

The Fall of the Mandarin: Citrus Decline Reshapes Hill Agriculture in West Bengal

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Khasi Mandarin (*Citrus reticulata*) is grown across eight states of North-East India. In North Bengal it is known as Darjeeling Mandarin, in Sikkim as Sikkim Mandarin, Naga Mandarin in Nagaland and in Assam as Khasi Mandarin. These are essentially the same biotypes, with only slight differences in their genetic constitution. The fruits are small, globose, orange in colour, sweet, juicy, and smooth-skinned. Their unique features—fragrance, colour, and taste—have brought global recognition to the fruit, earning it a Geographical Indication (GI) tag. However, in North Bengal, mandarin cultivation is shrinking at an alarming rate due to a steep decline in productivity.

In a study by Sarkar et al (2021), it has been found that 80 per cent area under mandarin orchards in Mongpoo was diverted within last decade. The villages in Kalimpong experienced a downfall of productivity to the extent of 70 per cent. According to another study (Acharya, 2019), more than 50 per cent of the total area under mandarin cultivation in North Bengal has been converted to either

homestays or to vegetables, large cardamom, and fruits-growing fields.

The decline in productivity of Citrus is the most critical reason behind crop- diversification in this region. The problem arises from a combination of different factors e.g. changing climatic conditions, technical limitations, socio-economic constraints, and biological factors. Mandarin growers and scientists working on Citrus decline often blame each other. Farmers generally lack confidence in scientific recommendations. Moreover, reports indicate that growers have not adopted modern cultivation techniques and practices recommended repeatedly (Sarkar et. al, 2021).

The quality of Darjeeling mandarin is a gift of Himalayan climate. However, recent challenges posed by climate change have undermined its suitability. Farmers report rising temperatures and shifts in seasonal rainfall pattern. As a result, the phenology of mandarin orange in Darjeeling and Kalimpong has shifted. New pests and diseases have also been reported. Environmental stresses such as frequent landslides, floods, dry

spells in spring, untimely hailstorms aggravated the decline. Together these climatic challenges make mandarin cultivation unsustainable in this region. Citrus is a nutrient-sensitive crop. It has been found that 15 elements are required for growth and development of Mandarin orange. However, soils in Darjeeling and Kalimpong are deficient in essential elements due to its acidic nature. Incorporation of well decomposed Farm Yard Manure (FYM) in soil in plant basin before monsoon is a recommended practice. Moreover, application of Micronutrients like calcium, zinc, manganese, copper, iron, molybdenum and boron is essential for optimum to high productivity of Mandarin Orange. It has also been found that application of vermi-compost improves fruiting and fruit quality in Khasi Mandarin. Additionally, vermi-compost was found replacing some part of nitrogen fertilizer. Microbial agents e.g. rhizo-bacteria, microbial cultures of *Azospirillum* and *Trichoderma* was found improving nutrient availability. However, farmers' reluctance to micro-nutrient usage and limited application of organic manure

has worsened the problem of nutrient unavailability in soil.



Nutritional deficiency and citrus decline



Attack of serpentine leaf miner and leaf eating caterpillar

Citrus decline in North Bengal is a matrix of complex biological stresses. Citrus tristeza virus (Bhagabati et al., 1989) and yellow mosaic virus (Ahlawat et al., 1985) are the major threats. Virus infection weakens trees, while dieback, foot and root rot, and powdery mildew remain persistent threats (Meena et al., 2017). Pest infestations such as trunk borer, fruit fly, leaf miner, and leaf-eating caterpillar, nematodes together affect nearly 90% of orchards (Roy et al., 2018). The combined action of these pathogens and insect

pests leads to reduced vigour, shortened orchard lifespan, and drastic yield losses.



Stem borer infestation



Intercropping with maize in citrus plantation

Mandarin orchard in the Darjeeling district was ranged between 40-60 years. Prevalence of old orchards is considered to be one of the most serious reasons for decline of Mandarin cultivation. The State and Central Government bodies realized - rejuvenation of the old Mandarin orchards to be the most important step towards bringing Mandarin cultivation back on track in Darjeeling. Although government subsidies are available for rejuvenation of old mandarin orchards, growers are often rigid and reluctant to adopt the rec-

ommended strategies due to the initial financial losses and long gestation period of mandarin plants before returns. Instead, many chose to sell their land or convert their orchards into tourist stays with the help of investors for quick and easy return. The scarce availability of disease-free planting materials and their high cost further aggravate their unwillingness for orchard renewal.

Traditionally, Khasi Mandarin plants were grown using seeds. However, with the growing awareness among the farmers about late-bearing of seedling trees and usefulness of grafted/budded plants encouraged them to plant trees with grafted or budded-plants on suitable rootstocks. Rangpur lime (*Citrus limonia*); Jambhiri (*Citrus jambhiri*), which is also known as Rough lemon; Trifoliate orange (*Poncirus trifoliate*), Grapefruit, Citrumello can be used as rootstocks for Khasi Mandarin. Sometimes, plants are also grafted on Mandarin orange rootstocks itself.

Khasi/Darjeeling mandarin trees have spreading canopies. For this, they are planted in tea gardens to provide shed to tea crop. However, in newly established or rejuvenated Mandarin orchards, the interspaces can be profitably utilized for growing short duration crops. Intercropping can help generate revenue for nearly five years of planting. Choice of intercrops is crucial. Vegetables, legumes and soyabean can be successfully cultivated as inter-crops. Care should be taken while irrigating inter-crops in Mandarin orchard so that the tree trunk doesn't come in contact with the water.

Repeated recommendations—such as the application of 1% Bordeaux paste before and after the monsoon, fungicide sprays after scrapping gum-oozing bark, installation of pheromone

traps to control fruit-sucking moths, and adoption of drip irrigation—was never or seldom followed. Reluctance, lack of knowledge, and the failure of effective extension strategies have ultimately led to the decline of mandarin cultivation in Darjeeling.

Alternatives in the region

Fruit crop diversification in North Bengal is gaining focus and momentum. In Darjeeling district, the Department of Horticulture has encouraged strawberry (*Fragaria* × *ananassa*, family Rosaceae) cultivation and linked it with tourism initiatives by offering tourists the opportunity to pluck their own strawberries. Kalimpong, which was previously known for Darjeeling mandarin and tea has emerged as a hub for coffee (*Coffea arabica*, family Rubiaceae) cultivation.

The higher altitudes of Darjeeling could also be explored for commercial blueberry and Kiwifruit (*Actinidia deliciosa*, family Actinidiaceae) cultivation. State Government has already started their trials at higher elevation (4000 ft.) for kiwifruit. North Eastern states such as Assam, Meghalaya, Arunachal Pradesh, and parts of Nagaland and Mizoram—provide highly suitable agro-climatic conditions for commercial kiwifruit and blueberry (*Vaccinium corymbosum*, family Ericaceae) production. The soil and agro-climatic conditions of these states resemble that of Darjeeling, which makes this region suitable for commercial production of these high value fruit crops.

Peach (*Prunus persica*, family Rosaceae) is drawing attention of both public and private sectors in West Bengal. A local peach, Arucha is planted in various parts of Darjeeling. Assam, on the other hand produces peaches abundantly, locally known as Ahom Bogori. These low-chilling peaches of Assam are valued for their soft texture,

taste and nutritional quality. They also hold a promise for West Bengal. Importantly, peaches are also being targeted for processing purposes, making them a high value crop for future development of North Bengal.

Some low-chilling germplasms of apple (*Malus domestica*, family Rosaceae) are under trial in Darjeeling hills. Moreover, passion fruit (*Passiflora edulis*, family Passifloraceae), rambutan (*Nephelium lappaceum*, family Sapindaceae), dragon fruit (*Hylocereus undatus*, family Cactaceae) also have potential to grow in North Bengal.

Conclusion

The decline of Khasi/Darjeeling mandarin in North Bengal is a matrix of climatic variability, nutrient imbalances, persistent pest and disease pressures, and socio-economic challenges. Despite government support for rejuvenation, farmers remain indifferent towards adopting science-backed production technologies and rejuvenation due to long juvenile periods and associated financial risks. This has accelerated the shift in land-use and influenced crop diversification. Fruit crops e.g. strawberry, coffee, kiwifruit, blueberry, and peach and low-chilling apple germplasms offer opportunities for sustainability in the region. The best way forward is to explore the potential of these alternative crops in the region and restore the mandarin orchards that the farmers already have as much as possible. For that, each component of the dynamics i.e. growers, scientists, Institutes, intermediaries, industries has to work together.

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