



Citrus in North Eastern India: Challenges and Future Prospects

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North-eastern India (NEI), a global biodiversity hotspot comprising eight states, is part of the centre of origin of citrus and harbours rich genetic diversity, including several native citrus species. Despite this inherent potential, the region's citrus productivity remains low, contributing only 5.04% to national production while accounting for 11.27% of the total citrus area in India. Although Mizoram leads in area under cultivation and Assam in production and productivity, the region overall suffers from declining wild citrus populations, genetic erosion, nutrient-deficient soils, citrus decline, and limited post-harvest shelf life. Socio-economic and anthropogenic factors—such as shifting cropping preferences, habitat destruction, and unsustainable harvesting—further exacerbate the problem, along with the erosion of traditional ethnobotanical knowledge. Species-specific ecological niche modelling indicates continued climatic suitability for key citrus species across parts of Arunachal Pradesh, Assam, Meghalaya, Mizoram, Tripura, and Manipur, highlighting strong prospects for conservation and expansion. Recent initiatives such as GI tagging of Kaji Nemu and Khasi Mandarin and their international market presence demonstrate the region's potential for premium branding and export. To unlock this opportunity, a multipronged strategy is essential, including: production of elite disease-free planting material; development of Citrus-Based Integrated Farming Systems; rejuvenation of senile orchards; scientific orchard management; robust cold chain infrastructure; processing industries for citrus by-products; strengthened FPOs; and coordinated institutional support. With growing domestic demand, export prospects, and wide applications in food, pharmaceutical, cosmetic, and aroma industries, NEI is well-positioned to emerge as a major citrus hub, provided systematic interventions strengthen the entire citrus value chain from conservation to commercialization.

Introduction

North-eastern India (NEI), comprising eight states, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, is a biodiversity hotspot. The region is a part of the centre of origin of citrus. In spite of having high genetic diversity, the yield of citrus remains very low in the region. Export-Import data showed that India is a net importer of citrus fruits. This creates ample opportunity for scientific citrus cultivation in the NEI. In India, 11,20,090 ha area is under citrus cultivation with 1,49,23,720 Tonnes production. However, NEI comprises 11.27% area with only 5.04% of production. Among the northeastern states, Mizoram has the highest acreage under Citrus, but Assam enjoys the highest production and productivity.



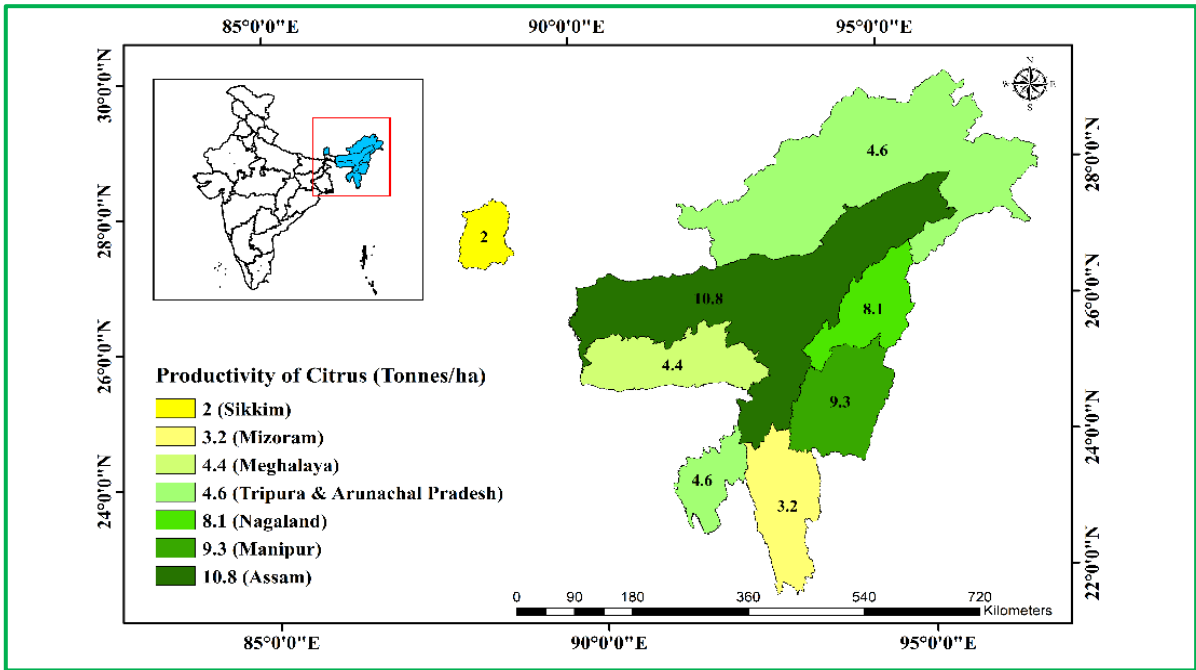


Fig. 1: Productivity of citrus in the northeastern states of India

Table 1: Citrus area and production among North-Eastern States

Sl. No.	States	Area ('000 ha)	Production ('000 Tonnes)
1.	Arunachal Pradesh	12.79	58.93
2.	Assam	27.54	296.48
3.	Manipur	12.01	112.07
4.	Meghalaya	14.05	62.16
5.	Mizoram	28.84	91.24
6.	Nagaland	6.85	55.72
7.	Sikkim	13.27	26.70
8.	Tripura	10.94	49.97
9.	North East India Total	126.29	753.27
10.	India Total	1120.09	14923.72

Source: 2024-25 Second Advance estimate

Challenges and possible strategies for citrus promotion in North East India

North Eastern India is considered to be the natural home of many citrus species, landraces and hybrids. Five native species (*Citrus indica* Tanaka, *C. medica* L., *C. latipes* (Swingle) Tanaka, *C. hystrix* DC., and *C. cavaleriei* H. Lév. ex Cavalerie) (Hazarika, 2012; Hynniewta et al., 2014) are found in NEI. From time immemorial, these wild and semi-wild citrus are entangled with the culture of people of the region. But, a rapid decline in wild citrus population causes great concern regarding genetic erosion. This was mainly due to anthropogenic factors like changing attitude of the farmers towards some newly introduced cash crops (Hazarika, 2012), small-scale of domestication of *C. indica* Yu. Tanaka and other species remain confined to natural habitats and destruction of natural habitats (Upadhaya et al., 2016), multiple nutrient deficiencies in soil due to soil erosion, coupled with early onset of citrus decline and reduced post-harvest shelf life (Sharma and Srivastava, 2024), unsustainable use of these plants, etc. The traditional knowledge associated with the use of various wild species of citrus seems to erode with each passing generation. Traditional uses of *Citrus latipes* (Swingle) Yu. Tanaka leaves are reported to be used in common cold, Headache and body ache, Stomach disorder, and juice is used in Skin diseases, fever, Cuts and wounds, Stomach disorder, Headache and Body-ache, Antidote, and skin diseases. *Citrus macroptera* Montrouz peel and juice are used in culinary, pulp in pickle, whole fruit in

Wangala dance, and antidote to food poisoning. *Citrus indica* Yu.Tanaka juice/ fruit is used for Stomach disorders (Upadhaya et al., 2016). Anti-inflammatory assay of Peel Essential Oil among five *Citrus* species revealed the highest anti-inflammatory activity in *C. indica* (Maurya et al., 2024). Citrus peel oil is used in food, pharmaceuticals, cosmetics, and aroma industries (Bora et al., 2020). Keeping in view the future climate change scenario, ecological niche modeling (ENM) predicted species-wise suitable areas, and showed species-specific niches for *C. indica* and *C. medica* were distributed in Arunachal Pradesh, Meghalaya, and Assam, while for *C. macroptera*, it was distributed in Meghalaya, Mizoram, Tripura, and Manipur. Highly suitable areas for *C. karna* and *C. sinensis* were distributed in the foothills of Arunachal Pradesh and Assam, while for *C. latipes*, they were mainly distributed in Meghalaya. This indicates that species-specific niches in the above-identified areas continue to be available, ensuring the climatic stability for the concerned species (Barik et al., 2022). This also indicates about high time in changing anthropogenic behavior like deforestation, high selection pressure and crop monoculture, etc (Malik, 2012) to tackle citrus germplasm erosion in north east India. Strategies like in situ conservation and establishment of germplasm banks and citrus orchards may be encouraged in these identified areas (Barik et al., 2022). GI tagging and Assam's Kaji Nemu (*Citrus limon*) and branding as Assam's state fruit in 2024 and subsequent use in Cherrapunji Eastern Craft Gin brings its footprint to the global spirit industry; similarly, GI tagging of Meghalaya's Khasi Mandarin (*Citrus reticulata*) and export to Dubai and other Middle East countries. Apart from above mentioned strategy, the following multipronged strategy can be taken up for the development of North-eastern States through citrus promotion

1. Production of elite disease-free planting material is of paramount importance. To achieve this objective, well-equipped certified nursery with indexing facilities have to be established and the manpower has to be trained. Progeny orchards, root stock and bud wood banks for production and supply of disease-free elite planting materials have to be maintained.
2. Development of different Citrus-Based Integrated Farming System (CBIFS) including animal husbandry, fishery, etc. with emphasis on soil and water conservation.
3. Sequential replanting of senile orchards through participatory approach and rejuvenation of declining orchards.
4. Adoption of scientific orchard management practices including pest and disease control measures.
5. Propagation of Public-Private-People Partnership in relation to fruit-based agro-industries.
6. Development of customized end-to-end Cold Supply Chain services capable of handling the produce from the farm gate to the end customer to eliminate wastage by integrating all activities from pre- and post-harvest management to storage and logistics for the fresh produce.
7. Establishment of packing station in each North Eastern State, Establishment of small scale industry for commercial by-product utilization like seed oil and seed meal (from seed); peel oil, terpenes, citric acid and pectin (from peel and pomace), etc.
8. Coordinated planning for the development of agri-export zones on citrus
9. Strengthening of FPOs, SHGs, etc.
10. Strategic advertising by using print, electronic and web media for marketing and export promotion.
11. Proper coordination between ICAR and State Government and other organizations like NEC, CAU, NHB, APEDA, NABARD, NGOs, Other funding agencies, etc.
12. Popularization of cost-effective technology like mulching, bamboo drip irrigation, which can mitigate the effect of drought or scarcity of water during lean period.

Conclusion

The domestic demand of citrus fruits, export opportunity, value addition opportunity in food processing, pharmaceuticals, cosmetics, and aroma industries etc, positioned citrus as an

important fruit crop. The scope of improvement in planting materials, production-distribution-marketing aspect of the citrus value chain in North Eastern India makes an optimistic future of citrus farming.

References

1. Upadhaya, A., Chaturvedi, S. S., & Tiwari, B. K. (2016). Utilization of wild Citrus by Khasi and Garo tribes of Meghalaya. *Indian Journal of Traditional Knowledge*, 15(1), 121-127.
2. Maurya, A., Mishra, B. P., Mohan, R., Sharma, V. K., Nair, N. K., Lehri, A., & Rana, T. S. (2024). Essential oil composition and anti-inflammatory activity in wild citrus from northeast India. *Biochemical Systematics and Ecology*, 116, 104878.
3. Hazarika, T. K. (2012). Citrus genetic diversity of north-east India, their distribution, ecogeography and ecobiology. *Genetic resources and crop evolution*, 59(6), 1267-1280.
4. Hynniewta, M., Malik, S. K., & Rao, S. R. (2014). Genetic diversity and phylogenetic analysis of Citrus (L) from north-east India as revealed by meiosis, and molecular analysis of internal transcribed spacer region of rDNA. *Meta Gene*, 2, 237-251.
5. Bora, H., Kamle, M., Mahato, D. K., Tiwari, P., & Kumar, P. (2020). Citrus essential oils (CEOs) and their applications in food: An overview. *Plants*, 9(3), 357.
6. Barik, S. K., Behera, M. D., & Adhikari, D. (2022). Realizing certainty in an uncertain future climate: modeling suitable areas for conserving wild Citrus species under different change scenarios in India. *Environmental Monitoring and Assessment*, 194(12), 864.
7. Sharma, L., & Srivastava, A. (2024). Citrus nutrition research in northeast India: An overview. *Annals of Plant and Soil Research*, 26(2), 175-183.
8. Malik S. K., Chaudhury R., Kumar S., Dhariwal O. P. & Bhandari D. C. (2012) Citrus Genetic Resources in India, Present Status and Management. New Delhi: National Bureau of Plant Genetic Resources.