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Original Research Paper

Constraints and strategies of smallholder farmers for successful protected cultivation of capsicum: A critical appraisal

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ABSTRACT

The study was framed to assess the challenges/constraints in protected cultivation of capsicum by small holder farmers in Karnataka state, India and provide strategies for sustained profitability. *Ex-post-facto* research design was followed for conducting study in three districts (Bangalore Rural, Bangalore Urban and Chickballapur) of Karnataka. From each district, 50 smallholders capsicum cultivation farmers under protected cultivation were selected through purposive random sampling, constituting 150 respondents. Garrett's ranking technique was adopted to analyse the constraints faced by the farmers in the study area. The various constraints experienced by the farmers were broadly grouped in to production constraints, market constraints, financial constraints, technological constraints, institutional constraints, weather-based constraints, health and labour constraints. These finding demonstrated urgent need to intervene towards the constraints experienced by the smallholder capsicum grows under protected cultivation, which not only ensures to get stable income but also sustain their livelihoods.

Keywords: Capsicum, constraints, protected cultivation, smallholder, strategies

INTRODUCTION

Protected cultivation plays a significant role in addressing the specific needs and challenges of agriculture in India, in the present scenario of land constraints, vagaries of climate change, prevalent pest and diseases etc. The scope of area expansion under cultivation of vegetables and flowers is very little. The only option is vertical expansion through increased productivity and cropping intensity using protected farming with environment control measures, quality seeds, fertilizers and plant protection measures (Paroda, 2013; GOH 2013). Plastic mulching, protected nursery production, use of green/polyhouses/ shade net houses for off-season production of vegetables and flowers have consistently given good results both at research farms and farmers' fields. In the recent years, increasing attention has been focused on several environmentally safe methods of pest management, including polyhouse cultivation to reduce pesticide use mainly because of growing concern over food safety issues and environmental concerns. Protected cultivation technology allows year-round off-season production of high-value low-volume vegetables, as well as virus-free quality seedlings, high-quality hybrid seeds, and the facilitation of disease resistance breeding programs.

Special schemes and programme of state government like *Krishi Bhagya* etc., and the supportive ecosystem including subsidies to the tune of 50 to 75%, led to large scale adoption of protected cultivation by smallholders also. Despite the success in polyhouse farming achieved by large scale horticultural and floricultural farmers for many years, smallholder polyhouse farming is beset by many challenges leading to the abandonment of some protected structures.

Capsicum, commonly known as bell pepper or sweet pepper, cultivated across an extensive area of 39,000 hectares with a substantial production (6,01,580 metric tons) and productivity (15.40 metric tons/ha) in 2022-23 (Indiastat, 2023). This adaptable crop excels in protected environments such as polyhouses, making it a preferred choice for cultivation. Growing capsicum under protected cultivation offers several advantages, including increased control over environmental conditions, protection from pests and diseases, and extended cropping seasons.

Consequently, it is pertinent to examine and outline the constraints and challenges faced by farmers in adopting polyhouse technology, as this understanding can help formulate strategies to overcome these hurdles.

MATERIALS AND METHODS

The study was conducted in three districts (Bengaluru Rural, Bengaluru Urban and Chickballapur) of Karnataka state, considering the leading districts in area under protected cultivation, during 2021. In total, 150 farmers (50 farmers from each district) who had adopted polyhouse technology were selected purposefully.

Respondents were asked to rank the constraints listed according to its degree of importance so that the most crucial constraint will be ranked first. The outcome, which was in the form of ranking, was converted into per cent position by using formula:

$$\text{Percent position} = \frac{100\ (\text{Rij} - 0.5)}{\text{Nj}}$$

where, Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variables ranked by j^{th} respondents

The per cent position estimated was converted into scores with the help of Garrett's table. The scores of each individual rank corresponding to that particular constraint were added and the mean values of score were calculated. Higher mean Garrett value indicated the higher degree of constraint.

The strategies to overcome the challenges faced by farmers in adoption of polyhouse technology were pooled based on discussions with all the respondents under study. Strategies were analysed and tabulated using frequency and percentage.

RESULTS AND DISCUSSION

Production constraints

The major production constraints faced by capsicum farmers were inadequate information on scientific crop production (Table 1). Ghanghas et al. (2015) reported the lack of knowledge of latest package of practices. Hence, the farmer needs to abreast about latest information to tackle various issues in the production of capsicum.

As the crop under protected cultivation desires intensive crop management like attending to various crop needs *viz.*, from preparing soil bed to training, pruning, harvesting etc unlike under open cultivation, hence, the respondents perceived it as second major constraints under protected cultivation.

Market constraints

The major constraint perceived by the capsicum growers (Table 2) was fluctuations in market prices and demand, leading to the poor income to farmers followed by lack of specialised supply chain management practices. Rajesh & Shivalingaiah (2022) and Saravanan (2012) opined that problem of lack of suitable cold storage facilities (57.63%) and Singla et al. (2021) observed lack of market information (57.42%) as major marketing constraints.

Saini (2012) emphasized the importance of Government intervention in the price policy mechanism to prevent price fluctuation. The deficiencies in the infrastructure such as poor grading and transport facilities and cold chain management combined with market malpractices add to the risk component of farmers in India.

The primary financial challenges faced by respondent farmers were the 'high cost of initial infrastructure', followed by concerns such as the 'high cost of nutrient inputs' and the 'high cost of plant protection chemicals' (Table 3).

Financial constraints

The cost of establishment of polyhouse varies anywhere between Rs. 700 per metre to Rs. 1000/- per metre, which accounts to Rs. 35 lakhs to Rs. 40 lakhs per acre, respectively. The economic burden is heightened by the need for quality planting material, inputs, and the lack of subsidies and pricing policies, increasing the risk of cultivation. Subsidies typically cover 20 to 50% of the polyhouse erection cost, making protected cultivation financially demanding. Similar results were reported by Choudhary et al. (2022) that high cost of fertiliser, high cost of seeds as major constraints expressed by respondents.

Technological constraints

The capsicum growers expressed that availability of package of practices for cultivation of crops under polyhouse is either limited or requires lot of modification to suit their agro-ecological and socioeconomic conditions. Limited crop choice for diversification of crops under protected cultivation was also one of the major constraints perceived by the respondents (Table 4).

Farmers face challenges in obtaining the latest information and techniques for crop production under protected conditions, particularly in their regional

languages. Limited access to quality planting material at reasonable prices, dominated by a few private players, leaves farmers heavily dependent on companies. Successful polyhouse farming requires proper management and technical skills (FAO, 2013), but farmers struggle to access up-to-date information and techniques, impacting their effective use of technology. While extension staff visits significantly influence greenhouse performance, unrestricted access to unbiased technical information is essential (Omoro et al., 2015) given the limited technical support for greenhouse farming in the study region.

Institutional constraints

The major constraints perceived by the respondents were non-existence of price control mechanisms through institutional control, followed by high premium to claims ratios of insurance and absence of crop insurance for crops grown under protected cultivation. While insurance mechanisms are available for protected cultivation structures, they do not cover the crops grown in them. Choudhary et al. (2022) found that the biggest problem, reported by 60.47% of respondents, was the lack of a minimum support price (Table 5).

Institutional constraints stem from the framework and policies governing the sector, significantly affecting productivity and profitability. Inconsistent government policies, unreliable electricity supply, subsidy fluctuations, complex licensing, and regulatory hurdles create uncertainties, hindering investment and impacting operational profitability for these farmers.

Weather based constraints

The major constraints perceived by the respondents were that the structure is prone to wind damage, particularly cladding material followed by 'high summer temperatures causes pests severity and more crop loss' (Table 6). Specific climatic changes can alter yield, productivity, plant characteristics (quantitative and qualitative), and disease development (Egel & Saha 2015), which is due to the non-uniformity of microclimate inside the polyhouse (Qian et al. 2015). A single measurement cannot represent the entire polyhouse or provide complete information on the distribution of temperature and relative humidity (Korner *et al* 2007).

Health constraints

The farmers opined 'inappropriate handling of chemicals leads to ill health', 'improper disposal of chemicals causes health hazard' were some of the major health constraints perceived by them (Table 7).

Otto et al. (2017) found that 86.30% of vegetable greenhouse farmers reported pain, indicating a higher prevalence of muscular skeletal disorders (MSD) compared to traditional agricultural workers. MSDs in this context are linked to factors like physical strain, heavy lifting, and poor postures. Aging and prolonged greenhouse work contribute to tissue degeneration and chronic overload, supported by research on age and years working in greenhouses as risk factors (Yao, 2019; Leite et al., 2021).

Labour constraints

The result presented in Table 8 outlined that labour scarcity during peak seasons and denial by labours to work under protected environment due to stress and health issues, are the major labour constraints.

Finding and retaining skilled labour is difficult, leading to shortages and increased competition for experts in polyhouse operations. The seasonal nature of labour-intensive activities, such as planting and harvesting, complicates securing temporary workers during peak periods. High labour costs, especially in regions with elevated wages, affect overall profitability, requiring farmers to balance cost management with quality work. Migration trends and social factors contribute to labour shortages, as younger generations favour alternative employment opportunities. Studies by Choudhary et al. (2022) highlighted the significant impact of labour scarcity on protected cultivation.

The strategies as perceived by the smallholder capsicum farmers to increase the profitability and sustainability of capsicum under protected cultivation are presented below

To enhance capsicum profitability and sustainability in protected cultivation, farmers can implement strategies outlined in Table 9. Key measures include acquiring technical knowledge, staying updated on polyhouse practices, ensuring timely access to quality seed, reducing implementation costs, standardizing production technology, addressing marketing challenges through research and direct channels, seeking government support, managing technological constraints through training and research, mitigating

Table 1 : Production constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. Lack of scientific knowledge about crop production under protected structures	59.987	I
2. Requires intensive crop management under protected cultivation	54.953	II
3. Non-availability of required quality of seeds and planting materials of desired hybrids/varieties	50.207	III
4. Difficulty in following the recommended package of practices	46.747	IV
5. Limited and irregular power supply	46.353	V
6. Fluctuation of electrical conductivity (EC) of water under intensive crop management practices and difficult to manage this problem	43.567	VI

Table 2 : Market constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. Fluctuation in market prices and demand leading to poor income to farmers	65.78	I
2. Lack of specialized supply chain management practices	58.05	II
3. Difficulty in accessing export markets	54.22	III
4. Export of high value vegetables has drastically reduced	45.47	VI
5. Insufficient cold chain infrastructure for storage and transportation of produce	45.68	V
6. Poor payment and less adoption of business ethics in marketing of crops produced under protected environment	48.39	IV
7. Lack of exclusive markets for the crops grown under protected cultivation	38.00	VII

Table 3 : Financial constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. High cost of initial infrastructure	62.93	I
2. High cost of nutrient inputs	62.63	II
3. High cost of plant protection chemicals	59.17	III
4. High cost of seeds & planting material	52.64	IV
5. High cost of skilled labor	50.06	V
6. Complex loan procedures and high rate of interest	48.93	VI
7. Poor accessibility to subsidy and delay in release of financial assistance leading to higher debits	44.53	VIII
8. Poor financial support for maintenance and repair of protected structure	44.72	VII
9. Continuous change of guidelines by financial institutions for getting financial support for protected cultivation	35.45	IX

Table 4 : Technological constraints experienced by the smallholder capsicum growers under protected cultivation

Constraints	Mean Garret score	Rank
1. Lack of technical know-how about growing crops under protected cultivation	58.07	I
2. Limited crop choice for diversification of crops under protected cultivation	55.15	II
3. Repair and maintenance of protected structures is difficult	50.30	III
4. Availability of spare parts is difficult	44.34	VI
5. Stability of constructed protected cultivation structure towards various damages	46.17	V
6. Lack of relevant literature on production and protection in local languages	48.79	IV

Table 5 : Institutional constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. Non-existence of price control mechanisms through institutional control	54.27	I
2. High premium to claims ratios of insurance	53.83	II
3. Absence of crop insurance for crops grown under protected cultivation	53.55	III
4. There is no sustained policies and long term plans to stable growth and development of protected cultivation industry	49.25	IV
5. No specific institutions to give knowledge on Protected cultivation	47.29	V
6. Frequent change of government policies with respect to protected cultivation	42.66	VI

Table 6 : Weather based constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. Structure is prone to wind damage, particularly cladding material	61.63	I
2. High summer temperatures causes pests severity and more crop loss	51.87	II
3. Structure is prone to hailstorm damage	49.05	III
4. High rainfall causes disease intensity & crop loss	39.93	IV

Table 7 : Health constraints experienced by the smallholder capsicum growers under protected cultivation

Constraint	Mean Garret score	Rank
1. Inappropriate handling of chemicals leads to ill health	62.10	I
2. Improper disposal of chemicals causes health hazard	57.62	II
3. Use of Protected protection equipment (PPE) usage causes suffocation and difficulty to work under protected structures	41.05	III
4. Protected structures are designed to optimize the environment for plant growth, rather than for workers health	40.92	IV

Table 8 : Labour constraints experienced by the farmers

Constraint	Mean Garret score	Rank
1. Labour scarcity during peak seasons	52.90	I
2. Denial by labors to work under protected environment due to stress and health issues	49.62	II
3. Lack of availability of skilled labour for various operations	47.43	III

Table 9. Strategies to address constraints of smallholder farmers for Successful Protected Cultivation of Capsicum

Strategies to address the constraints	f	%
Production Strategies		
1. Enhancing information accessibility on capsicum cultivation	131	87.33
2. Optimizing digital platforms for information dissemination	119	79.33
3. Ensure timely availability of seeds and planting material	105	70.00
4. Addressing the high costs associated with the implementation of protected cultivation	87	58.00
5. Establishing standardized production technologies specific to protected cultivation of capsicum	65	43.33
6. Implementing measures for the management and improvement of water quality	52	34.67
Marketing Strategies		
1. Conducting market research and analysis to understand market dynamics for capsicum cultivation	112	74.67
2. Promotion of direct marketing and forward marketing of capsicum	103	68.67
3. Creating conducive ecosystem that supports and facilitates the export of capsicum	75	50.00
4. Advocating government policies that support the successful cultivation of capsicum	73	48.67
Financial Strategies		
1. Seeking government support and incentives to promote capsicum cultivation	139	92.67
2. Improving access to credit and grants for smallholder farmers engaged in capsicum cultivation	124	82.67
3. Implementing strategies to optimize costs and reduce the overall cultivation expenses	118	78.67
4. Ensuring procurement of cost-effective need-based inputs through line departments	97	64.67
Technological Strategies		
1. Conducting training and skill development programs for capsicum cultivation under protected structures	86	57.33
2. Conducting advanced research and development for varieties and planting material suitable for protected cultivation of capsicum	78	52.00
3 Fostering research and innovation in capsicum cultivation technologies	56	37.33
Institutional Strategies		
1 Advocating policies that endorse and facilitate successful cultivation	103	68.67
2 Providing insurance coverage to crops grown under protected cultivation	101	67.33
3 Implementing institutional programs providing support and incentives for capsicum cultivation	97	64.67

Weather Strategies			
1.	Designing protected structures customized to the specific agro-ecosystem and locations	105	70.00
2.	Choosing capsicum varieties resilient to abiotic stress	75	50.00
3.	Implementing measures for effective microclimate management in Capsicum	66	44.00
4.	Using wind and shelter brakes to protect capsicum crops from adverse weather conditions	60	40.00
Health Strategies			
1.	Encouraging the use of plant protection equipment for the safety of farmers in protected structures	150	100.00
2	Educating farmers on safe practices for handling chemicals	145	96.67
3	Encouraging and enforcing good agricultural practices in capsicum cultivation	129	86.00
Labour Strategies			
1	Implementing mechanization and automation to address labor scarcity	138	92.00
2	Conducting capacity development programs to enhance the skills of laborers	131	87.33

institutional issues via policy advocacy, addressing weather challenges through proper design and variety selection, and tackling health and labour constraints with good practices, protective equipment, mechanization, and skill development. This comprehensive plan aims to empower farmers and improve capsicum production, fostering increased productivity and sustainability in agriculture.

The strategies proposed by smallholder capsicum farmers aim to enhance profitability and sustainability in protected cultivation through a holistic approach. This includes improving information access for informed decision-making, ensuring timely availability of quality seed, addressing financial constraints by reducing implementation costs, and standardizing production technology. Marketing strategies focus on market research and exploring direct channels to overcome price fluctuations and enhance market access. Technological advancements and continuous learning address knowledge gaps and skill shortages, while institutional support through policy advocacy aims to positively impact regulatory frameworks. Weather-related constraints are addressed through proper structure design, resilient variety selection, and microclimate management. Health and labor challenges are tackled with good agricultural practices, protective equipment, mechanization, and skill development. These comprehensive strategies collectively work towards eliminating diverse constraints, fostering a more sustainable and profitable future for smallholder capsicum farmers in protected cultivation.

CONCLUSION

Adoption of polyhouse technology for capsicum cultivation under protected conditions in India faces multiple constraints and challenges such as inadequate information on scientific crop production, limited availability of quality seed and planting material, high costs of implementation, water quality management, market constraints, institutional constraints, weather-based constraints, health constraints, and labour constraints. To unlock full potential of protected cultivation in capsicum, a comprehensive approach is required that involves providing farmers with up-to-date knowledge, right information at right time, improving access to quality seeds and planting material, addressing the high costs of implementation through subsidies or financial assistance, developing mechanisms for price stabilization and market support, addressing institutional constraints through policy interventions, improving infrastructure and cold chain facilities, promoting crop insurance for crops grown under protected cultivation, managing weather-related risks, promoting occupational health and safety measures, and addressing labour shortages through skill development and attractive incentives.

By addressing these constraints and challenges, the potential of protected cultivation for capsicum and other high-value crops can be fully realized, leading

to increased productivity, extended cropping seasons, improved quality, reduced pesticide use, and better economic outcomes for farmers.

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