The varieties/hybrids developed from IIHR, Bangalore namely Arka Lohit (chilli) covered 4.8 lakhs hectare area with net return of 47,000 crore; Arka Vikas (tomato) which spread over 4.0 lakhs hectare with net return of 2000 crores; Arka Kashav (brinjal) cultivated over an area of 1.5 lakhs hectare with net return of 800 crores during XI Plan.

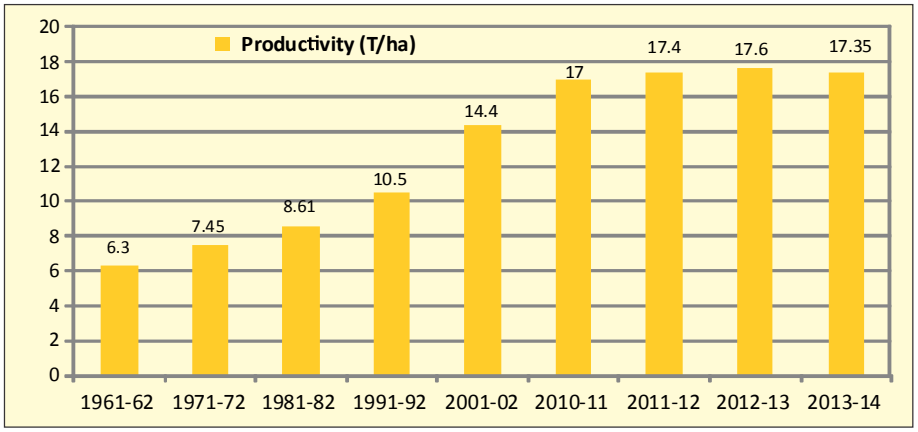

Fig 16: Vegetable productivity increasing steadily after inception of AICRP (VC)

Parental lines of the hybrids developed from IARI, New Delhi *viz.*, tomato (PH-2, 4 & 8), brinjal (Ph-5, 6 & 9), bitter gourd (PH-2), bottle gourd (PH3), cauliflower (PKS & PH-2) have been sold to 15 Pvt. seed companies for multiplication and making it available to farmers during XI Plan.

The pea varieties Punjab-89 (vegetable pea) & chilli hybrids CH-1 are the leading varieties/hybrids spreading over 6000 hectare area each in Punjab and provided net return of 110 crores by pea variety & 140 crores by chilli hybrid.

In Orissa, tomato varieties, namely Utkal Kumari, Utkal Raja and Utkal Deepti developed are being grown in 12,280 hectare acreage with area expansion of 12% annually, which benefited farmers @ 1.6 lakhs/ha net profit and contributed 27,900 lakhs annually to the state exchequer.

In Tamil Nadu, parental seed of okra hybrid COBhH-1 (moderately resistant to YVMV) were given to M/s Kirthiman Seeds, Aurangabad for largescale hybrid seed production.

In Gujarat, 18.45 % area and 27.29 % production has been increased during XI Plan through adoption of newly developed varieties and production technologies from JAU, Junagadh in the Sawratra region of Gujarat.

One step behind the second Green Revolution

To harness the yield potential and giving new heights to vegetable production in the country and make icon at global level, there is need of the hour to take special attention on the following issues-

a. Emphasis on Tapping the potential of underutilized vegetables

There are many crops which are grown in the country, but no systematic research has been executed on such crops. These crops are faba bean, lima bean, winged bean, clove bean, jack bean, sword bean, velvet bean, tree bean, chive, leek, welsh onion, broccoli, Brussels sprouts, Chinese cabbage, celery, lettuce, globe artichoke, sweet corn, baby corn, asparagus, Indian spinach, *Chenopodium*, water leaf, drumstick, curry leaf, ash gourd, snake gourd, *Momordica dioica,. M. cochinchinenesis, Coccinia indica, C. cordifolia, Melorthia hetrophylla* (dioceous) and pointed gourd etc. Potentialities of these vegetables need to be harnessed by systematic research.

b. Prospects of organic farming of vegetables

India being an agriculture-based economy which is backed by a legacy of "organic farming", has a potential to make a mark in the international market. However, this has brought forth the need for certification and maintaining strict quality standards in organic products. In view of this, India has implemented the national standards for organic products under the *National Standards on Organic*

Programme (NSOP) in order to have access to global organic product market. A trade mark of "*Indian Organic*" will also be granted on the basis of compliance with NSOP. Communicating the genuineness as well as origin of the product, this trademark will be owned by the Government of India. Only such exporters, manufacturers, and processors whose produce is duly certified by the accreditation and certifying agencies will be able to use the trademark. Government of India will register this Certification mark globally and its use will be governed by a set of regulations pertaining to Organic Products. APEDA being an export promotion organization would take a lead to publicize this mark globally across media. The world market for organic produce is $35 billion and growing at a rate of 15%. One of the factors that promote growth in organic markets worldwide is consumer awareness about health, environment issues and food safety.

Uttarakhand Organic Board (UOCB) has taken steps to develop market linkages in the domestic and international market. In the past two years, the model has been tested for different terminal markets as well as for specific food fairs. The major supply chain members are the producer groups, trainers, service providers, wholesalers and retailers. Facilitation of retail sales of organic commodities packaged by producer groups through "Saras" marketing centers in Dehradun, Haldwani and other districts is constantly being encouraged. The UOCB has also facilitated the retailing of its organic commodities from producer groups through private outlets like "SARV, Handicraft Emporium" in Dehradun and outlets in other cities. More organic producer groups / federations are being directly linked with the retail outlets for the supply of value-added products. Marketing of organic vegetables from three clusters of bio-villages in the Ramgarh belt, Bhagwanpur, Doiwala and Chamba have been initiated. Most of these villages have been successfully linked to the markets and have provided reasonable premiums to the farmers. Vegetables are being marketed to the two Maharishi Ashrams in Uttarkashi on a monthly basis. The Ramgarh belt has been connected with Heritage Foods, Delhi for a range of continental and offseason vegetables. Plans to facilitate the sale of organic vegetables grown by organic producer groups in Dehradun and other cities through the existing "Saras" marketing center in Dehradun, Nainital and other districts are in the offing.

For the domestic market, COF (Certificate in Organic Farming) made generic agreements with 26 marketing agencies engaged in the marketing and sales of organic produce within the country. These agencies are registered with the COF marketing cell and then introduced to the farmer groups. The number of agencies interested in marketing organic produce in the domestic market is increasing at a very rapid rate. A regular market for the sale of organic produce is linked with the 35 outlets of 'Kendriya Bhandar' in Delhi.

c. Threats 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. Fruits and vegetables are more climate-sensitive than other crops. Quality is critical in determining price and whether the product can be sold. Cool-season crops may be especially sensitive to summer heat stress. More frequent droughts would damage fruits and vegetables which are vulnerable to quality defects caused by fluctuations in water availability. Adaptive mechanisms like time adjustment and effective use of water will help reduce these negative impacts. A longer growing season, however, does open up early- and late-season opportunities, when prices are higher. Warming may also open up opportunities for more profitable fruits and vegetables.

Development of climate resilient horticultural crops which are tolerant to high temperature, moisture stress, salinity and climate proofing through 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 of 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, we feel that horticultural crops will 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 most of the adverse climatic conditions.

d. Water scarcity: strategy for per drop more crop

In India, around 80 per cent water is being used in agricultural sector, covering 80 million hectares land under irrigation. The situation of water availability is alarming, since per capita availability of water in India has decreased to 1700 m^3/caput/year (2010) from 5500 m^3/caput/year (1950). Due to water demand in industrial as well as domestic sectors, there is an increasing pressure on the availability of water for agricultural sector. Over the years, due to frequent incidences of drought and over exploitation of ground water, the water table has been declining in many parts of the country. Such situations are most alarming in Punjab, Haryana and Western Uttar Pradesh. Vegetables need assured irrigation whereas in India irrigation facilities are limited in most pockets of the country. Further, water use efficiency is also poor as compared to other advanced countries. Releasing the more yield on per drop of water is the need of hour. In this context much emphasis is needed in application of micro mode of irrigations coupled with the drip and trickle irrigation. It is estimated that with the use of drip technologies vegetable production can be enhanced 20-30 per cent with water saving of 40-50 per cent. Drip irrigation embedded with fertigation may prove boon in improving the nutrient use efficiency as well as enhancing the quality of the produce.

The Centrally sponsored National Mission on Micro Irrigation (NMMI) was launched in June 2010 in addition to the earlier Micro Irrigation Scheme launched in January, 2006. The Mission is being implemented during the Eleventh Plan period for enhancing water-use efficiency by adopting drip and sprinkler irrigation systems in all States and Union Territories for both horticulture and agricultural crops. The scheme provides assistance at 60 per cent of the system cost for small and marginal farmers and at 50 per cent for general farmers. Since 2005-06, a sum of Rs. 2,739 crore has been released by the Government of India under the scheme and 2.27 lakh ha brought under microirrigation. The system is beneficial for farmers in increasing crop productivity and water-use efficiency; reducing fertilizer consumption (fertigation through drip system) and electricity and labour consumption; and enhancing income.

e. Emphasis on Protected Cultivation

Protected cultivation is providing opportunities for improving productivity by reducing climatic extremes (temperature, rainfall, pest incursion) in hot and cool elevated areas. Although systems are expensive, yield increases of up to 300% for high-value, high-quality produce offset costs. Walk-in tunnels have been evaluated for off-season vegetable and seedling production. Insect-proof houses are also being used to reduce pest levels, pesticide use and virus. Polyhouses and polytrenches are being used in cold desert areas for early and late season production.

The 11th 5-year Plan sets targets of 100 ha of high-tech greenhouses, 500 ha of low-tech greenhouses, 2000 ha of low tunnels, 200 ha of shade nethouses and 4000 ha of hail/bird netting for fruit, vegetable flower production, with proposed government subsidy of 50% of cost. Micro-irrigation systems are also being used with and without protective structures to improve water use efficiency. Potential of drip irrigation in vegetables 3.6 m ha and that of sprinkler 2.4 m ha. In March 2006, > 800,000 ha under drip irrigation, and 1.9 million ha under mini-sprinklers, but just 1.9% was for vegetables (15,900 ha under drippers and 10,000 ha under mini-sprinklers), the majority being for fruit trees and plantation crops. Applications of nutrients using fertigation can increase yields by 25-35% and improve produce quality. Savings of 20 to 40% in fertilizer use could be achieved by use of fertigation systems with hydroponics.