

DOMESTICATING THE DRAGON

Contextualizing Dragon Fruit's Life Cycle



**CENTURION
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An innovative experiential learning initiative
of M.S. Swaminathan School of Agriculture

***“Action research project connecting
ecology, economy, education and
entrepreneurship”***

Prologue

The Mission Possible “Every Piece of Land is an Enterprise and Every Farmer – Small and Marginal is an Entrepreneur”

Dragon fruit *Native to Central America and Mexico, dragon fruit has a sweet and rich pulp with seeds. It has a crunchy texture, like a blend of kiwi fruits and pears, a recently introduced as super fruit in India. It is considered promising, remunerative and relatively durable fruit crop. Fruit has very attractive colour and mellow mouth melting pulp with black colour edible seed embedded in the pulp along with tremendous nutritive property which attracts the growers from different part of India to cultivate this fruit crop which is originated in Mexico and Central and South America (Britton and Rose, 1963; Morton, 1987 and Mizrahi et al., 1997). It is a long day plant with beautiful night blooming flower that is nicknamed as “Noble Woman” or “Queen of the Night”. The fruit is also known as ‘Strawberry Pear’, ‘Dragon fruit’, ‘Pithaya’, ‘Night blooming Cereus’, ‘Belle of the night’, ‘Conderella plant’ and ‘Jesus in the Cradle’. Fruit is named as ‘Pitaya’ because of the bracts or scales on the fruit skin and hence the name of pitaya meaning ‘the scaly fruit’. It has ornamental value due to the beauty of their large flowers (25 cm) that bloom at night which are creamy white in color. It is considered as a fruit crop of future. The biggest advantage of this crop is that once planted, it will grow for about 20 years, and 1 hectare could accommodate about 800 dragon fruit plant. Farmers in the Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Odisha, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands have already taken up its cultivation and the estimated total area under Dragon fruit cultivation in these regions may be less than 400 ha.*

Fig 1: Different types of dragon fruits in Indian Sub-continent

- i) Red skin, white flesh: *Hylocereus undatus*, mainly from Thailand and Vietnam.
- ii) Red skin, red flesh: *Hylocereus polyrhizus*, come mainly from Israel and Malaysia.
- iii) Red skin, purple flesh: *Hylocereus costaricensis*, from Guatemala, Nicaragua, Ecuador, and Israel.
- iv) Yellow skin, white flesh: *Hylocereus megalanthus*, from Colombia and Ecuador.

HEALTH BENEFITS

Proximate nutraceutical values in g or mg per 100 g edible portion of white fleshed dragon fruit are as follows: moisture (85.3 %), protein (1.1), fat (0.57), crude fiber (1.34), energy (Kcal) (67.7), ash (0.56), carbohydrates (11.2), glucose (5.7), fructose (3.2), sorbitol (0.33); vitamin C (3.0), vitamin A (0.01), niacin (2.8), Ca (10.2), Fe (3.37), Mg (38.9), P (27.75), K (272.0), Na (8.9) and Zn (0.35) and for red-flesh fruit, moisture (82.5-83.0), protein (0.159-0.229), fat (0.21-0.61), crude fiber (0.7-0.9) and ascorbic acid (8-9) (Jaafar *et al.*, 2009).

- Regular consumption of Dragon fruit helps in fighting against cough and asthma; also, it helps for healing wounds and cuts quickly due to it contains high amount of vitamin C.
- The high level of vitamin C found in Dragon fruit plays an important role to enhance immune system and to stimulate the activity of other antioxidant in the body.
- Dragon fruit is also packed with B vitamin group (B₁, B₂ and B₃) which possess an important role in health benefit.
- Dragon fruit is also helpful in reducing blood sugar levels in people suffering from type II diabetes.
- Dragon fruit contains high level of phosphorus and calcium which helps to reinforce bones and play an important role in tissue formation and forms healthy teeth.
- Dragon fruit is also rich in flavonoids that act against cardio related problems, also dragon fruit aids to treat bleeding problems of vaginal discharge.
- Dragon fruit acts as a multivitamin; however, it aids to improve and recover the loss of appetite and vitamin B₃ present in dragon fruit plays an important role in lowering bad cholesterol levels; it provides smooth and moisturizes skin appearance.
- It contains high level of phosphorus and calcium. It helps to reinforce bones and

play an important role in tissue formation and forms healthy teeth.

ENVIRONMENTAL BENEFITS

- Water footprint is low as only 967 liters of water used to produce 1 kg of fruit.
- Carbon footprint is low as only 0.9 kg CO₂ is emerged to produce 1 kg of fruit which is equivalent to drive a car only for 3.25 km. It is comparatively lower than most of the fruits (on an average carbon foot print value is 1.1 kg), vegetables (on an average carbon foot print value 2.0 kg), beans (carbon footprint = 2.0 kg), nuts (2.3 kg), rice (2.7 kg) and potatoes (2.9 kg).
- Destruction to other environmental components is low as dragon fruit production is relatively sustainable and there are no significant damages to air, water, land, soil, forests etc.

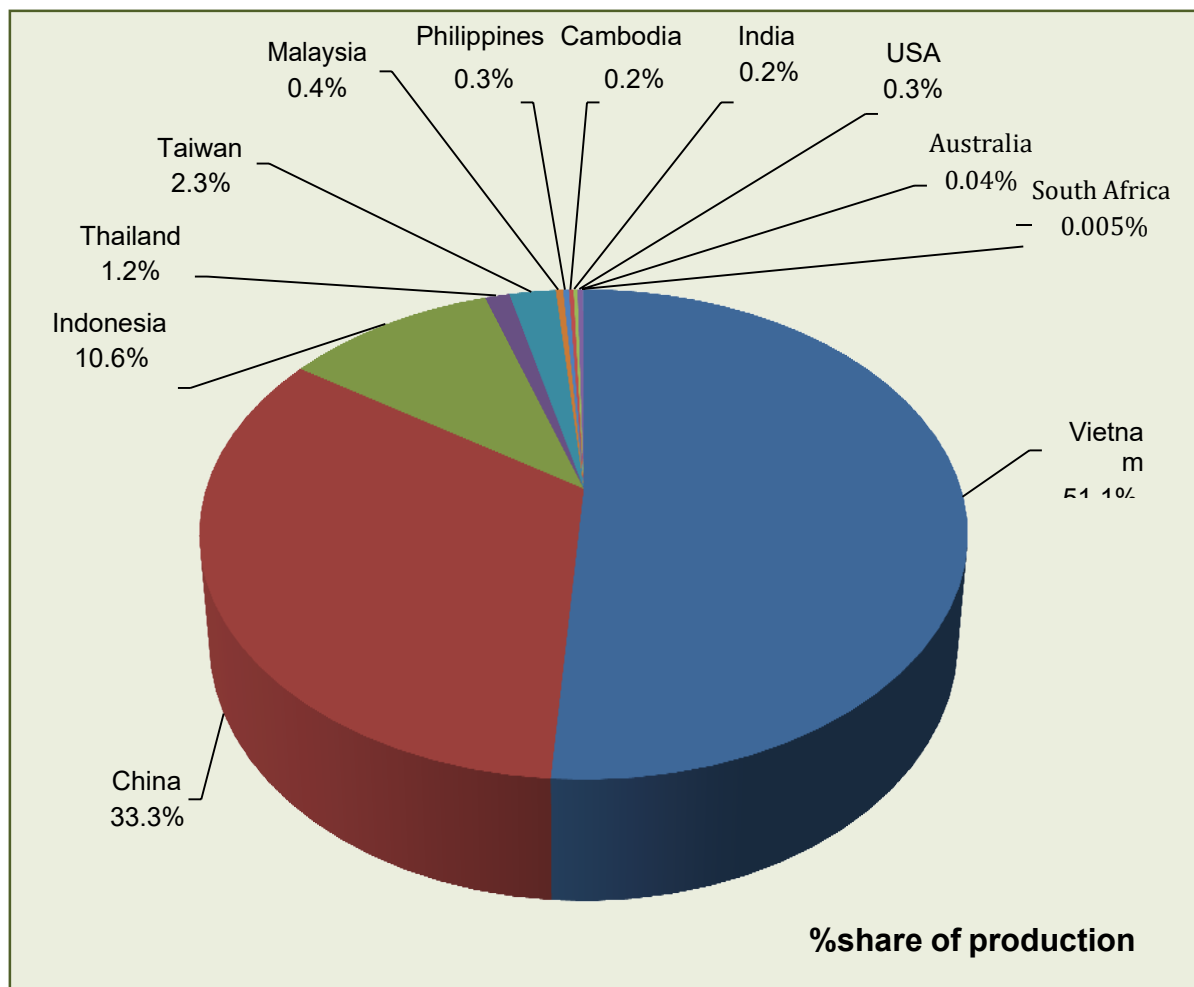
The crop is hardy and can survive in any type of climatic condition favorable for flowering and fruiting and soil condition provided with good drainage with less demanding cultivation requirements as the crop is having high drought and soil salinity tolerance and easy adaptation to light intensity and high temperature.

GLOBAL DRAGON FRUIT PRODUCTION STATUS

Three major countries viz., Vietnam, China and Indonesia contribute more than 93% of dragon fruit production of world. The share of Vietnam alone is more than half (51.1%) of the world production over an area of 55, 419 ha with average productivity of 22–35 metric tonnes (MT) / hectore (ha) / year. The volume of dragon fruit produced in Vietnam is more than 1 million metric tonnes of worth US (\$) 895.70 million (Chen and Paull, 2018). Dragon fruit cultivated in almost all provinces of Vietnam, but largely concentrated in Binh Thuan, Tein Giang and Long An regions (Hein, 2018). China is second largest producer contributing 33.3% of world production of dragon fruit i.e. producing about 7, 00,000 MT dragon fruit of worth US (\$) 397 million over growing areas of 40,000 ha with average productivity of 17.5 MT/ ha/ year (MZMC, 2020).

Table 1. Major dragon fruit producing countries (area, production and productivity, 2017–2018)

Country	Production area (ha)	Production (MT)	Productivity (MT ha ⁻¹)
Vietnam	55,419	10,74,242	22–35
China	40,000	7,00,000	17.5
Indonesia	8,491	2,21,832	23.6
Thailand	3,482	26,000	7.5
Taiwan	2,490.6	49,108	19.7
Malaysia	680	7,820	11.5
Philippines	485	6,062.5	10–15
Cambodia	440	4,840	11.0
India	400	4,200	8.0–10.5
USA	324	5,832	18.0
Australia	40	740	18.5
South Africa	12	100	8.3
Total	1,12,264	21,00,777	-

**Fig. 2. Global dragon fruit production (% share country wise) DRAGON FRUIT**

PRODUCTION STATUS IN INDIA:

In India, dragon fruit was introduced during the late 1990s (Arivalgan *et al.*, 2019). Thereafter, area under its cultivation was gradually increased from 4 to 400 ha in different states during 2005–2017 (Table 2). Initially cultivation of dragon fruit was started by the farmers from Karnataka, Maharashtra, Gujarat, Kerala, Tamil Nadu, Orissa, West Bengal, Andhra Pradesh, Telangana and Andaman & Nicobar Islands (Fig. 3). Nowadays, its cultivation has extended to Rajasthan, Punjab, Haryana, Madhya Pradesh, Uttar Pradesh and North Eastern States. According to recent estimates, India's dragon fruit production increased drastically to more than 12,000 MT over an area of 3,000–4,000 ha in 2020 (Table 3). The sudden rise in production and cultivated area are mainly because of states like Karnataka, Maharashtra, Gujarat, Telegana, Andhra Pradesh and West Bengal, which have taken initiatives to promote commercial production after 2018 onwards. Out of total 3,085 ha, more than 80% area (2,468 ha) is under new cultivation with less than 18 months old plantation. Further, average productivity of these areas is ranging from 1.5 to 3.1 MT/ha. While remaining 20% cultivation area (617 ha) is already well established and attained its full maturity level with average productivity of 8–13.5 MT/ha. Indian farmers, who follows good cultivation practices under drip irrigation, can get up to 4.5 tonnes of fruit per ha in the first year after planting, up to 7.5–10 tonnes/ha in the second years and 16–24 tonnes/ha on third year onwards.

Table 2. Year wise estimated area (ha) under dragon fruit cultivation in India

Years	Area (ha) under cultivation
1990	Introduced in India (0.5)
2005	4.0
2010	12.0
2012	15.0
2014	35.0
2017	400.0
2020	3,085.0 [#]

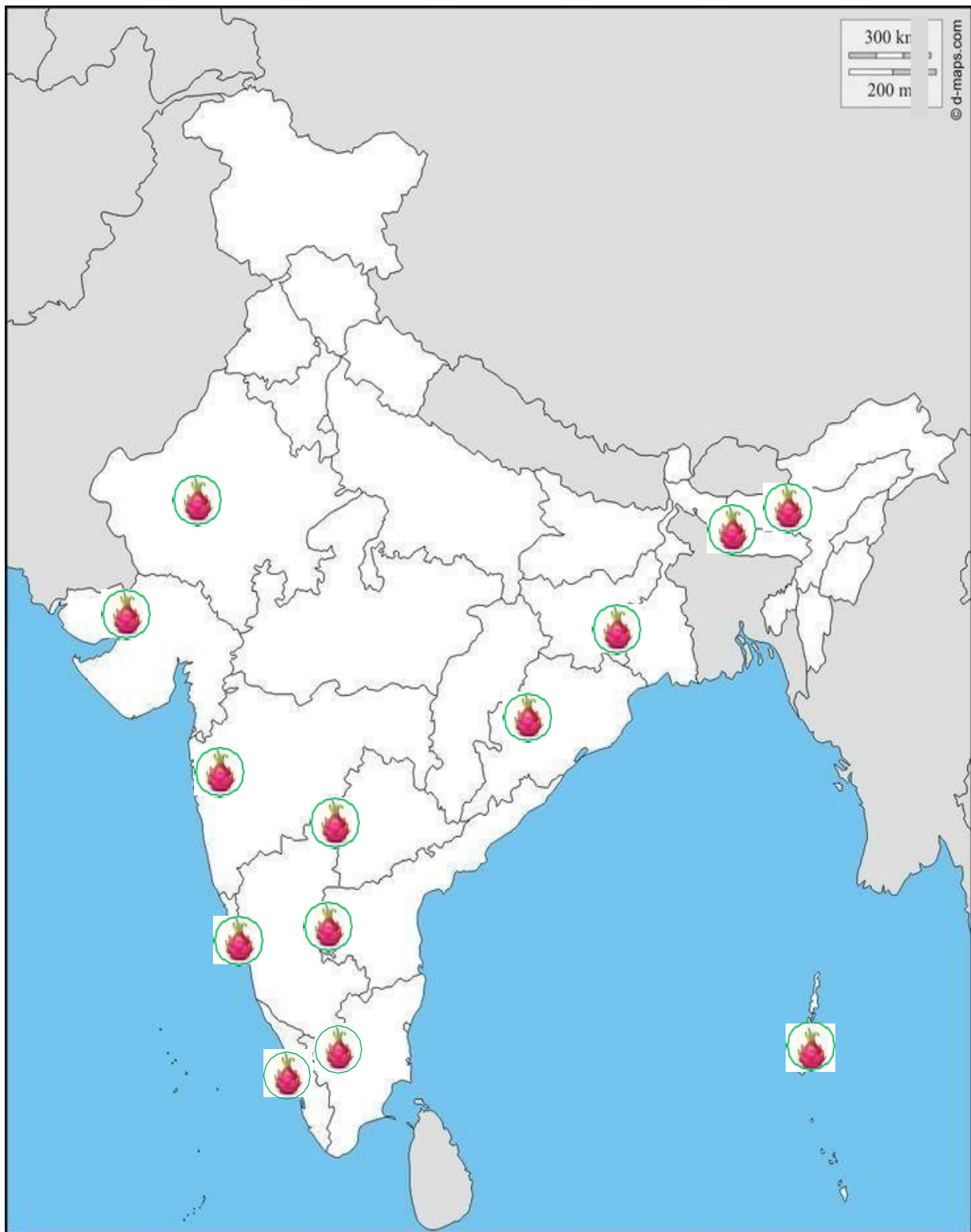


Fig 3: Major dragon fruit producing states of India

Gujarat, Karnataka and Maharashtra are the leading producers contributing about 70% of India's dragon fruit production (Fig. 4). The water scarce areas of Kutch in Gujarat, Northern Karnataka and Western Maharashtra are major dragon fruit growing regions of the country. Overall, southern and western states are contributing a major share for the production of dragon fruit since they have been growing dragon fruit during last 5–8 years. For example more than 600 farmers from Karnataka alone have taken up dragon fruit cultivation in the last five years after seeing the performance of the fruit. In Karnataka, area under dragon fruit cultivation was about 8–10 ha during 2012, amplified to about 500 ha in 2020 and it is likely to reach around 5000 ha in next five years. Presently over 200 farmers in Gujarat's Kutch are cultivating this fruit in approx. 800 ha of land.

Table 3. Major dragon fruit producing states (Estimated area, production and productivity, 2020)

Major States	Total Area (ha)	New area (ha) 80%, A1*	Product ivity of A1 (MT/h), P1	Produc tion in A1 (MT), Y1	Old Area (ha), A2	Product ivity of A2*, (MT/h) P2	Producti on in A2 (MT), Y2	Total producti on (MT) (Y1+Y2)
Andhra Pradesh	140.4	112.3	1.5	168.5	28.1	10.2	286.5	455.0
Telangana	80.9	64.8	1.8	116.6	16.2	10.0	161.9	278.4
Tamil Nadu	121.4	97.1	2.2	213.7	24.3	12.0	291.4	505.1
West Bengal	303.5	242.8	2.1	509.9	60.7	11.0	667.7	1177.7
Maharashtra	323.8	259.0	3.1	802.9	64.8	13.5	874.1	1677.1
Karnataka	485.6	388.5	3.0	1,165.5	97.1	12.4	1,204.4	2,369.9
Gujrat	1,214.1	971.3	2.2	2,136.8	242.8	8.0	1,942.5	4,079.3
Rajasthan	38.4	30.8	1.5	46.1	7.7	8.0	61.5	107.6
Meghalaya	174.0	139.2	2.8	389.8	34.8	11.4	396.8	786.6
Other	202.3	161.9	1.5	242.8	40.5	10.7	433.9	676.7
Total/ average	3,084.6	2,467.7	2.2	5,792.6	616.9	10.7	6,320.7	12,113.4

Note: A1* newly cultivable area after 2018–19 and A2* well established cultivable area more than 4 years olds plantation

The cultivation of dragon fruit increased to more than 400 ha in other parts of Gujarat state. Similarly, it can be estimated that about 250 farmers in Maharashtra growing dragon fruit over 200 ha areas in Western Ghats regions and remaining 100 farmers over 125 ha area in the rest of Maharashtra that includes Marathwada, Konkan and Vidharbha regions. Similarly, agriculture departments and SAUs of the few states viz., Andhra Pradesh, Telegana, West Bengal, Tamil Nadu and Meghalaya (Singh and Singh, 2017) are in the ways of popularising this crop in water scarce regions. There are several success stories of farmers indicating that dragon fruit already gaining popularity in different parts of India. This is also evident from the fact that many nursery owners have started propagation of planting material of dragon fruit. Most widely grown and commonly available cultivars of dragon fruit in India are the red skin-white flesh (93%) followed by red skin-purple/red flesh (6.5%) and yellow skin-white flesh (<0.5%). Overall, it is fast returning perennial fruit crop with economic production in the first year after planting, and full production within three to five years. It was also noted that after first years onwards desirable cultural management practices are highly essential. Although the initial investment is relatively high, profit is substantial within 4–5 years. The linear equation ($y = 508.33x - 1000000$, $R^2 = 0.84$) was used to estimate the projected area for the next five years up to 2025. These projections show that the area under dragon fruit cultivation is expected to rise more than ten times i.e. ~ 30,000 ha in next five years (Fig.5). Further, this rise in projected trend will depend on the market demands, consumer acceptability and government policies.

RESEARCH GOALS @ CUTM

- We are intending to cultivate dragon fruit organically with several treatment (nutrient) combinations. We shall explore which nutrient combination is emerging out as best for different quality and quantity parameters of dragon fruits.

(Note: Treatment administration details are not being disclosed as of now)

- Production of dragon fruit during off-season (October end- March beginning) by maneuvering lighting effects.

(Note: By installation of LED/ Solar lights)

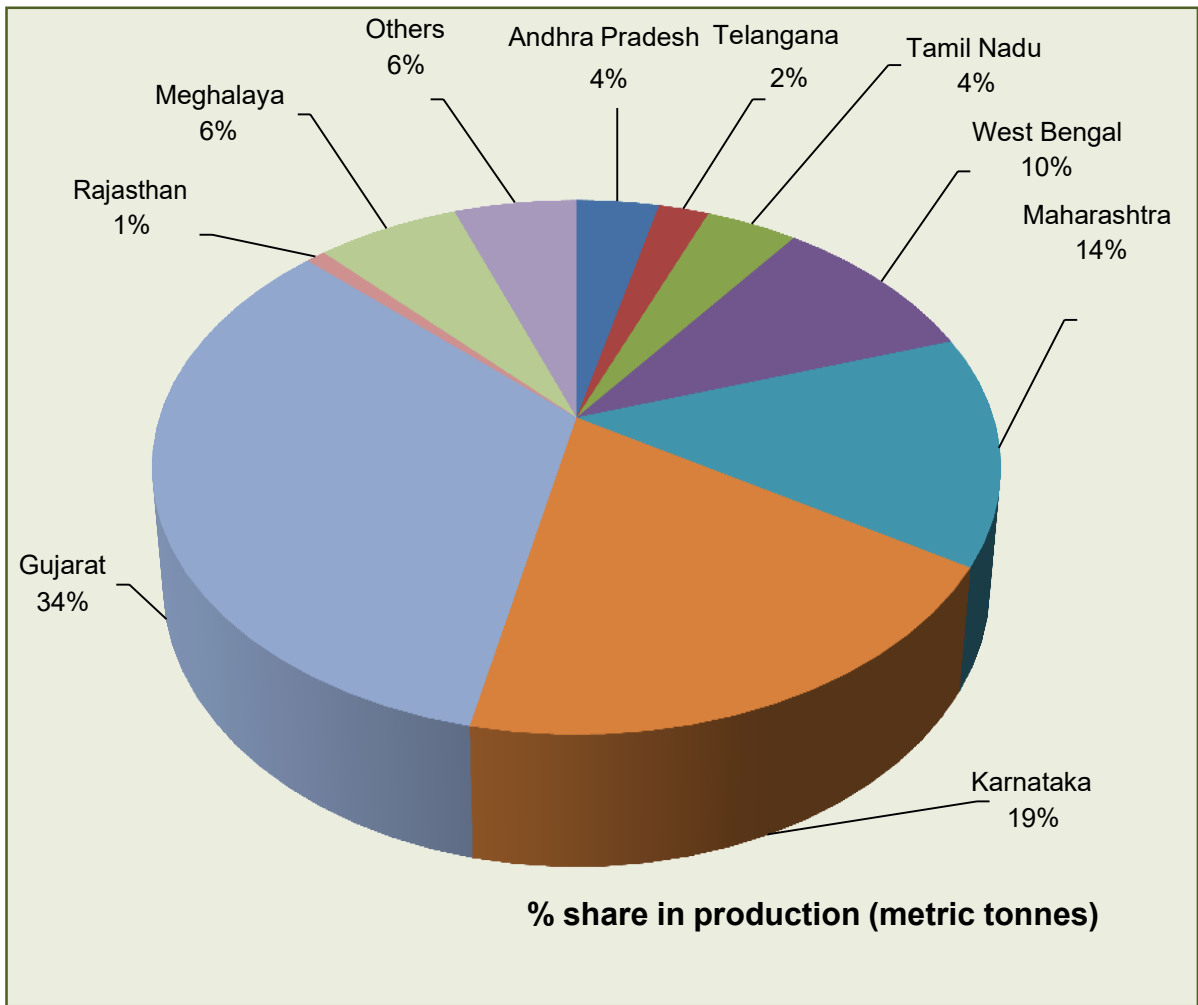


Fig 4: Estimated production of dragon fruit (% share state wise), India

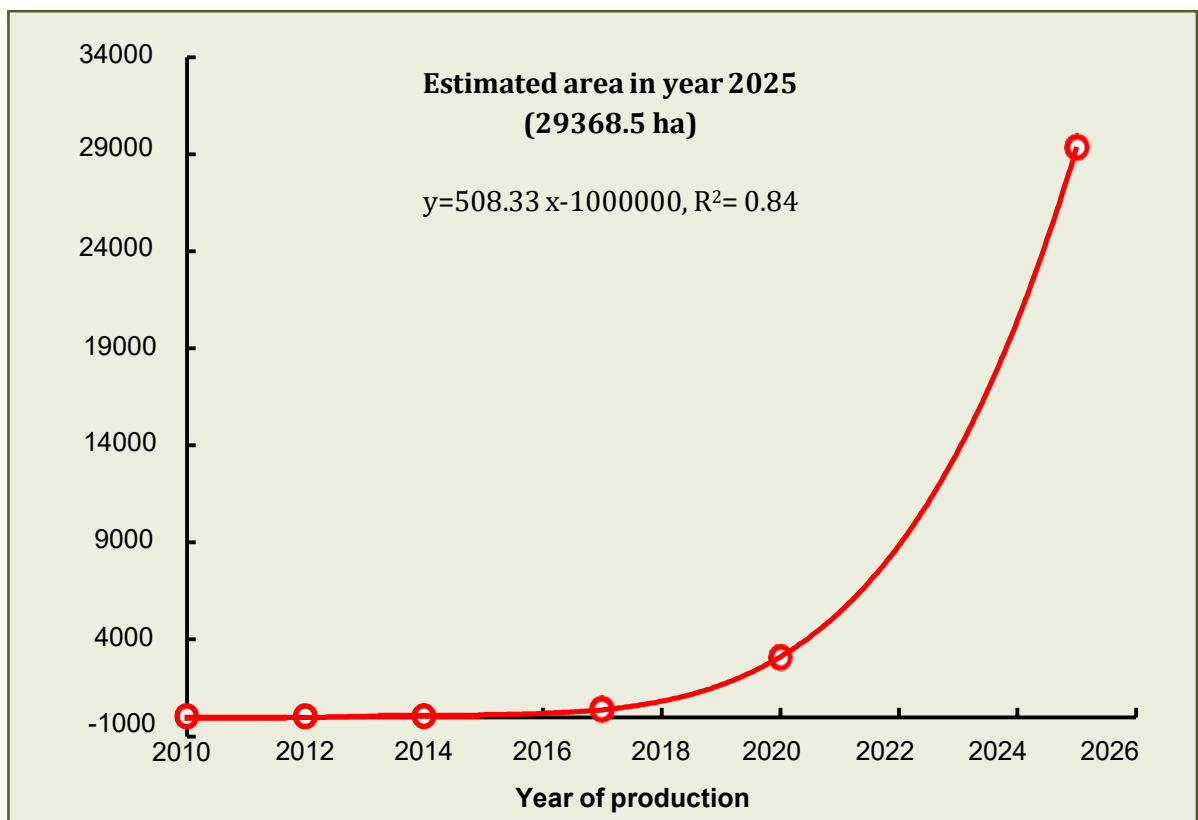


Fig 5: Projected area under dragon fruit cultivation for next five years (2025)

OBJECTIVES

- Make Odisha State a major producer of organic dragon fruits
- Formation of applied and action learning lab.
- Advance research on life cycle of dragon fruit.
- Pest and disease control of dragon fruit in an organic way.
- Crop cycle time reduction.
- Development of interbreed varieties.
- Popularizing dragon fruit cultivation as alternative farming to double the farmers' income and Co-create dragon fruit enterprises
- Backyard and roof top farming of dragon fruit for nutritional security.
- Production of planting material in a large scale under poly house condition and distribution among the farmers.

(Note: Plant propagation will be done by cutting and grafting)

- Popularization of this remunerative crop among the farmers of Gajapati district of Odisha through different capacity building programs.
- Development of a standard package of practice (POP) documentation for dragon fruit which is not standardized yet for the Gajapati district of Odisha.
- Cultivation of different types of dragon fruit gradually which are mentioned earlier and finding out which one is most suitable under the climatic condition of Gajapati district of Odisha.
- Post-harvest processing if possible at a later stage.

EDUCATION

Considering the climatic condition in Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands can be ideal for dragon fruit production. Besides, according to observation on the agro-physical characteristics of dragon fruit, the level of risk in producing the crop is lesser and to some extent more tolerant to adverse weather conditions as compared to the production of other high-value commercial crops like rambutan, mangosteen and durian. However, available sources of information on crop management and multiple cropping schemes integrating dragon fruit to other crops in location specific areas are still unavailable.

- We are going to develop a skill course syllabus for dragon fruit cultivation.

PACKAGE OF PRACTICES (PoP)

CLIMATIC REQUIREMENTS

It is very ideal to be grown in most parts of the India except the area less rainfall. The reported rainfall requirement of dragon fruit is 1145- 2540 mm/year. Dragon fruit plant prefers a dry tropical climate with an average temperature of 20-29° C, but can withstand temperatures of 38-40° C, and as low as 0° C for short periods. The plants are damaged at temperatures above 40° C, cause yellowing of the stem. Heavy rain fall areas are not suitable for the crop, as excessive rain causes flower drop and fruit drop.

SOIL REQUIREMENTS

Dragon fruit can be grown in wide range of soil types provided it is well drained. However, the most ideal soil type is rich in organic matter and slightly acidic. Since the area to be used is sub-marginal, organic fertilizer will be applied to patch up the lacking amount of organic substances in the soil. Dragon fruit plants prefer sandy loam with high organic matter and grow well in soil having good drainage.

PROPAGATION

Dragon fruit plants can easily multiply through stem cutting. Generally 20-25cm long stem cuttings are used for planting. These cuttings are planted in 12 cm × 30 cm size polyethylene bags, filled with 1:1:1 ratio of soil, farmyard manure and sand. The bags are kept at a shady place for rooting. Excess moisture should be avoided for prevention of rotting of cutting.

PLANTING

Dragon fruit cultivation prefers full sunlight open area is very suitable for planting. The shady areas are not suitable for dragon fruit planting. Generally in single post system planting is done at 3 m × 3 m distance. Single post vertical height of pole should be of 1.5 m to 2 m at which point they are allowed to branch and hang down. The dragon fruit may be planted near the poles to enable them to climb easily. Number of plants per pole may be 2 to 4 plants depending on the climatic condition. Lateral shoots must be limited and 2-3 main stems are allowed to grow. Because lateral shoots must be removed time to time. It is important to arrange round metal/concrete frame to maintain balanced shrub.

NUTRIENT MANAGEMENT

For better yield performance of the crop proper nutrient requirement is needed. Dragon fruit plant root system is superficial and can rapidly assimilate even the smallest quantity of nutrients. Mineral and organic nutrition is particularly advantageous and, when they are combined, their experiment conducted in BCKV, Kolkata, India for

different combination of N, P, K fertilizer doses revealed the dose of N 450: P₂O₅ 350: K₂O 300 perform best result for yield and quality.

(Note: Our trial will be fully organic)

IRRIGATION

Dragon fruit root system is shallow and distributed in 15 to 30 cm depth. Hence irrigation should be insured to provide enough water during dry season. Excessive irrigation may cause fungal disease. Therefore, proper drainage should be provided in rainy season. Frequent dry period without irrigation reduces the yield and quality of fruits. The dry period before flowering is required for production of more fruits. Local drip irrigation found beneficial for better yield and growth. Irrigation by flooding is not recommended as it wastes water and increases work of weeding. Approximately 2-4 liters of water weekly twice per plant is enough during the summer/dry days. Water requirement may increase or decrease depending upon soil, climate and plant health.

HARVESTING

The plants start yielding after 12-15 months from the date of planting and the fruit maturity can be optimized with the change of fruit epicarp color from green to red. Proper time of harvesting is found after seven days of color transition. The plants yield the fruits in the months between April to October and harvesting can be done three to four times in a month. The fruit weight is ranged between 300-800 g and the average yield from the single post is realized about 30 to 35 kgs from the three years old planting. Present farm gate price ranged between INR. 100-150 per kg.



Fig 6: Mother Block in Organic Research Farm @ CUTM Campus *for Cuttings.*



Fig 7: Nursery Soil mixture preparation



Fig 8: Planting of cuttings in poly bags



Fig 9: Eradication of weeds from the main field



Fig 10: Removal of Boulders



Fig 11: Land pulverization and labelling



Fig 12 & 13: Application of different organic amendments in the soil



Fig 14: Production of dragon fruit in organic research farm @ CUTM



Fig 15 & 16: Cut fruits of the Yield @ CUTM

ECONOMICS

Several documents are available on different platform about the cost of cultivation of dragon fruit/ acre that generally varies from 5-7 lakhs. As we are at nascent stage, so we started keeping records of all datas regarding several variable and non-variable input costs. Once, the planting will be done, we will come up with our own hands-on practice economic analysis of dragon fruit for 1 acre of land.

COMPOST OUT OF DF SKIN

There are several standard nutrient statuses are available of different organic compost but compost out of dragon fruit skin will be a new area of intervention and we intend to have a comparative study in terms of nutrients status of dragon fruit skin compost with other composts.

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