Biological Forum – An International Journal **14(1): 1358-1364(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Trend Analysis of Area and Production of Vegetables under Open and Protected Cultivation in Haryana

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(Received 25 November, 2021, Accepted 04 February, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Protected cultivation is one of the most used methods for diversification of agriculture and to increase the farm income. From this study trend analysis was performed to show the trends of area and production of vegetables under open and protected cultivation. This paper is based on secondary data (time series data of vegetables from 1990-91 to 2020-21 in open field condition and from 2015-16 to 2018-19 in protected cultivation) was taken for trend analysis. Linear trend analysis model was used to analyse the time series data of area and production of vegetables under protected cultivation in Haryana. The major challenges of the study is the availability of a small data set of area and production of vegetables under protected cultivation (2015-16 to 2018-19) due to which linear trend analysis was not well defined. In the current context, trend analysis of area and production of vegetables in open field cultivation shows that the cultivation area has increased by 713.6% between 1990-91 and 2020-21 while production has increased by 1027.8% during the same duration. Similarly trend analysis of area and production of vegetables under protected cultivation reflects that area and production is increasing by 53.84% and 70.53% between 2015-16 and 2017-18 but decreased by 9.38% and 260.755 from 2017-18 to 2018-19 respectively.

Keywords: Protected cultivation, environmental factors, seedlings, vegetable crops, trend analysis.

INTRODUCTION

Protected cultivation in a shortly modified environment structure is useful in combating both abiotic and biotic stresses that limit the productivity and quality of horticultural crops. Systematic planning and due care is required in detail, including timing of production and harvest to coincide with high market prices, choice of varieties adopted to the off-season environment Malik *et al.* (2017). Farmers, who are living in semi-urban region of the country can successfully diversify their traditional agricultural practices by opting or using various levels of protected cultivation technologies for production of horticultural crops looking towards their resources, availability of emerging market of usual and unusual off season horticultural produce, year-round demand of high valued vegetables like: slicing tomatoes, coloured peppers, parthenocarpic cucumbers etc. High quality nursery raising of vegetables in different areas, where complete diversification in the traditional system of nursery is required.

Different abiotic and biotic factors are the limiting constraints for the production of vegetables in out-door conditions. Lenka *et al*. (2020) studied that the increasing demand of high-quality or off-season vegetables and further control of the abiotic and biotic stresses from protected cultivation calls the attention of farmers. Vegetables' growers can increase their income by supplying the vegetables in irregular season as during normal season, farmers did not fetch a reasonable rate due to large availability of produce in the market.

In north India, growing cucurbits in plastic low tunnels is a profitable technique. Raising off-season nursery is very effective to walk in tunnels (Fig. 1) as there is low initial cost. During the rainy season, virus free vegetables like tomato, chilli and sweet pepper can be cultivated in insect proof nets (Fig. 2) (Ojha, 2018).

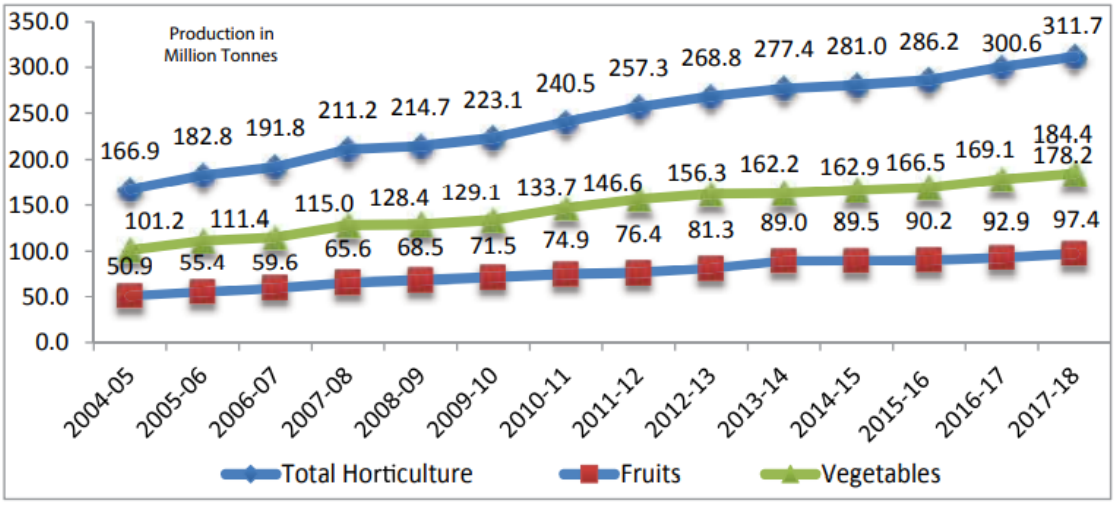
India has perceived a large growth of horticultural products over a couple of years. Substantial growth has taken place with widening of area leads to higher production. Over the last decade, horticultural area has increased by 2.6% per year and yearly production has increased by 4.86%. In 2017-18, the production by horticulture was 311.71 million Tonnes from an area of 25.43 million Hectares The production of vegetables has increased by 83.2 million Tonnes (from 101.2 million Tonnes to 184.40 million Tonnes) since 2004-05 to 2017-18 and production of fruits has increased by 46.45 million Tonnes (from 50.9 million Tonnes to 97.35 million Tonnes) since 2004-05 to 2017-18 as depicted in Fig. 3 (Ministry of Agriculture and Farmer Welfare, 2018).

According to National Horticulture Board (2017) area and production of vegetables in India is 10259.120 (in '000 hectare) and 184394.280 (in '000 tonne) respectively. In Haryana, total area and production of vegetables is 443598.3 hectare and 7305010 tonnes respectively (NHB Database, 2018). For raising disease free nursery, off-season and pesticide residue free vegetables, greenhouse technique will work as brick of building. Up to March, 2018 total area 757.81 hectare is covered. In the year 2017-18, construction of 78.88-hectare Poly houses took place and expenditure of 2053.43 Lakh was incurred (Government of Haryana. 2017).

The potential crops produced under protected cultivation are tomato, cucumber, sweet pepper and chilli etc. From this study trend analysis was performed to show the trends of area and production of vegetables under open and protected cultivation.

Fig. 1. Walk in tunnel.

Fig. 2. Insect proof net.



Source: NHB Database, 2018

Fig. 3. Increasing production of horticultural crops.

REVIEW OF LITERATURE

Akibode *et al.* (2012) in their study Global and Regional Trends in Production, Trade and Consumption of Food Legume Crops found that the pulses production in the past 14 years has increased at a higher rate than the growth rate over population.

In the study Trend Analysis and Forecasting of Maize Area and Production in Khyber Pakhtunkhwa, Pakistan by Abid *et al.* (2014) uses linear trend analysis as one of the method which shows decreasing trends of maize production over a period of time from 2000-06 to 2010-12.

A study was conducted by Gayathri, (2018) to find out the status of area, production and yield of groundnut in India. The result of the study shows that production and yield of groundnut shows the increasing trends but area was in decreasing trends.

The study conducted by Kumar *et al.* (2018) in Haryana revealed that the maximum number of polyhouse technology was adopted in Karnal district followed by Rohtak and Mahendergarh district of Haryana state.

Saikia *et al.* (2021) in their study trend of raw silk production, growth of area under food plant cultivation and generation of employment through silkworm culture in Assam is not smooth during the study period.

According to Working Group Report on Development of Protected Cultivation in Haryana states that Haryana has emerged as a major producer of button mushrooms

because of the use of black polyethylene-protected structures in waste land, primarily in the Sonipat and Panipat districts. NGOs manage a number of spawn production and training centers.

Significance

a) In a greenhouse, four to five crops can be grown throughout the year.

b) Regular control of pests, insects and diseases will be possible through protected cultivation.

c) Controlled climatic conditions can be provided to plants.

d) Superior quality of produce can be produced.

e) Germination percentage of seed is high under a greenhouse.

f) Greenhouse is ideally suited for the farmers having a small area under cultivation and will be helping hand in generation of rural employment.

g) Vegetables can be grown round the year, in adverse weather conditions and during off season.

h) Through protected cultivation, uniform quality of vegetables with higher productivity will be produced that can be exported with higher returns.

i) Protection of vegetable seedlings from biotic & abiotic stress and healthy production.

Types of protected structure

Low tunnels: Low tunnels are generally used in the field to shield the plants in rows. Plastic films are stretched over the loops (arcs up to 1.0m high) of wires to protect the plants from winds, frost, insects and pests. The low tunnels are also called a 'miniature greenhouse'. Malik *et al.* (2017) in their practical manual has pointed out that the low tunnels allow early yield of spring crops resulting in comparatively higher yields. The crops generally grown under low tunnels are sweet corn, strawberry, melon, tomato, cucumber and pepper.

Walk-in tunnel: These are the temporary structures made by bamboo or GI pipes. They are generally arc shaped of height 2 to 2.5 m and width about 4m. The height would be enough to walk properly during operation. Walk-in tunnels are generally used for off season cultivation of vegetables' seedlings (Ummyiah *et al.,* 2017).

Net-house: Net-house is of two types depending upon cladding material: insect proof house and shade net house.

Insect proof net house: An insect proof net house is a temporary or permanent structure covered with UV stabilized insect proof net 40-50 mesh. Wang *et al.* (2018) in their study have found that Insect-proof netting with 80-mesh size provided a 98.4% level of protection against *Bemisia tabaci*. The proper production along with quality of seedlings can be possible through selection of varieties without application of chemicals. There are certain advantages of insect proof net housing *viz*., off season cultivation, production of quality seedlings and resist the growth of insects, pests and diseases.

Shade net house: The materials used for constructing shade net are wood, plastic, GI pipes, etc. The framed structure is covered by plastic nets mostly. It modifies the climate by reducing the light and temperature parameters. Before construction of shaded net structure, it should be taken care of which type of crops are to be grown in it. Shade net protects the plants from frost, heavy light intensity and large insects (Lenka, 2020).

Greenhouse. Greenhouse is a semi-permanent, mounted construction shielded with transparent or translucent material in which environmental conditions are to be modified to provide the particular or optimum conditions for growth of plants. In a greenhouse, the environment can be changed to come across the particular requirements for plant growth. Greenhouses provide early production of quality seeds, propagation of quality fruit plants, more production as compared to open fields along with appropriate management of insects, pests and diseases. Off season cultivation of crops round the year can be possible through greenhouse (Ummyiah *et al.,* 2017).

Principle of greenhouse. It works on the principle of greenhouse effect, which defines that once the solar radiation moves in a greenhouse that is absorbed by material and plants esoteric the greenhouse. The material inside the greenhouse emits long wave thermal radiations that are trapped inside the greenhouse and as a result of this, temperature increases.

MATERIAL AND METHODS

This paper is based on secondary data (time series data of vegetables from 1990-91 to 2020-21 in open field condition and from 2015-16 to 2018-19 in protected cultivation was taken for trend analysis) which was composed from diverse sources of information like various journals, research papers, different departments', annual reports, official websites, different group reports, area and production reports on protected cultivation of vegetables in Haryana state of India.

Trend analysis was used to analyse the time series data of area and production of vegetables under protected cultivation in Haryana. Linear trend analysis model was used to analyse the time series data of area and production of vegetables in Haryana. The statistical analysis of area and production was carried out through Microsoft excel tool. Line graph was organised to interpret the results.

RESULTS AND DISCUSSION

A. Trend Analysis of Area and Production of Vegetables in Open Field

By analysing the area and production of vegetables over 30 years (1990-91 to 2019-20) (Table 1) shows that trends of area and production increasing over time (Fig. 4). The cultivation area has increased by 713.6% between 1990-91 and 2020-21 while production has increased by 1027.8% during the same duration. The area under cultivation of vegetables is continuously increasing from 1990-91 to 2006-07 which shows positive trends in area but after that there is irregular pattern of increase and decrease in area is observed between 2006-07 and 2020-21 which shows negative trends. But in case production is increasing from 1990-91 to 1996-97 after that similarly irregular pattern of increase and decrease in production of vegetables is

observed between 2006-07 and 2020-21. In Fig. 4 the R^2 value of production is 0.9372 and for area is 0.9693 which is very significant. This signifies that the trend line is more accurate to the data. To support these results, Ghimire *et al.* (2018) in their study of Analysis of Trend in Area, Production and Yield of Major Vegetables of Nepal taken the time series data from 1977/78 to 2016/17 (40 years) of vegetables production and they have found that area under cultivation of vegetables is sharply increases by 222.8% and production is increased by 728.21% during this course. The R^2 value for production is 0.924 and for area is 0.880 which is significant and the trend line is more accurate to the data.

Table 1: Area and production of vegetables in Haryana.

Year	Vegetable	
	A	P
1990-91	55360	802240
1991-92	60800	877000
1992-93	69586	1029430
1993-94	75260	1155000
1994-95	85000	1275000
1995-96	94000	1420000
1996-97	98000	1455000
1997-98	102000	1350000
1998-99	120000	1850000
2000-01	133000	2100000
2001-02	150200	2150000
2002-03	163000	2245200
2003-04	203740	2701300
2004-05	207750	2980400
2005-06	232660	2984800
2006-07	280870	3366860
2007-08	274580	3277100
2008-09	298430	3893430
2009-10	300860	4020720
2010-11	346400	4649280
2011-12	356769	5068426
2012-13	360339	5011311
2013-14	373170	5565900
2014-15	359395	5285590
2015-16	410740	6156880
2016-17	379203	5684463
2017-18	446995	7140700
2018-19	443598	7305010
2019-20*	384090	6052871
2020-21	450430	9047715

Source: Horticulture Department, Government of Haryana

Table 2: Area and production of vegetables in protected condition in Haryana.

Year	Total	Tomato	Capsicum	Cucumber	Total
2015-16	Area	56.5	65	314	435.5
	Production	4035	2769	20720	27524
2016-17	Area	121.7	113	387	621.7
	Production	5365	4349	21956	31670
2017-18	Area	83	100	487	670
	Production	7702	6243	32992	46937
2018-19	Area	58.3	72	48.2	612.5
	Production	7077	5578	355.6	13010.6

Source: Horticulture Department, Government of Haryana

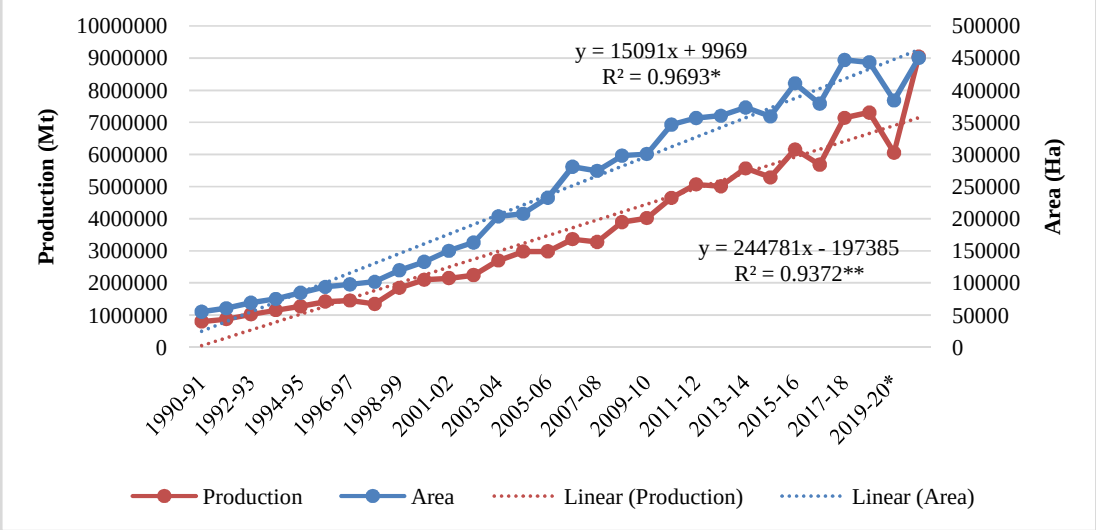
B. Trend Analysis of Area and Production of Vegetables under Protected Cultivation

Table 2 depicted the area and production of major three crops; tomato, capsicum and cucumber under protected cultivation. By analysis the area and production of vegetables under protected cultivation over four years (2015-16 to 2018-19). Fig. 5 shows that area is increasing by 53.84% between 2015-16 to 2017-18 but the area has decreased by 9.38% from 2017-18 to 2018-19. Similarly production has increased by 70.53% between 2015-16 and 2017-18 but the production has sharply decreased by 260.75% from 2017-18 to 2018-19 due to decreasing area. In Fig. 5, the value R^2 of production is 0.0684 and for area is 0.5297 which is not so significant because we have a small dataset. Due to small data set values available to the Horticulture Department, Government of Haryana we cannot show the significant trend line. To support the results

Kalpana *et al.* (2018) in their study Trend analysis of area, production and productivity of jute in India showed that period from 1900-2000 there is positive growth in area with 1.5% rate but period from 2000-10 show negative growth in area with 0.2% rate.

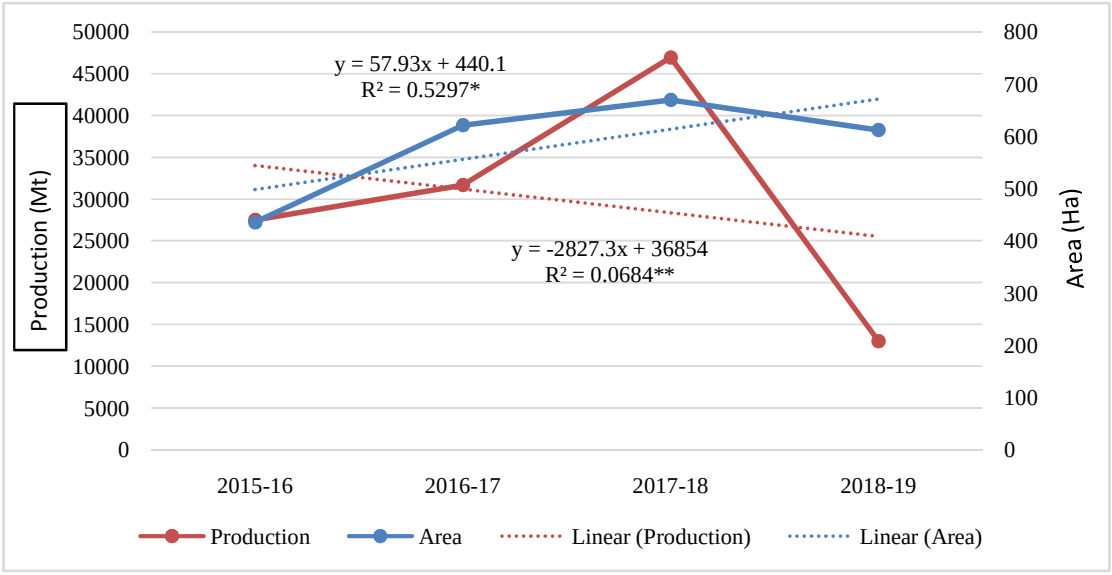
Different vegetables are grown under protected cultivation in Haryana state of India, tomato, capsicum and cucumber are the major crops considered under the study. Cucumber has the highest share of 65.9% of area under protected cultivation (1236.2 ha) followed by capsicum with a share of 17.06% (320 ha) and tomato with a share of 17.03% (319.50 ha) of total area 1875.70 ha (Fig. 6). During the period of four year area is continuously increasing over years except for; tomato in 2017-18 where it declined by 46.62%, in 2018-19 it declined by 42.36% than the previous year. Cucumber and capsicum area in 2018-19 is declined by 910.37% and 38.89% than previous year respectively (Fig. 6).

If we talk about production of vegetables under protected cultivation then trend analysis shows that cucumber major shares in production of vegetables under protected cultivation with 63.8% (76023.6 Mt) followed by tomato with a share of 20.29% (24179 Mt)and capsicum with a share of 15.9% (18939 Mt) of total production 119141.6 Mt. Similar trends of production scenario which is increasing every year with a varying rate except for; cucumber in 2018-19 is sharply declined by 9177.84% than previous year; capsicum in 2018-19 with declining percentage of 11.92% than previous year (Fig. 7).



*Significant at R^2 = 0 to1; **Significant at R^2 = 0 to 1

Fig. 4. Vegetable area and production trend line (Open Field).



*Not significant at R^2 = 0 to1; **Not significant at R^2 = 0 to 1

Fig. 5. Vegetable area and production trend line (Protected Cultivation).

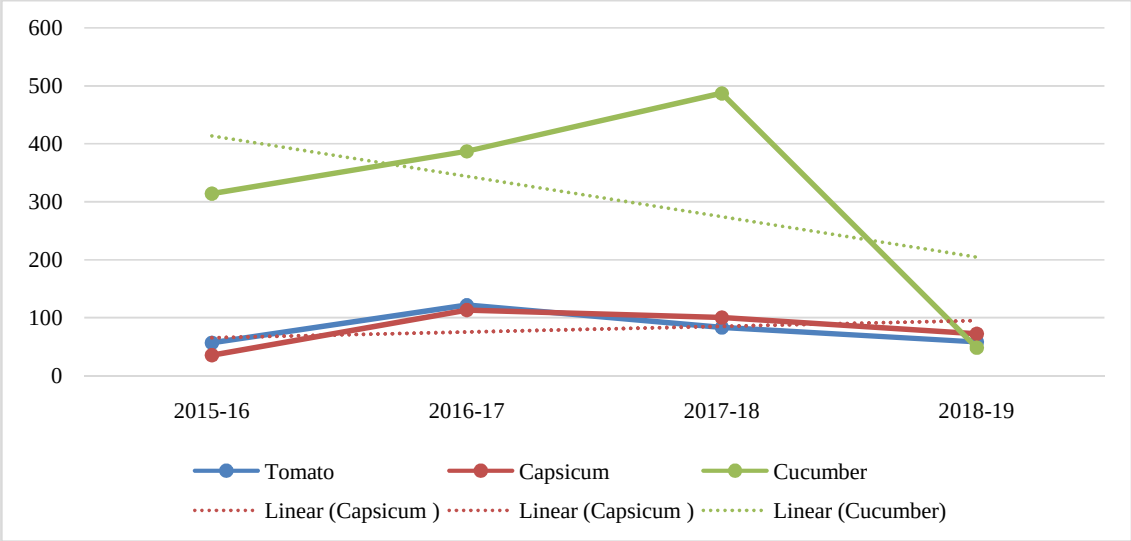


Fig. 6. Trends in area cultivated of vegetables under protected cultivation (2015-16 to 2018-19).

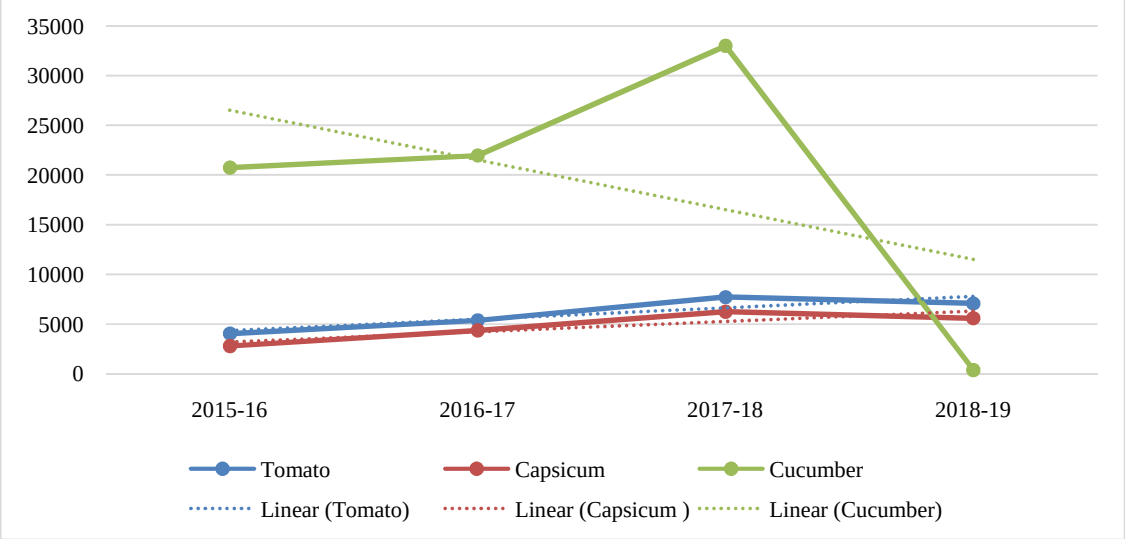


Fig. 7. Trends in production of vegetables under protected cultivation (2015-16 to 2018-19).

CONCLUSION

It is concluded from the study that farmers can add-up to their earnings through protected cultivation of vegetables. Protected cultivation is one of the most used methods for diversification of agriculture and to increase the farm income. Production of crops under protected conditions has great potential to augment produce and quality of vegetables in main and off seasons through maximization of water and nutrient use efficiency, under varied agro- climatic environments of India. Trend analysis of area and production of vegetables in open field cultivation shows that the cultivation area has increased by 713.6% between 1990-91 and 2020-21 while production has increased by 1027.8% during the same duration. Similarly trend analysis of area and production of vegetables under protected cultivation reflects that area is increasing by 53.84% between 2015-16 and 2017-18 but the area has decreased by 9.38% from 2017-18 to 2018-19.

The production has increased by 70.53% between 2015-16 and 2017-18 but the production has sharply decreased by 260.75% from 2017-18 to 2018-19 due to decreasing area.

FUTURE SCOPE

Further research can be done in future or any statistical method can be found to show the trend analysis of area and production of crops through a small data set. At present there is no appropriate and accurate way through which we can show trend analysis using small data sets, which is the limitation of this study. Further due to small data set values available to the Horticulture Department, Government of Haryana we cannot show the significant trend line.

Acknowledgment. There is no financial assistance provided for this study. We are thankful to Dr. Sushil Kumar, Assistant Professor (Horticulture) and Mr. Anubhav, Ph.D. Scholar, IABM who provided expertise that greatly assisted the study. I would like to thank Dr. Satyveer Singh Meena, Assistant Professor, (Finance) for his overall guidance throughout this study. We have to express our appreciation to the National Horticulture Board for providing the data regarding area and production under protected cultivation of vegetables.
Conflict of Interest. None

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How to cite this article: Vikash* and Satyveer Singh Meena (2022). Trend Analysis of Area and Production of Vegetables under Open and Protected Cultivation in Haryana. *Biological Forum – An International Journal*, *14*(1): 1358-1364.