

# IIVR at a glance



Indian Institute of Vegetable Research  
Varanasi

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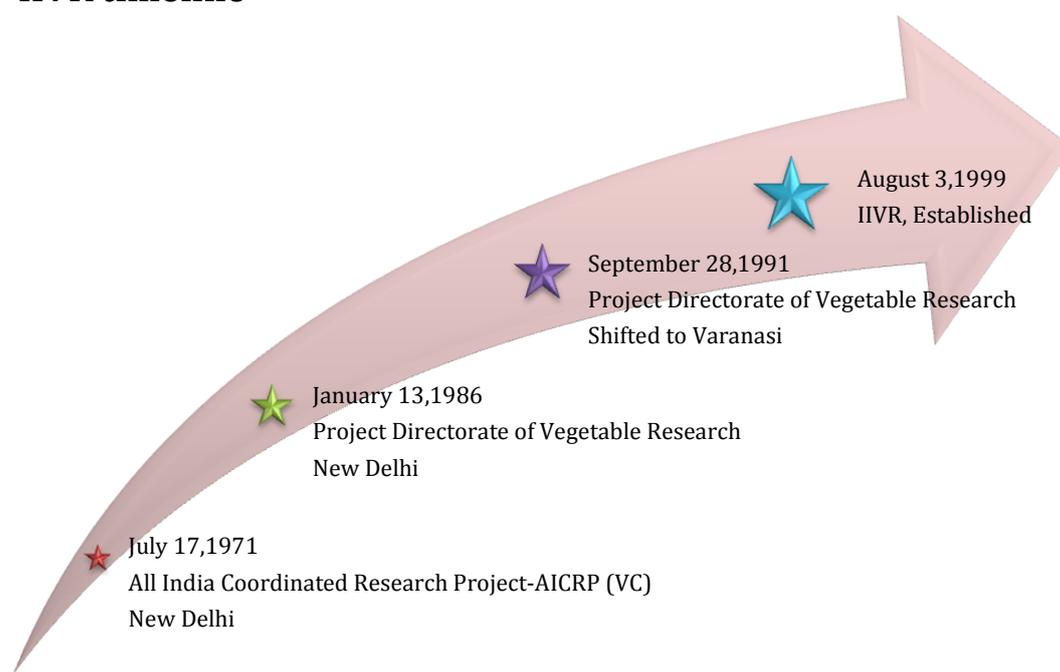
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## Genesis

Vegetables are important constituents of Indian agriculture for livelihood security of resource poor farmers and nutritional security of the country. Short duration, high yield, nutritional superiority, economic viability and ability to generate on- and off-farm employment are important virtues of vegetables. In view of the importance of vegetables, systemic research in network mode on vegetables was initiated in the country with the establishment of All India Coordinated Research Project on Vegetable Crops-AICRP (VC). AICRP (VC) was later upgraded as Project Directorate of Vegetable Research (PDVR) and subsequently shifted to Varanasi. Seven years later, PDVR was elevated to a national level institute as Indian Institute of Vegetable Research (IIVR). Since the establishment in 1999, IIVR has been the leading institute on vegetable research in In-

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### IIVR timeline



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### Subsequent additions in IIVR

Seed production center at Sargatia, Kushinagar, Uttar Pradesh started functioning in 2002. Later, three Krishi Vigyan Kendras were also established in different districts of Uttar Pradesh to disseminate vegetable and other agricultural technologies among the farmers of respective districts.

**April 07 , 2004** - Seed Production Center, Sargatia

**March 03, 2007** - Krishi Vigyan Kendra, Kushinagar

**March 2, 2009** - Krishi Vigyan Kendra, Deoria

**Febraury 27, 2009** - Krishi Vigyan Kendra, Sant Ravidas Nagar

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# Mandate

## Mission statement

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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**

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- To undertake **basic, strategic and applied research** for developing technologies to enhance productivity of vegetable crops.
  - To provide scientific **leadership in coordinated network research** for solving location specific problems of production and to monitor breeder's seed production of released/notified varieties.
  - To act as a **national repository of scientific information** relevant to vegetable crops and as a centre of training for up-gradation of scientific manpower in vegetable crops.
  - To **disseminate the vegetable production technologies** to the farmers and **to provide consultancy** in vegetable research and development
  - To **collaborate with relevant national and international agencies** for achieving the above mandate.



IIVR started functioning from this facility in 1999

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# Focus Vegetables

## Solanaceous vegetables



**Tomato**



**Brinjal**



**Chillies**

## Leguminous vegetables



**Peas**



**French bean**



**Cowpea**

## Cruciferous vegetables



**Cauliflower**



**Cabbage**

## Cucurbitaceous vegetables



**Bitter gourd**



**Ash gourd**



**Pumpkin**



**Pointed gourd**



**Musk melon**



**Bottle gourd**



**Sponge gourd**



**Ridge gourd**



**Cucumber**

## Malvaceous vegetable

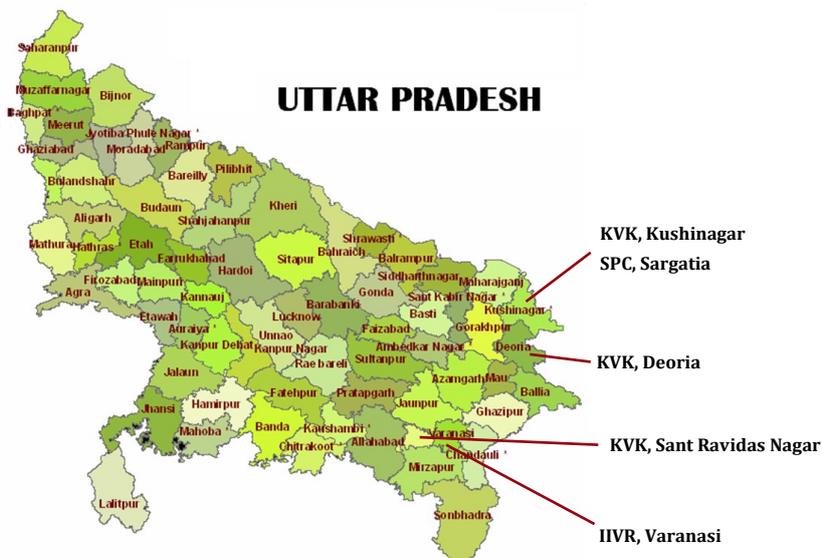


**Okra**

## Location



### Uttar Pradesh



### IIVR Main Campus, Varanasi



The main campus of the institute is located near Adalpura village on south of Varanasi. Geographically it is at 83.53°E longitude and 18.52°N latitude. It is spread in an area of 60 ha. The campus is 25 km from Varanasi railway station and 45km from Lal Bahadur shastri airport, Babatpur, Varanasi. It receives an annual rainfall of 1000 mm. The minimum temperature is recorded during January (<5°C) and maximum during May-June (45°C)

### Seed Production Center, Sargatia

The centre is located at Sargatia on south east of Kushinagar district headquarter. The center has an area of 52 ha. It is 35 km from Kushinagar and 15 km from Dudahi block headquarter on Kasya-Turkpatti-Tamkuhi road. Geographically Kushinagar is at 26°45'N latitude and 83°24'E longitude. This center is in Tarai region that records an annual average rainfall of 1240 mm, and 4.9°C minimum and 44.2°C maximum temperature. This campus also **houses KVK, Kushinagar** with an area of 20 ha.

### Krishi Vigyan Kendras (KVKs)

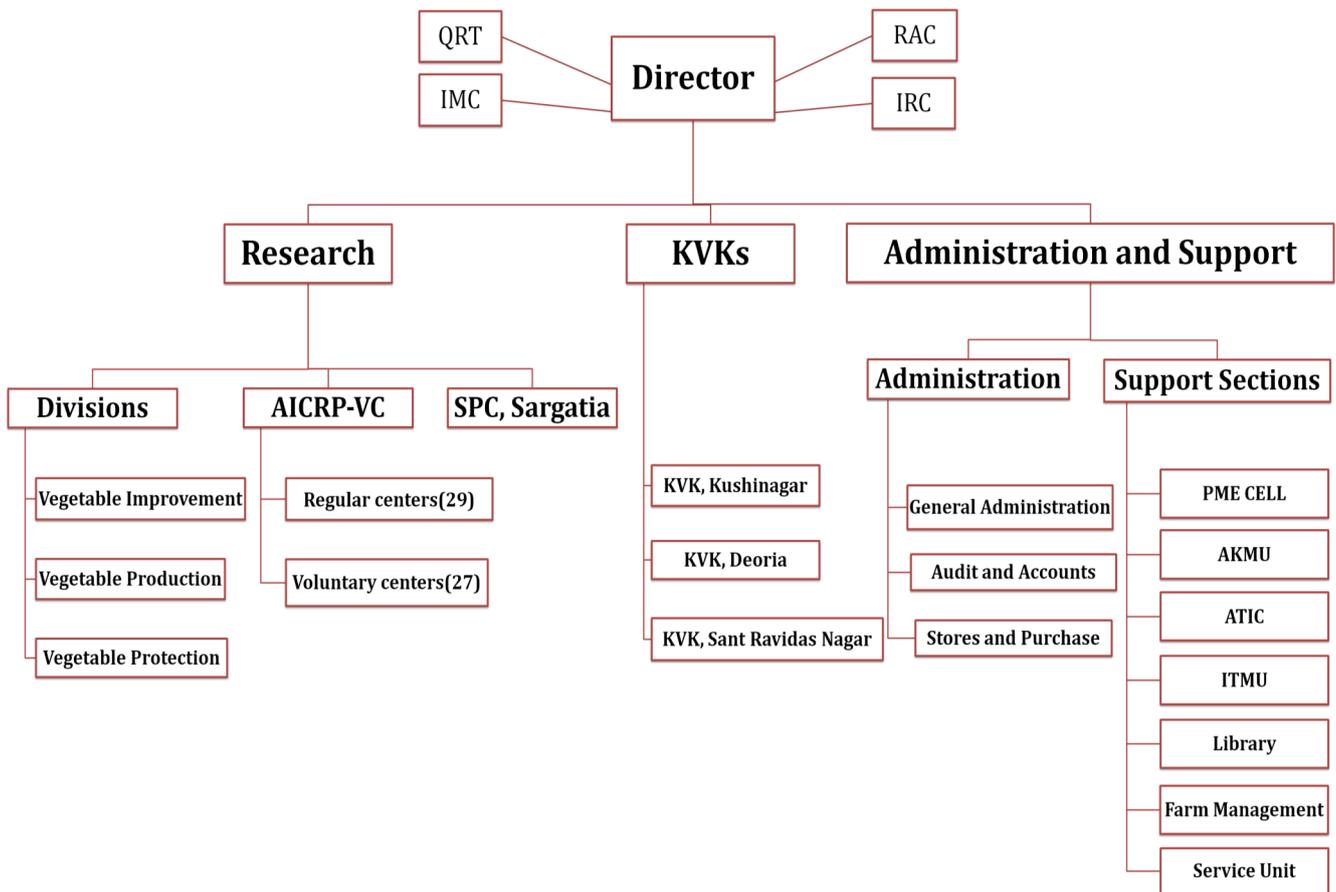
#### KVK, Deoria

KVK, Deoria is located at Malhana village of Bhatpar Rani Tahsil. Campus is spread in 8.16 ha area. It is 38 km from Deoria district headquarter, on Salempur-Bhatpar Rani road and 8 km from Salempur Railway Station.

#### KVK, Sant Ravidas Nagar

This KVK is located at Bejwan village. It has an area of 14.07 ha. It is 20 km away from Gyanpur district headquarter and 8 km away from Aurai on Aurai-Ugapur-Manikpur road.

# Organizational structure



AICRP (VC)	All India Coordinated Research Project on Vegetable Crops	KVK	Krishi Vigyan Kendra
AKMU	Agriculture Knowledge Management Unit	PME Cell	Project Monitoring and Evaluation Cell
ATIC	Agriculture Technology Information Center	SPC	Seed Production Center
IMC	Institute Management Committee	RAC	Research Advisory Council
IRC	Institute Research Council	QRT	Quinquennial Review Team
ITMU	Institute Technology Management Unit		

# Infrastructure

## Laboratory complex



This complex is home for **24 state-of-the-art laboratories** belonging to vegetable improvement, vegetable production and vegetable protection divisions.

Lab complex harbours necessary infrastructure for laboratories, administrative offices, conference halls, library, well equipped auditorium and unit of All India Coordinated Research Project on Vegetable Crops.

## Research Farm



Improved vegetable varieties, hybrids, vegetable production and protection technologies are evaluated and refined in this farm.

With an area of **60 ha**, submersible tube wells, underground and drip irrigation systems, and water harvesting tank facilities, IIVR farm is an ideal farm for field experiments and vegetable seed production.

## Greenhouse facilities



Main campus houses four well equipped greenhouses, eight polyhouses, eleven net houses and a temperature gradient tunnel.

These provide platform for research on protected cultivation, screening for pest and disease resistance and multiplication and conservation of precious plant genetic material. Also, confined trials and climate change impact studies are conducted in these facilities.

## Gene Bank

Medium storage gene bank facility available at the institute helps in maintaining and conserving the valuable genetic resources of vegetables.

## Seed Processing Unit

Modern equipment required for seed processing like seed cleaning, seed treatments and packing are available to ensure supply of quality vegetable seeds to the farmers

## Library

Library subscribes to 58 journals of national and international repute. It holds more than 2800 books, and CAB abstracts since 1970 in digital form. Besides, IIVR provides free online access to more than 3000 agricultural and other biology journals through consortium of e-resources in agriculture (CERA).

## Agriculture Knowledge Management Unit

Ten work stations and a server are available in AKMU cell. Institute receives high speed internet services from National Knowledge Network (NKN) and local area network connects all the computers of the institute. High-end statistical softwares are also available in AKMU.

# Infrastructure

## Agricultural Technology Information Center (ATIC)

Since its establishment in 2002, ATIC is playing an important role in dissemination of vegetable technologies for the benefit of farmers and other stakeholders. It provides a single window delivery system for products and services including quality vegetable seeds, vegetable production and protection technologies and other vegetable products. ATIC facilitates vegetable growers and others by providing direct access to institutional resources available in terms of training, demonstrations, and technology advices. It also creates opportunities for researchers to receive feedback on the technologies from the vegetable growers and other stakeholders.



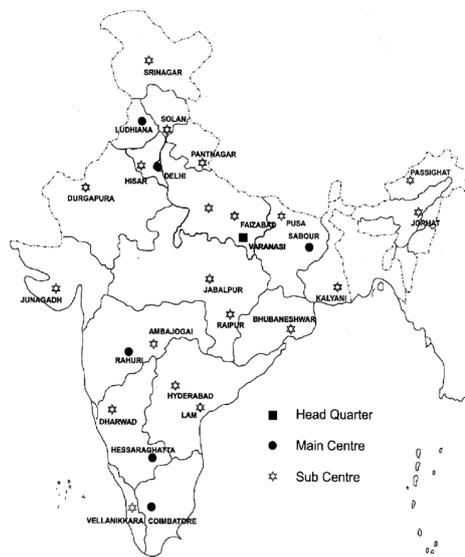
## Center of excellence for Training (CET)

IIVR is a recognized Center of Excellence for Training on Vegetable Production technology by the Department of Agriculture and Cooperation (DAC), Directorate of Extension, Ministry of Agriculture, New Delhi. Well furnished training facilities and a hostel are available at the IIVR premises for the benefit of participants of different training programs.



## All India Coordinated Project on Vegetables (AICRP- VC)

AICRP Vegetable Crops is a network of 29 regular and 24 voluntary centres. The network is headed by the Project Coordinator and its headquarter functions from IIVR main campus. The AICRP centers are located in different agro-climatic zones of the country. The centers in the network include ICAR institutes, central institutes, state agricultural and traditional universities and a few other public and private research organizations. The main function of AICRP-VC is to provide a national level platform for multi-location testing of the vegetable technologies developed by various research institutes and state agricultural universities to identify region specific recommendations.



## Germplasm resources



### IIVR is an active germplasm center for vegetables in India

- IIVR facilitates multiplication, conservation and evaluation of vegetable germplasm in collaboration with NBPGR, New Delhi. **IIVR holds 5320 germplasm accessions** of 23 vegetables.
- Vibrant pre-breeding programs of IIVR continuously augment the germplasm repository of vegetables.
- Germplasm holdings of IIVR are enhanced through regular introductions from international genetic resource centers and indigenous collections.
- Germplasm resources available at IIVR are exchanged with the members of national agriculture research system (NARS) on request.



Variability in Chilli genetic resources at IIVR

### Germplasm status at IIVR

#### Solanaceous vegetables

Tomato	1250
Chillies	295
Brinjal	295

#### Malvaceous vegetable

Okra	245
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#### Leguminous vegetables

Peas	425
Cowpea	217
French bean	136
Lablab bean	129

#### Cucurbitaceous vegetables

Bitter gourd	230
Bottle gourd	145
Ridge gourd	68
Sponge gourd	93
Sathputia	09
Pointed gourd	160
Muskmelon	619
Pumpkin	423
Ash gourd	293
Cucumber	104
Ivy gourd	26

#### Cruciferous vegetables

Cauliflower	48
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#### Leafy vegetables

Amaranth	40
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#### Root vegetables

Radish	45
Carrot	25

## Genetic stocks contributed to national genebank

Novel genetic stocks generated and identified in different vegetable breeding programs of IIVR have been deposited and registered in the national genebank facility available at NBPGR, New Delhi.

These are available for exchanges and utilization in vegetable breeding programs of national agriculture research system.



Leaf Curl resistant chilly (INGR07039)



Downy mildew resistant Snap melon (INGR07044)



High carotenoids Pumpkin (INGR05027)



Jointless tomato mutant (INGR06036)



High carotenoids tomato (INGR06037)



Dwarf Okra (INGR05026)



Gynoecious bitter gourd (INGR03037)



Thin and long fruited Okra (INGR09125)



Seed less Pointed gourd (INGR03035)



Male sterile Carrot line flowers (INGR10110)

## Improved Varieties and hybrids

### Tomato

Variety/ Hybrid (H)	Yield potential	Special traits
Kashi Vishesh	40-45 t/ha	Leaf curl virus tolerance
Kashi Amrit	50-60 t/ha	Leaf curl virus tolerance
Kashi Anupam	50-60 t/ha	Juicy fruits
Kashi Hemant	40-42 t/ha	Indeterminate
Kashi Sharad	40-50 t/ha	Firm fruits
Kashi Abhimaan (H)	80-90 t/ha	Firm fruits



Kashi Vishesh fruits

### Brinjal

Kashi Prakash	65-70 t/ha	Oblong and green fruits
Kashi Taru	70-75 t/ha	Long and purple fruits
Kashi Sandesh (H)	75-80 t/ha	Round and purple fruits



Kashi Sandesh fruits

## Improved Varieties and hybrids

### Chillies

Variety/ Hybrid (H)	Yield potential	Special traits
Kashi Anmol	20 t/ha	Pendant fruits
Kashi Gaurav	10 t/ha	Thrips and mites tolerance
Kashi Sinduri (Paprica type)	20 t/ha (green) 14 t/ha (red)	Anthracnose tolerance
Kashi Surkh (H)	24 t/ha (green) 14 t/ha (red)	Light green fruits



Kashi Anmol fruits

### Cowpea

Kashi Shyamal	7-8 t/ha	Early and bushy type
Kashi Gauri	10-12 t/ha	Golden mosaic resistance
Kashi Unnati	10-15 t/ha	Golden mosaic resistance
Kashi Kanchan	15-20 t/ha	Golden mosaic resistance
Kashi Nidhi	10-14 t/ha	Golden mosaic resistance



Kashi Kanchan pods

### Pea

Kashi Nandini	11-12 t/ha	Early maturity
Kashi Udai	10-11 t/ha	Early maturity
Kashi Shakti	14-16 t/ha	Medium maturity
Kashi Mukti	11-12 t/ha	Powdery mildew tolerance
Kashi Samridhi	12-14 t/ha	Late maturity



Kashi Udai pods

### Okra

Kashi Mohini	13-15 t/ha	Leaf curl (OLCV) tolerance
Kashi Vibhuti	17-18 t/ha	OLCV & YVMV tolerance
Kashi Pragati	13-14 t/ha	OLCV & YVMV tolerance
Kashi Satdhari	11-14 t/ha	Yellow vein (YVMV) tolerance
Kashi Lila	15-17 t/ha	Yellow vein (YVMV) tolerance
Kashi Kranti	12-14 t/ha	OLCV & YVMV tolerance
Shitla Uphar (H)	15-17 t/ha	Leaf curl (OLCV) tolerance
Shitla Jyoti (H)	20-22 t/ha	Yellow vein (YVMV) tolerance
Kashi Bhairav (H)	16-18 t/ha	OLCV & YVMV tolerance



Kashi Pragati fruits

### Radish

Kashi Sweta	45-47 t/ha	Early harvest
Kashi Hans	43-45 t/ha	Suitable for rabi planting



Kashi Sweta roots

## Improved Varieties and hybrids

### Ash gourd

Variety/ Hybrid (H)	Yield potential	Special traits
Kashi Dhawal	55-60 t/ha	Suitable for Petha sweet
Kashi Ujwal	40-50 t/ha	Suitable for Petha sweet
Kashi Surbhi	70-75 t/ha	Suitable for Petha sweet



Kashi Dhawal fruit

### Bottle gourd

Kashi Ganga	48-55 t/ha	Light green fruits
Kashi Bahar (H)	50-55 t/ha	Long fruits



Kashi Ganga fruits

### Pumpkin

Kashi Harit	30-35 t/ha	Early and green fruits
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### French bean

Kashi Param	12-14 t/ha	Fleshy fruits
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Kashi Harit fruits

### Dolichos bean

Kashi Haritima	35-37 t/ha	Pole type & parchment free
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### Cauliflower

Kashi Kunwari	30-35 t/ha	Early maturity
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Kashi Param crop

### Muskmelon

Kashi Madhu	20-27 t/ha	High soluble solids
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### Sponge gourd

Kashi Divya	25-30 t/ha	Light green fruits
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### Pointed gourd

Kashi Alankar	18-20 t/ha	Spindle shape fruits
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Kashi Haritima pods



Kashi Kunwari curd



Kashi Madhu fruits



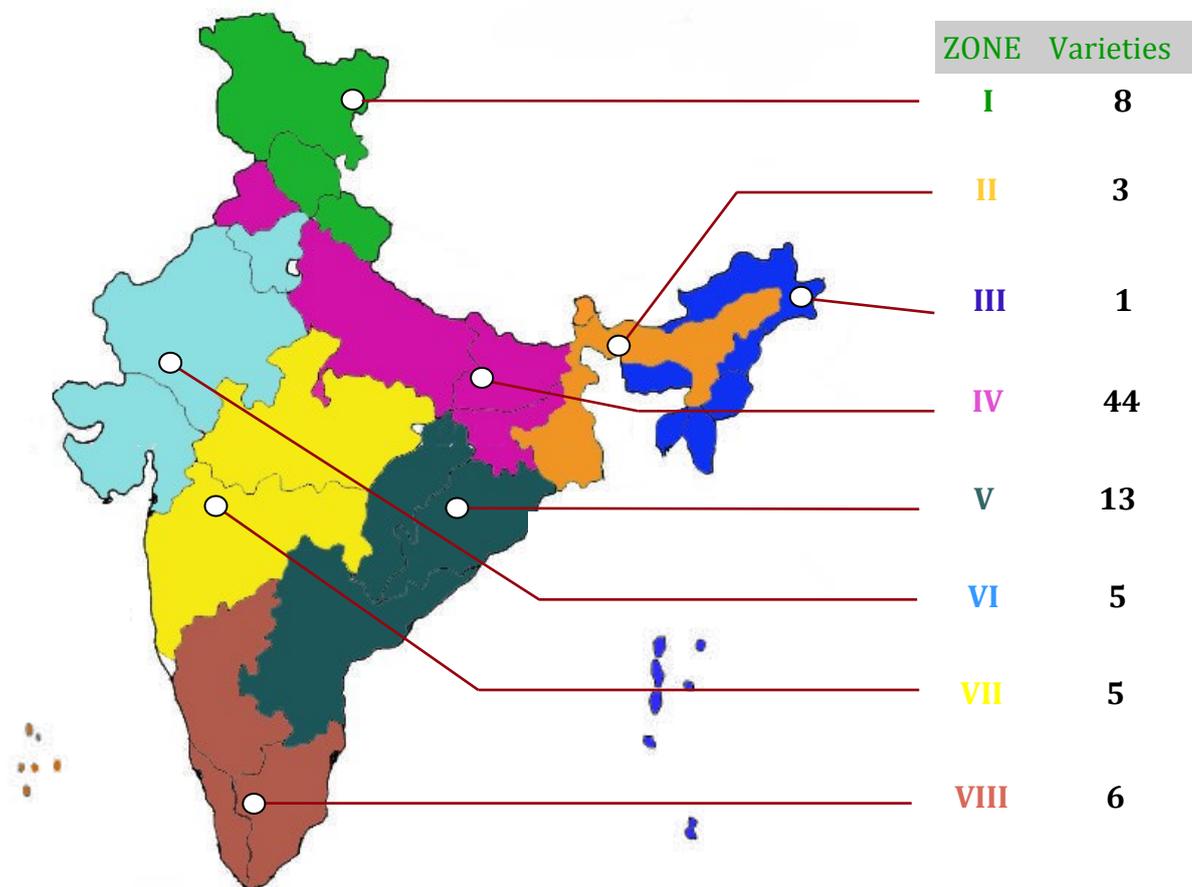
Kashi Divya fruits



Kashi Alankar fruits

## Improved varieties of IIVR **break zonal barriers**

Improved varieties of IIVR are highly adaptable and suitable for cultivation across different vegetable growing zones of India as identified by AICRP (VC).



## IIVR vegetable varieties with **wide adaptability**

Variety	Zonal suitability
Kashi Bhairav (Okra)	All 8 Zones
Kashi Mohini (Okra)	All 8 Zones
Kashi Vishesh (Tomato)	I, IV, V, VIII
Kashi Surkh (Chilli)	II, IV, V, VII
Kashi Sinduri (Chilli)	I, IV, VIII
Kashi Kanchan (Cowpea)	IV, V, VII
Kashi Nandini (Peas)	I, IV, VIII
Kashi Haritima (Indian Bean)	III, IV, VIII

## Social Impact of improved varieties of IIVR

Impact analysis studies conducted on IIVR developed vegetable varieties indicate to

- **Enhancement of productivity in the range of 6.25–40.34 %** . This impact is mainly because of adoption of new high yielding varieties along with improved production and protection technologies.
- **Kashi Pragati** in okra, **Kashi Kanchan** in cowpea and **Kashi Anmol** in chilli are the most successful varieties adopted by the growers of Eastern Uttar Pradesh with a **record 20% increase in productivity**.
- High yielding varieties developed by the institute in Garden Pea (Kashi Nandani, Kashi Udai and Kashi Mukti), Pumpkin (Kashi Harit), Brinjal (BR-14) and sponge gourd (Kashi Divya) show an average **increase of more than 10% yield at farmers' field**.

### An illustrious case of cowpea variety Kashi Kanchan



**Keshav Prasad**, a vegetable grower from Jamalpur block of Mirzapur, Uttar Pradesh was impressed with IIVR cowpea varieties and production technologies on his visit to IIVR research farm. He acquired all relevant information and started cultivation of IIVR cowpea varieties **Kashi Unnati** and **Kashi Kanchan** with regular production and protection advisories from IIVR scientists.

Tender green pod harvest at right stage helped Keshav Prasad to cash in on early market price (@ Rs. 28/- per kg) from first week of July. Regular pickings of green cowpea pods fetched him a return of Rs. 1.50 lakh by September. Later, due to decline in the market price on cowpea pods, he left the crop in the field for seed harvest. About 0.35 tons of cowpea seed yield was later sold @ Rs. 90/- to 150/- per kg and thus again he earned about Rs. 0.50 lakh from seed sales. Overall, with a single crop of cowpea, Keshav Prasad earned a **net return of Rs. 1.60 lakh from an area of 1.5 hectare**.

Now, Keshav Prasad is one of the cheerful farmers in the region. **He bought two buffaloes and three cows from the earning of cowpea**. Keshav Prasad now is inspiring other farmers in Mahogni village to grow cowpea and other vegetable crops.

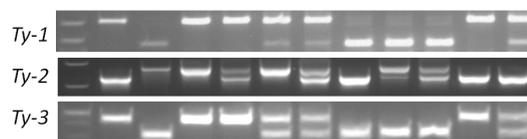
## Biotechnological interventions

Vegetable breeding programs of IIVR exploit the benefits offered by modern tools of vegetable improvement. Molecular breeding tools and transgenic research are currently employed in vegetable improvement programs of IIVR to address the challenges of biotic and abiotic stresses on vegetables. These efforts have begun to deliver the products for the sustainable future.

### Gene pyramiding for durable resistance

**“Pyramided lines with *Ty-1-Ty-3+Ty-2* genes offer non-transgenic option for pesticide free tomato cultivation in areas plagued by leaf curl disease ”**

Tomato leaf curl virus disease is one of the most destructive diseases on tomato, caused by whitefly-transmitted begomoviruses. India is a home for diverse begomoviruses that belong to both monopartite and bipartite groups. The diverse begomoviruses that infect tomatoes in India complicate breeding durable resistance. Using known wild introgressions that confer resistance to tomato leaf curl viruses and molecular breeding tools, major *Ty* genes (*Ty-1-Ty-3+Ty-2*) have been pyramided. These pyramided lines offer non-transgenic and sustainable option for growing tomatoes in areas plagued by leaf curl virus disease.



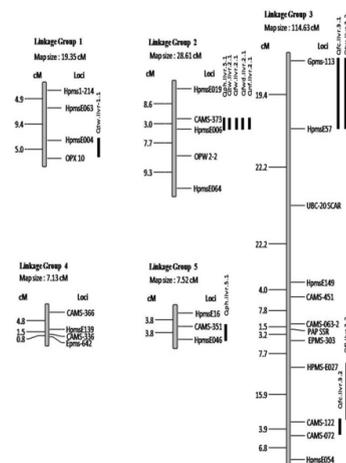
Marker assay platform for *Ty* resistance genes



Response of pyramided lines in hotspot

### Tracing genes in chillies by forward genetics approach

Pungency and oleoresin are important quality traits in chillies. The quantitative trait loci were identified for these traits in mapping studies conducted at IIVR. Two new QTLs for pungency (*Qcap.iivr-3.2*) and (*Qcap.iivr-3.4*) and two known loci for pungency trait were validated in this study. For the first time, two QTLs *Qole.iivr-3.3* and *Qole.iivr-3.5* were identified for oleoresin content. Three QTLs (*Qtw.iivr-1.1*), (*Qtw.iivr-3.1*) and (*Qtw.iivr-2.1*) were also detected for fruit weight. This study is likely to enhance our understanding on these quality traits in chilli and facilitate breeding programs towards the development of superior chilli varieties.



### Biotechnology products: gearing up for water saving tomato cultivation

***AtDREB1A* and *BcZAT12* transgenic tomatoes developed at IIVR are water efficient and could help to practice water saving agriculture.**

Drought and high temperature adversely affect vegetable production. The *BcZAT12* and *AtDREB1A* transgenic tomato lines developed by IIVR show higher tolerance to moisture stress. Also, the *BcZAT12* transgenic tomato line shows significantly higher tolerance to heat stress. These transgenic lines use 50% less water than their non-transgenic counterparts. Therefore, these tolerant tomato transgenic lines could be useful for cultivation of tomatoes in drought prone areas.



Response of *BcZAT12* transgenics under drought condition

## Biotech products: managing fruit borer menace in brinjal and tomato

The major limitation in brinjal production is severe damage caused by a Lepidopteran insect pest, the brinjal shoot and fruit borer (FSB; *Leucinodes orbonalis*). Control measures for this pest rely mainly on the application of insecticides, which are often ineffective because the insect tends to develop resistance and the larvae that reside inside the fruit escape contact with the insecticide. On the other end of the spectrum, the indiscriminate use of insecticides leads to increased costs of production and production of unsafe brinjal. The lack of any natural source of resistance to FSB in all cultivated and conventionally cross-compatible species of brinjal has been a major obstacle in developing conventional FSB-resistant cultivars. Biotechnology products of IIVR developed using insecticidal crystal proteins (*Cry1Ac*) offer an option of management of FSB with a significant



Tomatoes infested with fruit borer

## Arming wide array of brinjal varieties with *Bt*-gene

Using conventional backcross method, *Bt* gene has been transferred to the genetic background of six open pollinated varieties that are popular in India. This was achieved through ABSP-II program funded by USAID. These products offer wider options for brinjal growers and would help to produce their own seeds and preserve the varietal diversity in the event of wider acceptance of *Bt* technology.



IVBL-9



Punjab Barsati



Uttara



BR-14



VR-5



Pant Rituraj

## Vegetable Production Research

### Evolving nutrient packages for better productivity and soil health



Performance of cowpea in IPNM trial

Disproportionate use of chemical fertilizers impact soil nutrient imbalance in terms of NPK ratios. To increase the vegetable productivity and sustain soil health, it has now been realised that integrated plant nutrient management comprising chemical fertilizers, environment friendly organic manures, bio-fertilizers, crop residues and green manures are essential.

Integrated Plant Nutrient Management (IPNM) studies conducted at IIVR indicate likely increase in the vegetable productivity to the extent of 18-40% over the present recommended practices. These IPNM practices improve physical, chemical and biological properties of the soil. Additionally, these practices maintain and increase long term fertility to encourage and enhance the biological cycle of microorganisms within the farming system

for sustainable cultivation. IPNM modules developed at IIVR can increase in the profit, quality attributes of vegetables and **minimise the use of chemical fertilizers up to 15-20%**.

## Nutrient packages for better productivity and soil health

IPNM packages for realizing better productivity in selected vegetables

Vegetable	Organic manure	Inorganic manure NPK (Kg/ha)	Biofertilizer	Yield enhancement* (%)
Tomato	Poultry manure (5 t/ha)	60:30:40	-	21
Cowpea	Farm Yard Manure (10 t/ha)	30:30:30	Phosphate solubalizing bacteria	13
Bottle gourd	Vermicompost (2.5 t/ha)	120:60:60	Micronutrient mixture	18
Capsicum	Poultry manure (5 t/ha)	150:80:100	-	26
Brinjal	Vermicompost (5 t/ha)	120:60:60	<i>Azospirillum</i>	77

### Optimizing nutrient requirements of vegetables

Nutritional studies conducted at IIVR have helped to evolve optimum dose of fertilizers required to realize potential yield levels of selected vegetables.

Vegetable	Optimum dose of fertilizer
Dolichos bean	80:60:60
French bean	180:80:100
Chillies	120:80:100



Performance of dolichos bean under optimum nutrient availability

## Better agronomic practices for enhanced resource use efficiency

### Nitrogen use efficient practices

Better agronomic practices have potential to increase yield and enhance nitrogen use efficiency from 0.099t/kg to 0.229t/kg in different vegetable crops.

Nutrient use efficiency of all the major, secondary and micronutrients continues to be low in India. Development of better agronomic practices can enhance nutrient use efficiency, restore soil fertility and sustain productivity. The studies conducted at IIVR on tomato and cabbage indicate that the 52.37t/ha of maximum tomato yield and 64.70t/ha of cabbage yield can be obtained using combination of practices like seedlings raised on seed bed + foliar spray of water soluble fertilizers + seedlings treatment with biofertilizers + foliar application of micronutrient mixture+plastic mulching of the beds. Similarly the maximum yield of 12.17t/ha of cowpeas and 14.26t/ha of okra could be realized using practices like seeds sown on the ridges+ foliar spray of water soluble fertilizers+biofertilizers treated seeds+foliar application of micronutrient mixture+plastic mulching of the beds.



Tomatoes under nitrogen use efficient practices

## Agronomic practices for saving water



Pea straw being used as an organic much in Okra

India consumes 83 per cent water for agriculture. The per capita availability of water is declining from 5300 m<sup>3</sup> in 1955 to approximately 1545 m<sup>3</sup> in 2011. Due to demand of water in domestic and industrial use, there is increasing pressure for judicious use of water for agricultural purpose. Considering its scarcity in future, the planning and management of this resource and its judicious, economical and equitable use is a matter of utmost urgency. Various options such as; drip fertigation, mulching, regulated deficit irrigation, furrow irrigated raised bed planting have ability to improve water productivity in vegetable crops.

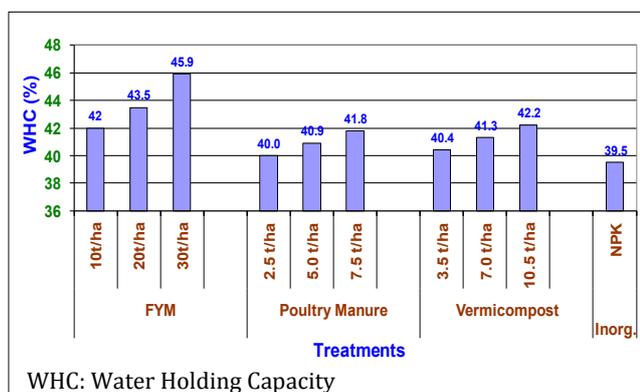
### Water saving practices suggested for different vegetables

Vegetable	Suggested water saving practices	Anticipated water use efficiency
Tomato	Drip irrigation at 1.0 V or 0.75 V and black polythene mulch	5.81-6.15t/ha/cm
	Alternate furrow irrigation and black polythene mulch	0.942 t/ha/cm
Okra	Irrigation at 10 day interval and pea straw mulch	0.602 t/ha/cm

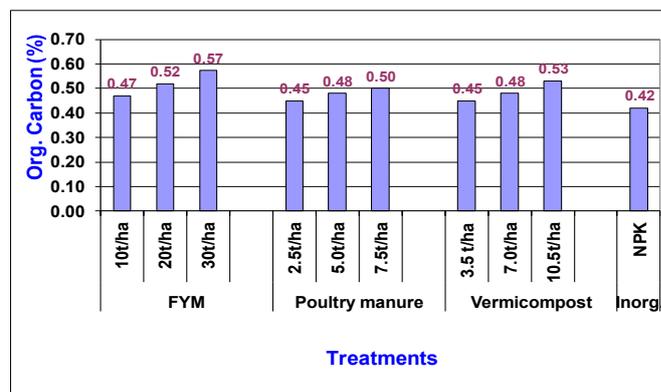
## Organic farming for safe vegetables

There is an increased awareness and concern on adverse effects of indiscriminate use of chemical fertilizers and pesticides on food quality, soil health, human health and environment. Organic farming, especially of vegetable and fruits is therefore, gaining momentum worldwide. The studies initiated at IIVR on organic farming in tomato, cabbage, cowpea and okra establish the benefits of organic farming on vegetable quality and soil health.

- Application of poultry manure @ 7.5 t/ha can ensure 28- 35 % higher yield as well as 17-25% higher vitamin-C content in cabbage, cauliflower, tomato, okra and cowpea over the inorganic management system.
- The soil health in terms of organic carbon, bulk density, water-holding capacity, microbial biomass carbon and dehydrogenase activity was improved under organic system as compared to inorganic system.



Effect of different manures on water holding capacity of soil



Effect of different manures on organic carbon content of soil

## Saving energy through tillage and residue management



Cowpea crop grown in zero tillage and residue retention trial

Zero tillage on permanent ridges with residue retention can save inputs cost to the extent of Rs.18,394/ha/yr and energy saving to the tune of 9626 MJ/ha/yr. As much as 61 L/ha/yr of fuel could also be saved by zero tillage practices.

Intensive tillage associated with high input driven modern agriculture with little or no residue recycling pose serious sustainability concerns. This is leading to deterioration of soil quality and a consequent decline in crop productivity. Therefore, the zero tillage and

residue management practices can help us to sustain soil properties and productivity of vegetable crops.

- Zero tillage (on permanent ridges with residue retention) is beneficial over the conventional tillage (flat planting and residue removal) in realizing higher yields of cowpea and tomato crops.
- In cowpea-tomato cropping sequence, the net economic benefit of Rs. 1, 58,265/ha/yr could be realized with zero tillage against Rs. 1, 05,484/ha/yr with conventional tillage.
- Zero tillage with residue retention improved the physical, chemical and biological properties of soil. Organic carbon storage, labile organic carbon content, carbon pool index and carbon management index were higher by 4.67 Mg/ha, 0.06 g/kg, 0.34 and 17.5, respectively under zero tillage with residue retention.

## Post harvest technologies

High post-harvest losses and surplus during glut season demands preservation of vegetables using low cost technologies. Among all the processing techniques, drying is one of the most versatile methods to preserve vegetables. It is economical and can ensure preservation for longer duration with good rehydration and sensory attributes. Besides reduction in bulkiness, it facilitates easy transportation due to reduced weight and volume and ensures availability of vegetable food throughout the year. Therefore, processes for drying different vegetables were developed at IIVR to retain nutrients, colour and good sensory qualities for several months.

- The blanching treatments (1-5 min) of broccoli, ivy gourd, pointed gourd and green chillies in boiling water containing 0.1-0.5% magnesium oxide and 0.25-0.5% magnesium carbonate followed by dipping in 0.5-1.0% sodium sulfite and 0.5-0.75% potassium metabisulfite solution for 10 min could retain 40-50% ascorbic acid, 94-96% chlorophyll content. Such treatments can retain 65-70% capsaicin content in green chillies.
- Good body and texture during drying and good rehydration qualities can be retained by osmotically diffusing blanched broccoli, ivy gourd, pointed gourd, cauliflower and green chillies in 1-2% sodium chloride at 50-60°C for 1-2 hrs.
- Drying vegetables at 50-60°C for 6-8 hrs could retain 30-35% ascorbic acid, 90-92% chlorophyll, 60-65% capsaicin in green chilli powder and good overall acceptability score of 7.5-8.0 on 9-point Hedonic scale.



Green chilli powder

## Integrated pest management strategies

### IPM for brinjal fruit and shoot borer (BSFB)

IPM module for BSFB has a potential to reduce infestation of borer by more than 85 % and increase yield by 40%. The total cost of the production would be reduced by 30% due to reduced cost of pesticide application by 35.20 %.



Larvae (left) and adult of brinjal fruit and shoot borer

In India, BSFB causes extensive yield loss varying from 37 to 93 % in various states. The average damage of this pest in Uttar Pradesh is recorded to the extent of 48%. Farmers spray insecticides indiscriminately to control BFSB. As many as 15-25 sprays per cropping season have been reported from farmers fields. Such high insecticide use has led to resistance to insecticides, residues of pesticides on fresh produce, reduced farmer profits and hazards to human health and environment. Integrated pest management options for BSFB were investigated and refined at IIVR to reduce costly and intense use of hazardous insecticides.

#### IPM module for BSFB

Seedlings root dip in Rynaxypyr 18.5 SC (0.5 ml/l) for 3 hours

Plastic funnel traps@100/ha baited with BSFB sex pheromone at 25-30 days of planting

Weekly removal of infested shoots and fruits

Need based application of NSKE 4%,  $\alpha$ - cyhalothrin 2.5 EC 1.25 ml/l or cypermethrin 20 EC 2 ml/l in rotation at flowering and fruiting phase.



Funnel trap in brinjal field

### IPM for fruitfly in cucurbits

IPM module for cucurbits fruitfly can reduce the fruit damage by 71% and ensure reduced pesticide applications. Fruitfly (*Bactrocera cucurbitae*) is a serious pests of cucurbitaceous crops mainly on bitter gourd, pumpkin, cucumber and

musk melon. Its infestation varies from 50-100%. Farmers resort to heavy use of pesticides at fruiting stage which leads to high level of pesticide residues in the fruits. Since the cryptic nature of fruitfly damage initiates with egg laying itself, therefore, it is imperative to develop approaches for adult management. Considering this, the behavioural aspects of adult fruitfly were exploited for developing IPM technology.



Cucubit fruitfly eggs

#### IPM module for fruitfly in cucurbits

Trap bottles baited with cue lure (Male Annihilation Technique-MAT) saturated wood blocks (ethanol: cue lure: carbaryl in 8:1:2 ratio) @ 25 traps/ha prior to flower initiation

Bait spray containing malathion (50 EC) 20ml+20 litres water+500 g molasses (random spray on 250 plants/ha) (Bait Application Technique-BAT)

Use of repellent (NSKE 4%) for enhanced trapping and luring in bait spots

Integration of MAT+BAT+ repellent for higher effectiveness



Low cost trap for fruitflies

## Biological control of insect pests

Off late, dependence on chemical pesticides for the management of insect pests is declining because of higher cost, build-up of insecticide resistance, pesticide residues in vegetables and pollution to the environment. In this backdrop, biological agents can be an alternative to pesticides. The biocontrol agents identified and tested at IIVR can play a significant role in managing wide range of insect pests and can provide an option as a component in IPM programmes.

### Promising biocontrol agents identified at IIVR

Pest	Biocontrol agent	Expected pest mortality (%)
Hadda beetle ( <i>E. vigintiostopunctata</i> )	<i>Pediobius foveolatus</i>	37.00
Okra borer ( <i>E. insulana</i> )	<i>Agathis</i> sp <i>Chelonus blackburni</i>	27.50
Chilli yellow mite ( <i>P. latus</i> )	<i>Actinomyces bacteria</i> <i>Amblyseius</i> & <i>Orius</i> sp	20.00
Mealy bug (Okra) ( <i>P. solenopsis</i> )	<i>Aenasius bombawalei</i> <i>Promuscidea unfasciti</i>	22.35



Adults of *P. foveolatus* on hadda beetle (left) and cocoons of *A. bombawalei* on mealy bug (right)

### Effective bioagent packages for pest management

Vegetable pest	Recommended bioagent
Tomato fruit borer ( <i>Helicoverpa armigera</i> )	<i>Trichogramma brassiliense</i> (2,50,000 eggs/ha) at weekly interval + NPV (250 LE) at 10 day interval
Brinjal fruit borer ( <i>Leucinodes orbonalis</i> )	<i>Trichogramma chilonis</i> @ 2.5 lakh parasitoids/ha (in conjugation with insecticide/botanicals)
Maruca management	Microbial formulations of <i>Bt</i> and <i>Beauveria bassiana</i> , botanical and NSKE
Aphid ( <i>Aphis craccivora</i> ) Mealy bug ( <i>Phenacoccus solenopsis</i> ) Mustard Aphid ( <i>Lipaphis erysimi</i> )	Entomopathogenic fungus - <i>Verticellium lecanii</i>

### Botanicals and cultural practices for pest management

#### Cultural practices for pest management

Vegetable pest	Recommended cultural practice
Brinjal fruit and shoot borer (FSB)	Boron spray (75 ppm)
Brinjal FSB ( <i>L. orbonalis</i> )	Coriander/Fennel (2:1) as intercrop
Leaf minor and tomato fruit borer	Marigold as trap crop
Diamond back moth	Chinese cabbage as trap crop



Chinese cabbage as trap crop

#### Botanicals for pest management

Vegetable pest	Recommended botanical
Chilli yellow mite	Hexane extracts of <i>Kochea</i> @ 1g/lit, followed by <i>Calotropis</i> and Golden Duranta extract
Tobacco caterpillar	Hexane extracts of <i>Calotropis</i> and Golden Duranta @ 1g followed by <i>Jatropha</i> and <i>Tridox</i>
Diamond back moth	Hexane extracts of <i>Calotropis</i> and <i>Croton sparsiflorus</i> @1g/lit

## Disease management

### Management of soil borne diseases in vegetables



Promise of bio-control agents in managing tomato damping off

Soil borne diseases are major problem in cultivation of vegetable crops. The damping off caused by different species of *Pythium* and collar rot caused by *Sclerotium rolfsii* are known to cause severe damage to the crop from nursery. Reliance on chemical pesticides for

the management is not an attractive option because of higher cost and environmental pollution. Alternatively, biocontrol agents isolated from soils at IIVR have shown greater potential in managing wide range of phytopathogens.

Soil borne disease	Biocontrol package
Tomato and chilli damping off	Seed treatment using IIVR isolated and formulated <i>Trichoderma</i> isolates BATF 39-1 and BATF 43-1 (10g/kg). Soil application of BATF 39-1 or BATF 43-1 (@2.5 kg mixed in 50 kg FYM/ha).
Collor rot ( <i>Sclerotium rolfsii</i> ) and <i>Fusarium</i> wilt	Seed treatment and soil application of IIVR isolated and formulated- <i>Bacillus amyloliquefaciens</i> (BA1) and <i>Bacillus subtilis</i> (BS2)

### Integrated disease management of bacterial diseases

Bacterial diseases of vegetables are one of the major constraints of sustainable production causing an annual loss of 28-40%. Under favourable conditions a loss of more than 80% has been reported. Management of bacterial diseases is difficult owing to its quick spread and complex nature of host-pathogen interaction. Generally antibiotics are used to control these diseases. However, there are concerns on development of antibiotic resistance and human hazards as many of these antibiotics are also used as human drugs. Integrated management packages developed at IIVR against bacterial diseases have potential to address these issues.



Black vein of cabbage

Bacterial Disease	IDM for bacterial diseases
Black vein of cabbage and cauliflower	Seed treatment with streptomycin sulphate@ 100ppm followed by kresoxim methyl (0.1%) and fenamidone-mancozeb (0.2%) sprays after germination.
Leaf spot of tomato	Soil solarization in nursery beds followed by seed treatment with streptomycin sulphate@ 100ppm and soil drenching with kresoxim methyl@0.1% controls seedling infection and post emergence losses.  One spray each of kresoxim methyl @ 0.1 %, fenamidone-mancozeb@ 0.25% and copper hydroxide @0.3% at 10 days interval.

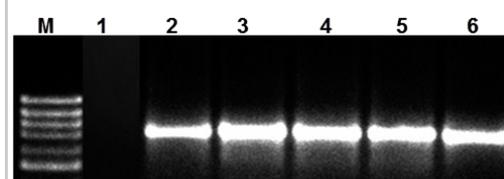
## Molecular diagnostics

Accurate diagnosis of causal organism of plant disease is an essential component of strategic disease management. The serological and molecular based diagnostics have been developed at IIVR for many vegetable diseases to aid disease management. These will help in early and accurate detection of causal organisms and diseases.

Diagnosis method	Target disease/Organism
PCR- based	Cucurbit-infecting begomoviruses
	Chilli leaf curl virus disease
	Tomato leaf curl virus disease
	Raddish leaf curl virus
	Raddish enation virus
DAC-ELISA	Pea nut bud necrosis virus
	Watermelon bud necrosis virus
PCR- based (16SrRNA)	Brinjal little leaf (Phytoplasma)
PCR- based (ITS region)	Fusarium wilt - <i>Fusarium oxysporum</i>
	Fusarium wilt - <i>Fusarium solani</i>
PCR- based (ITS region)	Tomato early blight- <i>Alternaria solani</i>
	Tomato early blight - <i>Alternaria alternata</i>



Brinjal little leaf caused by phytoplasma



PCR-based diagnosis of summer squash leaf curl virus. Lane one is disease-free sample and rest of the lanes include diseased plant samples

## Taking technologies from lab to land



Tomato pickings in the farmer field from Kashi Vishesh

The institute has organized **15 Annual National Farmers Fairs** at its campus in Varanasi, **09 regional/state level Farmers' Fair** outside campus, **11 Field days and Kisan Gosthies**. The institute also participated in **47 national and international exhibitions** all over the country including Agri-Expo and Trade Fair at Pragati Maidan, New Delhi. These events are used to showcase IIVR technologies for farmers and other stakeholders. Thousands of farmers participated in these melas and exhibitions. These events have enhanced the awareness and knowledge of farmers on modern vegetable technologies.

Creating awareness in farming community about the benefits of advanced vegetable technologies through outreach programs is considered as the most important activity. In order to popularize varieties/technologies of vegetables in the country various mass media approaches, and massive front line demonstrations were conducted in the farmers fields using the recommended varieties and hybrids along with number of training programs.

Recently the institute has started "**Vegetable School on Air**" in collaboration with All India Radio, Varanasi which will continue for one year. These efforts not only help farmers in solving their problems in vegetable cultivation but also help to improve their livelihood.

## Quality seed production program



Preparing bitter gourd fruits for seed processing

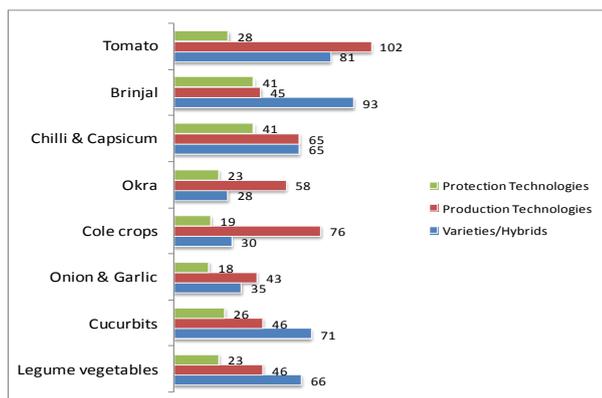
High quality vegetable seeds of different vegetables are produced at both IIVR research farm and Seed Production Center, Sargatia. The small scale seed processing facility available at IIVR main campus is used for seed sorting, and seed treatments like priming and packaging before delivery. IIVR produces both truthfully labeled seeds and breeder's seeds of vegetable varieties. While the truthfully labeled seeds are supplied to farmers, breeder's seeds are provided to different state National Seed Corporations (NSC). Maintenance breeding activities of varieties are also undertaken to keep the genetic purity of vegetable varieties.

### Quantity of vegetable seed produced and supplied

Period	Truthfully labeled (Kg)	Breeders seeds (Kg)	Total quantity (Kg)
1992-1997	16667.80	11600	28267.8
1997-2002	31064.25	24502.50	55566.75
2002-2007	55778.36	15682.75	71461.11
2007-2012	86939.37	13040.92	99980.29

## All India Coordinated Project on Vegetables (AICRP- VC)

AICRP Vegetable Crops is a network of 29 regular and 24 voluntary centres located in different agro-climatic zones of the country. This network of centers focus on development and identification of region-specific vegetable varieties, production and protection technologies. The AICRP-VC is a main national level platform for multi-location testing of the vegetable technologies developed by various research institutes and state agricultural universities.



Number of vegetable technologies evolved through AICRP-VC in different vegetables since its establishment

Since its establishment in 1971, AICRP-VC has been instrumental in recommending **450 vegetable varieties** in 24 vegetables including 267 open pollinated varieties, 136 hybrids and 47 improved cultivars with resistance to different biotic and abiotic stresses. In addition, **361 production, 143 seed production, 121 disease and 90 insect pest management technologies** have been recommended. These technologies have been rigorously tested in multi-locations over multiple years. These test results are used for identification and recommendation of technologies.

### Producing vegetable seeds for the nation

AICRP-VC provides leadership in producing quality breeder seeds of different vegetables. Network of 4 units in ICAR research institutes and 10 units in the State Agricultural Universities produce breeder seeds of different vegetables. **In the last five years (2007-2012) 12.6 tons of vegetable breeder seeds have been produced.** This seed lot forms the basis for further production of foundation seeds and certified seeds for downstream supply at the national level.

## Linkages

IIVR joins hands with various research organizations for solving present problems of vegetable growers, and in preparing for the future challenges. Current linkages include both national and international organizations in the areas of collaborative research, outreach programs, education, human resource development and genetic resource exchanges.



Scientists from world vegetable center (AVRDC), Taiwan interacting with IIVR scientists

### National linkages

Linkage area	Organization
Research and Development	Members of National Agriculture Research System Department of Biotechnology (DBT) Department of Science and Technology (DST) Indian Council of Medical Research (ICMR) National Horticulture Board (NHB) National Seed Corporation National Horticulture Research and Development Foundation (NHRDF)

### International linkages

Linkage area	Organization
Identification of plant pathogenic fungi	IMI, London
Promotion of IPM of eggplant shoot and fruit borer	AVRDC, Taiwan BARI, Bangladesh NARI, UK DFID, UK
Integrated management of fruitfly	Imperial College, London DFID, UK
Predator and parasite identification	International Institute of Entomology, London
Integrated Nutrient Management	Rothamsted Experiment Station, UK
Fruit and Shoot borer resistance in brinjal	ABSP-II Cornell University, USA
Exchange of genetic resources	AVRDC, Taiwan IPGRI IITA Tomato Genetic Resource Center, Davis, USA
Human Resource Development	Wisconsin University, USA Michigan University, USA University of California, Davis, USA

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## Moments of pride

The performance of Indian Institute of vegetable Research and its scientific staff has been recognized by Indian Council of Agriculture Research, and various other organizations and academies. The honours and awards received have motivated the institute and scientists to perform and deliver quality research outcome.

### Sardar Patel Outstanding Research Award, 2005



This award sponsored by Indian Council Agriculture Research (ICAR), was bagged by IIVR in 2005. The award recognizes the outstanding performance of ICAR institutes, Deemed Universities, state agriculture universities and central agriculture universities.

This recognition provided the incentives for IIVR performance and promoted sense of pride in institutional achievements.

### Best Annual Report Award, 2000-2001



This award was bagged by IIVR in 2000-01. Best annual report award sponsored by Indian Council Agriculture Research (ICAR), recognizes the outstanding performance in publication of annual reports of different ICAR institutes.

### Chaudhary Devi Lal outstanding All India Coordinated Research Project Award



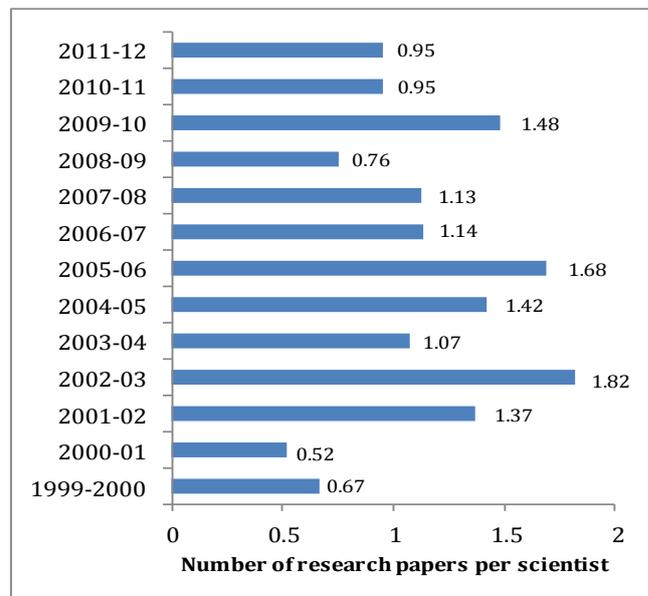
This award sponsored by Indian Council Agriculture Research (ICAR), was bagged by IIVR in 2000-01. The award recognizes the outstanding performance of AICRP (VC) and its cooperating centers.

The award is a testimony to the linkages and impact of research outcomes of AICRP (VC).

In addition to these recognitions for institutional achievements, the performance of individual scientists of IIVR has been recognized by ICAR, and others. Since the establishment, scientists of IIVR have bagged 26 awards. Some of these include **ICAR team research award**, **Swami Sahajanand Saraswati outstanding extension scientist award**, **Lal Bahdur Shastri outstanding young scientist award**, **Rajiv Gandhi Gyan Vigyan Puraskar Rajbhasha**, and **international IPM recognition award**.

## Research publications

The outcomes and findings of various basic and applied research projects of IIVR have featured in reputed national and international journals. During the last five years (2007 to 2012) **58 research papers of IIVR** have appeared in journals with NAAS score of more than 6 (journals with ISI impact factor).

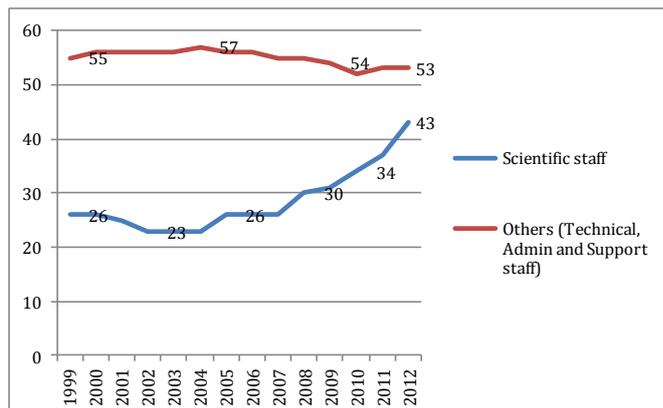


Average number of research publications per scientist since inception of IIVR, Varanasi

## Human Resources

Scientists, technical officers, administrative and support staff form the work force of IIVR. The Scientific staff of the institute are recruited by Agriculture Scientist Recruitment Board (ASRB) at the national level. Other staff members are recruited at the institution level. Over the years there is a considerable growth in IIVR scientific staff. At present (December, 2012) **43 scientists, 24 technical, 13 administrative and 16 support staff** members are working in IIVR.

In addition, Research Associates (RAs) and Senior Research Fellows (SRFs) recruited on contractual basis in sponsored projects contribute to the research projects.



## Funding

IIVR is a national level research institute of Indian Council of Agricultural Research (ICAR). Major part of IIVR outlay is funded by ICAR. There has been a steady increase in allocations of funds to IIVR over the five year plan periods.

Financial support is received through different heads such as plan and non-plan allocations.

In addition, IIVR has received grants from international agencies like DFID, and USAID, ABSPII and regularly receives grants through projects sponsored by national agencies like DBT, DST, PVP FRA, UPCAR, UP DASP, AP CESS and NHB.

