

Analysis of Constraints in Adoption of Polyhouse Cultivation among Farmers in North Karnataka

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ABSTRACT

Polyhouse technology has become a valuable part of the concept of protected cultivation and has a great promise to increase the productivity of crops, enhance the efficiency of resource use, and alleviate the negative impact of abiotic stresses like drought, temperature variations, and unpredictable rainfall. The application of polyhouse technology has not been widely applied in various regions such as North Karnataka because of various limitations although it has proven to be beneficial. Therefore, the current research was carried out to critically examine the barriers to its adoption by farmers. This study was done in the selected districts in North Karnataka using a sample of 80 polyhouse farmers who were selected using a multistage sampling method. Structured interview schedule was used to gather data and limitations were classified under technical, environmental, economic, labour, marketing and miscellaneous. Mean Percent Score (MPS) and ranking were the methods to measure the severity of constraints. The findings indicated that technical reasons were the most common with poor knowledge about polyhouse crop management first (MPS: 89.20). High perishability of produce (MPS: 88.60) was the major reason of environmental constraints. The most serious in general were economic, high capital investment in the polyhouse setup (MPS: 93.40) came first in the list of the constraints. The labour related factors like high wages (MPS: 81.75) and shortage of labour were also important. Lack of assured market and stable pricing (MPS: 78.85) was found to be the greatest constraint in terms of marketing whereas lack of knowledge on processing and value addition (MPS: 91.30) dominated the miscellaneous category. The paper arrives at the conclusion that the key barriers to adoption are the economic and knowledge-based ones. These require to be tackled by means of financial support, capacity building, better infrastructure and better market connectivity so as to help to increase the adoption and sustainability of polyhouse technology in North Karnataka.

Keywords: Protected cultivation, Adoption constraints, North Karnataka, Mean Percent Score (MPS), Horticultural crops

In India, agricultural activities are becoming threatening due to a several of abiotic stresses like drought, salinity, heavy metal pollution, extreme temperatures, and unpredictable rainfall, which severely impact crop productivity and agricultural earnings (Mohanty *et al.* 2016; Sahu *et al.* 2024; Maitra *et al.* 2025). These stresses are more pronounced in

semi-arid areas such as in North Karnataka because of the low and uneven rainfall, high evapotranspiration

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and frequent dry spells (Santosh *et al.* 2024). Research has revealed that climate variability and abiotic stresses are significant limitations to sustainable agricultural production particularly in rainfed and resource-scarce areas (Sairam *et al.* 2023; Maitra *et al.* 2024a). Such challenges have led to the need to adopt new and climate-resilient production systems. In this regard, the notion of protected cultivation has become an exciting option to reduce the negative impact of both abiotic stresses through the development of the controlled environment where crops can be cultivated (Maitra *et al.* 2001; Santosh *et al.* 2025).

Protected cultivation entails greenhouses, shade nets, and polyhouses, as types of structures used to control temperature, humidity, and light to improve crop productivity and quality (Maitra *et al.* 2024b). Of these, the polyhouse is popular owing to its relatively cheaper cost and flexibility within the Indian circumstances (Sairam *et al.* 2022). Polyhouses are able to use resources efficiently such as water and nutrients and safeguard against extreme weather conditions and thus can support high-value crops in horticulture (Santosh *et al.* 2024). Polyhouse cultivation has challenges and opportunities in the agro-climatic conditions of North Karnataka due to semi-arid climate, great fluctuation in temperatures, and limited water availability. Although the area experiences numerous droughts and soil-related problems including salinity and alkalinity, polyhouse technology has a chance to fight off these drawbacks with the help of regulated microclimatic conditions and accurate input control. Vegetables (tomato, capsicum, cucumber, and leafy greens), flowers (gerbera and carnation), and vegetables are the most common crops that are grown under polyhouses in this area and have higher prices in the market and generate more farm income (Maitra *et al.* 2024c).

Although this technology has the potential, polyhouse technology has not been widely adopted by farmers in North Karnataka. In several studies, various limitations to adoption have been identified, such as large initial investment, technical-level ignorance, ineffective access to quality inputs, insufficient market linkages, and infrastructural constraints (Sarkar *et al.* 2000; Junatha and Sekar, 2017). Moreover, the issue of water shortage, expensive materials, and unskilled labour in the region also limit the use of the technologies of protected cultivation on a large scale.

Though some past studies have been conducted on the economic feasibility and overall limitations of polyhouse farming in other regions of India, no location-specific studies have been conducted in North Karnataka, especially regarding the systematic classification of limitations into technical, environmental, economic, labour, marketing, and miscellaneous. Furthermore, few studies has been conducted using measurement of the severity of these constraints with standardized measures like the Mean Percent Score (MPS) that is critical in prioritizing interventions. Thus, the given work was conducted to thoroughly identify and classify the key obstacles that farmers have to encounter when adopting the polyhouse technology in North Karnataka, calculate the level of the mentioned obstacles through the proper statistical instruments, prioritize them in accordance with their relative significance, and propose the appropriate measures that can be implemented to enhance the adoption and sustainability of the protected cultivation in the area.

MATERIALS AND METHODS

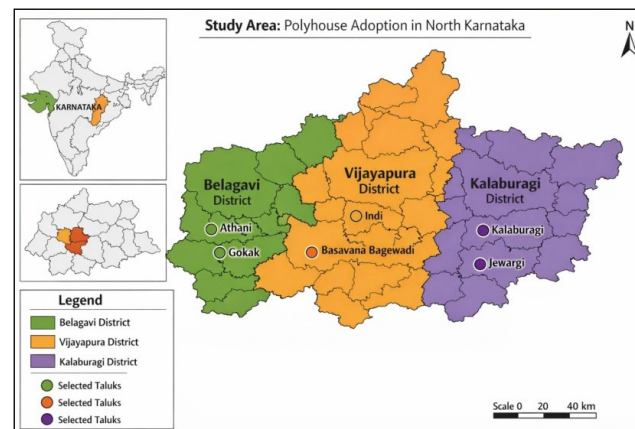


Fig. 1: Study area map showing selected districts and taluks for polyhouse adoption in North Karnataka, India

The present study was carried out in the North part of Karnataka where adoption of polyhouse technology by farmers is comparatively higher for horticultural crops. The selection of respondents was done using a multistage sampling technique. During the initial phase three large districts with polyhouses, i.e. Belagavi, Vijayapura and Kalaburagi, were selected randomly, according to the density of the units of the protected cultivation. Two taluks per

district with greater levels of polyhouse adoption were then sampled in the second step, including Athani and Gokak in Belagavi district; India and Basavana Bagewadi in Vijayapura district; and Kalaburagi and Jewargi in Kalaburagi district (Fig. 1). Simple random sampling was used to select the respondents by selecting a list of polyhouse farmers provided by the Department of Horticulture of the respective districts. The study sample comprised 80 polyhouse farmers which is sufficient to conduct socio-economic and adoption research studies in agricultural research.

The purpose of the study was to establish the limiting factors that influence the adoption of polyhouse technology. A detailed list of constraints was compiled by literature review, consultation with experts and communication with progressive farmers. The same strategy has been predominantly used in the agricultural extension studies to detect the constraints that are location-specific (Dadheech *et al.* 2024). The constraints identified were grouped into major categories namely technical, environmental, economic, labour, marketing and miscellaneous constraints. A pre-tested structured interview schedule was used to gather primary data and this guaranteed reliability and validity of data. The respondents were requested to rate the severity of each constraint on a three-point scale that is most severe, moderately severe and least severe with the corresponding scores of 3, 2 and 1, respectively. This scaling technique has been commonly used in constraint analysis studies in agriculture (Mishra and Mallik, 2024). The responses were quantified and converted into Mean Percent Scores (MPS) using the following formula:

$$MPS = \frac{\text{Obtained Score}}{\text{Maximum possible score}} \times 100$$

The computation of the MPS values allowed ranking the constraints in a decreasing order to define their relative significance. The data under analysis were in the table format and the proper statistical tools like frequency, percentage, mean and ranking procedures were used to interpret the data. These types of analytical frameworks have been extensively applied in research associated with adoption behavior and constraint analysis of agricultural technologies (Verma *et al.* 2025).

RESULTS AND DISCUSSION

Findings of the current study are clearly outlined and explained in this section with regards to limitations that farmers are experiencing when adopting polyhouse technology in North Karnataka. The data is interpreted with the help of the proper statistical indicators including Mean Percent Score (MPS) and ranking in order to determine the relative severity of various constraints.

The findings in Table 1 show that farmers in North Karnataka have a number of serious technical limitations in adopting polyhouse technology. Among them, the most serious constraint with the highest Mean Percent Score (MPS: 89.20) and thus taking the first place was poor knowledge of polyhouse crop management. This was then succeeded by poor access to good planting material (MPS: 83.75) and untrustworthy electricity supply (MPS: 80.40) ranked second and third respectively. The unavailability of polyhouse equipments at the local level (MPS: 76.10) and inadequate extension support (MPS: 72.85) were other significant limitations. The results indicate clearly that technical constraints due to knowledge, infrastructure, and availability of inputs are the main barriers to effective use and management of polyhouse technology in the area.

The results of the current research strongly point to the fact that technical factors and especially poor understanding of polyhouse crop management is a major factor in the inhibition of polyhouse technology adoption among North Karnataka farmers. This highlights the significance of training and capacity building based on skills, since the protection of cultivation necessitates particular knowledge of microclimate control, fertilizer application, and control of pests. Nasrin *et al.* (2017) also reported similar observations and discovered that the deficiency in technical know-how is a major factor that determines the capacity of farmers to adopt and maintain polyhouse practices. Also, systemic problems of rural areas include infrastructural problems, like poor electricity supply and inaccessibility of polyhouse equipment, which have been further identified as significant adoption barriers to high-technology farming technologies (Prajapati, 2023). The lack of extension support also suggests inadequate spread of scientific knowledge

because to fill the gap between research and field-level implementation, effective extension services are necessary; the same conclusions were made by Atheequalla *et al.* (2023), who also highlighted the importance of extension systems to increase farmer confidence and adoption behavior. In general, the research indicates that technical constraints are interconnected and can be efficiently managed by integrated interventions such as farmer training, enhanced delivery systems of inputs and enhanced extension networks.

Table 1: Technical Constraints Faced by Farmers of North Karnataka

Sl. No.	Specific Constraint	MPS (%)	Rank
1	Inadequate knowledge of polyhouse crop management	89.20	I
2	Limited access to quality planting material	83.75	II
3	Unreliable electricity supply	80.40	III
4	Non-availability of polyhouse equipment locally	76.10	IV
5	Insufficient extension support	72.85	V

Table 2 results show that farmers in North Karnataka have various environmental constraints that are of great importance in adopting polyhouse technology. First in the list of these was the high perishability of produce (MPS: 88.60). Water shortage to irrigate the farms was second and climate variability and extreme temperatures were ranked second and third respectively. Poor drainage of the soil (MPS: 69.80) and pests and diseases (MPS: 63.55) were other identified constraints that were noted to be particularly challenging. These results indicate that, even with the manipulated polyhouse cultivation, factors of the environment still have a significant impact on crop production and control.

The high degree of perishability as one of the main limitations indicates the extreme sensitivity of the horticultural products produced in polyhouses, and effective post-harvesting management and storage practices are needed. Recent studies also report similar findings, noting that high-value crops grown using a protected cultivation are more likely to be post-harvest losses because of poorly developed cold chain and storage facilities (Singh, 2024).

Water scarcity is also a limitation that also brings into focus the difficulties of polyhouse technology implementation in semi-arid areas such as North Karnataka where water supply is not regular. Research has demonstrated that the lack of water and ineffective irrigation practices are major causes of reduced productivity even with the safeguards of the protective structures, especially in arid and semi-arid areas in India (Kumar *et al.* 2024).

Extreme temperatures and climate variability also proved to be key limiting factors, which means that despite the partial control of the environment in polyhouses, they are also affected by outside weather conditions. Studies of the cultivations within the protection have proven that the change in temperature and the weather extremities still impacts the performance of crops, and the design and management strategies must be specific to the region. Moreover, the poor soil drainage and pest and disease occurrence present some concerns implying that the microclimatic conditions inside polyhouses are sometimes conducive to the development of pathogens. As an example, the accumulation of soil-borne pests in nematodes due to continuous cropping and favorable moisture conditions in the interior of polyhouses has been reported and leads to a substantial loss of yield (Kamra *et al.* 2024).

Table 2: Environmental Constraints Faced by Farmers of North Karnataka

Sl. No.	Specific Constraint	MPS (%)	Rank
1	High perishability of produce	88.60	I
2	Water scarcity for irrigation	79.95	II
3	Climate variability and extreme temperatures	75.30	III
4	Poor soil drainage conditions	69.80	IV
5	Incidence of pests and diseases	63.55	V

The findings in Table 3 clearly show that farmers in North Karnataka are constrained with both economic and labour factors in switching to polyhouse technology. High capital investment that is necessary in the setup of polyhouses was found to be the greatest constraint among economic constraints (MPS: 93.40) followed by high cost of planting material and inputs (MPS: 87.25) and high cost of plant protection measures (MPS: 82.10).

Other constraints included delay in institutional credit support (MPS: 78.60) and high logistics and transportation expenses (MPS: 74.35) were also noted to be key obstacles.

In terms of labour constraints, high wages of skilled labour (MPS: 81.75) was ranked on the top followed by labour shortage during peak operations (MPS: 76.90) and untrained manpower to operate polyhouses (MPS: 68.20). These observations suggest that a high level of financial burden and labour-related issues are some of the major factors that slow down the uptake and sustainability of polyhouse technology in the region. The high capital investment as the most important constraint denotes the capital-intensive nature of polyhouse technology, which in many cases, restricts its use to farmers with their own resources. Indian Council of Agricultural Research-based studies also provided similar results, showing that high initial investment and input costs were found to be the major obstacle to adopting the use of a protected cultivation system (Bala and Rana, 2022). Economic studies also indicate that establishment costs represent a significant portion of total investment, which in polyhouse cultivation can exceed 7080 percent of total costs, and thus, small and marginal farmers are unlikely to use the technology (Khapte *et al.* 2021).

Studies indicate that the cost of planting material and labour constitutes a significant percentage of the costs of operation in polyhouse systems, which makes farmers more financially risky. Also, the increase in the costs of inputs in agriculture, especially labour and agrochemicals, is reported to have adverse impacts on the farm profitability in some areas such as Karnataka. Institutional constraints such as delay in credit support and high transportation costs further exacerbate financial challenges. The availability of credit in good time is essential to invest in polyhouse infrastructure and inputs but due to the delays in the processes and the lack of institutional coverage, the farmers are deterred to implement such technologies. Studies on agricultural systems have highlighted that lack of efficient credit and market infrastructure reduces farmers' willingness to invest in high-cost technologies (Kannan & Pohit, 2021).

The study has labour-related constraints that were evident in terms of high wages and lack of skilled labour, which are characteristic of poly house

cultivation that is labour-intensive. It has been shown that labour consumes a substantial proportion (up to 35) of the total cultivation costs in a system of protection, which constitutes a substantial economic burden (Pachiyappan *et al.* 2022). Moreover, untrained manpower means that there is no skill development and technical training, which would be necessary in managing the polyhouse operations effectively. This has been observed in other research on the topic of protected cultivation, with lack of skilled labour and technical expertise highlighted as the main limitation to productivity and adoption (Dahiya and Singh, 2018).

Table 3: Economic and Labour Constraints for adoption of polyhouse technology from North Karnataka farmers

Sl. No.	Constraint Category	Specific Constraint	MPS (%)	Rank
1	Economic	High capital investment required for polyhouse setup	93.40	I
2	Economic	Expensive planting material and inputs	87.25	II
3	Economic	High expenditure on plant protection measures	82.10	III
4	Economic	Delay in institutional credit support	78.60	IV
5	Economic	High logistics and transportation costs	74.35	V
6	Labour	High wages of skilled labour	81.75	I
7	Labour	Labour shortage during peak operations	76.90	II
8	Labour	Lack of trained manpower for polyhouse operations	68.20	III

The findings in Table 4 show that farmers in North Karnataka are faced with significant marketing and miscellaneous limitations in adoption and sustainability of polyhouse technology. Lack of assured market and stable pricing was found to be the worst constraint (MPS: 78.85) in the marketing that ranked first, next was the absence of adequate market infrastructure at the local level (MPS: 73.40), and the third was low price realization of produce (MPS: 70.15). There were also other limitations like

lack of special markets to sell polyhouse produce (MPS: 67.80) and mediation of middlemen in fixing the price (MPS: 62.55). As far as miscellaneous constraints are concerned, knowledge on processing and value addition was found to be the most serious constraint (MPS: 91.30), and also soil related issues like high pH and salinity (MPS: 84.20) and high cost of structure fabrication materials (MPS: 79.60). Other limitations were a low durability of cladding materials (MPS: 75.10) and nematode and soil-borne disease issues (MPS: 66.75). These results suggest that the inefficiencies at the market level as well as the technical problems at the farm level play a significant role in adoption and profitability of polyhouse cultivation.

The results indicate that the marketing constraints, especially the absence of guaranteed markets and fluctuating prices, are one of the big challenges facing the farmers who have adopted polyhouse technology. It is also in line with the existing literature, which indicated that the lack of price support systems and poor market connections have a profound impact on profitability and deter the adoption of high-value cultivation systems among farmers (Ghimire *et al.* 2022). A further problem of structural inefficiencies in agricultural supply chains is the presence of poor market infrastructure and poor price realisation. Research studies carried out in Karnataka and other areas revealed that inadequate storage, transportation and market access facilities highly diminish farmers bargaining power and cause distress sales (Preeti *et al.* 2024). Moreover, the role of the mediators in price fixing underscores the inability of farmers to access the market directly, a suggestion that has been extensively cited as one of the key limitations of the horticultural marketing systems (Shubha *et al.* 2024).

Among other constraints, the lack of knowledge that predominates in processing and value addition implies that farmers cannot leverage the economic potential of polyhouse products to the maximum. Value addition and processing are very important in decreasing perishability and increasing income, but the lack of awareness and technical expertise does not allow farmers to use value addition and processing. Moreover, soil-related challenges such as salinity and high PH are of special concern especially in the semi arid areas like North Karnataka where

soil degradation is a problem that influences crop output. Studies have shown that soil limitations and pest issues, namely the infestation of nematodes, are widespread in intensive cultivation regimes and may lead to a significant decline in productivity unless addressed (Ruli *et al.* 2024).

The limitations associated with the expensive nature and low reliability of cladding materials also underline the necessity of region-specific, affordable polyhouse systems because the damage to materials caused by climatic factors raises the maintenance expenses. Generally, the results indicate that marketing and miscellaneous constraints are connected and need to be combined with interventions like infrastructure strengthening of the market, distribution of farmers producer organizations (FPOs), value addition capacity and better soil and crop management practices that support sustainable adoption of polyhouse technology.

Table 4: Marketing and Miscellaneous Constraints for adoption of polyhouse technology from North Karnataka farmers

Sl. No.	Constraint Category	Specific Constraint	MPS (%)	Rank
1	Marketing	Lack of assured market and stable pricing	78.85	I
2	Marketing	Inadequate market infrastructure at local level	73.40	II
3	Marketing	Low price realization for produce	70.15	III
4	Marketing	Absence of specialized markets for polyhouse produce	67.80	IV
5	Marketing	Influence of intermediaries in price fixation	62.55	V
6	Miscellaneous	Lack of knowledge on processing and value addition	91.30	I
7	Miscellaneous	Soil-related issues (high pH and salinity)	84.20	II
8	Miscellaneous	High cost of structure fabrication materials	79.60	III
9	Miscellaneous	Poor durability of cladding materials	75.10	IV
10	Miscellaneous	Nematode and soil-borne disease problems	66.75	V

CONCLUSION

As it is evident in the current research, polyhouse technology in North Karnataka is limited by a set of technical, environmental, economic, labour, marketing and miscellaneous factors that are limited by a range of severity. Out of all the constraints, economic factors came out as the most crucial ones, especially the large capital investments needed to establish polyhouses, high costs of inputs and inaccessibility to timely credit. It was also discovered that technical factors such as poor knowledge on polyhouse crop management, and lack of access to good planting materials had a major negative impact on adoption. The high perishability of the produce and scarcity of water are also some of the environmental factors that impact efficiency and sustainability of polyhouse farming in the area. Moreover, high wages and scarcity of skilled labour, and marketing limitations such as inability to guarantee markets and price volatility make polyhouse farming less profitable and attractive. There are other miscellaneous constraints such as absence of knowledge on value addition and soil related problems that further complicate the situation of farmers. On the whole, the results show that the most prevalent obstacles are economic and knowledge-based ones, and the next are infrastructural and environmental.

The research paper concludes that effective promotion of polyhouse technology in North Karnataka needs to be integrated and holistic, in terms of offering financial assistance in the form of subsidies and credit facilities, enhancing extension services towards capacity building, timely supply of quality inputs, market linkages promotion, and value addition practices promotion. A systematic approach to tackling these constraints will not only increase the adoption of polyhouse technology but also the income and livelihood security of farmers in the region.

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