PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol x(x): xx–xx
https://doi.org/10.14719/pst.5825

HORIZON
e-Publishing Group
HePG

RESEARCH ARTICLE

Supply chain and market dynamics of GI Kodaikanal Malai Poondu: A socio-economic and medicinal perspective

K Praveena[1], A Malaisamy[1]*, Raswanthkrishna M[2], Balasubramanian M[3] & Pramod Kumar[3]

[1]Department of Agricultural Economics, Agricultural College and Research Institute, Madurai 625 104, India

[2]Department of Computer Science and Engineering, Amrita University, Coimbatore 641 112, India

[3]Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi 110 012, India

*Email:malaisamy@tnau.ac.in

OPEN ACCESS

ARTICLE HISTORY
Received: 15 October 2024
Accepted: 29 December 2024
Available online
Version 1.0 : 05 March 2025

Check for updates

Additional information
Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE
Praveena K, Malaisamy A, Raswanthkrishna M, Balasubramanian M , Kumar P. Supply chain and market dynamics of GI Kodaikanal Malai Poondu: A socio-economic and medicinal perspective. Plant Science Today (Early Access).
https:/doi.org/10.14719/pst.5825

Abstract

Kodaikanal Malai Poondu, a traditional garlic variety with deep historical roots in Tamil Nadu, is closely associated with the 3000-year-old Kuzhanthai Velappar Temple in Poombarai and was recognized by King Kulashekhara Pandyan as part of the "Vellaipoodu Kandam." This rare garlic variety is also renowned for its medicinal properties, such as boosting immunity, reducing hypertension and enhancing digestion. This study investigates the supply chain management of Kodaikanal Malai Poondu, focusing on the socio-economic status of farmers, market dynamics and key marketing practices, including handling, packaging, costs, margins and price spreads. The Udai Pareek scale assessment revealed that the socio-economic status of farmers is moderate. The compound growth rates for area, production and productivity were 4.77%, 5.07% and 0.34%, respectively, with statistical significance at the 1% level for area and production and 5% for productivity. Marketing efficiency was highest in channel II (efficiency index 4.86) in Dindigul and lowest in channel I (index 2.80) in Madurai. This study underscores the importance of targeted interventions to enhance productivity, stabilize production areas, improve supply chain efficiency and leverage the medicinal benefits of this historically significant garlic variety, ensuring its sustainability and economic viability.

Keywords

constraints; market efficiency; medicinal properties; price spread; socio-economic status

Introduction

Kodaikanal, a picturesque hill station in Tamil Nadu, is renowned for its prized hill garlic, locally known as "Malai Poondu" (Fig. 1). This unique variety is celebrated for its intense flavor, long shelf life and medicinal properties, including its use in traditional remedies for digestion and immunity (1). This traditional garlic, scientifically named *Allium sativum*, has earned the prestigious Geographical Indication (GI) tag, recognizing its distinctive qualities that are intrinsically linked to the Kodaikanal Hills in the Dindigul district, Tamil Nadu, India. Kodaikanal's cool climate, characterized by temperatures ranging between 11 to 20°C, provides the ideal conditions for cultivating this highly valued garlic, known for its potent flavor and medicinal properties (2).

The GI tag, a globally recognized certification, plays a crucial role in preserving traditional agricultural products and promoting sustainability. GI tags not only safeguard the cultural heritage and authenticity of such

Fig. 1. Kodaikanal Malai Poondu.

products but also contribute to economic development by enhancing market access and ensuring fair returns for producers. They act as a tool for rural development by incentivizing sustainable agricultural practices tailored to specific geographic conditions. In the context of Kodaikanal Malai Poondu, the GI tag ensures that the traditional knowledge and unique cultivation practices associated with this garlic variety are preserved while also offering economic benefits to the farmers.

The traditional variety of Malai Poondu holds deep cultural and economic significance in the region. The garlic's deep-rooted connection to the Kodaikanal region is closely linked to the three-thousand-year-old Kuzhanthai Velappar Temple in Poombarai, further solidifying its cultural importance. Historical records from King Kulashekhara Pandyan mention the surrounding territories, collectively known as the Vellaipoodu Kandam (garlic continent), highlighting the long-standing tradition of garlic cultivation in this region, as documented by the GI registry (3). The Kodaikanal garlic market has existed for over 150 years, underscoring its historical and economic relevance.

The farmers aim to protect the authenticity and quality of Kodaikanal Malai Poondu, which faces numerous challenges. These include high and fluctuating product prices, inadequate infrastructure and inefficiencies in marketing channels, all of which contribute to farmers receiving a smaller share of the consumer's expenditure (4). According to research, consumer spending on perishable crops is relatively smaller than the producers' share (5). Kodaikanal Malai Poondu has unique characteristics such as pungency, medicinal properties, smaller bulb size, intense flavor and adaptability to the high-altitude climate of the Western Ghats. Garlic has greater health benefits due to its higher levels of organosulfur compounds, phenols and flavonoids compared to other garlic varieties, giving it antioxidant and antimicrobial properties (6).

Understanding the supply chain dynamics of the traditional variety of Kodaikanal Malai Poondu is essential for enhancing marketing efficiency and improving the socio-economic status of the farmers. A supply chain encompasses all activities needed to convert raw materials into final products (7). This includes sourcing, component manufacturing, final assembly and distribution to end-markets. It also covers material handling and storage (in short, logistics) activities (8). Marketing channels are the final part of the supply chain, but they also drive the inputs needed to deliver customer value (9). This study explores various aspects of the supply chain, including production, distribution and the socio-economic status of the farmers. It also examines key factors influencing marketing efficiency and the challenges that must be addressed to ensure the sustainability and prosperity of this prized agricultural product.

Kodaikanal Malai Poondu is renowned for its medicinal potency and is considered up to ten times more effective than other Indian garlic varieties (10). The exceptional medicinal properties of Malai Poondu, such as its antioxidant and antimicrobial benefits derived from high levels of organosulfur compounds, phenols and flavonoids, greatly enhance its market potential. These attributes cater to the growing demand for natural health products and functional foods, positioning it as a premium commodity in domestic and international markets (11). Grown in the cool climate of Kodaikanal (11°C to 20°C), it thrives in conditions that challenge other garlic types, benefiting from the region's unique climate and soil. Its extended storage life, lasting 8 to 11 months, sets it apart from other varieties. It is integral to local healthcare and treats ailments like headaches, digestive issues and respiratory problems (12). Traditional preparations include "Poondu Rasam" and "Poondu Laegiyum," which are used for post-delivery healing, appetite stimulation and weight management. This garlic plays a vital role in local health practices (13). This study aims to evaluate the supply chain management of Kodaikanal Malai Poondu, focusing on production, distribution and marketing efficiency. The study examines the socio-economic status of farmers and identifies challenges in marketing practices. The research highlights the medicinal properties of Kodaikanal Malai Poondu to enhance its market potential and sustainability.

Materials and Methods

The study was conducted in the Kodaikanal region of Dindigul district in 2023, focusing on five purposively selected blocks due to their prominence in cultivating Kodaikanal Malai Poondu (Fig. 2). The study employed a random sampling method to select 60 farmers from 25 villages across five blocks (Manavanoor, Poombarai, Poondi, Kavinji and Kilavarai), which are prominent in Kodaikanal Malai Poondu cultivation. A list of farmers actively engaged in garlic farming within each village was obtained from local agricultural offices and farmer associations. The sample size from each village was proportional to the total number of garlic farmers in that

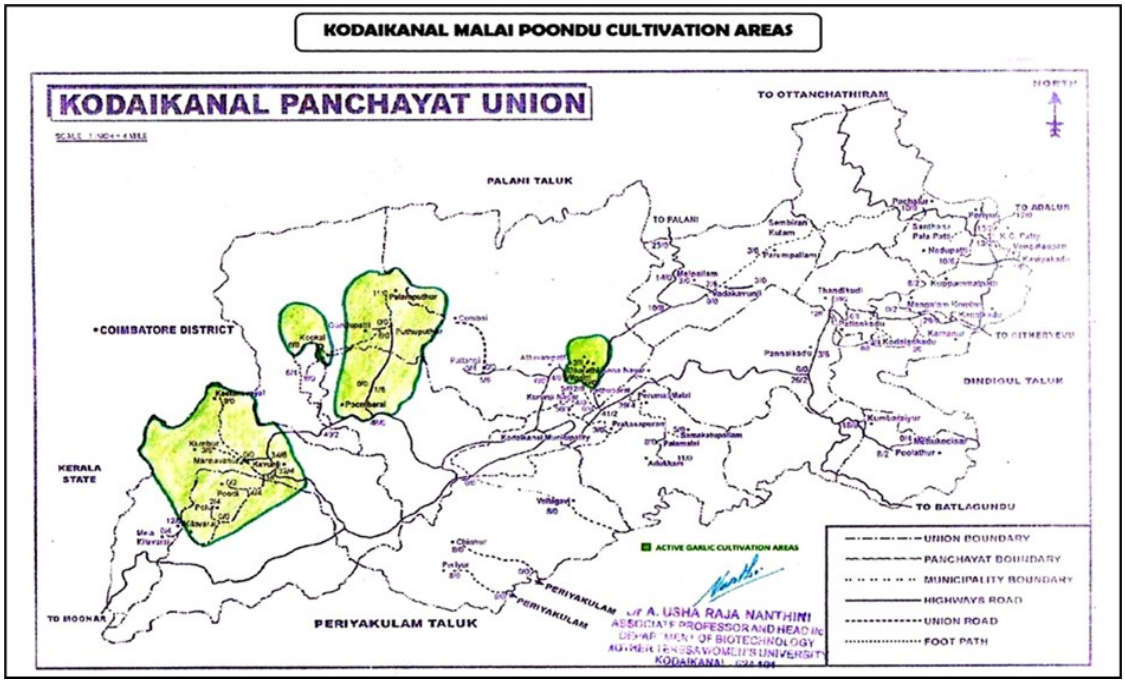

Fig. 2. Kodaikanal Malai Poondu cultivation area.

village, allowing equitable distribution across all selected areas. This approach ensured a comprehensive and representative dataset for analyzing socio-economic status, supply chain management and farming challenges. Primary data were collected through personal interviews with farmers and intermediaries, while secondary data such as area, production and productivity were sourced from the Dindigul statistics office. Descriptive statistics and efficiency indices were used to analyze the data.

Conventional analysis

Simple averages and percentages were calculated to examine the rationale behind cultivating a traditional variety, the source of input purchases and the selection of a particular store. They were also used to analyze farm-level grading practices and standards, packaging materials, modes of transportation, market preferences, marketing expenses and any challenges faced. Data were gathered from dealers about the motivations behind buying from specific farms, including quality standards such as size, pungency and freshness of the produce, as well as pricing considerations. The facilities offered, such as storage, transportation and packaging support, were also examined, along with any issues encountered during transactions.

Udai Pareek's method

The Udai Pareek scale is a well-accepted measure of socio-economic status (SES) that includes nine domains, i.e., caste, occupation, house, land, education, social participation, farm power, material possessions and family members (14). After collecting the necessary information and scoring each item, the total score is summed and interpreted in terms of the class. Each domain has different scores, which are shown in (Table 1).

Each domain is assigned a score and by summing the scores of all the domains, the SES can be determined and categorized into several classes, as shown in (Table 2).

Table 1. Nine domains with scores

Components	Score	Components	Score	Components	Score
Caste		**Education**		**House**	
Scheduled caste	1	Illiterate	0	No house	0
Lower caste	2	Can read-only	1	Hut	1
Artisan caste	3	Can read and write	2	Kutcha house	2
Agriculture caste	4	Primary	3	Mixed house	3
Prestige class	5	Middle	4	Pucca house	4
Dominant class	6	High school	5	Mansion	5
Occupation		Graduate and above	6	**Family member**	
None	0	**Land**		Up to 5	2
Laborer	1	No land	0	>5	1
Caste occupation	2	<1 acre	1	**Farm power**	
Business	3	1-5 acre	2	No draft animals	1
Independent profession	4	5-10 acre	3	1-2 draft animals	2
Cultivation	5	10-15 acre	4	3-4 draft animals	4
Service	6	15-20 acre	5	5-6 draft animals	6
>20 acre	6	**Material possessions**			
Social participation		Bullock cart	0		
None	0	Cycle	1		
Member of one organization	1	Radio	2		
Member in more organization	2	Chairs	3		
Officeholder	3	Mobile phone	4		
Wide public leader	4	Television	5		
		Refrigerators	6		

Table 2. Udai Pareek scale

Socio-economic status	Total scale
Upper class	>43
Upper middle scale	33-42
Middle scale	24-32
Lower middle scale	13-23
Lower class	<13

The compound growth rates (CGR)

The exponential growth function is suitable for analyzing the growth rate in area, production and productivity of Kodaikanal Malai Poondu because it effectively captures trends over time, accounting for compounding changes. This method provides a precise estimate of the growth rate by modeling the variables as continuously growing phenomena, which is particularly relevant for agricultural data that often exhibit non-linear growth patterns influenced by multiple factors.

$$Y = a$$

Where Y= dependent variable to be estimated (area, production, productivity), a = intercept, b = regression coefficient, t = time variable. The equation will be estimated after transforming as follows:

$$\text{Log } Y = a + b_t$$

Where a = Log A; b = Log B. Then, the percentage compound growth rate was calculated using the relationship (15):

$$\text{CGR} = [(\text{Antilog of b}) - 1] \times 100$$

Statistical significance was evaluated at the 1% ($p<0.01$) and 5% ($p<0.05$) levels, indicating high and moderate significance, respectively, to validate the reliability of observed growth trends.

Price spread

The price spread is defined as the difference between the price paid by consumers and the net price received by the producer for their equivalent produce/products (16). Price spread analysis estimates the share of different market functionaries in the consumer's rupee and this would facilitate the understanding of the relative efficiencies. The price spread was calculated using the following formula (17).

Price spread = Consumer's price - Producer's price

Market efficiency

Marketing efficiency is a complex concept that refers to the degree of market performance. The present study employed the Shepherd method to estimate marketing efficiency for the present study. Efficient marketing refers to the movement of goods from producers to end consumers at the lowest possible cost while ensuring the provision of desired services (18). The economic efficiency of markets was calculated using marketing costs, margins and price spread by employing Shepherd's formula (19).

$$\text{ME} = (V/I) - 1$$

Where:

ME = index of market efficiency, V = value of goods sold, or price paid by the consumer

I = total marketing cost or marketing cost per unit

Garrett's ranking technique

Garrett's ranking technique was employed to prioritize the cultivation and marketing challenges of Kodaikanal Malai Poondu. Farmers ranked challenges such as high cultivation costs, pest incidence and water scarcity. In marketing, major challenges included low prices, exploitation by middleman and poor infrastructure. Scores derived from the assigned ranks systematically identified the most critical problems (20). The selected respondents were asked to rank the factors that limit Kodaikanal Malai Poondu production, as well as the various marketing problems they faced. Respondent rankings were converted into ranks using the following formula separately for both the production and marketing problems.

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

Where:

Rij is the rank assigned to the i^{th} factor (constraint) by j^{th} individual

Nj is the number of factors (constraints) ranked by j^{th} individual

Results and Discussion

Preference for cultivating a particular variety

The preference for cultivating Kodaikanal Malai Poondu among farmers was analyzed and the results are depicted in (Fig. 3). Farmers favored this variety due to its desirable physical attributes, such as its appearance, pungent flavor, superior storability and resistance to pests and diseases. Specifically, 56.6% of farmers preferred the variety for its quality, particularly during the 60-to-90-day growth period. Additionally, 16.7% prioritized its high-yielding characteristics, while 10% valued its pest and disease resistance. Furthermore, 13.4% of farmers preferred the variety for its physical appearance and 3.3% for its pungency. Malai Poondu was preferred over other garlic varieties for its superior storability and greater resistance to pests and diseases.

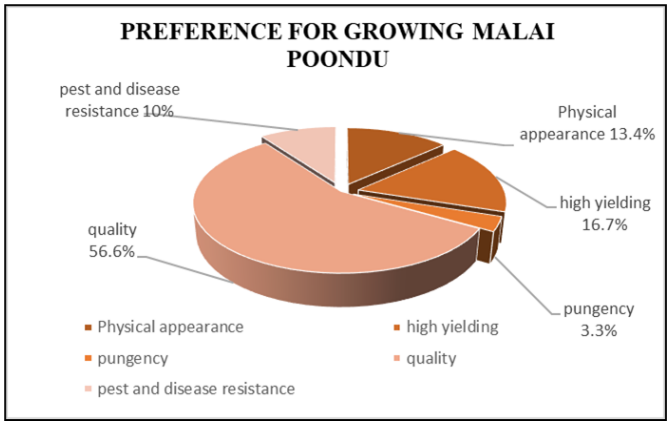

Fig. 3. Farmers preference for growing Malai Poondu.

Source of planting material

The majority of farmers (66.7%) used self-produced bulbs as planting material for next planting season, while 23.3% purchased planting material from private agencies. Farmers typically procure seed material from commission agents on credit and repay after harvesting the crop. Only 10% of farmers opted to purchase planting material from neighbours (Fig. 4). Bulbs are commonly stored in bamboo structures for future planting. However, during periods of high market prices and demand, farmers often sell Malai Poondu immediately and buy plant material from private agencies as needed.

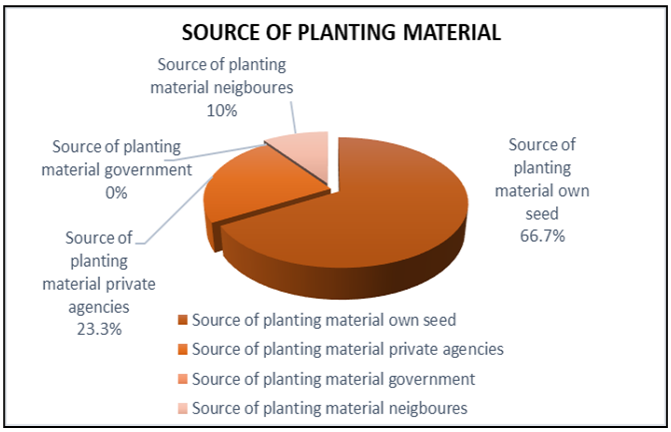

Fig. 4. Source of planting material of Malai Poondu respondent.

Grading practices at the farm level

Farmers commonly practice farm-level grading of Malai Poondu by sorting the bulbs into large, small and very small sizes, which are then stored in separate gunny bags. Proper grading is crucial for obtaining remunerative prices in the market (Fig. 5). Despite this, only 25% of farmers perform proper grading before marketing, due to lack of labours. While the remaining 75% ensure product quality by simply removing decayed bulbs from the fresh ones in the harvested and stored lots before packing them in gunny bags.

Storage of Malai Poondu

The primary factors influencing the storage of Malai Poondu include market price, farmers' economic conditions and government support in the form of storage structure subsidies. Stored Malai Poondu is preferred in the market and commands higher prices compared to fresh produce. Farmers typically store Malai Poondu in bamboo structures (locally known as *Pattarai*) or in houses with concrete walls and bricks. While these traditional methods are cost-effective and utilize locally available materials, they are less effective than modern storage techniques in controlling temperature, humidity and pests critical for preserving quality over extended periods. While 60% of farmers stored their produce for up to 5-6 months before marketing, only 6.6% sold their garlic immediately after harvest and 33.4% stored it for 30-60 days (Fig. 6).

Preference for marketing location

The Farmers from Dindigul, Theni and Madurai preferred selling Malai Poondu in both local and distant markets. Specifically, 33.3% of farmers sold their produce in local markets, while 66.7% preferred distant markets (Fig. 7).

Means of transportation

Farmers used various means of transportation to bring their produce to market (Fig. 8). Tempo vans were the most commonly used mode (76.6%), followed by jeeps (23.4%) and traditional bullock carts, which are primarily used for farm operations.

Socio-economic status

Udai Pareek's method is well-suited for assessing the socio-economic status (SES) of farmers, as it provides a comprehensive framework that considers both economic and social dimensions of rural livelihoods. By evaluating factors such as land ownership, farm power, material possessions and social participation, the method captures the unique socio-economic realities of farming communities, offering a holistic perspective (21). The total SES score for Kodaikanal Malai Poondu farmers was 31.74, placing them within the middle scale (24 - 32 range), indicating an average income level (Table 3). Kodaikanal Malai Poondu farmers predominantly belong to lower and agriculture-related

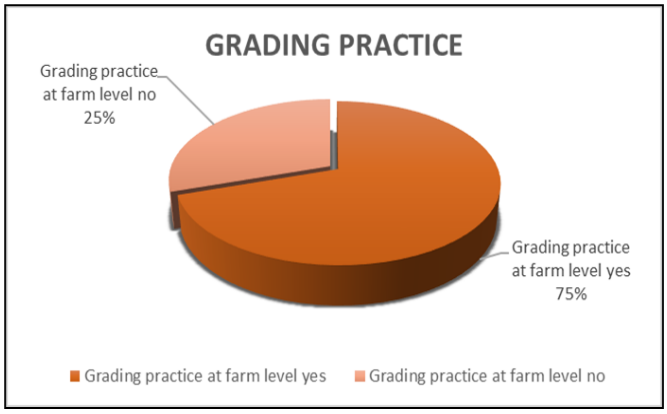

Fig. 5. Grading practices at the farm level.

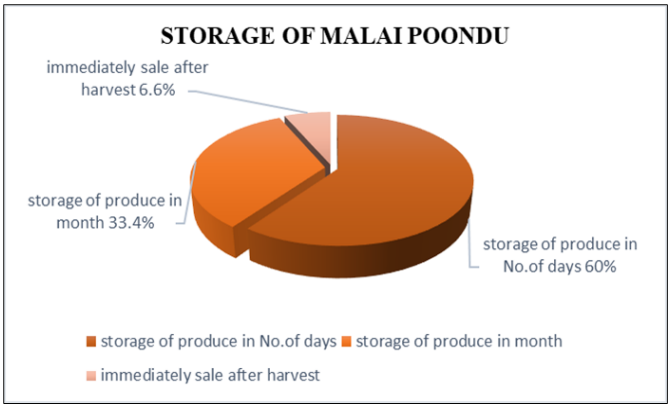

Fig. 6. Duration of storage of the produce before marketing.

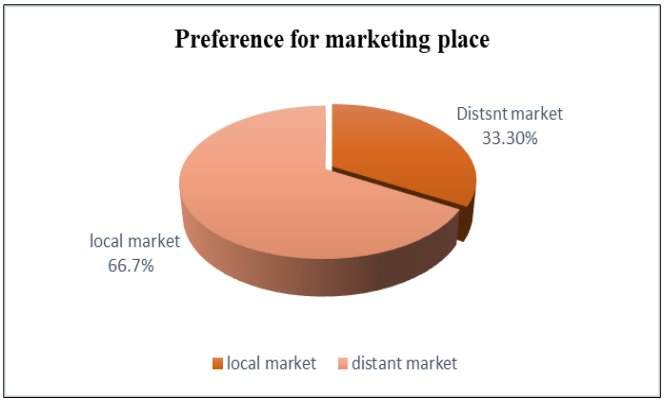

Fig. 7. Preference for marketing place for Malai Poondu.

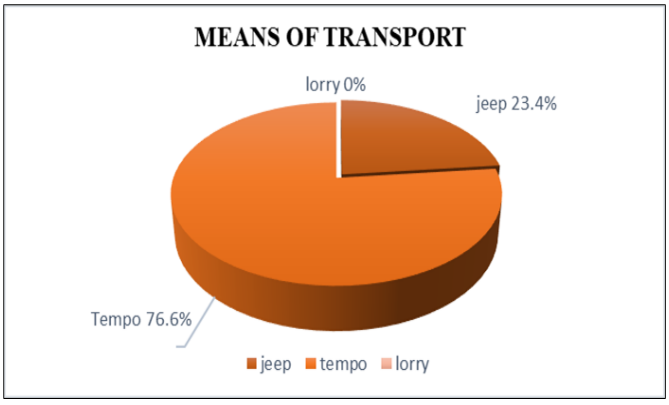

Fig. 8. Means of transport used for Malai Poondu distribution.

Table 3. Nine domains with scores

Components	Score	Components	Score	Components	Score
Caste		**Education**		**House**	
Scheduled caste	1	Illiterate	0	No house	0
Lower caste	2	Can read-only	1	Hut	1
Artisan caste	3	Can read and write	2	Kutcha house	2
Agriculture caste	4	Primary	3	Mixed house	3
Prestige class	5	Middle	4	Pucca house	4
Dominant class	6	High school	5	Mansion	5
Occupation		Graduate and above	6	**Family member**	
None	0	**Land**		Up to 5	2
Laborer	1	No land	0	>5	1
Caste occupation	2	<1 acre	1	**Farm power**	
Business	3	1-5 acre	2	No draft animals	1
Independent profession	4	5-10 acre	3	1-2 draft animals	2
Cultivation	5	10-15 acre	4	3-4 draft animals	4
Service	6	15-20 acre	5	5-6 draft animals	6
>20 acre	6	**Material possessions**			
Social participation		Bullock cart	0		
None	0	Cycle	1		
Member of one organization	1	Radio	2		
Member in more organization	2	Chairs	3		
Office holder	3	Mobile phone	4		
Wide public leader	4	Television	5		
		Refrigerators	6		

castes, which moderately influences their socio-economic status (SES). Their education levels vary, ranging from primary education to high school or higher, with more educated farmers generally achieving a higher SES. Most farmers are engaged in cultivation or related agricultural activities, which contribute positively to their SES, though those in non-agricultural occupations like business or independent professions score higher. Land holding size plays a major role, with larger land owners having higher SES, although most farmers fall within the small to medium categories. Farmers with smaller family sizes tend to score higher due to better per capita resource distribution. Ownership of more draft animals also boosts SES by enhancing agricultural capacity. Possession of modern amenities like mobile phones, televisions and refrigerators positively impacts SES, as does active social participation, particularly for those holding leadership roles in community organizations. This indicates that these farmers, on average, occupy a middle position in terms of socio-economic standing within their community. This is similar to the study on the socio-economic condition of Tharu tribes in the Bahraich district of Uttar Pradesh in India (22).

Compound growth rate

The cultivation analysis of Kodaikanal Malai Poondu from 1999 to 2023 reveals significant trends in area, production and productivity. The average area under cultivation has expanded steadily at a compound annual growth rate (CAGR) of 4.77% per year, with a mean area of 445.94 hectares. Similarly, production has shown substantial growth, averaging 2908.01 tonnes annually, with a CAGR of 5.07% per year, indicating increasing output. However, the productivity growth rate, which measures yield per hectare, has been much slower at 0.34% per year, with an average yield of 6183.66 kg/ha. This slow productivity growth suggests that while the cultivation area and production have expanded, technological or efficiency improvements have not kept pace. The R^2 values for area, production and productivity (0.3569, 0.3511 and 0.2332) indicate moderate to weak fits, suggesting that other factors beyond time may influence these trends (Table 4). These factors could include weather variations, market conditions, changes in input costs, government policies, pest or disease outbreaks and shifts in farmers' cultivation practices. This pattern of expansion in area and production, with limited gains in productivity, aligns with findings from similar research on garlic production in India, which reported similar trends in area and production growth (23).

Table 4. Compound growth rate of Kodaikanal Malai Poondu in Dindigul district

Period	Mean	CAGR	R^2	p-value
Area				
1999-2023	445.9383ha	4.771086*	0.356867	0.002054
Production				
1999-2023	2908.006t	5.0728*	0.351061	0.002891
Productivity				
1999-2023	6183.663kg/ha	0.340287*	0.233207	0.01959

** Significance at 1% probability level; * Significance at 5% probability level.

Price spread and market efficiency

***Price spread*:** In Kodaikanal region, the marketing of the traditional variety of Malai Poondu is structured through various channels, differing by market. In Dindigul district, two predominant channels are utilized, classified as channel I and channel II. In channel I, the product moves from the producer to the commission agent, then to the wholesaler, followed by the retailer and finally reaches the consumer. In contrast, channel II simplifies the process by eliminating the wholesaler, allowing the product to move directly from the producer to the commission agent, then to the retailer and subsequently to the consumer.

Analysis of the price spread of Kodaikanal Malai Poondu in channel I, which follows the route from producer to wholesaler, retailer and finally to consumer (Table 5). In this channel, the farmer receives a significant portion of the final consumer price, with the highest share observed in Dindigul channel (85.7%), followed by Theni (81.3%) and Madurai (80%). However, the net price received by the farmer decreases due to marketing costs (24), which include expenses for transport, commission and loading/unloading. These costs lead to a net price ranging from 76% in Dindigul to 70.8% in Madurai. The wholesaler's costs, including transport, packing and spoilage, are relatively low, but they secure a margin that varies by location, with the highest in Madurai (5.1%) and the lowest in Dindigul (3.6%). The retailer then incurs additional costs, particularly in Madurai, where marketing expenses are substantial (7.1%). Retailer margins also vary, with Theni offering the highest at 10.3%. This results in the final sales price to the consumer being highest in Madurai (₹25,000) and lowest in Dindigul (₹17,500). The price spread, which is the difference between the price received by the farmer and the price paid by the consumer is highest in Madurai (₹5,000) due to higher cos and lowest in Dindigul (₹2,500) (25). This indicates that consumers in Madurai pay a significantly higher price compared to what the farmer receives, largely due to the additional costs and margins added by wholesalers and retailers in this channel.

Table 6 illustrates the price spread of Kodaikanal Malai Poondu in channel II, where the product moves directly from producer to retailer and then to consumer (26). In this channel, the farmer's share of final consumer price is slightly higher than in channel I, particularly in Dindigul, where the farmer receives 88.9% of the consumer price, followed by Theni at 86.8% and Madurai at 83.3%. However, after deducting marketing costs, which include transport, commission and loading/unloading, the net price received by the farmer varies, being highest in Theni (86.8%) and lowest in Dindigul and Madurai.

In this channel, the retailer bears additional costs such as transport, packing, tolls and cleaning, with these costs being highest in Madurai, where the marketing cost reaches 7.8% of the final price. The retailer's margin is also significantly higher in Madurai (18.5%) compared to Dindigul (7.8%) and Theni (9.6%). This results in the final sales price to the consumer being highest in Madurai (₹24,000) and lowest in Dindigul (₹18,000). The price spread is highest in Madurai (₹4,000), indicating a larger markup by the retailer and lowest in Dindigul (₹2,000). This suggests that consumers in Madurai pay more due to higher retailer margins and marketing costs (27), even though the farmer's share remains substantial.

Table 5. Price spread of Kodaikanal Malai Poondu in channel I

Components	Dindigul channel I		Theni channel I		Madurai channel I	
	Cost	Percentage	Cost	Percentage	Cost	Percentage
			Farmer			
Gross price received	**15000**	**85.7**	**19520**	**81.3**	**20000**	**80**
Transport cost	80	0.5	150	0.6	180	0.7
Packing charges	0.0	0.0	0	0	0	0
Loading/unloading	120	0.7	120	0.5	120	0.5
Commission (10%)	1500	8.6	1750	7.3	2000	8
Weighing charges	0.0	0.0	0	0	0	0
Spoilage	0.0	0.0	0	0	0	0
Marketing cost	1700	9.7	2020	8.4	2300	9.2
Net price received	13300	76	17500	72.9	17700	70.8
			Wholesaler			
Transport cost	80	0.5	150	0.6	200	0.8
Packing charges	20	0.1	30	0.1	80	0.3
Loading/unloading	120	0.7	120	0.5	120	0.5
Commission (10%)	0.0	0.0	85	0.4	0	0
Weighing charges	0.0	0.0	0	0	0	0
Spoilage	150	0.9	280	1.2	320	1.3
Marketing cost	370	2.1	665	2.8	720	2.9
Margin	630	3.6	815	3.4	1280	5.1
Sales price	16000	91.4	21000	87.5	22000	88
			Retailer			
Purchase price	16000	91.4	21000	87.5	22000	88
Transport cost	0.0	0.0	150	0.6	220	0.9
Packing charge	120	0.7	0	0.7	0	0
Toll Charges	0.0	0.0	0.0	0.0	400	1.6
Loading/unloading	120	0.7	120	0.5	140	0.6
Cleaning charges	0.0	0.0	85	0.4	120	0.5
Spoilage (2-3 kg/bag)	220	1.3	180	0.75	900	3.6
Marketing cost	500	2.9	535	2.2	1780	7.1
Margin	1000	5.7	2465	10.3	1220	4.9
Sales price	17500	100	24000	100	25000	100
Price paid by the consumer	17500	100	24000	100	25000	100
Price spread	**2500**		**4480**		**5000**	

Table 6. Price spread of Kodaikanal Malai Poondu in channel II

Components	Dindigul channel II		Theni channel II		Madurai channel II	
	Cost	Percentage	Cost	Percentage	Cost	Percentage
Farmer						
Gross price received	16000	88.9	19520	86.8	20000	83.3
Transport cost	80	0.4	150	0.7	180	0.8
Packing charges	0	0	0	0	0	0
Loading/unloading	120	0.7	120	0.5	120	0.5
Commission (10%)	1500	8.3	1750	7.7	2000	8.3
Weighing charges	0	0	0	0	0	0
Spoilage	0	0	0	0	0	0
Marketing cost	1700	9.4	2020	8.97	2300	9.6
Net price received	14300	79.4	17500	86.8	17700	73.8
Retailer						
Purchase price	16000	88.9	19520	86.8	17700	73.8
Transport cost	120	0.7	180	0.8	200	0.8
Packing charge	40	0.2	32.5	0.1	80	0.3
Toll Charges	0.0	0.0	140	0.6	160	0.7
Loading/unloading	120	0.7	85	0.4	400	1.7
Cleaning charges	40	0.2	60	0.26	150	0.6
Spoilage (2-3 kg/bag)	280	1.6	320	1.4	880	3.7
Marketing cost	600	3.3	817.5	3.6	1870	7.8
Margin	1400	7.8	2162.5	9.6	4430	18.5
Sales price	18000	100	22500	100	24000	100
Price paid by the consumer	18000	100	22500	100	24000	100
Price spread	**2000**		**2980**		**4000**	

Market efficiency: The market efficiency analysis of Kodaikanal Malai Poondu across the Dindigul, Theni and Madurai markets reveals that channel II (producer-retailer-consumer) is generally more efficient than channel I (producer-wholesaler-retailer-consumer) (Table 7). In Dindigul, channel II has a higher index of marketing efficiency (IME) of 4.86 compared to 4.17 for channel I, thanks to lower marketing costs and margins. Theni shows similar trends, with channel II achieving an IME of 4.50 versus 3.70 in channel I. Madurai exhibits the lowest efficiency, with channel I at 2.80 and channel II slightly better at 3.42. channel II consistently provides higher price realization, allowing farmers to earn more by selling directly to retailers and avoiding multiple intermediaries. This direct approach reduces costs and improves margins, particularly evident in Dindigul and Theni. Although less pronounced in Madurai, it still results in better price realization than channel I (28). Overall, direct sales in channel II allow farmers to retain a larger share of the market price, leading to improved income.

Constraints faced by Kodaikanal Malai Poondu farmers

In Kodaikanal, Malai Poondu cultivators face several significant production constraints that impact significantly impact their farming practices (29). The most pressing issue is persistently low market prices, highlighting the urgent need for better pricing mechanisms to ensure fair returns for growers (Table 8). Price fluctuation further compound this challenge, creating market instability and unpredictability (30). Limited government support also poses a barrier, indicating that stronger institutional backing could significantly promote the development and sustainability of Kodaikanal Malai Poondu cultivation.

Another major challenge is restricted market access, which limits farmers' ability to achieve profitable outcomes. The absence of proper procurement processes exacerbates these difficulties, making it harder for farmers to efficiently sell their produce. Additionally, labor shortages, pest attacks, rising cultivation costs and high investment requirements further hider productivity and profitbility (31). These constraints significantly hinder the productivity and profitability of Kodaikanal Malai Poondu farming, underscoring the need for targeted interventions to support farmers. The study is limited to the Kodaikanal region, relying on structured interviews, which may introduce biases and limit generalizability. It focuses on a specific timeframe restricts long-term trend analysis and offers limited insights into consumer demand and institutional market dynamics. Addressing these constraints through targeted interventions is crucial to improving the livelihood of Malai Poondu farmers. Farmers face limited market access, poor procurement processes, labor shortages, pest attacks, rising cultivation costs and high investment requirements, all of which hinder productivity and profitability.

Table 7. Market efficiency of three markets

Component	Dindigul market		Theni market		Madurai market	
	Channel I	Channel II	Channel I	Channel II	Channel I	Channel II
Value of goods sold (consumer price)	17500	18000	24000	22500	24000	25000
Total marketing cost	2570	2300	3220	2837.5	4170	4800
Market margin	1630	1400	3280	2162.5	4430	2500
Total marketing cost + Market margin	4200	3700	6500	5000	8600	7300
Index of marketing efficiency	**4.17**	**4.86**	**3.70**	**4.50**	**2.80**	**3.42**

Table 8. Constraints faced by Kodaikanal Malai Poondu farmers

S. No.	Constraints	Mean score	Rank
1.	Low price	74.46	I
2.	Price fluctuations	66.83	II
3.	Lack of support from government	59.26	III
4.	Low yield	55.76	IV
5.	Market availability	52.9	V
6.	Proper procurement	44.16	VI
7.	Nonavailability of labor	41.16	VII
8.	Pest attack	38.76	VIII
9.	High cost of cultivation	32.26	IX
10.	High investment	28.4	X

Conclusion

The supply chain of the traditional Kodaikanal Malai Poondu suffers from inefficient price discovery mechanisms, negatively impacting farmers' livelihoods and market dynamics. Farmers face issues such as inadequate infrastructure, limited access to fair markets and price fluctuations, all of which hinder economic stability. Implementing standardized production practices and establishing a cooperative marketing society can reduce middlemen's influence and high commission fees. Enhancing storage and transportation facilities can prevent distressed sales. The state government supports productivity through subsidies, training and farmer producer organizations (FPOs) while promoting the GI tag and improving infrastructure. Technological advancements, such as precision farming tools, mobile apps for market access and improved storage and processing techniques, combined with tailored financial support and strengthened cooperatives, are crucial for boosting productivity and market efficiency.

Acknowledgements

We express our sincere gratitude to all farmers and community members of Kodaikanal for their valuable insights and we appreciate the funding partner of ICSSR for the successful completion of this work. Our gratitude extends to the agricultural officers and experts who provided critical guidance and feedback. Finally, we are grateful to our colleagues and the research team for their unwavering support and dedication in making this study possible.

Authors' contributions

KP designed the study framework, conducted the economic analysis and drafted the manuscript. AM contributed to the analysis of the results and RM assisted in drafting the manuscript. BM performed the statistical analysis and contributed to refining the methodology. PK conceived the overall research idea, supervised the study and coordinated the manuscript preparation. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

References

1. Hiremath VM, Raghavendra HR, Tejukumar BK, Udaya TV. Geographical indications of vegetables in India. Indian Hortic. 2020;65(3):133. https://epubs.icar.org.in/index.php/IndHort/article/view/105392
2. Chatzistergos T, Ermolli I, Solanki SK, Krivova NA, Banerjee D, Jha BK, et al. Delving into the historical Ca II K archive from the Kodaikanal observatory: The potential of the most recent digitized series. Solar Phys. 2019;294(10):145. https://doi.org/10.1007/s11207-019-1532-5
3. Premalatha P. Kodaikanal: An emerging MICE tourism destination in Tamil Nadu (India). IOSR J Humanit Soc Sci. 2017;22(6):101–05. https://doi.org/10.1007/s0017850081671
4. Jain V, Gohain N, Sekhon MK. An introspection of agricultural marketing reforms in India. J Agric Dev Policy. 2024;34(1):163–73. https://doi.org/10.63066/23220457.34.1.020
5. Zepeda L. Finding alternatives in our broken food system: The illusion of choice. In: Handbook on the human impact of agriculture. Edward Elgar Publishing; 2021. p. 399–415. https://doi.org/10.4337/9781839101748.00032
6. Ugwu CE, Suru SM. The functional role of garlic and bioactive components in cardiovascular and cerebrovascular health: What we do know? J Biosci Med. 2016;4(10):28–42. https://doi.org/10.3390/en15176260
7. Bartkowiak A, Bartkowiak P, Kinelski G. Efficiency of shaping the value chain in the area of the use of raw materials in agro-biorefinery in sustainable development. Energies. 2022;15(17):6260. https://doi.org/10.1007/978-3-319-92447-2_3
8. Zijm H, Klumpp M, Heragu S, Regattieri A. Operations, logistics and supply chain management: Definitions and objectives. 2019. p. 27–42. https://doi.org/10.1016/j.jretai.2015.03.003
9. Kozlenkova IV, Hult GT, Lund DJ, Mena JA, Kekec P. The role of marketing channels in supply chain management. J Retail. 2015;91(4):586–609. https://api.semanticscholar.org/CorpusID:43309010
10. Papu S, Jaivir S, Sweta S, Singh BR. Medicinal values of garlic (*Allium sativum L.*) in human life: An overview. Greener J Agric Sci. 2014;4(6):265–80. https://doi.org/10.1007/s40618-015-0313-8
11. Yin HY, Tsai WC. Advances of nanomaterials for food processing. In: Handbook of food chemistry. 2015. p. 1–18. https://doi.org/10.1007/978-3-642-41609-5_27-1
12. Hosseini A, Hosseinzadeh H. A review on the effects of *Allium sativum* (garlic) in metabolic syndrome. J Endocrinol Invest. 2015;38:1147–57. https://doi.org/10.1016/j.tifs.2020.08.006
13. Gebreyohannes G, Gebreyohannes M. Medicinal values of garlic: A review. Int J Med Med Sci. 2013;5(9):401–18. https://doi.org/10.4103/jfmpc.jfmpc_600_21
14. Majumder S. Socioeconomic status scales: Revised Kuppuswamy, BG Prasad and Udai Pareekh's scale updated for 2021. J Family Med Prim Care. 2021;10(11):3964–67. https://doi.org/10.4337/3383339401748.002
15. Nayak S. Dynamics of vegetable production in Chhattisgarh plains agro-climatic zone of Chhattisgarh. Doctoral [Dissertation]. Jawaharlal Nehru Krishi Vishwavidyalaya. 2021:73-82. https://doi.org/10.4236/jbm.2013.4104354
16. Majumder R, Kumar A, Zechariah J, Jhariya PN. A case study on marketing of pineapple on behalf of marketing margin, marketing cost, marketing efficiency, price spread, producer's share in consumer rupee in Gomati district of Tripura. J Pharm Innov. 2022;11(4):704–07. https://doi.org/10.1007/s00675808678671
17. Singh P, Vaidya MK. Marketing efficiency and problems of peach crop in Himachal Pradesh of northwestern Himalayan region. Int J Farm Sci. 2020;10(3-4):22–30. https://doi.org/10.5958/2250-0499.2020.00046.4

18. Midhun VM, Velavan C, Palanichamy NV, Ramesh D. A study on price spread and marketing efficiency of honey value chains in Thrissur district of Kerala. Asian J Agric Ext Econ Socio. 2022;40(10):668–76. https://doi.org/10.9734/ajaees/2022/v40i1031128

19. Olugbade YK, Oluwasola O, Ayanwale AB, Oyedele DJ. Information use for marketing efficiency of underutilized indigenous vegetable. Int J Veg Sci. 2019;25(2):138–45. https://doi.org/10.1080/19315260.2018.1487497

20. Upadhyay S, Singh VK, Verma AP, Verma AK, Asha K. Constraints analysis in hybrid paddy farming in the eastern zone of Uttar Pradesh using Garrett ranking technique. Int J Curr Microbiol Appl Sci. 2021;10(02):791–96. https://doi.org/10.20546/ijcmas.2021.1002.094

21. Chakrabartty SN. Methodological issues: Socioeconomic status. SN Soc Sci. 2024;4(8):1–5. https://doi.org/10.1007/s43545-024-00949-y

22. Kumari J, Dubey R, Bose DK, Gupta V. A study on socio-economic condition of Tharu tribes in Bahraich district of Uttar Pradesh in India. J Appl Nat Sci. 2018;10(3):939–44. https://doi.org/10.31018/jans.v10i3.1785

23. Mahajan V, Benke A, Gupta AJ, Singh M. Garlic (*Allium sativum* L.) research in India. Prog Hortic. 2017;49(2):101–12. https://doi.org/10.5958/2249-5258.2017.00024.0

24. Osebeyo SO, Aye GC. Transaction costs and marketing decision: A case study of smallholder tomato farmers in Makurdi, Nigeria. Urban Plan Transp Res. 2014;2(1):333–40. https://doi.org/10.1080/21650020.2014.939296

25. Kumar PH. An economic analysis of red chillies production in Guntur district of Andhra Pradesh. Doctoral [Dissertation]. Dr. Rajendra Prasad Central Agriculture University, Pusa. 2020:43-59. https://krishikosh.egranth.ac.in/handle/1/5810155659

26. Fernie J, Fernie S, Moore C. Principles of retailing. Routledge. 2015. https://doi.org/10.4324/9781315762432

27. Bhat A, Kachroo J, Singh SP, Sharma R. Marketing costs and price spread analysis for citrus in Samba district of Jammu region. Agro-Economist. 2015;2(1):39–44. https://doi.org/10.5958/2394-8159.2015.00007.9

28. Jhade S, Singh A. Integration and causality of major garlic markets in Uttar Pradesh state. J Res ANGRAU. 2021;49(2):100–06.

29. Dahal S, Regmi B, Panta HK, Timalsina P, Chaudhary R, Khadka T, et al. Analysis of economic, production and marketing aspects of potato farming in Changunarayan municipality of Bhaktapur, Nepal. Arch Agric Environ Sci. 2023;8(4):545–52. https://doi.org/10.26832/24566632.2023.0804013

30. Guo F, Liu P, Zhang C, Chen W, Han W, Ren W, et al. Research on the law of garlic price based on big data. Comput Mater Continua. 2019;58(3):795. https://doi.org/10.32604/cmc.2019.03795

31. Shiferaw B, Prasanna BM, Hellin J, Bänziger M. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. Food Secur. 2011;3:307–27. https://doi.org/10.1007/s12571-011-0140-5