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REVIEW ARTICLE

Fruit Crops and Their Varietal Wealth in the Northeastern Region of India: Current Status and Prospects

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Abstract

The Northeast region comprises eight states: Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Tripura, Nagaland, and Sikkim. This region spans approximately 25.608 million hectares, accounting for 7.79% of the total geographical area of the country. The area boasts a distinctive array of living organisms, habitats, and ecosystems, collectively contributing to its rich diversity of resources. The region's varied climatic conditions support the cultivation of numerous tropical and temperate fruit crops that are highly nutritious. It serves as one of the most abundant sources of genetic variability and diversity among various horticultural crops, including a wide range of fruits, vegetables, spices, ornamental plants, as well as medicinal and aromatic plants. Here in this review paper, we have attempted to summarize the genetic and varietal wealth of important fruit crops that are being grown in these northeastern states of India. Also, the trend in the area and production of fruit crops in northeastern states in the last 10 years has been discussed. This document will help students, researchers, academicians and policy makers to formulate any future planning related to research and development of fruit crops in these areas.

Keywords: Fruits, Horticulture, North-east, Varieties.

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Introduction

The Northeast region (NE) of India, which includes the states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland, and Sikkim, can be classified physiographically into three main areas: the Eastern Himalayas, the Northeast hills (comprising the *Patkai-Naga* Hills and *Lushai* Hills), and the plains of the Brahmaputra and Barak Valleys situated at the intersection of the Indo-Malayan, Indo-Chinese, and Indian biogeographical realms, the NE region is distinctive for its abundance of habitats, showcasing a wide variety of flora and fauna with a significant degree of endemism. The NE region exhibits significant variations in altitude and topography, which facilitate the presence and distribution of biodiversity within the area (Dutta *et al.,* 2018). Although *jhum* cultivation, a traditional agricultural practice, is frequently cited as a contributing factor to the region's deforestation, it remains a vital economic activity for local tribes, who cultivate 35 different crop varieties (Dutta *et al.,* 2016; Lungmuana *et al.,* 2018). The Indian Council of Agricultural Research (ICAR) has recognized the region as a significant center for rice germplasm, while the National Bureau of Plant Genetic Resources (NBPGR) in India has noted its abundance of wild relatives of crop plants. Additionally, this area is acknowledged as the origin of citrus fruits. The region boasts a wealth of medicinal plants and numerous rare and endangered species. Its significant levels of endemism among higher plants, vertebrates, and bird species have earned it the designation of a biodiversity 'hotspot'. In 1995, the International Union for

Conservation of Nature (IUCN) recognized Namdapha in Arunachal Pradesh as a center of plant diversity (Chatterjee *et al.,* 2006).

Major and underutilized fruit crops represent a significant portion of the biodiversity found in these regions. In the NE region, which is home to the country's most diverse fruit crops, there is a notable variety of citrus, banana, and jackfruit. Additionally, a wide range of other temperate, tropical, and subtropical fruits from genera such as *Pyrus*, *Rubus*, *Ribes*, *Prunus*, *Garcinia*, *Artocarpus*, *Phyllanthus*, *Annona*, *Averrhoa*, *Persia*, *Aegle*, *Passiflora* and *Tamarindus* have also been documented in this area. The local population primarily utilizes these underutilized fruits for medicinal purposes, and they hold significant socioeconomic value in the rural lives of tribal communities, serving as sources for furniture wood, firewood, fodder, dyes, oils, and various other value-added products (Rai *et al.,* 2005; Deka *et al.,* 2012; Singh *et al.,* 2014). The literature has been extensively reviewed by various authors regarding the fruits of NE India, focusing on their ethnomedicinal applications, socioeconomic significance, and strategies for conservation (Dutta *et al.,* 2018). Numerous studies have documented the geographical distribution and ethnomedicinal applications of various local fruits; however, there is a lack of comprehensive reports regarding the diversity of existing fruit crop varieties. For decades, some of the commercial varieties of fruits have occupied significant positions in the socioeconomic growth of these areas. A preliminary investigation into the reporting of the diverse varieties of major and locally cultivated fruit crops was deemed essential to uncover the potential fruit crop varieties found in the remote and difficult-to-access regions of the country. In this review paper, we aim to provide a comprehensive overview of the diverse varieties of significant fruit crops cultivated in the northeastern states of India. This document is intended to assist students, researchers, academics, and policymakers in developing future strategies for the research and advancement of fruit crops in these regions.

Biodiversity of Fruit Crops in the NE Region

The NE region is a significant reservoir of genetic variability and diversity among various crops, particularly different types of fruits and plantation crops (Table 1). This diversity in fruit crops has primarily been preserved and managed by local farmers, with a notable contribution from women. There is substantial variation among the fruit species in this region, encompassing differences in plant types, morphological and physiological traits, responses to diseases and pests, as well as adaptability and distribution patterns. In addition to their nutritional benefits, many local fruit crops are utilized for medicinal purposes and play a crucial role in income generation and poverty alleviation initiatives in rural communities (Rai *et al.,* 2005).

The region is home to a variety of citrus species, showcasing significant genetic diversity. Researchers have identified 17 citrus species along with 52 cultivars and several potential natural hybrids from this area. Notably, there are 32 distinct strains of lemon. The indigenous species include *C. limon, C. medica, C. jambhiri, C. ichangensis, C. latipes, C. macroptera, C. assamensis, C. indica* and *C. aurantium*. Additionally, the Indian wild orange, *C. indica*, is found in the Naga hills and Meghalaya (Bhattacharya and Dutta, 1956). The highest genetic diversity of *Musa acuminata* and *M. balbisiana* is found in NE India. *M. flaviflora* is specifically found in the regions of Manipur and Meghalaya. Additional species are present in Sikkim and the *Khasi* Hills, which require systematic collection and conservation efforts. Several native *Mangifera* species can be located in Tripura, Manipur, Mizoram, and South Assam. The Indo-Burma region is also considered the center of diversity of mango. A cultivar named '*Rangkuai*' is found in the border village of India with Myanmar near the *Koladyne* River. The wild varieties of *M. indica* and its related species, *M. sylvetica*, are found in Arunachal Pradesh, while *M. khasiana* and *M. pentandra* are located in Assam. A significant variety of species is found within the genera *Pyrus, Rubus, Ribes* and *Prunus*. The Shillong plateau, located in the *Khasi* hills of Meghalaya, is home to several *Prunus* species, including *P. napalensis, P. undulata* and *P. cerasoides*. The variety of *Pyrus pyrifolia* var. cubha makai (also known as *P. serotina* Red) is cultivated semi-commercially in Meghalaya, Manipur, and other regions. Additionally, wild kiwi species, such as *Actinidia callosa* and *A. stragosa* thrive in the natural forests of Arunachal Pradesh and Sikkim (Rai *et al.,* 2005). Numerous tropical and subtropical fruits from the genera *Garcinia, Artocarpus, Phyllanthus, Annona, Averrhoa, Persia, Aegle, Passiflora* and others, as shown in Table 1, thrive in the wild within the region. Among the several edible plant species identified in the NE region, several are highly valued by various tribal ethnic groups. Two species of *Elaeagnus*, specifically *E. latifolia* and *E. pyriformis*, are known to thrive in this area (Pandey, 2002). These species are prevalent in *Sibsagar* (*Dikho* Valley), the Naga Hills, as well as the *Khasi* and *Jaintia* Hills. Additionally, *Docynia indica* and *D. hookeriana* are commonly found throughout the region. *Pyrus pashia*, a medium-sized deciduous fruit tree, is also present in the northeastern region (Rai *et al.,* 2005).

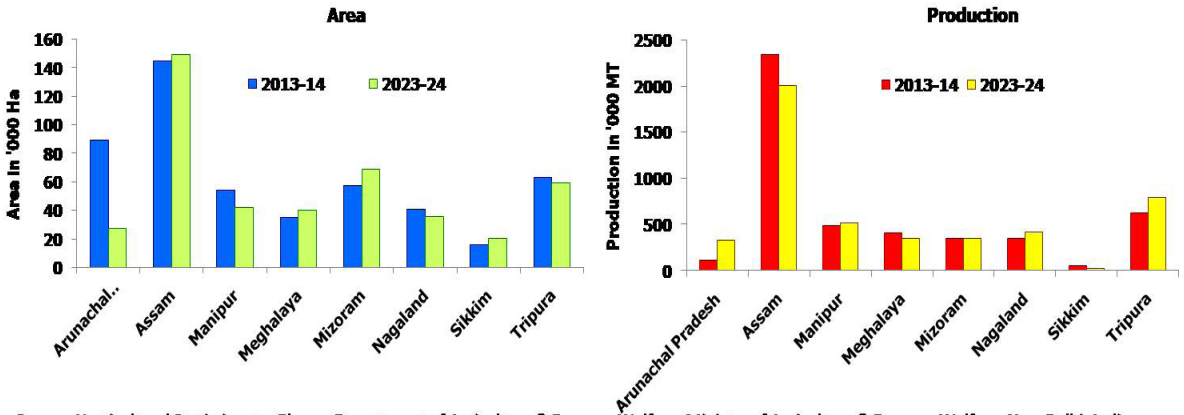
Area and Production of Major Fruit Crops

The whole NE region can be divided into six agroclimatic zones which are the alpine Zone (>3500 m), temperate sub-alpine zone (1500–3500 m), sub-tropical hill zone (1000–1500 m), sub-tropical plain zone (400–1000 m), mild tropical hill zone (200–800 m) and mild tropical plain zone (0–200 m). The alpine zone is found in Arunachal Pradesh and Sikkim and major crops here are wild strawberries, sea buckthorn, blueberries, raspberries and other wild nuts. Temperate sub-alpine zones are found in Arunachal Pradesh,

Meghalaya, Manipur, Sikkim, Mizoram, and Nagaland; here apple, pear, peach, plum, walnut and kiwifruit are mostly grown. Sub-tropical hill zones are found in the states of Arunachal Pradesh, Assam, Meghalaya, Sikkim, Mizoram, and Nagaland; here mango, lemon, guava, banana, strawberry, and passion fruit are mostly grown. Mild tropical hill zones are found in the states of Arunachal Pradesh, Assam, Meghalaya, Sikkim, Mizoram, Tripura and Nagaland; in these areas, pineapple, mandarin, banana, papaya, litchi, areca nut and coconut are the major fruit crops. Mild tropical plain zones are found in almost all the northeastern states; here, pineapple, litchi, mango, banana, jackfruit, citrus and cashew nut are the major fruit crops. The area and production of fruit crops in northeastern states in the last 10 years (2013-14 to 2023-24) are presented in Figure 1. Over the last 10 years, the area of fruit crops has increased in the states of Assam, Meghalaya, Mizoram and Sikkim, while it has decreased in Arunachal Pradesh, Manipur, Nagaland and Tripura. Production of fruit crops has increased in the states of Arunachal Pradesh, Manipur, Mizoram, Nagaland and Tripura, while it has reduced in Assam, Meghalaya and Sikkim. As per the data of Horticultural Statistics at a Glance, Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, New Delhi, India, Assam, followed by Mizoram and Tripura, records the maximum area, whereas Assam, followed by Tripura and Manipur, records the maximum in production. In the year 2023-24, the NE region recorded an area of 442.20 thousand Ha and production of 4758.05 thousand MT.

Soil and Climatic Conditions

The NE region of India includes the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. This region is situated between latitudes 21.5°N and 29.5°N, and longitudes 85.5°E and 97.5°E. The area is classified as a high rainfall zone, with a climate that varies from subtropical to alpine. It encompasses two primary river basins, the Brahmaputra and Barak, and exhibits a significant reliance on natural resources among its population, coupled with underdeveloped infrastructure. The region is marked by a variety of climate patterns that are heavily influenced by the southwest monsoon, which occurs from June to September. Rainfall amounts differ across locations, with *Mawsynram* (Meghalaya) recording a maximum in a single day. The number of rainy days varies significantly, ranging from 80 days in *Jharnapani*, Nagaland, to 181 days in Tadong, Sikkim. Additionally, the region features challenging terrain, considerable differences in slopes and altitudes, diverse land tenure systems, and a variety of agricultural practices. The agricultural system is primarily rainfed, characterized by subsistence-level mono-cropping that is highly susceptible to climate fluctuations. Slash-and-burn agriculture continues to be practiced in nearly all states, except Sikkim, on steep slopes, with a reduced cycle of 2 to 3 years compared to the previous 10 to 15 years, leading to adverse effects on both soil quality and climate (Verma *et al.,* 2015). This region is characterized by monocropping practices that yield low agricultural production, which is insufficient to support the livelihoods of impoverished tribal farmers. Reports indicate that traditional *jhum* farming results in a loss of 76.6 tons of soil per hectare per year. Soil erosion associated with *jhum* cultivation on slopes of 60 to 70% has been documented, showing losses of 147, 170, and 30 tonnes per hectare per year during the first, second, and third years of abandonment, respectively. The area faces significant challenges related to land degradation, soil acidity, and severe erosion due to the current *jhum* farming practices employed by tribal communities. Notably, severe soil acidity (pH <5.5) is widespread in this region, representing approximately 54% of India's acid soils. Soil acidity plays a critical role in influencing nutrient availability for crops and often leads to mineral stress issues. Additionally, the extent of soil erosion in *jhum* cropping varies significantly from year to year, largely influenced by rainfall patterns (Kumar and Meena, 2016).



Source: Horticultural Statistics at a Glance, Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, New Delhi, India

Figure 1: Area and production of fruit crops in northeastern states in last ten years (2013-14 to 2023-24)

Table 1: Botanical name, English name, vernacular name, family and parts used of some of the fruit crops in northeastern India

S. No.	*Botanical name*	*English name*	*Vernacular name*	*family*	*Parts used*
1	*Aegle marmelos* (L.) Correa.	Golden apple	*Bael*	Rubiaceae	Fruit and leaves
2	*Aglaia edulis* A. Gray	Aglaia	*Sanulahsune*	Meliaceae	Fruit
3	*Annona squamosal* L.	Custard apple	*Sarifa*	Annonaceae	Fruit, bark, root and leaves
4	*Artocarpus heterophyllus* (*A. integrifolia*)	Jack Fruit	*Rukh katar*	Moraceae	Fruit and leaves
5	*Artocarpus lakoocha* Wall.ex Roxb.	Monkey fruit	*Badar phal*	Moraceae	Fruit, leaves and latex
6	*Baccaurea ramiflora* Lour	Burmese Grape	*Kusum*	Euphorbiaceae	Fruit, wood, seed leaves and bark
7	*Calamus erectus* Roxb.	Rattan fruit	*Fakery*	Arecaceae	Fruit, shoot and seed
8	*Carica papaya* Linn.	Papaya	*Mewa*	Caricaceae	Fruit, leaves and seed
9	*Castanopsis hystrix* Miq.	Chestnut	*Kattus*	Fagaceae	Fruit and leaves
10	*Citrus maxima* (Burm.) Merr.	Pomelo	*Phoksey*	Rutaceae	Fruit, leaves, flower and seed
11	*Citrus medica* L	Citron	*Bimbira*	Rutaceae	Fruit, seed, leaves, flower and shoot
12	*Citrus reticulata* Blanco.	Mandarian orange	*Suntala*	Rutaceae	Fruit and flower
13	*Dillenia indica* L	Elephant apple	*Ramphal/Panchphal*	Dilleniaceae	Fruit, leaves and root
14	*Diospyros virginiana*	Persimmon	*Halle Beth*	Rubiaceae	Fruit and leaves
15	*Diploknema butyraceae* Roxb. Lam.	Indian Butter Tree	*Chuirii*	Sapotaceae	Fruit, seed and leaves
16	*Docynia indica* (Wall.) Decne.	Docynia or Assam apple	*Mehel*	Rosaceae	Fruit
17	*Elaeagnus latifolia* L.	Himalayan Silverberry	*Musleri/Maldhero*	Elaeagnaceae	Fruit
18	*Elaeocarpus sikkimensis* Rox b.	Sikkim Quandong	*Badrasey*	Elaeocarpaceae	Fruit
19	*Ephedra gerardiana* Wall. ex Klotzsch & Garcke	Indian joint-fir	*Somlata*	Ephedraceae	Fruit
20	*Ficus hirta* Vahl.	Hairy fig	*Khasre*	Moraceae	Fruit
21	*Ficus racemosa L.*	Cluster fig	*Dumri*	Moraceae	Bark, root, leaf, fruit and latex
22	*Ficus roxburghii* Wall.	Fig	*Nebaro*	Moraceae	Fruit, leaves and gum
23	*Ficus semicordata Buch-Ham*	Fodder fig	*Khaniu*	Moraceae	Fruit and root
24	*Fragaria nubicola* (Hoof.f) Linn.	Himalayan strawberry	*Bhui aiselu*	Rosaceae	Fruit, rhizome and leaves
25	*Garcinia cowa* Roxb.ex Choisy.	Cowa or Brindal berry	*Kaphal*	Clusiaceae	Fruit, leaves and root
26	*Grewia elastica* Roxb.	Grewia	*Kunsung*	Tiliaceae	Fruit
27	*Helicia nilagirica* Bedd.	Not found	*Bandre*	Proteaceae	Fruit, leaves and bark
28	*Heracleum nepalense* D. Don	Hogweed (cow parsnip)	*Chimphing*	Apiaceae	Fruit, seed and root
29	*Hippophae rhamnoides Linn*	Sea buckthorns	*Chuma/Durchuk*	Elaeagnaceae	Fruit, leaves and seed.
30	*Holboellia latifolia* Wall.	Sausage vine	*Golpha*	Lardizabalaceae	Fruit and leaves
31	*Juglans regia* L.	Wild Walnut	*Okher*	Juglandaceae	Fruit, leaves and wood
32	*Litchi chinensis* Sonn.	Sapindanceae	*Lychee*	Sapindanceae	Fruit
33	*Litsea cubeba* (Lour) Pers.	Mountain Pepper	*Siltimur*	Lauraceae	Fruit and leaves
34	*Machilus edulis* King ex Hook.f.	Wild Avocado or Pumsi	*Pumsi/ Lapche kaulo*	Lauraceae	Fruit and leaves
35	*Malus sikkimensis*	Sikkim crabapple	*Aiphal*	Rosaceae	Fruit
36	*Mangifera sylvatica Roxb.*	Himalayan mango	*Chuche anp*	Anacardiaceae	Fruit

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S. No.	Botanical name	English name	Vernacular name	family	Parts used
37	*Morus alba* Wall.	Mulberry	*Kimbu*	Moraceae	Fruit, leaves and bark
38	*Musa balbisiana* Colla	Sweet wild banana:	Bankera.	Musaceae	Fruit, root and leaves
39	*Passiflora edulis* Sim.	Passion Fruit	*Grenadelle,*	Passifloracerae	Fruit
40	*Phyllanthus emblica* L.	Indian gooseberry	*Amala*	Phyllanthaceae	Fruit, leaves and root
41	*Prunus cerasoides* D. Don	Wild Himalayan Cherry	*Painyuu*	Rosacea	Fruit, seed, gum, wood, branch, leaves and twig
42	*Prunus domestica* L.	Plum	*Arru bhakara*	Rosaceae	Fruit
43	*Prunus persica* Batsch	Peach	*Arru*	Rosaceae	Fruit
44	*Psidium guajava* linn.	Guava	*Ammuk*	Myrtaceae	Fruit and leaves.
45	*Pyrus pashia* (Buc h.-Hamex Don.	Pear	*Naspati*	Rosaceae	Fruit
46	*Rhus chinensis*	Chinese sumac	*Bhakimlo*	Anacardiaceae	Fruit
47	*Rubus ellipticus* Sm.	Yellow Himalayan raspberry,	*Aiselu*	Rosaceae	Fruit and root
48	*Saurauia napaulensis* DC	Gogan	*Gogun*	Saurauiaceae	Fruit
49	*Spondias axillaris* Roxb.	Hog Plum	*Lapsi*	Anacardiaceae	Fruit and bark
50	*Spondias pinnata* (L.f.) Kurz	Indian hog plum	*Amara*	Anacardiaceae	Fruit
51	*Syzygium kurzii*	Not found	*Ambakey*	Myrtaceae	Fruit and leaves
52	*Tamarindus indica* L.	Tamarind	*Titri*	Fabaceae	Fruit
53	*Terminalia bellirica* (Gaertn.) Roxb.	Bedda nut tree	*Barra*	Combretaceae	Fruit
54	*Terminalia chebula* Retz.	Chebulic Myrobalan	*Harra*	Combretaceae	Fruit, bark and seed
55	*Tetradium fraxinifolium* (Hook.) T.G.Hartley.	Euodia, Evodia, or Bee bee tree	*Khanakpa*	Rutaceae	Fruit, seed and wood
56	*Trichosanthes tricuspidata* Lour.	Redball snake gourd	*Indreni*	Cucurbitaceae	Fruit, seed and leaves
57	*Vaccinium corymbosum* L.	Blueberry	*Chasey/Khekea*	Ericaceae	Fruit
58	*Viburnum erubescens* Wall	Reddish viburnum	*Asaare*	Adoxaceae	Fruit
59	*Zanthoxylum acanthopodium* DC.	Andaliman/lemon pepper	*Bokey timbur*	Rutaceae	Fruit and bark

The NE region of India is experiencing significant challenges due to heavy rainfall during the monsoon season, which leads to soil erosion and flooding in the valleys. The steep terrain exacerbates the issue of drought during the winter months, particularly from November to March. In recent years, there has been a noticeable decline in young Mandarin orchards throughout the entire NE region. Over the past 15 to 20 years, irregular rainfall patterns, rising temperatures, and fluctuations in relative humidity have contributed to the emergence of new biotypes among various insect and pest species affecting many fruits and vegetables. These changes have adversely impacted the flowering, fruiting, production, and overall productivity of these crops (Jha *et al.,* 2015).

Varietal Suitability for Different Areas

Varied agro-ecological conditions characterize NE region; therefore, a variety of fruit crops and varieties are grown in these areas. These improved fruit crop varieties have been introduced over the last few decades and some have been introduced very recently. As these areas were remote, inaccessible and fragile, therefore these areas remained isolated from the mainland for a longer period of time. With the advent of modern infrastructure, many improved fruit crop varieties have been introduced in these areas from the rest of the country. For example, kiwifruits were introduced during the 1960s from the north-western Himalayan region; similarly, avocado was introduced by the kings in Sikkim. Table 2 provides the list of improved varieties of different crops grown in the eight states of northeastern India.

Fruits as Ethnomedicine

Although the NE region is recognized as a global biodiversity hotspot, it has not been extensively studied. The indigenous communities in this area highly value wild edible fruit plants, which also serve as a vital source of ethnomedicine. In a case study conducted in Sikkim (Table 2, data not previously published by the author), 76 individuals from 23 villages

Table 2: Major fruit crop varieties for northeast region

State	*Fruit*	*Varieties*
Arunachal Pradesh	Apple	Black Bendavis, Royal Gala, Jonathan, Red Gold, Gani Gala, Rich-A-Red, Royal Delicious, Red Delicious, Golden Delicious, Cooper- IV, McIntosh, Crofton, Granny Smith, Starkrimson, Fokla, Ruspippin, Rajakori, Ganu and Mutsu
	Orange	Wakro orange, Valencia, Mosambi, Soh-niang Riang and Dambuk
	Kiwifruit	Allison, Bruno, Hayward, Monty, Jintao, Chuhong and Sanuki Gold
	Peach	TA-170, Flordasun, Shan-e-Punjab and Sharbati.
	Pear	High Hills: Bartlett, Red Bartlett, Flemish Beauty, Max Red Bartlett, Starkrimson, Conference' and Clapp's Favourite Mid, Low hills and Valley areas: Patharnakh, Kieffer, William, Lagoon, Fertility, Baggugosha, Punjab Beauty and Punjab Gold
	Plum	Santa Rosa
	Pineapple	Kew, Giant Kew, and Queen (Mauritius)
Assam	Banana	Malbhog, Jahaji, Bar Jahaji, Chenichamma, Kanaibansi, Saapkal, and Garo Moina
	Sweet orange	Valencia, Westin, TM-33, Cutter Valencia, Pera and Natal
	Pineapple	Kew and Queen
	Arecanut	Mohitnagar and Shatamangala
	Coconut	Assam Tall, Kamrupa, West Coast Tall (WCT), inter-varietal hybrids (D × T and T × D) and Chandrasankara (COD × WCT)
	Lemon	Assam lemon
	Guava	Megha Supreme, Megha Magenta, Megha Wonder, Megha Seedless, Allahabad Safeda, Sardar and Red Fleshed
	Jackfruit	Mostly local, Singapore Jack and Rudrakshi
	Mango	Amrapali, Malika, Lengera, Dasahari, Himsagar, Palmar and Red Palmar
	Sapota	Cricket Ball, Kalipatti and Pala
Manipur	Pineapple	Queen and Kew
	Papaya	Red Lady, Ameena, Red Baby, Lunar, Indus Honey Gold, Indus Red Sun Dwarf and Sarpan Solo-109
	Banana	Laphu, Robusta, Rasthali and Red Banana
	Peach	Pratap, Florda Prince, Shan-i-Punjab, Earli Grande, Prabhat, and Punjab Nectarine
	Lemon	Kachai Lemon (Kachai Champra)
	Sweet orange	Tamenglong orange
	Passion fruit	Yellow, Purple and Kaveri
Meghalaya	Pineapple	Kew and Queen
	Guava	Megha Guava-1 (RCGH-1), Megha Saw Priam (RCGH-4), Megha Khongpheram Paudiik (RCGH-7), Megha Priam Thiang (RCG-11), Megha Supreme, Megha Wonder, Megha Magenta and Megha Seedless
	Banana	Dwarf Cavendish, Jahaji, Chenichampa and Malbhog
	Mandarin	Khasi Mandarin
	Sweet orange	Mosambi
	Passion fruit	Purple and yellow type
	Strawberry	Winter Dawn, Festival, Ofra, Camarosa and Sweet Charlie
	Soh-iong (*Prunus nepalensis)*	Local types
	Soh-phie (*Myrica nagi)*	Local types
Mizoram	Mandarin	Khasi Mandarin
		Sweet Charlie, Ofra, Camarosa and Festival
	Banana	G-9 and local types

Cont...

State	*Fruit*	*Varieties*
	Papaya	Pusa Nanha, Pusa Delecious and Honey Dew
	Grape	Bangalore Blue and Pusa Navrang
	Passion fruit	Purple, Yellow, Hybrid and Giant
	Hatkora (*Citrus macroptera*)	Local types
	Chenkek (*Garcinia cowa)*	Local types
	Star aonla (*Phylanthus acidus)*	Local types
	Soh-shang (*Elaegnus latifolia)*	Local types
Nagaland	Pineapple	Kew and Queen
	Banana	G-9, Jahaji and Pisang abok
	Sweet orange	Mosambi
	Mandarin	Khasi mandarin
	Passion fruit	Purple
	Jackfruit	Local types
	Litchi	Shahi, Tezpur seedless and China
	Plum	Santa Rosa
	Kiwifruit	Hayward, Monty, Allison and Bruno
Sikkim	Mandarin	Sikkim mandarin
	Passion fruit	Yellow, Purple and Kaveri
	Kiwifruit	Hayward, Allison, Monty, Bruno, Tomuri and local genotypes.
	Avocado	Hass, Furete, Zutano, Pinkerton and Arka Supreme
	Peach	Pratap, Florda Prince, Shan-i-Punjab, Earli Grande, Prabhat and Punjab Nectarine
	Pear	High Hills: Bartlett, Red Bartlett, Flemish Beauty, Max Red Bartlett, Starkrimson, Conference' and Clapp's Favourite Mid, Low hills and Valley areas: Patharnakh, Kieffer, William, Lagoon, Fertility, Baggugosha, Punjab Beauty and Punjab Gold
Tripura	Pineapple	Queen and Kew
	Banana	Shabri Kela, Martaman, Malbhog, Samai/Gopi/Bangla Kela-1, Samai/Gopi/Bangla Kela-2, Champa Kela, Mizo-Cavindish, Katch Kela, Kanai Basi, Red Banana, Attia Kela, AthiaKol and Bhimkol.
	Litchi	Shahi and Bombai
	Jackfruit	Local, Baramasi
	Mango	Amrapali, Himsagar, Fazli and Arunika
	Papaya	Tripra papaya (RCTP1), Honey Dew and Pusa Delecious
	Sapota	Calcuttia and Cricket Ball
	Lemon	Kagzi local, Ellaichi lemon and Gandharaj
	Dragon fruit	Red and white fleshed
	Avocado	Hass and Furete
	Sweet orange	Mosambi
	Mandarin	Jampui Kamala
	Pummelo and Grape fruit	Local types
	Strawaberry	Winter dawn and Festival

were interviewed, encompassing a diverse age range of 45 to 75 years, with both male and female participants. The study identified 59 species of fruit, belonging to 48 genera and 32 families. These local wild edible fruits are known to treat a variety of ailments, including gastrointestinal issues (such as dysentery, diarrhea, ulcers, vomiting, and constipation), fever, bronchitis, diabetes, jaundice, toothaches, anemia, swellings, skin disorders, bone fractures, itching, conjunctivitis, viral infections, urinary conditions, tuberculosis, heart diseases, and more. Similar findings have been reported by numerous researchers globally, particularly in the northeastern Himalayan region.

Among the families studied, Rosaceae was the most prevalent, comprising 14% of the total genera, followed by Moraceae (12%), Rutaceae (8%), Anacardiaceae (7%), Combretaceae (5%), and Elaeagnaceae, Fabaceae, Lauraceae, Myrtaceae, and Rubiaceae, each contributing 3%. In terms of socioeconomic significance, wild fruits are predominantly utilized in rural areas for traditional medicine, firewood, construction, animal feed, and charcoal production. These fruits are typically available in local markets, priced between ₹60 to 300 per kilogram. It is advisable to conserve the diverse range of edible wild fruit plants for future use, as certain species can be cultivated in marginal soils.

Germplasm Conservation and Utilization Efforts

The conservation of germplasm in fruit crops is crucial for ensuring the stability of global food systems and protecting agricultural biodiversity. Maintaining genetic diversity in fruit crops is vital due to the increasing threats from climate change, new diseases, and habitat destruction. The active preservation of diverse varieties through both *in-situ* and *ex-situ* methods is necessary for cultivating resilient and adaptable fruit crops. These innovative plant genetic resources (PGRs) present opportunities for the identification of new genes. Present conservation approaches focus primarily on *in-situ* conservation, which includes participatory plant breeding. There are ongoing collaborative international initiatives aimed at enhancing and regulating the global accessibility of PGRs. Alongside the trade-related intellectual property rights framework, recent endeavours also address issues such as the unfair nature of unrestricted access, plant breeders' rights, the Convention on Biological Diversity, prior informed consent, and global action plans (Gautam *et al.,* 2004). Global partnerships and increased public awareness are essential for addressing financial limitations and ethical issues. The future of germplasm conservation in fruit crops relies on a comprehensive strategy that includes community involvement, advanced technological solutions, and international collaboration to promote sustainable agriculture and enhance the resilience of these crops against evolving environmental challenges.

Future Directions

The selection of high-value, low-volume fruit crops tailored to specific areas, along with the horizontal expansion of improved agricultural practices on cultivable wasteland, aims to enhance productivity at a rate of 7.14 lakh per hectare in the region (De, 2017). This initiative includes replacing low-yielding traditional varieties with high-yielding, disease-resistant varieties, particularly dwarf cultivars suitable for high-density planting. To support this effort, the production of adequate planting materials has to be facilitated through tissue culture techniques and other propagation methods, both in field and protected environments. Nurseries have to be established in each district or block, managed by state horticulture departments, certified growers, farmer-producer organizations, farmers' clubs, or progressive farmers. Additionally, training sessions and workshops have to be organized to disseminate orchard management practices that enhance production and maximize yields. To promote organic nutrient management, production sites for organic compost have to be set up in each identified area. Training on Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Integrated Disease Management (IDM), Integrated Organic Nutrient Management (IONM), Integrated Organic Pest Management (IOPM) and Integrated Organic Disease Management (IODM), will also have to be introduced in these regions. Furthermore, the concept of *Jalkund* (water storage structures), drip irrigation, and other water harvesting techniques will have to be taught to ensure life-saving irrigation. Post-harvest management, processing, and value addition of surplus produce have to be conducted at the block or district level. The adoption of high-tech horticultural practices, including micro-propagation, micro-irrigation, fertigation, protected cultivation, organic farming, and remote sensing, will be crucial for ensuring nutritional security for future generations. Advanced agricultural techniques such as crop diversification, contract farming, precision farming, and fruit-based farming systems have to be implemented to reach underserved areas in real time for high-value fruit crops. Additionally, the development of wholesale and rural markets at the district level, in proximity to urban centers and various agri-export zones has to be established for the North Eastern Region.

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