

17. Research for Tribal and Hill Regions

The ICAR through its institutes located in the North-west Himalayas, North-east Himalayas and Andaman and Nicobar Islands evolved technologies to meet the needs of tribal and hill farmers. These technologies are intended to improve the socio-economic status of target groups, and will help them acquire special skills through vocational training in traditional and non-traditional

crops, agroforestry, apiculture, horticulture, animal husbandry, poultry and fisheries.

NORTH-WEST HIMALAYAS

Varietal development

Vivek Maize Hybrid 39, VL Lahsun 2, VL Mandua

Variety/Hybrid	Adaptation region/ Agro-ecology	Duration	Salient feature
Varieties/hybrids notified			
Vivek Maize Hybrid 39 	For commercial cultivation in Zone I (UA, HP, J and K and NEH region)	Extra-early (85–90 days)	Single-cross hybrid with yellow, semi-dent grain, gave 21.93% higher yield over the best check Vivek Maize Hybrid 17.
VL Lahsun 2	Zone I	190–195 days 	It showed higher bulb weight, less storage loss and high TSS (°Brix). It also possessed resistance against purple blotch and stemphylium blight in Zone I.
VL Mandua 347	Bihar, Gujarat, Jharkhand, Karnataka, Madhya Pradesh and Uttarakhand	Early duration (95–100 days)	VL Mandua 347, a cross between VR 708 × VL 149 surpassed the check variety VR 708 by 10% higher yield and showed moderately resistance to blast. It will be suitable for those areas where monsoon gets delayed or drought is a common phenomenon, higher hills.
Varieties/hybrids released			
VL Tamatar Hybrid 1	Uttarakhand	60–75 days (first picking)	It showed 27.97% higher yield than the check hybrid DARLH 304 in State Varietal Trials and is suitable for both organic and inorganic conditions as well as for polyhouse cultivation.
VL Shimla Mirch Hybrid 1	Uttarakhand	65–70 days (first picking)	It is suitable for both organic and inorganic conditions as well as for polyhouse cultivation.
VL Cherry Tamatar 1	Uttarakhand	70–75 days (first picking) 	An indeterminate, open-pollinated variety, can be grown both under polyhouse and open-field conditions. Fruits small, attractive, red with oval shape; better in nutritive traits (Vitamin C and TSS), good taste and being table type, it can fetch high price to the growers.
VL Shimla Mirch 3 	Uttarakhand	70–80 days (first picking)	An open-pollinated variety, can be grown under both organic and inorganic conditions especially during summer-rainy season in hills. Fruits are uniform, attractive dark green, medium size (60–70 g), blocky, 3–4 lobes with bright smooth surface. It is also suitable for polyhouse cultivation.
VL Tamatar 5	Uttarakhand	70–80 days (first picking)	A semi-indeterminate, open-pollinated variety, can be grown both under polyhouse and open-field conditions especially during summer-rainy season in the hills. It is suitable for both organic and inorganic conditions.
UA, Uttarakhand; HP, Himachal Pradesh; J and K, Jammu and Kashmir; NEH, north-eastern hills			

347, VL Tamatar Hybrid 1, VL Shimla Mirch Hybrid 1, VL Cherry Tamatar 1, VL Shimla Mirch 3 and VL Tamatar 5 were notified/released for various agro-climatic regions of country.

Development of VL Syahi Hal

Hill farmers generally use the locally available traditional wooden plough. VL Syahi hal was developed as an alternative to the traditional plough. This plough can be used for ploughing as well as levelling fields. The weight was also kept within 11–14 kg to make it convenient for handling.



VL Syahi Hal

Colocasia (taro)-based cropping system

In hills of Almora, potato consumed the highest total input energy (25,084 MJ/ha), and in colocasia-based relay intercropping the consumption was least (5,108 MJ/ha) by coriander. Colocasia–coriander–tomato showed higher energy ratio (30.4), human energy profitability (2,813.4) and energy profitability (29.43) with the highest system

biomass. The total energy output of the crop production systems followed the order: colocasia–wheat–okra (1,362,928 MJ/ha), colocasia–coriander–tomato (1,249,136 MJ/ha) and colocasia–gardenpea–frenchbean (839,299 MJ/ha). The colocasia–coriander–tomato and colocasia–onion–frenchbean cropping systems were more suitable in the North-Western Himalayas for higher energy-use efficiency and energy productivity respectively.

Effect of PSB strains on pea

Carrier-based formulation of eight cold-tolerant P-solubilizing bacterial strains were tested for P uptake in pea variety VL 47 under pot condition. *Pseudomonas fragi* strain CS11RH1 and *Pseudomonas poae* strain PB2RP1(2), and *Pseudomonas* sp CS11RP1 improved the number of seed in pea plants by 10.1% and 7.7% respectively. Maximum P uptake was recorded by *Pseudomonas poae* NS12RH2(1) (47.3%), *Pseudomonas poae* CS11RP1 (44.2%) and *Pseudomonas fragi* CS11RH4 (40.6%), respectively, over uninoculated control. Rockphosphate application combined with bacterial inoculation improved the P uptake by 17.6 to 27.3%.

NORTH-EAST HIMALAYAS

Soil fertility mapping

Geo-referenced soil fertility mapping of macro- and micro-nutrients for the 13 priority districts of Asom state (1 : 50,000 scale) was carried out. These maps can be utilized for optimization of nutrient supply for better crop production and for regularizing supply of nutrients during crop season.



Organic carbon map of Nagaon district of Asom (left); and available zinc map of Marigaon district of Asom (right)

Varietal improvement

RCM 13, a pre-released short-duration rice culture: RCM 13 line, having a short-duration character, was developed at Manipur centre. The line takes 75 days to reach 50% flowering and matures in about 95–105 days. The genotype was also found suitable as contingent variety for pre-kharif/early kharif/main kharif condition and different cropping systems in the region. It is the first evolved culture having low amylose content (11.7%).

Akhanphou rice: Akhanphou, a popular local rice cultivar of Manipur, was found highly resistant to leaf blast under uniform blast nursery continuously for two seasons. Besides, the genotype possessed four major blast-resistant genes (*Pita/Pita2*, *Pi40*, *Pi54* and *Pi2*), and also showed tolerance to low phosphorus conditions.

Taro: RCMC 5, a very high-yielding clone of taro (*Colocasia esculenta*) developed at Manipur centre, showed a potential yield of 28.31 tonnes/ha and moderate resistance to *Phytophthora* leaf blight.

King chilli: Genetic diversity study of 22 king chilli landraces of Manipur, one landrace of Nagaland and two capsicum varieties using 38 microsatellite markers showed 9 distinct groups. The Manipur accessions were found different from Nagaland accession. The Nagaland accession showed similarity with those collected from Ukhrul district, Manipur (RCMKC 7 and RCMKC 9) bordering Nagaland. The accessions collected from Chatrik village of Ukhrul (bordering Myanmar) and Thingkeu village of Churachandpur (bordering Mizoram) were also found different from other Manipur accessions. Among the Manipur accessions, RCMKC 7 (collected from Ramva, Ukhrul) was different from rest of the group.

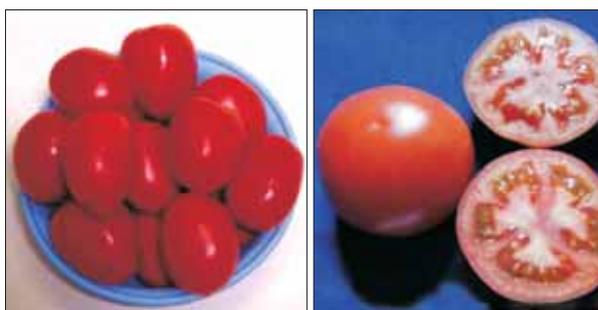
Identification of candidate genes for aluminium-toxicity tolerance

In order to improve aluminium toxicity tolerance in rice, differential expression of six candidate genes under aluminium toxicity stress was studied through semi-quantitative PCR. Two candidate genes *IPSI* and *CAX2* were identified for improving aluminium toxicity tolerance.

Temperature-tolerant rice and maize and moisture-tolerant tomato for North-eastern hill ecosystem

Of the 600 rice genotypes tested at Umiam for heat tolerance, RCPL 1-136 genotype appeared most tolerant to high temperature (72% spikelet fertility on recovery) with tolerance for drought (RWC 48.6). Similarly, pollen-grains of nine genotypes of maize were exposed to heat stress at 45°C for different periods. RCM 17 genotype showed highest tolerance. However, one hour exposure at 45°C reduced pollen viability by 50% in almost all genotypes in Meghalaya.

Of the 38 genotypes of tomato collected and evaluated under poly-house condition at 20–30°C at three levels of moisture stress (90±2.3%, 80±2.3% and 70±2.3% moisture stress), Megha Tomato 3 variety performed best at low-moisture condition. Similarly, five tomato genotypes collected from Varanasi and five breeding lines



Manileima tomato hybrid found suitable under frost condition (left); and Kashi Hemant performed better under low light condition (right)

from Manipur were evaluated under three growing conditions, viz. natural field (exposure to frost), low-cost polyhouse (exposure to heat) and 50% agro shade net (exposure to low light intensity). Tomato variety Manileima was found suitable under frost condition, whereas Selection 9A has shown resistance to drought and high temperature. Under low light condition, Kashi Hemant performed better than other genotypes.

Unique traits of local pigs and poultry

Pigs: The performance of pig breeds, Ghongroo/Duroc was evaluated under low input production system and demonstrated the technology for climate resilient production system. At Umiam, the unique traits of the indigenous pigs of the north-eastern region were identified. Phenotypic and morphometric traits of Bru pigs in Mizoram and their performance and the production system were evaluated. Blood samples from Bru pigs and Khasi local pigs were collected, and genomic DNA isolated for microsatellite genetic characterization and DNA repository of indigenous pigs.

Indigenous poultry: The indigenous chickens were of medium size, active and having multi-colour plumage. Majority of the birds are normally feathered; however, frizzled and naked neck types were also observed in many areas. The birds possess single comb, red ear lobe and white non-feathered shank.



Local poultry—Naked neck types were also observed in many areas

Thermal tolerance and reproductive competence of native fish species of NEH region

Thermal tolerance and rate of oxygen consumption, critical thermal maximum (CT_{max}) and lethal thermal maximum (LT_{max}) were studied in two potential ornamental fishes of the region—*Brachydanio rerio* and

Danio dangila. The results showed that *B. rerio* was more thermal tolerant, indicating better adaptation than *D. dangila*.

Animal production

Different freezing rates (20, 40 and 60°C/min) using programmable freezer, were tried to optimize the freezing of boar semen. Freezing rate of 40°C/min showed the maximum post thaw motility and viability of spermatozoa in boar semen. Significantly higher sperm plasma membrane integrity and mitochondrial membrane potential and lower DNA damage were recorded at 40°C/min freezing rate than that at 20°C/min and 60°C/min. The plasma membrane, mitochondrial and DNA damages were significantly higher during manual freezing than during programmable freezing.

ANDAMAN AND NICOBAR ISLANDS

Germplasm and crop improvement

CARI Brinjal 1, developed by repeated selection and purification cycles from the local collection, survived under wilt pathogen sick condition and gave better yield than other varieties under island conditions. It has been registered with the NBPGR, New Delhi.

Thirtythree accessions of *Morinda citrifolia*, one of *Eryngium foetidum*, two of *Amaranthus viridis*, seven each of *karanja* and *jatropha*, and 16 of tuber crops were collected and deposited in the NPBGR, New Delhi. Two new indigenous vegetables—*Mukia maderaspatana* and *Linnophila chinensis*—were identified, and 64 species of medicinal and 19 of speciality flowers were collected and maintained in the gene garden of the institute.

Indigenous vegetables having rich source of zinc and calcium (*Centella asiatica*), copper (*Sauropus androgynous*), iron (*Portulaca oleracea*) and magnesium (*Amaranthus viridis*), and underutilized fruit *Malpighia glabra* for polyphenol, anthocyanin, carotenoids, tannin and ascorbic acid were identified. *Morinda citrifolia* accession TRA1 was the richest source of polyphenol, flavonoids and ascorbic acid, while TRA2 had higher tannin and anthocyanin.

Water and nutrient management in capsicum through drip system

Under protected cultivation, application of 50% recommended dose of fertilizers (RDF) as vermicompost + 50% RDF as water-soluble fertilizer through fertigation + vermiwash spray was found highly profitable and economically viable to get more of yield of Indra variety of capsicum under island ecosystem.

Organics in managing acid soils of Andaman

A field experiment was conducted with maize consisting of seven treatments, viz. poultry manure, vermicompost, coconut husk compost, coconut husk compost + lime, gliricidia, lime and control. Significant enhancement was observed in root volume, grain yield, stover and biological yield owing to poultry manure

followed by vermicompost and gliricidia treatments. The yield increase in these treatments was mainly owing to increased availability of nutrients such as nitrogen and phosphorus besides improvement in soil reaction. Though lime application has improved the soil pH to 6.69, the yield parameters were lesser than the organic amendments due to limited availability of major nutrients such as N and P.

Production technology including protection

Cauliflower varieties, viz. Mareet F₁, Shobha F₁, White Marble, White Shot and White Taj, performed well in heavy rainy season under rainshelters.

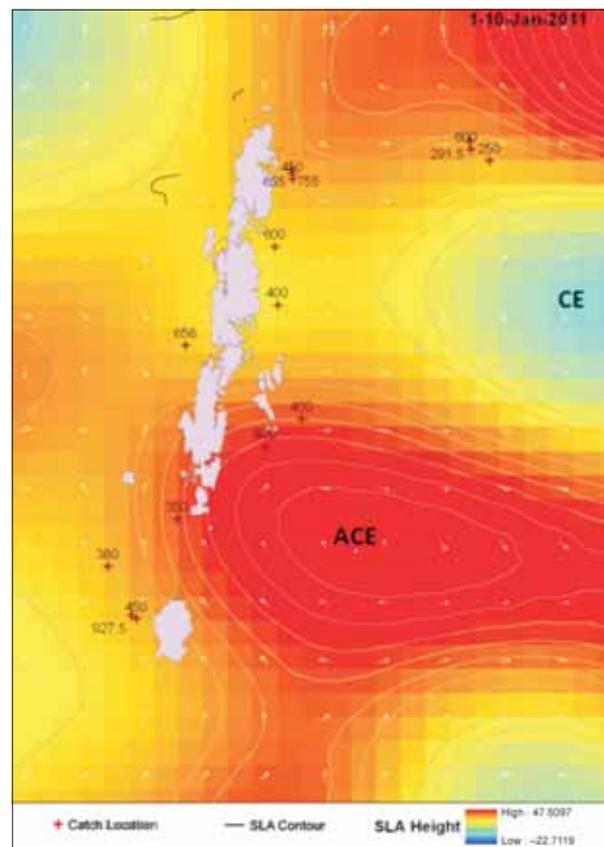
The lowest bacterial wilt incidence (20%) was reported in tomato grown on cocopith : vermicompost : lime (1 : 1 : 0.01) compared to 56.7% in control pots.

Deepika, an improved dual-purpose Nicobari fowl produced by crossing White Nicobari and Vanaraja, showed higher adult body weight and annual egg production with better survivability.

Two herbal products, namely Gromune (Tonic) and Morical feed supplement, were prepared from the fruits of *Morinda citrifolia*. Feeding Gromune @ 15 ml/bird improved immunity, and Morical @ 4% in feed supplement enhanced 24% egg production in Japanese quail.

Potential fishing zone advisories for Andaman

Andaman receives rainfall for almost 250 days in a year and due to non-availability of cloud-free satellite data, the PFZ advisories for this region have been grossly



Altimeter derived eddy map. ACE, Anti-cyclonic eddy; CE, Cyclonic eddy

Capacity Building of Tribal Farmers

Under tribal sub-plan project for improving livelihood of tribal farmers of Jharkhand, Manipur, Asom and Rajasthan by enhancing rapeseed-mustard production through capacity building of the stakeholders, 120 farmers were trained at the DRMR, Bharatpur, and more than 2,500 farmers were benefited through farmer participatory on-farm demonstrations, exposure visits and supply of simple tools for agricultural operations, etc. A mini workshop of the programme coordinators from cooperating centres was organized at the ICAR Krishi Bhavan, New Delhi, on 19 March and at the DRMR, Bharatpur, on 20 March 2012.

discontinuous. Hence a study was designed to explore methods to augment Chlorophyll-a and SST-based operational PFZ advisories with AltiKa-based satellite altimetry data.

The mesoscale features, particularly eddies, in the fishing areas around the A&N islands were characterized. Overlay of fish catch positions on altimeter-derived eddy maps indicated significant catches in areas (i) between anti-cyclonic and cyclonic eddies where divergence followed by enhanced primary productivity occurs; (ii) between two anti-cyclonic circulations where divergence and upwelling occur and (iii) around the boundary/periphery of anti-cyclonic eddies which are productive. The analyses of data showed that such mesoscale eddies are very common in the vicinity of A & N islands and need to be targeted for increased catches of pelagic fishes.

Optical characterization of coral reef diversity

The coral reefs in Andaman were monitored to study the coral recovery and reef fish diversity after the 2010 mass bleaching phenomena. All the sites showed significant increase (11%) in live coral cover. The study showed that the abundance of Chaetodontids and Pomacentrids decreased with decrease in coral cover

Success story

Improving living standards of tribal farmers through technological interventions

The Tribal Sub Plan scheme was implemented in the fields of 96 tribal farmers of Macharam, Jangamreddy palle, Chitlankunta, Petanchenu and Maddimadugu in Amrabad Mandal of Mahabubnagar district in Andhra Pradesh. To improve living conditions of the tribal farmers through interventions of improved oilseeds technologies, especially in castor a non-edible and high-value crop, besides creating agricultural related assets, a scheme was initiated. The farmers were trained in improved production technologies of *rabi* castor including cropping systems for sustainable production.

Seeds of castor hybrids, DCH 519 and DCH 177, were given to farmers for growing in *rabi*. At different stages of crops, they were trained to apply fertilizers, weedicides and pesticides. Besides, 55 sprinkler sets and 125 secateurs were supplied. To alleviate the problem for transporting agricultural produce, assistance was given of three bullock carts. Farmers could earn on an average ₹ 8,000/0.4 ha despite severe drought. It indicates scope for higher economic returns under good years.

while that of Acanthurids and Scarids, which are predominantly algal grazers, increased.

Underwater radiometer survey was carried out at North Bay and in the Mahatma Gandhi Marine National Park (Tarmugili and Chester Island) and a total of 62 spectral signatures covering different life forms of live and dead corals, rubble and sand were obtained. The analysis of the data indicated the potential of using satellite data for differentiation of live forms of corals.

Economic valuation of mangroves in A & N islands

Total economic value of the A & N mangroves was worked out to be more than ₹ 12,000 crore per annum on

TRIBAL SUB PLAN PROGRAMME

Jute and allied fibres

Under the programme, major emphasis was given to bring more area under cultivation of sisal and ramie in tribal areas of the country to uplift their socio-economic conditions. The TSP activities comprised generation and distribution of planting materials, crop area expansion, and transfer of technology, human resource development, public awareness generation and literature development.

Ramie: Planting materials of ramie, rhizome, plantlets and stem-cuttings for 10 ha generated at Ramie Research Station, Sorbhog, Asom, was supplied to Assam Ramie Fibre Cultivation Cooperative Ltd. About 25 ha area of the research farm was exclusively under use for generation of planting materials for the TSP. Tribal areas of Lakhimpur, Dhemaji and Sonitpur districts of Asom were selected for expanding ramie cultivation.

Ramie nurseries were established at four tribal villages. Ten ha area covering 51 farmers was brought under ramie plantation. Stem-cuttings as a low-priced and alternative planting material to ramie rhizome was popularized among the farmers, and about 50% of the covered area was planted with stem-cuttings. Among the trained farmers, group leaders were identified for effective implementation of tribal support programme in those districts. In total 80 farmers were trained.

Sisal: Under TSP, Sisal Research Station, Bamra, Odisha, generated 51,328 sisal-suckers that were distributed among the tribal farmers of Jharsuguda and Sambalpur districts of western Odisha. With the continued meetings and awareness programmes with the tribal farmers at the research centre and also at the tribal villages, tribal farmers of Jharsuguda and Sambalpur were encouraged for sisal plantation. As a result, 11.55 ha of land covering 28 tribal farmers were brought under sisal cultivation. The improved production technologies of sisal were demonstrated to farmers.



current prices and per household harvest was more than ₹ 65,000 annually from the mangroves. Economic value of mangroves was found to be more than ₹ 2 lakh/ha/annum.

Impact assessment of technological interventions in Andaman

The impact assessment revealed that composite fish culture with CRM was promising both in South and North and Middle Andaman districts. In 30% cases the farmers have resorted to adoption of the technology even after *Tsunami* 2004 in South Andaman. An average harvest of 2.5 to 3 tonnes/ha/year against 0.07–0.08 was obtained. Many farmers, through the sale of the fish, i.e. 1.5 to 2

tonnes/year, could earn an income of ₹ 1.85 to 2 lakh against 0.45 lakh. The technology has helped the farmers getting regular income and nutritional supplements. The horizontal spread of the technology was to the tune of 20 ha in N&M Andaman. Broad bed and furrow system (BBFS) was adopted by the farmers in the villages of South Andaman. Farmers could earn an additional income of ₹ 20,000 to 25,000/year against ₹ 800–1,000 from rice crop alone from an area of 0.2 ha. In addition to that, employment generation of 90 to 120 man-days took place under these technologies. Major constraints observed were lack of labour, marketing, storage facilities and non-availability of essential inputs in time.

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