

Mainstreaming of Potential Fruit Crops in Northeast India

The Northeast Region represents eight states, namely, Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Tripura, Nagaland, Tripura and Sikkim cover an area about 25.608 m ha consisting 7.79% of the national geographical area. The region has its unique combination of living species, habitats, and eco-systems, which together make up its diversity rich resources. The diverse climatic conditions of the region are conducive to the growth of a wide variety of tropical and temperate horticultural crops that are high in nutritional value. The region is one of the richest reservoirs of genetic variability and diversity of different horticultural crops, i.e. various kinds of fruits, vegetables, spices, ornamental plants, medicinal and aromatic plants.

HORTICULTURAL crops grown in Northeast (NE) region account for about 5.1% of fruits and 4.5% of vegetables in the national horticulture basket. Major fruit crops grown in the NE region which have commercial value are pineapple, citrus, banana, kiwi, passion fruit, mango, guava, litchi, papaya, lemon, orange, jackfruit, etc. The region possess huge opportunities to increase the area under cultivation, productivity, and value-addition through developing food processing industries based on these crops.

Mandarin orange is grown commercially in all the eight states of northeast. Assam lemon (*Citrus limon*) is one of the most important citrus crops of Assam and adjoining areas. This indigenous citrus has a unique aroma without seed, and bears round the year, having two peak seasons in a year. In the region, Banana has around 15 to 20 varieties available, the famous ones are Jahaji, Bor Jahaji, Chenichampa, Malbhog, and Amrit Sagar. The unique climatic and soil conditions favour pineapple cultivation in almost all the northeastern region. The Cachar district of Assam, famous for the Queen variety of

pineapple, has good potential for expansion of the area. Out of the major fruits in Manipur, pineapple contributes the highest production to the total fruit production. In Nagaland, pineapple grown is of excellent quality in terms of size, appearance, TSS and aroma, but the commercial cultivation is still in its infancy. Kiwi is a temperate fruit crop, which has shown tremendous potential in recent years, owing to its preference amongst the growers as well as the consumers due to its favourable properties for easy maintenance and marketing as well as having high nutritional and health-promoting attributes. Dragon fruit, being a highly remunerative crop has emerged as one of the promising fruit crops in NER, where the wide range of soil and climatic conditions suits its cultivation. In Mizoram, Hnahlan village, near the Indo-Myanmar border, noted for its extensive grape cultivation, is now striving to become the largest grape producing village in India. Around 80% of the villagers are engaging in grape cultivation and wine making.

This region enjoys the unique advantage of growing temperate fruits. Temperate fruits, viz. apple, pear, plum,

Major fruit crops of Northeast region

State	Fruits
Arunachal Pradesh	Apple, orange, kiwi
Assam	Banana, sweet orange, pineapple, arecanut, coconut, Assam lemon
Manipur	Pineapple, papaya, banana, lemon, sweet orange, passion fruit
Meghalaya	Pineapple, banana, sweet orange, passion fruit, strawberry
Mizoram	Orange, banana, papaya, grape, passion fruit
Nagaland	Pineapple, banana, sweet orange, passion fruit
Sikkim	Orange, passion fruit, kiwi
Tripura	Pineapple, banana, litchi, jackfruit, mangoes

Potential temperate fruit crops of Northeast region

State	Fruits
Arunachal Pradesh	Apple, peach, pear, plum, walnut, cherry, kiwi
Tripura	Passion fruit, kiwi, peach, pear, plum
Meghalaya	Strawberry, passion fruit, kiwi, peach, pear, plum
Mizoram	Apple, passion fruit, kiwi, strawberry
Nagaland	Apple, passion fruit, kiwi, peach, pear, plum
Sikkim	Apple, passion fruit, kiwi, peach, pear, strawberry

peach, kiwi, walnut, chestnut, strawberries, etc., are grown semi-commercially on a small scale in Arunachal Pradesh. In Arunachal Pradesh, barring apple, all temperate fruits are localized to homestead only. Young apple orchards are now coming up in few places above 1600 m. Plum (cv. Santa Rosa), Asiatic pear and peach are common backyard plants. High hills of West Kameng, Tawang, Ziro, Anini, Upper reaches of Anjaw, Upper Subansiri, West Siang, Upper Siang and Tirap are some potential areas suitable for promotion of temperate fruit production. In Meghalaya, temperate fruit cultivation is limited to homesteads, only Asiatic pear is semi-naturalized in the entire state. Peach and plum are common kitchen garden plants. Kiwi is becoming popular with few farmers.

Several fruits from Northeast India have already been given the GI registration, granting the region exclusive rights to produce them. These include Arunachal orange, Khasi mandarin, Tezpur litchi, Kachai lemon, Indian wild orange popularly known as 'Memang narang', Tripura Queen pineapple, etc. In the fruit export market, the region has established its existence by exporting a number of fruits. During 2020-21, from Assam, organically grown, juicy jackfruit, Assam lemon, plum, and star fruit, have been exported to Singapore. Tripura's jackfruit was exported to London. Assam's local fruit Burmese grape was exported to Dubai.

Diversity of fruit crops in Northeast India

The Northeastern (NE) region of India is a rich treasure of various *Citrus* species. Natural and undisturbed populations of citrus gene-pool observed during collection trips from time to time confirm the assumption that this area might be the center origin of several *Citrus* species. The region is also considered as original home of citrus species and parts of Assam and Meghalaya are located within "World Citrus Belt". As many as 17 *Citrus* species, their 52 cultivars and 7 probable natural hybrids are reported to have originated in the Northeastern region of India. Citrus plants growing in deep forests undisturbed by abiotic factors have also been reported from the region, thus bestowing this area with a special status of "treasure house" of *Citrus* germplasm. Besides two commercial species, viz. Khasi mandarin (*C. reticulata*) and Assam lemon (*C. limon*), many inedible and edible species are also grown.

The great diversity of soil and climate in this region offers optimum conditions for luxuriant production of different types of citrus species making it a natural respiratory for citrus species. The indigenous citrus

species found in the region are: Citron (*C. medica*), Ada Jamir (*C. assamensis*), Assam lemon (*C. limon*), pummelo (*Citrus grandis*), sweet orange (*C. sinensis*), mandarin (*Citrus reticulata*), Rangpur lime (*Citrus aurantifolia*), Hatkara (*Citrus macroptera*), Gol nemu (*Citrus jambhiri*), grapefruit (*Citrus paradisi*) and *Bor tenga* (*Citrus megaloxycarpa*) are distributed extensively throughout the region. Presence of three wild types of sweet orange (*C. sinensis*), viz. Soh Bitara, Soh Nairiang and Tasi in Meghalaya and Arunachal Pradesh provided strong evidence that most of the *Citrus* species originated in this region.

The Northeastern states of India are major hotspots of banana diversity. Due to the favourable climate, edaphic and market prospective, there is great potential to increase the production of banana in the region. Goalpara district of Assam is well-known for its commercial cultivation of banana and has tremendous potential for further area expansion. The bananas of this region is unique in the world. In addition to numerous cultivated triploids, *Musa acuminata* and *M. bulbisiana* diploids are found in semi wild state in this region. Maximum genetic variability of *Musa acuminata* and *M. bulbisiana* occurs in NE India. *M. flaviflora* is localized to Manipur and Meghalaya. ICAR-National Bureau of Plant Genetic Resources (NBPGR) in 1986 collected some of the important land races of banana (Seeded Ladiarit and Ladison, Rigitchi and other elite types, Hatigola, Eboke, Ginde, Egitchi and Essing) from Meghalaya. There are some other species found in Sikkim and Assam. The banana cultivars found in the region are Bhimkal, Athiakal, Bhog Manuhar, Honda, Malbhog, Cheni Champa, Champa, Saker Champa, Amrit Sagar, Agnisagar, Jahaji, Bor Jahaji, Kabuli Jahaji, Digjoa, Kachkal, Jatikal, etc. Each of these has its own appearance, taste, flavour and unique organoleptic qualities.

Northeast region is also said to be the native home of many mango (*M. indica* and *M. sylvatica*) species. Many species of mango are found in the wild in Tripura, Manipur, South Assam and Mizoram. The allied species of mango like *Mangifera sylvatica* and *M. foetida* are said to be indigenous to Assam and Arunachal Pradesh; while *M. khasiana* and *M. pentandra* are from Assam.

There are several distinct types of pineapple (*Ananas comosus*) viz. Joldhap, Bakhat, Ravanmuria belonging to the queen group of pineapple are available in the region. Pineapple is commercially grown in hill districts of Assam and Tripura. The region is also exceptionally rich in jackfruit germplasm. Both the cultivated (*Artocarpus heterophyllus*) and wild (*Artocarpus chaplasha*) type of jackfruit are available in the region. Jackfruit is common in Tripura, Meghalaya and Assam with a large number of cultivars.

Quite a good number of minor fruits are indigenous to the region and it is an indication of strength of the biodiversified fruit crops in the eight states of northeast India. These fruits are unique in taste, appearance, food value and medicinal properties. They are found to grow wild and semi-wild states and mostly concentrate in green forests and homestead gardens. Two species of *Elaeagnus*, viz., *E. latifolia* and *E. pyrifolia* are known to be grown in NE region. It is quite common in Sibsagar, Dikho valley, Naga Hills, Khasi and Jaintia hills. *Docynia indica* and *D.*

hookeriana are commonly found in the region. *Pyrus pashia*, a medium sized deciduous fruit tree is also found in the region. A number of indigenous fruits, viz. custard apple (*Anona squamosa*), wood apple (*Aegle marmelos*), carambola (*Averrhoa carambola*), sapida (*Baccaurea sapida*), indian star apple (*Chrysophyllum roxburghii*), elephant apple (*Dillenia indica*), amla (*Emblica officinalis*), bon mirika (*Embellica nutans*), black plum (*Eugenia jambolana*), rose apple (*Eugenia jambos*), olive (*Elaeagnus floribundus*), jackfruit (*Artocarpus heterophyllus*), flacourtia (*Flacourtia gangomus*), mulberry (*Morus accidus*), thereju (*Prunus jenkinsii*) are grown in the region.

Improved production technologies

Rejuvenation of old/senile peach trees: For rejuvenation of old/senile peach trees of more than 20 years old, it is selected and heading back primary branches leaving 50 cm on the main trunk to be carried out during November-December. The cut portion should be pasted with copper oxychloride and main trunk with Bordeaux paste, mixing 25 kg FYM and fertilizer, mulching of basin area with black polythene. After heading back, 10-15 new shoots will emerge in 30-45 days. The 2-3 new shoot/branch should be selected and remaining will be removed during March-April. It is then followed by terminal pruning of the selected shoot up to 50% of its length. The reproductive pruning of the shoots should be performed in October-November.

Early maturity and quality fruit production in peach cv. Flordasun: Profuse bearing of peach cv. Flordasun, resulted into excessive crop load of undersized fruits with impaired fruit quality and limb breakage. In addition, the ripening of this cultivar coincides with rains in late April which hampers fruit quality and marketability. To get rid of these problem fruit/fruitlets of cv. Flordasun should be thinned on 20 days after full bloom with spacing of fruits at 10 to 15 cm on shoot on the whole tree canopy. This advanced the fruit maturity by 12-14 days with an average fruit yield of 28.10 kg/tree.

Production of grafted/budded plants of Khasi mandarin: To increase the production of budded/grafted plants, the Division of Horticulture ICAR, Umiam, Meghalaya has standardized the wedge grafting technique, which is done in July-August on 6-7 month rootstock for the production of grafted plants with more than 80-85% plant survival. Thus, it is suggested to do wedge grafting during July-August on 6-7 months old rootstock. Rootstock left after grafting can be utilized for T-budding during February to extend the grafting/budding period up to 3 months with the use of available resources.

Off-season production of strawberry under low tunnels: Strawberry can be produced 30-35 days earlier than normal period, when planted in low tunnels of 50% shade net in July-August and the period of fruit availability may be extended to 47 days from normal when planted in November under UVS polythene tunnels. Normal fruiting period under open condition was 2nd fortnight of January to 2nd fortnight of March.

Stage-wise requirement of N and K in banana: The Department of Horticulture, Assam Agricultural University has standardized the Stage-wise requirement

of N and K in banana by applying 60% of N at planting to five-month stage, 20% of N at shooting, 20% of N at last hand opening to one month before harvest and potassium fertilizer: 40% of K at shooting to last hand opening and 60% of K at last hand opening to one month before harvest stage.

Lowcost structure for organic Kiwi multiplication: Semi-hardwood cuttings of 0.5-1.0 cm thickness with relatively short internodes and about 15-20 cm in length are most ideal and showed 70% rooting under low cost structure with the media composition of sterilized growing medium composed of perlite, vermiculite, cocopeat and vermicompost (1:1:1:1 ratio). Jute bags should be removed after 90 days planting of the cuttings.

Improved Cultivar Development

Papaya: Tripura Papita: ICAR Research Complex for NEH Region, Tripura Centre, developed a papaya cultivar RCTP1 which produce much higher average fruit yield per plant (63.25 kg/ plant). It has remarkably higher fruiting zone of 214.68 cm on an average. Average fruit size is 2.05 kg. Tolerant to Papaya Ring Spot Virus. Average Yield, 63.25 kg/plant

Guava: Megha Guava-1 (RCGH-1): It is a progeny of cross Sour Type x Red Fleshed. Plant growth was upright, erect with dark green broad leaves. Yield potential was 17-19 t/ha under mid hill condition. Fruits are medium size, globose, greenish yellow with red dots at ripening. Pulp is creamy white, soft seeded, rich in vitamin C (230.66-246 mg/100g), pectin (1.26-1.37%) and dietary fibres (3.41-3.52%). Fruits matured 8-12 days earlier than other varieties under mid hills and is suitable for table and processing purpose.

Megha Saw Priam (RCGH-4): It is a progeny of cross Red Fleshed X Allahabad Safeda, which was bred to develop coloured high yielding guava variety. It has semi-spreading growth habit with yield potential of 11-14 t/ha under mid hill condition. Fruit is medium to big in size; fruit shape is elliptical to ovate with greenish yellow at maturity. Pulp is red and it can products viz., jam, jelly, juice, and RTS can be prepared.

Megha Khongpheram Paudiik (RCGH-7): It is a progeny of cross Lucknow-49 X Pear Shaped guava. Variety has drooping growth habit suitable for high density planting with yield potential of 12-15 t/ha under mid hills. Fruits are medium size, light green at maturity. Pulp is creamy white with less and soft seeded (107-119 seeds/100g fruit weight), high in sugar (7.96-8.39%), pectin (1.29-1.40%) and phenol content (358.14-369.00 mg GAE/100g) suitable for table and processing purpose.

Megha Priam Thiang (RCG-11): It is a seedling progeny selection from Meghalaya for low seed content. Plant growth is semi spreading type with yield potential of 11-13 t/ha under mid hills. Fruits are sweet (TSS: 11.88-12.50 OB) with low seed content (42-55 seeds/100 g fruit wt), rich in pectin (1.28-1.32%), phenol content (330.65-340.11 mg GAE/100 g) and vitamin C (207-215.33 mg/100g) suitable for table and processing.

Mainstreaming of Minor Fruit Crops

Several of the edible minor fruit crops are growing

in wilderness in Northeastern states. Several of them nutraceutically rich and also used in traditional medicinal systems. With the increasing demand for fruits, these underutilized fruit crops need to be brought under systematic and commercial cultivation, so that they can enrich the fruit basket and become the source for value-addition and export.

Blood fruit (*Haematocarpus validus* (Miers.) Bakh. f. ex. Forman): It belongs to the family Menispermaceae. In India, it is naturally distributed in Tripura, Meghalaya, Assam, Arunachal Pradesh, Sikkim, West Bengal and Andaman and Nicobar Islands. Fruits of this species are relished by the local masses for sweet-sour blood red pulp, hence the local names Roktogota, *khoon phal* or *rakta phal*. It is a woody climber and it is very popular among tribes in the Northeastern states, Andaman and Nicobar Islands and Bangladesh. The fruit is not only tasty and rich in anti-oxidants but it is also a good source of dye for the local handicraft industry. Blood fruit is known to be a good source of iron and carotene. In the Northeastern Indian states, the species is valued ethno-botanically for preparation of beverages, dyeing local handicrafts and also in traditional medicines.



Burmese Grape (*Baccaurea ramiflora*): It is a slow-growing evergreen tree in the family Phyllanthaceae, growing up to 25 m, with a spreading crown and thin bark. It is native to Asia, from Nepal in the west, east to southern China and south to Peninsular Malaysia. It grows in evergreen forests on a wide range of soils. The fruit is oval, yellowish, pinkish



to bright red or purple, 2.5–3.5 cm in diameter, glabrous, with 2–4 large purple-red seeds, with white aril. The fruit is harvested and used locally, eaten as a fruit, stewed or made into wine; it is also used medicinally to treat skin diseases. The bark, roots and wood are harvested for medicinal uses.

***Donella lanceolata*:** It is a plant species in the family Sapotaceae, a tree growing up to 30 m tall, with a trunk diameter of up to 40 cm. The bark is grey to dark brown. Inflorescences bear up to 45 flowers. The fruit is brownish to purplish-black, ripening yellow, round, up to 4 cm in diameter. Raw fruits are brown to purplish black, sub-globose fruit is usually 15–20 mm in diameter, but can be up to 40 mm. The roots and leaves are used medicinally.



***Elaeagnus pyrifomis*:** It is a much-branched, deciduous shrub with stems that are often scandent, clambering into neighboring trees. It is scattered in East Asia - Himalayas of northeastern India. The fruit of many members of this genus is a very rich source of vitamins and minerals, especially in vit. A, C and E, flavonoids and other bio-active compounds. It is also a fairly good source of essential fatty acids, which is fairly unusual for a fruit. It is being investigated as a food that is capable of reducing the incidence of cancer and also as a means of halting or reversing the growth of cancerous cells. The fruit is used to relieve constipation. The plant is harvested from wild for local use as food and medicine. The fruit is commonly sold in local markets.



Elephant Apple (*Dillenia indica*):

It is an evergreen large shrub or small to medium-sized tree growing to 15 m tall. It is native to southeastern Asia, from India and Sri Lanka east to southwestern China and Vietnam, and south through Thailand to Malaysia and Indonesia. The leaves are 15–36 cm



long, with a conspicuously corrugated surface with impressed veins, like potato chips. The flowers are large, up to 5 inches across, with five white petals and numerous yellow stamens. Flowers arise solitary at the ends of the twigs, facing downward. The sepals are rounded and yellowish-green. The fruit is a 5-12 cm diameter aggregate of 15 carpels, each carpel containing five seeds embedded in an edible pulp. The fruit pulp is used in Indian cuisine in curries, jam, and jellies.

Hatkora Lemon (*Citrus marcoptera*): It is also known as Satkara is one of the most important under exploited and endangered species of *Citrus* found in Northeast India. It is tight-skinned citrus type popularly grown in Northeast states like Manipur, Tripura, Assam and Mizoram as a popular

spice fruit crop. In Manipur locally known as Heiribob, is an important spice crop for making fish curry and other spicy dishes. In Assam it is used as medicinal plant by the local people. Besides, it is used in the perfume



industry for the extraction of oil from its peel. In Meghalaya, both Garo and Khasi tribes use peel and fruit juice for culinary and pulp for pickle. Among the Northeastern States, it is more costly in Manipur as compared to other states due to more consumption among the people as a spice. Fruits, leaves, and stems contain phytochemical like limonene, beta-caryophyllene, beta-pinene, geranial edulinine, ribalinine and isoplatydesmine, which are useful for antioxidant, cytotoxic, antimicrobial and thrombolytic.

Sohiong (*Prunus nepaulensis*): It is a species of bird cherry (family, Rosaceae) native to the eastern foothills of the Himalayas, including Nepal, Myanmar and China. A tree can reach 27 m and can grow between 1800 and 3000 m above sea level. The fruit is cultivated in Assam, Ukhrul district in Manipur, and Meghalaya. Its wood is used locally for making furniture, grown in different parts of Northeast India. The edible fruits are rich in several bioactive compounds, such as quercetin, quinic acid, rutin, scopoletin, naringenin and are often used for making fruit juice, jam, squash and assorted wines. Further, the fruits are used as an astringent, and the leaves are a diuretic agent and are used for oedema.

Tara Palm (*Calamus erectus*): It is also known as Viagra palm and locally as tynriew, tara, and zhi li sheng teng, is a flowering shrub in the family Arecaceae. The genus *Calamus* is native to India and Nepal east to northern Laos and southern China. It is found scattered in the states of Arunachal Pradesh, Mizoram, Sikkim, Assam, West Bengal, Manipur and Meghalaya. It grows wild in lower hill forests, especially on drier slopes, and

grows frequently in the Teesta and Rangit valley of West Bengal and Sikkim. The fruit contains rich amounts of vit. C, A, E, calcium, magnesium, and phosphorus. In Assam plains, the cane is used along with bamboo to make huts and leaves for thatch of huts. The stems and leaves are also used by them to make poultry houses, while seeds are chewed in the place of betel nuts. It is sometimes used in folk medicine, as it is considered to hold antioxidant and anti-diabetic properties.



Future Strategies

- Large scale generation of quality planting material of elite cultivars with major focus on establishment of mother / Scion Blocks of improved varieties with provision for good quality root stock banks.
- Replacement of low yielding traditional varieties with resistant and high yielding varieties especially dwarf stature suited for high-density plantation.
- Adoption of hi-tech horticulture includes micro-propagation, micro-irrigation, fertigation, protected cultivation, organic farming and use of remote sensing to ensure nutritional security for future generation.
- Adoption of advanced techniques of agriculture like crop diversification, contract farming, precision farming, and fruit based farming system and reach the unreached in real time for high value fruit crops.
- Genetic erosion is very serious problem in non-traditional fruits and many land races will become extinct if these are not conserved soon. Domestication of potential wild species through homestead cultivation should be encouraged for avoiding over-exploitation from natural sources.
- In order to reduce post-harvest losses at production centers, low cost eco-friendly on-farm storage structures should be made. Also, standardization of packing line operations and proper packaging of different commodities are of urgent need.
- Development of proper market linkage from the farmers to the retailers in order to facilitate remunerative price to the farmers at production site.

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