



Protected Cultivation in Himachal Pradesh: A Case Study of Farmers Perspectives in Kanda Village, District Solan

Rohit Kumar • Ajay Kumar • Navneet Kaur

Department of Geography, Panjab University, Chandigarh - 160 014

Corresponding Author Email id: rohitkumar80822@gmail.com

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Abstract: Himachal Pradesh, known for its diverse topography and varied climatic zones, presents challenges and opportunities for agriculture, especially in regions like Solan, which experience unpredictable weather patterns and harsh winters. The present study investigates the practical implementation and outcomes of protected cultivation in the unique agro-climatic conditions of Himachal Pradesh, focusing on the case study of Kanda Village in the Dharampur block of Solan District. The study delves into the intricacies of protected cultivation, a method involving the use of greenhouses, polyhouses and tunnels to shield crops from adverse environmental conditions, optimize growth and enhance crop productivity. Therefore, the key objective of the present study is to examine the local farmers' perception about advantages of Protected Cultivation techniques. It will also analyse their experiences, challenges and successes in employing these methods in a region with distinct weather fluctuations. To achieve the objectives of the study the data has been collected through field survey and direct observations. The findings of this research contribute to a deeper understanding of the feasibility and benefits of protected cultivation in Himachal Pradesh, providing insights for policymakers, agricultural practitioners and stakeholders to further develop and promote sustainable agricultural practices in similar agro-climatic regions.

Keywords: protected cultivation • Himachal Pradesh • Kanda village • agricultural practices • adaptability • farming techniques.

Introduction

India's agriculture is frequently faced with a range of challenges under dynamic conditions, which include the country's fast changing climate, degraded soil, increasing population, fragmented land, limited water resources, marketing and entrepreneurship, among other issues. (Hasan et al 2021). Therefore, reducing these unfavourable environmental circumstances and increasing agricultural productivity and efficiency is the biggest challenge in modern times to feed the increasing population. This can only be accomplished in agriculture through the use of sustainable agricultural practices and solutions. The idea of "sustainable agriculture" is multifaceted and may be evaluated in several contexts related to sustainability.

Sustainable Agriculture includes all of the systems and practices that will improve the protection of the environment and natural agricultural resources necessary to ensure the production of adequate and high-quality foodstuffs at affordable costs which the rapidly growing world population needs (Tugrul 2019). Sustainably producing food and textiles while protecting future generations' ability to fulfil their own needs is the aim of sustainable agriculture. There are several techniques to enhance the agricultural productivity and among these productivity-enhancing techniques protected cultivation has a high potential to increase the yield of vegetables and flower crops by many folds. Protected cultivation can be defined as a cropping technique in which the micro climate surrounding the plant body is controlled partially or fully as per the requirement of the



plant species grown during their period of growth. Greenhouse and Polyhouse technology is the most practical way of achieving the goal of protected cultivation (Nagarajan et al 2002). A Greenhouse or Polyhouse can be defined as a "framed or an inflated structure with a transparent or translucent material in which crops could be grown under at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations" (Devi and Thakur 2013). There are more than 55 countries now in the world where cultivation of crops is undertaken on a commercial scale under cover and it is continuously growing at a fast rate internationally (Reddy 2016). Protected cultivation overcomes spatial constraints and the negative effects of climate change, enabling precision farming. Globally, large

number of vegetables are being produced under protected circumstances. Numerous environmental elements, including air quality, temperature, humidity and the composition of atmospheric gases are regulated in these systems (CIAR 2018). By creating the suitable micro-climate for plant growth round the year cultivation of vegetables can be done under adverse climatic conditions. It is possible through protected cultivation which has tremendous scope in peri-urban areas of India (Singh and Sirohi 2006). Protected farming which may be achieved by growing crops of high quality and production in low tunnels, greenhouses, net houses, mulches, etc. and so making better use of the land and other resources. The Table: 01, given below shows the world scenario of protected cultivation:

Table 1. Area Under Protected Cultivation in Different Countries of the World (2011)

S.No.	Country	Area ('000) Hectares	S. No.	Country	Area ('000) Hectares
1	Algeria	05.00	23	Lebanon	01.00
2	Argentina	02.20	24	Libya	01.00
3	Australia	01.30	25	Mexico	04.30
4	Belgium	01.60	26	Moldova	00.50
5	Brazil	01.00	27	Morocco	16.50
6	Bulgaria	01.00	28	Netherlands	04.60
7	Canada	01.00	29	New Zealand	00.70
8	Chile	02.10	30	Palestine	03.30
9	China	81.00	31	Poland	05.20
10	Columbia	01.20	32	Portugal	01.50
11	Ecuador	02.70	33	Romania	01.30
12	Egypt	01.20	34	Russia	01.40
13	France	10.00	35	Serbia	01.00
14	Germany	01.40	36	South Korea	47.00
15	Greece	05.00	37	Spain	70.40
16	Hungry	05.40	38	Syria	03.10
17	India	00.70	39	Tunisia	01.30
18	Iran	04.00	40	Turkey	33.50
19	Israel	04.00	41	UK	00.70
20	Italy	25.00	42	Ukraine	02.70
21	Japan	36.00	43	UAE	00.80
22	Jordan	02.00	44	USA	00.70

Source: Published Report of Central Institute for Arid Horticulture, Bikaner (Rajasthan), 2018.

India is the world's second-largest producer of vegetables, after China. India currently

produces 166.61 million tonnes of vegetables overall, but because of the biotic and abiotic



stressors associated with open-field farming, the yield and quality of the majority of vegetable crops are extremely low (17.41 t/ha) (Agriculture Census of India 2021-2022). It has been noted that the area in India under protected agriculture is increasing frequently; in 2012–13, it accounted for around 25,000 hectares, whereas the area used for greenhouse vegetable cultivation was just 2,000 ha. (Singh and Sabir 2013). But at present the total area in India under protected agriculture is now 70,000 hectares (ICAR 2018). Table: 02, lists the crops by state that are cultivated in India

under protected agriculture. In terms of protected agriculture Maharashtra leads the Indian states, followed by Karnataka Himachal Pradesh. Similarly, Punjab, Uttarakhand, Haryana, Uttar Pradesh, Gujarat, Rajasthan, Jharkhand, J&K, Delhi, West Bengal, Orissa, Bihar, Madhya Pradesh and other states have areas under protected cultivation. In general, farmers are cultivating tomatoes, cucumbers and capsicums under vegetable crops and roses, gerberas and carnations under flower crops.

Table 2. India: Leading States with Major Crops Under Protected Cultivation

S.No.	State	Crops
1	Maharashtra	Carnation, Gerbera, Rose, Capsicum
2	Karnataka	Roses, Gerbera, Carnation, Vegetable Seed Production and Nursery Raising of Vegetables
3	Himachal Pradesh	Capsicum, Carnation, Gerbera, Tuberose
4	Punjab	Vegetable Crops
5	Uttarakhand	Gerbera, Capsicum
6	Tamil Nadu	Floricultural Crops
7	North-Eastern States	Floricultural and Vegetable Crops

Source: Published Report of Central Institute for Arid Horticulture, Bikaner (Rajasthan), 2018.

Production under protected cultivation is not only providing high water and nutrient use efficiency but it can easily increase productivity and production by 3-5 folds over open/outdoor field cultivation (Ministry of Agriculture and Farmers Welfare-GOI 2020). In the Himalayan state of Himachal Pradesh (HP), the area under protected cultivation/structures promoted by National Horticulture Mission has been found nearly 1.5 lakh ha. in 2014-15 (Punera et al 2017). In

the state traditional farming—which is not profitable—is practiced by the majority of marginal and small farmers (Chaudhary et al 2012). Furthermore, the northwest Himalaya's mountainous terrain restricts the ability to expand agricultural land and farm earnings. Polyhouses may increase the viability of small holdings by growing more high-value products like vegetables and flowers on a less amount of land (Thakur et al 2011). The table: 03, provides the district wise details of polyhouse:

Table 3. Himachal Pradesh: District Wise area Under Protected Cultivation (2011)

S. No.	District	Number of Polyhouses	Area Under Protected Cultivation (Hectares)
01	Bilaspur	270	20.97
02	Chamba	135	02.29
03	Hamirpur	99	04.18
04	Kangra	256	06.58
05	Kinnaur	00	00.00
06	Kullu	22	00.57
07	Lahul and Spiti	17	00.05
08	Mandi	204	09.88
09	Shimla	89	05.84



10	Sirmour	75	05.42
11	Solan	127	11.06
12	Una	50	04.80
13	Under RKVY*	170	09.58
Total		1514	81.22

*RKVY (Rashtriya Krishi Vikas Yojana).

Source: Directorate of Horticulture, Government of Himachal Pradesh, Shimla.

Consequently, poly houses can help small farmers to become profitable by maximising production on a limited amount of land, overcoming natural calamities and diversifying into high-value vegetable crops. By utilising vertical space and precision farming, it may also increase quality and stabilise the production system. Furthermore, if vegetable cultivation is not possible due to harsh weather, these buildings can help with crop production.

Study Area: District Solan, situated between 30°05" and 31°15" N latitude and 76°42" and 77°20" E longitude, features a varied terrain that reaches up to 3,000 metres above sea level. spanning 179,426 square feet in area. Today, Solan boasts a populace of 409,362, with 2011 census statistics indicating 214,150 men and 195,212 females. Its climate, ranging between 39°C in summer and around 10°C in winter, exhibits a spectrum from subtropical to subtemperate. The five blocks that make up the district are Dharampur, Solan, Kunihar, Kandaghat and Nalagarh. Here, agriculture is the primary livelihood, making use of a variety of agroclimatic conditions to grow floriculture, commercial off-season vegetables and temperate vegetable seeds. As one moves upwards from low-elevation regions that grow maize, wheat, pulses, oats and oilseeds to mid-high-elevation regions that concentrate on growing vegetables and fruits, the agricultural landscape becomes more varied. Sheep, goats, buffaloes and cows are examples of livestock that greatly boost the local economy. The

district has 54,116 sq. km. of cultivated wasteland in addition to 11,361 sq. km. of irrigated land and 32,068 sq. km. of unirrigated land. 24,290 square kilometres of forests cover the area, adding to its natural cover. In recent years, Solan has witnessed changes in climate, posing challenges to farmers and the agricultural landscape.

Therefore, the present study focusses on the Kanda Village which lies in the Hurang Panchayat of community development block Dharampur of district Solan. The Dharampur block is one of the developing blocks of Solan district, covering a total area of 29132 sq. km. and is spread over 44 panchayats (Department of agriculture of Dharampur Block). The total population of Dharampur block is 16,596 (Census, 2011). Kanda village, nestled within the Hurang Panchayat of Solan district in Himachal Pradesh, boasts a diverse topography characterized by rolling hills and verdant valleys. Situated at an elevation ranging from approximately 1,500 to 2,000 meters above sea level, this picturesque region offers breathtaking panoramic views of the surrounding Himalayan landscape. The varying elevations contribute to a rich biodiversity, making Kanda village an ideal habitat for a wide range of flora and fauna and agriculture is the main occupation of the people of the Hurang Panchayat and nowadays the trend of protected cultivation giving new feathers to the farmers to enrich their livelihood.

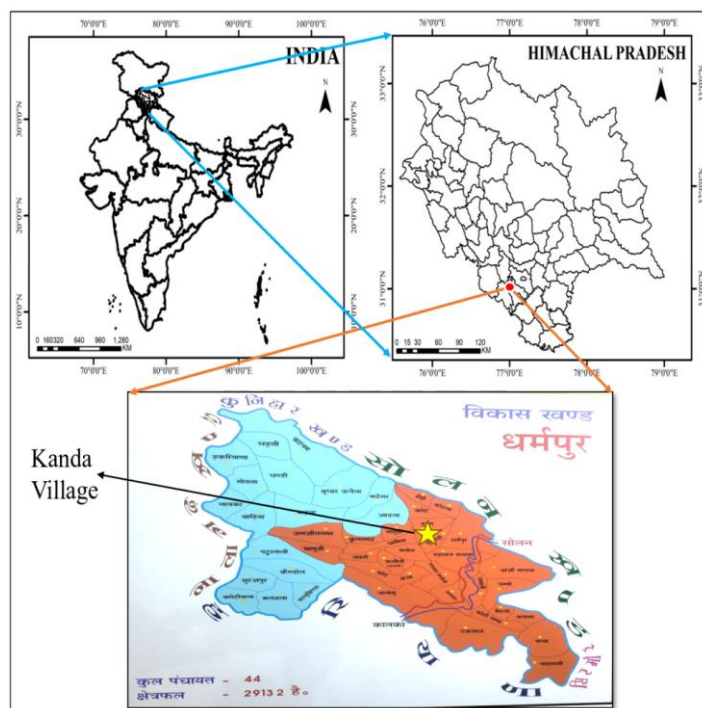


Fig 1. Dharampur Block of District Solan: Location of Kanda Village

Source: Department of Agriculture of Dharampur Block, 2023.

Research Objectives

- To examine the local farmers' perception about advantages of Protected Cultivation techniques.
- To highlights the Challenges faced by Protected Cultivators.

Research Methodology

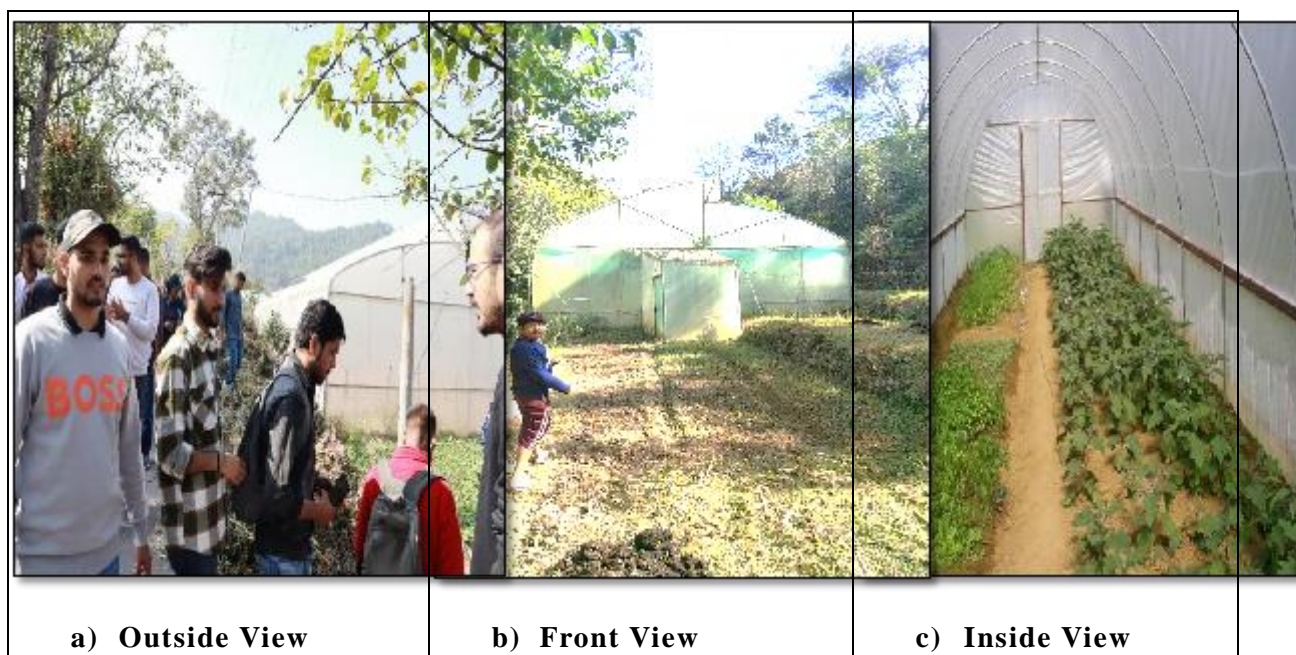
This study primarily lies on primary data sources collected through filed survey with the use of purposive sampling from protective cultivators. Besides this, some secondary data resources are also used in the given research. A total of 50 responses have been collected through filed survey with the help of interview schedule. After collection, data been processed and analysed. Mainly, descriptive and narrative analyses have been done to achieve the objectives. The final results have been presented through Tables and Figs.

Results and Discussion

Himachal Pradesh faces agricultural challenges due to its mountainous terrain and climatic variations. Traditional farming encounters limitations due to erratic weather

and land constraints. Therefore, to feed the growing population is a big challenge and protected cultivation is a best solution to address such problems in hilly and mountainous areas. The following are the advantages of the protected cultivation as cited by the farmers:

Enhanced Crop Yield and Quality: In hilly regions, protected farming extends the growing season, regulates temperature and improves crop output and quality. In addition to effectively managing water, these structures reduce the danger of pests and diseases and serve as windbreaks to protect crops from harm. They also maximise light exposure, which is important in areas with little sunshine. Raised beds or containers combined with protected cultivation techniques solve issues with soil erosion and enhance the general health of the soil. In difficult terrain, farmers may establish a more dependable and sustainable agricultural production system by extending growing seasons, guaranteeing a steady supply of water and shielding crops from unfavourable weather conditions.



Source: Filed Survey, 2023.

Fig 2 : Kanda Village: Basic Structure of a Poly House (Inside and Outside View)

Table 4. Kanda Village: Comparative Analysis of Productivity Major Crops (between Open Cultivation and Protected Cultivation)

Crop	Average Production under Open Cultivation (mt/ha)	Average Production under Protected Cultivation (mt/ha)
Tomato	45.10	122.00
Cucumber	20.60	84.00
Capsicum	35.00	130.00
Peas	15.43	26.00
Beans	14.55	33.00
Coriander	12.00	20.14

*mt: metric tonnes and *ha: hectare

Source: Field Survey, 2023.

For example; Mr. Mohan Lal Kashyap (one of the respondents, a retired bank official and currently working as a farmer in the field of Protected Cultivation from Kanda Village) said that the average tomato production in an open field usually ranges from 5 to 20 pounds (2.3 to 9 kilogrammes) per plant but on the other side the same plant in a poly house can yield 20 to 40 pounds (9 to 18 kilogrammes)

or more with excellent management approaches. He also adds that ‘Dr. Illy’ Scientist from Israel trained him on how to use Israeli Technology to get more yield of tomatoes, capsicum (green, yellow and red), cucumber, strawberry, peas, ginger, lady finder, pumpkin, reddish, coriander, kiwi and garlic, green chilli and ridged gourd etc.



1. Enhanced Crop Yield



2. Multicopying



3. Drip Irrigation



4. Organic Fertilizer



5. Cow Urine



6. Jeevamrit from Urine



7. Water Storage Tank



8. Pipe to Irrigate



9. Farrow to Irrigate



Fig 3. Kanda Village: Various Agricultural Practices Under Protected Cultivation (Source: Field Survey, 2023)

Water use and Resource Efficiency:
Protected cultivation under poly houses in

Himachal Pradesh maximizes water and resource efficiency through precise drip



irrigation and uniform sprinkler systems. On areas facing water scarcity and water constraint drip irrigation is relevant as it reduces wastage of water and conserves water by delivering water directly to the roots of plants. Water distribution is also ensured by sprinkler irrigation, which helps to improve growth conditions and lowers energy use in irrigation. Both techniques reduce runoff and evaporation losses, which is important in dry regions like Himachal Pradesh. Using water in a regulated manner improves the retention of nutrients and prevents soil erosion. All these things, not only solve the problem of water shortage but also support sustainable agriculture, which is why protected cultivation is an essential tactic for resource-conscious farming in the area. Another farmer, **Mr. Sanjay Kumar** (Organic and Protected farming Practitioner and Cultivator from Kanda Village) commented that in open-field cultivation, a normal plant like a tomato or capsicum typically needs about 2.5 to 4 litres of water per day during the growing season. But, on the other side, under the poly house, it only requires 1 to 1.5 litres of water per day. This is because of the controlled environment and efficient watering systems, which lead to slightly lower water requirements for tomato plants.

Pest and Disease Management: Common pests like aphids and whiteflies are repelled by the poly house's physical barrier, while fungal diseases are prevented by regulated surroundings. In order to maintain a natural balance, integrated pest management (IPM) techniques are used, these are introduction of beneficial insects like ladybirds. While disease-resistant crop tackle problems like early blight and powdery mildew, early identification within the restricted space enables prompt response against possible threats. Crop rotation breaks the life cycle of hazardous organisms and strict quarantine regulations stop pests from entering the area. Aphids, whiteflies and early blight have all been successfully managed using selective pesticide application only when required. Besides this Jeevamurt (a kind of pesticide) prepared from cow urine with the help of water, cow dung, pulses flour, jaggery and soil is also used as a pesticide in poly houses, which is purely organic and has no harmful impact on health. Therefore, polyhouse farming is generally regarded as a sustainable method that reduces the need for chemical treatments and encourages agricultural techniques that are robust to pests and illnesses

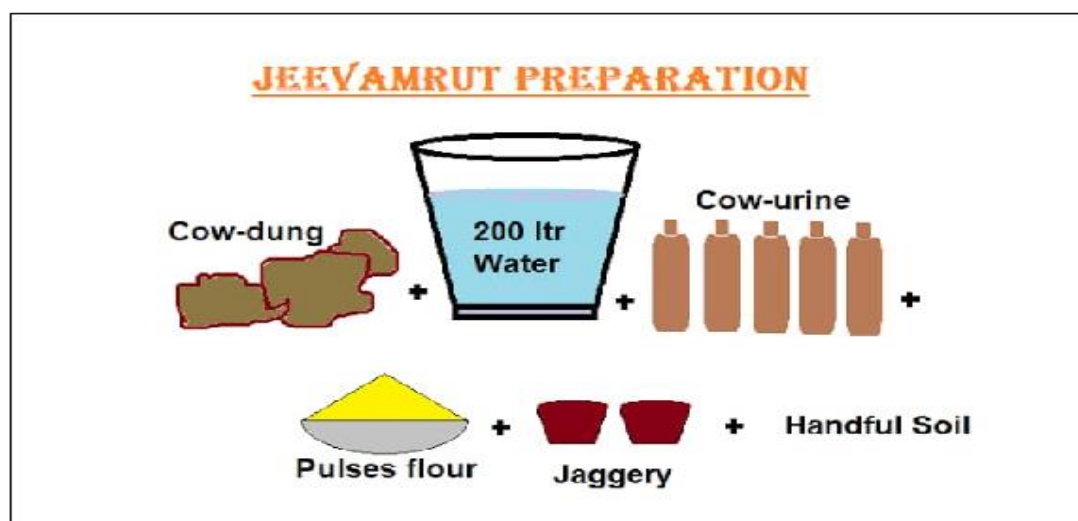


Fig 4. Jeevamrut Preparation Procedure (Source: Icsfarm.blogspot.com)



Economic Empowerment: In Himachal Pradesh, protected farming promotes economic empowerment by allowing for the year-round production of high-value crops. The regulated setting guarantees reliable, high-quality yields that improve market accessibility and earn higher prices. Protected farming reduces crop failure risks, promotes technological adoption and draws government assistance for farmers. Stability and more revenue streams are facilitated by the longer growing season and crop diversity. Additionally, as protected agriculture grows, job opportunities are created, bolstering the economic growth of rural areas. Farmers may

overcome early investment hurdles with the help of subsidies and initiatives and value-added activities increase total economic returns. Protected agriculture essentially changes conventional farming by providing farmers in Himachal Pradesh with resilience, diversity and long-term economic prosperity. For example, another farmer, **Mrs. Lila Devi** (Female Cultivator and farmer from Hurrang Panchayet) stated that she earned 1.5 lakh profit in one season from a small poly house on 250 m² land by selling Capsicum and Peas and she believed that it is the best technique to earn more money from small piece of land.

Table 5. Kanda Village: Total Cost of Cultivation and Total Income of Major Crops

Crop	Size of Poly House (m ²)	Total Cost (Rs.)	Total Income (Rs.)
Tomato	500	92,550	1,70,763
	250	52,981	83,704
Capsicum	500	88,657	2,81,082
	250	57,092	1,62,872
	40	3,200	15,000
Peas	240	11,837	24,009
	100	5,922	8,633
	40	2,100	3,108
Cucumber	500	62,045	97,997
	250	30,671	64,334
	100	16,0765	32,006
Coriander	250	8,943	26,809
	100	3,208	10,400
	40	1,703	3,602

Source: Field Survey, 2023.

Mutlicropping and Vertical Farming within Limited area: In protected cultivation, Mutlicropping is the practice of cultivating several crops in one greenhouse or polyhouse to lessen the effects of the region's severe cold. This method increases the period of the producing season, maximises resource utilisation and diversifies farmers' sources of revenue. For example, slow-growing, long-duration crops like tomatoes or peppers may be grown alongside fast-growing, short-duration crops like lettuce or radish. These buildings offer a controlled environment that

shields crops from bad weather, allowing for year-round production. Mutlicropping is a useful tactic in the context of protected farming in Himachal Pradesh because farmers may produce continuous harvests and improve overall production by deliberately mixing crops with distinct growth seasons or complementing actions. **Mohan Lal Kashyap** (a farmer) shared that he always believed in innovation for sustainable farming. He also adds that embracing Mutlicropping in polyhouses has been a game-changer. As they can grow fast crops like spinach alongside



slower ones like bell peppers, ensuring a year-round harvest. He focuses on maximizing our resources and thriving in the challenging climate.

Environment Conservation: Protected farming makes a substantial contribution to environmental preservation by using less water, fewer chemicals and techniques that preserve soil. By using ecologically friendly pest management techniques and Integrated Pest Management (IPM), greenhouses'-controlled environs reduce their ecological effect while maintaining the biodiversity of the surrounding area. Energy-efficient features in protected buildings, like greenhouses, maximise resource utilisation and help reduce carbon emissions. Furthermore, waste minimization techniques and land conservation aid in halting needless deforestation and preserving natural equilibrium. The capacity of protected farming to adjust to shifting climate conditions improves climate resilience and the total decrease in greenhouse gas emissions is consistent with attempts to mitigate climate change. Protected farming, which embraces sustainable agricultural methods, is essential for promoting a harmonious coexistence with Himachal Pradesh's fragile ecology to achieve the goal of sustainable development.

Problems and Challenges faced by Protected Cultivators: Although protected cultivation technology is the best technology for raising off season vegetables, flowers and other high valued crops. Among these challenges natural calamities plays a major role followed by lack of knowledge and training, techniques of how protected cultivation. However, Cultivators face some problems listed below

Lack of skilled, Professional and Trained Labour: The main component of protected culture is technology, which creates an atmosphere that is ideal for plant development while controlling harmful environmental

impacts. Few of the farmers faced problems like economic, technical, Labor, environmental and marketing in mobilizing sustainability and profitability of protected cultivation technology as experienced and proficient human resources will be required for the design, manufacture and year-round maintenance of the greenhouse structure. Regrettably, the dearth of experienced workers and experts has resulted in a low pace of development for this industry.

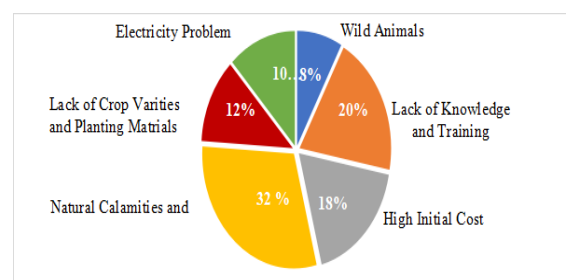


Fig 5. Kanda Village: Problems and Challenges faced by Protected Cultivators
Source: Field Survey, 2023.

High Initial Cost: Cultivation of vegetable crops inside protected cultivation was also felt challenging like a high initial cost for the establishment of structures discourage its wider adaptation, nonavailability of various construction materials like GI pipes, polyethylene sheet, etc are not generally available in the local market which needs to be imported at high costs including freight and customs duty. Sometimes farmers are requiring monitoring and supervision, skilled workers for installation of poly houses which are not easily available in the village areas.

Insects and Natural Calamities: Protected cultivating farmers in Himachal Pradesh encounter a numerous of challenges, chief among them being the management of insect pests and diseases within poly houses. Insects like aphids, whiteflies and thrips pose significant threats to crop health, while diseases such as powdery mildew and damping-off can spread rapidly in the controlled environment of poly houses. Weed growth further complicates matters, competing



with crops for resources and hindering their growth. Temperature fluctuations and humidity management also present hurdles, as extreme conditions can stress plants and foster disease development. Moreover, the region's susceptibility to natural calamities like hailstorms and heavy rainfall adds another layer of complexity, causing physical damage to poly houses and crops. **Puram Chand** (a determined protected cultivating farmer) stated that in August 2023 a sudden hailstorm tore through his poly house, leaving behind a trail of shattered covers and damaged crops. He also adds that it made him lose 3 lakh last year.

Lack of Crop Varieties and Planting materials: Protected farming requires a certain variety or planting materials. Farmers are only allowed to select crops that have a high market value. The cost of the particular planting materials required for protected cultivation is prohibitive and only a small portion of the private sector can afford them. The government ought to investigate this so that farmers should be able to obtain high-quality seeds from government seed organisations.

Short life of Poly Sheets and Wild Animals: Poly sheets are frequently used in protected culture to establish regulated growth conditions for plants. Nevertheless, because of general deterioration, sunlight exposure and weather conditions, these sheets have a limited lifespan. As poly sheets don't last very long so, one has to replace them frequently to keep the protected environment intact and allow for the best possible development for plants. Wild animals are a menace to protected agriculture environments. In quest of food, animals such as deer, rabbits, birds and rats try to enter these regions, damaging crops or the protective structures themselves. Their presence may cause poly sheets to break or puncture, creating weaknesses that jeopardise the controlled environment.

Electricity Problem: Electricity serves as a crucial barrier in protected cultivation due to its necessity for powering climate control systems, lighting and irrigation. Inaccessible or unreliable electricity can hinder temperature regulation, impede lighting cycles critical for plant growth and disrupt automated processes, compromising the controlled environment essential for successful cultivation.

Unwillingness of youth to Venture into Agriculture: Many young individuals might perceive agriculture as an outdated or labor-intensive profession, unaware of the technological advancements and innovations within the field. The image of traditional farming might not appeal to those seeking modern, tech-driven careers. There might be a lack of awareness among the youth regarding the potential opportunities and benefits associated with modern agriculture practices, such as protected cultivation. They might not be informed about the advancements, profitability, or the scope for innovation within this sector.

Conclusion

The above discussion showed that how protected cultivation revolutionizes agriculture in Himachal Pradesh. It harmonizes modern technology with traditional wisdom, bolstering yields while preserving the environment. This shift ensures resilience against climatic challenges, empowering farmers and fostering community growth. Challenges like costs and knowledge dissemination persist but can be overcome through continued support. Overall, this approach stands as a beacon for sustainable agricultural development, offering a blueprint for nationwide replication. Protected cultivation presents a transformative solution for Himachal Pradesh's agricultural sustainability. It not only secures food production but also elevates livelihoods, underlining the transformative potential of protected cultivation in fostering a thriving agricultural landscape. By boosting resilience against environmental challenges, optimizing



resource use and improving economic prospects, it can significantly contribute to the state's agricultural development while fostering a more sustainable future.

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