Vision 2050

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Central Institute of Temperate Horticulture
Indian Council of Agricultural Research

Vision 2050

Central Institute of Temperate Horticulture
(Indian Council of Agricultural Research)
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संदेश

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कई बदलाव होने की उम्मीद नहीं की जाती है। अतः खाद्य, पोषण, पर्यावरण आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आया है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवि संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)

Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-Central Institute of Temperate Horticulture (CITH), Srinagar has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

(S. AYYAPPAN)
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and Director-General, Indian Council of Agricultural Research (ICAR)
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Preface

Horticulture in temperate region is the main source of livelihood to more than half of the population and draws about 10,000 crores revenue from the surrounding ecological resources. This region having unique climate offers tremendous opportunities for production of high quality temperate fruits, vegetables and flowers which have commercial importance besides distinct nutraceutical and medicinal properties. To increase production and productivity and to exploit the full potential of temperate horticultural crops in the region, the Central Institute of Temperate Horticulture was established in the year 1994 and since then it is actively engaged in R&D activities and able to identify few promising varieties and technologies especially in fruits which are now becoming very popular and yielding returns to farmers in the region. But still suitable varieties and wholesome package of technologies suiting changing climate and consumer needs are yet to be made available to meet the growing demand and compete globally.

Looking at diversified uses, changing dietary habits and higher purchasing power, the demand for temperate horticultural products is increasing. It is expected that by 2050 we require about 20 million tonnes of temperate fruits and 23 million tonnes of vegetables at a growth rate of 6.7%. While the existing production of temperate fruits is only 31 lakh tonnes with very low productivity (6.19t/ha) as against requirement of about 50 lakh tonnes. Similar is the situation in vegetables and flowers. Moreover, in this fragile Himalayan, agro ecosystem, the soil is degrading, water has become scarce and climate is fast changing leading to emergence of new diseases and pests, quality seed and planting material not adequately available, limited mechanization and finally the low farm returns moving away farmers and rural youth from agri-horticultural activities. With the opening of global market and the export import scenario the temperate fruits, vegetables and cut flowers have to be competitive to meet the international standards.

I have a great pleasure in presenting the "Vision 2050" of this institute. Our mission is to ensure nutritional and economical security by increasing vertical productivity and higher quality. This would not

only makes us self sufficient but we shall have sufficient quantity for export market. For addressing production limiting factors, the vision document has been devised to increase the productivity and improve the quality thr ough genetic resource management and crop improvement, adoption and development of eco-friendly and sustainable production technologies with a focus on orchard management integrated nutrient, disease and pest management, water productivity, pre and post harvest management, value addition and processing including those technologies which mitigates and makes full use of the effects of climate change. The CITH will strive hard to be at par with advanced countries and shall be the torch bearer for the stakeholders of temperate region.

I am highly thankful to the council and to my colleagues who sincerely contributed for the growth of this Institute and also to my fellow editors Dr. O.C. Sharma, Dr. J.I. Mir and Mr. Shiv Lal for bringing out this document. The suggestions received from Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. Krishna Kumar, Deputy Director General (Hort.) is placed on record with high gratitude and the support received from Dr. S.K. Malhotra, ADG (Hort- I) in preparation of this document is highly acknowledged.

(Nazeer Ahmed)

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Context

India is the second largest producer of horticultural crops (240.5 million tonnes) next to China contributing 10 and 13.8 per cent to world's fruit and vegetable basket respectively. It is also the largest producer of plantation crops (12.0 million tonnes) and spices (5.35 million tonnes) and has made noticeable advance in production of flowers. However, the productivity and per capita availability is still much below the world average. Since horticulture forms an integral part of nutritional and economic security, it needs serious policy and technological interventions in the coming years for realizing four percent agricultural growth envisaged by planning commission. In the recent years, the main pillars of agricultural production are greatly affected. The soil is degrading, water has become scarce, climate is fast changing, seeds and planting material not adequately available, limited mechanization and finally the low farm returns moving away farmers and rural youth from agriculture. With the opening of global market, the export-import scenario is changing at much faster pace where Indian horticultural produce have to be of high standards to be competitive in domestic and international market. The committed efforts of research organizations and extension departments in the last two decades have yielded significant results in horticulture with a growth rate of about 6.7 percent. But for continued growth and for meeting the demand of growing population, the innovative technologies and efficient varieties have to be developed using power of science and great potential of different agro climate regions.

In India, temperate

Apple production in Ladakh
(Future potential area)

horticulture like tropical and subtropical has great significance, occupying about 1/8th of total geographical ar ea of country covering Himalayan states in north and north east. It plays a vital role in providing nutritional and economic security of the region. Horticulture in these states, forms the backbone of economy by providing direct or indirect employment to 8-10 million people and generate revenue of 10000 crores annually. Among temperate horticultural crops, apple, pear, peach, plum, kiwi fruit, apricot, cherry, almond and walnut in fruits are important with apple, walnut and pear sharing major area while in vegetables, temperate cultivars of cole crops, bulb and root crops; capsicum, peas, high value leafy vegetables like lettuce, parsley, celery, chinese cabbage etc. are commercially important. In floriculture, tulip, lilium, alestromaria, carnation and gerbera and in medicinal and aromatic plants, Lavender, Lavendine, Geranium, Dioscoria, Podophyllum, Pyr ethrum, Mentha, Artemisia etc. are becoming increasingly significant in the recent years. A very high value and low volume crops like saffron and kalazeera which are exclusively grown in this region too are commercially important. Temperate horticulture, therefore needs to be developed systematically to harness the vast potential of genetic wealth and natural resources in the coming years.

Temperate fruits

Prior to independence, horticultural activities in the region were insignificant. However, after independence, the activities especially in apple and other temperate fruits were initiated with the introduction of exotic varieties alongwith vegetable seed production. In 1960-61 the area under temperate fruits in the country which was just 0.8 lakh hectares increased to 5.03 lakh by hectares 2010-11 and production from 3.03 to 31.10 lakh tonnes. The productivity however increased marginally from 3.7 to 6.19t/ha. As per the dietary recommendations, the modest requirement of temperate fruits as on 2012 is about 48 lakh tonnes which is expected to increase to 200 lakh metric tonnes by the end of 2050 for meeting growing domestic consumption, processing and export market. Among fruits, apple represent major crop covering about 54% of the total area and accounting for 82% of

temperate fruit production while rest of the production comes from other fruits like pear, peach, plum, almond, walnut, apricot, cherries etc. which too contribute towards region's economy. The trend in growth of different fruits indicated that apple showed reasonable growth both in area and production from 1960-61 to 2010- 2011 with slow growth in productivity. When we compare our productivity of apple (9.73 t/ ha) with world average (15 t/ha) and of other developed countries (40 t/ha), it is very low. Among apple growing states of India, there is a large variation in productivity. It ranges from just 4 t/ ha in Uttarakhand to 11.5 t/ha in J&K. Due to increasing demand, apple is now being imported especially during off season and is increasing every year. This needs to be reversed by increasing total production and productivity by bringing new potential areas under cultivation and making available suitable region specific technologies and varieties.

No doubt, there has been manifold increase in area, production and productivity of temperate fruits over the years but as compared to average world productivity (8.80 t/ha) and productivity of advanced countries, our position is far behind the advance countries whose productivity has gone up to 30-40, 3-5 and 5-6 t/ha as against 9.73, 0.70 and 1.63 t/ha in India for apple, almond and walnut respectively. The low fruit productivity and quality is attributed to non availability of quality planting material, seeds and inputs; small and un-irrigated land holdings; use of inferior genetic stocks/ varieties/ hybrids; water scarcity; poor orchard management and non adoption of good horticultural practices; high incidence and emergence of pests and diseases; heavy pre and post harvest losses; and lack of trained skilled human resource and poor TOT. More recently the climate change has become a major impediment effecting temperate horticultural production.

Temperate vegetables

Like in fruits, the area, production and productivity of vegetables also increased over the years in temperate hill states. The area which was just 1.77 lakh hectares in 2000-01 was increased to 2.30 lakh hectares in 2010-11. Similarly production raised from 18.2 lakh tonnes to 37.6 lakh tonnes in the same period. The productivity however, showed marginal increase from 13.06 to 16.38 t/ha. A comparison of productivity revealed that the productivity of vegetables in hill states who grow mostly temperate types is slightly higher than national average (13.4 t/ha) but is lower than the world productivity (19.03 t/ ha). The temperate climatic conditions in the region provide unique

opportunity for seed production of cole, bulb and root vegetables.

This can generate lot of employment and reduce the burden on foreign exchange being spent on import of these seeds. The agro-climatic conditions of the region are most ideal for growing of off season and high value vegetables when these are not available in the plains especially the capsicum, cucumber, peas, lettuce, Chinese cabbage, broccoli, parsley, celery, asparagus etc. Identification and development of suitable varieties and hybrids of high value temperate vegetables especially for off season and protected cultivation with matching production and protection technologies and minimal processing and value addition for export to distant markets can bring enormous revenue to the vegetable growers.

Temperate floriculture

The Indian floriculture industry is growing very fast with an annual growth rate of more than ten percent and total turnover has crossed Rs 1000 crores. But in North Western Himalayan states inspite of congenial conditions it is grown only in about 1800 hectares as against 1.76 lakh hectare in the country. The major flowers grown in the region are lilium, tulip, alstromeria, carnations, gerbera and gladiolus. But in these states, in spite of congenial agro-climatic conditions and proximity to markets, still their potential yet to be harnessed especially under protected floriculture. In countries like Netherland and Colombia, the proportion of area under protected condition has gone upto 70 and 90 percent respectively and is the leaders in cut flowers in the world. Serious efforts are therefore needed to increase area both under open and protected cultivation in view of growing demand of cut flowers. The Himalayan states having ideal climate can be hub for protected cultivation. To make this industry attractive, genotypes and production technologies suited to protected cultivation need to be standardized in the coming years for realizing higher returns from limited area.

Temperate spices

Saffron and kalazeera are important spice crops of temperate region which are most expensive and popularly known as “Golden Spices”. Their cultivation mostly confined to J&K and some parts of HP whose share in global production has gone down substantially because of drastic reduction in cultivable area and productivity. The leading saffron growing countries like Iran and Spain are able to achieve higher production and productivity (4-7 kg/ha) posing great threat to

domestic saffron industry as imports are increasing. There is an urgent need to increase production by bringing more area under cultivation and triple the average productivity to make it globally competitive and remunerative. The productivity in India, has remained low (2.5 kg/ ha) mainly because, saffron is grown as a rainfed and whose, soils are thirsty and unfertile and are overloaded with pathogenic fungi and rodents. Irrigation and nutrient management, corm rot and rodent control shall be the crucial factors to achieve higher productivity besides making available quality planting material and appropriate planting geometry. The traditional method of long planting cycles of 10-12 years has to be substituted with short cycle to avoid spread of corm rot. No irrigation and negligible application of manures and fertilizers resulting in too many non-productive corms. Efforts are being made to increase area, production and productivity under National Saffron Mission and HMNE. However to improve production and productivity, the weaknesses in our production system need to be scientifically upgraded and replaced with new elite high yielding clones and intensive production and protection technologies including the large scale production of quality flower bearing corms and its post harvest management so that the targeted production of 150 tonnes by 2050 is achieved and productivity is tripled to come at par with Iran.

Crop diversification and biodiversity

Temperate region with varied climatic conditions offers great scope for growing wide range of fruits and vegetables having diversified uses. Due to urbanization, higher income, increased population and industrialization, there is a competition for land and water. Agricultural land is shrinking, water for irrigation is becoming scarce, rich horticultural genetic diversity is endangered and denuding from centre of origin and diversity, pollution, high cost of cultivation and fast changing climate, low returns, shortage of labour and skilled man power etc are greatly effecting the temperate horticultural production and productivity under fragile and extremely sensitive agro-ecosystem. In the recent past, with the scientific advancements and the knowledge on phyto-chemistry, therapeutic effects of bio-active principles such as phytomins, minerals, anti-oxidants etc. present in fruits and vegetables and mechanism of action resulted in better understanding that has lead to greater role in nutraceutical and therapeutic uses. Their daily consumption as deserts and salads and utilization of health foods has increased tremendously. Garlic pills, fresh fruit and vegetable juices and other health beverages are in great demand and

their potential as a functional food has tremendous scope. The scientific validation of medicinal and nutraceutical properties using state of art technology like molecular biology and nano technology holds great promise to yield a number of drugable compounds and to be in competition we need to have our own brand name and identity with products and produce having quality matching to international standards. In the context of fast changing production scenario and ever increasing demand for protective and functional foods in daily diets it is necessary to go for diversification with new crops like olive, kiwi fruit, minor berries and nuts and varieties which are low chilling, regular bearing, early maturing, high yielding, nutritionally rich and have greater adoptability to changing climate.

Climate change and its impact

The entire Himalayan region in India has a unique and fragile eco-system which is now greatly affected by climate change, causing droughts, erratic rains or snowfall, increased temperature, depleting glaciers, changing seasons etc. In the past 20 years the average mean temperature in these hill states has risen from 1.45^0C to 2.32^0C effecting vernalization of high chill requiring fruits like apple, pear, walnut, apricot, almond and cherries leading to slow growth in production and productivity especially in rain-fed areas where there is a clear trend of switching over from high chill varieties of apple walnut, apricot, cherries and almond to growing of low chilling crops and varieties. Due to rise in temperature and decline in overall precipitation, the apples in lower attitudes are shifting upwards, replacing with low chilling crops like peaches and apricots. Cherries are fast disappearing from their traditional growing areas of Kashmir valley. With the unusual hailstorms and windstorms in summer months, all kinds of pome and stone fruits are getting heavily damaged and quite often there is a coincidence of snowfall and flowering in most of the fruit and nut crops resulting in severe frost injury and in some cases the higher average temperature during winter inducing early bloom and maturity. For some varieties and crops, warmer temperature is found very beneficial and can be exploited. The increase in temperature and CO_2 also effecting the plant disease triangle. The diseases like Alternaria leaf spot and scab in apple, gummosis in stone fruits and nuts have become severe. The aphid attack is occurring approximately two weeks earlier under increased temperature. The red mite, white grub and scale insects have emerged serious in almost all crops impacting productivity and quality of the produce. In light of increased global

warming, there is a need to develop heat and drought resistant varieties where crop architecture and physiology may be genetically altered to adapt to warmer environmental conditions besides developing those technologies which mitigates and makes full use of the effects of changing climate.

Export and import scenario

With the opening of global markets and removal of quantitative restrictions under WTO agreement, the export import scenario has changed much faster. Over the years, India's share in world fruit and vegetable market has not appreciated much and temperate fruit and saffron industry have threatened by countries like China, USA, Australia, Argentina, Italy and Spain in the liberalized world trade. Our export of temperate fruits is very less to the tune of about 284 crores while the imports have gone upto 1435 crores. India imports huge quantity of almonds worth Rs. 1061 crores followed by apple (335.6 crores) pear (32 crores), plum (4.5 crores) and apricot (1.2 cores) while among exports walnut ranks first with export value of 147 crores followed by apple (54.3 crores) and plum (1.9 crores). With the increase in purchasing power, domestic demand has increased leaving very less for export. Due to non availability of sufficient quantity of quality local produce, the fresh and processed material from outside especially from China, USA, Italy, Iran and Australia etc. is increasing every year. To save our temperate fruit industry from imports and for pushing more exports we have to make full efforts in the coming years to identify the genotypes with superior quality export traits and matching production technologies to increase both production and productivity of temperate horticultural crops especially in fruits and saffron with matching international standards.

Post harvest processing and value addition

Processed products, ready to use beverages have gained tremendous popularity and their production accounted for major share in advanced countries. The commodity based products are important for reducing the post harvest losses besides providing high returns and employability. Important value added products manufactured in temperate fruits like apple juice are gaining popularity throughout the country and abroad. The fresh fruit export from India is very small owing to a number of constraints. These constraints relate to production practices, product quality, storage, issues related supply chain, grading, packaging and marketing. The future growth of

temperate horticulture industry largely depends on new and globally competitive technologies and varieties and marketing strategies.

Production targets by 2050

Taking into account the dietary requirement of the growing population, present level of production, anticipated growth rate, export and import, the production targets of 20 million tonnes for temperate fruits, 23 million tonnes of temperate vegetables and 150 tonnes of saffron have been made to achieve by 2050 (Table 1 and 2). These estimated targets of 43 million tonnes of temperate fruits and vegetables by 2050 are expected to be achieved with annual growth rate of about six percent. Looking at the average productivity at national level and of world and other advance nations, our productivity of temperate horticultural crops is very low with gap of 20-30 t/ha in pome fruits, 2-3 t/ha in nuts, 10-15t/ha in vegetables and 3-4 kg/ha in saffron that require major concerted efforts in the form of technological interventions to bridge the gap in productivity. To achieve this targeted production under changing climate, we require both horizontal expansion through identifying new potential areas and varieties and by increasing vertical productivity by developing and fully utilizing the cost effective and eco-friendly scientific and traditional technologies without disturbing the fragile eco-system in the coming years along with efficient post harvest management and value addition of international standards.

Looking at the current growth of more than 6 percent in temperate horticulture especially in fruits and nuts, the fruit production is expected to increase by 200 lakh tonnes by 2050 if concurrent growth in vertical productivity from present 6t/ha to 20t/ha and horizontal expansion in area from 5 lakh hectare to 10 lakh hectares. This targeted production not only meet the domestic demand of 162 lakh tonnes, but sufficient quantity of quality produce will also be available for processing and export. Besides increased production, there will be substantial increase in employability as horticulture activities are labour intensive. The temperate horticulture, although made some progress, but it is still in infancy and is yet to make a breakthrough in varietal and root stock improvement, production, quality enhancement and value addition. Pre and post harvest infrastructure and skilled manpower are still lacking in temperate horticulture which has tremendous scope and require thrust in coming years. To improve production and productivity, the research activities need to be intensified for combating major biotic and abiotic stresses, mitigation of

climate change, harnessing solar energy through plant geometry and architectural engineering, increasing productivity through INM, IPM, water harvesting and water use efficiency and work for development of high yielding and nutrient rich varieties, hybrids and efficient root stocks besides, production of quality seed and planting material. With this targeted growth and production there will be significant growth in employment and net returns resulting in drastic improvement in socio economic conditions of hilly people. Besides production, there will be a tremendous scope for value addition in temperate fruits. To be competitive in the world market, quality produce and products with least residues as per codex standards need to be produced to establish a brand name in the market. Since fruits and vegetables are mostly eaten raw or in desert form, productions of residue free products is a herculine task. Considerable efforts are therefore required to improve pre and post harvest production, processing, storage and handling practices. For targeted export of fresh and value added products, there is a need to develop and refine technologies for rural based grading, packaging, storage and processing to enhance product value and reduce post harvest losses.

For ensuring the nutritional and economic security to present and growing population of 162 crores by 2050, it would be a major

Crop	Estimated Production targets for 2050					
	Area (lakh ha)		Production (lakh/tonnes)		Productivity (t/ha)	
	Present (2012)	Proposed (2050)	Present (2012)	Proposed (2050)	Present (2012)	Proposed (2050)
Temperate fruits						
Apple	2.73	5.46	25.63	163.8	9.73	30.0
Pear	0.34	0.68	1.73	10.2	5.00	14.0
Peach	0.16	0.32	0.58	4.8	3.60	10.0
Plum	0.22	0.44	0.60	4.4	2.74	10.0
Apricot	0.18	0.36	0.49	5.4	2.65	15.0
Cherry	0.04	0.08	0.12	0.8	3.03	10.0
Almond	0.23	0.46	0.16	1.8	0.70	4.0
Walnut	1.10	2.20	1.84	8.8	1.60	4.0
Total	5.02	10.00	31.15	200.0	6.19	20.0
Temperate vegetables	2.30	4.60	37.60	230.0	16.38	50.0
Saffron	0.04	0.20	0.0001	0.0015	2.50(kg)	7.5 (kg)

Area (lakh ha.)		Total production by 2050 (lakh tonnes)		Extra to be produced compared to present production by 2050 (lakh tonnes)	Productivity to meet the total demand by 2050 (t/ha)	Productivity to be increased from existing (t/ha)	Total domestic requirement for 1620 million population (lakh tonnes)		Produce available for export during 2050 (lakh tonnes)	Import during 2050
2012 (present)	2050	2012 (present)	2050				2012 (present)	2050		
5.0	10.0	31.0	200.0	160.0	20.0	13.81	48.0	162.0	38.0	NIL

challenge. With shrinking land for agri-horticultural activity, the sensible option is to increase further the production levels per unit area. The challenges are many and the weaknesses have to be converted in to opportunities, through appropriate scientific interventions in the form of more efficient genotypes and technologies which are modern, environmentally stable, cost effective and have the capacity to improve productivity as well as quality to provide food, fuel, and health care coupled with increased availability at affordable price, higher returns to farmers and better employment and environmental services to growing population besides enough quantity for export market.

The temperate region including Southern hills with ideal climate and topography has tremendous potential to grow variety of fruits, vegetables, flowers and medicinal and aromatic plants having excellent quality. The natural resources and manpower of these regions need to be exploited by planned developmental programmes for increasing production and their availability locally besides improving their farm income.

Current dimensions and approaches

Temperate horticultur e today is not mer ely a means of diversification but forms an integral part of nutritional and economic security. This region is highly fragile and depended on natural resources especially the soil, water and climate. These natural resources are now fast degrading due to excessive human interference, fast changing climate and natural calamities. But still, the natural resources and rich biodiversity of temperate region offers tremendous opportunities

for production of high quality temperate fruits, nuts, vegetables and flowers which are yet to be exploited fully. During the last fifteen years, the institute identified few promising varieties and technologies especially in fruits, but it is yet to make impact on production and productivity which is far less to meet the growing demand and compete globally. Since temperate fruit production is highly skilled activity, the development of skilled manpower and scientific technological interventions would be very crucial and therefore, research in coming years should focus to speed up production more efficiently and competitively without disturbing the fragile hill ecosystem by sustainable use of natural resources and biodiversity.

The germplasm resources with special attributes, rootstocks, high yielding varieties and hybrids are limited in temperate fruits, vegetables and flowers. The breeding and genetic up-graduation in these crops is yet to be initiated utilizing available scientific tools and rich local genetic wealth. The old senile orchards, rainfed farming, poor plant architecture and canopy management, lack of eco-friendly cost effective intensive production and protection technologies, global warming and changing climate scenario are the major challenges limiting production and productivity of quality produce. The poor pre and post harvest management further deteriorating the perishables leading to heavy losses. Exploitation and conservation of genetic resources through morphological and molecular characterization, association mapping and allele mining and their subsequent utilization, introduction of trait specific germplasm and initiation of strong breeding programme for development of efficient rootstock and varieties having precocious bearing, high productivity and quality, shelf life, resilience to biotic and abiotic stresses and for replacing old varieties and for new plantations would be one of the long term objective.

To overcome the production limiting factors, technological interventions for rainfed farming relying on conservation horticulture, insitu water harvesting and micro irrigations needs to be perfected. For combating climate change, harnessing solar energy through plant geometry and density, plant architectural engineering and nutrient scheduling are yet to be understood and recommended. Efficient farming systems for high and sustainable returns, diagnostics and integrated weed and pest management and rejuvenation are yet to be standardized and perfected. All these production factors shall be our immediate short and medium term objectives in the coming years. The low productivity is associated with non availability of quality planting material of elite varieties, preferably on highly productive

clonal rootstocks. For production of large quantity of disease free planting material, the more efficient micro propagation/micro grafting and low cost high humidity propagation techniques need be standardized for commercialization of elite varieties, especially of walnut, apple and cherry. The temperate fruit and vegetable crops are highly perishable in nature, the post harvest management and processing is a missing link. Since market for value added and processed products is consistently increasing, low cost rural based technologies would be developed to improve market efficiency and to remain viable in competition. Technology demonstration and transfer are very poor, limiting fast dissemination and adoption of technologies and varieties. Participatory research and communication technologies would be strengthened and efficiently utilized to showcase research products and technologies along with developing matching training infrastructure, HRD and capacity building for developing skilled manpower.

For ensuring nutritional and economic security for present population of 126 crores and growing population of 162 crores by 2050, it would be a major challenge. With shrinking land, water and labour for agri-horticultural activity and under increasing global warming situation, the sensible option is to increase further the production levels per unit time per unit area by harnessing power of science and natural resources to ensure comprehensive and sustained physical, economic and ecological access to food and livelihood security of hilly people, through generation, assessment, refinement and adoption of appropriate technologies and varieties.

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Challenges

Past achievements in temperate horticultur e are although commendable in terms of development of few varieties and technologies in apple almond and walnut etc; yet lot more to be done in these and other crops to provide whole package of technologies suiting to changing climate and consumer needs as the productivity and quality is still very low. Monoculture of inferior varieties, traditional farming practices, alternate bearing, old and senile orchards, high incidence of insect pests and diseases, small and marginal land holdings, rainfed farming and water scarcity, poor orchard and canopy management, deteriorating land and water resources, poor weed, water and nutrient management, heavy pre and post harvest losses are of major concern and have lead to poor yield and quality. The major challenges which are impacting horticultural growth and production in temperate region are:

- Degradation of land and water resources in fragile Himalayan agro-ecosystem, effecting nutrient and water availability.
- Low productivity and quality of produce of temperate fruits and vegetables resulting in poor returns.
- Poor crop and varietal diversification, monoculture and traditional orcharding system leading to heavy incidence of pests and diseases, poor yield and quality.
- Inadequate number of improved genotypes/rootstocks having higher productivity, superior quality, stability and resilience to biotic and abiotic stresses.
- Old and senile orchards and alternate bearing, effecting productivity and quality.
- Inadequate availability of quality planting material of elite varieties and rootstocks restricting commercialization for achieving higher productivity.
- Climate change has lead to shift in seasons resulting in change in cropping pattern, reduced yield, quality and availability.
- Emergence of new pests and diseases and problem of existing pests and non availability of suitable IPM module severely effecting the overall yield and quality.
- Erratic precipitation, water scarcity and constant draughts limiting water availability and causing severe crop losses.
- Lack of scientific knowledge on protected cultivation and seed

production of vegetables and flowers in temperate region is yet to be popularized and commercialized.

- Inadequate intensive production technologies of orchard, canopy and pollination management affecting productivity and production of quality fruits.
- Continuous and heavy application of pesticides, pesticide residues and sub standard spurious pesticides, fertilizers, seeds etc. hindering in realization of higher productivity and quality.
- Lack of efficient, cost effective and eco-friendly plant nutrient, weed and protection technologies and forewarning systems leading to heavy losses.
- Severe pre and post harvest losses and lack of maturity standards, post harvest processing facilities, storage, cool chain, transport and marketing affecting overall yield and returns.
- Lack of trained skilled manpower and shortage of labour resulting in poor TOT.
- International competition and heavy flow of fresh and processed products effecting domestic production and marketing.

The challenges are many but the weaknesses have to be converted in to opportunities, through appropriate scientific interventions in the form of more efficient genotypes and technologies which are modern, environmentally stable, cost effective and have the capacity to improve productivity as well as quality to provide sufficient food, fuel, nutrition and health care coupled with increased availability of produce at affordable price, better returns to farmers and higher employment and environmental services to the growing population besides making available enough quantity for export market. Still great opportunities exists if challenges and critical issues of temperate horticulture are prioritized and taken up scientifically by management of genetic resources and improvement of crops for yield and quality through integration of both conventional and molecular breeding techniques; enhancing productivity and quality through development of efficient cost effective and eco-friendly intensive production and protection technologies; development and utilization of rootstocks and diversification of crop varieties; development of technologies and varieties for mitigation of climate change challenges; development of eco-region specific horticulture based cropping systems; development of efficient systems for enhancement of nutrient and water productivity, water harvesting and moisture conservation; HDP and development of canopy and plant architecture for higher energy harvest; development of efficient package for organic and protected cultivation;

development of technology for pre and post harvest management and product diversification;

To overcome problems of bio-risk, efforts have to be made to develop effective and integrated risk and disaster management production systems and bio risk intelligent systems and finally the human resource development and transfer of technologies would lead to commercialization and higher production and remuneration.

Operating Environment

The national agricultural policy is targeted for attaining agricultural growth rate of more than four percent. But the agricultural production in the country is greatly affected as the main factors of production namely soil, water, climate, seeds, tools and peasants are seriously threatened and the global issues like climate change, rising food prices, free trade and increasing global competition and imports have become major challenges. Sustainable and stable livelihood for farmers and growing population require focus on each component areas and factors of productivity and issues of agriculture. Looking at diversified uses and changing dietary habits towards horticultural products and higher purchasing power, the demand for horticultural products is increasing. It is expected that by 2050 we require about 43 million tonnes of temperate horticultural produce at a growth rate of 6.7%. For achieving four percent growth in agriculture envisaged by planning commission, the golden revolution need to continue at 7-8 percent growth rate. The soil is degrading, water has become scarce, climate is fast changing, new diseases and pests are emerging, quality seed and planting material not adequately available, limited mechanization and finally the low farm returns moving away farmers and rural youth from agri-horticultural activities. With the opening of global market, the export import scenario is changing at much faster pace where horticulture stands as the major beneficiary in such a scenario to contribute to the much needed forex reserves. For that Indian horticultural produce especially the temperate fruits, vegetables and cut flowers have to be competitive.

For ensuring nutritional and economic security for present population of 126 crores and for target population of 162 crores by 2050, it would be a harculine task. With shrinking land for agri-horticultural activity, the sensible option is to increase further the production levels per unit area per unit time. When we look at the production and productivity of temperate horticultural crops, the area under temperate fruits in the country has increased over years from 0.82 lakh hectares in 1960-61 to 5.03 lakh hectares by 2010-11 along with production from 3.03 to 31.14 lakh tonnes, while the productivity during the same period, increased only marginally from 3.17 to 6.19t/ ha. However, the modest requirement of temperate

fruits at present is about 48 lakh tonnes which is expected to increase to 16.20 million tonnes by the end of 2050. Almost similar situation also prevails in temperate vegetables and ornamental crops. Among various crops apple, pear and walnut represent major crops of temperate fruits covering about 54, 22 and 6.9% of the total area and accounting for 82.3, 1.1 and 5.6% of temperate fruit production respectively while rest of the production comes from other fruits like peach, plum, almond, apricot and cherries etc. which too have significance in regions economy.

Since biotic and abiotic stresses, post harvest losses, low input and water use efficiency, natural calamities, physiological disorders, weeds etc. limiting the potential of temperate horticulture production by various yield losses upto 30-40 percent. The intensive cost effective and eco-friendly production and protection technologies have to be standardized and adopted alongwith efficient genotypes. Although our overall productivity of temperate fruits is very low (6.19t/ha) as compared to world and advance countries, now efforts are being intensified for promotion of R&D in horticulture which received impressive support in the last two decades from a meager 25 crores in VIIth plan to 14966 crores in XIth plan while allocation to horticultural research rose from 3.5 crores to 629.8 crores. As a result, the research infrastructure increased manifold with the setting up of several new institutes and NRC's which resulted in development of good number varieties and hybrids accompanied by matching technologies but still the production and productivity is low to meet the dietary requirement of present and growing population. In 11th plan 5.24 percent of the total budget of ICAR and 22.5 percent of the total budget of DOAC was earmarked for horticulture and is expected to be much higher in 12th plan to provide much needed nutrition, health care and higher returns.

In temperate horticulture, efforts started in the early 1970's with the introduction of new varieties and root stocks which had positive socio economic impact through apple and other fruits like pear, peach, almond, walnut and vegetables. But the low yield and quality, impact of climate change and heavy flow of imported products of temperate fruits experienced in the last few decades demand concerted efforts through appropriate scientific interventions and national policies on R&D which is still in infancy in temperate region. The rapidly unfolding natural and manmade changes of the environment on crop production and protection necessitates dynamic approach to basic, strategic and applied research. At national level,

the horticultural research activities in our country have been spear headed by the Indian Council of Agricultural Research through ten Institutes, six Directorates, seven NRC's nineteen AICRP and Net work projects and two hundred fifty one research centers. Thirty five horticulture departments in the SAU's complementing through research and education on horticulture largely supported by ICAR and act as link to state extension machinery while in temperate horticulture, inspite of vast potential, the much needed institutional infrastructure and manpower is still to come. The private and corporate agencies are also working and contributing to horticulture R&D in seed and planting material production, fertilizers, pesticides, farm machinery etc. and are the part of developmental programmes. However, the Central Institute of Temperate Horticulture with its one regional station and eight network centres with following mandates and objectives is concentrating on research and developmental needs alongwith six State Agricultural Universities of Himalayan states in the country.

Mandate

- To act as national repository of germplasm & scientific information on temperate horticultural crops.
- To undertake basic, strategic and applied research on temperate horticultural crops in collaboration with national and international agencies to enhance productivity and quality.
- To serve as centre of training for human resource development & transfer of technology.

Objectives

- Establishment of field gene bank and management of genetic resources and scientific data base of temperate horticultural crops.
- Genetic improvement of temperate horticultural crops for yield, maturity, quality, resistance to biotic and abiotic stresses through conventional breeding methods and use of biotechnological tools.
- Standardization of nursery management and high tech propagation techniques of temperate horticultural crops.
- To device efficient and cost effective production technologies and cropping systems for increasing productivity and improving quality of temperate horticultural crops.
- To develop eco-friendly integrated disease/pest management modules and diagnostics.
- Post harvest value addition, product diversification and waste utilization for increasing availability and returns.

- To work out economics of production and impact assessment of technologies.
- Commercialization and transfer of technologies and skilled manpower development.

R & D initiatives in Temperate Horticulture and significant achievements

Apple Field Gene Bank

Green House Complex

Quality Laboratory

- For strengthening R&D activities and horticultural production in the temperate region the Indian Council of Agricultural Research established Central Institute of Temperate Horticulture in 1994 as a premier institute with its HQ at Srinagar, Jammu and Kashmir and Regional Station at Mukteshwar, Uttarakhand. The institute is mandated for carrying out basic, strategic and applied research on major temperate horticultural crops besides serving as a centre for national repository of germplasm, scientific information and HRD.
- For carrying out R&D activities the institute was provided scientific and other auxiliary staff which is very limited needs strengthening for achieving goals and production targets set for 2050. However, during the last 18 years, the institute created sufficient field and

laboratory infrastructure both at main campus and at Regional Station.

- A well planned field orchard with adequate drip and sprinkler irrigation facilities have been established along with set of poly greenhouses, net houses and mist chambers for production of planting material and protected cultivation. The laboratories are adequately equipped with need based equipments to conduct research on plant nutrients, micro-propagation, plant pathology, entomology, post harvest technology etc and supported by ARIS, internet, library and of fice equipments for computerized accounting, record keeping and efficient communication.

Vance Delicious | Red Fuji | Silver Spur

Oregon Spur | Spartan | Granny Smith

Co-Red Fuji | Starkrimson

Elite apple cultivars for temperate region

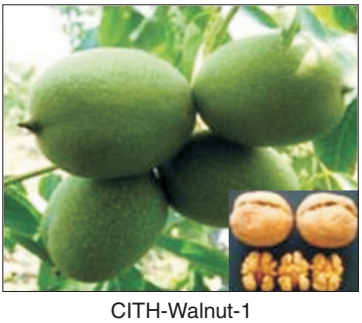
- In genetic resource management the institute made as many as 2116 collections which included 870 genotypes in temperate fruits and nuts, 948 in vegetables, 273 in ornamentals and 25

in medicinal and aromatic plants have been documented and maintained in field gene bank at both Srinagar and Mukteshwar centres.

- Some promising genotypes of apple, walnut, olive, cherry, apricot, garlic, kale, chilli have been registered with NBPGR and are being used in crop improvement as well as in large scale multiplication.
- Under diversification and off season cultivation, minor temperate fruits (Kiwi, olive), nuts and berries and high value vegetable varieties/hybrids were klintroduced and evaluated in each crop such as kale, lettuce, parsely, celery, swiss chard, broccoli, Chinese cabbage etc. and identified few promising varieties for distribution and popularization in the temperate region besides selection and identification of elite lines in chilli, sweet pepper, tomato, brinjal, peas, bulb and root crops suitable to temperate region which are now under advance stage testing in state and AICRP trials.
- In saffron, a field gene bank of 32 accessions have been established having varied stigma and pistil length with saffron yield ranging from 3.4 to 4.1kg/ha in 2nd year of planting while in ornamental, medicinal and aromatic plants a total collection of 189 genotypes have been collected, evaluated and maintained for further breeding. Work on development of suitable agronomic practices and value added products is under progress.

Elite lines in chilli, capsicum, lettuce and saffron identified for temperate region

- Under crop improvement and biotechnology, identified and released ten varieties of walnut namely CITH-walnut-1, CITH- walnut-2, CITH-walnut-3, CITH-walnut-4, CITH-walnut-5, CITH- walnut-6, CITH-walnut-7, CITH-walnut-8, CITH-walnut-9 and CITH-walnut-10 superior in yield and kernel quality; three varieties of apricot namely CITH apricot-1, CITH apricot-2 and CITH apricot-3 high in yield and superior in table



CITH-Walnut-1

quality; two varieties of cherry namely CITH-cherry-1 and CITH-cherry-2 and one variety each of apple (CITH- Lodh Apple-1) and garlic (CITH- Garlic(M)-1) having high yield, superior quality and early maturity. These varieties are now being multiplied and tested in entire temperate region of the country for release at national level.

- From field evaluation as many as 29 varieties with different maturity groups in apple, 5 in apricot, 8 in almond, 12 in walnut, 4 in peach, 3 in plum, 5 in cherry, 3 in pomegranate, 4 in olive, 5 in strawberry, 5 each in tomato, chilli and peas, 2 in onion, 1 in garlic and 10 in gladiolus have found promising and are being multiplied and supplied in large scale.
- Through inter-varietal crosses and pollen g e r mination studies identified most compatible parents and best pollinizers in apple and walnut.
- For production of large quality planting material micro-propagation protocols have been standardized for lilium and cherry and work on apple, walnut and saffron is under way. A major breakthrough has also been achieved for development of stigma like structures in saffron under In vitro conditions which has opened up possibility of production of saffranal through stigma like structures.

CITH-Apricot-1

CITH-Cherry-1

CITH-LodhApple-1

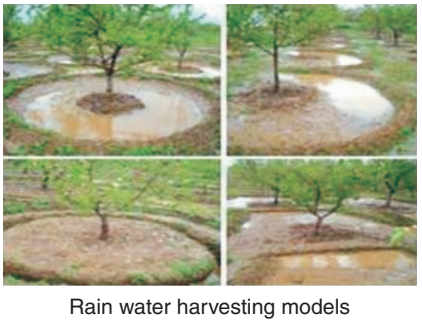
In-vitro micro-corm production in saffron

- In quality planting material and seed production, the institute made a good beginning and contributed about 7.0 lakh rootstocks/budded plants of elite varieties, 8.50 lakh budwood, 2148 kgs of quality seeds of vegetable varieties and hybrids, 8.75 lakh vegetable seedlings and 4.5 lakh saffron corms to State Development Departments for establishment of progeny orchards and to farmers besides establishment root stock and bud wood banks for quality budwood production.
- In crop production and protection, some very useful cost ef fective technologies have been standardized for increasing the production of quality fruits and vegetables.
- High and medium density orcharding with suitable varieties in apple, almond and apricot; drip irrigation, rainwater harvesting and moisture conservation in apple and almond; rejuvenation of old apple and almond orchards through pruning, nutrient and pest management; technology for production of quality corms of saffron and gladiolus and plug plant production in Fuchsia; intercropping, pollinizers and pollinators for higher fruit set and yield and early farm income in almond and apple; floral biology, pollination and pollinizer requirement in walnut; low cost efficient vegetative propagation techniques in walnut through

Low cost polyhouse propagation of walnut

High density apple plantation on clonal rootstock

Rejuvenation technology in almond



Rain water harvesting models

Green house tomato production

wedge grafting under low cost polyhouses and cuttings in apple and pomegranate using PGR; varieties/hybrids and production technologies for protected cultivation of tomato, cucumber, capsicum, strawberry and gladiolus; technology for organic baby corn production using ver micompost+biospirillum+ biophos+ biopotash; integrated management for control Fusarium wilt in chilli, Phytophtora fruit rot in tomato, corm rot of saffron and effective management of red mites through miticides, scab by fungicide kresoxim methyl and canker by AM fungi (Glomus sp.) in apple were standardized and recommended.

- For disseminating technologies and elite varieties/cultivars to the farmers, the Institute has developed good rapport and linkages with extension agencies of state development departments by putting up demonstrations conducting kisan melas, field visits, field days, trainings, exhibitions, delivering radio and TV talks and distributing technical literature in the form of Bulletins, Folders etc. for bringing socio-economic impact in the region.
- The technologies and the quality planting material and seeds provided to the local farmers of J&K, H.P. Uttarakhand and Arunachal Pradesh particularly the pollinizers and new varieties/ hybrids and rootstocks in fruits and high value temperate vegetables, chilli, capsicum, tomato, cucumber, peas etc. are paying dividend and farmers are realizing the benefits in terms of increased production, productivity, quality and higher net returns.
- Through technology adoption the productivity of important crops like apple, almond, apricot, chilli, pea and saffron has increased by 22-36% in adopted farmers field and demand for elite planting material of apple, almond, walnut, apricot and seed and seedlings of vegetable varieties and hybrids in the region has shown manifold increase.
- The Institute besides research and extension activities also contributing to scientific literature by publishing good number of research papers, books, manuals compendiums extension bulletins etc. and scientists and staff were also trained for exposure and skill upgradation in national and international institutes under HRD.
- Although CITH made substantial contribution in identifying and

establishing good number of promising varieties especially in walnut, apple, almond, apricot, saffron, garlic and chillies and evolving highly effective production technologies like planting densities, intercropping, pollination, water management, propagation etc. which have relevance at Regional and National levels. The thrust areas of research and priorities envisaged by ICAR programmes; the needs of the growers of the region and recommendations made by various QRT's, RAC's etc. have been taken care depending upon the availability of scientific staff. However, potential of genetic resources yet to be harnessed for varietal and rootstock improvement, intensive production technology generation and upscalling plant health and diagnostics, crop protection, post harvest management and extension.

- For strengthening the ongoing research programmes and to address the new challenging issues like quality planting material production, combating major biotic and abiotic stresses and climate change, harnessing solar energy through plant geometry and architectural engineering in canopy management, improving water and nutritional efficiency, identifying efficient and high tech propagation techniques, IPM, IDM and diagnostics, technology for protected cultivation of flowers and vegetables, sustainable and organic farming etc. have greater relevance in the region and shall be taken up in the coming years.
- Since problems in temperate horticulture are region specific, they are to be addressed at state and regional level while the centre has been instrumental in guiding the horticultural programmes and policies. Currently more than 800 horticulture experts from ICAR institutes and about 1200 in SAU's are available in the country for horticultural research activities. But in temperate horticulture only few scientists (22) at present are available at Central Institute besides some researchers of SAU's who are exclusively working on more than twenty five economically important horticultural crops. This very meager manpower and inadequate infrastructure are limiting the progress. To make temperate horticulture more vibrant, the manpower and infrastructure in coming years have to be strengthened to meet the challenges of low productivity and quality, climate change, international competition and biodiversity concerns. To achieve vision 2050 goals, a comprehensive multidisciplinary approach with adequate scientific, technical and state of art infrastructure in field and laboratory, trained human resources in frontier areas of science, conducive horticultural policies and mission programmes have to continue in the coming years to harness the great potential of monopoly temperate horticultural crops.

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Opportunities

The high production cost and increased demand for safe horticultural produce in the West and Middle East; increasing purchasing power of middle and higher income group in India and the uncertainty of weather under climate change scenario all over the world have resulted in greater demand for horticultural produce and products in the global and domestic market. The temperate region still practicing traditional farming has great potential for producing variety of fruits, nuts and vegetables which are safe from harmful chemical pesticides and fertilizers. Apart from traditional agricultural exports and tropical fruits, the temperate fruits like apple, walnut, vegetable seeds, cut flowers and processed products will have high export potential. Irrespective of tough competition under liberal trade, the significant opportunities exist for temperate horticultural crops and we have to try to capitalize our existing strength of the organizational support, advantages of climatic conditions, fertile land, water and relatively cheap agricultural labour and more importantly the available technologies and varieties. To feed ever growing population with quality horticultural produce, the break throughs and new knowledge developed in science have to be fully utilized. Genomics, marker aided selection, bioinformatics and biotechnology for developing designer varieties and hybrids by cloning and transfer of specific genes against biotic and abiotic stresses, improving nutritional quality, shelf life, herbicide resistance etc. have to be fully utilized along with conventional breeding techniques. The advancements and knowledge on phyto-chemistry has lead to better understanding of therapeutic effects of bioactive compounds such as phytomins, antioxidants, minerals etc. has great role in development of nutraceutical, health and functional foods and beverages. The nanotechnology has great promise for improving input efficiency, developing diagnostics, smart packaging etc. Remote sensing and GPS for survey and forecasting; space and nuclear science for creation of mutations, new variability and varieties and use of ICT in transfer of technology, data analysis, storage and management hold great promise for achieving goals of the vision.

The free trade among countries provides excellent opportunities for export of more farm produce, but it require greater attention in respect of sanitary and phytosanitary measures and production of quality safe

residue free produce acceptable in international market. Production of temperate fruits and nuts especially the high quality walnuts and apple, high value exotic vegetables, cut flowers, aromatic and medicinal plants and their products would need greater attention for enhancing and exploiting the potential for global as well as domestic markets along with production of efficient fortified organic inputs and bio-pesticides. The temperate region having excellent genetic biodiversity and climatic variability also provides great opportunities for crop and varietal diversification, regional resource utilization, increased production and higher employment and returns.

Goals and Targets

For ensuring nutritional and economic security to present population of 126 crores and growing population of 162 crores by 2050, it would be a major challenge. By 2050 we require about 20 million tonnes for temperate fruits, 23 million tonnes of temperate vegetables and 150 tonnes of saffron. These targets have been made taking in to account the dietary requirement of the growing population, present level of production, anticipated growth rate, export and import. The estimated targets of 43 million tonnes of temperate fruits and vegetables by 2050 are expected to be achieved with annual growth rate of about six percent. With this targeted growth and production there will be significant growth in employment and net returns resulting in drastic improvement in socio economic conditions of hilly people. With shrinking land for agri-horticultural activity, the sensible option is to increase further the production levels per unit area. The challenges are many and the weaknesses have to be converted in to opportunities, through appropriate scientific interventions in the form of more efficient genotypes and technologies which are modern, environmentally stable, cost effective and have the capacity to improve productivity as well as quality to provide food, fuel, nutrition and health care coupled with increased availability at affordable price, higher returns to farmers and better employment and environmental services to growing population besides enough quantity for export market. But this could only be possible if matching state of art infrastructure facilities and trained scientific and skilled manpower are created and made available. For achieving estimated production targets by 2050, the following goals and targets are set to bring higher growth rate, stability, sustainability, efficiency, improved quality, productivity and returns besides reducing environmental pollution and drudgery.

- To make temperate horticultural R&D more vibrant using power of science and human resources to solve national and crop specific problems and issues through challenge and flagship programmes and platforms.
- To contribute towards nutritional and economic security through increased productivity, quality, employment and farm returns.
- To bring sustainable development through conservation and efficient utilization of natural resources by improving water use efficiency and productivity, building soil fertility and micro flora, increasing input use efficiency etc.

- To act as national repository of genetic resources and scientific information on temperate horticultural crops through enrichment of germplasm, their maintenance, characterization, evaluation, documentation, conservation and commercial utilization and development of crop wise scientific information data base and its utilization in planning and promotional activities.
- To undertake basic, strategic and applied research for increasing productivity and quality of temperate horticultural crops through genetic improvement in yield, quality and resilience to biotic and abiotic stresses and by development of eco-friendly and cost effective production and protection technologies through input use efficiency like water, nutrients, pesticides etc
- To study climate change impact and develop resilient varieties and technologies for mitigating and makes full use of climate change effects.
- Expansion of temperate horticultural activities to non-traditional areas for increasing production and availability leading to higher income and health care at regional level.
- To promote urban and semi urban horticulture and protected and eco friendly farming for round the year availability of quality vegetables and flowers and better environmental services.
- To increase overall production of quality horticultural produce for greater availability of fresh and processed products, encourage establishment of seed and processing industries and nurseries for better employment, nutrition, health care and exports.
- To train human resources in frontier areas and improve collaborations for greater innovations for betterment of mankind and environment.
- To establish centre of excellences and new centres in temperate region to provide quality research and skill upgradation to bring regional balance, efficiency and prosperity by harnessing natural and human resources.
- Technology development for pre and post harvest management, value addition and product diversification for self-employment, especially for women and weaker sections of the society.
- To establish linkages and collaboration with national and international organizations for conduct of advance research, genetic resources sharing and HRD.
- To serve as centre of training for promotion of HRD and effective transfer of technologies.
- To register, patent and commercialize viable technologies for higher remuneration and employability.

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Way Forward

Temperate horticultural research is still in infancy, the CITH as ICAR's lone institute has greater role in designing and developing research programmes on crop improvement, production, protection and post harvest management for achieving economic and nutritional security in the entire Himalayan region and shall look forward to take up following issues to fulfill the vision.

1. In temperate horticulture, there are number of national and regional researchable issues spread across entire temperate region. Focus required on development of time bound multidisciplinary/multi-institutional target oriented challenge programmes to augment and efficiently use the limited manpower and infrastructure.
2. Short and long term policies and programmes required in temperate horticulture alongwith matching manpower and infrastructure for greater availability of quality seed and planting material and improving productivity and quality leading to higher returns and employability.
3. A critical review of strength and weaknesses of temperate horticultur e and for mulating multi disciplinary r esearch programmes and their validation across locations through net work or AICRP should find priority.
4. Biodiversity provides building blocks for sustainable food, health and livelihood security. Tremendous diversity still exists in temperate Himalayan region. Intensification of collection and identification of trait specific germplasm is vital for future breeding programmes for overcoming challenges of biotic and abiotic stresses. Genetic resource management and sustenance of biodiversity would be the focused areas but that needs active collaborations from NBPGR and other CGIAR institutes
5. With the changing climate scenario, extreme climatic conditions and fragile ecosystem in Himalayan hills necessiates initiation of programmes on conservation horticulture, climate resilient horticulture, intensive high-tech irrigated horticulture, rainfed and cold arid horticulture and protected horticulture for sustainable production and availability of horticulture produce in the region throughout the year.
6. Changing dietary habits, demand for safe or organic products,

increasing purchasing power, international competition and high value nutrients in temperate fruits, nuts and vegetables have lead increased demand for quality fresh and processed products. The demand driven horticultural research utilizing the power of science and technology such as physiology, biotechnology, nanotechnology, biochemistry, etc has to be given priority in the coming years.

7. Increasing population has lead to pressure on agricultural land, water and energy. For meeting the ever increasing demand of temperate horticultural crops, the new alternative intensive production under green house and aeroponics, urban/periurban horticulture, ecotourism horticulture etc have great potential and must be given priority for economizing and efficient utilization of natural resources.
8. Secondary agriculture is the missing link. Post harvest processing, value addition and product diversification are very poor in temperate region. Quality improvement and redesigning of supply chain from seed to consumer plate is the need of the hour. Assessment and refinement of ITK and development of rural based processing and value addition would minimize pre and post harvest losses.
9. Training of farmers and extension workers and effective transfer of new varieties and technologies involving state extension agencies, KVK's NGO's etc. would be crucial for achieving targeted production and continued growth.

Major approaches for making temperate horticulture more vibrant and remunerative

1. Restructuring and strengthening of CITH with need based infrastructure and manpower for conducting priority research for ensuring nutritional and economic security.

Action Points:

- Human resource development in advance laboratories in frontier areas of research for developing scientific confidence and building collaboration with national and international organizations to meet the regional, national and global challenges.
- Creation of Centre of Excellence in frontier areas, establishment of new centres in north eastern, tribal and cold arid regions for promotion of horticulture in critical areas.
- Re-structuring of AINRP to AICRP for doing research in critical areas with project based funding for improving efficiency.
- Reorganizing institute and regional stations based on mandate, strength, expertise and facilities. Priority setting and focusing on critical issues with challenge and flagship programmes.

- Focusing on national issues through time bound and target oriented challenge/network programmes involving multi-institutions.
- Strengthening of field and laboratory facilities for conducting research on new emerging frontier areas of molecular breeding, nanotechnology etc. and for demand driven horticulture.
- Developing infrastructure and field facilities for protected cultivation and climate change impact studies (Multi-institutional)
- Developing post harvest processing storage and value addition facilities focusing on on-farm rural based agro-preprocessing and waste utilization.
- Strengthening and improving efficiency of outreach extension activities and human resource.
- Capacity building and development of skilled manpower for intensive horticulture operations.

2. Biodiversity and genetic resource management

Biodiversity provides building blocks for sustainable food, health care and livelihood security which is diminishing very fast causing great concern. Greater emphasis on collaboration with NBPGR, Biodiversity International, CGIAR Institutes, ICAR and SAU's is required for long term sustainability.

Action Points:

- Intensification of collection and conservation of trait specific germplasm.
- Screening of germplasm for abiotic and biotic resilience.
- Characterizing important wild species and land races using molecular techniques.
- Identification of new genes, genotyping and phenol-typing of gene pool.
- IPR, patenting and safeguarding against gene piracy.
- Exchange and effective use of germplasm in genetic enhancement/ pre breeding to meet challenges of biotic and abiotic stresses, besides yield and quality.

3. Genetic improvement of temperate horticultural crops for higher productivity and quality

The changing dietary habits and nutritional significance; shrinking land and water; fast changing climate; biotic and abiotic stresses etc. have necessitated breeders to develop and identify varieties, hybrids having higher productivity, rich nutrients and bioactive compounds, higher consumer quality and acceptability, ideal processing and export

attributes, suitable for protected cultivation and having greater flexibility to climate change and other biotic and abiotic factors.

Action Points

- Screening and identification of underutilized nutrient rich horticultural crops-under diversification.
- Integration of both conventional and molecular breeding approaches for developing more efficient varieties and hybrids.
- Exploitation of biotechnological tools for improvement such as bio-informatics, genomics, allele mining, molecular markers etc.
- Pre-breeding and isolation of somachonal variation and in vitro mutagenesis.
- Development of transgenics for dwarfing, nutrient use efficiency, insect pest and disease resistance, abiotic stress tolerance, increasing shelf life, improvement in processing and nutritional quality with matching infrastructure.

4. Development and evaluation of rootstocks for different situations.

In temperate fruits, rootstocks play significant role in enhancing early maturity and productivity by enabling high density plantations and providing biotic and abiotic resilience.

Actions points

- Identification and development of efficient root stocks
- Screening of rootstocks for biotic and abiotic stresses; precocity; yield and quality; vigor and productivity (for HDP) and nutrient use efficiency.
- Study of scion rootstock compatibility and their commercialization.

5. Development of ef ficient system for higher water productivity and nutrient use efficiency.

Global warming has resulted in erratic precipitation and depletion of perennial water resources like glaciers in Himalayan region. The share of water for agricultural use is reducing drastically due to over consumption and competition from domestic use and industries while on the other hand the fertilizers and nutrients have become costly and not fully utilized due to leaching and faulty application. Developing technologies for higher water productivity and nutrient use efficiency are the future researchable issues.

Action points:

- Standardization of pressurized irrigation and fertigation.
- Rainwater harvesting and moisture conservation.

- Developing diagnosis, leaf nutrient norms and nutrient scheduling based on leaf and soil test and crop response.
- Balanced and integrated use of nutrients and micro-nutrients.

6. Conservation horticulture and development eco-friendly region specific horticulture based cropping systems for sustainable production of high quality safe produce and higher farm income.

Action points

- Building and sustainable use of natural resources.
- Improving soil health and minimizing erosion.
- Recycling of farm wastes and biological material.
- Study of cover crops, intercrops and their utilization.
- Building of soil micro-flora and improving fertility etc.
- Waste land management for orcharding.
- Horticulture based integrated farming system.
- Mixed and multistoried cropping.

7. Development of hi-tech pr opagation techniques in temperate horticultural crops for large scale production of nucleus quality planting material.

Action points

- Innovations and refinements in conventional propagation techniques.
- Micro-propagation techniques for saffron and rootstocks.
- Greenhouse technology for plant propagation and nursery production.
- Aeroponic production of soft fruits and vegetables.
- Micro and shoot tip grafting.
- Quality seed production and maintenance breeding.
- Health management of seed and planting material.

8. Hybrid seed and seedling production technology for high value vegetable and or namental cr ops for pr otected environment and promotion of hybrid technology.

Action Points

- Assessment of optimum climatic requirements for green house seed and seedling production.
- Standardization of hybrid seed production technology.
- Standardization of package of practices for hybrid cultivation for exploiting their yield potential

9. Development of intensive production technologies for higher vertical productivity

Action points

- Evaluation of high density planting on clonal rootstocks.
- Development of canopy and plant architectural engineering for higher energy harvest.
- Pollination and orchard management for higher fruit set and yield.
- Evaluation and selection of dwarf cvs and scion varieties for early and higher yield.
- Impact of pruning and growth regulators for regulating ideal canopy and regular bearing.
- Standardization of nutrient, irrigation and pest management schedule for HDP
- Study of pre harvest practices for higher yield.

10. Organic horticulture for production of residue free fruits and vegetables.

Action points

- Documentation of existing ITK on organic agriculture.
- Development of organic package involving all components of organic farming.
- Development of quality standards for organic produce.
- Establishment of suitable analytical laboratories to assess and evaluate the quality of produce and inputs.

11. Protected cultivation and urban and peri-urban horticulture for higher productivity.

Action points

- Design and development of greenhouses for different agro-climatic conditions.
- Genotype selection and development of indigenous varieties and hybrids.
- Standardization of intensive production and eco-friendly IPM technologies fine-tuned to suit our climate and export market.

12. Plant health management of temperate horticultural crops.

Insect pests, weeds and diseases causing heavy losses. Development of region specific eco-friendly modules will be the focus. Action points

- Development and use of forecasting systems.
- Development of resistant varieties and transgenics.

- Standardization of technology of rejuvenation of old senile orchards
- Solarization and use of cultural practices.
- Identification and exploitation of bio-agents, bio-pesticides, traps etc.
- Diagnostics for detection of plant viruses and diseases.
- Development and use of eco-friendly compatible need based organic/ chemical pesticide formulations and IPM modules.
- Use of GPS and remote sensing for disease mapping.

13. Secondary agriculture and technology development for pre- and post harvest management and product diversification in temperate horticultural crops.

Quality improvement and redesigning the supply chain from seed to consumer plate is the need of the hour.

Action points:

- Development of nutrient rich varieties for processing and higher shelf life and identification of bioactive components.
- Assessment and refinement of ITK and development of rural based processing and value addition.
- Development of technologies for preventing huge pre & post harvest losses.
- Development of harvesting and quality standards for horticulture produce and products.
- Development of maturity indices, non destructive measurement of maturity and quality parameters.
- Minimal processing and development of value added products and product diversification.
- Standardization of safe grading, packaging and storage.
- Utilization of nano technology for smart packaging, shelf life, fortified foods etc.
- Promoting partnership with private industries for commercialization of products.

14. Climate resilient horticultur e-impact assessment and mitigation strategies.-

Action Points:

- Simulation studies of climate change impact on apple and other fruits.
- Development of mitigation strategies in temperate fruit and vegetables by early forecasting, varietal selection, agronomic

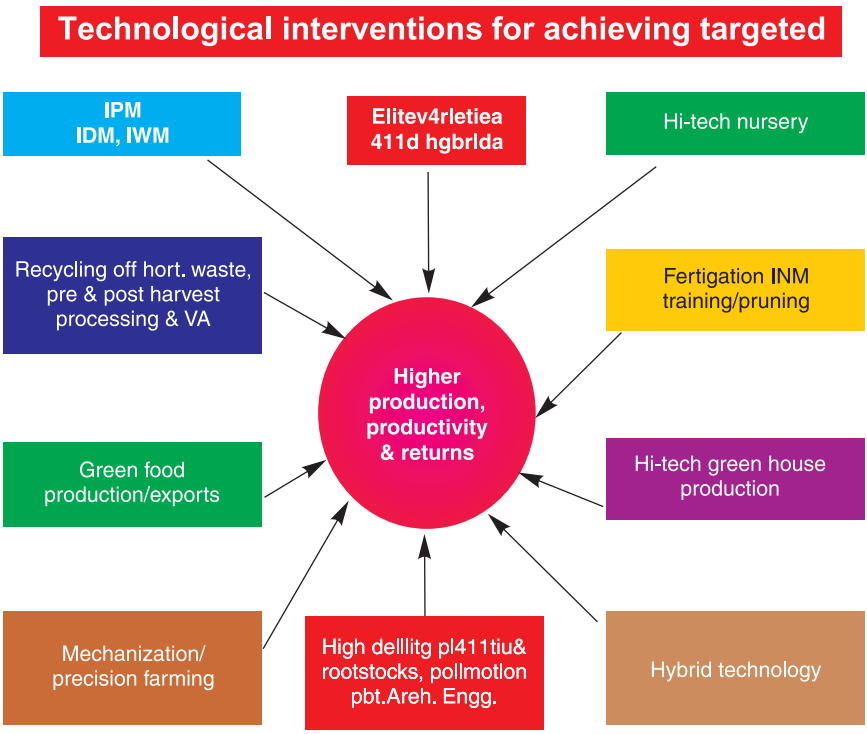
adjustments, suitable cropping system, soil and water conservation and water use efficiency.

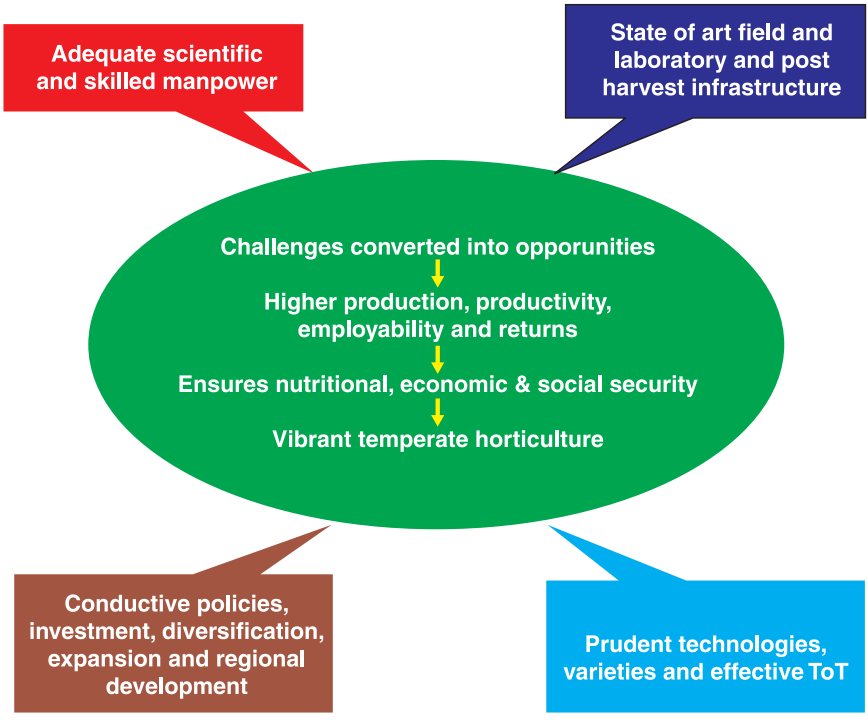
15. Promotion of mechanization in temperate horticulture.

- Development and use of horticultural tools/equipments for improving efficiency and quality of work, reducing drudgery and cost of cultivation.
- Utilization of farm waste and byproduct development.

16. Commercialization and Transfer of Technologies.

- Constraint analysis and development of extension modules
- Effective transfer of technologies through use of ICT, KVK's and extension agencies.
- Promotion of modern technologies through contract farming.
- Participatory research and promotion of Public Private Partnership.
- Patenting and commercialization of technologies.
- Impact assessment of new technologies and varieties.




Adequate scientific and skilled manpower
State of art field and laboratory and post harvest infrastructure
Challenges converted into opporunities
Higher production, productivity, employability and returns
Ensures nutritional, economic & social security
Vibrant temperate horticulture
Conductive policies, investment, diversification, expansion and regional development
Prudent technologies, varieties and effective ToT