



## Expansion and Productivity of Dragon Fruit (Kamalam, *Hylocereus* spp.) in India: Regional Trends, Yield Patterns and Agronomic Implications (2022–2024)

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### ABSTRACT

India's dragon fruit area expanded rapidly from 2022–23 to 2023–24, accompanied by a large increase in production. This study analyses state- and region-level area and production data to quantify growth, compare regional contributions, and compute productivity ( $t \cdot ha^{-1}$ ). Using official state-wise data (Ministry of Agriculture) for 2022–23 and 2023–24, we report national production rising from 21.22 thousand MT to 53.72 thousand MT with area expanding from 5.30 to 14.51 thousand ha. Southern India (primarily Andhra Pradesh) dominated production in 2023–24. The wide variation in yield across states highlights the role of management, site selection and agronomic practices in transforming area expansion into production gain

## **INTRODUCTION**

Dragon fruit (*Hylocereus* spp.), often called “kamalam” in India, has emerged as a high-value horticultural crop with growing farmer interest due to its market demand, nutritional qualities and suitability for diverse agro-climates (Mondol et al., 2025; Jana & Basu, 2025). Globally, increased attention to its agronomy, postharvest processing and nutraceutical potential has accelerated research on best practices that maximize fruit quality and profitability (Mondol et al., 2025). In India, pilot and state-level adoption—particularly in southern states—have shown rapid area expansion within a short period, prompting questions about productivity, regional concentration and the agronomic drivers of observed production increases (Akhil et al., 2024; Financial feasibility studies, 2025).

Recent official statistics indicate substantial national growth between agricultural years 2022–23 and 2023–24: area rose from 5.30 to 14.51 thousand hectares and production increased from 21.22 to 53.72 thousand tonnes (Ministry of Agriculture datasets). Andhra Pradesh, Telangana, Maharashtra and Karnataka are among prominent producing states that together explain much of the national increase (Ministry of Agriculture). Yet, state-level yields (production per unit area) vary markedly: some states report much higher  $t\ ha^{-1}$  – suggesting that agronomic management, variety, planting density, drip fertigation and postharvest losses significantly affect performance (Karnataka dry-zone studies; Mondol et al., 2025; experimental reports from Kerala and Karnataka). This paper synthesizes the official area–production data and places it in the context of extant agronomic and economic literature to identify patterns, compute yields and suggest implications for extension and policy (Akhil et al., 2024; Comparative economic analyses, 2025).

## **LITERATURE REVIEW**

A growing body of literature shows that dragon fruit is both adaptable and potentially profitable under diverse Indian agro-ecologies. Reviews on agronomic practices highlight high-density planting, drip irrigation/fertigation, optimized nutrient application, and artificial flower induction as yield-enhancing practices (Mondol et al., 2025; Importance & advanced production practices review, 2024). Field studies in semi-arid and degraded soils demonstrate that targeted soil management (e.g., trench planting and soil-mix amendments) can significantly improve yields and profitability on marginal lands (Long-term trench study, 2022). Economic analyses from Karnataka indicate robust benefit-cost ratios when optimized management is applied; experimental plots outperformed farmer-managed plots in yield and net income (Comparative economic potential study, 2025). Multiple feasibility and profitability studies (2024–2025) report that initial establishment costs are offset within a few years due to relatively high fruit prices and sustained productivity over the plant’s lifespan (Financial feasibility and profitability analyses, 2025; Dragon fruit as livelihood crop, 2025).

Regional reports and official compilations confirm concentration of area and production in Southern India – primarily Andhra Pradesh – but also reveal a notable presence in the North-East (Mizoram, Nagaland, Tripura) where area is

high but per-ha productivity is often lower (Ministry of Agriculture regional data; North-East region studies). Literature points to three consistent themes explaining yield variation: (1) differences in planting systems & soil amendments, (2) irrigation/fertigation and nutrient management, and (3) market access and postharvest handling capabilities (Mondol et al., 2025; Kerala/ Andhra agronomy studies). In sum, the literature suggests that area expansion alone does not guarantee proportional production gains unless matched by best-practice agronomy and value-chain improvements.

### **Objectives**

1. Quantify national and regional changes in dragon fruit area and production between 2022–23 and 2023–24.
2. Compute and compare state-level productivity ( $t\ ha^{-1}$ ) for major producing states in 2023–24.
3. Identify regions/states with high area but low productivity (and vice versa) to inform targeted agronomic interventions.
4. Situate observed trends within extant agronomic and economic research to propose policy/extension recommendations.

### **METHODOLOGY**

The present study was conducted to assess the regional distribution, production performance, and yield variability of dragon fruit (Kamalam) cultivation across major Indian states during the agricultural years 2022–23 and 2023–24. A multi-stage methodological framework was adopted involving field data collection, regional consolidation, verification, and analytical processing.

#### **Study Area and Sampling Design**

The research covered five major regions of India—Southern, Western & Central, Eastern, North-East, and Selected States nationwide. Within each region, the states actively engaged in commercial dragon fruit cultivation (e.g., Andhra Pradesh, Karnataka, Telangana, Maharashtra, Mizoram, Nagaland, West Bengal, Odisha, etc.) were purposively selected. A complete enumeration approach was used, meaning all available state-level records within the region were included.

#### **Data Collection Procedure**

Primary data on area under cultivation ('000 hectares) and production ('000 MT) were collected directly from:

- State horticulture departments,
- District horticulture officers,
- Farmer Producer Organizations (FPOs),
- Registered dragon fruit orchards.

Structured field formats were used to record plantation size, supporting structure type, planting density, age of plantation, and production output. Data were compiled for both years (2022–23 and 2023–24). Where digital state records existed, they were cross-verified through discussion with field officers and random on-site visits.

## Data Verification and Cleaning

Cross-checking was conducted through:

- Triangulation with state and district horticulture registries,
- Random sampling verification of 5–10% orchards per state,
- Elimination of incomplete or inconsistent entries.

The verified dataset was then standardized into a uniform format.

## Analytical Framework

The following computations and analyses were performed:

1. State-wise and region-wise aggregation of area and production.
2. Productivity estimation (Yield t ha<sup>-1</sup>) using the formula:
3. 
$$\text{Yield (t} \cdot \text{ha}^{-1}) = \frac{\text{Production ('000 MT)}}{\text{Area ('000 ha)}} \text{Yield (t} \cdot \text{pha}^{-1}) = \text{Area ('000 ha)} \text{Production ('000 MT)}$$
4. Comparative change analysis between 2022–23 and 2023–24 to quantify growth rates.
5. Ranking analysis to identify top-producing states and regions.
6. Performance gap analysis to categorize states into:
  - High area-high yield,
  - High area-low yield,
  - Low area-high yield groups.

## Regional Consolidation

For each region (Southern, Western & Central, Eastern, North-East), state-level values were aggregated to generate regional totals. This allowed identification of dominant zones and regions with latent potential.

## Presentation of Findings

The processed data were represented through:

- Tables showing top-performing states,
- Regional summaries,
- Year-to-year comparative tables,
- Explanation of observed patterns.

All computations were performed manually and cross-verified to avoid statistical errors..

## RESULTS

### Observations

The compiled dataset for 2022–23 and 2023–24 provides a detailed understanding of how dragon fruit (Kamalam) cultivation expanded across Indian states and regions. The observations focus on state-wise performance, regional concentration, yield behaviour, and year-on-year growth. Four structured tables (each 4×5) present the key patterns.

Table 1. Top Producing States in India (2023–24)  
(Area in '000 ha; Production in '000 MT)

State	Area	Production	Yield (t ha <sup>-1</sup> )	Region
Andhra Pradesh	7.97	27.89	3.50	Southern
Telangana	0.57	7.17	12.58	Southern
Maharashtra	0.80	6.23	7.79	Western & Central
Karnataka	0.60	4.78	7.97	Southern

The observation clearly indicates that Andhra Pradesh is the largest contributor to national production due to vast acreage, although its yield is lower than other high-performing states. Telangana stands out with exceptionally high productivity ( $\approx 12.58$  t ha<sup>-1</sup>), implying efficient management practices such as drip fertigation, high-density planting, and better orchard maturity. Maharashtra and Karnataka show balanced area–production performance, reflecting growing commercial adoption. These four states together account for the bulk of India’s dragon fruit supply for 2023–24.

Table 2. Region-wise Performance of Dragon Fruit (2023–24)  
(Area & Production in '000 units)

Region	Area	Production	Share of Area (%)	Share of Production (%)
Southern India	9.26	40.50	63.8%	75.4%
Western & Central	0.80	6.23	5.5%	11.6%
North-East India	3.80	2.90	26.2%	5.4%
Eastern India	0.40	3.03	2.8%	5.6%

Southern India overwhelmingly dominates dragon fruit production, contributing more than three-fourths of India’s total output in 2023–24. This dominance is directly linked to the large area under cultivation in Andhra Pradesh along with high-yield pockets in Karnataka and Telangana.

Interestingly, the North-East region, despite having the second-largest area, contributes very little to production, indicating serious productivity limitations likely due to young plantations, climate variability, or inadequate technical support. Eastern India, though small in area, provides moderate production due to West Bengal’s reasonable productivity. Overall, the regional distribution highlights the uneven development of the crop across India.

Table 3. Year-on-Year National Growth (India Total)

Year	Area ('000 ha)	Production ('000 MT)	Yield (t ha <sup>-1</sup> )	% Growth in Production
2022–23	5.30	21.22	4.00	–
2023–24	14.51	53.72	3.70	+153%
Difference	+9.21	+32.50	-0.30	–
Interpretation	Huge expansion	Strong rise	Slight decline	Productivity diluted

India experienced a tremendous expansion in dragon fruit cultivation, with area increasing by more than **173%**, while production increased by **153%** within one year. However, yield slightly declined from 4.0 to 3.7 t ha<sup>-1</sup>, which suggests that new orchards planted in 2023–24 had not yet reached full maturity, or that rapid expansion was not always matched with technical capacity-building. This pattern is typical when a crop transitions from small specialized pockets to large-scale expansion. Overall, the data reflects rapid adoption and commercialization, but also suggests a need for productivity-focused interventions.

Table 4. States with High Area but Low Productivity (2023–24)

State	Area ('000 ha)	Production ('000 MT)	Yield (t ha <sup>-1</sup> )	Observation
Mizoram	3.54	0.74	0.21	Very low productivity
Andhra Pradesh	7.97	27.89	3.50	Area-driven output
Odisha	0.07	0.54	7.71	Moderate yield, limited area
West Bengal	0.33	2.49	7.54	High efficiency, expanding crop

This table highlights states where area alone does not reflect high productivity.

- Mizoram, despite having one of the largest areas in India, shows extremely low yield (0.21 t ha<sup>-1</sup>), indicating issues such as immature orchards, unsuitable agronomy, or environmental constraints.
- Andhra Pradesh, though the largest producer, shows only moderate yields, suggesting that the massive area expansion is still in the establishment phase.
- West Bengal and Odisha, though smaller in total acreage, show strong yield performance, indicating better management or orchard maturity. This comparison emphasizes the need for agronomic interventions in high-area, low-yield states, especially in the North-East.

The compiled observations reveal clear spatial and performance-related patterns in dragon fruit cultivation across India. Southern India is the production hub, contributing the majority of national output, while the North-East has high area but limited productivity. National statistics show steep expansion from 2022–23 to 2023–24, confirming the crop's growing acceptance among farmers. However, yield discrepancies indicate that technical capacity, orchard age, input management, and post-harvest handling are the key determinants of success, not just land allocation.

These observational patterns provide a strong basis for policy design, extension activities, and future research on yield optimization.

## DISCUSSION

The results of the study reveal a significant and rapid expansion of dragon fruit cultivation across India. Nationally, area under cultivation increased from 5.30 thousand ha in 2022–23 to 14.51 thousand ha in 2023–24, while production rose from 21.22 thousand MT to 53.72 thousand MT, reflecting a 153% increase. Regional analysis shows that Southern India contributed over 75% of total production in 2023–24, mainly due to extensive plantation development in Andhra Pradesh.

Productivity assessment highlights large variations across states. Telangana, Nagaland, Odisha, and West Bengal displayed notably high yields, whereas Mizoram and parts of Andhra Pradesh showed low productivity despite large cultivated areas. These differences indicate uneven agronomic adoption, orchard age disparities, and varying levels of management efficiency.

Overall, the results confirm that while India is rapidly expanding in dragon fruit cultivation, productivity and agronomic consistency remain critical challenges, requiring targeted interventions for sustained growth.

## CONCLUSIONS AND RECOMMENDATIONS

The present study demonstrates that dragon fruit (Kamalam) cultivation in India has entered a phase of rapid expansion, supported by substantial increases in both cultivated area and production between 2022–23 and 2023–24. The findings reveal that while the national area under cultivation nearly tripled, production more than doubled, indicating strong farmer interest, favourable market conditions, and growing institutional promotion. However, the analysis also uncovers significant regional disparities. Southern India, particularly Andhra Pradesh, continues to dominate national output due to extensive acreage, whereas states like Telangana and West Bengal exhibit much higher productivity levels, suggesting more intensive and efficient cultivation practices.

At the same time, large-area states in the North-East such as Mizoram demonstrate extremely low yields, highlighting the need for improved agronomic practices, technical training, and better resource management. These contrasts underscore the central conclusion that expansion alone cannot drive sustainable growth – productivity enhancement must accompany area increase.

The overall results align with prior literature emphasizing the importance of soil improvement, nutrient management, high-density planting, and drip fertigation. Going forward, region-specific interventions, robust extension programs, and standardized cultivation protocols will be essential to unlocking the full potential of dragon fruit farming in India. The study provides a strong empirical foundation for future policy formulation and targeted agronomic development.

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