G Karunakaran[1], M Arivalagan[1], T Sakthivel[1], P C Tripathi[1], Pushpa Chethan Kumar[1], A Shameena[1], B M Muralidhara[2] and T Ruchitha[1]

Promising High Value Fruit Crops for Northeastern Region

Among the high value fruit crops, jackfruit, passion fruit, dragon fruit and avocado holds prime position for diversification as a commercial crop. The present market appeal and demand, growers' interests and consumers preference indicate that high value fruits have good potential for commercial exploitation in the near future; hence needs due attention. At present, the major market demand for these crops is from metropolitan cities in India, and market prices for these fruits varies between ₹ 150-300 per kg depending upon the grade and quality. Northeastern region has high potential of international quality grade fruits crops to produce with the bio diversity and suitable climate.

INDIA is blessed with varied agro-climatic conditions providing a scope for cultivation of high value fruit crops having national importance in the view of their nutritional value and potential market. Fruit crops like jackfruit, avocado, dragon fruit, passion fruit and rambutan, etc., has been successfully cultivating in India. Recently, cultivation of these high value fruits have gained substantial momentum due to steadily increasing market demand and compared to traditional fruit crops. Jackfruit, being an underutilized crop, has gained popularity in recent past due to emerging ethnic and mainstreaming marketing opportunities. Apart from ripe fruits, tender jackfruit is used as vegetable during early spring and summer because of its anti-diabetic property. Currently, there is an ever-increasing demand for new world fruit crops like avocado and dragon fruit; rich in nutritive value and plays significant role in human diet. People were significantly influenced by the COVID epidemic to switch from traditional fruit crops to high-value fruit crops after realizing their huge health benefits. However, commercial exploitation is yet to be done. Commercial production and processing for value addition of these crops would enhance the income of small and marginal farmers of Northeast India.

Jackfruit

Jackfruit is popularly known as poor man's fruit in the eastern and southern parts of India. India is the second largest producer of jackfruit in the world and is considered as the motherland of jackfruit. In India, it has wide distribution in Assam, Tripura, Bihar, Uttar Pradesh, the foothills of the Himalayas and South Indian States of Kerala, Tamil Nadu and Karnataka. The ripened fruit significantly contributes to the nutrition of lower income families as it is a good source of vitamins, minerals and calories. Presently, the regular varieties like yellow and white bulb fruits are not fetching premium price in market. Further, in substitution to existing varieties, ICAR-IIHR identified two elite lines having greater potential for commercial acceptability namely, Siddu and Shankara;

Siddu Jackfruit

Shankara Jackfruit

selection from farmers field of Tumkur, Karnataka known for their unique coppery red bulb colour and higher biochemical constituents. The jackfruit variety Siddu has average fruit weight of 2.44 kg/fruit; each fruit consisting 25-30 bulbs with carotenoids content of 4.43 mg/100g lycopene: 1.12 mg/100g and total phenolics: 31.76 mg Gallic acid equivalents/100g. The variety Shankara is also a clonal selection bearing fruits of 2-5 kg with 60 bulbs. The bulbs are sweet, crispy and coppery red in colour. It had total carotenoid content of 5.83 mg/100 g; lycopene: 2.26 mg/100 g and total phenolics: 37.99 mg GAE/100g. These varieties are suitable for commercial planting and home gardens. Further, fruits are highly palatable with tasty edible flakes, fetching premium price in the market due to their attractive coloured flakes, nutritional value and keeping quality.

Jackfruit has huge potential for value addition. In recent decades, number of scientific and economic interests have emerged to promote and commercialize the jackfruit products like jackolates, jackies, dehydrated raw jackfruit flour, squash, nectar and RTS, etc. Value addition in jackfruit helps in popularizing the fruit among the masses thereby creating supplementary income for stakeholders. New technologies and increasing moves by farmers and some NGO's to popularize this fruit are helping to raise the awareness regarding its production and economic value.

Avocado

Avocado is the most nutritive among fruits and is regarded as the most important contribution of the New World to human diet. The growing use of Avocado oils and fats in cosmetics is also a reason of increasing popularity of this fruit. The pulp is rich in proteins (up to 4%) and fat (up to 30%), but low in carbohydrates. Avocado is mainly used fresh, in sandwich filling or in salads. It can also be used in ice creams and milk shakes and the pulp may be preserved by freezing. Avocados can be grown on a wide range of soils, but they are extremely sensitive to poor drainage and cannot withstand water-logging. They are intolerant to saline conditions. Optimum range of pH is from 5 to 7. Depending on the race and varieties, avocados can thrive and perform well in climatic conditions ranging from true tropical to warmer parts of the temperate zone.

All three horticultural races i.e. West Indian, Guatemalan and Mexican of avocado have been tried in India. Mexican and Gautemalan races are grown successfully in humid mid hill of Himalaya. Several varieties such as Purple, Green, Fuerte, Pollock, Peradeniya Purple Hybrid, Trapp, Round and long are grown in India. In India commercial orcharding of avocado is raising exponentially. The total area under avocado cultivation in India was 1,328 ha in 2019-20, with a total production of 2,538 metric tonnes. Tamil Nadu is the largest producer of avocados in the country, followed by Kerala. It is also being cultivated in Sikkim, a state in North east Indian region at altitudes ranging between 800-1600 meters. The climate zone of avocados is from true tropical to warmer parts of the temperate zone. India imported 1,222 tonnes of avocados in 2020-21, with a value of $3.23 million (APEDA). The majority of avocado imports is used for the domestic market and is primarily consumed in urban areas.

Avocado is a very popular fruit crop in Mizoram; its fruits are in high demand due to its buttery texture and nutritive value. But the availability of the fruits is very less in the markets due to less area of production and very few commercial plantations of Avocado. Most of the avocado orchards in Northeastern region are rainfed and are seedling progenies which generally takes 5-6 years to attend bearing period. Presently, plantations are not well organized and they are scattered. There is a quantum jump in the area and production of avocado because of its growing awareness as a diet fruit among the consumers. Realising the advantages of avocado, serious attempts have been made during the last two decades to develop trait-specific superior types, popularise the cultivation of underutilised plants. Varietal improvement in Avocado has so far been limited to selection of regular bearing and high yielding genotypes with improved fruit quality. Upon continues effort two elite lines were released by ICAR-IIHR, Bengaluru which is today under commercial cultivation in India namely Arka supreme and Arka Coorg Ravi.

Arka Supreme

It is a regular bearing and high yielding seedling

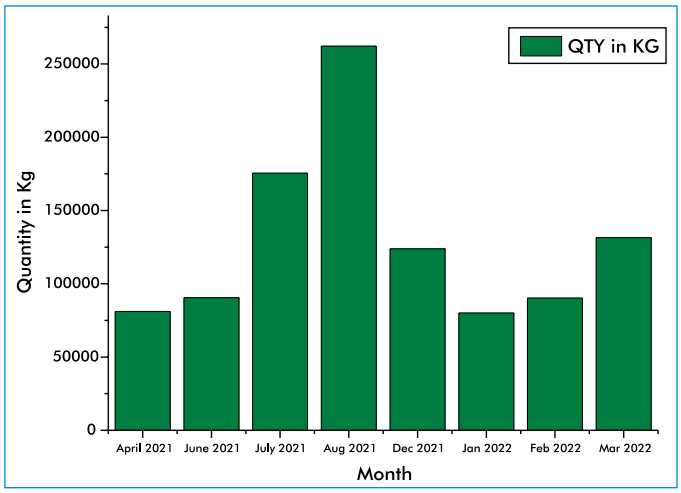

Fig. 1. Fruits imported (year wise)

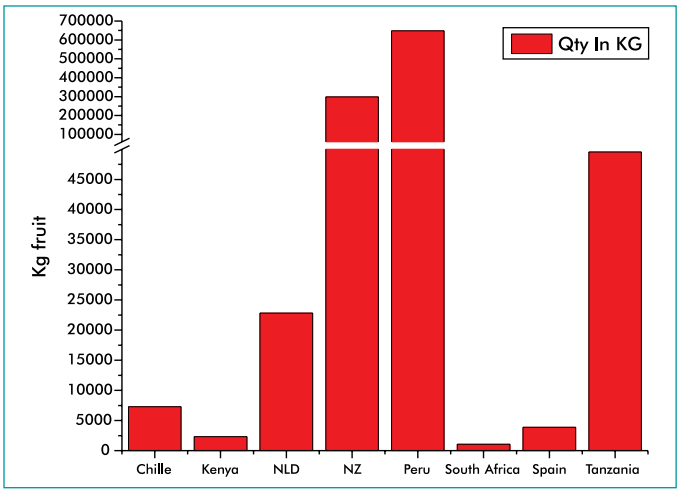

Fig. 2. Fruits imported (Country wise)



selection from local collection with spreading type growth habit. A fully grown tree gives the fruit yield about 200-250 kg/plant with average fruit weight of 367-428 g. The fruits are oblong with 7.80 Brix TSS. The flowering behaviour of this variety falls under Type "A" category. Total fat content is 20.0 %. Trees are Vigorous trees with spreading branches. The fruits are oblong, light green, pale yellow pulp with prominent lenticels on shoulders.

Arka Coorg Ravi

It is a regular bearing and high yielding seedling selection from local collection with spreading type growth habit. A fully grown tree gives the fruit yield about 150-200 kg/plant with average fruit weight of 450-600 g. The fruits are rhomboidal with thick base with 6.5 to 8.0 0 Brix TSS. The flowering behaviour of this variety falls under Type "B" category. The fat content is around 12 to 14 %. This variety showed tolerance anthracnose and scab disease.

Selection of these potential accessions besides increasing the area and production could also address the issues of sustainability and profitability frequently faced by growers, and also provide nutritional security that boost the region's economy.

Value addition and Processing

In order to commercialize avocado on a large scale, it is important to develop food products derived from this fruit with prolonged shelf life long. This would also promote the creation of processing plants, which in turn would generate new jobs, and increase the profit of the farmers. Products like Arka avocado chutney, bread spread and spray dried powder are available in market. Arka Spray dried avocado powder developed and commercialized by ICAR-IIHR, Bengaluru has typical avocado flavour, stable for more than 3-6 months at room temperature, without change in taste, colour (pleasant greenish yellow) or texture at ambient, when stored in aluminium laminated pouches is obtained. Product will ensure year-round supply of value-added Spray Dried Avocado Powder, which is convenient and flexible to use and transport.

Nevertheless, due to increasing health consciousness among the educated population and the high nutritive value of avocado, it is expected to find its rightful place in the Indian market in due course. Presently, there is concrete ideas to strengthen research and promotion of avocado in India for import substitution. Due to the availability of a large number of fruit crops in India and consumer preference for more palatable fruits of sweet taste; besides avocado has caught the imagination of the consumers for its nutrition security as a super fruit.



Spray drying- IIHR Technology

Dragon fruit

Dragon fruit is an herbaceous perennial climbing cactus, widely known as Pitaya, has recently drawn much attention among the Indian growers due to its economic value as well as numerous health benefits. Dragon fruits are currently being grown commercially in South East

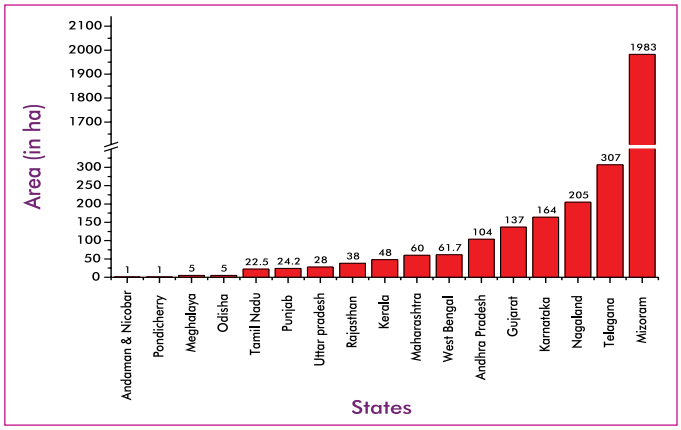

Fig. 3. Area under Dragon fruit cultivation in India (data as on 2021)

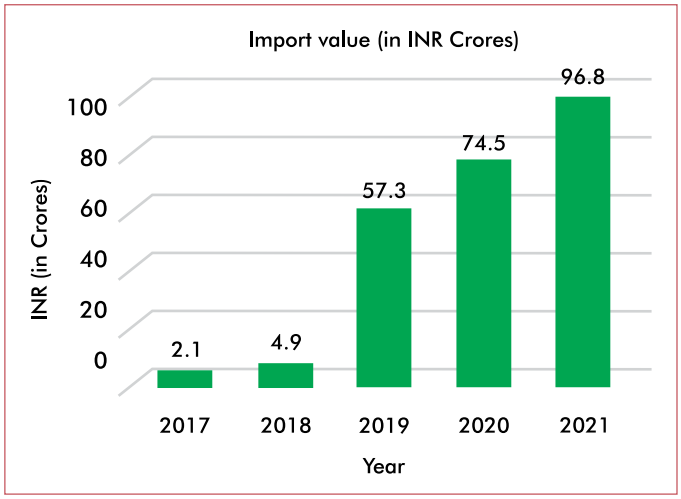

Fig. 4. Import of Dragon fruit, 2021

Asia and the USA. In India it was introduced during late 90s. Farmers of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, West Bengal, Nagaland and Mizoram have taken up dragon fruit cultivation successfully. Total area under dragon fruit cultivation is less than 5000 acres. More than 80% of this area has started cultivation from 2018-19 onwards. Majority of the dragon fruits available in India is imported from Thailand, Malaysia, Vietnam and Sri Lanka. In India, dragon fruit import was started during 2017 with a quantity of 327 tonnes with the value of ₹ 2.1 cr, which has increased sharply to 9162 tonnes in 2019 with the value of ₹ 57.3 cr. There is good scope for dragon fruit cultivation in India for import substitution.

Dragon fruit adapts well to tropical climates. It can be cultivated in tropical wet zone or intermediate zone as well as dry zone with the irrigation facilities. Heavy rain fall areas are partially suitable for the crop. Generally, an altitude up to 1500 m altitude is suitable for the cultivation. Three types of Dragon fruit types, *viz*., Red skinned fruit with white and pink/red pulp and third one has yellow skin with white pulp. Red and pink pulp cultivars showed better adaptability to a wide range of climate and yield potential compared to white pulp cultivars.

Value addition and processing

Presently, fresh juice of dragon fruit is sold in Indian market. Many value added products can be produced on commercial scale with attractive colour without adding any synthetic colour as fruit contains bright purplish to pink colour pigment. Different products include ready-to-serve beverage (RTS), squash, fermented beverage, jelly, osmotically dehydrated cubes or slices, frozen cubes or slices, ice cream, flavored milk and yoghurt can be prepared from the dragon fruit. Arka RTS beverage technology is developed and commercialized from ICAR-IIHR; Bengaluru can be helpful for startup business.

Techno-Economic Feasibility

Dragon fruit being a perennial climber requires natural or artificial support adjacent to them. Thus, the provision of properly designed artificial support is essential for the proper growth of the plant. At IIHR, Bengaluru, four different trellis systems (a single pole with cement ring, single pole with an iron ring, continuous pyramid stands, and 'T' stands) were evaluated for their suitability for the support system. Single pole system showed better performance in terms of growth and yield when comparatively other trellis systems.

A technology for off season production is in progress, trial has been initiated in farmers field for the producing off-seasonal fruits by adopting technology of LED bulbs (14w 1500 lumens). Further in dragon fruit it is very important to manage sunburn injury. To overcome this problem dragon fruits were grown under shade net house and anti-transpirants [kaolinite (50 g per litre of water) plus neem soap (4 g per litre of water) along with sea weed extract and humic acid (4 mL per litre of water)] were sprayed during the month of January, March and April resulted in reduction of damages caused by sun burn. Further, filler crop (drumstick/sesbania/glyricidia) can also give some level of control from the physiological injury. However, under heavy shade the plants may become etiolated with reduced flowering and production levels, thus minimal amount of shade is advocated to prevent bleaching of the stems. These technologies can be adopted for good horticulture practice in Northeastern regions.

Dragon fruit provides fast return with economic production in the first year after planting (1.5 t/acre accommodated 448 poles), and full production is attained within 3-4 years. The life expectancy of the crop is about 20 years. Initial investment for dragon fruit cultivation is comparatively high, and is mainly due to training system establishment. Estimated cost of establishment of one acre land for dragon fruit production is ₹ 5,90,000, which includes cost of land, single pole training system (about 450 Nos. at ₹ 1250/pole) and land preparation, etc. For the fully established orchard, the annual maintenance cost is about ₹ 3,65,500 per acre. Average economic yield after 2 years of planting is 6-8 tonnes per acre. At present the market rate is ₹ 70-120 per kg fruit, so the revenue generated by selling fruits is per year is ₹ 7 to 8 lakhs. Benefit Cost Ratio (BCR) is: 2.58. Marketability of Dragon fruit in India is expected to be very high because of limited number of commercial producers and high demand. Dragon fruit cultivation had been started from past few decades in Mizoram, Assam, Sikkim and Nagaland so that there can be availability of high value

Offseason technology

Training modules

fruits in local market and with income generation to the farmers. The climatic condition of Northeastern states is suitable for the cultivation of dragon fruit on a large scale, production and processing of this fruit crop improves nutritional and livelihood security.

CONCLUSION

The increase in area and production of future fruit crops in Northeastern states will not only strengthen nutritional security, but also assist in boosting the local economies and sustainable livelihoods. Empirical appraisal of agro-climatic requirements of the crop, appraisal of ecological plasticity of potential tropical and subtropical humid areas in parts of India through application of GPS tools for area expansion needs due consideration. Commercial production, optimizing post-harvest handling protocols and value addition of these crops would also enhance the income of small and marginal farmers.

For further interaction, please write to:
[1]ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India
[2]ICAR, Central Horticultural Experimental station, Chettalli, Karnataka, India
Email ID: avojack2023@gmail.com