in the state while the importance of protected

cultivation has increased in recent years, as reflected in its growing share of the cultivated area.

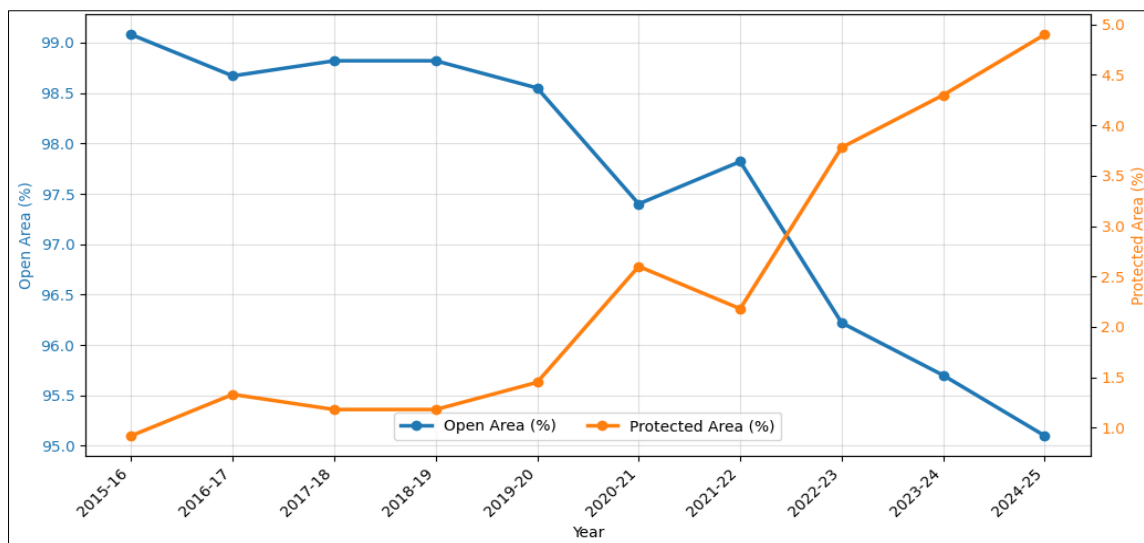


Figure 3.4: Total Area of Cultivation under Selected Vegetable Cultivation (in %)

Source: Department of Horticulture, Haryana

Figure 3.4 shows the changing composition of total vegetable area under open-field and protected cultivation. Over the course of the study the difference between the two cultivation systems has been decreased, especially since the year 2020-21 when protected cultivation has increased significantly. The protected

cultivation share increased the most in 2021-22 to 2024-25 indicating faster adoption of protected cultivation technologies. The figure clearly reflect that open-field cultivation still dominates the total vegetable area during the decade despite this increase in adoption of protected cultivation system.

Table 3.3: Production of Selected Vegetable Crops (in 000' quintal)

Year	Tomato	Tomato (%)	Capsicum	Capsicum (%)	Cucumber	Cucumber (%)	Total Production (1+3+5)
	(1)	(2)	(3)	(4)	(5)	(6)	
Open-field Cultivation							
2015-16	6753	78.30	258	2.99	1612	18.69	8625
2016-17	6276	77.23	289	3.56	1560	19.20	8126
2017-18	7460	73.05	338	3.31	2414	23.64	10212
2018-19	6435	72.03	361	4.04	2136	23.91	8934
2019-20	4935	64.54	522	6.83	2189	28.63	7646
2020-21	4402	68.04	520	8.04	1548	23.93	6470
2021-22	3403	63.17	449	8.33	1534	28.48	5387
2022-23	4005	65.75	784	12.87	1301	21.36	6091
2023-24	4668	71.44	670	10.25	1194	18.27	6534
2024-25	4790	72.82	671	10.20	1116	16.97	6578
Protected Cultivation							
2015-16	40	14.55	27	9.82	207	75.27	275
2016-17	53	16.77	43	13.61	219	69.30	316
2017-18	77	16.42	62	13.22	329	70.15	469
2018-19	70	14.55	55	11.43	355	73.80	481
2019-20	71	12.20	77	13.23	433	74.40	582
2020-21	49	8.03	71	11.64	488	80.00	610
2021-22	31	7.45	48	11.54	336	80.77	416
2022-23	35	7.26	57	11.83	389	80.71	482
2023-24	88	6.80	148	11.43	1058	81.70	1295
2024-25	54	6.16	116	13.23	706	80.50	877

Source: Department of Horticulture, Haryana

Table 3.3 reports the production performance of selected vegetable crops in Haryana during 2015-16 to 2024-25 under open-field and protected cultivation systems. In open-field cultivation, total vegetable production shows inter-annual fluctuations, rising from 8,625 (000' q) in 2015-16 to a peak of 10,212 (000' q) in 2017-18, followed by a decline to 5,387 (000' q) in 2021-22 and a partial recovery thereafter to 6,578 (000' q) by 2024-25. The share of tomato in total open field output is also the highest and ranges between 63.17 to 78.30 per cent over the years, although it's share dropped significantly during 2019-20 to 2022-23 due to the increased share of other crops. Cucumber is the second highest contributor in open field which ranges from 17 to 29 per cent, and was higher in the years like 2019-20 and 2021-22. Initially marginal, with a contribution to the total of approximately 3 per cent in 2015-16, capsicum shows a steady rise in contribution over time, with a peak of 12.87 per cent in 2022-23, reflecting diversification in open-field vegetable production.

The scale of producing under protected cultivation is still small, compared to the scale of open

field cultivation, but the growth of the system is very large. Total protected production increases from 275 (000' q) in 2015-16 to 610 (000' q) in 2020-21, with a sharp jump in 2023-24 to 1,295 (000' q), before moderating to 877 (000' q) in 2024-25. Cucumber is the major crop in protected agriculture, with production almost three-quarters to three-quarters of the total in protected agriculture in most years of the study period. This dominance indicates that it is very adaptable and economically feasible to grow in a controlled environment. Tomato and capsicum contribute comparatively lesser shares, with tomato's share steadily declining since 2017-18, dropping from 8.47 per cent to 6.16 per cent in 2024-25 and capsicum's share ranging between 10 and 13 per cent in recent years with higher share in both 2016-17 and 2024-25. The overall trend of the table shows that there is a different trend of production between the two cultivation systems. Tomato is still the main crop for the open field, although the crop diversification for open field is increasing at a slow rate, while the use of protected cultivation has increased significantly and the majority of this cultivation takes place in cucumber production.

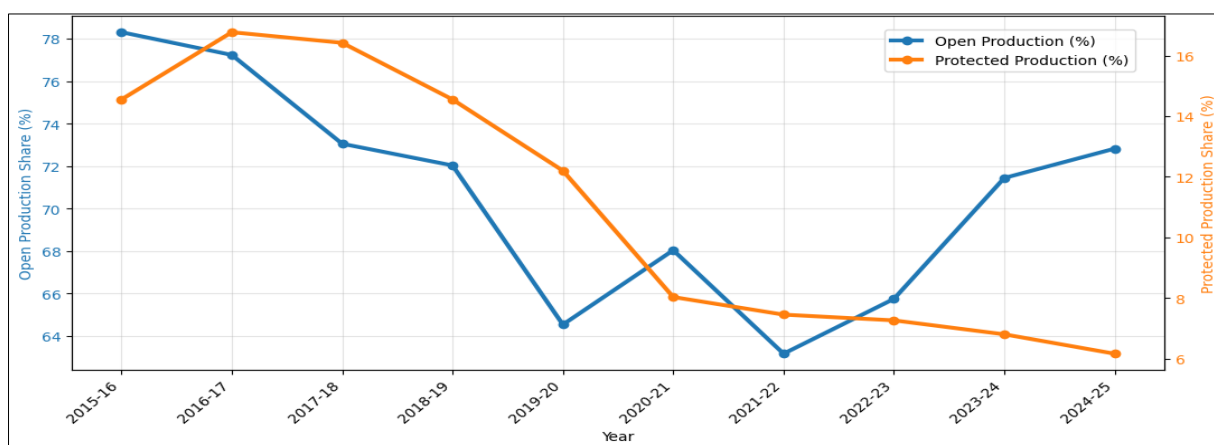


Figure 3.5: Trends in Tomato Production under Open-field and Protected Cultivation (in %)
 Source: Department of Horticulture, Haryana

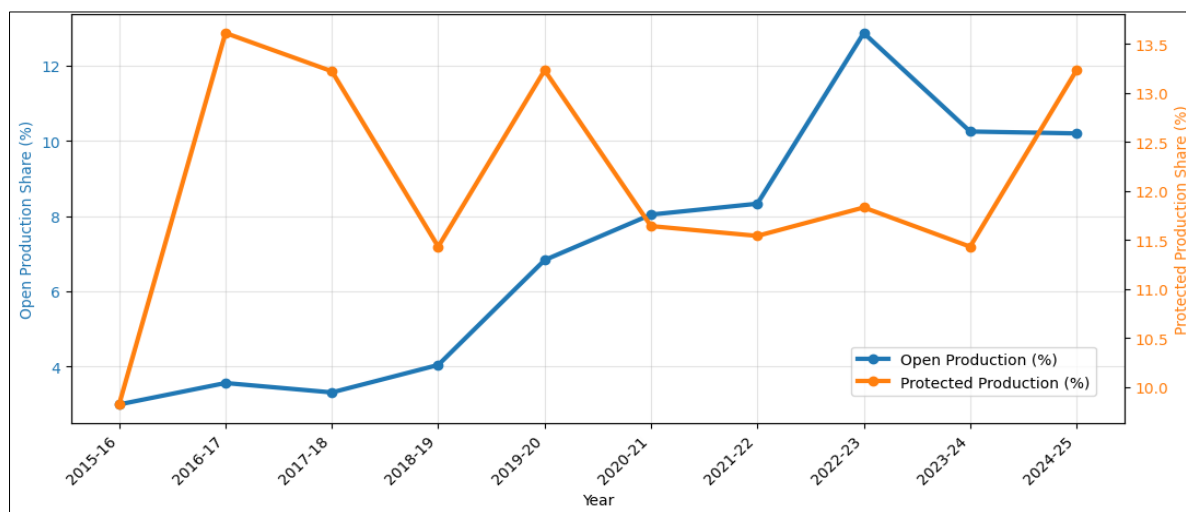


Figure 3.6: Trends in Capsicum Production under Open-field and Protected Cultivation (in %)
 Source: Department of Horticulture, Haryana

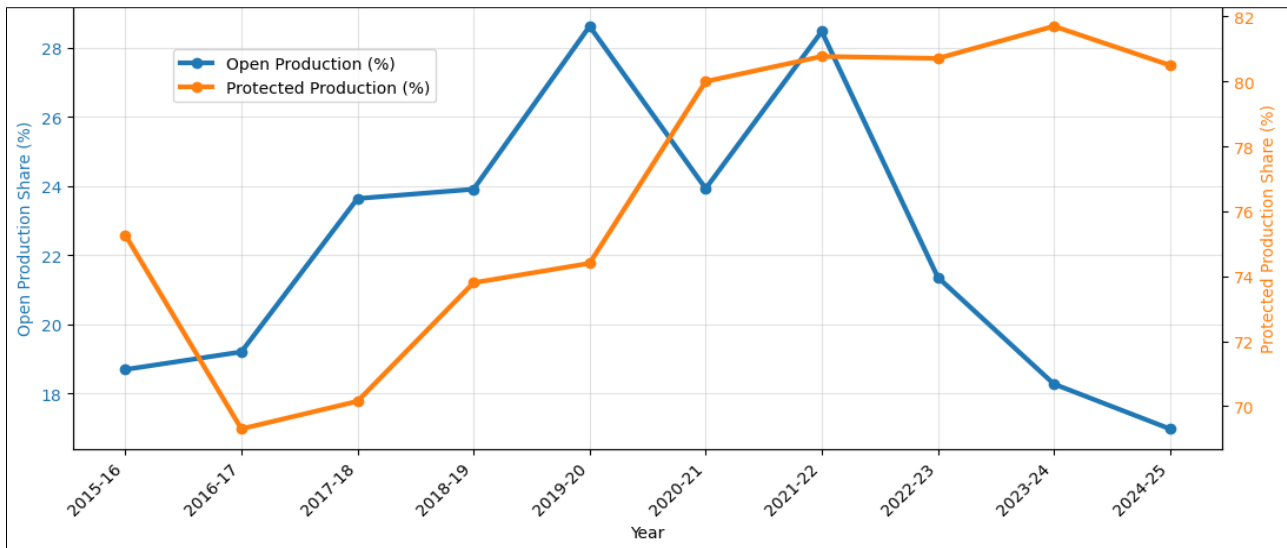


Figure 3.7: Trends in Cucumber Production under Open-field and Protected Cultivation (in %)

Source: Department of Horticulture, Haryana

Open field and protected cultivation production patterns are shown in figures 3.5 to 3.7. In open-field, tomato remained the dominant crop throughout the study period, contributing the largest share to total vegetable production. However, its production share has decreased from 2015-16 to 2021-22 and then slightly increased in the following years. Cucumber emerged as the second major crop in terms of production after tomato. Capsicum production showed an increasing importance

over the years in the open-field system, reflecting diversification in vegetable production. While in protected cultivation, cucumber was consistently the major crop and did well especially in the 2020-21 to 2024-25. The figures also indicate that the variations in tomato production and capsicum production were relatively greater for protected cultivation than for open field cultivation, which showed that there was a change in preference and opportunities for the crop.

Table 3.4: Total Production of Selected Vegetable Crops (in 000' quintal)

Year	Open-field Cultivation	Open-field Cultivation (%)	Protected Cultivation	Protected Cultivation (%)	Total Production
	(1)	(2)	(3)	(4)	(1+3)
2015-16	8625	96.91	275	3.09	8900
2016-17	8126	96.26	316	3.74	8442
2017-18	10212	95.61	469	4.39	10681
2018-19	8934	94.89	481	5.11	9415
2019-20	7646	92.93	582	7.07	8228
2020-21	6470	91.38	610	8.62	7080
2021-22	5387	92.83	416	7.17	5803
2022-23	6091	92.67	482	7.33	6573
2023-24	6534	83.46	1295	16.54	7829
2024-25	6578	88.24	877	11.76	7455

Source: Department of Horticulture, Haryana

Table 3.4 summarizes the relative contribution of open field and protected cultivation to the total of selected vegetable production in Haryana for the period 2015-16 to 2024-25. In given time period, the open field cultivation dominates the output, accounting for more than 90 per cent of the total output in most of the years and was highest with 96.91 per cent in 2015-16. But in the long-term, the percentage share of open field production decreased. In absolute terms, open-field production showed considerable fluctuations during the study period. It reached a peak of 10,212 (000' q) in 2017-18, declined to 5,387 (000' q) in 2021-22, and then

recovered, stabilizing at around 6,500-6,600 (000' q) during 2023-24 and 2024-25. In contrast, although protected cultivation contributed a much smaller volume of production, it recorded a strong growth trend, increasing from 275 (000' q) in 2015-16 to 610 (000' q) in 2020-21, rising sharply to 1,295 (000' q) in 2023-24, and then fell to 877 (000' q) in 2024-25. Overall, the table shows that open-field systems will continue to be the backbone of vegetables in the state, but protected cultivation is becoming a significant and growing source of production, especially in recent years where it is a major component of the total production mix.

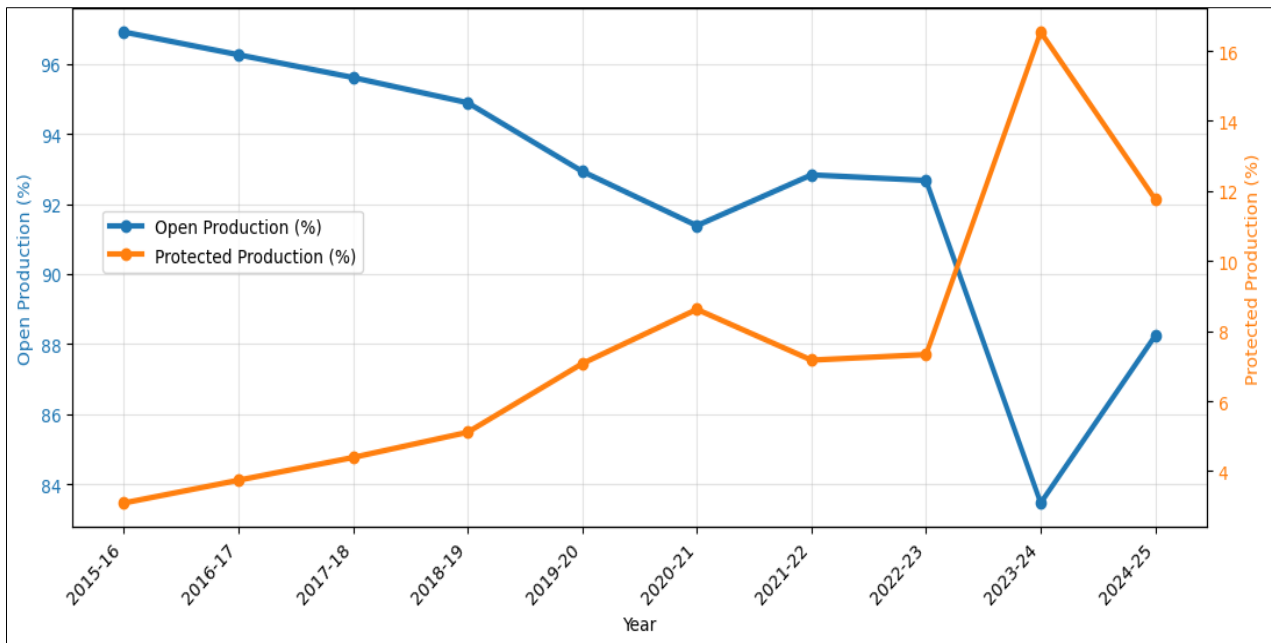


Figure 3.8: Trends in Total Vegetable Production under Open-field and Protected Cultivation (in %)

Source: Department of Horticulture, Haryana

Figure 3.8 shows the trend that the contribution from protected cultivation to vegetable production has increased over time, whereas it was solely in open field cultivation. After 2019-20, the role of protected cultivation in the total vegetable output has increased steadily, as shown by its upward trend in the protected cultivation curve, while the share of open field has shown a general downward trend. This difference between the two curves was most noticeable during 2023-24, indicating strong growth in protected cultivation activity over the past few years. However, open field production was still the main source of vegetable production during the whole of the study period.

4. CONCLUSION AND RECOMMENDATION

The study concludes that the cultivation of vegetables has improved over a period of time from 2015-16 to 2024-25 in Haryana. First, the cultivated area in open field for tomato, capsicum and cucumber is on the decline in all years, reflecting increasing limitations on land, climate variability and increased production risks. Second, the area under protected cultivation has shown a steady increase over the study period. Cucumber remains the dominant crop in protected cultivation, followed by capsicum, as it is more adaptable and economically viable under protected conditions. Third, the production of vegetables in open field condition is showing decreasing trend especially in tomato and cucumber; while capsicum is relatively better in open field crop. Fourth, the production in protected system has increased significantly for some crops such as cucumber and capsicum, which indicate that it can yield a more consistent production. Fifth, protected cultivation showed a relatively high growth rate in production despite the relatively small area, suggesting that it has the potential to increase the efficiency of production.

Overall, the results suggest that protected farming can be an effective option to traditional farming, but maintaining productivity in the long term needs to be balanced between protected and open field farming.

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