



## **Economic Value and Supply Chain Analysis of Palmyra (*Borassus flabellifer*) and its Products**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The main focus of this study is the cultivation and marketing of palmyra and its value-added products in the Thoothukudi district of southern Tamil Nadu. The supply chain of palmyra products is represented in a block diagram that explains the complete marketing channel through which products move from farm to the ultimate consumer. The accumulative added value per tree gives the benefits of palmyra growing and its value addition. According to the findings, the highest profit was shared by farmer cum processors (31.33%) followed by wholesalers (21.58%) for palm sugar, and for palm, jaggery wholesalers had the maximum profit (28.86%) followed by the marketing cooperatives (28.47%). Base on the accumulated added value the payback period of the palmyra tree is the 12th year and the lifetime added value per tree can reach up to Rs. 36000 during the

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peak period from 41 to 60 years of its age. Growing palmyra has the feasibility of giving more income and strengthening the marketing channel by reducing the intermediaries can give additional income to the farmers in the consumer price.

*Keywords: Palmyra; market margin; profit; cost; revenue and added value.*

## 1. INTRODUCTION

Palmyra (*Borassus flabellifer*), a multipurpose tree of greater value, occurs widely in Tamil Nadu state, India [1]. India boasts the world's largest population of Palmyra (102 million), more than half of the population (51.9 million trees) are located in Tamil Nadu, with Thoothukudi district alone accounting for 10 million palms [2]. The Palmyra was designated as the geographical representation of Tamil Nadu in 1978. Palm trees, also known as Palmyra, are one of Tamil Nadu's oldest and most naturally occurring vegetations which can withstand extreme drought. Tamil Nadu is the pioneer in the development of the palm product industry in India. Tamil Nadu can grow and develop the palm products industry to a higher extent to attract foreign exchange through palm product exports. Palmyra has been designated as Tamil Nadu's "State Tree" [3].

Palmyra grows best in hot, dry climates, but it may also grow in alkaline and salty soil. The sweet sap or neera collected from the inflorescence is a major source of sweetening agent and it replaces the cane sugar in palmyra growing tracts of Tamil Nadu and other states. The chief product of the palmyra is the sweet sap (Neera) obtained by tapping the tip of the inflorescence, as is done with the other sugar palms. The palmyra can yield neera for 90-120 days in Tamil Nadu - each male spadix producing 4-5 liters per day; the female gives 50% more than the male [4]. Palm sugar and Jaggery are the two main products which are produced by processing the neera. These products have high demand in the domestic market and fetch high value in export to foreign countries due to high medicinal values.

However, due to several production-related challenges, the country's potential for palm product manufacturing has yet to be fully fulfilled. Due to the dynamic nature of ASCM, Asian economies like India, future studies will focus on diverse supply chain actors or stages that are often absent in the current scenario [5]. Lack of links between industry, government, and institutions, lack of technology and modern techniques in food processing, and lack of

linkage between farmers and processing units were determined to be the most significant causes of post-harvesting losses in the agriculture supply chain in India [6].

The Agricultural supply chain is usually applied to the wide range of products and services required for the movement of produce from the farm to its end-user [7]. It is necessary to develop marketing centers and strengthen the cooperatives based on supply chain studies to decrease the effect of local collectors, traders, and transporters on the pricing process. Therefore, this study aimed to analyze the supply chain of palmyra in Thoothukudi district, southern Tamil Nadu. More specifically, the study examined the division of market margins throughout the Palmyra supply chain, as well as the economic value and potential income generation of a single palm tree throughout its lifetime.

## 2. METHODOLOGY

### 2.1 Description of the Study Area

The study was carried out in India's main palm growing state, Tamil Nadu. Thoothokudi is the district in southern Tamil Nadu, with a total population of 17,50,176. The district's total area is estimated to be 4,707 sq. km. The total cultivable area in this district is 213738 ha. Out of which palmyra is grown in 3665.18 ha [8].

### 2.2 Sample Size and Sampling Procedure

The Thoothukudi district was purposively selected for this study because of its highest palm production in Tamil Nadu State. The study was carried out by using the Snowball sampling method because access to farmers is difficult for this crop. To get the necessary information, 120 farmers (90 farmer cum processors and 30 Neera farmers), 20 traders, 2 commission agents, Palm marketing federation, Palmyra Farmer producer company, and 10 consumers were interviewed.

### 2.3 Method of Data Collection

Data were collected through a pre-designed interview schedule during summer 2021. The unit

of data collection was a single palm tree of each selected farmer where detailed information regarding the crop was taken and analysis was done on a per kilogram basis conversion ratio of the product. Marketing data was collected from different markets where palm sugar and jaggery were sold. The collected data were compiled and analyzed using SPSS.

## 2.4 Method of Data Analysis

To meet the Research objectives, the descriptive and statistical methods of analysis were used to analyze the data collected from the farmers and palm supply chain actors. The descriptive method includes chain maps and analysis defines the role of each marketing chain actor. Profit and gross margin were analyzed across the chain using the economic parameters. The analysis included the Cost, Revenue, and accumulative added value of the single palmyra tree throughout its lifetime.

### 2.4.1 Market margin

According to Ayele [9], marketing margins are crucial indices in evaluating individual actors' performance in the chain. Market margin is defined as the difference in purchase and sales price of an agricultural commodity through its marketing channel. Gross margin is calculated by subtracting the purchase price from the net revenue or sales price, dividing the result by net revenue, and multiplying by 100%. The Gross Marketing Margin of palmyra is calculated using the formula.

$$\text{Gross Marketing Margin} = \frac{\text{Sales price} - \text{Purchase price}}{\text{Sales Price}}$$

The Net Market margin is the net income earned by the market intermediaries after deducting the cost, from the final price of the product.

$$\text{Net Marketing Margin} = \frac{\text{Gross margin} - \text{marketing cost}}{\text{sales Price}}$$

### 2.4.2 Accumulative added value

To determine the feasibility of cultivating a single palm tree and its cultivation, the added value and accumulative added value techniques are used [10]. The added value or annual profit is the difference between the revenue and cost of one tree per year.

$$\text{Added Value} = \text{Revenue} - \text{cost}$$

The costs are calculated by the sum of all inputs used per tree per year.

$$\begin{aligned} \text{Cost} &= \text{Seeds} + \text{Labour} + \text{Manure} + \\ &\text{Plant Protection} + \text{Tapping Charge} \\ \text{Revenue} &= \text{Production} * \text{Price} \end{aligned}$$

The accumulative added value is calculated by summing the profit of the specific year (i+1) to the sum of profits of the previous year.

$$\begin{aligned} \text{Accumulative (i + 1)} &= \text{Accumulative (i)} + \\ &\text{Added Value (i + 1)} \end{aligned}$$

## 3. RESULTS AND DISCUSSION

### 3.1 Palm Market Channel

The movement of goods from point of production to point of consumption through marketing channels involves individuals and institutions is known as a distribution channel or marketing channel. The market channel or supply chain shows how products reach the end-user. Palm sugar and Palm Jaggery are the two major products used widely by consumers. Both the products had different marketing channels before reaching the final consumers. The most important palm marketing channels identified in the study area are as described below. These are:

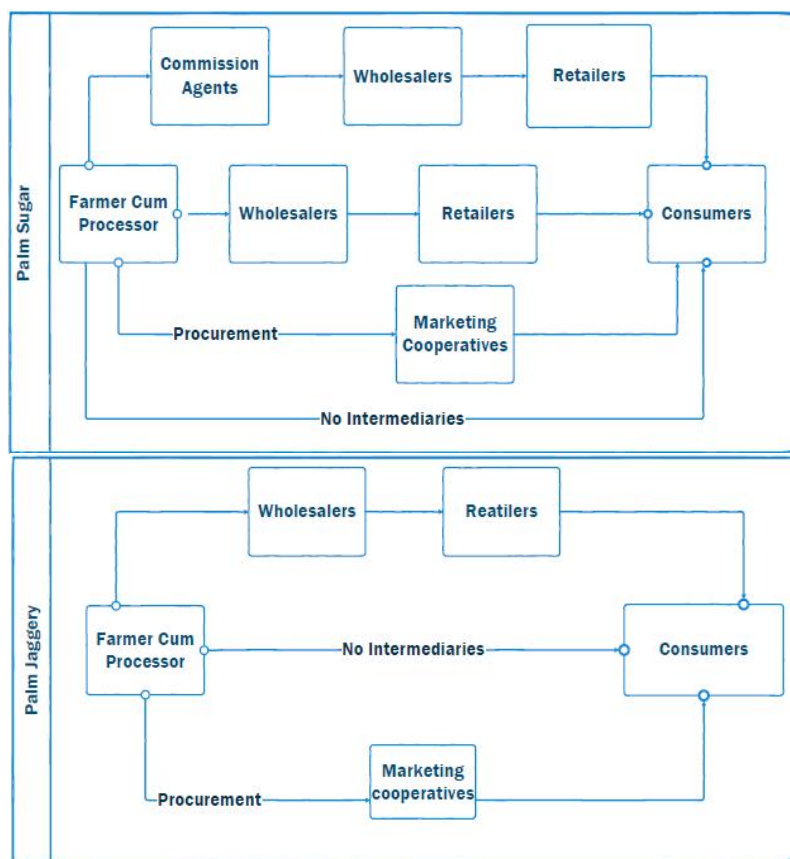
Palm Sugar

Channel I: Farmer cum Processor → Retailers → Consumer  
 Channel II: Farmer cum Processor → Commission Agents → Wholesaler → Retailer → Consumer  
 Channel III: Farmer cum Processor → Wholesaler → Retailer → Consumer  
 Channel IV: Farmer cum Processor → Marketing Cooperatives → Consumer

Palm Jaggery

Channel I: Farmer cum Processor → Consumer  
 Channel II: Farmer cum Processor → Wholesaler → Retailer → Consumer  
 Channel III: Farmer cum Processor → Marketing Cooperatives → Consumer

### 3.2 Supply Chain Mapping of Palm Sugar and Palm Jaggery



Graph 1. Chain mapping of palm sugar and palm jaggery

### 3.3 Production and Market Margin

The performance of the palm market was evaluated using associated expenses, profit margins, and marketing margins for the major actors in the supply chain. Producers, Farmer cum processors, Marketing cooperatives, Commission agents, wholesalers, retailers, and consumers were the major actors in the Palm supply chain in the study area. Table 1 shows

the cost item for palm sugar and palm jaggery production in the study area. In the case of the total cost of production for both sugar and jaggery, labour cost to tap neera constitute a maximum amount than other costs. The conversion ratio of neera processing to the kilogram of sugar and jaggery is 8:1 and 5.7:1 respectively. In general, the average production cost for 10 kgs of sugar and Jaggery is Rs. 2441 and Rs. 1696 respectively.

Table 1. Production and processing cost for sugar and jaggery

S. No	Particulars	Sugar (10 Kg) (80Lit)	Jaggery (10 Kg) (57lit)
1	Neera	2000	1425
2	Labour	340	200
3	Boiling Vessel	5	5
4	Chulas	16	26
5	Fuel	20	20
6	Mud Pot	20	0
7	Post-harvest	40	20
	<b>Total</b>	<b>2441</b>	<b>1696</b>

**Table 2. Marketing costs and benefits for different marketing agents (Sugar) Rs/ Quintal**

S. No	Marketing Cost	Far Cum Processors	Commission Agent	Wholesale	Retailer	Marketing Cooperatives	Total
1	Production Cost	24410	-	-	-	-	24410
2	Purchase Price	-	47000	45000	60000	60000	236410
3	Packing cost	50	50	50	100	100	350
4	Grading cost	-	330	330	100	330	1090
5	Loading/Unloading	60	60	50	30	30	230
6	Transport Cost	10	15	20	10	30	85
7	Storage cost	30	60	50	25	50	215
8	Physical loss	20	20	10	10	20	80
9	Other costs	400	12	10	12	20	454
10	Total Marketing Cost	570	547	520	287	580	2504
11	Total cost	24980	547	520	287	580	26914
12	<b>% Share of Total cost</b>	<b>92.81</b>	<b>2.03</b>	<b>1.93</b>	<b>1.07</b>	<b>2.16</b>	<b>100</b>
13	Sales Price	46000	60000	60000	70000	70000	306000
14	Market Margin	21590	13000	15000	10000	10000	69590
15	<b>% Share of Market margin</b>	<b>31.02</b>	<b>18.68</b>	<b>21.55</b>	<b>14.37</b>	<b>14.37</b>	<b>100.00</b>
16	Profit margin	21020	12453	14480	9713	9420	67086
17	<b>%Share of Profit</b>	<b>31.33</b>	<b>18.56</b>	<b>21.58</b>	<b>14.48</b>	<b>14.04</b>	<b>100</b>

Table 2 and Table 3 show the marketing costs and benefits of palm sugar and jaggery are calculated to estimate the share of profit for individual key actors in the supply chain respectively. The Standard unit of measurement used in the analysis is rupees per quintal. The individual actors incurred costs for Packing cost, Grading-cost, Loading/Unloading, Transport cost, Storage cost, Physical loss, etc, each actor in the chain adds value to the product by performing various marketing functions such as changing the form of the product through processing and creating the time and space utility through transportation and storage.

In the Palm sugar supply chain indicated in Table 2, the farmer cum processor had the highest share of market margin (31.02%) followed by the Wholesalers (21.55%), Commission agents (18.68%), Marketing Cooperatives (14.37%), and the Retailers (14.37%). However, the highest profit was shared by farmers (31.33%), but the cost incurred for production was very high (92.81%) compared to other market actors such as Commission agents (2.03%), Marketing Cooperatives (2.16%). In the Palm sugar supply chain, the most profit in consumer rupees was shared by the wholesalers and the Commission agents.

Table 3 indicated that in the palm jaggery supply chain, the wholesalers and the Marketing cooperatives shared the highest market margin

(28.49%), followed by the farmer cum processor (21.65%) and the retailers (21.39%). The producers (Farmer cum Processor) incur more costs (96.11%) than other actors. The highest profit share (28.86%) was obtained by the wholesalers and the farmers obtained the lowest (21.33%) profit share than the other actors.

### 3.4 Accumulative Added value

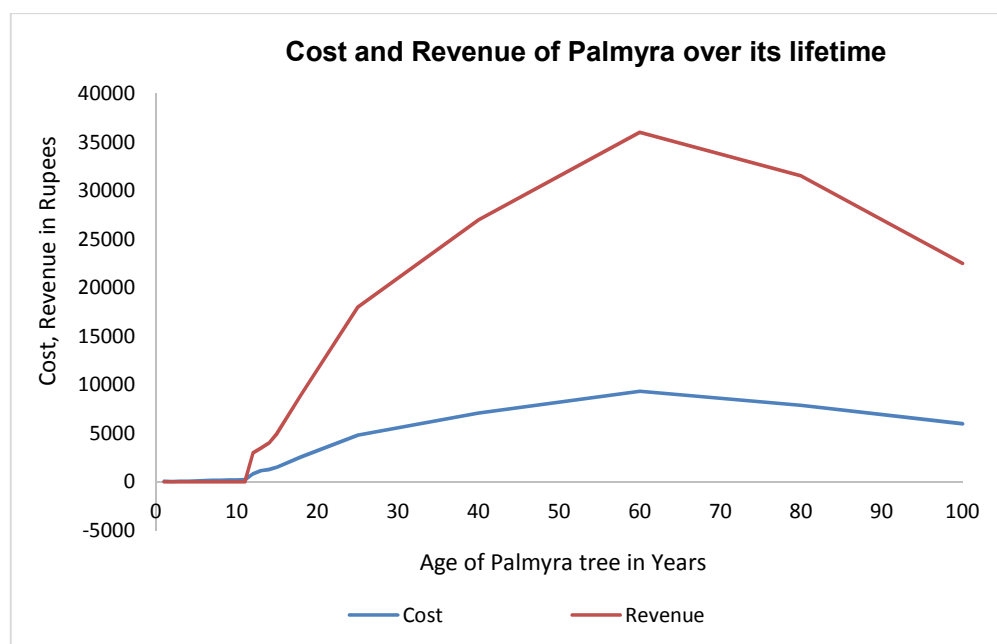
From the economic side, palmyra cultivation is a growing business that has to be developed. The economic indicator over the age of the palmyra tree is shown in Table 4. According to Sankaralingam [11], farmers can plant 1110 palm trees in one hectare. Table 4 indicates the value for one palm tree per year. Fig. 1 and Fig. 2 illustrate the annual quantity of Neera production and subsequent sugar obtained from neera of one palm tree over the years of its age. The palm tree starts producing from the 12th year with small quantities, will increase gradually to the 360 liters per year per tree up to 25th years. In the period from the 26th year to the 60, the single palmyra tree will produce a maximum of 720 liters per tree per year which will correspondingly give the sugar production to approximately 90 kg per year. The palmyra tree gives maximum yield up to the age of 60 and it started decreasing to its higher age. From the age of 80 to 100 years, the palmyra tree starts losing its feasibility, and the length of the tree is too high for tapping for which labour charges are high.

**Table 3. Marketing costs and benefits for different marketing agents (Jaggery) Rs/Quintal**

S. No	Marketing Cost	Far Cum Processors	WholeSaler	Retailer	Marketing Cooperatives	Total
1	Production Cost	16960	-	-	-	16960
2	Purchase Price	-	22000	27000	26000	91960
3	Packing cost	120	100	120	150	490
4	Loading/Unloading	60	60	40	30	190
5	Transport Cost	12	10	10	40	72
6	Storage cost	20	20	10	15	65
7	Damage/ Physical loss	10	10	10	12	42
8	Other costs	25	20	15	25	85
9	Total Marketing Cost	247	220	205	272	944
10	Total cost	17207	220	205	272	17904
11	<b>% Share of Total cost</b>	<b>96.11</b>	<b>1.23</b>	<b>1.14</b>	<b>1.52</b>	<b>100.00</b>
12	Sales Price	20000	26000	30000	30000	106000
13	Market Margin	3040	4000	3000	4000	14040
14	<b>% Share of Market margin</b>	<b>21.65</b>	<b>28.49</b>	<b>21.37</b>	<b>28.49</b>	<b>100.00</b>
15	Profit margin	2793	3780	2795	3728	13096
16	<b>%Share of Profit</b>	<b>21.33</b>	<b>28.86</b>	<b>21.34</b>	<b>28.47</b>	<b>100.00</b>

**Table 4. Production, cost, revenue and added value per palm tree**

Year	Cost (Rs)	Production(l)	Product(kgs)	Revenue (Rs)	Added-Value (Rs)
1	58.5	-	-	-	-58.5
2	53.3	-	-	-	-53.3
3	78.3	-	-	-	-78.3
4	78.3	-	-	-	-78.3
5	103.3	-	-	-	-103.3
6	127.2	-	-	-	-127.2
7	152.2	-	-	-	-152.2
8	157.6	-	-	-	-157.6
9	197.6	-	-	-	-197.6
10	203.3	-	-	-	-203.3
11	232.3	-	-	-	-232.3
12	862.3	60	7.5	3000	2137.7
13	1146	70	8.75	3500	2354
14	1286	80	10	4000	2714
15	1536	100	12.5	5000	3464
16-18	2576	180	22.5	9000	6424
19-25	4826	360	45	18000	13174
26-40	7076	540	67.5	27000	19924
41-60	9336	720	90	36000	26664
61-80	7875	630	78.75	31500	23625
80-100	5991	450	56.25	22500	16509

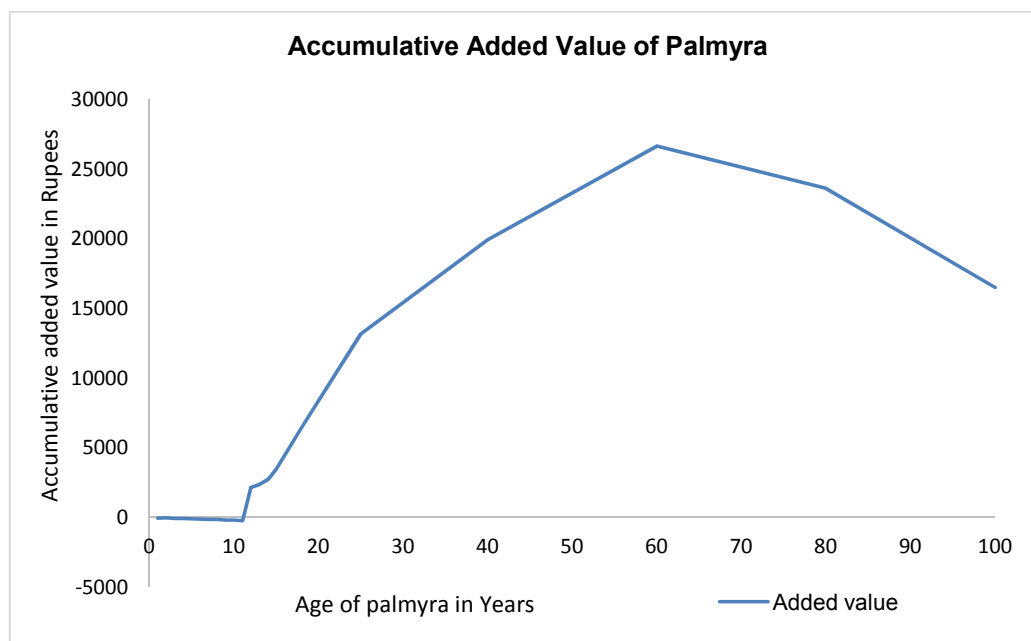


**Fig. 1. Cost and revenue of the palmyra per tree per year**

Two curves are shown in Fig. 1 shows the costs and the revenue of palm trees (in terms of sugar). The costs included seed, labour, manure, plant protection chemicals, and the tapping charges for neera extraction. The cost of growing the palmyra tree increases gradually till reaching its maximum level at 15th year (Rs. 1536) and

the cost remains constant for its lifetime except for labour charges for tapping the Neera, as it completely depends on its neera production.

Neera is the most vital product that determines the revenue of the palmyra tree. The revenue was calculated in terms of one of its products



**Fig. 2. Accumulative added value of palmyra per tree per year**

such as sugar, knowing that the price of 1 kg palm sugar is sold at Rs.450. To produce 1 kg of sugar 8 liters of neera are to be processed. The annual revenue per tree is estimated by multiplying the quantity of sugar in kg by its price in rupees which are shown in Table 4. It is shown that revenue starts after the 12th year where the tree starts production and keeps increasing till it reaches the maximum at 60th year and starts declining after 80.

Fig. 2 shows the added value of a single palm tree per year. The maturity of the palmyra tree is obtained in the 11th year for which the added value is negative. After the maturity period at 12th year, the palmyra tree gives profit and reaches the maximum value of (Rs. 36000), but its start rolls after 80th year.

The added value per tree is calculated by the annual profit of that tree. To get a whole profit or lifetime profit, the accumulative added value is used. It is shown that from Table 4 and Fig. 2 the curve stayed negative till crossing the X-axis at the 12th year, which is the breakeven point for that tree. The maximum accumulative profit (Rs. 26664) is obtained at the 60th year of its life.

#### 4. CONCLUSION

In the study area, there are many actors involved in the supply chain playing different functions.

Regarding the market margin and profit of the palm sugar supply chain, the highest margin was shared by the Farmer cum processor (31.02%) followed by the wholesalers (21.55%) and the commission agent (18.68%). The highest profit was share was obtained by the Farmer cum processor (31.335) followed by the wholesalers (21.58%). Though farmer gets the highest market margin and profit, most of the cost was shared by farmers (92.81%), and also the farmers share in consumer rupees was quite low. In the case of the palm jaggery supply chain, the highest market margin was obtained by the wholesalers (28.49%) and the marketing cooperatives (28.49%) and regarding the profit share, the wholesalers get the highest (28.86%) followed by the Cooperatives (28.47%).

In addition, the estimation of accumulative added value shows that the payback period for the palmyra tree starts from the 12th year and gets the maximum revenue from 41 to 60 years. The palmyra cultivation has the feasibility of giving the maximum income to the farmers and the strengthening of marketing channel can give the additional income to the farmer especially in terms of farmer share in consumer rupees.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.



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