



Potential Review on Palmyra (*Borassus flabellifer* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. Author TRSK designed the study and wrote the first draft of the manuscript. All the co-authors including RA, MC, GP and RN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The state tree of Tamil Nadu, *Borassus flabellifer* L. is a nature's gift to the mankind. It is plant that serves various ecological, medicinal, economical and sociological benefits to the society. It a plant of heaven that could sustain adverse climatic conditions and withstand natural calamities. It is one among the most beneficial species that has economical and medicinal value for each and every part. It found widely in tropical and arid countries ranging from India through South-East Asia to New Guinea. The plant has a very close connection with the rural livelihood and cottage and agro based industries of Indian economy. The utility of the plant could be widely classified into Non-edible, edible and value addition based uses. This paper attempts to give a birds eye view about palmyra's distribution, nutritional and medicinal properties, different utility forms and the impact on rural livelihood.

Keywords: Palmyra; Tamil Nadu; area and production; Utility of Palmyra; impact on livelihood and rural development; value-addition; medicinal and nutritive value.

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1. INTRODUCTION

Borassus flabellifer commonly known as Palmyra palm got its name from Greek roots namely 'Borassus' and 'flabellifer' which means fruit with leather covering and fan-bearer respectively. *Borassus flabellifer* is found to have Indian subcontinent and Southeast Asia to be the place of origin. It is also considered to be a nature's perennial gift that could flourish well in arid and semi-arid conditions and, also could withstand any adverse climatic conditions. This plant has got many unique names in different languages across India viz., Tal. Talgachh and Tarkajhar in Hindi and Bengali. In Telugu, it is called as Lulu or Tadi. It is also called as 'Karimpana' in Malayalam. In English, it is also called as Fan palm, Brab tree, Toddy palm and Tala palm. It is a perennial plant that grows up to 30 meters and has a maximum life span of 100 years and starts yield from 15 years in the area with plenty of water source and within 25 years in the arid regions [1]. Despite the Palmyra trees are being destroyed like never before. When fertile agricultural lands or sand dunes are being traded by land sharks and real estate brokers, the Palmyra trees in these parcels of land are also sacrificed. We are witnessing the tragedy of the Palmyra trees being cut to be used as fuel for brick kilns. When we are facing heating of the earth and depletion of ground water resources, we must pay attention to one of our hopes, bestowed by nature - the palm trees. Thus this paper attempts to bring out the potential benefits of Palmyra with scientific perspectives and reviews.

2. HISTORICAL IMPORTANCE OF PALMYRA

Palmyra is celebrated and honoured to be the state tree of Tamil Nadu in 1978 owing to its widest distribution across the state and its undeniable contribution in rural and cottage industries and the impact on rural livelihood [2]. It is a plant that can grow in adverse and diverse agroclimatic conditions ranging from seashores, plains, valleys and hills up to an altitude of 762 meters above sea level. Palmyra has been in touch with Tamil culture since time immemorial. The ancient sages, rishis and scholars used the matured leaves of palmyra as writing materials to engrave ancient scriptures to pass on their acquired knowledge and wisdom over more than 2500 years. These are nature's gift that has multifaceted benefits. A book named 'Thalavilasam' in Tamil authored by Thiru

Arunachalam provides the proof of bondage between Palmyra and ancient India and has attempted to explore more than 801 uses of this tree. Mahatma Gandhi the father of our nation called this tree to be the remedy of poverty. It is also called as 'Karpakatharu' in Tamil and which means a wish tree in English. This tree got this fame owing to the economic usage of the entire parts of the plant and its capacity to withstand extreme drought and other adverse climatic situations.

3. DISTRIBUTION OF PALMYRA IN WORLD AND INDIA

B. flabellifer is believed to be a varietal selection from *B. aethiopum* native of Africa. Thus few authors state that the plant is native to the African continent in origin. However, it is found to be distributed from India through South-East Asia to New Guinea and majorly in India, Burma (Myanmar) and Cambodia. Despite its extensive distribution, no reliable current statistics are available on its area and production from many of these countries, since, the palm is exploited mainly in the wild. According to Aman et al., (2018) in Sri Lanka there are 10 million palms on 25 000 ha (two-thirds in Jaffna district), and in India 60 million palms (two-thirds in Tamil Nadu)[3]. Central Burma (Myanmar) has 2.5 million palms on 25 000 ha, and central Cambodia has 1.8 million palms. In Indonesia, toddy palm is found in Central and East Java and on Madura, totaling 0.5 million palms on 15 000 ha. There are also large stands in Sulawesi and on the Lesser Sunda Islands, and some in the Moluccas and south-eastern Irian Jaya. In Burma (Myanmar) and Cambodia smallholders own 30-40 toddy palms on average (25 male, 15 female trees). According to Golly et al., (2017) it grows extensively in different parts of Asia especially India, Sri Lanka, Myanmar and Bangladesh [4]. The coconut-like plant is also cultivated in Nepal, Laos, Vietnam, Malaysia and Indonesia. Palmyrah palm, embellish the dry landscape of the semi-arid regions of Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Bihar, Karnataka and Maharashtra. India has nearly 102 million palms and half of them are in Tamil Nadu. The following figure explains the spread of Palmyra across the world according to Sankaralingam et al. [5].

According to the report titled "Palm Sugar Market: Global Industry Analysis (2012–2016) and Forecast (2017–2025)", the value of the worldwide palm sugar market was US\$ 1684.2

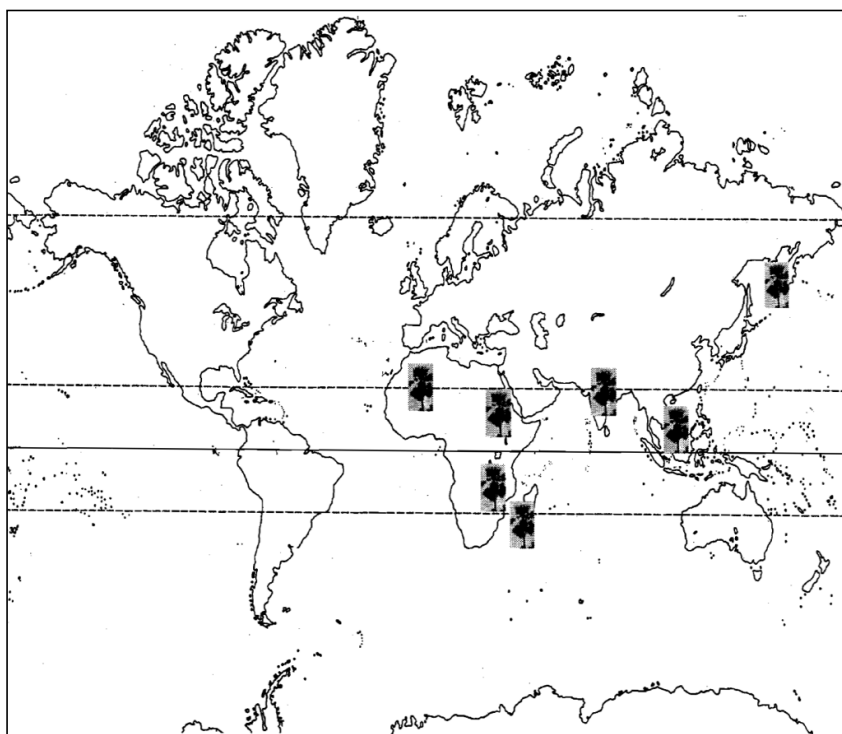


Fig. 1. Distribution of *Borassus* sp. in the world

Table 1. Details of major state wise jaggery production (2013)

State	Production (Million tones)
Assam	0.792
Bihar	0.115
Haryana	0.268
Karnataka	0.294
Madhya Pradesh	0.111
Tamil Nadu	0.283
Uttar Pradesh	1.443
Uttranchal	4.918
Andhra Pradesh	1.80
Others	0.3485

Source: Indian sugar (March 2013)

million in 2017 and was estimated to reach US\$ 2205.8 million in 2025. Income from trade is anticipated to gain at a compounded annual growth rate of 3.4% in the prediction time (2017–2025). The state-wise jaggery production in India during 2013 is given in Table 1. Recently, the commercialization potential of palm sugar as an important alternate sweetener has become an attractive prospect. However, these products are not currently popular. The price of palm sugar is often decided by its quality, as well as by its colour, flavour, and texture.

4. DISTRIBUTION OF PALMYRA IN TAMIL NADU

According to Veilmuthu (2020), India has the highest number of Palmyra (85.9 million) in the world and out of this 60% are in Tamil Nadu (51 million)[1]. According to Kanthimathi (2015), Tamil Nadu has the major share with 51.9 million trees with the district of Thoothukudi ranking first. District wise area and production of the Tamil Nadu state for the year 2015-16 is given in Table 2 [2]. Based on the data in Table 2 it is clear that Ramanathapuram ranks first than other districts in area and production.

Table 2. District wise area and production of Palmyra in Tamil Nadu (2015-16)

Sl. No.	District	Area (ha)	Production (000 tones)
1	Ariyalur	8	NA
2	Coimbatore	36	1
3	Cuddalore	45	1
4	Dharmapuri	151	3
5	Dindigul	68	1
6	Erode	9	NA
7	Kancheepuram	3	NA
8	Kanyakumari	1141	19
9	Karur	31	1
10	Krishnagiri	75	1
11	Madurai	180	3
12	Nagapattinam	411	7
13	Namakkal	NA	NA
14	Perambalur	4	NA
15	Pudukkottai	119	2
16	Ramanadhapuram	3264	55
17	Salem	9	NA
18	Sivagangai	3	NA
19	Thanjavur	182	3
20	Theni	18	NA
21	The Nilgiris	NA	NA
22	Tiruvallur	76	1
23	Thiruvarur	9	NA
24	Tiruvannamalai	70	1
25	Thoothukudi	2889	49
26	Tirupur	12	NA
27	Trichy	41	1
28	Tirunelveli	1159	20
29	Vellore	15	NA
30	Villupuram	48	1
31	Virudhunagar	366	6
	State Total	10442	176

Source: TN government data

Table 3. Economics of single palm per year

Raw material	Quantity	Finished product	Approximate value (in Rs.)
Neera / Juice	150 liters	Gur (20kg)	4000
Karuppatti / Jaggery / Gur	20-25 kg	-	-
Panankarkandu / Palm candy	16 kg	-	-
Matured leaves	10 kg / 8 Nos.	Mat 6 Number	100
Thumbu / Coir	11 kg	-	-
Eeark / Ekil (Leaf ribs)	2.25 kg	Brush 12 Number	70
Naar / Fiber	16-20 kg	Basket 1 Number	70
Viragu / Fire wood	10 kg	-	-

Source: Veilmuthu (2020) and Preservation of produces and products of palmyrah (2010)

5. ECONOMY OF SINGLE PALM PER YEAR

The Palmyra is found in the drier areas of India, Sri Lanka and Burma and also in most of the tropical countries. Economics of single palm per year is given in the following table.

The above table stands as proof that the plant could provide a sustainable livelihood to the rural families throughout the year.

6. NUTRITIVE AND PHARMACOLOGICAL PROPERTIES OF PALMYRA

According to Gummadi et al., (2016) Palmyra products are found to have anti-inflammatory, anti-arthritis, cytotoxic, antibacterial, analgesic, antipyretic, hypoglycemic and anti-oxidant properties [6]. According to Jerry (2018), the countless constituents of *Borassus flabellifer* are gums, albuminoids, steroidal glycosides, fats,

and carbohydrate like sucrose, spirostane type steroids like borassosides and dioscin are found in the plant [7]. Antimicrobial activity is noted in seed coat extract of the *Borassus flabellifer*. Its male inflorescence shows a significant anti-inflammatory activity. Young roots are diuretic and anthelmintic and a decoction is given in certain respiratory diseases [8]. The roots of the plants are cooling, curative and diuretic [9]. The bark decoction, with salt, is used as a mouth wash, and charcoal made of the bark serves as a dentifrice [10]. Palm fruit has anti-inflammatory and antioxidant properties. The antioxidant activity could be attributed due to the presence of high content of crude flavonoids, saponins and phenolic compounds [11].

The fruit pulp helps to cure skin inflammations. It is used to treat nausea and vomiting as well as worm infestation. It is used as an expectorant and also as a liver tonic. A thin layer of palm fruit jelly applied to the affected area has a soothing effect and immediately alleviates the itchiness associated with prickly heat. During summers use palm fruit, to keep the body hydrated. It is used effectively to treat digestive problems and other stomach ailments. It is also used as a laxative. Palm fruit is a good option for those who are on a diet. It also prevents malnutrition in children and adults [7]. According to Jamkhande et al., (2016) consuming leaves, bark, roots have a role to play in promoting as well as disease-preventing benefits because of a few substances namely phytochemicals viz. polyphenols, vitamins, minerals, proteins, etc [12]. Dennis et al. (2011) in his work on the Palmyra tree has found that the ash of the spadix of the *Borassus flabellifer* is taken to relieve heartburn and enlarged spleen and liver [13]. Sap from the flower of the matured tree stalk is prized as a tonic, diuretic agents, stimulant, laxative and anti-phlegmatic and amebicide that are considered to be the best for day to day life. Sugar made from this sap is said to counteract poisoning, and it is fairly prescribed for liver disorders according to Saranya [14].

Fresh toddy heated to promote fermentation is covered onto all kinds of ulcers [8]. In addition to these, the tree sap is taken as a laxative and is believed to possess medicinal virtues have also been ascribed to other parts of the plant. The 'neera' and toddy are good for controlling gastric troubles and ulcers. The inflorescences are widely used in Ayurvedic medicines. The wine was produced using the toddy of *Borassus flabellifer* in Sri Lanka and it has antimicrobial

activity [15]. The antibacterial potential of seeds was examined against Gram-positive bacteria, i.e., *Staphylococcus aureus*, *Bacillus subtilis* and Gram-negative bacteria, *Klebsiella pneumoniae* and *Serratia marcescens*. The methanol extract of the seed coat showed consistently significant inhibitory activity on different bacterial species tested [16]. The overall medicinal properties of the Palmyra tree is listed in Table 4.

The nutritional analysis of the roots has shown 8.54% protein content, 23.53% carbohydrates, 7.29% crude fibre and negligible fat content and these roots are found to be high in calories [17]. This is a plant with high level of genetic variation thus several authors report different levels of nutritional composition. The palm fruits being rich in minerals and vitamins, Palm fruits are a healthy option for people on diet or suffering from diabetes. It is a rich source of vitamins such as A, B, C and their precursors and rich in minerals such as iron, zinc, potassium, calcium, phosphorus, thiamine, and riboflavin. Palm jaggery is also known as Palmyra palm sugar and is a natural sweetener. It is also a low-calorie sugar compared to cane sugar. It is used extensively in cooking and has many health benefits; Low glycemic index sugar in the palm sugar is exceedingly helpful in reducing obesity and to prevent diabetes, it also provides sustained and uniform energy supply to the body, and it is rich in many nutrients such as vitamins B1, B2, B3, B6 and C [18]. Toddy contains a nutritive value with Vitamin A, Ca, Fe, Zn, Cu and the fermented sap results in increased levels of Thiamine, riboflavin and niacin [19]. The sprout is known as Thegalu or Gaygulu in Telugu, as Panang kizhangu in Tamil. The stem of the sprout is very fibrous and nutritious [16]. The following table reveals the nutritive value of neera.

7. ENVIRONMENTAL BENEFITS OF PALMYRA

While most of the palm plants have a fibrous root system, Palmyra has a tap root system that shoots straight downward vertically. It could store a huge volume of water in their tubular roots and increases the water table level of the locality. Thus it has a greater capacity to turn arid land into highly fertile land with rich groundwater resource. This could be a major reason for our ancestors planting palm trees around the water resources like rivers, tanks and wells [1].

Table 4. Medicinal properties of parts of Palmyra

S. No.	Part of the Plant	Pharmacological properties
1.	Seed and seed coat extract	Antimicrobial activity
2.	Male inflorescence	Anti-inflammatory activity
3.	Young roots	Diuretic, anthelmintic, coolant and to treat respiratory issues,
4.	Palm fruit	Anti-inflammatory, anti-oxidant and hydrant
5.	Spadix	To treat heartburn and enlarges spleen and liver
6.	Flower sap	Tonic, laxative, diuretic agents, stimulant, laxative and anti-phlegmatic and amebicide
7.	Palm sugar	Counteracting agent for poison and to treat liver disorder
8.	Toddy	To treat ulcer
9.	Neera	Controlling gastric troubles and ulcers

Table 5. Nutritive value in 100cc of neera (or jaggery or fruit pulp or tuber)

Moisture	86.6 g	Protein	350g
Reducing sugar	998 mg	Ash	0.53g
Calcium	143mg	Phosphorus	10mg
Iron	0.30mg	Ascorbic acid	15.74mg
Thiamine	82.3mg	Riboflavin	44.4mg
Niacin	674.4mg	TSS	12.5percent

Source: Palm (2012)

Table 6. Nutrient composition of palmyra fruit pulp

Constituent	Quantity
Moisture (g)	79.1
Energy (k cal)	87
Protein (g)	2.8
Fat (g)	1.0
Total Carbohydrates (g)	18.5
Sugars	14-16
Crude Fibre	15
Ash	4.3

This plant is too sturdy that could withstand natural calamities like a magical wall. Tamil Nadu has witnessed several natural calamities. The 'Thane' cyclone that hit Tamil Nadu on 30th of December 2011 has caused an unimaginable level of damage to all aspects including ecosystem, agriculture, livelihood, etc. Scientists quote that this devastation could have been controlled in the coastal districts like Cuddalore if the natural barrier Palmyra had not been cut. Scientific evidence state that many of the strong and sturdy palmyras stood strong and tall even withstanding Tsunami in 2004, while many age-old trees and buildings were flattened to the ground. Which intrigued Tamil Nadu government to take emergency measures to replant a large number of felled plants as a natural barrier. This plant even has the potential to block and reduce the speed of the storms and hurricanes and could also prevent soil erosion to a greater extent.

The Palmyra based agro-industries also plays a considerable role in environmental preservation. Palm gur or karupatti is the best alternative to white sugar and was used as the major sweetener by our forefathers. The white sugar industry causes an extensive level of pollution and natural resources exploitation. Canes need a lot of water to cultivate, high level of fertilizers and agro-chemicals, transport intensive leading to greater GHG emission and releases huge amount of effluents from processing into the environment. While gur production uses traditional methods for processing, molding and packing which is not chemical-intensive. Moreover, the processing areas are installed near the Palm fields and the produces are sold in nearby areas using bus or cycle or even in the village itself, thus the GHG emission due to transportation is also very much low.

According to Mehta et al., (2016) The Palmyra palm has profound potential for beekeeping by furnishing various essential elements in the beekeeping activity [20]. It is helpful in hive making, shade provision and baiting. It provides the nectar and pollen source which is essential for the honey production as well as brood development in the colonies of all honey-producing bees. This tree can be utilized in the landscape as important bee flora besides its other important utility.

8. NON-EDIBLE USES OF PALMYRA

Leaves: The leaves are used for thatching roofs, screening as a fence, as mats, baskets, fans, hats, umbrellas, buckets, sandals etc. Senesced leaves are utilized as fuel for cooking. The leaves after using for thatching and fencing when replaced are used by the farmers as organic fertilizer.

Matured fruit: Mesocarp of the matured fruit yields small quantities of fibre. This fibre is used for making fancy decorative items and toys.

Stem: Palmyra palm trunks are used either as live poles in construction of thatch sheds or as timber in replacement of wooden poles.

Petiole and leaf blade: Tough and long fibre extracted from petiole is used for making of ropes used in the building of houses and boats. The fibre extracted from leaf blades is hard, stiff and very resistant. The petiole fibre and leaf blade are used to make products such as brushes and handicrafts artefacts etc.

Trunk: The vacant stem of the palmyra palm tree is considered as best for making water pipes.

Timber and Fiber: Two other commercially useful by-products of palmyra palm are fibres and timber. Burkill (1966) lists five separate kinds of fibres produced by a single palm: a loose fibre from the base of the leaf stalk; a long fibre from the leaf stalk; fibre from the interior of the stem; a fibre or coir derived from the pericarp; and the fibrous material of the leaves [21]. Local usages of the various fibres produce beautiful local basket ware, cord, rope and matting. The leaf-base fibre is the raw material for the production of brushes and this type of fibre is an important export commodity from various regions of India.

9. EDIBLE USES OF PALMYRA

Neera / Palm sap: The sap extracted from the inflorescence of Palmyra palm is called 'Neera'.

Neera is typically the most economic produce of Palmyra palm. It is a good source of minerals like calcium, phosphorus and iron and vitamins like vitamin A, niacin, thiamin and riboflavin. Neera acts as laxative and diuretic. Alcohol builds up naturally in neera when left undisturbed for a few hours.

Endosperm: Jelly like endosperm of young fruit (60 – 70 days) of Palmyra palm is very nutritive and is a summer delicacy.

Tuber (Apocolon): Mature tuber is brittle and breaks off easily which is a rich source of carbohydrates. The optimum time for harvesting of the tuber is 135 days after sowing.

Fruit: The soft orange-yellow mesocarp pulp of the ripe fruit is sugary, dense and edible. It is rich in vitamin A and C. The ripened fibrous outer layer of the palm fruits can also be eaten raw, boiled or roasted.

Spongy haustorium: The haustorium formed during germination of seed nut is a spongy sweet delicacy.

Seedlings: The peeled seedlings of Palmyra palm are eaten fresh or sun-dried, raw or cooked in various ways. They also yield starch, which is made into gruel, with rice, herbs, chilli peppers, fish or other added ingredients.

Pananchoru: When the crown of the tree is cut, an edible cake is obtained from which the leaves grew out. This is called "Pananchoru" in Tamil.

10. VALUE-ADDITION IN PALMYRA

Palm Toddy: Toddy is formed as a result of fermentation of sugary sap by wild yeasts and bacteria, which come into contact with the sap. This is an uncontrolled natural fermentation by several different strains of yeast and bacteria. The alcohol content in fully fermented toddy is 4-8%. But fermentation of palmyra sap using pure yeast cultures gives about 7.8% [22]. Palm toddy is a traditional drink and has a refreshing quality. The juice collected in the evening or after fermentation becomes sour - is called *Tadi* in Marathi and *Kallu* in Tamil. Tadi is consumed by coastal Maharashtra mostly by villagers as a raw alcoholic beverage.

Toddy palm wine: The toddy palm wine is an alcoholic beverage made using the fermented flower sap of palm trees. Toddy wine is white and

sweet with a strong smell but mild taste. The tapped sap of the palm flower undergoes natural fermentation due to yeast which is present in the sap itself. Fermentation starts soon after the sap is collected and within two hours it becomes reasonably high in alcohol yet less than 4 per cent. However, it has a very short shelf life which is 24 hours [23].

Palm jaggery: It is also called as palm *gur*. It is highly-priced due to its nutritional and medicinal properties. It has an earthy, intense taste reminiscent of chocolate. The jaggery is processed from the unfermented tree sap (neera). Initially, the sap is collected in slacked lime treated earthen pots by tappers. The cleared sap after lime sedimentation and filtration is transferred into the boiling galvanised iron pan on a traditional furnace and boiled at 110°C. Neera gets transformed into a viscous fluid which is poured into wooden moulds and allowed to harden. About 8 litres of neera is required to get 1 kg of jaggery. The quality of *gur* can be improved by precipitation of lime with carbon dioxide or citric acid or unripe tamarind fruits before boiling the juice [24]. The major problem of jaggery storage is blackening of colour in a short period.

Palm sugar: Neera, free from debris is boiled in an alloy vessel adding a small quantity of superphosphate. After uniform boiling, the liquid is allowed to cool. After removal of sediments, it is heated to 110°C for 2 hours until it reaches honey-like consistency. The fluid is then allowed to cool and poured into a crystallizer. After forming sugar crystals, it is centrifuged to collect sugar and dried and powdered to store.

Palm Oil: Palm oil is extracted from highly perishable oil palm fruit through wet processing.

Palm tamarind candy: Neera is heated for 2 hours to obtain the honey-like consistency. The syrup is then transferred to mud pots. Ripe, dry and shelled tamarind fruits devoid of seeds are added into the syrup. About 1 kg of fruit is required for 10 litres of syrup. The pot is closed tightly with cloth and vessels are kept in a shockproof, cool and dry place for 130 to 180 days. Sugar crystallises on the sutures of tamarind and the fruits turn into delicious candies.

Palm spread: For the preparation of palm spread, firstly the fruit pulp is extracted by using water (1:1) and heat (70° C for 10 min) to ensure

maximum pulp recovery. The extracted pulp is mixed with other ingredients (sugar, skim milk powder, small cardamom and citric acid) and heated on a low flame with continuous stirring till the TSS reaches 65–68 degree Brix. Cooked material is then removed from heat, filled into broad mouth sterilized bottles, capped, labelled and stored [25].

Palm toffee: Palm toffee is prepared by mixing fruit pulp with sugar, skim milk powder, glucose, maida and starch as ingredients. The mixture is cooked with constant stirring for up to 40 minutes. The endpoint is determined following the drop test in water. The container is then removed from heat; the toffee mixture is spread on an aluminium tray which is smeared well with oil/butter and kept overnight in air. Then the toffees of desirable size and shape are cut, wrapped with butter paper and stored at room temperature [26].

Palm burfi: For palm burfi preparation, khoa, butter and lime water are used along with fruit pulp and sugar.

Palm Pickle: Small fruits of Palmyra palm are pickled in vinegar.

Canned Palm: Jelly-like kernels of half-grown soft-shelled seeds of palm are canned in clear, mildly sweetened water for exportation purposes.

Chilling: For distant transportation, neera cannot be cooled and preserved. In this case, neera is filled in cans and kept in an ice-making room. Thus, neera remains for many days without fermentation [22].

Palm Cola: Palm cola is an aerated soft drink containing 11% sugar. Its other ingredients are cola concentrate, citric acid and food colour [22].

Palm Honey: After filtering the neera, it is heated in a pan made of GI (galvanized iron) sheet. Heating is done with conventional fuel. To control fast boiling, a few drops of coconut oil is added. It takes 2 to 2 1/2 hours to obtain the honey-like consistency.

Sankaralingam et al., (1999) have also reported various value-added products namely, dehydrated palmyra tuber, palmyra tuber flour and rava (sooji), palmyra tuber laddu (sweet balls), palmyra tuber-soya laddu (sweet balls), palmyra tuber kesari (Sweet), palmyra tuber payasam (Kheer), palmyra tuber idli (Steamed

buns), palmyra tuber uppuma (tiffin), palmyra tuber porridge, palmyra tuber pakora (Crunchy hot and salt snack), Thavan peda (Sweet), Thavan halva (Sweet), fruit squash, ready to serve juice from fruit, fruit leather, nungu candy, nungu peda, nungu sarbat (refreshing drink), neera khova (Condensed milk sweet), neera pongal (Sweetened rice mix) and neera payasam (Kheer) [5].

11. RESEARCH AND DEVELOPMENT IN PALMYRA

Palmyra is a mandatory crop under All India Coordinated Research Project on Palms. Pandirimamidi in Andhra Pradesh and Killikulam in Tamil Nadu are research centres under AICRP on palmyra where collection, conservation and evaluation of existing germplasm in palmyra and hybridization for developing dwarf types are focused [22]. The following image indicates the various locations of AICRP centres across India contributing to various researches oriented to Palmyra according to Sankaralingam et al. [5].

The Tamil Nadu palm products development board was established in 1995 based at Egmore, Chennai under Tamil Nadu Act (15) of 1994. Though the Tamil Nadu Palm Products Development Board is not directly involved in trading activities, it promotes production and trade through 996 Primary Palm Jaggery Cooperative Societies (including Palm Leaf Workers Cooperative Societies), 8 District Palm gur Marketing Cooperative Federations and one Tamil Nadu State Palmgur and Fibre Marketing Co-operative Federation. Research on the preservation of palmyra nungu and palmyra fruit Jam has been completed and the technical know-how has been provided to the Tamil Nadu State Palm gur and Fibre Marketing Cooperative Federation. This would create awareness among the Self-Help Groups and other individuals interested in palm products industry to produce and market these products.

Department of post-harvest technology in Tamil Nadu Agricultural University has developed more and more products based on palmyra palms such as palmyra tender fruit RTS beverages, jam, jelly, candy, preserve, peda, ice cream; palm tuber flour idly, rotti, panaiyaram, uppuma, muruku, pakoda, laddu, kesari, payasam, soya laddu using palm tuber flour, porridge, bread, cookies and vermicelli. Tamil Nadu is a pioneer in the development of the palm products industry in India. Out of the estimated 8.59 cores of

palmyra in India, about 5.10 cores of palmyra are in Tamil Nadu. Tamil Nadu is a potential centre for the growth and development of palm products industry to a greater extent to attract foreign exchange by way of export of palm products.

12. IMPACT OF PALMYRA ON LIVELIHOOD

India is a young country as highlighted by our Prime Minister in his Independence Day Speech of August 2017. India today has the world's largest youth population. Rural youth and women are the key agents for rural development. They play a catalytic role towards reaching of transformational financial, ecological and social changes required for sustainable development. But education level, limited access to credit and skilled knowledge are among the many challenges they face. Empowering them is crucial, not only for the well-being of persons, families and rural communities but also for overall economic efficiency.

A significant proportion of the rural population from the natural ranges of palmyra palm in India is involved in obtaining and preparation of different products from different parts of palmyra palm trees. It is one of the best examples of indigenous value addition and generally does not involve any sophisticated technique or equipment. Therefore, palm-based processing industries seem to be suitable and viable alternative for sustainable livelihood of the poor communities involved in palm growing and processing. Value addition in palmyra palm may assist in the development of rural communities through small-scale investment. It has also contributed to the conservation of elite germplasm, enhanced marketability and increased income. Post-harvest technology of palmyra concerning to value-added products like *neera*, jaggery, palm sugar, candy, based products, tuber based bakery products, pulp-based beverages and spongy endosperm needs to be refined and popularised. Many types of value-added products from Palmyra palm are being produced at both household and commercial levels in the natural range of palmyra palm.

According to Swathilekshmi (2010), women self-help groups have demonstrated their capabilities in mobilizing the micro-credit and involving in income-generating activities such as Palmyra crafts, and cottage industries [27]. It is necessary to employ modern methods to extend the storage

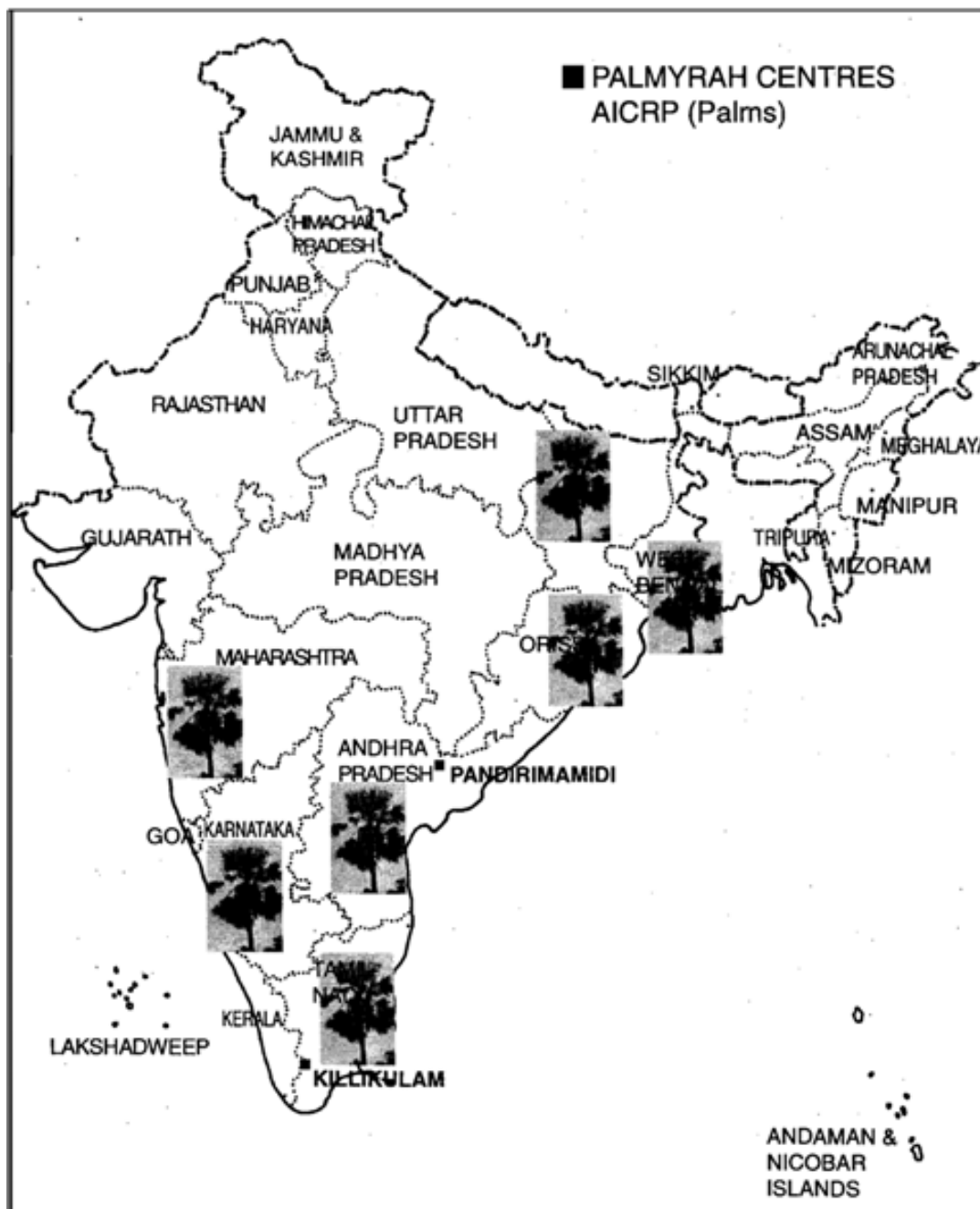


Fig. 2. AICRP Palmyra Centre in India

life of the value-added products from palmyra palm for better distribution and also processing techniques to preserve them for utilization in the offseason. A study conducted by Suma et al., (2017) in Indonesia substantiate the above fact. She used Palmyra based crafts and agro-industries as an alternate revenue-generating

source for the beggar communities in two villages with a greater scope of tourism [28].

13. CONCLUSION

Palmyra production and processing industry ensure food security, livelihood security and

ecological security of the country. However, the population of this “Kalpavriksha” is been on declining rate due to globalization, industrialization, urbanisation, habitalisation etc. Despite various benefits and utility these trees are destroyed like never before and never taken care of and were always taken for granted. Real estate industry also plays a major role in the eradication of these natures gift. Palmyra trees are unique in providing us with food and non-food products, suitable for the typical climate prevalent in Tamil Nadu. It provides an opportunity for the employment and welfare of society. Younger and younger trees are being cut and the growth of the trees is stunted and weakened because of excessive tapping or cutting of leaves. Efforts should be aimed at planting more number of trees, protecting existing trees, promote self-help groups for palmyra farmers or tappers, promote FPO based approach, encourage more research on developing advanced varieties, production and processing technologies and cultivation of more plant around water bodies to improve the underground water table. The government should focus on the living and health conditions of the tappers and their families. Line departments must take initiatives to create awareness among the people about the health benefits of Palmyra products.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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