Carrying capacity of Indian horticulture

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Growing population and rise in income level will lead to increase in demand of high-value agriculture (HVA) produce that includes fruits, vegetables, meat, eggs, milk, fish and value-added food products. The annual growth rate in domestic demands for fruits and vegetables is estimated at 3.34% and 3.03% respectively. The required growth rates to meet projected demands in the horticulture sub-sector for 2050 may be lower than the growth already achieved during 1998–99 to 2006–07. Economic considerations could lead to diversification of cereal land to high value crops like horticultural crops, as in the southern parts of the country, where cultivation of spices generates more income than food crops for the farmers. This is not likely to happen in the northern states of Punjab, Haryana and Uttar Pradesh that contribute to the food security as buffer stocks of wheat and rice in reserve. Expected climatic changes may increase the overall productivity of coconut in the coastal areas, except in the northern parts. Cultivation of temperate fruits like apples may move to further higher elevations.

Keywords: Fruits, horticulture, spices, vegetables.

Introduction

THE projected population of India is likely to range between 1.64 and 1.74 billion by 2050, when the world population is likely to reach 9 billion. Already, with a global share of 2.3% land, 4.2% of water, the per capita availability of resources in India is 4–6 times less than the world average. The pressure on limited natural resources will increase further and it is feared that food demand of the country may exceed production from 2021 onwards. Our burgeoning population and the rise in income level will lead to increase in demand of high-value agriculture (HVA) produce (fruits, vegetables, meat, eggs, milk, fish) and value-added food products.

It is known that transformation in favour of HVA is driven mainly by changes in food consumption patterns and income elasticity. Increased demands of value-added processed products and imported food items in big city markets in recent years signal the nature of domestic markets that are likely to emerge. The growing rural–urban divide and inter-sectoral disparities may lead to increase in urbanization. Demand projections through 2020 show that diversification in consumption patterns towards HVA products will become more pronounced with income growth and changes in other determinants such as urbanization. Also, globalization may further create opportunities for the export of high-value commodities. National nutrition policy has laid emphasis on protective food items like fruits, vegetables, milk, meat, egg and fish.

Emerging scenario of horticulture sub-sector

The income elasticity for fruits and vegetables is reported to be 0.42% and 0.35% respectively, against only 0.05% for rice and –0.06% for wheat. The annual growth rate in domestic demands for fruits and vegetables is estimated at 3.34% and 3.03% respectively[1]. Other independent estimates[2] also show that about 76% of fruits and vegetables (F&V) are consumed fresh, whereas 22% is lost or gets wasted in the marketing channel.

The projected demands of various food products are shown[3] in Table 1. About 127.2 Mt of vegetables and 86.2 Mt of fresh fruits will be required by 2020–21. During 2005, area-wise vegetables covered 59.73%, fruits covered 29.03% and plantation crops covered 7.75% of the total horticultural area.

The National Horticulture Mission (NHM) launched during 2005 in 18 states and 3 Union Territories (UTs) (371 districts covered so far) aims to record a production of 300 Mt by 2012. Up to 2009–10, 16.57 lakh ha additional area has been brought under different horticultural crops under NHM. For fruits, maximum area coverage has been under mango, aonla, citrus, guava, sapota, banana and pineapple. About 3.4 lakh ha was brought

Table 1. Projection of demands for various food products (in Mt)

Commodity	Base year 2004–05	Projection 2011–12	Projection 2020–21
Food grains	207.0	235.4	281.1
Milk and milk products	91.0	113.7	141.5
Egg (number billion)	44.1	60.8	81.4
Meat	6.0	8.3	10.9
Vegetables	90.6	108.0	127.2
Fresh fruits	52.9	67.3	86.2

Source: Ref. 3.

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Table 2. Arrival of horticulture produce and number of markets involved in its trade (quantity in '000 tonnes)

Commodity	2004–05		2009–10	
	Quantity	Number	Quantity	Number
Fruits	11,907	227	28,683	600
Vegetables	12,147	367	35,582	897
Spices	4,457	334	7,671	828
Flowers	2,172	9	54,462	57
Plantation crops	2,372	40	8,396	123

under spices and 1.04 lakh ha expanded under flowers. Besides, 1.01 lakh ha was brought under cashew and cocoa, and 2.78 lakh ha of old and senile orchards had been rejuvenated. Vegetables are not covered under the NHM.

Fruit cultivation has become a game changer in many parts of rural India with crop area increase by a blistering 27% between 1997 and 2006, as a result of which fruit production has increased substantially. Benefits in terms of market arrivals are already visible. Maharashtra is the showcase: between 1997 and 2006 fruit acreage shot up from 3.9 lakh ha to almost 7.0 lakh ha, an increase over 80%. It is reported that during 1986–2000, about 2 lakh ha fallow land was covered by improved varieties of mango and cashewnut, mainly using over 10.5 million quality planting materials of mango and cashew nut produced by Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. Horticulture-linked employment guarantee scheme also helped in the expansion of high-value horticulture in the state[4].

In the hill states (eight in the North Eastern Region (NER), Himachal Pradesh, Jammu and Kashmir, Uttarakhand) area expanded under Technology Mission for the North Eastern States/Horticulture Technology Mission (TMNE/HTM) of the Ministry of Agriculture, Government of India is also considerable. Total additional area brought under the NE states alone is: 5.65 lakh ha in fruits and 6.15 lakh ha in vegetables. The perennial fruit species have a long productive life and may bring stability in the supply chain in the NER in the coming years.

The enhanced market arrival of horticultural produce and larger involvement of markets in horticultural trade during implementation period of NHM (2004–05 to 2009–10) have been highly impressive (Table 2)[5].

In the horticultural crop sector, impressive growth in fruits and vegetables helped in improving nutritional security and increased export earnings. Share of fruits, vegetables and flowers helped in increasing agricultural export basket considerably. Further, growth in the horticulture sector is likely to be through enhancement of productivity, quality assurance and reduction of post-harvest losses and value-addition.

Demand projection and expected production in 2050

Based on the presumption that the projection of demands of various food items during 2020–21 as made by the senior agricultural experts[6] is reasonably accurate, and considering the average demand growth per annum of different commodities (average of 16 years covering 2004–05 to 2020–21), the estimated demands by 2050 are likely to be as follows: vegetables 199 Mt and fruits 146 Mt.

The required growth rates to meet the projected demands in the horticulture sub-sector may be lower than the growth already achieved during 1998–99 to 2006–07. The governmental emphasis to achieve 4% annual growth in agriculture production and enhanced food grain production is likely to receive major focus. Diversification of cereal land to high value crops (HVCs) like horticultural crops is unlikely to happen. Marginal mountainous lands, coastal areas, semi-arid and irrigated arid zones, and the NE hills are possible options for area expansion and enhancement of yield per ha through knowledge and technology transfer; improved post-harvest management will result in higher levels of market availability of perishable horticultural commodities.

The present growth pattern and its sustainability

The present growth rate in the horticulture sub-sector is reasonably high. However, reduction in regional disparities across eco-regions, careful treatment of ecologically fragile areas, water management in rainfed areas and group actions for small and marginal farmers are crucial for sustenance of gains achieved.

The Fertile Crescent area (Punjab, Haryana and western Uttar Pradesh), the mainstay of India's food security system, is presently facing serious ecological and economic problems associated with soil health, groundwater depletion and unfavourable cost risk return structure. It points towards the need to change the very approach for sustainable growth by combining crops, including horticulture, animal husbandry, fisheries, agro-forestry to advance productivity in perpetuity, without the associated ecological harm.

Horticulture should receive greater attention in the hills after taking care of proper soil and water-conservation measures. Climate-change adaptations, particularly in temperate fruits and nuts requiring specific chilling hours for flowering, irrigation management (drip-fertigation) and drought management (water harvesting, hardy rootstock use) are immediate research and extension issues. Transfer of proven technologies has already brought significant improvements in productivity of horticultural crops such as banana, grapes, potato, etc.

The accelerated growth rate required to meet the demands

The untapped production opportunities need to be tapped. Within the country, large regional variations in agricultural productivity have been reported[7]. In general, very low and low productivity districts in the country are characterized by low rainfall and low irrigated area, which also results in a lesser amount of fertilizer use.

To meet the annual growth rate in domestic demands for fruits (3.34%) and vegetables (3.03%), a partial shift in agricultural policy and practices will be essential. Expansion of area in higher-productivity zones, increase in fertilizer and irrigation water-use efficiency in the crop sector, and reinforcement of package of technology will be possible options. The low (191) and very low (66) land productivity districts offer immense opportunity for production of hardy horticultural crops with minimum infrastructure support. Small-holder horticulture through group farming (SHGs, horticulture estates as suggested by the National Commission of Farmers (NCF)) and cluster approach of the NHM should be attempted. In most of the 'very high' and 'high' productive districts, horticultural crops have a predominant presence.

Productivity levels that can be achieved on a sustainable basis with minimum adverse environmental impact should be kept in mind. It is estimated that by 2050, about 22% of the geographical area and 17% of the Indian population would face under water scarcity. Water supply for horticultural crops and livestock will face more intense competition among the multiple users of water, and therefore, investment in micro-irrigation for horticultural crops will need attention to mitigate the problem. Enhanced use of agro-bioinputs (biofertilizers, biopesticides, botanicals, etc.), Integrated Pest Management (IPM) technology, and use of hardy rootstocks are certain other options for greater ecological balance and sustenance. For sustainable development and realization of high productivity levels, crop planning based on agro-ecological considerations and efficient use of inputs has been attempted, only with partial success.

Higher productivity levels from the eastern region (Bihar, eastern Uttar Pradesh, West Bengal and Assam) experiencing abundant water availability and good soil have not been harnessed fully so far. Within the region also there are large variations in agriculture productivity. For example, West Bengal, where 14 out of 18 districts fall under 'Very high productivity/ha' and 3 districts fall under the 'high productivity/ha' category (only one district, Purulia falls under the 'average productivity' category and none under 'low productivity' category), ranks first in vegetable production in the country and the state average productivity of potato is very high. The inter-state variation in fertilizer use and irrigation is considerable[8], e.g. NPK consumption (235 kg/ha) and area under irrigation (52%) were much higher in West Bengal in comparison to those of Assam (60 kg NPK/ha and 5%). The study by Chand *et al.*[7] reveals that none of the 22 districts of Assam fall under the 'very high productivity' category and only one district falls under the 'high productivity' category. Under such circumstances, proper crop selection based on agro-climatic suitability and levels of consumption of inputs like fertilizers, pesticides and irrigation water needs careful consideration. Land reforms and land tenure systems also have an impact on agricultural productivity. The soil resource maps prepared by the National Bureau of Soil Survey and Land Use Planning (NBSSLUP), Nagpur and GIS data are not of much use at the ground level.

Horticultural developmental activities through perennial fruit orcharding have already paid high dividends both in terms of upliftment of socio-economic status of poor hill farmers as well as bringing stability in fragile ecosystems (e.g. apple in Himachal Pradesh, mango and cashew nut in the Western Ghats in Maharashtra and large cardamom in Sikkim). The niche potential of marginal mountain lands, if properly nurtured with scientific horticultural practices can bring fortunes and can convert the non-viable, subsistence farming to economically viable farming. The success story of the Konkan region in the Western Ghats in commercialization of mango, cashew, black pepper, etc. demonstrates the possibility of converting once barren hilly tracts into economically viable regions. Both Himachal apple and Konkan cashew nut have shown that productivity can be achieved on a sustainable basis without adverse effects on the environment.

Both in the NER and in coastal areas, diversification of cropped area with high-value horticultural crops has been successful. Horticulture-based land use is being increasingly considered in developmental plans both in the arid and semi-arid regions. Success stories of seed spices, and medicinal and aromatic plants in the highly arid zones of Rajasthan and Gujarat, and commercial fruit cultivation (e.g. Kninow mandarin) in a canal-water-covered area (viz. Sri Ganganagar) are pointers in the right direction. Coastal areas have already been utilized for plantation crops and spices; further growth is possible in the coastal eco-regions with transfer of relevant technologies.

Another partially tapped region for horticultural growth is the NE hill region. In the North East, out of 2.2 M ha of shifting cultivation (Jhum) land, only 17.5% is cultivated at any point of time. Excellent quality apple and kiwi fruit in the rain-shadow, temperate zone belts of Arunachal Pradesh; mandarin orange and pineapple in the mid-hills of almost all the hill states; ginger and turmeric in Mizoram, Meghalaya, Sikkim, Nagaland; large cardamom in Sikkim; flowers (*Anthurium*, *Gerbera*, rose, *Lilium*, *Cymbidium*) in most of the states, small-holder tea in Assam and Nagaland, and rubber cultivation in Tripura are some examples in support of the great potential. When apple cultivation is moving out from the Kullu

valley to higher altitude and cooler places in Himachal Pradesh due to climate change, the possibility of expansion of the fruit apple in low-rainfall region in Arunachal Pradesh hills (e.g. Shergaon, Dirang, Bomdilla) should not be ignored.

Futuristic view for high-value horticulture to meet the demand of 2050

1. Diversification of cropped area with high-value horticultural crops in the hills, arid and coastal agri-ecosystems, if properly focused for future expansion and the gains already achieved though recent missions like NHM, TMNE/HTM and others are consolidated, India should be in a position to meet the domestic demands in the coming years.

2. In the area of R&D, a strong research base has been already created and with proper technology transfer, fast-tract development of established crops should be possible[4]. Remarkable achievements in certain crops like onion and grapes leading to successful export are well recognized. Similar potentiality for potato, litchi, pomegranate, certain vegetables, flowers, spices and processed products exists, where basic R&D has provided leads for commercial exploitation. Technological improvements accruing from R&D are the key for fast-tract developments.

3. Processing is becoming increasingly important to help farmers in realizing a better price; it has been identified as a priority sector for bank credit and certain fiscal concessions. Recently, the processing industry has started growing rapidly, aiming to process 7–8% of horticultural commodities. The estimated market potential of processed food in 2015 is reported to be 11 times in fruits and vegetables, compared to the figures for 2003–04, and 4.5 times in spices. Some established agro-processing players have shown interest in sourcing raw materials directly from the farmers through contract farming arrangements. Some of the states are encouraging such systems. Farm–corporate house relationship has helped both farmers and corporates in bringing high-quality, low-cost produce to the retail shelf. For example, apple trade in Himachal Pradesh was around Rs 1500 crores in 2005–06, and corporate houses like Reliance Fresh, Adani Exports and ITC picked up the best quality apples for their own retail outlets. Similarly, in Andhra Pradesh, Coca-Cola, Reliance and others have been involved in procuring mangoes directly from growers for processing.

4. Marketing of horticulture produce has improved after amendment of the APMC Act and certain other market intervention schemes. Terminal markets are being developed at selected locations under public–private partnership and NDDB has already established such a modern unit for marketing of fruits, vegetables and flowers in Bangalore with provisions of forward (with processors, retail stores, traders) and backward linkage (with farmers/farmers' associations). More such auction markets will help farmers realize better returns.

5. Climate change will have some impact on horticultural crops due to erratic rainfall, general warming and enhanced biotic and abiotic stresses. Impacts of climate change on different horticultural crops have been projected by Aggarwal[9] by citing case studies from the ICAR network project. Some relevant observations are:

(i) Perennial horticultural crops have to face the impacts of climatic variability in standing plantations, but not essentially only negative impacts will be experienced. For example, research findings indicate that coconut productivity is likely to go up by 10% in 2050 over the current yields. While positive impacts on coconut yield in Kerala, parts of Tamil Nadu, Karnataka and Maharashtra have been predicted, negative impacts are projected for coastal Andhra Pradesh, Odisha, Gujarat and parts of Karnataka and Tamil Nadu. Cashew nut, which is mostly grown as rainfed crop, is vulnerable to climatic variability and drought conditions caused by the shifts in rainfall pattern and inter-seasonal variability. Similarly, in mango, temperature rise may influence flowering, as hermaphrodite flowers are normally more in late emerging panicles, which coincides with higher atmospheric temperature. Using the DOMAIN nice model, possibility of shift in mango-growing regions in future climate is reported[10].

(ii) In temperate fruits like apple, chilling is crucial for fruiting and fruit yield. Studies on changing parameters, especially chilling units in Himachal Pradesh over time and their impacts on apple productivity revealed that:

(a) Apple productivity in Bajaura valley (1500–2200 m) decreased by 2–3% due to climate change. Apple has been replaced by off-season vegetables. In more recent years, apple in Kullu valley has been replaced by pomegranate and kiwi fruit.

(b) In over a decade, cooler Lahoul valley (2500 m) has recorded a remarkable increase of more than 122% in area under apple, while productivity of ruling seasonal crops like potato and pea has declined by 11–15%.

(c) In case of short-duration vegetables like onion and tomato, impact of elevated CO_2, associated with global warming, is likely to be positive on yield.

(d) Probability of yield losses may decrease in crops like mango, guava, papaya, brinjal, tomato and potato all over northern India[11].

6. The importance of horticultural biodiversity has been well recognized among the mitigation strategies for climate-change adaptation. For example, to mitigate temperature rise in temperate zones, introduction of newer varieties adapted to a wide range of chilling hours, and use of hardy rootstocks to overcome lower/delayed rain-

fall are possible options. Use of insect-pest-tolerant crop varieties and soil-borne disease-resistant rootstocks needs to be encouraged. In future, during crop and land-use planning, possible climate change dimensions must be kept in mind. The indigenous genetic resources provide a buffer in times of drought, heat and biotic stresses, and genetic resources with bio-alternatives may reduce the vulnerability of production systems to climate change. According to the assessment of the Inter-Governmental Panel on Climate Change (IPCC)[12], South Asia (the Indian region) will experience a temperature rise of 0.88°–3.16°C by 2050, and overall temperature increase is likely to be higher in rabi or winter season. In planning rabi vegetables cultivation, selection of suitable varieties with lesser thermo-sensitivity should not be difficult even from within the available varietal base. Developing cultivars tolerant to heat, drought and agronomic manipulations, including water management to match adverse climate change impacts should get research priority.

7. With economic liberalization, the efficiency of production and post-harvest management have become highly relevant as the domestic production has to compete with products from other countries. Major reasons for weak competitiveness are found to be low productivity, poor marketing, underdeveloped infrastructure and undesirable regulations. Enhancement of small-holder competitiveness and increase of labour intensity both through on-farm and non-farm activities are possible by promoting horticulture. The marketing disadvantages are severe in perishable horticultural crops and strong infrastructure support and investment are, therefore, needed. Output per hectare of land from fruits and vegetables is reported to be Rs 135,000 against that of Rs 18,000 in the case of fine cereals[13]. Therefore, institutional reforms such as strengthening of market, credit and pricing, accelerated goal-oriented research and technology transfer for horticultural development need greater focus.

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