HORTICULTURE R&D IN INDIA: INFRASTRUCTURE, PROGRAMMES AND ACHIEVEMENTS

Dr K.L. Chadha

President, The Horticultural Society of India

e-mail: klchadha@gmail.com

Primacy to Horticulture

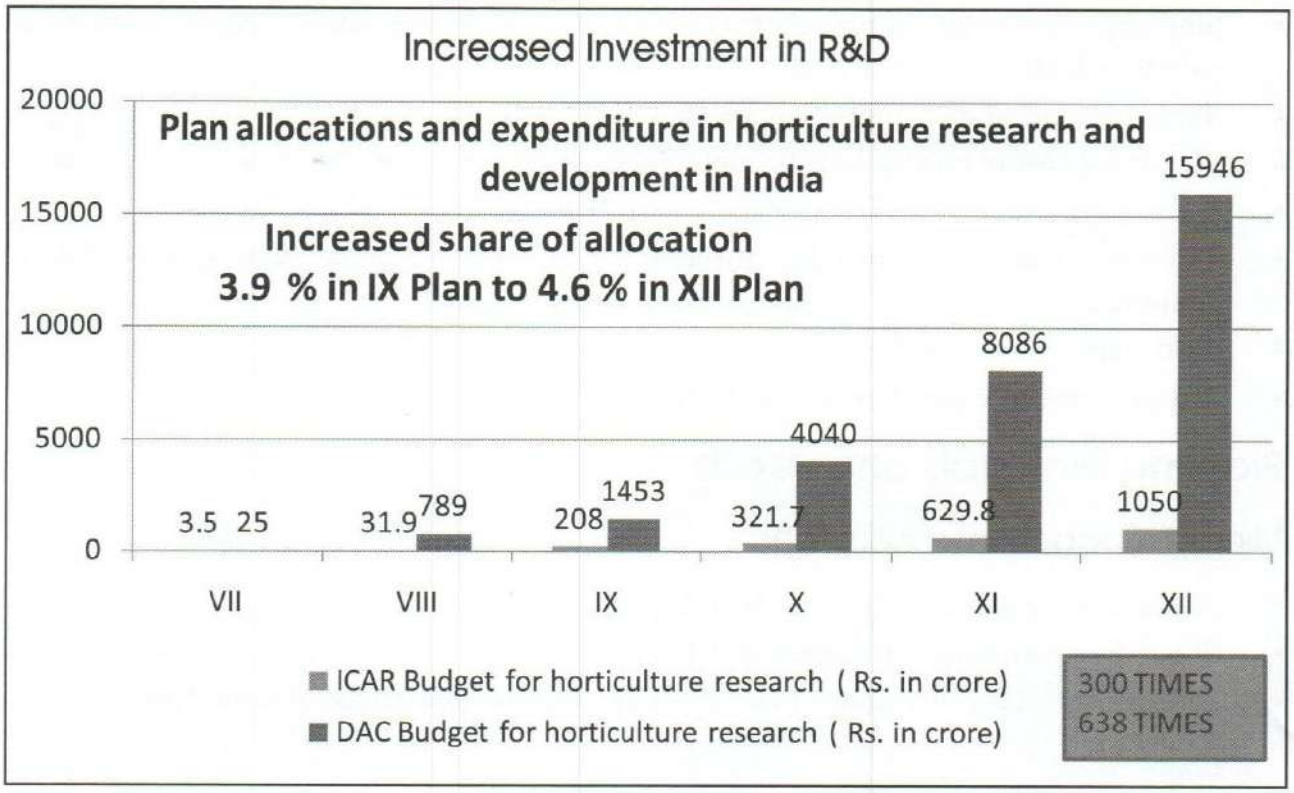
- Global emphasis on horticulture
- Area under horticulture crops doubled
- Farmers convinced about profitability
- Global trade dramatically increased
- Recognition of crop diversification globally as remunerative, viable, sustainable, production systems

Horticulture in India

- Fatigue in rice-wheat based cropping system,
- Increase in small, economically non-viable holdings
- Shift from production of staple commodities to high value produce and products
- Comparative advantage offered by horticulture crops through additional employment opportunities
- Rapid change in demographic profile - resulting in increased consumption of high-value horticultural items
- Increased realization about role of fruits and vegetables in health and nutrition

Pathway of Horticulture Development

- Increasing financial allocation for R&D programmes
- Establishment of sound R&D infrastructure
- Launching of flagship programmes
- Pro-active policies encouraging international participation in joint ventures in PPP mode.



Sound R&D Infrastructure

Research

- 12 Central Institutes, 6 Project directorates, 5 NRCs; 11 AICRPs; 6 network projects; 6 Horticulture Universities, several colleges of horticulture and 35 Dept. of horticulture in Universities, Krishi Vigyan Kendras (642)

Development

- 4 Ministries, e.g. Agriculture, Food Processing, Commerce, Rural Development.
- 7 Boards e.g. NHB, CDB, Coffee, Bee, Tea & Rubber
- Other organisations like APEDA , NCDC, NAFED, SFAC,
- Institutes for Organic Farming, Ghaziabad, Central Institute of Horticulture, Nagaland

Flagship Programmes

Integrated Horticulture Development Programme which covers:

- National Horticulture Mission, National Bamboo Mission, Technology Mission on North East &
- All Central Schemes covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo.

Focus Areas of Intervention

- Improvement in quality & availability of planting materials & seeds
- Development of varieties/ hybrids in Horticulture
- Area expansion through establishment of crop clusters

- Improve availability & productivity through hi-tech intervention & adaptability to climate change
- Promoting alternate production systems
- Reducing cost of cultivation through efficient use of inputs
- Mechanization
- Improve quality & marketing through AEZs, GAP, Organic & pesticide residue standards
- Post harvest management
- Human resource development at all levels

Planting Materials and Seeds

Micro-Propagation - Fruit Crops

- Virus free mandarin through Shoot Tip grafting
- Virus free mandarin through Shoot Tip grafting
- During last 12 years more than 30 lakh disease-free citrus plants distributed to growers.

Disease Free Citrus Nursery

- TC of Banana plantlets
- TC of Papaya
- TC of Pomegranate

Improved Propagation Techniques

Walnut propagation	Cashew nut propagation
TPS based propagation in potato	Seed coating with Rhizobacteria on Seed spices

Vegetable Grafting Techniques

- Grafted Brinjal VNR – 212 at Farmer Field
- Capsicum (California Wonder) on Bacterial wilt resistant rootstock (hot pepper)
- Grafted Tomato Seedling

Planting Material: Tuber Crops

Miniset Technique in Tuber Crops

- Problem of low multiplication rate
- Miniset technology developed to enhance multiplication rate
- Minisets raised under shade nets for disease and pest freedom
- Multiplication ratio increased in

Cassava	:	1:1 to 1:60	6 times
Elephant foot yam	:	1:2 to 1:15	7.5 times
Yams	:	1:4 to 1:24	6 times
Colocacia	:	1:2 to 1:120	6 times

Varieties/ Hybrids in Horticulture

New Crops Commercialized - Fruits

Kiwi	*Kokum (Garcinia indica)*	Noni	Oil Palm, Palode-I
Passion fruit	Rambutan	Seabuckthorn *(Leh Berry)*	

New Crops Commercialized - Vegetables

Gherkin	Cherry tomato	Baby corn	Broccoli

Varieties Developed - Horticulture

Total varieties	:	1596
Fruits	:	146
Vegetables	:	485
Potato	:	48
Flowers	:	115
Tuber Crops	:	87
Spices	:	250
Plantation Crops	:	217
M & A Plants	:	124

Varieties Commercialized- Fruit

SN	Crop	Variety
1	Banana	Grand naine
2	Citrfus	Kinnow clone
3	Lemone	Rasraj
4	Papaya	Pusa Draft
5	Sapota	PKM 4 Sapota
6	Mango	Amrapali, Mallika
7	Guava	Lalit Guava
8	Grape	Sarad Seedless
9	Litchi	Swarna Roopa

Varieties Commercialized- Arid & Temperate Fruits

SN	Crop	Variety
1	Aonla	Narendra 7
2	Anona	Arka sahan
3	Beal	Goma Yashi
4	Guava	Lalit
5	Jamun	Goma Priyanka
6	Pomegranate	Phula Arakta
7	Walnut	Clonal Selection

Popular Vegetable Varieties

SN	Crop	Variety
1	Onion	N-53
2	Cabbage	Pusa Mukta
3	Chilli	Arka Lohit
4	Okra	Arka Anamika
5	Water Melon	Arka Manik
6	Tomato	Arka Rakshk

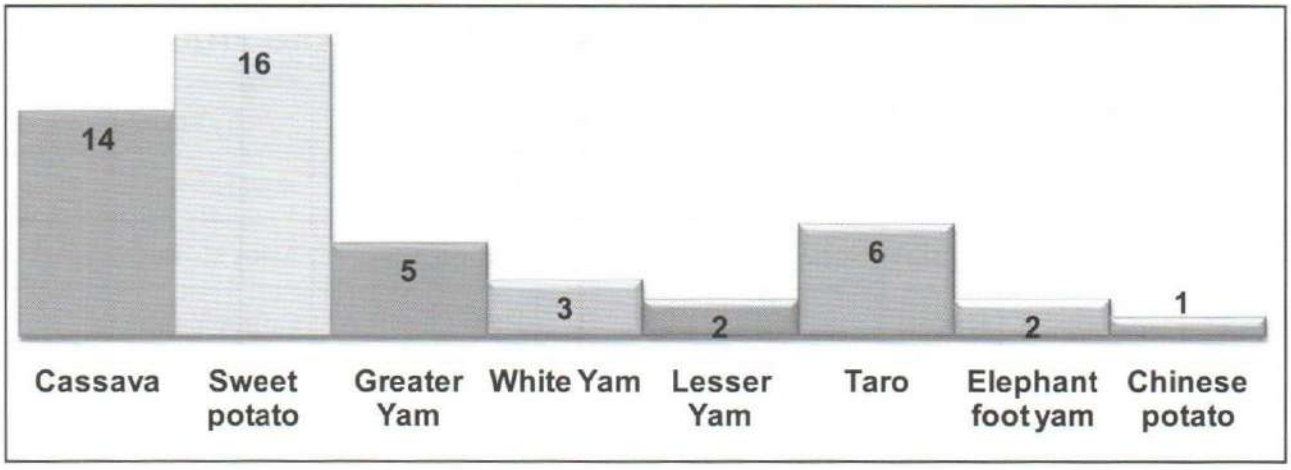
F1 Vegetable Hybrid Varieties

SN	Crop	Variety
1	Bottle gourd	
2	Brinjal	Pusa Hybrid 1 Arka Navneeth
3	Cabbage	Pusa cabbage hybrid 1
4	Cauliflower	Pusa Hybrid 2
5	Tomato	Pusa Hybrid 1
6	Bitter Gourd	Pusa Hybrid 1

Popular Vegetable Varieties

SN	Crop	Variety
1	Kufri Chipsona - 1	Chips & French fries
2	Kufri Chipsona - 2	Chips
3	Kufri Chipsona - 3	Chips
4	Kufri Satlaj	French Fries
5	Kufri Ananda	French Fries

Tropical Tuber Crops Varieties



Cassava

H-97, H-165, H-226, Sree Visakham,Sree Sahya, Sree Jaya, Sree Vijaya, Sree Prakash, Sree Harsha,Sree Rekha, Sree Prabha, Sree Padmanabha, Sree Ayhulya, Sree Apoorva

Sweet Potato

H41, H42, Sree Arun, Sree Varun, Sree Nandini, Sree Vardini, Varsha, Kishan, Kalinga, Gautam, Sourin, Shankar, Sree Rethna, Sree Bhadra, Gouri, Sree Kanaka

Yams

Sree Shilpa, Sree Karthika, Sree Keerthi, Sree Roopa, Orissa Elite, Sere Priya, Sree Subhra, Sree Dhanya Sree Latha, Sree Kala

Amorphophallus: Sree Padma, Sree Athira

Taro

Muktakeshi, Sree Rashmi, Sree Pallavi, Panisaru 1, Panisaru 2 Sree Kiran (Hybrid)

Chinese Potato: Sree Dhara

Varieties Rich in Nutrient Content

SN	Crop	2010-11	2020-21
1	Cassava	Sree Athulya H165	Rich in starch, Revolutionized starch industry in Tamil Nadu
2	Sweet Potato	Sree Kanaka	Rich in β carotene
3	Turmeric	Rajendra Sonia	6.0% curcumin

Ornamental Crop Varieties

SN	Crop	Variety
1	Rose	Dr. GS Randhawa rose, Pusa Mohit
2	Chrysanthemum	Pusa Anmol, Pusa entenry
3	Gladiolus	Pusa Shubam
4	Tuberose	Prajwal
5	China Aster	Kamini
6	Gerbera	Arka Krisika
7	Marygold	Pusa Arpita, Pusa Narangu Gaid a

Plantation & Spice Crops Varieties

- More than 467 varieties/hybrids developed in plantation crops and spices
- Coconut - 35
- Arecanut: 11 varieties
- Cashew- 42
- Black pepper: 17
- Fennel: 14
- Coriander: 30
- Fenugreek: 20
- Cardamom: 15
- Turmeric: 30

Coconut: Kalparaksha, a root (wilt) disease tolerant variety

Arecanut: Mohitnagar

Cocoa: Superior hybrid – VTLCH1

Cashew: Bhaskara

Medicinal and Aromatic Plants Varieties

- 36 varieties in medicinal plants and 8 in aromatic plants
- 945 germplasm accessions of 13 species of MAP at DMAP and 2712 accessions of 33 MAP species and 278 accessions of Betelvine (Piper betle) are being maintained

Innovative Hi-tech Interventions

1. Commercial Adoption of Micro-propagated Plants

- Banana (Mah, Kar. T.N., A.P., Bihar)
- Strawberry (Mah., Pun)
- Small cardamom (Ker, Kar, T.N.)
- Large cardamom (Sikkim, W.B.)
- Vanilla (Ker, Kar, T.N.)
- Black pepper (Ker)
- Potato (Pun., H.P., C G)

2. Marker Assisted Selections

Intensive research underway and several useful markers identified at IARI, IIHR, IIVR & CPRI.

- Indian hot peppers: fertility restoration gene (Rf
- Pointed gourd: RAPD maker (OPCO7) associated with female sex identified. Used to screen gender of *Trichosanthes* at seedling stage; molecular basis of sex determination in dioecious species.
- Okra: SSR markers developed & commercialised, 55 markers sold to 6 private firms

3. Genome Sequencing in Horticultural Crops

Crop	Status
Tomato	Completed
Chilli	Completed
Grape	Completed
Watermelon	Draft
Apple	Draft
Mango	Draft
Banana	Going on
Rose	Going on

4. Developments of Diagnostics

- Through diagnostics quality of seed and planting material can be ensured.
- PCR based diagnostic protocols developed for rapid detection of citrus greening and citrus Tristeza virus .
- Diagnostic technologies like ELISA and ISEM developed for early detection of several disease of asexually propagated plants like potato.
- Disease management for cassava mosaic disease by multiplication in vector free zones.

5. High Density Planting - Fruit Crops

- HDP Technology standardized in Mango, Guava, Banana, Citrus, Pineapple, Pomegranate, Papaya, Cashew and Coconut.

6. Canopy Architecture- Fruit Crops

Canopy management important for

- Maintaining of proper plant health
- Increasing productivity (per unit area)
- Sustaining high yields
- Optimum fruit quality
- Restoration in regularity in bearing
- Reducing cost of production

Following Canopy Architecture standardized

- Espalier system in apple
- Vertical axis in apple
- Y-Trellies in peach

7. Water and Nutrient Use Efficiency

- Only 40% of total area irrigated.
- Drip irrigation successful in saving 25-60% water with 10-60% increase in yield over conversational irrigation
- Fertigation requirement (application of 100% soluble fertilizer through irrigation) in several fruits, vegetables and plantation crops.

8. Use of Growth Regulators

Several plant growth regulators and chemicals being commercially employed by farmers for improving productivity and quality of horticultural crops. These include:

- IBA for rooting in cuttings and dormex for hastening bud break in grape,
- Paclobutrazol for flower induction in mango,
- Ethrel for flowering in pineapple,
- Urea sprays for crop regulation in guava
- NAA and 2,4 D for control of fruit drop in mango and citrus
- Gibberellic acid in improving berry elongation and quality of grape

- Maleic hydrazide is as a sprout suppressant in potato and onion for prolonging storage life.

9. Rejuvenation

- Rejuvenation technology mango, guava and Aonla

10. Crop Specific Micro-nutrient mixes

1. Rainbow Arka Banana Special
2. Rainbow Arka Citrus Special
3. Rainbow Arka Mango Special
4. Rainbow Arka Vegetable Specilal

11. Vegetables Production- All the year round

- Varieties suitable for different seasons developed in Carrot, Cauliflower, Onion, Radish, Turnip.
- Vegetables produced under plastic houses
- Use of low tunnels for production of vegetables in off-season
- Use of plastic tunnels in arid temperate regions for production of vegetables during extreme cold temperatures

Promoting Alternate Production Systems

Diversification of Horticulture Systems

- Protected Cultivation- becoming popular for production of quality horticulture crops
- Organic Farming- A popular alternative in areas with depleted natural resources; Sikkim, Meghalaya, Mizoram already declared as fully organic states
- Peri-urban & Urban Horticulture- Emerging as new area for cultivation of horticultural crops grown for human consumption and ornamental use within & in the surroundings of urban areas Aeroponics & Hydroponics- Getting popular for production of crops and planting material through soilless cultivation around metropolitan cities
- Conservation Horticulture- Change in crop management system. i.e. management of crop residue and their effective utilization, e.g. crop rotation, mulching, in situ water conservation being followed by progressive farmers
- Protected Cultivation- becoming popular for production of quality horticulture crops: Protected cultivation hybrid developed, use of low tunnel, plastic mulches, vertical gardening, hydroponics in ginger and aroponics in potato,
- Organic Farming- A popular alternative in areas with depleted natural resources; Sikkim, Meghalaya, Mizoram already declared as fully organic states
- Peri-urban & Urban Horticulture- Emerging as new area for cultivation of horticultural crops grown for human consumption and ornamental use within & in the surroundings of urban areas Aeroponics & Hydroponics- Getting popular for production of crops and planting material through soilless cultivation around metropolitan cities
- Conservation Horticulture- Change in crop management system. i.e. management of crop residue and their effective utilization, e.g. crop rotation, mulching, in situ water conservation being followed by progressive farmers

Mechanization

- Tools & machineries developed include:
- Tractors drawn implements including seed & fertilizer drills for vegetable & Potato cultivation
- Fruit harvesters for Mango, Guava, Sapota, Pomegranate, Citrus, Coconut.
- Graders and washers for fruits, potato & onion
- For Nurseries media sievers and plastic bag fillers available
- Automatic grafting machines available in advanced countries introduced for adoption.
- Self propelled pruners for tree crops and vine yards available for use.

Reducing Losses and Improving Quality

1. Bagging of Fruits

2. Postharvest management

- Maturity standards developed in several important crops
- Pre-harvest treatments to reduce post harvest losses developed in several crops (Mango, Citrus, Grape).
- Controlled atmospheric storage technology development and adopted in apple.
- Low cost eco-friendly cool chambers developed for on farm storage of some commodities (Onion, Potato).
- Storage temperature standardized for different crops

3. Improved Packaging in grape, banana, strawberry, okra, flowers, cauli-flower, vegetable seedling

4. New Products developed

Several new products developed and commercially exploited e.g.,

- Grape- Raisin and wines
- Potato- Chips and Fingers
- Banana- Concentrate
- Gherkin- In brine
- Peas- Frozen
- Coconut- Pouched water, Snow ball, tender coconut

Dehydrated products

- Osmotically dehydrated fruits Pineapple, mango, aonla, sapota and papaya
- Dehydrated fruits – Grapes, fig, anardana from pomegranate

5. Development of Value Added Products like Juices from unexploited crops like Passion fruit, Leh berry, Pomegranate Noni etc;

Consumer friendly products

- Frozen green peas, ready-to use salad mixes, vegetable sprouts, ready-to-cook fresh cut vegetables, sprouts and ready-to-use cooked vegetables, dry flowers

All India Area, Production & Productivity Horticulture Crops

(Area in '000 Ha, Production in '000 MT, Productivity in Tonnes/ha)						
Crops	**1991-92 (Final)**			**2014-15 (Final)**		
	Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
Total Fruits	**2874**	**28632**	**9.96**	**6110**	**86602**	**13.97**
Total Vegetables	**5593**	**58532**	**10.47**	**9542**	**169478**	**17.64**
Flowers Cut	NA	NA			484	
Flowers Loose	NA	NA		249	1659	
Aromatic	NA	NA		659	1000	
Total Flowers & Aromatic	**NA**	**NA**		**249**	**2143**	**3.96**
Coconut	NA	NA		1976	14067	
Arecanut	NA	NA		450	747	
Cashewnut	NA	NA		1030	745	
Cocoa	NA	NA		78	16	
Total Plantation	**2298**	**7498**	**3.26**	**3534**	**15575**	**4.84**
Total Spices	**2005**	**1900**	**0.95**	**3317**	**6108**	**1.87**
Average Productivity			**7.56**			**12.11**

Export of Horticulture Crops

Value in Rs., Qty in MT (Crores)

		2014-15
Product	**Qty**	**Rs.**
Floriculture	35.45	8.87
Fresh Fruits & Vegetables	250.1	74.74
Processed Fruits And Vegetables	78.58	54.61
Total Exports 332.21 Crores MT valued at 138.22 Crores Rupees		

Source: DGCIS Annual Data

Impact

- Horticulture crop production surpassed food crop production in India for first time during 2013-14. The trend continued during 2014-15 (283.5 MT)
- Share of horticulture output in agriculture rose to 33%.
- Highest annual growth rate of 9.5% in fruit production during 2013-14
- Annual growth of 7% in vegetable production (1991-92 to 2014-15)
- Significant increase in floriculture crops
- Virtual revolution in potato production
- India second largest producer of fruits & vegetables; largest producer of banana & mango and second largest producer of potato, tomato and onion
- Exports of horticultural produce rose by 536.42 times in quantity and 2007.80 times in value (1991-92 to 2012-13).

To Conclude.....

Horticulture has emerged as the Growth Driver of Agriculture in India.

Future of sustainable agriculture in South Asia lies in promoting technology led horticulture development.