Vision 2030

Indian Institute of Vegetable Research
Varanasi

www.iivr.org.in

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सत्यमेव जयते

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SECRETARY & DIRECTOR-GENERAL

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भारतीय कृषि अनुसंधान परिषद्
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Foreward

The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, new parasites, slow growht in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural research programmes. The emerging scenario necessitates the institutions of ICAR to have perspective vision which could be translated through proactive, novel and innovative research approach based on cutting edge science. In this endeavour, all of the institutions of ICAR, have revised and prepared respective Vision-2030 documents highlighting the issues and strategies relevant for the next twenty years.

In the global endeavour for food and nutritional security, the diversity of vegetable crops and their nutritional value are of special significance. Beside this, vegetables are usually higher in productivity, have shorter maturity cycle, have high value and provide a valuable source of income, leading to improved livelihood. Thus, the growth in vegetable sector has played an important role in the country's food and nutritional security, health and economic development. The overall growth rate of 1.96% in area, 2.22% in productivity and 4.39% in total production has been achieved during the last five years. Our demand of vegetables will be 225 million tonnes by 2020 and 350 million

tonnes by 2030. The Indian Institute of Vegetable Research (IIVR), Varanasi has a major challenge in the years ahead to develop technologies that enhance quality and productivity of vegetables in an environment with several biotic and abiotic stresses.

It is expected that the analytical approach and forward looking concepts presented in the '*Vision 2030*' document will prove useful for the researchers, policymakers, and stakeholders to address the future challenges for growth and development of the agricultural sector and ensure food and income security with a human touch.

(S. Ayyappan)

Dated the 30 June, 2011
New Delhi

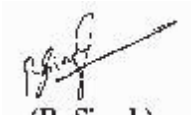
Preface

India has to go a long way to accelerate the vegetable production, considering the national and international demand. There is a need to achieve the target of 225 million tonnes by the end of 2020 and 350 million tonnes by 2030. Existence of adequate eco-diversity in the country has enabled to grow more than 60 vegetable crops in the country. In addition, about 30 lesser-known and underutilized vegetable crops need research and development efforts to promote their cultivation under suitable climatic conditions. So far research work has been concentrated only on 30 vegetable crops. Out of these, tomato, eggplant, chilli, okra, bitter gourd, bottle gourd, cauliflower, melons, peas, etc. are the important crops on which adequate emphasis has been given. Under All India Coordinated Research Projects on Vegetable Crops emphasis has been given to 24 vegetable crops and 423 varieties have been identified and recommended for release and cultivation in different agro-climatic zones of the country. Similarly 403 production and 179 disease as well as 112 insect management technologies have also been developed and recommended.

The preparation of IIVR Vision 2030 provided us with an opportunity to introspect our accomplishment vis-a-vis the Vision 2020 and Perspective Plan 2025. Although, at this point of time IIVR seems moving faster than the required pace for timely achievement of our previous goals, yet, changing food security scenario of the country necessitates us to set much challenging targets for the year 2030. On the other hand, newer challenges in the form of increasing shortage of quantity and quality of agricultural land and deteriorating production environment on account of climate

change make it increasingly difficult even to maintain the current growth rate of vegetable production in the country. Through biotechnology and molecular biology techniques we have been pursuing functional genomics of biotic and abiotic stresses, development of transgenics and molecular markers for various traits, and allele mining, etc. The application of GIS techniques and modelling research on the effects of climate change will provide solutions to mitigate ill effects of global warming and climate change. Thus, IIVR is well prepared to accept the challenge of facilitating the nation for achieving fresh target of producing 350 million tonnes of vegetables by the year 2030.

Dr. H.P. Singh, Deputy Director General (Horticulture), ICAR has always been a motivating and guiding force behind setting future research priorities of the IIVR. I would be failing in my duties if I don't acknowledge his extraordinary interest and guidance in finalization of IIVR Vision 2030. I sincerely acknowledge efforts of the scientists of Institute in preparation of this vision document. I believe the document will provide precise direction and focus to the current and future vegetable research in the country.



(B. Singh)
Director (Act.)

June 2011
New Delhi

Preamble

Looking at the national scenario, vegetables have tremendous strength in terms of natural resources and biological assets especially genetic resources. A large number of wild taxa of indigenous vegetables are available in the different agro-ecological zones of the country and hardly some of them have been capitalized. This needs further attention and efforts to develop varieties resistant to biotic and abiotic stresses. The country is endowed with varied climatic conditions for cultivation of number of vegetables in one or other parts of the Country. The strength of vegetable research and development in our country is the rich biodiversity, potential market, cheap labour and qualified scientific manpower.

However, on the other hand weakness of vegetable research lies within the fact that a large number of crops (more than 30) are addressed by a very limited number of scientific manpower and organizations. The weakness increased with lack of financial support and infrastructure besides, extreme climatic conditions, heavy infestation of insect pests and diseases. .

There are issues in research which warrant adequate attention with special reference to the problems of diseases and pests. Such problems can be minimized by developing resistant varieties and plant protection technologies. However, this requires the application of modern Bio-technological and Genetic engineering approaches. Further, such resistance breeding approach should be supplemented by the integrated pest management approach to reduce the application of chemicals and environmental pollution. Considering the natural resources, soil and water are the

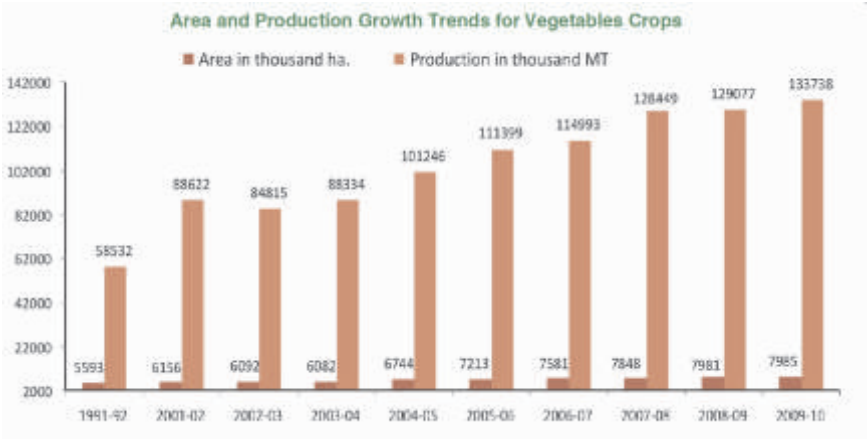
major areas which suffer with salinity, alkalinity, excessive moisture, scarcity of moisture affecting the production of vegetables in the country. In the wake of liberalization of seed policy, large quantities of seeds of vegetables are being imported and marketed in the country. To a great extent it offers a threat to the introduction of new diseases and pests in coming years. A strong quarantine as well as multi location testing of the seeds before commercial sale/distribution will be rather more beneficial to the country.

Notwithstanding the development of numerous technologies, there is a critical gap between experimental yield and national average which needs to be minimized by a strong extension service, training and demonstration. Further there is need of execution of a programme like Frontline Demonstrations in vegetable crops with the financial support of Department of Agriculture and Cooperation, Ministry of Agriculture. Such approaches will help reduce the yield gap between the farmers' field and experimental field. Also there is a need of technology assessment, technology refinement and technology transfer. In the coming years, in view of the fragmentation of land and change of food habits and nutritional quality of the vegetables, research and development have to play a vital role in overall economic well being of the farmers of the country. However, this needs strong support from the Government to equip this dynamic sector with latest technology to meet the national and international challenges.

Contents

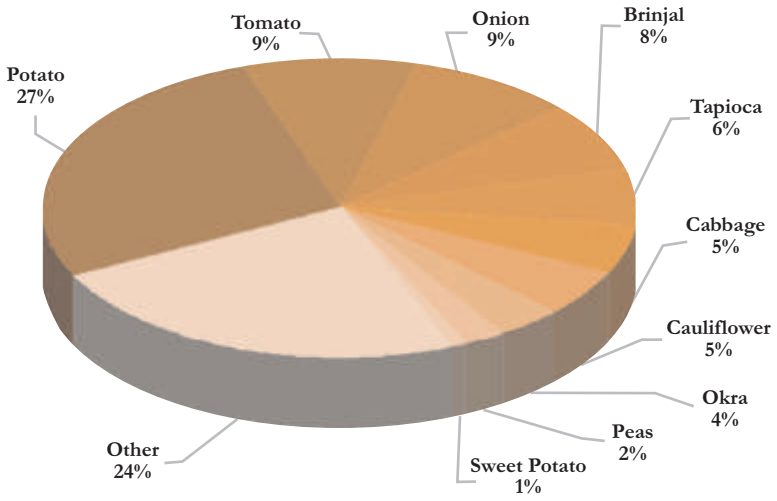
Scenario of Vegetable Sector

Vegetables are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. They are valued for their high carbohydrate, vitamin, mineral and fibre contents. Vegetables make up a significant proportion of the diet of most of the people and the production of vegetables is a significant factor in ensuring that people have an adequate intake of many essential vitamins, minerals and carbohydrates every day.



India is a leading vegetable producing country in the world. Presently it occupies 7.98 million hectare area with the annual production of 133.74 million tonnes. The country being blessed with the unique gift of nature of diverse climate and distinct seasons, make it possible to grow an array of vegetables number exceeding more than hundred types. However, potato being the staple food and easy to mix in several preparations ranks first (26.6%) in total production of vegetables followed by other important solanaceous vegetables like tomato (8.6%) and brinjal (8.0%). Onion is one of the most important vegetables, occupies significant share (10.5%) in vegetable production. Cauliflower and cabbage are most preferred winter vegetables and their total share in the country's vegetable production is 5.1 and 5.3%, respectively. Other important vegetables which are primarily grown in the

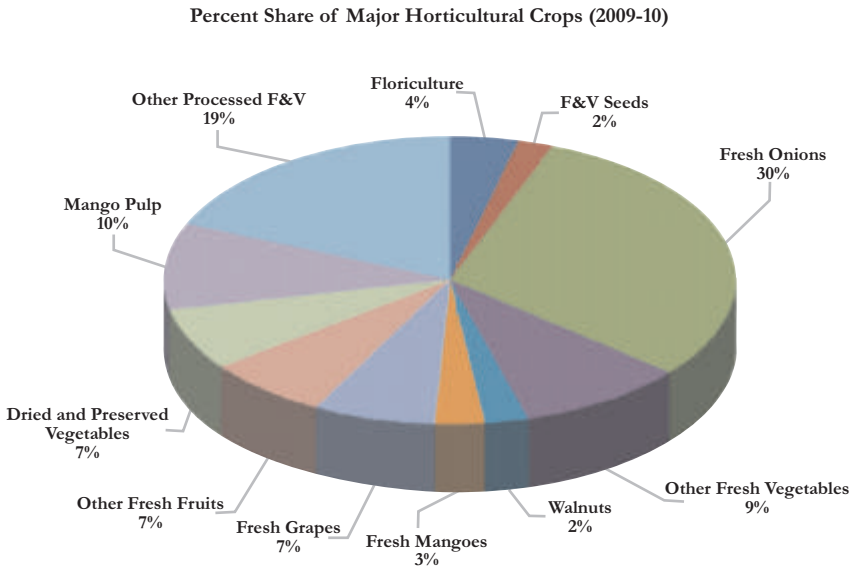
Production Share of Major Vegetable Crops in India (2009-10)



country are okra, vegetable peas and a good range of cucurbits. There is mis-match in area, production and productivity of vegetables among various states of the country. Presently UP ranks first in the total production of vegetables. West Bengal, Bihar and Orissa in North India and Tamil Nadu and Karnataka in South India are the other leading vegetable producing states in the country. In last one decade, there has been considerable progress in enhancing the productivity of vegetables which is presently 16.7 tonnes per hectare.

Vegetable Export- Present Status

India is the fruit and vegetable basket of the world. India being a home of wide variety of fruits and vegetables, holds a unique position in production figures among other countries. According to current figure (09-10), out of the total 68 million tones of India's exports in fresh vegetables, over 75% went to asian countries being maximum to Nepal (23%) followed by UAE and Pakistan (20%), Bangladesh (10%) and Soudi Arabia (4%) and remaining (18%) in rest of the countries. According to value wise export, UAE ranks first (23%) followed by Pakistan (12%), UK (11%), Nepal (9%), Saudi Arabia and Bangladesh (8%). Considering crop-wise values, tomato contributes to the maximum of 44% of total export of all vegetables followed by Chilli (27%), garlic (19%), Pea (3%) and Cucumber (1%).



Export of Processed Fruits and Vegetables

India can become one of the largest fruit and vegetable exporters in the world due to its agro-climatic diversity. There should be technology upgradation, quality management, firm adherence to export commitments and acquisition of appropriate negotiation skills. Many non-traditional vegetables mainly processed gherkins and others like asparagus, celery, bell pepper, sweet corn, green and lima beans and organically grown vegetables are also being increasingly exported. India's exports of processed food was Rs. 10065.58 crores in 2008-09, which included the share of products like mango pulp (Rs. 752.99 crores), dried and preserved vegetable (Rs. 496.42 crores), other processed fruit and vegetable (Rs. 1371.79 crores), pulses (Rs. 542.32 crores), groundnuts (Rs. 1239.01 Crores), guar gum (Rs. 1338.99 crores), jaggery & confectionary (Rs. 2004.82 Crores), cocoa products (Rs. 84.04 Crores), cereal preparations (Rs. 1100.93 crores), alcoholic and non-alcoholic beverages (Rs. 542.54 crores) and miscellaneous preparations (Rs. 591.73 crores). The Indian food processing industry is primarily export oriented. India's geographical situation gives it the unique advantage of connectivity to Europe, the Middle East, Japan, Singapore, Thailand, Malaysia and Korea. One such example indicating India's location advantage is the value of trade in agriculture and processed food between India and Gulf region. India's export

of other processed fruits & vegetables has increased from Rs. 962.82 crores in 2007-08 to Rs 1371.79 crores in 2008-09. Major export destinations (2008-09) are USA, UK, Saudi Arabia, Netherlands and Russia.

Challenges of Climate Change

Global climate change is projected to cause increase in the surface air temperature by 1.8 to 4.0 °C by the end of the century. This will be accompanied by increase in the frequency of climatic extreme events such as heat and cold waves, episodes of heavy rainfall, and a likely increase in the frequency of droughts and floods. All these pose immense challenges to agriculture, and horticultural crops are no exception. In order to provide nutritional security and sustainable farm income, it is imperative to understand the impacts of climate change on various horticultural crops and to identify adaptation strategies/measures to minimize the adverse effects of climate change and to maximize its positive influence, if any. Adaptive mechanisms like time adjustment and effective use of water will help to reduce these negative impacts. These challenges could be addressed through identification of the gene for tolerance to high temperature, flood and drought, development of nutrient efficient cultivars, and production system for efficient use of nutrients and water.

For development of climate resilient horticultural crops which are tolerant to high temperature, moisture stress, salinity and climate proofing though genomics and biotechnology would be essentially required. This would need highly prioritized research to address the impact of climate change. This changing scenario is attributed to technological interventions where understanding the physiology of plant growth and development has played a vital role. Thus, there is an urgent need to strengthen the ongoing research and to initiate focused research programmes to address the identified gaps. It is also important to analyze the socio-economic impacts of climate change on horticultural production systems. By providing weather based advisory, by strengthening the developmental programmes on natural resource management and low-carbon storage structures and by policy support, the Indian horticulture can be made more resilient to climate change. In all these complexities of climate, horticultural crops may prove one of suitable options, since most of the vegetables and fruit crops are grown in country from sea shore to snow lines and have immense ability to cope up with the most of the adverse climatic conditions.

Technology Landscape

Modern scientific technologies have been extensively applied in all aspects of genetic improvement, production, protection, post harvest handling and processing of vegetable crops. Recent advances in molecular breeding *vis-a-vis* marker-assisted selection have opened new avenues for the breeders to tap desired genetic variability more efficiently and to exploit it across trans-specific or generic barriers. The tomato genome has recently been deciphered by a consortium of international laboratories including India. The sequence data would open up opportunities to understand and exploit complex agronomic traits that could not be manipulated so far. Developments in the area of functional genomics, proteomics, metabolomics and phenomics will help in understanding and exploitation of novel traits and also in breaking the yield barrier. Similarly, advancement made in the area of nanotechnology will have immediate application for better detection of pathogens and for efficient nutrient and pesticide delivery.

Emergence of Agri-business

Business opportunities in the area of seed production, storage and processing would increase steeply for vegetable crops. Several private enterprises have already ceased this opportunity and are increasing their capacity for quality seed production. The perishable nature of vegetables necessitates its post harvest storage under refrigerated condition. Although chain of conventional refrigerated storage structures is available in the country, there is a need to refine the storage technology to economize energy consumption as well as to ensure better quality of stored produce. Similarly, opportunities in the area of post harvest processing would increase many folds in near future. Most of the multinational companies dealing with processed vegetable products have already established their links in India. Business opportunity in this area is also going to be increased at a high rate in near future. Besides, latest concepts and business opportunities in the area of contract farming, crop insurance, consultancy, mechanization, hightech farming, procurement, packaging, retailing, etc. would be favoured in vegetable crops compared to other food crops.

Research System

In order to sustain the growth of vegetable production and productivity in India, during 1999, ICAR approved a separate research institute on vegetable namely, Indian Institute of Vegetable Research (IIVR). Prior to this, work on vegetable research was addressed by the All India Coordinated Research Project (AICRP) which was started in the year 1971 to plan, coordinate and monitor the research activities on vegetable crops. To give a fillip to the research and to meet the challenges, the status of AICRP on vegetable crops was elevated to the level of Project Directorate of Vegetable Research (PDVR) during 1986 with its headquarter at IARI, New Delhi. During 1992, the head quarter was shifted to Varanasi. The institute has a total staff strength of 127 out of which 65 are scientific personnel. Research and development work is carried out under three major Divisions, *viz.*, Divisions of Vegetable Improvement, Vegetable Production, Vegetable Protection, including Post-harvest Technology, Seed Technology as well as extension as a seperate section. There are 44 institute research projects and 15 externally funded research projects running in the institute. The research work conducted by the institute is reviewed every five years by a high power Quinquennial Review Team (QRT). Besides, the annual progress of research projects is critically monitored and analyzed by external reviewers of the Research Advisory Committee (RAC) and internally by the Institute Research Council (IRC). The institute has created state-of-the-art laboratories for conducting basic and strategic research in different areas of vegetable research. The Institute has very well equipped laboratory complex building. This complex has well-equipped laboratories for conducting researches on various disciplines of vegetable science, *viz.,* Biotechnology and Tissue Culture, Crop Improvement (Genetics, Cytogenetics and Vegetable Breeding, Genetic Resources), Crop Production (Soil Science, Crop Biochemistry, Physiology, Ecology), Crop Protection (Toxicology, Residue Analysis, Bio-Control, Fungal Pathology, Bacteriology, Virology), Seed Technology, Post-harvest Technology, Extension and Training.

Mandate

- To undertake innovative, basic, strategic and applied research for developing technologies to enhance productivity of vegetable crops, their nutrient quality, post harvest management and value addition.
- To provide scientific leadership in coordinated network research for solving location specific problems of production and to monitor breeder seed production of released / notified varieties.
- To act as a national repository of scientific information relevant to vegetable crops and as a centre for training for up-gradation of scientific manpower working on vegetable crops.
- To develop high yielding, good quality, disease and pest resistant varieties/hybrids of selected vegetable crops.
- To develop advanced production and protection technologies for selected vegetable varieties/hybrids.
- To undertake germplasm collection, maintenance and documentation in vegetable crops.
- To improve the compilation of data and analysis by provision of micro processing facilities especially of regional trials undertaken in coordinated research project and network schemes.
- To provide technical supervision for the breeder seed production of released varieties and parental lines of vegetable crops.

Mandate Crops

Based on high nutritional value and scope for value addition, major emphasis will be laid on the following crops for developing technologies at national level:

- Tomato, Brinjal, Chilli, Okra, Bitter gourd, Cucumber, Muskmelon, Pumpkin, Bottle gourd and Pea

All India Coordinated Research Project on crops was started during the fourth five-year plan in 1970-71, to provide a national grid for multi-location

testing of the vegetable technologies developed by various research institutes and state agricultural universities. Presently the project has 29 centres located in different agro-climatic zones of the country. Besides these, about 25 centres involving central institutes, state agricultural and traditional universities and a few other public and private organizations are participating in the cooperative research programme of the project on voluntary basis. Under All India Coordinated Vegetable Improvement Project emphasis has been given to 24 vegetable crops and 423 varieties have been identified and recommended for release for cultivation in different agro-climatic zones. Similarly 403 production and 179 disease as well as 112 insect management technologies have been developed and recommended

The Institute has made significant contribution in basic, strategic and applied research. Till date 54 varieties/hybrids in 14 vegetable crops have been developed and notified for cultivation in different agro-climatic zones. In addition, molecular markers have been identified for genetic purity testing of hybrids in tomato, brinjal and chilli and to test the gender of pointed gourd at juvenile stage. Transgenic lines have been developed in tomato and brinjal using *Cry 1Ac* gene, which are in T_5 stage. Gynoecious line in bitter gourd, seedless pointed gourd, high carotene genotype in pumpkin, high lycopene and high carotenoid lines in tomato are the other major achievements. The institute has standardized suitable package of practices for realizing optimum yield of improved varieties/hybrids. Besides, integrated plant nutrient management package has also been developed and validated for yield maximization in major vegetables. Emphasis has also been given on development of technologies for post-harvest management and value addition in vegetable crops. Integrated pest management technologies against major insect pests have been standardized and validated for production of residue-free vegetables. Biological control, use of predators and parasites is being encouraged for safe vegetable production. Considering the significant achievements and progress made by the institute, ICAR has bestowed the Best Annual Report Award in the year 2002, Sardar Patel Best Institute Award in 2003, Chaudhary Devilal Award for best AICRP -2003 and ICAR Best Team Research Award in 2005.

IIVR 2030

Under the above mentioned background, the targeted production need to be achieved without increasing the area under the crops potentially utilizing the scientific, technological and traditional strengths for sustainable production. India can withstand the competition only by increasing productivity and reducing cost of cultivation leading to low cost per unit of production. The growth of vegetable production will lead to a significant growth in on-farm employment opportunities as vegetables are labour intensive crops. Further, there is substantial scope for value addition in vegetables. Presently, less than 2% of vegetables produced in the country undergo value addition. Concerted efforts are needed to improve the present post harvest processing and storage systems and in educating the farmers and traders in handling/processing the produce hygienically. The envisaged increase in share of value added products in the export basket of vegetables needs strengthening of processing facilities both on farm and outside.

Vision

To increase the production, productivity and utilization of vegetables for economic livelihood and nutritional security.

Mission

The mission of Indian Institute of Vegetable Research is to contribute significantly to the nutritional security of India through the development of production technologies of vegetable crops, which are resource sustainable, economically viable and environmentally safe.

Focus

The main focuses on researchable areas to accomplish the vision are:

- Conservation of genetic resources, DNA fingerprinting and crop improvement
- Increasing productivity of vegetables
  - Quality seed production and supply

  - Productivity enhancement technologies and systems through better input management
  - Bio-risk management
- New market oriented technologies for secondary agriculture and value addition
- Effective transfer of technologies to the target groups

Proposed solutions and policy options

Genetic enhancement

- Crop-wise catalogues of all germplasm collections using IPGRI descriptors
- Gene pyramiding and development of varieties with multiple resistance and quality
- Locating sources of resistance for biotic and abiotic stresses using conventional and biotechnological tools and developing varieties with high yield, quality and specific traits
- The varietal evaluation of newly developed genotypes to suit specific agro ecological and soil conditions.

Synergies of frontier science – Biotechnology, Nanotechnology, GIS

- Molecular profiling including genome sequencing of important cultivars, varieties and hybrids
- Marker-aided selection for the desired traits and identifying genes controlling superior quality traits, pests and diseases resistance
- Molecular mechanisms of host-pathogen interactions in tomato and chilli
- Nano-particles for detection of pests and efficient nutrients and pesticide delivery.

Managing natural resources

- Cost effective nutrient budgeting through integrated nutrient management (INM) for targeted production and organic farming strategies

- Development and popularization of cost effective agricultural practices (INM/IPM) for increasing the productivity
- Abiotic stress - Quantification of water use efficiency and water requirement in different vegetables

Management of inputs and energy

- Increasing the demand for vegetables and its value added products.
- Value addition through minimal processing
- Large scale drying technology to preserve vegetables

Plant health management

- Surveillance, identification and characterization of new invasive pests and pathogens
- Development of rapid and reliable diagnostics against pests and pathogens including invasive species.
- Pest and disease dynamics under changing climatic scenario
- Management of invasive pests and pathogens

Policies

- Commercialization of the techniques/ technologies
- Genetic finger printing of germplasm and its registration
- Registration of released varieties
- Patenting technologies related to vegetables
- Documentation of ITKs

TOT

- Constraint analysis and impact assessment of new technologies
- Production of nucleus and breeder seeds in adequate quantities
- Large scale demonstration of proven technologies through KVK's as FLDs
- Participatory Seed Production of major vegetables.

Harnessing Science

Agriculture has benefitted immensely from innovations in other related areas, *viz*., during iron age through tougher implements, era of industrial revolution through mechanization, era of chemical revolution through fertilizers and pesticides, era of Mendelian genetics through high yielding varieties, oil era through replacement of animal traction by tractor and era of green revolution through combination of varieties along with other inputs. Development of agriculture is now facing multiple challenges in terms of yield stagnation, soil quality deterioration, environmental pollution, bio-risk, and food safety related issues. Scientific knowledge in all those areas is increasing exponentially. Appropriate technologies need to be developed for confronting such challenges by efficiently exploiting available scientific knowledge. The state of scientific knowledge and its utilization in the following areas would be targeted for vegetable development.

Genetic resource enhancement

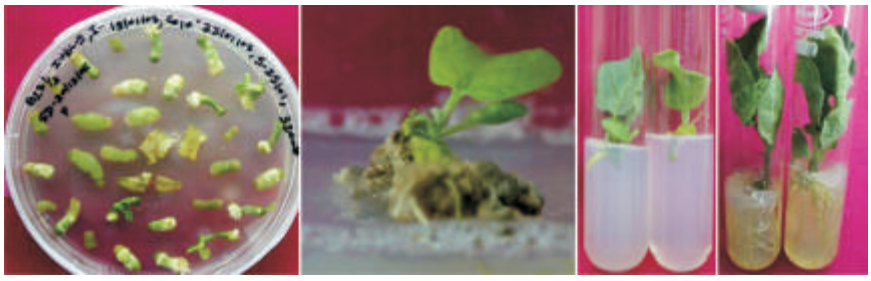
Genetic variability in tomato

Genetic resources of a crop are the basic material required for its improvement. Keeping this in view, the institute has collected and maintained a rich germplasm repository. At present, this repository holds more than 4,548 accessions of cultivated as well as wild species of vegetable. This serves the vegetable breeders and researchers by providing necessary parents with premium characters. The genetic improvement of a crop is a continuous task as growers and consumer's requirements go on changing, and new diseases, pests and abiotic stresses continue to evolve. The development of 54 varieties by IIVR and 423 varieties through AICRP(VC) for different agro-climatic regions has successfully taken care of the needs of vegetable cultivation in India. Keeping above in view, the potential areas of interest for vegetable genetic-resource enhancement and improvement are (i) identification of core

collection and mini-core collections for different agronomic traits (ii) evaluation and characterization of vegetable germplasm for biotic and abiotic stresses, quality, processing and nutrient and wateruse efficiency, (iii) pre-breeding for suitable parent development, and (iv) cryo-conservation of vegetable germplasm for long-term storage. Technological advancements made in the area of molecular characterization, cryo-conservation, cell biology would be exploited to achieve the goals.

Biotechnology

Vegetable has been among the first few crops where biotechnology was put to use due to relative ease in manipulating biological phenomenon by biotechnological tools. Despite having diverse wild relatives, the present day cultivated vegetable have narrow genetic base as majority of wild species are not crossable with cultivated vegetable. As vegetable crops are highly amenable to genetic engineering, transgenic technology could be a viable option for selective vegetable improvement. Development of transgenic vegetable for traits like insect resistance, tolerant to abiotic stresses for which no resistance source is available, needs to be taken up on priority. Development of marker-free transgenic vegetable on the above mentioned traits will also be attempted. The wild species will be exploited for introgression of durable resistance. The genome sequencing of important indigenous vegetables, especially okra, bitter gourd, brinjal, etc. will be attempted. Studies on vegetable functional genomics with reference to biotic and abiotic stresses will be attempted to decipher the genes involved in these traits. Studies on vegetable proteomics and phenomics with reference to abiotic stresses will be initiated. The next generation molecular marker, SNP, with reference to disease resistance and quality traits will be developed by allele mining and re-sequencing.



Transgenic brinjal plant carrying *Cry1Ac* gene

Synergies of frontier sciences

Agricultural research in future will be benefited by latest developments in areas like nano-technology, information and communication technology and remote sensing and also techniques like, geographic information system (GIS) and global positioning system (GPS). These frontier sciences and techniques would be well integrated in the on-going and future vegetable research for improving research efficiency, better targeting of technologies and also identifying production and marketing environments.

Management of natural resources


Drip irrigation and fertigation

Increasing input cost and various environmental concerns have made it essential to manage efficiently the two key inputs *viz*., nutrient and water. Attempts would be made not only to increase the productivity but also to maintain the environmental quality. In next two decades, strategy will be to follow precision management of nutrients and water. All major vegetable growing pockets needs to be spatially characterized for their natural resources, including soil available nutrients and water resources. For improving efficiency of resources, varietal and genetic variability will be exploited in different agro-ecological regions. Emerging secondary micronutrient imbalance is not only decreasing the vegetable yield but also affecting the quality of produce. Therefore, region specific management with respect to these nutrients needs to be improved in light of recently developed cultivars and intensive cropping systems. The efficiency of limited water resource can be increased by appropriate micro-irrigation system. Work in this line has been done, but it needs further refinement with respect to different soil texture and region. Target should be to bring maximum vegetable area under this improved method of irrigation along with fertigation technology.

Post-harvest and value-addition

India has witnessed at rapid growth in horticultural research development in recent past. There has been a rapid change in dietary habits

owing to increased incomes which has accelerated the demand of horticultural produce in recent past. However, the increased production could not keep the horticultural produce in fresh condition for longer time due to poor infrastructure for storage, processing and marketing as large quantities of fruits and vegetables perish to the extent of 5.8-18.0%. Major infrastructural limitations also continue to impose severe constraints to domestic distributions as well as to the export of vegetables. Considerable losses of perishable vegetables occur due to lack of cold chain storage facility and suitable post harvest handling practices during the marketing the produce. Lack of mechanized sorting facilities, inappropriate packaging and poor transport systems further add to the deterioration of perishable vegetables.


Osmo air drying of bitter-gourd

There should be strategies to ensure end-to-end holistic approach towards post-harvest management, processing and marketing to assure returns to growers and also to assist retailers and whole-sellers in setting up facilities of pack house with cold chain facility, modified atmospheric packaging and controlled atmospheric storage of vegetables. Edible coating of polysaccharides, lipids and proteins may be helpful in retaining the freshness of vegetables for longer time due to excellent moisture barrier and this will also be helpful in retaining the aesthetic quality of vegetables. Value addition of vegetables can convert the surplus vegetables into nutritionally rich processed products with wider acceptance. Minimally processed vegetables reduce the time of cooking with various health benefits. Similarly ready-to-eat vegetables provide varied taste and convenience of time with extended shelf life.

Management of energy and agricultural waste

Vegetable consumes lot of energy from planting till their post-harvest management. Development of energy efficient implements/machines to perform/various cultural operations in vegetable cultivation *viz.* planting, inter-culture operations, plant protection measures, harvesting and grading will be the priority. The farm implements/machines with improved energy

efficiency that can be adopted under different vegetable production systems/different types of farmers (for small and large-size holdings) will be developed and promoted. Emphasis will be given to incorporate crop residues in vegetable based cropping systems. Efforts will also be made to minimize the tillage/energy requirements in vegetable production.

Bio-risk management

Bio-risk is increasing in agriculture with climate change, intensive cultivation, evolution of new and more virulent strains of pathogens/ pests, and trans-boundary migration of insect-pests and diseases with commodities. It is adding cost, reducing produce quality and is adversely affect farm income. To overcome problem of bio-risk, efforts would be made to understand the genetic basis of pest/pathogen variability, develop quick, cheaper but robust diagnostic tools, effective interception mechanism for introduced pathogens/pests and develop effective and integrated risk management systems including remote sensing. Bio-risk intelligent system (surveillance of racial pattern of different pathogens and pests and early warning systems) would be developed for taking informed decision at the local, regional and national levels.

Pheromone trap: A safer alternative for pest management

Human resource development

An organization has to be prepared for future challenges. The research programmes at IIVR will need continuous refinement to enhance the quality of vegetable research and to solve the immediate and future problems of vegetable production. This will require the development of human resources of the institute through training of scientists of different disciplines at renowned national and international centres of vegetable research. Similarly, the Institute envisages that it will act as a center of excellence in training for vegetable researcher and other stake holders. Even if the institute's mandate does not reflect the education, the scientific faculty of the Institute is guiding Ph.D students of agriculture as well as traditional universities.

Technology transfer system

IIVR technology at farmer's field

The development of new vegetable technologies is not enough to encourage production and productivity but transfer of these technologies to appropriate stake holders is equally important. The Division of Social Sciences is organizing various trainings for vegetable growers in different locations of the country and also organizing seminars, symposium, workshop, etc. for dissemination of recent advances in vegetable technology. Now, there is a need to exploit the recent information communication technologies like mobile phones and internet services for effective technology transfer. Similarly, collaboration with ATMAs, KVKs and SAUs will be the focus for exchange of knowledge and technology for ultimate benefits of stakeholders i.e. vegetable growers, researchers and private companies involved in vegetable production and processing.

Strategy and Framework

Conservation of genetic resources, DNA fingerprinting of genotypes and crop improvement.

Perspective: To have a complete information on gene pool which is native to India for sustainable utilization and conservation and raise the production to targeted levels by developing improved varieties with high yield, quality traits, disease/ insect resistance and abiotic stresses.

Locating resistance source and evolving high yielding and disease resistant lines through conventional breeding and biotechnological methods are among the important programmes for vegetable improvement. Efforts are made to locate source(s) of resistance/tolerance to biotic and abiotic stresses. Efforts may also be oriented towards identification of varieties which can adapt to climate change and also management strategies to mitigate the ill effects of climate change.

Productivity enhancement technologies and systems through better input management

Perspective : Resource budgeting and management of cropping system for efficient use, stable yield, quality and income.

Generation of eco-region specific technologies will be important programme based on maximum productivity of available natural resources, soil fertility and water. The future strategy will be to increase the vegetable production and productivity to meet the per capita requirement of 300 g vegetables per day. In view of this, we have to go a long way to increase the productivity of the vegetables through adoption of improved production technologies in an ecofriendly manner.

Control of pest and diseases

Perspective : To raise the production levels through IDM/ IPM.

Emphasis should be on suvey and surveillance of pests and diseases in changing climatic scenario and identification of new and effective bio-

molecules for management of biotic stresses coupled with development of innovative diagnostic techniques for rapid, accurate and cost effective detection of high impact pest and diseases. Integrated management system for major and emerging pests and diseases will be essential for plant health management to reduce the losses. Holistic approach would be needed for pest and disease management and adoption of region wise agro-techniques.

Development of Secondary Agriculture and Value Addition

Perspective : To increase the acceptability, demand and value of vegetables

The research programmes should orient for this demand by focusing more attention on better agro-techniques in product diversification and varieties suitable for such products. Development of post-harvest technologies to improve product quality and minimize environmental impacts coupled with value addition could be a focus for reducing crop losses and increasing marketability.

Effective TOT to the target groups

Perspective: Effective technology dissemination, adoption and further refinement

There must be participatory approach for effective transfer of technologies, monitoring and evaluation and also feedback for further refinement. Stakeholders may be empowered through trainings and FLDs from ATIC and KVKs on proven technologies, for better adoption at field level. Private and public partnership as producers and distributors of certified planting material and products will help in fulfilling the demand for quality seeds in vegetables.

Epilogue

Vegetables are important component of agriculture for nutritional security being rich source of carbohydrates, proteins, vitamins and minerals. Since food and nutritional security are of our prime concerns, hence special efforts on intensification of vegetable research are necessary. New improved abiotic resistant varieties are pre-requisite for enhancing the vegetable production and for augmenting the breeding programme utilization of potential germplasm is indispensable. In the recent past, with the advent of hybrids, vegetable industries of the world are paying their high attention on this aspect and similar efforts are required in this country also especially to tackle the severity of pests and diseases in hybrids. Recently, biotechnology has emerged as an effective tool in solving the several problems which were not possible by conventional methods. Use of molecular marker for gene tagging, transfer of gene from wild taxa, development of biotic stress resistant varieties *in vitro* methods are some of the potential research areas where much attention is needed to be paid. Accordingly, much emphasis has been given while setting of programmes on a time scale. As the few varieties/hybrids are emerging, there is urgent need to give new production and protection techniques to exploit their full potential. In this connection, due importance has been given for producing the vegetables under protected conditions. Besides these, to minimize the use of chemicals in protection programme to safeguard the human health and environment, major emphasis has been given for biological approaches for the control of vegetable diseases and pests.

References

Anonymous, 2011. Vision 2030. Indian Council of Agricultural Research, New Delhi.

Anonymous, 2002. Vision 2020.Indian Instituite vof Vegetable Research, Varanasi

Anonymous, 2004. Perspective Plan 2025.Indian Instituite vof Vegetable Research, Varanasi

Anonymous, 2010. National Horticulture Database 2010. NHB, DAC, GOI, New Delhi.

Annexure I : Strategic Framework

Goal	Approach	Performance measure
Genetic enhancement, diversity analysis, utilization of gene pool in crop improvement	• Characterization of germplasm collections using IPGRI descriptors and development of database • Locating sources of resistance for biotic and abiotic stresses using conventional and biotechnological tools and developing varieties with high yield, quality and specific traits • Gene pyramiding and development of varieties with multiple resistance and quality • Marker aided selection for the desired traits and identifying genes controlling superior quality traits, pest and disease resistance • Maintenance breeding of popular varieties	No of germplasm collected and maintained Genes identified Varieties inbred lines developed Varieties developed
Frontier areas of research to improve understanding – diagnostics, sequencing, MAS, nutraceuticals	• Molecular mechanisms of host-pathogen interactions • Genomics, gene discovery and allele mining • Development of functional markers through transcriptome sequencing. • Development of transgenics for insect resistance and viruses • Full genome sequencing of important vegetables	Genes and promoters identified Molecular markers developed Transgenics developed Complete sequence of crops

	• Precision phenotyping and plant modeling in tomato for abiotic stresses	
Production system management for enhancing productivity	• Studies on soil health and nutrient dynamics under different vegetable production systems	Technology for water and Nutritional use efficiency
	• To improve the water and nutrient use efficiency in vegetable crops through precision farming approach- drip and fertigation, mulching and zero tillage	
	• Export oriented quality vegetable production under organic farming model to maintain the soil health for sustainability	Production technology developed
	• Vegetable based cropping system	Effective cropping system
	• Quality transplant production under protected environment	Healthy nursery
	• Dissemination of technologies and establishment of technology park at institute level	Transfer of technology
Crop Health management (pest, disease, input and climate)	• Development of effective disease/insect pest forecasting systems by using conventional and remote sensing and GIS/GPS technology.	Forecasting system developed
	• Pest and diseases dynamics in current scenario of climate change	Factors affecting disease/pest dynamics
	• Research on plant volatiles/ non-volatiles (chemical ecology) in tritrophic interactions for use in pest management	Repellent/attractant molecules
	• Enhancing potency of bioagents and search for new ones for application in pest and disease management	Promising bioagents identified

	• Developing diagnostic kits against major pathogens and pests of important vegetable crops. • Development and refinement of cost-effective, biointensive IPM/IDM technology under field and protected condition. • Toxicological investigation on susceptibility and resistance of major insect pests to pesticides and their safety and compatibility among newer molecules and with biocontrol agents and determination on the pesticide residues and fixing waiting period.	Diagnostic kits for important diseases and pests Suitable IPM/IDM technology Base line data, pesticide resistant status
Post harvest and value addition	• Technology for minimal processing of vegetables to extend shelf life • Application of hurdle concept in vegetables • Technology for vegetable processing to develop ready to eat food product • Technology for development of extruded vegetable product • Modified and controlled atmospheric packaging in vegetables • Management of vegetable wastes	Technologies for extended shelf life of vegetables/ processed vegetables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