

Research for Tribal and Hill Regions

The Indian Council of Agricultural Research (ICAR) through its institutes located in North-west Himalayas, North-east Himalayas and Islands evolved technologies to meet the needs of tribal and hill farmers.

These technologies are intended to improve the socio-economic status of the target group, and

will help them to acquire special skills through vocational training in traditional and non-traditional crops, agroforestry, apiculture, horticulture, animal husbandry, poultry and fisheries.

NORTH-WEST HIMALAYAS

The salient achievements of institute located

New Releases			
Variety/hybrid/composite	Adaptation region/ agro-ecology	Duration	Salient features
Vivek QPM 9	Zone I and Zone IV	Extra-early (85-90 days)	Yellow, single cross hybrid showed more yield, tryptophan, lysine, Fe and Zn than best check Vivek Maize Hybrid 9
Vivek Maize Hybrid 25	Zone I	Extra-early (85-90 days)	Single cross hybrid yielded more than the best check HIM 129. Also showed a high degree of tolerance to turcicum blight and better response to low dose of N (40 kg/ha)
Vivek Maize Hybrid 27	Zone III and Zone IV	Extra-early (80-85 days in Zone III and 85-88 days in Zone IV)	Single cross hybrid yielded higher than HIM 129, exhibited moderate tolerance to turcicum and maydis leaf blight and better response to higher doses of N
Vivek Sankul Makka 31	Uttarakhand hills	Early (90-95 days)	In spite of being a composite it yielded higher than popular hybrid HIM 129 and composite Surya. Also showed high tolerance to turcicum blight and better response to higher N doses in hills
VL Gehun 892	Late sown, restricted irrigation conditions of hills Uttarakhand and Himachal Pradesh	Early (140-150 days)	Variety showed yield superiority to checks Sonalika, HS 420 and HS 295, and resistance to brown and yellow rusts. Also possesses resistance against most virulent yellow rust pathotype 46S119 and 78S84. It is nutritionally rich
VL Matar 45	Rainfed, timely sown onditions of Uttarakhand hills, Jammu and Kashmir and Himachal Pradesh	160-165 days	Field pea variety possesses resistance to wilt disease and yellow round grains with higher 100-grain weight
VL Rajma 125	Rainfed, timely sown conditions of Uttarakhand hills	75-100 days	It possesses resistance to bacterial blight and root rot. Grains are yellow with higher 1,000-grain weight

in North-west Himalayas are:

Varietal release

Seven varieties/hybrids/composite of crops were released for different agro-climatic regions of country.

Seed production

Around 23.2 tonnes breeder seed of 47 released varieties/inbred lines was produced. A total of 20.2 tonnes breeder seed was supplied to different seed-producing agencies to take up further multiplication. Besides, 1.57 tonnes nucleus seed of 35 released varieties was also produced.

High frequency plant regeneration

A robust callus induction and high frequency plant regeneration system was observed from the mature seed-derived nodes in VQL 2, parent of recently developed QPM hybrid, Vivek QPM 9.

The regeneration frequency was more than 25%. The healthy plantlets were grown in greenhouse.

Cold-tolerant plant growth-promoting bacteria

More than 1,000 cold-tolerant bacteria were isolated from the rhizosphere, rhizoplane, endorhizosphere and phylloplane samples collected from high altitude areas (1,800 to 3,800 m amsl) of Uttarakhand, with greater diversity among the isolates from Garhwal region compared to Kumaon region.

Almost all cold-tolerant isolates possessed more than two low molecular weight plasmids,



Diversity of cold-tolerant bacteria from North-West Himalayas

while high molecular weight plasmids were detected in few isolates. The 16S rRNA gene of plant growth-promoting bacterial isolates from high altitudes were sequenced at IMTECH, Chandigarh. The sequences were deposited at GenBank, USA and their accession numbers were obtained.

SUCCESS STORY

Cultivation of off-season cauliflower

A system of off-season cauliflower cultivation in mid-hills, which includes growing of seedlings in polyhouses during November-December followed by transplanting in open fields in January, was developed by the Institute. With this cultural manipulation, the crop is ready to be harvested by the end of March, when cauliflowers are not at all available in the market. Twenty-five farm families in two clusters of villages of Champawat district followed this practice and got an average yield of 17 tonnes/ha with a curd size of 0.75 to 1.50 kg. With such a production, farmers got an earning of about Rs 2.0 lakh/ha. Thus off-season cultivation of late cauliflower has become highly remunerative for the hill farmers.

SUCCESS STORY

Water harvesting and surface storage in Darim village, Uttarakhand

Supplemental irrigation is necessary to maintain the soil-moisture regime at optimal level for obtaining higher production. The geographical limitations and terrain conditions indicate possibilities of small water harvesting tanks, which can be well integrated with the hill farming system and household.

Water resources of 2,417 m³ were developed at the farmers' fields under the outreach activities of the institute located at Almora, in two clusters of villages, namely Bhagartola (Almora district) and Darim (Nainital district). In village Darim 52 tanks were made. The capacity ranged from 10 m³ to 288.75 m³. Nearly one-third LDPE tanks (17) have capacity of 10 to 15 m³ because of the smaller size of terraces and land holdings of the farmers. Twenty-seven poly-tanks are of 15-30 m³ size and eight tanks above 30 m³ capacity.



The aerial view of tanks in Darim cluster is partially shown. The image was captured from web resources and the water-harvesting tanks were located in the present scene

The harvested water, when utilized through micro-irrigation system for cultivation of vegetable pea and French bean resulted in pod yield of 12.8 tonnes and 10.5 tonnes/ha, respectively, and provided annual return of more than Rs 1.75 lakh/ha, with a benefit:cost ratio of 2.32. The payback period for water resources development came to be 3.35 years, considering the internal rate of return being 27%. Moreover, the use of micro-irrigation saved harvested water up to 40%.

SUCCESS STORY

Integrated pest management

The IPM technology developed at the Institute was propagated amongst farmers in four blocks of Almora district (Hawalbagh, Tarikhet, Takula and Dauladhevi) during 2004-05 to 2006-07. The technology adopted by 480 farmers in 972 fields (19.44 ha area) of 200 m² each in six vegetable crops. As a result, germination in IPM-treated plots significantly improved (60-90%), being 20-30% higher than the local practice. Motivated by application of the bioagents *Trichoderma harzianum* using vermicompost as a delivering medium, the farmers prepared 84 tonnes vermicompost in 347 vermipits and applied it in the IPM fields.

The IPM adopting farmers realized higher yield of vegetables 20, 25, 15, 16.5, 20 and 14.5 tonnes/ha in bean, tomato, capsicum, cauliflower, cabbage and vegetable pea, respectively, which was 30-70% more than the local practice. Improved yield with reduced pesticide load through bio-intensive approach of IPM has become popular among the farmers. Encouraged by the success of IPM technology in getting healthy crop with higher yields, 43 farmers planted vegetable pea adopting IPM technology in the village Tipola Sera of Tarikhet block, where they obtained 65% higher pod yield (20 tonnes/ha). These farmers earned more than Rs 2 lakh/ha by selling their produce @ Rs 12-14/kg.

NORTH-EAST HIMALAYAS

The research work carried out at the institute located in North-East Himalayas includes:

Promising genotype of Indian bean

RCDL 10, A bush type, photo-insensitive, short duration, high-yielding genotype of Indian bean (*Dolichos lablab*) tolerant to aphids, leaf spot and powdery mildew disease was identified for NEH Region. It has yield potential of 14-15 tonnes/ha and can be grown from April to November at a spacing of 80 cm × 40 cm. First harvesting can be done 75 days after sowing. Average pod weight is 4.0- 4.5 g and pod yield varies from 95 to 100 g/vine.

High yielding crossbred cattle

The productive and reproductive performance of Holstein-Friesian (HF) crossbred cattle having around 75% HF blood was assessed for eight years in North-eastern Region of India. The milk yield/lactation (litre), lactation length (days), milk yield/day (litre), milk yield/day in first 300 days (litre), age at first calving (days), calving interval (days), dry period (days), and days open (days) were 3,423 ± 134, 390 ± 16, 9.2 ± 0.43, 11.7 ± 0.45, 811 ± 29.7, 437 ± 19, 50.4 ± 4.14 and 155 ± 18.15 respectively. The results indicated that milk

Rare and endemic butterflies of north-east India

Out of 125 butterfly species identified for the first time from North-Eastern Region of India, the following were found rare and endemic to the region.

Northern jungle queen (*Sticopthalma camadeva camadeva*): It is a large butterfly, found in thick forests at an altitude of 800 m in Arunachal Pradesh and its larva feeds on bamboo.

Green duke (*Euthalia sahadeva sahadeva*): It is found in mid-altitude of about 1,800 m in Manipur, and its larva is a pest of *Quercus* sp.

Tawny rajah (*Charaxes polyxena hierax*): An active and stout butterfly confined to thick forest areas of Meghalaya. It is a polyphagous larva, feeds on *Tamarindus indicus*, *Aglaia elaeagnoidea*, *Saccopetalum tomentosum*.

Dark archduke (*Adolias khasiana khasiana*): It is a black butterfly found below 1,800 m altitude in Meghalaya.

production under climatic conditions of NE region can easily be increased by rearing HF dairy cattle.

A technique for identification of meat species

Species-specific DNA markers for pig, chicken, duck and pigeons were developed and validated by cross checking with the other meat species such as cattle, sheep, goat, rabbit, chicken, duck, pigeon and turkeys. The DNA markers developed can help identify the species of raw as well as cooked meat of the species mentioned. This process of identification is simple, economical and quick as compared to the PCR-RFLP method of species identification.

ISLANDS

The research findings of the institute located in Islands are:

Rice

At the Bloomslade research farm, long-duration varieties (Gayatri, Savitri, Ranjit and Varshadhan) performed better than medium-duration Taichung Sen Yu. Among long-duration varieties, Ranjit recorded highest grain yield followed by Savitri, Varshadhan and Gayatri. In farmers' fields also, long-duration varieties gave significantly higher grain yield than long-duration C 14-8 in spite of minimal management practices adopted by the farmers.

Azolla : a feed substitute for poultry

Azolla can be supplemented for backyard poultry along with other foodgrains and kitchen waste. *Azolla* supplementation did not have any adverse effect on egg production, and showed

SUCCESS STORY

Integrated watershed management for livelihood security of shifting cultivation areas of Nagaland

In Peren district of Nagaland, integrated watershed development programme was taken up covering an area of 1,032 ha during 2003-04. The watershed area comprised 40 villages having population of 28,680. To operate the scheme, 1,016 self-help groups (SHGs) were formed under the banner of Union Cooperative Societies (UCOS) – Peren, Jalukie. Passion fruit, maize, turmeric and ginger were selected as the priority crops for cultivation within the watershed area. About 610 SHGs are involved in passion fruit cultivation in an area of 212 ha, whereas maize is being cultivated in an area of 105 ha involving 386 SHGs. The UCOS is cultivating these two commodities since last 3 years. The upper ridges of the area were rehabilitated through agroforestry interventions to produce biomass for firewood and timber, besides soil and water conservation. Around 76 ha area was covered with banana, pineapple, cashewnut, Assam lemon, guava, jackfruit and litchi under agri-horticultural land-use system. The institute-released turmeric variety (RCT 1) is also being commercially cultivated by the farmers in an area of 100 ha since last year.



Integrated watershed management in shifting cultivation areas of Nagaland



Increased population of Vanaraja poultry birds

Five hundred poultry birds (Vanaraja breed) were distributed to 30 SHGs, covering 27 villages in 2004-05. The bird population has now gone up to 4,000 by which 800 farmers were benefited through the distribution system being adopted by UCOS. Thirty-six piglets of improved breed (Large Black X) were also distributed to 20 SHGs and, as of now, 90 SHGs are rearing the improved breed of pig covering 40 villages. Besides, in 2007, UCOS has sold 400 quality piglets to Wokha district of the state. In fishery sector, UCOS in collaboration with the ICAR is adopting integrated fish farming system with duck and fish in an area of 3.6 ha. The fish productivity has increased from 1.2 tonnes/ha to 5.4 tonnes/ha by adopting integrated fish farming system. An employment of 43,500 man-days was generated during the last 4 years under different activities taken up in the watershed area.

During 2002-03, the total area under shifting cultivation in the watershed area was 512 ha, which has come down to 31 ha during 2007-08. The integrated watershed development programme taken up by the ICAR has helped the farmers in reducing shifting cultivation and reap benefits of settled cultivation.

immunoregulatory role in poultry. It is highly palatable in both growing and laying quails. *Azolla* supplementation in quails @ 10-20 g/bird/day could replace 21.7-30% concentrated feed. The technology of *Azolla* feeding was successfully transferred to the farmers' fields and they have started supplementing *Azolla* in the quail feed up to the age of marketing.

Coconut husk burial for round-the-year vegetable production

The areas, which are close to the sea and left as a fallow due to the clayey soils and seawater entry in subsoil during high tide after tsunami, can be effectively converted into cultivable land by a raised

bed method. In this, beds are raised to a height of 30 cm from the ground level. Coconut husks which are thrown as waste are chopped and covered over the beds as a layer. Above this layer, soil mixed with compost is applied before growing crops. High-value vegetable seeds and seedlings are taken on the surface of the raised beds. This facilitates survival of vegetable crops against the continuous and heavy rains and rise in the level of seawater. Coriander, capsicum, okra, tomato, French beans etc. can be taken on the beds, whereas *Tagetes* and swamp cabbage in furrows. An average net profit of about Rs 3.8 lakh can be obtained. These treatments also increased pH to 6.88 which was earlier in the acidic range (pH 5.24).

Microbial diversity and identification

Agriculturally important micro-organisms, i.e. 33 fungal pathogens, 31 bacterial pathogens, 434 bacterial antagonists and 83 fungal antagonistic isolates, were isolated from infected plant parts and rhizosphere soil samples of vegetable and spice crops cultivated in Andaman and Nicobar Islands. Two types of leaf anthracnose symptoms were observed on black pepper. The first symptom was consistent with the disease previously reported on pepper as *Colletotrichum gloeosporioides*. The second symptom was similar to that caused by *C. dracaenophilum*, a species identified as a pathogen on lucky bamboo (*Dracaena sanderiana*), and internal transcribed spacer region of the fungal DNA was amplified, sequenced and submitted to NCBI GenBank (Accession No EU744584). BLAST searches of GenBank using the ITS sequence revealed that this fungus was a member of the genus *Colletotrichum*, but a species level identification could not be made with this data. The fungus was mostly similar in sequence to phytopathogenic isolates of *C. dracaenophilum* (93% sequence similarity).

Renewable energy-based dryers

Renewable energy-based solar dryers and biomass fired dryer were tested and evaluated for product drying quality and were compared with natural sun drying method. Coconut, black pepper, chilli, jack fruit bulb, mushroom and fish were dried in these dryers. The drying under solar dryers

saved 33.3% time in model-1 (bamboo/wooden frame) and 37.5% time in model-2 (steel frame with trays, doors and ventilators). The quality of the copra obtained from solar dryers was at par with the quality of edible copra, and moisture content of product was between 6 and 10% (wb). These dryers are designed to work in wind speed of up to 45-60 km/hr.



Renewable energy-based solar dryer to improve the product quality of plantation crops

Under biomass fired dryer, drying of coconut and fish was done using coconut shell as fuel. Drying rate was higher under biomass fired dryers than solar dryer. Biomass fired dryer can be used for drying of coconuts and fish during rainy season.