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Assessment of change in yield, productivity and additional income generation through vegetable cultivation practices in polyhouse

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Abstract
Polyhouse vegetable cultivation has gained significant importance in modern agriculture, offering controlled environment conditions that enhance crop productivity and reduce the impact of external factors. The increasing global population poses a significant challenge to food security and necessitates the exploration of innovative agricultural practices. Among these practices, polyhouse cultivation has gained prominence due to its potential to optimize crop growth and yield in controlled environments. Therefore, the research aimed to assess the change in yield, change in productivity and additional income generation through vegetable cultivation practices in polyhouses. The study was carried out in two districts of Rajasthan namely Bhilwara and Chittorgarh. Data was collected through surveys and interviews conducted with farmers in the region. The resultant changes in yield, productivity and income of respondents were calculated by the consequences after the adoption of polyhouse technologies. The change was calculated by the difference between before and after the adoption of various polyhouse technologies. To categorize the changes in yield, productivity and income was further calculated by the mean and standard deviation score. The study clearly shows that better vegetable yield obtained by majority (69.00 %) respondents. Whereas, 23.00 per cent of respondents obtained high yield and rest 8.00 per cent respondents obtained least improvement in vegetable crops. It's also shows that that majority (76.00 %) of respondents were found to have medium level change in their productivity whereas, 15.00 per cent respondents found to have high level change in their productivity and remaining 9.00 per cent respondents found to have low level change in their productivity, respectively. The study also shows that majority (69.00 %) of respondents obtained better income whereas, 18.00 per cent respondents obtained high income and remaining 13.00 per cent respondents relatively obtained less improvement in their income.

Keywords: Polyhouse, yield, productivity, income change, farmers

Introduction
Vegetable cultivation plays a vital role in ensuring food security and income generation for millions of households worldwide. However, traditional open-field farming faces various challenges, including adverse climatic conditions, pests, diseases, and unpredictable market prices. Polyhouse cultivation, also known as greenhouse farming, has emerged as an innovative approach to address these challenges and improve agricultural outcomes. India's diverse climate ensures the availability of all varieties of fresh fruits & vegetables. The area under cultivation of fruits stood at 7.05 million hectares while vegetables were cultivated at 11.35 million hectares protected cultivation is a promising technology and becoming popular all over the world there are 115 countries in the world which have undertaken greenhouse vegetable cultivation commercially. India is the second largest producer of vegetables in the world i.e. next to China. Total vegetable production of India is 191.769 million tons of its total area 10.353 million ha (as per NHB database, 2019-20). Protected cultivation is a capital intensive technique, wherein the microclimate surrounding the plant body is controlled to clinch a higher net return compared to its traditional cultivation. Economic characteristics (profit orientation, agricultural income, technological investment behaviour and farm labour) have the strongest effect on both uptake and intentions to uptake novel technologies (Kaur and Ranguwal 2021) [2].

Materials and Methods
The study was conducted in two districts of Rajasthan namely, Bhilwara and Chittorgarh in

2022. These districts were purposively selected since these are leading districts in area under polyhouse vegetable cultivation. Two tehsils from each district were selected on basis of maximum number of farmers having polyhouses for protected vegetable cultivation, thus total four tehsils were selected for this study. Therefore, for this study namely Chittorgarh & Bhopal Sagar tehsils from Chittorgarh district and Bhilwara & Mandalgarh tehsils from Bhilwara district was selected purposely for this study. In total 100 farmers (25 farmers form each districts) who had adopted polyhouse technology were selected by simple random sampling technique. To measure the changes in yield, productivity and income of respondents were calculated by the consequences after the adoption of polyhouse technologies. The change was calculated by the difference between before and after the adoption of various polyhouse technologies. To categorize the changes in yield, productivity and income was further calculated by the mean and standard deviation score.

Results and Discussion

Change in yield through vegetable cultivation practices in polyhouse

Table 1 demonstrates that all participants experienced a 60.41 percent enhancement in crop yield. Furthermore, the table reveals that 61.26 percent of the respondents from Chittorgarh district achieved higher yields compared to their counterparts in Bhilwara (59.55 percent). This difference is attributed to the superior soil quality and irrigation resources available in Chittorgarh. The findings are supported by Kaur and Ranguwal (2021) [2] they concluded that yield of capsicum of farmers can be increased many folds by adoption of polyhouse technology.

Table 1: Distribution of respondents on basis of change in yield of vegetable crops

S. No.	Change in mean percent of yield differences		
	Districts	**Change in yield (%)**	**Mean differences**
1	Bhilwara (n_1=50)	59.55	130.18
2	Chittorgarh (n_2=50)	61.26	126.38
	Total (n=100)	60.41	128.28

%= per cent

The data of table 2 indicates that better vegetable yield obtained by majority (69.00 %) respondents. Whereas, 23.00 per cent of respondents obtained high yield and rest 8.00 per cent respondents obtained least improvement in vegetable crops.

Table 2: Distribution of polyhouse farmers on basis of change in yield through vegetable cultivation practices in polyhouse

S. No	Change in Yield (q/ha)	Bhilwara (n_1=50)		Chittorgarh (n_2= 50)		Total (n=100)	
		f	%	f	%	f	%
1	High(>181.02)	11	22.00	12	24.00	23	23.00
2	Medium(75.54-181.02)	39	78.00	30	60.00	69	69.00
3	Low(<75.54)	0	0	08	16.00	08	8.00
Total		50	100.00	50	100.00	100	100.00

f = frequency, % = percentage, mean = 128.28, S.D. = 52.73

A more detailed analysis of the information in Table 2 reveals that the majority of participants in both Bhilwara (78.00 percent) and Chittorgarh (60.00 percent) districts experienced a moderate shift in their crop yields. Similarly, 22.00 percent of respondents in Bhilwara and 24.00 percent of respondents in Chittorgarh districts observed a higher degree of change in their yields, while 16.00 percent of Chittorgarh respondents demonstrated the least improvement in their vegetable crop yields.

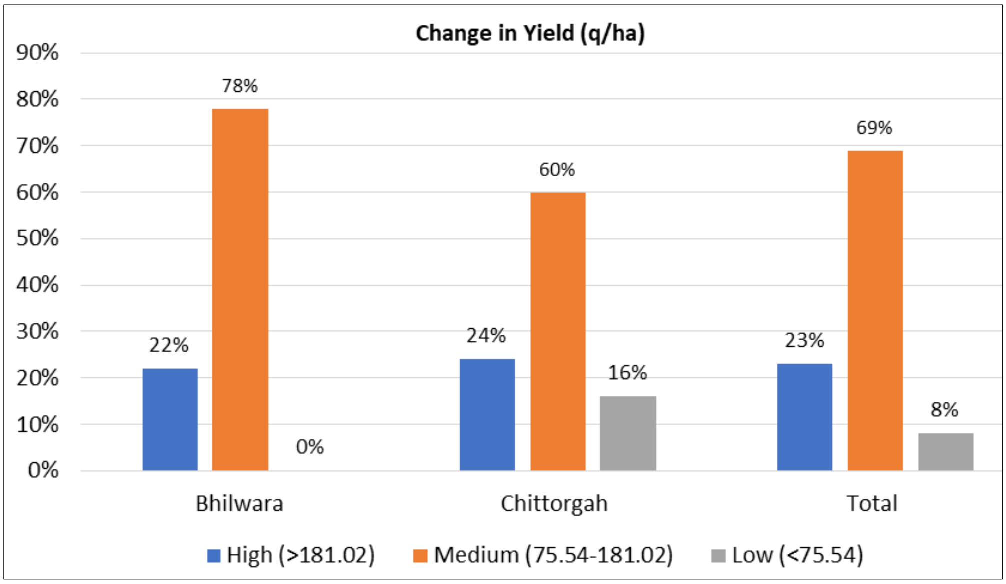

Fig 1: Distribution of polyhouse farmers on basis of change in yield through vegetable cultivation practices in polyhouse

Change in productivity through vegetable cultivation practices in polyhouse

Table 3 indicates that 60.51 per cent vegetable productivity enhanced when crop cultivated in polyhouse and table also indicates that Chittorgarh district vegetable productivity increased to 61.41 per cent as compare to Bhilwara 59.61 per cent due to better soil condition and irrigation facilities. The finding are supported by Sethi *et al.*, (2009) [3] found that under protected conditions the productivity has been reported doubled.

Table 3: Distribution of respondents on basis of change in their mean per cent of productivity difference

S. No.	Change in mean percent of productivity difference		
	District	Change in yield (%)	Mean differences
1	Bhilwara (n_1=50)	59.61	482.9
2	Chittorgarh (n_2=50)	61.41	465.3
	Total (n=100)	60.51	474.1

% = per cent

According to the information in Table 4, the data suggests that the majority of respondents (76.00 percent) experienced a moderate level of change in their productivity. In addition, 15.00 percent of respondents reported a high level of change in their productivity, while the remaining 9.00 percent noted a low level of change in their productivity.

Table 4: Distribution of polyhouse farmers on basis of change in productivity through vegetable cultivation practices in polyhouse

S. no	Change in productivity (q/ha)	Bhilwara (n_1=50)		Chittorgarh (n_2= 50)		Total (n=100)	
		f	%	f	%	f	%
1	High (>552.63)	08	16.00	07	14.00	15	15.00
2	Medium (395.56-552.63)	41	82.00	35	70.00	76	76.00
3	Low (<395.56)	01	2.00	08	16.00	9	9.00
Total		50	100.00	50	100.00	100	100.00

f = frequency, % = per cent, mean = 474.71, S.D. = 78.53

Upon closer examination of the data presented in Table 4, it becomes evident that a significant majority of respondents from both Bhilwara (82.00 percent) and Chittorgarh (70.00 percent) districts experienced a moderate level of change in their productivity. Furthermore, 16.00 percent of Bhilwara respondents and 14.00 percent of Chittorgarh respondents reported a high degree of change in their productivity, while the remaining 2.00 percent of Bhilwara respondents and 16.00 percent of Chittorgarh respondents indicated a low level of change in their productivity.

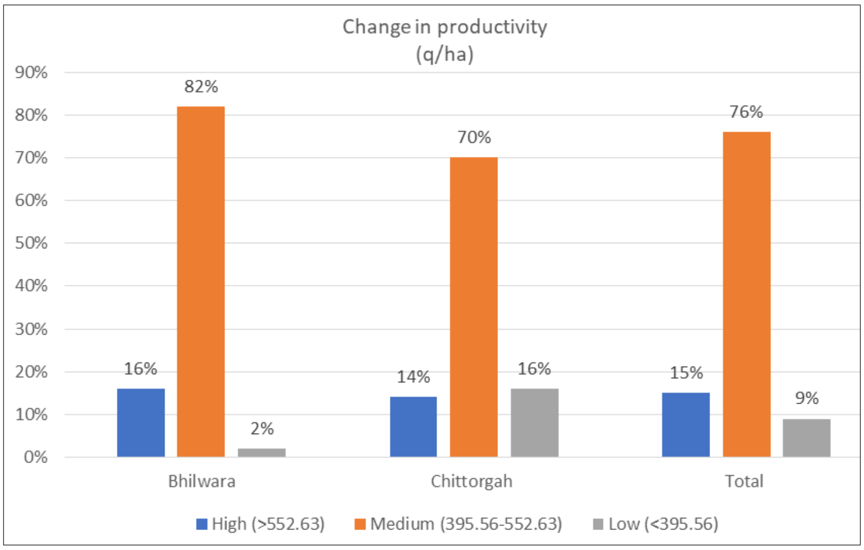

Fig 2: Distribution of polyhouse farmers on basis of change in productivity through vegetable cultivation practices in polyhouse

Change in gross income through vegetable cultivation practices in polyhouse

According to the data in Table 5, polyhouse vegetable growers experienced a 41.45 percent increase in their income, with respondents from Chittorgarh district achieving a slightly higher income gain (41.63 percent) compared to those in Bhilwara (41.28 percent). This difference is attributed to the improved soil conditions and irrigation facilities available in Chittorgarh. The finding are supported by Singh & Sirohi (2006) [4] also concluded that vegetable growers can substantially increase their income by protected vegetable cultivation in off-season.

Table 5: Distribution of respondents on basis of change in their income (mean per cent)

S. No.	Change in mean percent of income difference		
	District	**Change in yield (%)**	**Mean differences (Rs in lakh)**
1	Bhilwara (n_1=50)	41.28	13.52
2	Chittorgarh (n_2=50)	41.63	12.66
	Total (n=100)	41.45	13.09

% = per cent

The information provided in Table 6 reveals that the majority of respondents (69.00 percent) experienced an improvement in their income, with 18.00 percent of respondents achieving a high income, while the remaining 13.00 percent reported relatively lower gains in their income.

Table 6: Distribution of polyhouse farmers on basis of change in gross income through vegetable cultivation practices in polyhouse

S. No	Change in income (Rs in lakh q/ha)	Bhilwara (n_1=50)		Chittorgarh (n_2= 50)		Total (n=100)	
		f	%	f	%	f	%
1	High(>15.88)	10	20.00	8	16.00	18	18.00
2	Medium(10.31-15.87)	37	74.00	32	64.00	69	69.00
3	Low(<10.30)	3	6.00	10	20.00	13	13.00
Total		50	100.00	50	100.00	100	100.00

f = frequency, % = per cent, mean = Rs 13,09,193, S.D. = 278403.69

The data from Table 6 further highlights that a majority of respondents from both Bhilwara (74.00 percent) and Chittorgarh (64.00 percent) districts experienced significant improvements in their income. Additionally, 10.00 percent of Bhilwara respondents and 16.00 percent of Chittorgarh respondents achieved higher incomes, while the remaining 6.00 percent of Bhilwara respondents and 20.00 percent of Chittorgarh respondents saw the least improvement in their income.

Conclusion

The study's findings indicate that a significant majority of respondents (69.00 percent) achieved improved vegetable yield. Moreover, 23.00 percent of the participants attained a high yield, while the remaining 8.00 percent reported the least improvement in their vegetable crops. The study also revealed that all participants experienced a 60.41 percent increase in crop yield. In terms of productivity, the research demonstrated that most respondents (76.00 percent) experienced a moderate level of change, while 15.00 percent saw a high level of change, and the remaining 9.00 percent had a low level of change in their productivity. Furthermore, the study found that vegetable productivity increased by 60.51 percent when crops were cultivated in a polyhouse. It was observed that the majority of respondents (69.00 percent) achieved improved income, with 18.00 percent reporting high income, and the remaining 13.00 percent experiencing relatively less improvement in their income. Polyhouse vegetable growers saw their income increase by 41.45 percent, with respondents from Chittorgarh district achieving a slightly higher income gain (41.63 percent) in comparison to those in Bhilwara (41.28 percent). This variation can be attributed due to the improved soil conditions and irrigation facilities available in Chittorgarh.

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