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Exploring the dynamics of dragon fruit production and its constraints in southern states of India

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Abstract

Dragon fruit, or pitaya, has become famous owing to its unique look, health advantages, and resilience to diverse climates, rendering it especially appropriate for Southern India. This study investigates the economic feasibility and production challenges of dragon fruit farming in Andhra Pradesh, Karnataka, and Tamil Nadu in 2024. Financial assessments using Net Present Value (NPV), Benefit-Cost Ratio (BCR), and Internal Rate of Return (IRR) indicate that dragon fruit farming is profitable in these states, with Andhra Pradesh and Karnataka showing better financial outcomes compared to Tamil Nadu. Garrett's Ranking Technique was employed to identify and rank the production and marketing constraints. Key production challenges in Tamil Nadu and Andhra Pradesh include the high cost of installation materials and insufficient technical support, while Karnataka primarily faces a shortage of skilled labor. On the marketing front, the absence of adequate cold storage facilities and high transportation costs pose significant hurdles across all states. The findings highlight the need for targeted solutions, such as improving access to affordable installation materials, upgrading cold-storage infrastructure, and implementing training programs for farmers. Addressing these challenges can enhance the profitability and sustainability of the dragon fruit industry in Southern India.

Keywords

cost of production; dragon fruit; financial feasibility; production and marketing of dragon fruits

Introduction

Dragon fruit, also known as pitaya, has gained popularity due to its distinctive appearance, nutritional value, and adaptability to various climatic conditions. This exotic fruit, characterised by its vibrant skin and speckled flesh, has carved out a promising niche in the agricultural landscape of Southern India, particularly in Andhra Pradesh, Karnataka, and Tamil Nadu. The production of dragon fruit in India has experienced substantial growth, with certain locations expanding at an annual pace over 30%, propelled by robust market demand and a rising consumer preference for nutritionally rich exotic fruits. Despite its growing popularity, the production and marketing of dragon fruit in these regions face numerous challenges that affect its economic viability and scalability (1).

The dragon fruit market has been expanding globally, with Asia serving as the largest producer and consumer. In India, the fruit has seen a rise in cultivation due to its high market value and increasing consumer interest in health-conscious foods. The favorable climate and soil conditions in Southern India have catalysed a notable increase in dragon fruit farming. For instance, in Andhra Pradesh, the area under dragon fruit cultivation has expanded considerably, driven by the crop's adaptability to local climatic conditions, profitability, and rising market demand. Similar trends are evident in Karnataka and Tamil Nadu (2).

Nonetheless, various obstacles hinder fully actualizing the fruit's economic potential. Key production challenges include obtaining quality planting materials, managing pests and diseases, and adopting advanced cultivation techniques. Many farmers in these states lack adequate knowledge and training, adversely affecting yield and fruit quality. The lack of organized market infrastructure, price volatility, and limited consumer awareness present significant hurdles on the marketing front. Additionally, inadequate post-harvest handling practices result in substantial losses, further impeding profitability.

A study was conducted among dragon fruit producers in Pohuto Jaya village, South Konawe District, Southeast Sulawesi province, with 30 participants (3). Data were obtained via questionnaire-based interviews and in-depth discussions with agricultural extension officers. Using cost and returns analysis and descriptive statistics, the study found that dragon fruit farming is profitable, yielding high net returns. The farmers identified several benefits of dragon fruit cultivation, such as ease of cultivation, quick flowering, year-round harvesting, low risk of crop failure, and favorable market prices. These farmers' primary sources of information were fellow farmers, followed by social media. However, only 23.3 percent of the farmers rated their skills in dragon fruit cultivation as good, highlighting the need for enhanced knowledge and skill development through capacity-building methods (3).

This article explores the complexities of dragon fruit production in Andhra Pradesh, Karnataka, and Tamil Nadu, analyzing the economic prospects and challenges hindering its growth. The article also provides a comprehensive overview of the current situation and potential solutions by examining production methods, market conditions, and strategic interventions. This article aims to highlight opportunities for production, identify constraints, and propose implementable strategies for stakeholders to enhance the resilience and sustainability of the dragon fruit agro-business in Southern India.

Materials and Methods

This study investigated the economic viability and production challenges of dragon fruit farming in Andhra Pradesh, Karnataka, and Tamil Nadu. Key financial performance indicators, including NPV, BCR, and IRR, were employed to evaluate the profitability and long-term sustainability of dragon fruit farming in these regions.

Additionally, Garrett's Ranking Method was applied to identify and rank farmers' production and marketing constraints systematically. Data were collected through structured surveys and interviews with farmers, agricultural experts, and market stakeholders across the three states. This ensured a thorough and detailed analysis of the challenges and opportunities within the dragon fruit industry in Southern India.

Net present value

Net Present Value is the present value of net benefits, computed by deducting the total discounted costs from the total discounted returns. A positive NPV indicates the viability and worthiness of investing in a dragon fruit orchard. Essentially, it reflects the net present worth of the cash flow over time.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

.....Eqn (1)

Where, B_t: Benefits realized in rupees in t^{th} year, C_t: Costs incurred in rupees in t^{th} year, n: Number of years and r: Discount rate. (12%)

Benefit cost ratio

The BCR is another indicator used to evaluate the feasibility of an investment. It is the ratio of the sum of discounted net benefits to the sum of discounted capital costs. It is expressed as follows:

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+r)^t}}$$

.....Eqn (2)

Where, B_t: Discounted Benefits realized in rupees per ha per annum. C_t: Discounted Costs incurred in rupees per ha per annum, n: Number of years of investment and r: Discount rate (12%)

Internal rate of return

Internal Rate of Return is the discount rate that equates the net present worth of cash flow equal to zero. An investment is considered viable if the calculated IRR exceeds the bank interest rate, which represents the opportunity cost of capital.

$$IRR = r_a + \frac{NPV_a}{NPV_a - NPV_b}(r_b - r_a)$$

.....Eqn (3)

Where, r_a: lower discount rate, r_b: higher discount rate, N_a: NPV at r_a and N_b: NPV at r_b. Acceptable criterion: The IRR estimated is compared with the rate of return known as the cut-off or hurdle rate. The investment made is considered worthy if the IRR exceeds the bank rate.

Garrett's ranking technique

Proposed by Garrett (1965), this technique is used to convert ranks assigned by respondents into scores, allowing for the prioritization of factors or constraints. In this study,

Garrett's ranking technique was employed to rank the production, processing, and marketing challenges.

$$\text{Percentage Position} = 100*(R_{ij}-0.5)/N_j \quad \text{.....Eqn (4)}$$

Where, R_{ij}= Rank given for it factor by j^{th} individual, N_j= Number of factors ranked by j^{th} individual

Procedure

- The ranks assigned by respondents were converted into percentage positions using the formula.
- The corresponding scores for the percentage positions were obtained from Garrett's table.
- For each factor, the scores from all respondents were summed, and the mean value was calculated.
- The factors were arranged in descending order of their mean scores.
- The factor with the highest mean score was assigned the highest rank, indicating its importance.

This method enables the systematic identification and prioritization of key issues based on respondent feedback.

Results and Discussion

This study provides a detailed evaluation of the economic feasibility and operational challenges associated with dragon fruit cultivation in Tamil Nadu, Andhra Pradesh, and Karnataka. The analysis considered key financial indicators such as NPV, IRR, and BCR while addressing production and marketing constraints using Garrett's ranking methodology.

Financial feasibility of dragon fruit production

Table 1 presents the financial analysis of dragon fruit production across three states: Tamil Nadu, Andhra Pradesh, and Karnataka. The analysis includes cash flows over six periods, the NPV, and the IRR for each state, providing key insights into this agricultural venture's economic viability and profitability.

Initial investment costs

The initial financial outlay for dragon fruit production is significant in all three states, reflecting the highest start-up cost. Tamil Nadu requires an investment of ₹962,555.09, Andhra Pradesh ₹1,084,852.43, and Karnataka ₹817,301.35.

Cash flows over time

Positive cash flows are observed in each state from the first year through the sixth, demonstrating substantial revenue generation over the operational periods. In Year 1, cash outflow amounted to ₹9.63 lakhs in Tamil Nadu, ₹10.85 lakhs in Andhra Pradesh, and ₹8.17 lakhs in Karnataka. By Year 7, cash inflows had increased to ₹4.55 lakhs in Tamil Nadu, ₹6.36 lakhs in Andhra Pradesh, and ₹5.06 lakhs in Karnataka. The NPV for these states was ₹1.84 lakhs, ₹5.06 lakhs, and ₹4.48 lakhs, respectively, with corresponding IRRs of 17%, 23%, and 25%.

Present values

The present values (PVs) of cash flows, calculated using a 12% discount rate, account for the time value of money by employing a 12% discount rate. This analysis aims to deliver a conservative projection of future cash flows that incorporate considerations of risk, inflation, and financing expenses. In Tamil Nadu, the PVs range from -₹962,555.09 in the first year to ₹230,303.68 by year 7. Andhra Pradesh shows PVs increasing from -₹1,084,852.43 in year 1 to ₹322,069.32 by year 7. Karnataka's PVs start at -₹817,301.35 and rise to ₹256,119.09 in year 7. These PVs illustrate the time-adjusted financial benefits of the investment.

Net present value

Net Present Values, which measure the profitability of the investment after accounting for the time value of money, are positive across all three states. Tamil Nadu's NPV is ₹183,504.65, Andhra Pradesh ₹506,326.45, and Karnataka ₹448,140.04. Andhra Pradesh's higher NPV indicates the best financial returns, followed by Karnataka and Tamil Nadu.

Internal rate of return

The IRR, represents the discount rate at which the NPV of cash flows equals zero. IRR to produce dragon Fruit was estimated to be 17% in Tamil Nadu, 23% in Andhra Pradesh, and 25% in Karnataka. Higher IRR values indicate

Table 1. Financial feasibility of dragon fruit production of Tamil Nadu, Andhra Pradesh, and Karnataka.

Year	TN	TN_PV	AP	AP_PV	KA	KA_PV
1	-962555.09	-962555.09	-1084852.43	-962555.09	-817301.35	-817301.35
2	-31701.89	-28305.26	-41562.82	-25272.55	-32707.10	-29202.77
3	220098.73	175461.36	295068.42	139876.72	234136.04	186651.82
4	410899.45	292470.12	567046.10	208174.45	449190.50	319724.93
5	387164.87	246050.28	541669.65	156369.40	430561.66	273629.72
6	405478.82	230079.57	569482.06	130553.33	455598.12	258518.61
7	454578.64	230303.68	635707.72	116679.01	505533.68	256119.09
NPV		183504.65		506326.45		448140.04
IRR		17%		23%		25%

TN- Tamil Nadu, **TN_PV**- Tamil Nadu Present Value, **AP**- Andhra Pradesh, **AP_PV**- Andhra Pradesh Present Value, **KA**- Karnataka, **KA_PV**- Karnataka Present Value, **NPV**- Net Present Value, **IRR**- Internal Rate of Return..

a more profitable investment, making Karnataka the most attractive option, followed by Andhra Pradesh and Tamil Nadu.

The financial analysis indicates that dragon fruit production is economically viable and profitable in Tamil Nadu, Andhra Pradesh, and Karnataka. However, Andhra Pradesh and Karnataka provide higher financial returns than Tamil Nadu, as evidenced by their substantial NPVs and high IRRs. These metrics suggest that Andhra Pradesh and Karnataka are particularly favorable locations for dragon fruit cultivation, making them compelling choices for investors and farmers considering this agricultural venture, as shown in Fig. 1.

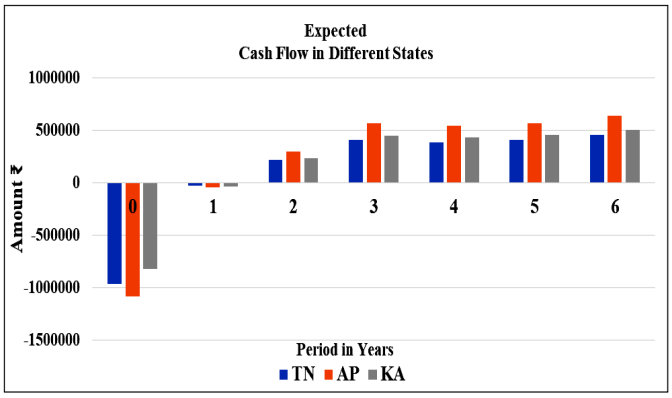

Fig. 1. Results of NPV of Tamil Nadu, Andhra Pradesh, and Karnataka.

Benefit cost ratio

Table 2 provides a financial evaluation of dragon fruit production across Tamil Nadu, Andhra Pradesh, and Karnataka over seven periods. It highlights total costs, total revenues, and their PVs to assess these scenarios' financial performance and efficiency.

Total costs and revenues are reported for each scenario across all periods. In the initial period (year 1), costs and revenues were relatively low but increased significantly, reaching their peak by year 6. To facilitate comparison across periods while accounting for the time value of money, the PVs of total costs (PV_TC) and total revenues (PV_TR) are computed. This approach adjusts future costs and revenues to their current value, facilitating a more accurate financial evaluation.

The BCR is a key indicator of financial viability. Benefit-cost ratio values exceeding 1 across all scenarios confirm that each project generates more revenue than its associated cost, demonstrating profitability even after discounting. The BCR values for Tamil Nadu are 1.09, for Andhra Pradesh, 1.19, and for Karnataka, 1.22.

Overall, the analysis demonstrates that all scenarios are financially feasible, with Karnataka exhibiting maximum efficiency and profitability, as indicated by its superior BCR values. This indicates that the rise in costs and revenues over time is effectively offset by the value generated, confirming the positive financial outcomes of these projects.

Various studies have assessed the economic feasibility of agricultural ventures by evaluating their costs and returns. For instance, In India, moringa plantations require significant initial investments, particularly for plant protection. Despite these costs, the high yields, positive NPVs, BCRs, and Internal Rates of Return (IRRs) confirm moringa cultivation's financial viability (4). Similarly, orchid farming in India has demonstrated increasing returns over time. Although the setup costs are substantial and favorable financial indicators, such as NPV, BCR, and IRR, confirmed the economic viability of orchid farming (5).

In contrast, research conducted in Indonesia on organic dragon fruit farming revealed significant social and economic benefits, with an annual Total Economic Value (TEV) of ₹. 3,736,890,099.95 per hectare. The study revealed an NPV of ₹. 28,303,945,382.50, an impressive BCR of 56.77, and a TEV of ₹. 3,671,069,440.01 per hectare per year, underscoring the significant economic advantages of this farming method (6). These studies emphasize the varying economic outcomes and highlight the importance of region-specific strategies for optimizing agricultural investments.

Table 2. Profitability of dragon fruit production in Tamil Nadu, Andhra Pradesh and Karnataka.

Period	TN		AP		KA	
	PV_TC	PV_TR	PV_TC	PV_TR	PV_TC	PV_TR
0	962555.09	0.00	1084852.43	0.00	817301.35	0.00
1	163654.29	135349.03	226218.12	189108.46	179455.53	150252.76
2	190863.72	366325.08	263829.53	499056.26	209292.10	395943.92
3	177605.74	470075.85	245503.11	649115.32	194754.02	514478.95
4	210370.14	456420.42	290793.11	635033.96	230681.92	504311.63
5	191718.47	421798.04	265011.04	588150.45	210229.38	468747.99
6	174357.56	404661.25	241013.18	563082.49	191192.23	447311.32
Total	2071125.01	2254629.67	2617220.50	3123546.95	2032906.53	2481046.57
BCR	1.09		1.19		1.22	

TN-Tamil Nadu, **AP**- Andhra Pradesh, **KA**- Karnataka, **PV_TC**- Present Value of Total Cost, **PV_TR**- Present Value of Total Returns, **BCR**- Benefit Cost Ratio.

Garrett ranking

Production constraints: Table 3 identifies and ranks the production challenges dragon fruit farmers face in Tamil Nadu, Andhra Pradesh, and Karnataka using Garrett Scores. The analysis highlights notable regional differences in the primary constraints.

Table 3. Production constraints faced by dragon fruit growers.

Production Constraints	Tamil Nadu		Andhra Pradesh		Karnataka	
	Garrett Score	Rank	Garrett Score	Rank	Garrett Score	Rank
High cost of Installation material (IM)	73.41	I	71.85	I	32.06	V
Durability of IM	34.09	V	32.88	V	64.00	II
Lack of Skilled labor	47.00	IV	47.71	IV	72.62	I
High cost of Fertilizers	49.95	III	50.44	III	48.09	IV
Lack of Planting Material	29.77	VI	30.53	VI	55.03	III
Lack of Continued Technical guidance by the field functionaries	65.77	II	66.59	II	28.21	VI

In Tamil Nadu, the most significant challenge is the high cost of installation materials, which ranks as the top constraints with a Garrett Score of 73.41. This is followed by a lack of continued technical guidance (65.77) and the high cost of fertilizers (49.95). Issues such as the lack of skilled labor (47.00) and durability of installation material (34.09) are of lesser concern, while the lack of planting material is the least significant issue, with a score of 29.77.

In Andhra Pradesh, the high cost of installation materials rank as the top constraint, scoring 71.85. This is followed by a lack of continued technical guidance (66.59) and a high cost of fertilizers (50.44). The lack of skilled labor (47.71) and durability of installation material (32.88) are of lesser concern, while the lack of planting material ranked lowest with a score of 30.53.

In Karnataka, the primary constraint here is the lack of skilled labor, scoring the highest at 72.62. This is followed by the durability of installation material (64.00) and lack of planting material (55.03). The high cost of fertilizers (48.09) and high cost of installation material (32.06), while lack of technical guidance ranks the lowest at 28.21.

Marketing constraints: In Tamil Nadu, the most significant marketing constraint is the lack of suitable cold storage facilities, with a Garrett Score of 64.59. This is followed by the high cost of transportation (61.59) and lack of suitable packaging material (60.09). Price fluctuations (52.91) and the unorganized marketing system (31.27) are ranked lower, while heavy market losses are the least pressing issue with a score of 29.55.

Similarly in Andhra Pradesh, the lack of suitable cold-storage facilities ranks highest (65.44), followed by the lack of suitable packaging material (61.18) and high cost of transportation (60.24). Price fluctuations (52.35) and the unorganized marketing system (30.41) are lesser concerns, while heavy market losses rank the lowest with a score of 30.38.

Similarly in Karnataka, the high cost of transportation is the most significant issue, with a score of 72.62, followed by a lack of suitable cold-storage facilities (64.00). Price fluctuations (55.03) and lack of suitable packaging material (32.06) are significant issues, while the unorganized marketing system (48.09) and heavy market losses (28.21) are lower ranked.

As shown in Table 4, the most significant production and marketing constraints in Tamil Nadu and Andhra Pradesh are the high cost of installation materials and the lack of suitable cold storage facilities. The primary challenges in Karnataka are a lack of skilled labor and elevated transportation costs. These findings emphasize the necessity for region-specific interventions, such as improving access to affordable installation materials, expanding cold -storage infrastructure, and introducing training programs to cultivate skilled labor in dragon fruit farming.

Utilizing Garrett's ranking technique explored various agricultural constraints across different contexts. An investigation has identified high input costs as the primary production challenge for papaya farmers, with marketing issues stemming from distant markets and a lack of regulated fruit markets (7). A study highlighted the challenges fruit and vegetable growers face in meeting export quality standards and inadequate storage and transportation facilities. it was also noted that exporters struggled with poor infrastructure and a lack of standardization in post-harvest handling (8). Additional research applied the Garrett ranking to examine sesame and mustard growers (9). At the same time, another analyzed consumer preferences for fresh fruit imports, identifying health benefits, taste, and family preference as key factors influencing consumption (10). These studies collectively underscore the diverse challenges faced across different agricultural sectors and highlight the importance of addressing specific constraints to improve productivity and market access.

Table 4. Marketing constraints faced by dragon fruit growers.

Marketing Constraints	Tamil Nadu		Andhra Pradesh		Karnataka	
	Garrett Score	Rank	Garrett Score	Rank	Garrett Score	Rank
Lack of suitable packaging material	60.09	III	61.18	II	32.06	V
Lack of suitable cold-storage facilities	64.59	I	65.44	I	64	II
High cost of Transportation	61.59	II	60.24	III	72.62	I
Unorganized Marketing system	31.27	V	30.41	V	48.09	IV
Too much fluctuation in prices	52.91	IV	52.35	IV	55.03	III
Heavy losses in the market	29.55	VI	30.38	VI	28.21	VI

Conclusion

Dragon fruit farming in Southern India shows strong financial potential, particularly in Andhra Pradesh and Karnataka, which offers higher returns than Tamil Nadu. However, the industry faces substantial constraints that hinder its growth. Key production issues such as the high cost of installation materials, and shortage of skilled labor, while marketing obstacles such as inadequate cold storage facilities and high transportation costs further complicate the situation. To overcome these barriers, targeted interventions are essential. The emphasis should be on enhancing the affordability of installation supplies, upgrading cold storage facilities, and offering training programs to cultivate a professional workforce. By tackling these issues, the industry can achieve higher profitability and long-term sustainability, paving the way for scalability. Future research could examine the impact of these interventions on production efficiency, market growth, and overall industry competitiveness. Additionally, it could explore the role of government policies in fostering the sector's growth and sustainability in both domestic and international markets.

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Authors' contributions

All authors have participated in the data collection and analysis of the study and its design and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

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During the preparation of this work, the authors used Quill Bot to improve language and readability, with caution. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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