

Scenario of Horticulture Research and Development in India and Northeast India

The Northeast region has a vast scope of horticultural crops. The temperate crops have a lot of potential in the hilly regions, similarly, flower crops particularly orchids, *Lilium*, *anthurium*, etc. Research on the mushroom cultivation and processing of produce are other potential areas that need to be encouraged in the region. There is a need to promote product diversification in a unit of land through horticulture to increase the land capacity and bring the land to its full potential by linking to assured marketing channels through identifying demands and outlets of the products in Northeast India.

HORTICULTURE is an important agriculture sector contributing towards food and nutrition security. Over the last three decades, horticulture sector has become a driver of economic growth. Horticulture provides an opportunity for crop diversification and intensification for adequate nutritious food and augmenting the income of the farmers. Horticulture production increased 13-fold from 25 million metric tonnes during 1950-51 to 347 million metric tonnes during 2021-22 surpassing food grain production. Currently, with 18% area, this sector contributes to about 33% of the gross value-added to the agricultural GDP of the country. India is the second largest producer of horticultural crops next to China contributing 11.4 and 11.8% to world fruit and vegetable baskets, respectively. India is the largest producer of ginger and okra amongst vegetables and ranks second in production of potato, onion, cauliflower, brinjal and cabbage. Amongst fruits, the country ranks first globally in the production of banana (36.7%), papaya (43.6%) and mango (40.4%), ranks second in cashew and third in citrus. This sector is being considered as a driver of economic growth and gradually turning into an organized industry

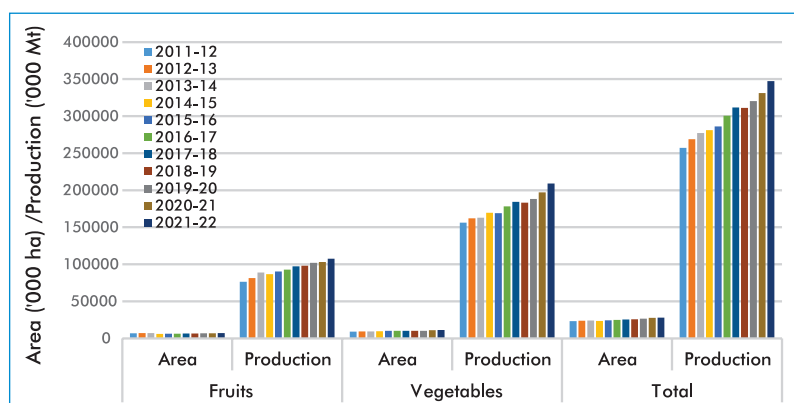
with key linkages to seed business, value-addition and exports. It is also well established that horticulture plays a key role in doubling the farmer's income along with meeting the much-needed nutritional security.

The area and production of horticultural crops have been increasing constantly over the last decade. The compound growth rate of area expansion is 1.72% while growth rate of the production is 2.78%. The growth rate in productivity of aromatic and medicinal crops, and plantation crops is negative, whereas fruit, vegetable and spices sector performed well during this period.

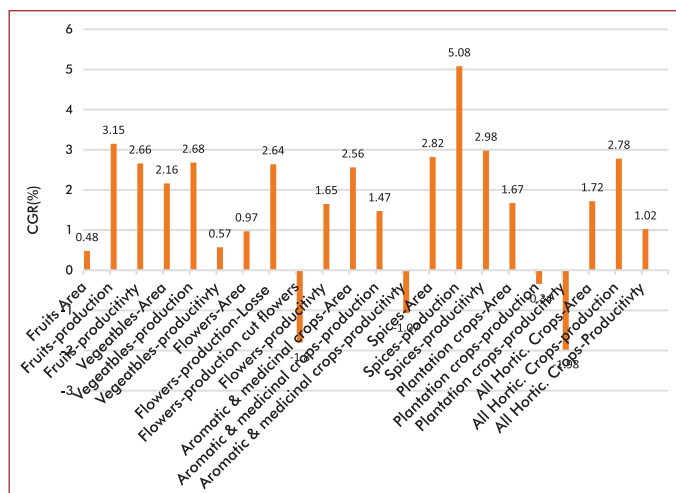
Status of Horticultural Research in India

India has a vast diversity of horticultural crops with 109 fruits, 54 vegetables and 27 spice species of economic importance. The indigenous germplasm includes more than 5,000 accessions of fruits, 35,000 vegetables, 500 ornamentals, 6,000 spices and 8,500 medicinal crops. Horticulture research in India was initiated in 1954, with the establishment of the Division of Botany at ICAR-IARI. Over the years, several institutions and ICAR-AICRPs were operationalized with the research agenda relevant to the national plans and priorities for dedicated development in horticulture. Today, horticultural research is conducted through 23 Institutes/Directorates/NRCs, 13 AICRPs and 6 Network Projects/Outreach programmes, and one R&D setup in the NARES. Horticulture in India comprises diverse crops and commodities i.e., fruits including nut and plantation crops; vegetables including tuber crops, mushroom; ornamental plants; spices; medicinal and aromatic plants; honey bee rearing; bamboo, etc., have emerged as a major alternative for diversification and are contributing 31% to the agricultural GDP.

Research on developing new varieties and management aspects of horticultural crops



Trends of area and production of Fruits and Vegetables in India (2011-12 to 2021-22)



**Compound growth of different horticultural crops
(2011-12 to 2021-22)**

over the past 75 years has contributed immensely to the growth of this sector. At present this sector is increasingly moving towards industries and commercialization, the new challenges are being thrown at us apart from the existing challenges. Intensive breeding efforts have resulted in the development of more than 2000 improved horticulture varieties encompassing high productivity, disease resistance, better nutritional quality, and suitability for processing. Amrapali in mango, Bhagwa in pomegranate, triple disease resistant tomato variety Arka Rakshak, leaf curl virus resistant chillies, high yielding Bheema super, Arka Kalyan in onion, Arka Prajwal in tuberose, and IISR Pratibha in turmeric are some examples. Potato varieties such as Kufri Jyoti, Kufri Bahar, Kufri Pukhraj, Kufri Chipsona-1 account for 75% of cultivated potato in the country. Rapid propagation techniques like micro propagation and bioreactor technology in banana, micro propagation in pomegranate and ornamentals, aeroponics in potato, shoot tip grafting in citrus have dramatically facilitated the quality planting material production. Diagnostic kits to identify virus in citrus, peach and apple have aided in production of disease-free planting material. Research efforts led to a revolution in the production of cashewnut, oilpalm, pomegranate, dragon fruit (Kamalam), date palm, with tremendous increase in area and production. Growth of mushroom sector is another success story with 36-fold increase in production in the last decade. Anti-browning button mushroom variety DMR-NBS-5 is contributing to 32% of total button mushroom production.

India has a lot of traditional horticulture crop varieties and 70 of them have been granted GI tags (fruit crops 36, vegetable crops 11, plantation and spice crops 8 each, flowering plants, and medicinal & aromatic plants 5 and 2 GI tags, respectively). Mango, citrus, banana, chilli, tea, cardamom, jasmine, grapes, pineapple, brinjal, onion and coffee are important horticultural crops with regard to GI tags.

Emerging pests and diseases, declining and degrading land and water resources, climate change, scarcity of water resources, natural calamities, high costs of agricultural inputs and transport, competing use of land and water and decline of investment in agriculture need immediate

action. India made great strides in the production of horticultural crops through precision horticulture, protected cultivation, high density planting. Several innovations in the horticulture sector mitigate adverse impacts of climate change such as grafting in vegetables (tomato grafted on brinjal rootstock), development of short duration horticultural crop varieties tolerant to high temperature and moisture stress (Arka Meghali and Arka Vikas in tomato, Arka Lohit in chilli, Arka Chaita and Arka Tapas in peas), adoption of climate resilient cropping systems (coconut, fruit crops, tuber crops, oil palm and spices). Vertical farming under artificial light conditions, protected cultivation, and soilless cultivation in high value horticultural crops meet sustainable developmental goals.

Higher emphasis has been given to safe food production through GAP, advocating the use of bio fertilizers, bio pesticides, evaluations through food safety traceability systems and better post-harvest handling which enhanced the export of grapes, mango and pomegranate. During 2021-22, India exported fresh fruits and vegetables worth ₹ 11,412.50 crores/\$ 1,527.60 million USD. Grapes, Pomegranates, Mangoes, Bananas, Oranges, Onions, Mixed Vegetables, Potatoes, Tomatoes, and Green Chilli account for a larger portion of fruits and vegetables exported from the country.

Horticulture in Northeastern region

The Northeastern (NE) region of India is rich in biodiversity and home to a large variety of flora and fauna. The region comprises of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and



Calamus erectus

Table 1. Horticultural crops in Northeastern India

State	Fruits	Vegetables	Spices
Arunachal Pradesh	Apple, Banana, Guava, Kiwi, Orange, Pear, Pineapple, Walnut	Bean, Bitter gourd, Brinjal, Cucumber, Potato, Pumpkin, Radish, Sweet Potato, Tomato	Ginger, Large Cardamom
Assam	Banana, Guava, Jackfruit, Lemon, Litchi, Mandarin Orange, Mango, Papaya, Pineapple, Sapota	Bean, Brinjal, Broccoli, Cabbage, Capsicum, Carrot, Cauliflower, Colocassia, Cucumber, Gourds, Knol-khol, Muskmelon, Pea, Potato, Pumpkin, Radish, Spinach, Sweet potato, Onion, Tapioca, Tomato, Yam	Black pepper, Chilli, Garlic, Ginger, Turmeric
Manipur	Banana, Lemon, Orange, Passion fruit, Peach, Pear, Pineapple, Plum	Bean, Cabbage, Cauliflower, Cucumber, Pea, Potato, Tomato, Onion	Chilli, Garlic, Ginger, Turmeric
Meghalaya	Banana, Guava, Lemon, Mandarin Orange, Pear, Pineapple, Plum	Broccoli, Cabbage, Capsicum, Carrot, Cauliflower, Colocassia, Potato, Radish, Sweet potato, Tapioca, Turnip	Black pepper, Chilli, Ginger, Turmeric
Mizoram	Banana, Hatkora, Orange, Papaya, Passion fruit, Pineapple	Bean, Brinjal, Broccoli, Cabbage, Capsicum, Carrot, Cauliflower, Chow-chow, Cucumber, Gourds, Knol-khol, okra, Pea, Potato, Pumpkin, Radish, Tomato	Chillies, Ginger, Turmeric
Nagaland	Banana, Guava, Jackfruit, Lemon, Litchi, Mandarin Orange, Mango, Papaya, Pineapple, Plum, Pomegranate	Brinjal, Cabbage, Carrot, Cauliflower, Chow-chow, Colocassia, okra, Pea, Potato, Radish, Sweet Potato, Tomato	Black pepper, Cardamom, Chilli, Garlic, Ginger, Turmeric
Sikkim	Banana, Kiwi, Mandarin Orange, Papaya, Passion fruit, Pear	Bean, Broccoli, Cabbage, Cauliflower, Cucumber, Pea, Radish, Tomato, Turnip	Ginger, Large cardamom, Turmeric
Tripura	Banana, Ber, Guava, Jackfruit, Lemon, Litchi, Mango, Musambi, Orange, Papaya, Pineapple, Sapota	Bean, Cabbage, Capsicum, Carrot, Cauliflower, Cucumber, Gourds, Potato, Pumpkin, Radish, Sweet potato, Tapioca, Tomato, Onion	Black Pepper, Betel vine, Chilli, Ginger, Tomato



Bumper Organic Ginger Crop



Plum

Table 2. State-wise area of horticultural crops ('000 ha) in 2021-22

State	Gross cultivable area	Fruits	Vegetables	Plantation crops	Aromatic & Medicinal	Flowers	Spice	Total	% of Gross cultivable area
Arunachal Pradesh	301	30.09	2.62	1.60	0.24	0	12.33	46.88	15.57
Assam	4,060	161.98	306.23	90.48	4.62	5.307	100.14	668.76	16.47
Manipur	437	43.12	38.35	0.9	0.04	0.07	9.34	91.82	21.01
Meghalaya	303	37.38	49.61	27.73	0	12.47	14.52	141.71	46.77
Mizoram	188	66.47	40.67	21.45	0.77	0.08	27.82	157.26	83.65
Nagaland	504	34.41	41.51	3.41	0.08	0.04	12.03	91.48	18.15
Sikkim	137	20.17	22.44	0	0	0	42.44	85.28	62.25
Tripura	486	57.72	54.74	16.21	0	0	7.26	135.92	27.97
Total	6,416	431.17	533.74	161.78	5.75	17.967	183.44	1333.8	20.79

Tripura. The diverse climatic conditions of the region are conducive to the growth of a wide variety of tropical and temperate horticulture crops.

Several horticulture products from the Northeast were given the GI registration, such as Arunachal orange, Khasi mandarin, Tezpur litchi, Kachai lemon, Indian wild orange 'Memangnarang', Tripura queen pineapple, Naga tree tomato, Assam Karbi Anglong ginger, Mizo Chilli, and Sikkim large cardamom, etc. In 2021-22, the total area in Northeast region under fruits, vegetables and spices is 431.17 thousand ha, 533.74 thousand ha and 183.44 thousand hectares, respectively. Depending on the climate, altitude, and physiographic difference of land, the major fruits, vegetables and spices are cultivated in different NE states. The mandarin, pineapple, turmeric, ginger, litchi, Lemon, banana, chilli, cucurbits, large cardamom etc., are traditional crops grown in the regions. Recently Kiwi fruit, Apple, Guava, Pear, Walnut, Broccoli, Cabbage, Capsicum, Carrot, Cauliflower, Knol-khol, Muskmelon, Pea, Potato, Pumpkin, Radish, Spinach, Sweet potato, Onion, Tapioca, Tomato are gaining popularity in some areas.

Assam is the largest producer of fruits, vegetables and spices in the region contributing almost 50% of the total area. The per cent of horticultural crops in Gross cropped

area (GCA) was lower (16.47%) in Assam but is higher in hilly states with a maximum in (83.65%) Mizoram and (62.25) Sikkim (Table 2).

The production was highest (6826.87 thousand M tonnes) in Assam which contributes more than 50% of total horticultural production in the region. Tripura and Meghalaya are second and third largest producers (Table 3).

The productivity of most of the crops is lower than the National average. The productivity is slightly higher in Assam as compared to other states. The productivity in Arunachal Pradesh and Sikkim is the lowest in the region (Table 4).

Trend analysis in the area and production of fruits, vegetables and spices for the period reveal that fruit cultivation can be adopted as a sustainable occupation in Assam, Manipur and Meghalaya. The compound production growth rates of the major fruit crops during the period such as banana in Assam, mandarin in Manipur, and pineapple in Meghalaya were higher. The growth rate of compound growth rates in production was 10.1% and 8% in Sikkim and Nagaland. A negative compound growth rate of production was noticed in Arunachal Pradesh. Uncertain weather conditions, inadequate irrigation facilities, vagaries of monsoon, inferior farm inputs,

Table 3. State-wise production of horticultural crops ('000 mt) in 2021-22

State	Fruits	Vegetables	Plantation	Aromatic & Medicinal	Flowers		Spice	Honey	Total
					Loose	Cut			
Arunachal Pradesh	138.16	17.41	7.05	0.16	0.00	0.00	18.59	0.15	181.52
Assam	2504.19	3747.48	163.0	0.17	35.58	57.79	317.24	1.40	6826.87
Manipur	468.16	376.58	0.32	0.12	0.01	0.17	66.48	0.40	912.23
Meghalaya	378.16	520.15	35.07	0.00	0.00	0.35	72.02	0.27	1006.03
Mizoram	345.36	224.64	33.64	0.78	0.00	0.80	100.93	0.30	706.45
Nagaland	316.29	455.96	7.12	0.66	0.04	0.24	40.84	0.72	821.87
Sikkim	50.78	129.37	0.00	0.00	16.50	0.09	102.95	0.53	300.22
Tripura	596.55	1179.22	37.21	0.00	0.00	0.00	27.43	0.22	1840.62
Total	4746.9	6521.4	283.41	1.899	35.63	59.35	643.53	3.46	12296.00

Table 4. State-wise productivity of horticultural crops (t/ha) in 2021-22

States	Fruits	Vegetable	Plantation crops	Aromatic & medicinal crops	Flowers	Spices	Total
Arunachal Pradesh	4.6	6.65	4.41	0.67	-	1.51	3.87
Assam	15.5	12.24	1.80	0.04	6.70	3.17	10.21
Manipur	10.9	9.82	0.36	3.00	0.14	7.12	9.93
Meghalaya	10.1	10.48	1.26	-	0.00	4.96	7.10
Mizoram	5.2	5.52	1.57	1.01	0.00	3.63	4.49
Nagaland	9.2	10.98	2.09	8.25	1.00	3.39	8.98
Sikkim	2.5	5.77	0.00	-	NA	2.43	3.52
Tripura	10.3	21.54	2.30	-	-	3.78	13.54
Total	10.63	11.96	1.75	0.33	2.86	3.30	8.88

Table 5. State-wise growth rate of area and production of horticultural crops in NEH region

State	Fruits		Vegetable		Spices	
	Area	Production	Area	Production	Area	Production
Arunachal Pradesh	-5.9	-1.3	-0.65	6.1	3.5	3.7
Assam	2.2	3.8	2.7	0.6	9.1	19
Manipur	-0.3	5.4	12.3	6.7	1.00	6.00
Meghalaya	1.1	3.2	2.3	4.4	-6.8	12.2
Mizoram	10	3.3	11.1	2.7	3	0.7
Nagaland	5.2	8.00	17.8	25.7	5.3	10.8
Sikkim	4.5	10.1	3.4	6.2	3.4	4.7
Tripura	3.7	-1.4	3.8	6.1	3	7.8
Total	1.8	3.2	4.4	2.9	7.6	3.4

and practices have resulted in severe fluctuations in the production of fruits. However, due to the recent surge in demand for kiwi, orange, and apple within the state, more land is being brought under cultivation and farmers are being induced to produce these crops (Table 5).

Status of Horticultural Research in NEH region

Research needs of the agricultural sector in the region are largely met by the ICAR Research Complex for NEH region, Umiam and its centres in Arunachal Pradesh (Basar), Manipur (Imphal), Mizoram (Kolasib), Nagaland (Jharnapani), Sikkim (Gangtok) and Tripura (Lembucherra). Two agricultural universities viz., (i) Assam Agricultural University at Jorhat and Central Agricultural University, Imphal also contribute to this requirement. The ICAR Research Complex for NEH region, Umiam has six regional agricultural research stations located in six agro-climatic parts of NER whereas the CAU has six colleges spread over all the six states and headquarters in Manipur. The other ICAR establishments that cater to the research needs of the region are NBPGR regional station, Shillong; CPRI Substation, Shillong; CPCRI substation, Kahikuchi; CITH regional station, Dirang; CCRI Regional Station, Bishwanath Chirali; and National Research Centre on Orchid Pakyang in Sikkim, CIH, respectively. These institutes and universities are working on the development of varieties and production technologies for horticultural crops in the region.

Several accessions of horticultural crops viz., Citrus (20), guava (15), peach (3), Kiwifruit (5), passion fruit (5), plum (3), sohiong (2), sohshang (2), ginger (124), turmeric (191), king chilli (6), chilli (10), tomato (23), brinjal (25), french bean (48), dolichos bean (12), ash gourd (6), bottle gourd (6), chow-chow (4), pumpkin (5), sweet potato (15), colocasia (40), gerbera (45) and orchid (19) have been maintained in field gene bank of Horticulture Farm at ICARRC-NEHR, Umiam. Guava cvs. Megha Magenta, Megha Supreme, Megha Supreme, Megha Wonder, Megha Seedless, Tomato cv. Megha Tomato-3 (Pusa Sheetal x Lima), Manikhamnu, Manikhamnu RC Manikhamenashinba-2, Colocasia varieties (ML-1 and ML-2), Megha Turmeric-1, Brinjal cvs. TRC Bholanath, TRC Singhnath, Megha Taro-1, Megha Taro 2, TRC Badama, etc., were released at ICARRC-NEHR, Umiam.

Protocols for the preparation of tuity fruity from chow-chow (*Sechium edule*), ready-to-cook (RTC) green Jackfruit slices and instant ginger candy had been developed at ICARRC-NEHR, Umiam. The Department of Horticulture, Assam Agricultural University has been working in the development of varieties and technologies in different horticultural crops. Banana cvs. Jahaji, Chenichampa, Malbhog, Barjahaji Pura Kal, Manohar, Jati and Bhimkal were recommended. Brinjal cvs. J1 and J-2 were released and several varieties of lines of Gerbera, *Anthurium*, *Chrysanthemum*, *Gladiolus*, Marigold were recommended. Detailed package of practices has been worked out for growing *Bhut Jalakia* (*Capsicum chinense*), technologies on protected cultivation of high-value vegetable and flower crops, and off-season flowering of marigold (Summer Marigold) have been developed.

CONCLUSION

Development of new varieties with conventional breeding methods, development of new production and protection and post-harvest technologies and value additions are the ongoing programme in all the major crops which are essential to keep up the pace of the current growth of horticulture section. Apart from new programmes such as Genome editing for quality storability and disease pests resistance, clean planting material production, digital horticulture, high value export oriented crops, etc. The present steps should be continued to boost productivity in the Northeastern region. Apart from these, development of climate resilient varieties and technologies of major horticultural crops, production large scale, clean production material to fulfilling the demands for replanting and new areas expansion, emphasis on cleaner and safer production for domestic, export market, and promotion of export oriented high value crops should be given greater emphasis for the Northeastern region.

For further interaction, please write to:

¹Assistant Director General (Horticulture), ²Principal Scientist
Indian Council of Agricultural Research, KAB-II, Pusa,
New Delhi 110 012
Email: vishaw.patel@icar.gov.in