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PAPER
13**

Hi-Tech Horticulture in India



**NATIONAL ACADEMY OF AGRICULTURAL SCIENCES, INDIA
October 2001**

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Introduction

India is endowed with a wide variety of agroclimatic conditions and enjoys an enviable position in the horticultural map of the world. Almost all types of horticultural crops can be grown in one region or the other. Horticultural crops occupy 8 per cent of the gross cropped area of the country contributing 24.5 per cent of the gross value of agricultural output and 54.55 per cent of export earnings in agriculture (1998-99).

India is the second largest producer of both fruits and vegetables. Total production of fruits has been estimated at 44.04 million tonnes from 3.72 million ha. Vegetables occupy an area of 5.78 million ha with a production of 87.53 million tonnes. Our share in world production in fruits and vegetables is 10 and 13.38 per cent, respectively.

India is the largest producer of coconut, cashew, tea and spices, with a total production of 14,9248 million nuts, 0.46 million tonnes, 805.61 million kg and 2.90 million tonnes, respectively.

India has made noticeable advance in production of flowers. Floriculture is estimated to cover an area of 73,970 ha with production of 4,59,163 mt of loose and 61,21,523 lakh cut flowers. The area undercut flowers has increased in recent years, so has the product range.

India exported horticultural produce and product worth Rs. 90315.20 million during 1998-99. Tea, fetched the highest exchange of Rs. 21918 million followed by spices, coffee and cashew. During this period, fresh fruits and vegetables earned foreign exchange of Rs. 5360.20 and 7056.80 million, respectively.

Horticulture today, is not merely a means of diversification but forms an integral part of food and nutritional security, as also an essential ingredient of economic security. Adoption of horticulture, both by small and marginal farmers, has brought prosperity in many regions of the country, of which, Maharashtra, Karnataka, Andhra Pradesh and Kerala are prime examples.

Research and development in horticulture has received impressive support in the last 15 years. As a result, the research infrastructure has increased manifold with the setting up of several new institutes and national research centres on several export-oriented crops. The development activities received a boost with approximately 40-fold increase in budget from the 7th and 8th Plan. At present, 10 per cent of the total budget of ICAR and 18 per cent of the total budget of DOAC is earmarked for the horticulture sector in the 9th Plan.

So far, Indian horticulture has been insulated from forces of outside world. Time-bound removal of quantitative curbs on imports and other barriers to access to domestic market under WTO, of which India is a signatory, will require Indian horticultural produce/product to be competitive both in the domestic and export market. This would call for use of hi-tech horticultural technologies. Such technologies can be defined as 'those, which are modern, less-environment dependent, capital intensive and have the capacity to

improve productivity and quality'. These will include, use of genetically modified crop varieties, micro-propagation, integrated nutrient and water management, integrated pest management, protected cultivation, organic farming, use of modern immuno-diagnostic techniques for quick detection of viral diseases and hi-tech post-harvest technologies, including cold chain.

Ensuring the nutritional and aesthetic security of our nation with a population of 120 crores by the end of 2005, would be a major challenge for the horticulture sector. With shrinking land for agri-horticultural activity, the sensible option before the nation is to increase further the production levels per unit area. Intensive cultivation in hi-tech protected environments with hi-tech production inputs will ensure higher productivity levels.

With the opening of global market and removal of quantitative restrictions under the WTO agreement, export-import scenario is likely to change at much faster pace. Horticulture stands as the major beneficiary in such a scenario to contribute to the much needed forex reserves.

Sensing this importance, the National Academy of Agricultural Sciences (NAAS) organised a National Seminar on Hi-tech Horticulture. The present trends, issues and constraints were discussed under seven theme areas and recommendations made.

1. Opportunities for New Biology for Germplasm and Crop Improvement

1.1 Issues in Germplasm Identification, Conservation and Exchange in Horticultural Crops

- Of the total germplasm collections held in various gene banks, horticultural crops comprise only 15 per cent. Hence, there is an urgent need for intensification of collecting and conservation activities, in these crops. There is need for duplicates of collections as back up for gene bank collection and intensifying *in situ* conservation activities. For doing so, the CBD mandate for *in situ* conservation offers appropriate guidelines.
- Conservation activities should involve participation of farmers in addition to the government agencies. Appropriate methods of conservation and emergency strategies, especially for threatened wild species need to be developed. The approaches for *ex situ* conservation of different species were reviewed. While technology-intensive methods like *in vitro* conservation and cryopreservation would help conserve genetic diversity, a low cost conservation technology like ultra dry storage, is the need of the hour.
- Cryopreservation of pollen has great significance, particularly in perennial tree crops. For *ex situ* conservation of perennial tree species, techniques like bonsai culture may be explored. There is need for screening of germplasm for pest resistance and for

* The National Seminar was held for three days at Bangalore from 26th to 28th June, 2000. The seminar was jointly organised and hosted by the Horticultural Society of India, New Delhi and Indian Institute of Horticultural Research, Bangalore.

characterising important wild species and land races using molecular techniques such as RAPD analysis and DNA finger printing.

1.2 New Biology for Developing Improved Cultivars of Horticultural Crops

Molecular characterisation is very important for IPR, patenting and safeguarding against gene piracy. Molecular marker-aided-selection and genetic engineering will have to be employed in future genetic improvement of horticultural crops. Breeding of horticultural crops should have broad genetic base. Isolation of somaclonal and protoclonal variation and *in vitro* mutagenesis need to be explored. Use of molecular methods of transferring male sterility need to be explored for development of hybrids. In near future, integration of conventional and molecular breeding will have to be resorted to, for genetic improvement of horticultural crops. Special areas, in which genetic enhancement in quality horticultural crops requires attention are: dwarfing, herbicide resistance, pest resistance, increasing shelf life, improvement in processing nutritional quality.

1.3 Hi-tech Propagation of Horticultural Crops

- Micropropagation has emerged as an important tool for quick production of large number of plants. It is already being exploited in crops like banana, capsicum, tomato, chilli and several ornamental plants. There is an enormous scope in India for micropropagation of crops especially ornamental crops, in years to come. Their protocols, therefore, need to be further refined for higher efficiency. There is also need to develop protocols for micropropagation in crops like mango, cashew, litchi, walnut and date palm which have a great commercial potential in India. Thrust on quality and strict avoidance of contamination hold the key for the success of Indian tissue culture industry. Efforts are, therefore, required to achieve high standards to meet international requirements. Further, innovative management practices like efficient use of techniques, such as, low cost polythene bags for raising plantlets, cheaper laminar flow facilities with more capacity, minimum contamination and faster sterilisation need to be developed and standardised.

1.4 Greenhouse Technology for Plant Propagation

- Presently greenhouse technology is practiced by very few in the country. Scope, therefore, exists for large-scale expansion of nursery activity under favourable microclimate created in cost-effective low cost structures. Efforts also need to be intensified to develop suitable technology for production of healthy and well-developed seedlings in plastic perforated trays for Indian conditions. New growing media also need to be standardised for optimum plant growth. Refined techniques for hardening of seedlings, including root pruning, have to be standardised. Greenhouse design, structure and technology for producing high quality planting material need to be fine-tuned to suit Indian conditions.
- Commercial grafting techniques with computer control are available in Japan for mass production of certain plants. Such machines need to be developed indigenously or need to be imported by a nodal agency in India, to standardise and perfect the technology for further dissemination.

1.5 *Hybrid Seed and Seedling Production Technology for High Value Vegetable Crops Under Protected Environment*

- Climatic factors, like temperature, relative humidity and sunlight, influence plant growth and pollen production. Optimum climatic requirements need to be worked out for all the crops suited to Indian conditions to exploit properly the greenhouse structures.
- Nearly 40 per cent of the total cost of hybrid seed production is incurred on labour employed for emasculation and pollination. Use of male-sterile lines, gynocious lines and growth regulators facilitate hybrid seed production by cutting cost of hand emasculation. Efforts are, therefore, needed to isolate/develop male-sterile/gynocious lines in important vegetable crops for hybrid seed production.
- While potato varieties suitable for production of TPS (True Potato Seed), have been evolved, there is need to standardise package of practices for TPS cultivation. In future, TPS production programmes' emphasis should be laid on selection for early maturing and improved tuber size and yield by improved agrotechniques which will greatly help to bring down risk and shall enhance efficiency.

2. **Hi-tech Production of Horticultural Crops**

2.1 *Developing High Density Planting (HDP) in Horticultural Crops*

- High density planting has a potential to increase yields and reduce cost of production of several horticultural crops. It has already been exploited successfully in kinnow, orange, pineapple, banana and to some extent, in apple and mango. There are several ways of achieving this objective such as selection of dwarf cvs and scions, use of dwarfing rootstocks/interstocks, pruning and growth regulators for canopy management. A better option would be to achieve dwarfing through genetic means.

2.2 *Developing Nutritional Need Diagnosis and Leaf Nutrient Norms*

- Leaf analysis, particularly in perennial crops, offers a means of assessing nutritional requirements. Leaf nutrient standards for a large number of crops have been developed and are in use in developed countries. Work on these lines is also underway in India. This needs to be intensified to ensure economy in fertiliser use through optimised application. To aid practical application, however, there is a need to correlate nutritional composition of leaf with fruit yield on the basis of extensive nutritional surveys of orchards and comprehensive field experiments.

2.3 *Micro-irrigation and Fertigation in Horticultural Crops*

- Micro-irrigation has proved its efficacy in saving water and improving yield but its large-scale adoption is limited to a few southern states especially for high value crops. High initial investment has been one of the critical factors. Therefore, there is need to develop a holistic approach to the problem through effective integration of research, development and industry, so that the gap between potential and current

status could be bridged. There is need to refine technology, improve design and articulate mechanisms for efficient utilisation of water through micro-irrigation. Availability of water-soluble fertilisers for fertigation and related policy matters, also need to be addressed on priority.

2.4 Organic Farming in Horticulture

- In their quest for higher yields, farmers are using heavy doses of fertilisers, herbicides, fungicides, pesticides, growth regulators. This results in not only increased cost of production but also drastically changes our environment. In recent years, there has been emphasis on organic farming to obtain pesticide residue-free fruits, vegetables, spices and other horticultural commodities. However, scientific technology with sound alternatives is not available. Keeping in view the benefits, which this technology offers alongwith higher returns in international markets for such products, systematic programmes need to be taken up. To ascertain and guarantee the consumer/importer that the produce has been genuinely raised organically, the production has to follow basic organic standards. An Indian Organic Food Production Act, has to be enacted early to safeguard consumers' interest and check exploitation of farmers.
- Suitable analytical laboratories need to be established, both by the Government of India and state governments, to assess and evaluate the quality of inputs. Research and development on upgrading compost quality, biomass production, biofertiliser and biocontrol measures should be the mandates of all agricultural research centres in the country.

3. Protected Cultivation

3.1 Design and Development of Greenhouses for Different Agroclimatic Conditions

- At present the greenhouse technology is imported either from the Netherlands or Israel, resulting in high cost of structures. Economically and ecologically sustainable polyhouse structures suited to different agro-climatic conditions need to be evolved indigenously.

3.2 Greenhouse Technology for Production of Cut Flowers

- Rose continues to be the prime floriculture product in the international market. India has proved its capability in growing and exporting roses despite several bottlenecks. Indigenous production technology based on ethnic growing media including coir-pith and post-harvest management to overcome impediments needs to be developed and fine-tuned to suit our climate. Therefore, research efforts need to be intensified on roses. To sustain and maintain superiority a diverse product mix is essential. As such, efforts need to be made for identifying suitable products for viable diversification.

3.3 Scope of Protected Cultivation of Vegetables in High Altitudes

- At high altitudes, especially Ladakh, polyhouses with low cost technology have been employed successfully to grow vegetables round the year and also to take up seed

production of vegetables round the year in spite of adverse climate. There is need to promote these polyhouses in other arid temperate regions of the country.

4. Hi-tech Plant Protection

4.1 *Integrated Pest Management (IPM)*

- Horticultural crops are adversely affected by a variety of pests. These pests result in annual loss of over 36 per cent. For the success of hi-tech horticulture, integrated management of these pests is essential. Research efforts are required to develop models for application of IPM practices for important crops in different locations. With changing horticultural practices new pests like thrips, white flies, mites, phytoplasma, viruses and viroids are emerging. Some of these are exotic pests. To protect horticultural crops from such pests, greater vigilance and stringent quarantine measures are required.
- With increasing awareness of the ill effects of environmental pollution, biological control of pests will be the most favoured and desirable approach for minimising losses caused by pests, like insects, fungi and bacteria. Transgenic crops alongwith biological control strategies will be the main armoury in fighting the pest menace in this country. Some initiatives in these directions have been taken in the country, but considering the range of horticultural crops and agroclimatic zones requiring high-tech approaches, a much greater effort is required for utilising the full potential of biological control and transgenic crops.
- Due to enormity of pest problems, need-based application of pesticides will have to continue as part of IPM. Present-day indiscriminate use of pesticides, which results in undesirable levels of residues in the produce and contamination of water and soil, will have to be stopped through appropriate policy measures. Success of such a policy will depend on the availability of 'safe' pesticides like botanicals. The country has good information about availability of basic materials like *neem*, but more emphasis is required for developing economical and environmentally compatible technologies for commercial production of safe pesticides.

4.2 *Diagnostic Molecular Techniques*

- Use of healthy and quality planting material is the key to improving production of horticultural plants—especially those propagated vegetatively. Success achieved in improving production of potato as a result of well-thought and meticulously implemented 'Certified Potato Seed' programme is a good example. Now that sensitive molecular diagnostic techniques are available, it is time to start certification programme for all horticultural crops grown in the country for export as well as internal consumption. A beginning has been made with the establishment of a 'Network National Facility for Virus Testing and Quality Control of Tissue Culture Raised Plants' by the DBT. A similar facility is also required for certification of horticultural exports for freedom from undesirable chemical residues, toxins, antibiotics and incipient pest infestation in order to prepare us to meet SPS (phytosanitary) regulations. This can be achieved through establishment of a network of micro and macro level diagnostic laboratories around the country.

5. New Developments in Post-Harvest Management

5.1 Marketing Opportunities and Infrastructural Support

- Implementation of nutritional security programmes, increase in purchasing power, shift in food habits, growing international trade and removal of quantitative restrictions (QR) are bound to influence the domestic market in India, both for fresh and processed horticultural products. Quality improvement and exploitation of both competitive and comparative advantages will largely determine future growth in the global trade.
- Redesigning the supply chain from seed bed to consumers' plate is the need of the hour. Technological advancement made so far and global competitive pressure should determine the path of restructuring the supply chains. The huge post-harvest losses particularly in perishable horticultural produce in tropical environment and unorganised market system requires priority developmental attention. Public-private partnership and massive investment in infrastructural development in post-harvest handling and modernisation of marketing systems of perishable products are essential.
- By checking losses through reducing multiple handling of fresh produce and adding value at producer's end by sorting, grading, waxing, precooling and improving storage, packaging and transportation systems, better economic return to the growers can be ensured. A network of farmers' service centres is recommended to be set up in major production areas to galvanise the whole production and supply system. Similarly, establishment of primary processing networks and a grid of centres of HRD will further consolidate the gains in modernising horticultural marketing system in India.
- Strategic marketing requires strengthening several areas e.g., sourcing for export and distant markets; contract farming may ensure both supply and better quality produce to maintain supply chain, modernising markets through central auction, reducing multiple handling and price setting mechanism. Direct involvement of growers' cooperatives, greater participation of stakeholders, retaining regulatory powers of the government may greatly help in re-organising the system. Market information database, market intelligence marketing system and use of information technology, are essential components for modernising horticultural produce marketing in the country.

5.2 Mechanising and Post-Harvest Handling

- Separation through conventional and modern techniques and gadgets based on photometry, acoustic response, short wave radiation, machine vision and laser technology hold promise to meet quality standards for markets and operations down-the-line including value addition. Appropriate field heat removal techniques, viz., cold air system, hydro-cooling, vacuum cooling or slush system, need to be adopted at the field level (*in situ*).

5.3 *Processing and Value Addition*

- Minimally processed for quick cooking of vegetables and their products, which are prepared with intermediate moisture and hurdle technology, have great potential in the civil sector besides the defense sector. These convenient foods can be stored without refrigeration and can be marketed in both domestic and international markets. Entrepreneurship in this area needs to be promoted. Designer foods developed by Defense Food Research Laboratory can go as calorie specific functional foods in the civil sector in the field of nutrition.

6. **Logistics and Policies for Hi-tech Horticulture**

6.1 *Human Resource Development*

- Since, hi-tech technology is new to the country, our curricula need to be fine-tuned to impart latest knowledge to both undergraduate and postgraduate students. Suitable nodal centres need to be developed to impart training in various aspects of organised farming and post-harvest management.

6.2 *HACCP Standards for Horticulture*

- With regard to the quality and safety parameters, the Indian standards are in agreement with those where we are not in concurrence with the international standards which need to be bridged. There is an urgent need to educate all organisations, institutions, both government and non-government, and the producers, regarding the HACCP standards and sanitary and phytosanitary measures.
- There is a need to develop special curriculum and vocational training for specific type of agribusiness. There is also urgent need for HRD for crop executives and exposure trips to other countries for the scientists/extension workers and personnel of financial institutions and industries.

6.3 *Mechanisation and Automation in Horticultural Crop Products*

- Mechanisation and automation has not yet been fully exploited for the benefit of Indian agriculture. These offer several benefits, e.g. improvement in efficiency and quality of work alongwith reduction of drudgery. Some of these innovations promote employment generation. In horticulture crops these efforts should help in vegetative propagation, planting and pruning of plants; harvesting, grading and post-harvest management, including value addition.

7. **Policy Issues**

- There is need for simplification of policies and issues such as plugging of loopholes in the land acquisition law. Priority treatment of hi-tech floriculture as an industry needs to be given. Availability and importing of quality inputs such as water-soluble fertiliser, pesticides, throughout the year, across the counter should be ensured. The

high cost of finance, sudden increase in quarantine duty and duty on plastics which have been hampering the growth of the industry, need to be reviewed.

- Information technology has the potential to shatter all the barriers reaching across the continents. A suitable mechanism to safeguard the interest of the Indian growers and consumers needs to be evolved. Since, this concept is new to Indian markets, suitable training needs to be imparted to all those involved in the cyber trading.
- In view of the fragmented landholdings in all the states of the country, contract farming/cooperative/consolidated farming needs to be encouraged so that modern technologies of cultivation can be adopted for increase of productivity and quality.
- In view of low productivity and poor quality, there is urgent need for effective transfer of technology within the country to increase production, productivity and to improve quality. Certification of nurseries should receive high priority.
- Domestic market has to be strengthened in order to increase exports. Without organised domestic market base, we cannot promote exports. Models like NODS (F&V units) and Hopcom need to be created in all the metropolitan cities in the country.
- High interest rates for export finance also make our exports non-competitive. In India, pre-shipment export credit is available at the rate of 10 per cent, that too, after observing so many formalities, whereas, the international exports in other countries get finance at the rate of 4 per cent. Such anomalies need to be removed.
- Immediate emphasis should be on creation of post-harvest infrastructural facilities, like, collection centres, grading centres, washing facilities, packing, refrigerated vans, precooling units, cold storages, intermediate cold storages, processing units, etc. A complete cold chain facility needs to be created.