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Adaptation strategies followed by fig growers in major fig-growing areas of Maharashtra

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Abstract

Fig (*Ficus carica* L.) is an economically important fruit crop cultivated in tropical and subtropical regions, contributing significantly to farmers' income and livelihood security. In India, fig cultivation is mainly concentrated in Maharashtra, particularly in Pune and surrounding regions. However, increasing climate variability, characterized by erratic rainfall, temperature fluctuations, and rising pest and disease incidence, poses serious challenges to sustainable fig production.

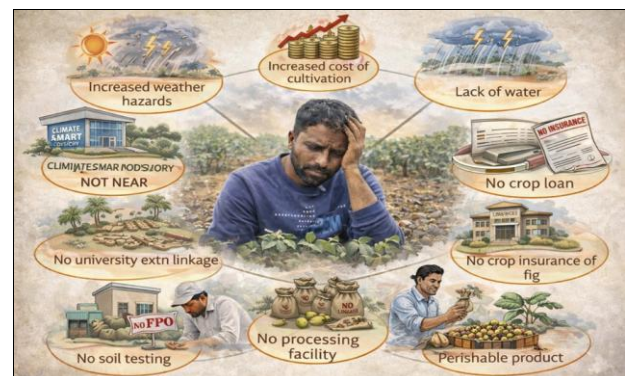
To address these challenges, farmers adopt various adaptation strategies aimed at reducing climate-related risks and improving resilience. Adaptation strategies involve long-term, planned adjustments in production practices, resource management, and institutional linkages, whereas coping strategies are short-term responses to immediate climatic stresses. Despite their critical role, limited research has systematically identified and prioritized adaptation strategies in fig cultivation systems. Therefore, the present study focuses on identifying and ranking the adaptation strategies adopted by fig growers using the Garrett ranking technique. The findings provide valuable insights for strengthening adaptive capacity and designing targeted interventions to promote sustainable and climate-resilient fig cultivation.

Keywords: Climate adaptation, fig cultivation, Garrett ranking, climate variability, Maharashtra

Introduction

Fig (*Ficus carica* L.) is an important fruit crop grown in tropical and subtropical regions due to its nutritional, medicinal, and economic significance. Globally, fig production exceeds 1.3 million tonnes, with major producers including Turkey, Egypt, and Iran. In India, fig cultivation is largely concentrated in Maharashtra, particularly in Pune district, where favorable agro-climatic conditions support its commercial cultivation.

However, increasing climate variability has emerged as a significant challenge affecting fig production. Irregular rainfall, prolonged dry spells, rising temperatures, and increased pest and disease incidence adversely influence flowering, fruit set, fruit development, and yield stability. Given the perennial nature of fig orchards, the impact of climatic stress is long-term, affecting both productivity and economic returns. These challenges necessitate the adoption of appropriate adaptation strategies to sustain fig cultivation under changing climatic conditions.



Adaptation strategies refer to long-term, planned adjustments in agricultural practices, technologies, and institutional arrangements aimed at minimizing the adverse impacts of climate variability and enhancing resilience. These include improved irrigation practices, soil moisture conservation techniques, adoption of climate-resilient

varieties, scientific orchard management, and strengthened market and institutional linkages. In contrast, coping strategies are short-term, reactive measures adopted by farmers to manage immediate climatic shocks and stresses. While coping strategies provide temporary relief, adaptation strategies are essential for ensuring long-term sustainability and resilience of farming systems.

Although farmers adopt a range of adaptation measures, there is limited empirical evidence on the relative importance and prioritization of these strategies in fig cultivation. Most existing studies focus primarily on production constraints, with insufficient attention to systematically evaluating adaptation practices. Therefore, the present study focuses on identifying and prioritizing the adaptation strategies adopted by fig growers using the Garrett ranking technique. The study aims to provide policy-relevant insights for enhancing adaptive capacity and promoting sustainable fig cultivation in the context of climate variability.

Methodology

The present study was conducted in major fig-growing districts of Maharashtra, namely Pune and Sambhajinagar.

An ex-post facto research design was adopted, as the study focused on existing adaptation strategies without manipulation of variables.

A combination of purposive and random sampling techniques was used for selecting respondents. Initially, major fig-growing areas were selected purposively, followed by random selection of villages and fig growers. A total of 300 fig growers were selected for the study.

Primary data were collected using a structured and pre-tested interview schedule, covering various adaptation strategies adopted by farmers under climate variability. The data were analyzed using appropriate statistical tools such as frequency, percentage, and Garrett ranking technique. The Garrett ranking method was used to prioritize adaptation strategies based on farmers' perceptions.

Results and Discussion

The adaptation strategies adopted by fig growers were analysed using the Garrett ranking technique, and the results are presented in Table 1. The ranking was based on mean Garrett scores to determine the relative importance of each strategy.

Table 1: Ranking of Adaptation Strategies using Garrett Ranking Technique (n = 300)

Sr. No.	Adaptation Strategy	Mean Score	Rank
1	Bio-mulching	60.80	I
2	Organic manures	58.70	II
3	Organic plant protection	57.00	III
4	Efficient irrigation	55.10	IV
5	Scientific pruning & spacing	53.00	V
6	Bahar management	51.20	VI
7	Community water conservation	49.00	VII
8	BBF system	47.30	VIII
9	Improved packaging & branding	45.40	IX
10	Participation in FPCs	44.00	X
11	Role of MPKV Scientists & Farmer-Scientist Forum (AICRP)	43.20	XI
12	Direct marketing	42.50	XII
13	Indigenous nurseries	41.20	XIII
14	GI-based export	39.60	XIV
15	Protected cultivation	37.50	XV
16	Agrotourism	36.30	XVI

Bio-mulching (Rank I) was identified as the most important adaptation strategy due to its effectiveness in conserving soil moisture, regulating soil temperature, and improving soil health under drought conditions. Its low cost and ease of adoption make it highly suitable for farmers.



Bio-mulching was found to be an effective climate-resilient practice adopted by fig growers, involving the application of

organic materials on the soil surface to conserve moisture by reducing evaporation losses and minimizing irrigation requirements during dry periods. It also regulates soil temperature, protects feeder roots from heat stress, and suppresses weed growth, thereby reducing competition and cultivation costs. Additionally, bio-mulching improves soil structure by enhancing organic matter content, microbial activity, nutrient availability, and water infiltration while reducing soil erosion and surface crusting. The practice contributes to improved fruit size, quality, and uniform maturity, and being low-cost and eco-friendly, it enhances overall productivity, sustainability, and adaptive capacity of fig growers under climate variability.

Use of organic manures (Rank II) such as compost, goat manure, and poultry manure was widely adopted for improving soil fertility, enhancing moisture retention, and ensuring sustained nutrient availability.



The application of compost, goat manure, and poultry manure was found to be an important practice among fig growers for improving soil health and crop productivity. These organic manures enhance soil fertility by increasing organic matter content and stimulating microbial activity, which supports efficient nutrient cycling. They provide a slow and steady supply of essential nutrients, including nitrogen, phosphorus, and micronutrients, ensuring sustained plant growth. Compost improves the soil's moisture-holding capacity and overall structure, while goat manure contributes to gradual nutrient release due to its rich organic content. Poultry manure, when properly decomposed, supplies nutrients quickly and promotes vegetative growth. The use of these manures also improves root development, reduces soil compaction, and enhances aeration, thereby increasing water use efficiency and drought tolerance. Additionally, it reduces reliance on chemical fertilizers, lowers cultivation costs, and supports organic farming practices. Overall, this approach contributes to better fruit quality, stable yields, and strengthens the adaptive capacity of fig growers under changing climatic conditions.

Organic plant protection measures (Rank III), including neem extract and Dashparni ark, were preferred for their eco-friendly nature and effectiveness in controlling pests while maintaining ecological balance.



The use of neem extract and Dashparni ark was observed to be an important eco-friendly adaptation strategy adopted by fig growers for managing insect pests and diseases. Neem extract effectively controls sucking pests such as thrips, aphids, mites, and early stages of stem borer by acting as a repellent, antifeedant, and growth regulator. Similarly, Dashparni ark, a botanical formulation prepared from leaves of multiple plant species, provides broad-spectrum protection against insect pests and certain fungal infections. These organic plant protection measures help in reducing pest populations without adversely affecting beneficial organisms, thereby maintaining ecological balance. In

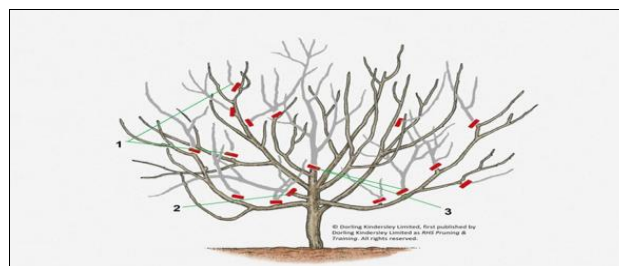
addition, their use enhances plant immunity and stress tolerance under adverse climatic conditions, while reducing dependency on chemical pesticides and lowering the cost of cultivation. Being safe for soil, environment, and human health, and easily prepared using locally available materials, these practices promote sustainable, residue-free fig production and significantly enhance the adaptive capacity of fig growers under climate variability.

Efficient irrigation practices (Rank IV) such as drip and rain pipe systems played a significant role in improving water-use efficiency and reducing drought stress.



The use of rain pipes and drip irrigation systems was found to be an effective water management strategy adopted by fig growers to cope with climate variability. These systems ensure uniform water application, similar to natural rainfall, and are particularly useful for providing protective irrigation during heat stress and dry spells. They help in reducing temperature stress on plants, improving soil moisture distribution, and supporting better growth, especially in young orchards and newly planted saplings. Additionally, rain pipes reduce dust and heat load on leaves and fruits, thereby improving plant health. These systems are simple to operate, suitable for light soils and uneven fields, and can also be used for applying fertilizers or organic solutions when required. They serve as a supportive irrigation method along with drip systems, ensuring adequate moisture during critical growth stages, reducing plant wilting, and enhancing overall plant survival and productivity under changing climatic conditions.

Scientific pruning and proper spacing (Rank V) helped improve canopy management, reduce pest and disease incidence, and enhance yield.



Scientific pruning along with recommended spacing was observed to be an important practice for reducing pest and disease incidence in fig orchards. Proper spacing and removal of overcrowded and diseased branches improve air circulation and sunlight penetration within the canopy, thereby reducing humidity conditions that favour pest and disease development. This practice results in healthier plants, lower dependence on chemical pesticides, and improved yield and fruit quality.

Bahar management (Rank VI) contributed to better flowering synchronization, improved fruit set, and higher fruit quality.



Bahar management in fig refers to a set of integrated cultural practices aimed at regulating and synchronizing flowering and fruiting to enhance productivity and fruit quality. It involves careful consideration of climatic conditions, soil health, nutrient management, irrigation scheduling, and timely pruning operations. Growers monitor environmental parameters such as temperature, humidity, and rainfall to determine appropriate timing for flowering induction. Soil testing is undertaken to ensure balanced nutrient application, along with the use of organic manures to improve soil health.

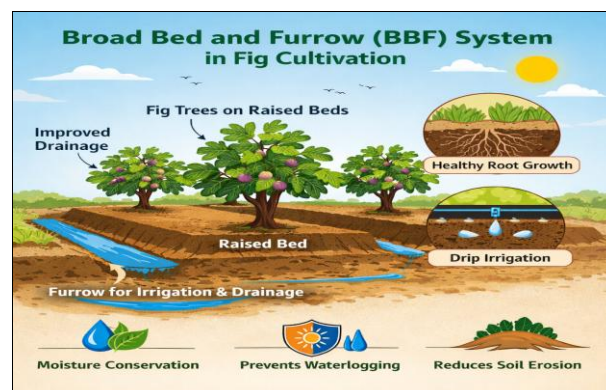
Community-based water conservation practices (Rank VII) ensured water availability during critical stages, thereby reducing crop risk.



The Sonori Model is a community-based water conservation approach adopted by farmers, including fig growers, to address water scarcity and climate variability. It involves collective implementation of rainwater harvesting structures such as farm ponds, check dams, contour bunds, and recharge pits, which help in improving groundwater recharge and ensuring protective irrigation during critical crop stages. The model emphasizes community participation, local leadership, and shared responsibility, leading to improved water availability, reduced crop risk,

and enhanced resilience and adaptive capacity of fig growers.

BBF system (Rank VIII) was effective in preventing waterlogging and improving soil aeration and root health.



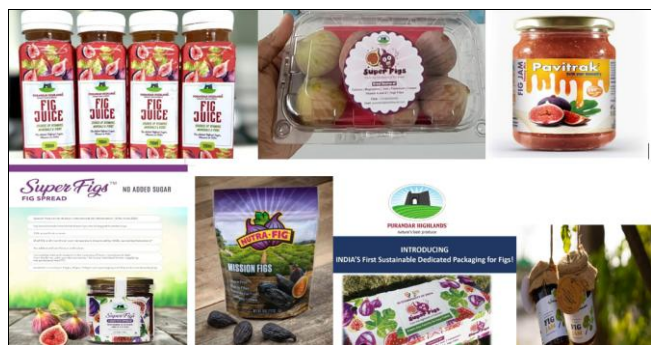
The BBF (Broad Bed and Furrow) system is an effective soil and water management practice adopted in fig cultivation, especially in areas prone to heavy rainfall, waterlogging, and poor drainage. In this system, fig plants are established on raised broad beds, while furrows between beds facilitate safe drainage of excess rainwater. BBF helps prevent water stagnation around the root zone, which reduces the incidence of root rot, wilt, and other soil-borne diseases in fig. It also improves soil aeration, root development, and moisture regulation by maintaining an optimum balance between water retention and drainage. During dry periods, furrows help in conserving moisture and efficient irrigation. Overall, the BBF system enhances soil health, plant vigor, and yield stability, making it a climate-resilient

Improved packaging and branding (Rank IX) helped reduce post-harvest losses and improve market value of fig fruits.





The use of suitable packaging materials such as plastic clamshell containers and ventilated trays was found to be an effective post-harvest practice among fig growers. These packaging methods protect fruits from mechanical damage, bruising, and compression during handling and transportation. Proper ventilation within the containers helps reduce moisture buildup and minimizes fungal spoilage. The packaging also helps in maintaining fruit firmness, colour, and quality, thereby extending shelf life and reducing post-harvest losses. Compartmentalized structures allow for uniform grading and ease of handling, which improves market presentation. As a result, growers are able to attract better prices and access higher-value markets through improved packaging practices. Commonly recommended packaging materials include corrugated fiberboard boxes with ventilation holes, plastic clamshell containers for fresh figs, and cushioning materials such as paper shreds or trays placed inside boxes to protect the fruits during handling and transportation.



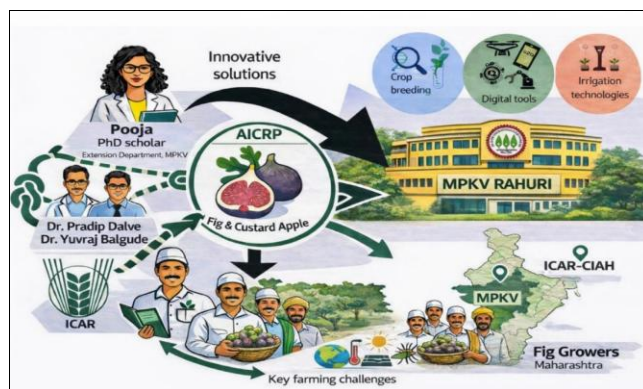
Participation in Farmer Producer Companies (FPCs) (Rank X) strengthened collective marketing, improved bargaining power, and facilitated access to resources. FPCs function as collective platforms that aggregate the produce of member farmers, thereby enabling bulk marketing and enhancing economies of scale. This collective approach reduces individual transaction costs related to transportation, grading, and marketing, while also strengthening farmers' bargaining power in price negotiations with traders, wholesalers, and exporters. As a result, farmers are less dependent on local intermediaries and are able to realize comparatively better and more stable prices for their produce.

In addition to market advantages, FPC membership facilitates improved access to critical inputs, credit, technical guidance, and government schemes. Through institutional linkages and coordinated efforts, FPCs provide services such as input procurement at lower cost,

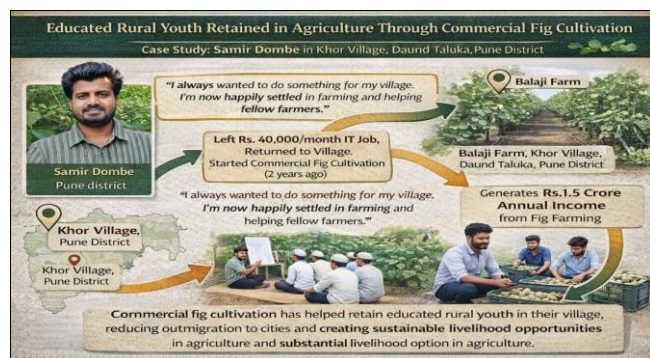
dissemination of improved production technologies, and access to extension and advisory support. These services enhance production efficiency and reduce vulnerability to both climatic and market risks. Consequently, participation in FPCs contributes to strengthening the adaptive capacity of farmers by improving income stability, promoting resource-use efficiency, and supporting sustainable agricultural practices under conditions of climate variability.

Role of MPKV Scientists and Farmer–Scientist Forum under AICRP on Fig and Custard apple (Rank XI)

Under the All India Coordinated Research Project (AICRP) on Fig and Custard Apple, scientists from Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, played a vital role in strengthening technical support and research–extension linkages through the farmer–scientist forum. This platform enabled direct interaction between farmers and scientists through field visits, demonstrations, and training programmes, facilitating the exchange of knowledge and field-level problem-solving. Scientists provided location-specific guidance on improved varieties, pruning, spacing, nutrient management, irrigation, and eco-friendly pest control practices. These efforts helped farmers address issues related to climate variability, pest incidence, and nutrient deficiencies, leading to the adoption of climate-resilient practices, improved yield and fruit quality, and reduced production risks.



Direct marketing (Rank XII) enabled farmers to reduce dependence on intermediaries and obtain better price realization. Samir Dombé expanded market access for his Pavitrak fig products by selling them through urban retail outlets such as shopping malls and organized farmer–consumer platforms like Kisan Connect. By entering malls and organized retail spaces, he was able to directly reach urban and premium consumers, where demand for hygienic, branded, and value-added fig products is high. Proper packaging, attractive labeling, and consistent quality helped his products meet retail standards. This strategy reduced dependence on traditional markets and intermediaries, ensured better and more stable price realization, and increased brand visibility. Selling through malls and Kisan Connect also provided direct consumer feedback, enabling continuous improvement in product quality and flavours. Overall, this market innovation significantly strengthened the market adaptive capacity, income stability, and entrepreneurial resilience of the fig grower under changing market and climate conditions.



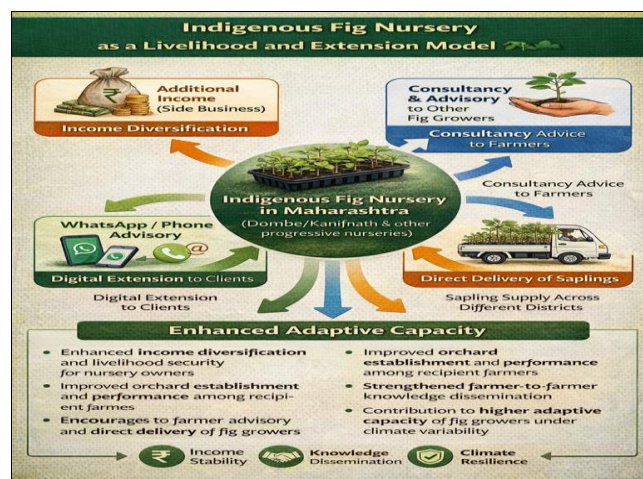
Indigenous nurseries (Rank XIII) supported the availability of quality planting material and provided advisory services, contributing to income diversification.



Indigenous fig nurseries have emerged as an important supplementary livelihood activity among fig growers in Maharashtra. Using traditional knowledge of grafting and vegetative propagation, farmers produce true-to-type, locally adapted, and disease-free planting material, reducing dependence on commercial nurseries. In addition to sapling production, these nurseries provide technical guidance on orchard management practices such as planting, pruning, irrigation, fertigation, and pest control.

Many nursery operators use digital platforms like WhatsApp and mobile communication to offer continuous advisory support, while also facilitating transportation and delivery of saplings. This integration of production, advisory services, and communication has transformed indigenous nurseries into informal extension centers. As a result, they contribute

to income diversification, knowledge dissemination, and enhanced adaptive capacity of fig growers under climate variability.

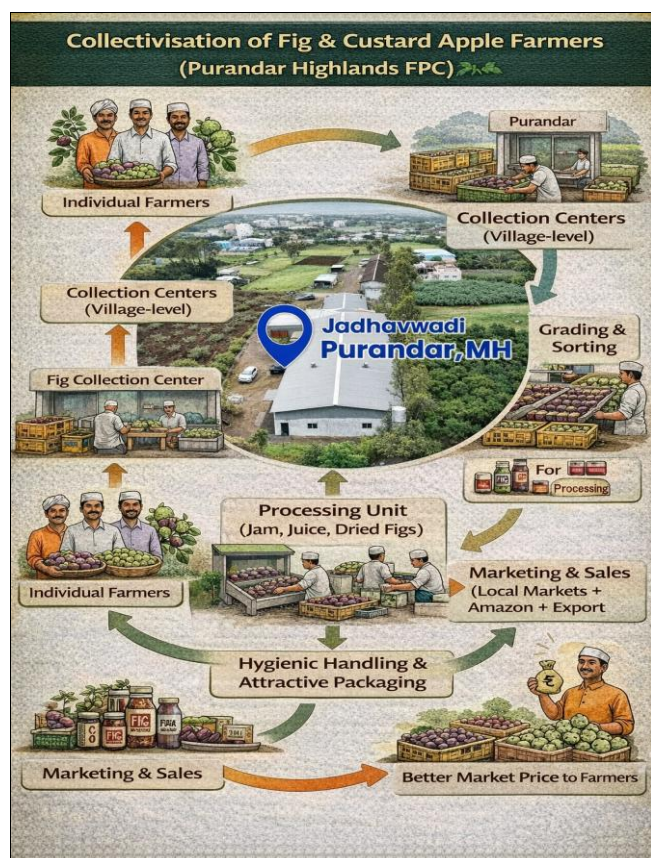


GI-based export (Rank XIV) offered opportunities for premium pricing and access to international markets, though its adoption remained limited.

Case Study: Exporting GI-Tagged Purandar Figs by Purandar Highland FPC

The success of Purandar figs as a Geographical Indication (GI) product demonstrates how place-based branding can transform traditional horticulture into a high-value, export-oriented enterprise. The GI certification formally recognizes the unique agro-climatic conditions of the Purandar region in Maharashtra, which contribute to the figs' distinct taste, texture, and nutritional quality. Leveraging this recognition, Purandar Highland Farmers Producer Company systematically introduced scientific orchard management practices, including regulated irrigation, canopy management, pest and disease control, and optimal nutrient scheduling. In addition, emphasis was placed on harvesting at the correct maturity stage, careful handling, grading based on size and quality, and the use of standardized, export-compliant packaging. These interventions ensured consistency in quality, minimized post-harvest losses, and enabled the produce to meet stringent international market standards.

Furthermore, GI-based branding played a crucial role in creating a distinct identity for Purandar figs in competitive domestic and global markets. By highlighting authenticity and traceability, the branding strategy enhanced consumer trust and allowed the product to command premium prices. Through collective marketing efforts facilitated by the FPC, small and marginal farmers were able to aggregate their produce, negotiate better prices, and directly connect with exporters and organized retail chains, thereby reducing dependence on middlemen. This institutional support improved price realization and reduced market uncertainties, ultimately contributing to income stability. The model illustrates how the integration of GI certification with Farmer Producer Company-led marketing can strengthen resilience against climate and market risks, enhance adaptive capacity, and promote the long-term sustainability of fig cultivation systems in Maharashtra.



Protected cultivation (Rank XV) improved micro-climate control and productivity but required higher investment and technical knowledge, limiting its adoption. In Guroli village of Pune district, Mr. Ganesh Jadhav has successfully adopted protected fig cultivation under a polyhouse on 12.5 guntha area, accommodating 310 fig plants at a spacing of 5 × 8 ft. The high-density planting combined with protected cultivation practices has enabled efficient use of space, better micro-climate control, and improved productivity.

Case Study: Protected Fig Cultivation in Polyhouse

Ganesh Jadhav,
Guroli, Pune District, Maharashtra

Polyhouse Details

- Area: 12.5 Guntha (about 1,125 m²)
- 310 Fig Plants at 5 × 8 ft Spacing
- Indo-Israel Techniques: Drip Irrigation, Fertigation, Shade Nets & Air Circulation Fans

Additional Observations from Protected Fig Farming (Polyhouse)

- Better synchronization of flowering & fruiting → planned harvesting in both bahars
- Stable yield compared to open-field fig cultivation
- Improved income stability under climate variability

Benefits of Protected Fig Farming

- High and consistent fig yield across seasons
- Allows taking both katta and meetha bahar
- Negligible weather-related losses: No Frost stress, rain or wind-related damage / humidity fluctuation
- Reduced labour requirement: Easier management and monitoring, lower pest/disease incidence

“ Growing figs in a polyhouse has allowed me to take both katta and meetha bahar with minimal weather-related losses and less labour requirement. My income has increased significantly with better control over water, nutrients, and climate. ”

– Ganesh Jadhav, Guroli, Pune District

This case study demonstrates how protected fig cultivation can significantly enhance adaptive capacity and income stability under climate change.

Agrotourism (Rank XVI) was the least adopted strategy, although it provides opportunities for income diversification and knowledge sharing; its lower adoption may be due to limited awareness and infrastructural constraints.



The agrotourism initiative in fig orchards of Khor village, Daund taluka, exemplifies an innovative, farmer-led extension and livelihood diversification model that enhances resilience of fig growers under climate variability.

The growers generate additional income through farm visits, agrotourism activities, training programmes, exposure visits, and demonstration-based learning related to fig cultivation. Moreover, these farmers conduct training and guidance programmes for fellow farmers interested in fig growing. The trainings cover orchard establishment, pruning, bahar management (katta and meetha), irrigation and fertigation, pest and disease management, protected cultivation, and marketing practices.

This farmer-led agrotourism model promotes peer learning, experiential extension, and diffusion of innovations, while also reducing dependence on fruit sales alone. Consequently, agrotourism in fig orchards contributes significantly to income diversification, social capital formation, and adaptive capacity enhancement of fig growers in the region.

Conclusion

The study revealed that fig growers in Maharashtra have adopted a combination of agronomic, technological, institutional, and market-oriented adaptation strategies to cope with climate variability. The Garrett ranking analysis indicated that bio-mulching, organic manures, organic plant protection, and efficient irrigation were the most preferred strategies due to their low cost, ease of adoption, and effectiveness in improving resource-use efficiency and crop productivity.

In contrast, capital-intensive and knowledge-driven strategies such as protected cultivation, GI-based export, and agrotourism showed relatively lower adoption due to financial, technical, and infrastructural constraints. Institutional mechanisms such as Farmer Producer Companies and the farmer-scientist interface under AICRP played an important role in enhancing knowledge dissemination and promoting the adoption of improved practices.

The findings suggest that strengthening climate-resilient practices, along with improved extension services and institutional support, is essential for enhancing the adaptive capacity and sustainability of fig cultivation under changing climatic conditions.

Suggestions

1. Promote low-cost climate-resilient practices such as bio-mulching, organic inputs, and efficient irrigation through extension programmes and farmer trainings.
2. Strengthen institutional support systems including

Farmer Producer Companies and farmer–scientist interactions to enhance knowledge transfer and collective action.

3. Enhance access to financial support and subsidies to encourage adoption of advanced technologies such as protected cultivation and export-oriented practices.
4. Develop market linkages and value chain support to improve price realization through direct marketing, branding, and GI-based promotion.
5. Encourage capacity-building programmes focusing on climate-smart agriculture, post-harvest management, and entrepreneurship development.

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