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Research for Tribal and Hill Regions

Specific technologies are required for the tribal and hill farmers of unique ecosystems of the Himalayas and Islands of Andaman and Nicobar. The research institutes located in north-west Himalayas (Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora), the North-east Himalayas (ICAR Research complex for NEH Region, Umiam), and Andaman and Nicobar Islands and Goa (Central Island Agricultural Research Institutes, Port Blair and ICAR Research Complex for Goa) are engaged in area-specific research.

NORTH-WEST HIMALAYAS

Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, caters to the agricultural research needs of the north-western Himalayan states of Uttarakhand, Himachal Pradesh and Jammu & Kashmir. The salient accomplishments during the period under report are presented here.

Variety released and notified

The following crop varieties developed from VPKAS, Almora were released and notified for the Himalayan states and elsewhere.

VLB 118: The barley variety was released for agro-ecological region of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, West Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura; and has high degree of resistance against yellow rust. Its yield is 3.084 tonne/ha and matures in 160–165 days.



VLB 118 barley

Vivek Maize Hybrid 47: Grain yield of the maize is 6,686 kg/ha in zone-I and exhibited 24.0% higher yield over other national check Prakash (5,394 kg/ha). It has resistance against *Turcicum* leaf blight and moderate resistance against maydis leaf blight and *C. rust*. The



Vivek Maize Hybrid 47

hybrid was resistant against BSDM and PFSR. Parental lines V 373 and V 391 exhibited resistance against *H. turcicum* leaf blight and *H. maydis*.

Vivek Maize Hybrid 51: Grain yield of the hybrid maize is 5,084 kg/ha in zone-I and exhibited 31.76% higher yield over national check Prakash (5,394 kg/ha). Exhibited resistance against *Turcicum* leaf blight and moderate resistance against PFSR, RDM and *C. partellus*. Parental lines V 405 and V 409 exhibited resistance against *H. turcicum* leaf blight.



Vivek Maize Hybrid 51

Vivek Maize Hybrid 53: Grain yield is 7,676 kg/ha in zone-I; and exhibited 26.08% higher yield over Vivek QPM 9. Exhibited resistance against *Turcicum* leaf blight and moderate resistance against maydis leaf blight and *C. rust*. The hybrid was resistant against BSDM and PFSR. Parental lines V 407 and V 409 exhibited resistance against *H. turcicum* leaf blight and *H. maydis*.



Vivek Maize Hybrid 53

VL Dhan 157: VL Dhan 157 (VL 8302), with average grain yield 2,250 kg/ha released by the CVRC, Uttarakhand for upland conditions, is suitable for the rainfed upland (June sown) ecosystem of Uttarakhand and Meghalaya. It is resistant against blast. It recorded

Organic farming

To promote double cropping of rice, pre-kharif rice was grown consecutively for 8 years with different varieties and organic sources of nutrients management in the lowlands. The highest grain yield was recorded with Shhsarang-1 (4.84 tonnes/ha) which was at par with IR 64 (4.63 tonnes/ha) but was significantly higher than Vivek Dhan 82 (3.19 tonnes/ha). Pig manure (4.79 tonnes/ha) was at par with FYM (4.77 tonnes/ha) and vermicompost (4.69 tonnes/ha) but recorded significantly higher grain yield than paddy straw (3.96 tonnes/ha) and farmers' practice (2.91 tonnes/ha). Among the nutrient sources, integrated nutrient management recorded maximum rice grain yield (3.58 tonnes/ha) followed by inorganic and organic sources.

**Seed production**

Breeder seed (30.44 tonnes) for 36 released varieties/inbreds of different crops were produced, of which 19.15 tonnes breeder seed was supplied to different seed producing agencies for further multiplication. Around 1.70 tonnes nucleus seed of 27 released varieties were also produced following standard methods to maintain genetic purity. In addition, around 6.33 tonnes truthfully labeled (TL) seed was also produced and 2.94 tonnes were supplied to meet the demand of institute extension activities. Under farmers' participatory seed production programme, 6.69 tonnes seed of various crops like, wheat and gardenpea were produced at farmers' fields at different places, out of which 5.59 tonnes seed was supplied.

moderately high HRR of 59.6%, desirable ASV (7.0) and amylase content of 21.2%.

VL Dhan 88: VL Dhan 88 (VL 31611) having grain yield of 4,251 kg/ha was released by the CVRC in 2014 for the irrigated conditions of Uttarakhand and Meghalaya. The first fine grain rice suitable for irrigated conditions of mid hills of Uttarakhand and North Eastern Hill. It is moderately resistant against leaf and neck blast, sheath rot, leaf scald and false smut. The variety recorded high head rice recovery of 65.8% and desirable alkali spreading value of 4.0.

VL Mandua 352: VL 352, an early duration (matures in 95–100 days) variety, is moderately blast resistant and moderately resistant to neck and finger blast disease. The variety suits to those areas also, where monsoon gets delayed, or drought is a common phenomenon, i.e. higher hills or areas where crop growth period is limited.



VL Mandua 352

Varieties identified

Besides the varieties released for commercial cultivation, 8 entries in 4 crops were identified for release. These include rice (VL 30560, VL 30425, VL 30240), wheat (VL 953), soybean [VLS 76, VLS 77, VLB 201 (Bhat)] and pigeonpea (VLA11).

Comparison of soil quality index in different cropping system: The influence of different nutrient sources on the soil health in gardenpea–french bean–okra cropping system was quantified. Application of FYM @ 69.9 kg P/ha showed the highest soil quality indices (SQI) indicating that the soil under these cropping systems was in better health than in other nutrient management practices. The soil quality under NPK was 42 and 25% degraded for productivity and environmental SQI, respectively, than FYM @ 69.9 kg and hence, should not be continued for long term as it slowly deteriorated the soil quality. The productivity SQI under NPK and INM could be achieved with application of 5.9 and 25.1 kg P/ha through FYM,

respectively, for gardenpea–french bean–okra cropping system.

Impact of INM on carbon dynamics of acid soil: Integrated nutrient management (INM) practices significantly influenced the soil organic carbon (SOC) content and maximum improvement (SOC: 2.09%) was recorded in treatments receiving NPK (50% of recommended fertilizer dose: 80-60-40 NPK kg/ha) along with FYM @ 5 tonnes/ha with lime @ 0.5 tonne/ha over the control (without any external input, SOC: 1.85%). However, the various sources of organic manures (vermicompost/weed compost) were statistically on par with FYM. INM practices with vermicompost [NPK (50% RDF) along with vermicompost @ 5 tonnes/ha and lime @ 5q/ha], microbial biomass carbon (MBC) as a part of SOC pools also showed significant improvement (889 mg/kg) over the control (638 mg/kg). Dehydrogenase activity (DHA), the measure of microbial activity in soil, was significantly higher in INM treatments receiving vermicompost (DHA: 18.15 µg TPF/g/ha) over control (DHA: 11.90 µg TPF/g/ha). Phosphatase and glucosidase enzyme activities were also significantly higher in all INM practices over control and manifested a positive relationship with INM practices.

Mitigating abiotic stresses in pulses in rice fallows: Rice–lentil cropping system was evaluated under upland and lowland conditions with different varieties and residue management options. The residue management options for lentil were mulching with paddy stubble, 20 cm standing stubble, control (residue removal) and farmers' practice (conventional tillage and residue removal). Significantly higher yield was observed for the rice line IURON-514 (4.3 tonnes/ha) in upland compared to local Kbalum (3.08 tonnes/ha). The relative water content and chlorophyll in lentil at 90 days after sowing (DAS) was highest under mulching than that of control and farmers' practice (53.9%). Among the different rice stubble management practices, the highest soil moisture content in 0–5, 5–10 and 10–15 cm soil depth was observed under mulching followed by 20 cm standing stubbles, control and farmers' practice. Regardless of variety and depth, less soil resistance was observed under mulching and 20 cm standing stubbles. Penetration resistance was more under farmers' practice followed by residue removal. Pods per plant, grain and stover yield of lentil were significantly influenced by rice and lentil cultivars. Lentil variety DPL 62 (0.65 tonne/ha) gave significantly higher yield than DPL 15 (0.49 tonne/ha). Among rice stubble management practices, mulching recorded significantly higher lentil seed yield (0.70 tonne/ha) than that under 20 cm stubble height (0.64 tonne/ha), removal (0.5 tonne/ha), and farmers' practice (0.35 tonne/ha). In lowland, performance of early duration HYV variety Shahsarang 1 was better giving higher grain yield (5.14 tonnes/ha) compared to the local variety Mendri (3.52 tonnes/ha). Taking advantage of the comparatively shorter duration of Shahsarang 1, sowing of lentil could be done earlier.





Eastern Himalayas

Crop varieties: ICAR Research Complex for NEH Region, Lembucherra, Tripura Centre released 16 improved varieties which include nine varieties of rice suitable for different ecosystems (Tripura Khara 1, Tripura Khara 2, Tripura Jala, Tripura Chikan Dhan, Tripura Sarath, Tripura Nirogi, Tripura Hakuchu 1, Tripura Hakuchu 2, Tripura Aus), two varieties of pulses (greengram Tripura Moong and blackgram Tripura Mashkolai), one sesamum variety (Tripura Seeping), one pineapple (Tripura Anarash 3), one elephant foot yam (Tripura Yam Batema), one greater yam (Tripura Yan Tha) and one papaya (Tripura Papita).

Improving productivity of *jhum* rice: Participatory field trials were conducted in the farmers' *jhum* field in Sonidan village, Ri-Bhoi, Meghalaya, to identify suitable rice varieties/lines in *jhum* condition under both local and improved agronomic management practices and to develop suitable crop establishment methods and nutrient management options for improving productivity of *jhum* rice and sustainable soil health.

A total of 11 varieties were evaluated. Under farmers' practice (randomly broadcast seed, without manure and fertilizer application), lower grain yield was recorded for improved varieties like Bhalum 1 (1.38 tonnes/ha), Bhalum 2 (1.31 tonnes/ha), Iuron 514 (1.32 tonnes/ha) and RCM 5 (1.23 tonnes/ha) compared to local varieties like Mannar (1.43 tonnes/ha), KbaKhasi (1.71 tonnes/ha) or Pnahlai spah (1.56 tonnes/ha). However, under improved agronomic management practices, both local and high yielding rice varieties performed well. The highest rice yield was obtained under IURON 514 (3.08 tonnes/ha) followed by Bhalum 3 (2.89 tonnes/ha), RCM 5 (2.88 tonnes/ha), Kbakhasi (2.76 tonnes/ha), KbaSlu (2.53 tonnes/ha) and Mannar (2.52 tonnes/ha).

Impact of climatic stress on Vanaraja: Adaptability of Vanaraja birds with particular reference to the physiological alteration in cold and heat stress condition and the ameliorative measures through dietary supplementation was evaluated during winter (December to March) and summer (June to September). A higher body weight gain was recorded in winter at 12 weeks of age in the ascorbic acid supplemented group (1,708.85 g) and in summer at pre+probiotic supplemented group (1,524.54 g) compared to the control. High rate of mortality was observed in Vanaraja birds (up to 12 wk) in summer (10–18%) due to sudden outbreak of coccidiosis and IBD compared to winter (0–6%). During winter, supplementation of pre + probiotic led to zero mortality and in summer the ascorbic acid supplementation was beneficial to prevent mortality.

ISLAND AND COASTAL REGION

Germplasm conservation

Rice landrace (Korgut): Korgut, a traditional rice landrace from Goa, was registered as unique germplasm,



Appearance of Korgut seeds

Korgut

for tolerance to salinity stress at seedling stage with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Plant Germplasm Registration Committee approved Korgut for registration and assigned the national identity number INGR14055.

Korgut is a medium duration (120–125 days), tall growing (145 cm) rice germplasm, having bold sized grains (3.26 g/100 seed) and the tolerance is associated with low ratio of Na^+/K^+ (0.18) in shoot as compared to susceptible check variety IR 29 (0.68).

Thirteen selected progenies of the rice land race C14-8 were purified. The performance of C14-8-11-113 (2.93 tonnes/ha) followed by C14-8-11-108 (2.66 tonnes/ha) was superior as compared to mix C14-8 control (2.46 tonnes/ha). The characterization for 60 DUS (distinctness, uniformity and stability) traits were completed for 7 rice land races. Collection of 19 mungbean, 23 urdbean and 27 accessions of pigeonpea landraces were made.

The wild relative of *Vigna* spp. namely, *Vigna marina* were collected from different parts of islands and maintained.

Genetic diversity of noni: A field gene bank of 20 accessions of noni (*Morinda citrifolia*) was established. The gene bank holds accessions collected from Goa and Maharashtra with national identity numbers IC 0595272 to 0595277; IC 0598228 to 0598235; IC 0598515 to 0598516. Leaf and fruit production is characterized in the noni germplasm.

The geostationary hotspots of *Morinda* species were marked in South (Port Blair and Neil Island), North and Middle Andaman and submitted CARI Rakshak, CARI Sanjivini and CARI Sampada genotypes of noni for Registration in NBPGR.

New cashew selections: Three promising selections of cashew, viz. Tiswadi 3 (Goa Cashew 2), Ganje 2 (Goa Cashew 3) and KN 2/98 (Goa Cashew 4) are suitable for commercial cultivation in Goa. Considering the nut yield performance (10.02 kg/tree) during the last 10 years and its jumbo nut size and juicy apple



Tiswadi – 3 (Goa Cashew -2) apples, jumbo nuts and jumbo kernels



characteristics, the entry Tiswadi 3 was approved for release as a commercial variety for cultivation in Goa under the name Goa 2.

Vegetables: Fourteen isolates of *Ralstonia solanacearum* were collected from different locations of Andaman island in four different solanaceous vegetables and were confirmed as Phylotype I and race 1 on tobacco plants.

Fish diversity in Goa: The coastal ecosystem, the mouth of Zuari estuary supports ¼ of the marine and brackish fish production along Goa. The fish and shellfish diversity along the estuarine ecosystem were catalogued. Aquatic species comprising 137 finfish species (Pelagic-56, Demersal-81) and 36 shellfish species (17 crustacean species and 19 molluscan species) were collected during the study.



Fish bio-diversity

Molluscan species (64) were identified *in situ* from Nancowry group of Islands, 53 species from Great Nicobar Islands and 70 species from Car Nicobar Islands. Three Opisthobranchs representing new additions to the Molluscan fauna, viz. *Dolabrifera dolabrifera*, *Herviella mietta* and *Phanerophthalmus smaragdinus* and a Pomacentrid, commonly called as Regal Demoiselle were recorded.

Conservation community: Custodian farmers and communities of biodiversity conservation and utilization in Andaman and Nicobar Islands were identified for cultivar/germplasm/land races, viz. Andaman coconut, Nicobari aloo, Khoon phal, Blue mango, Noni, Khushbayya rice, Black Burma, Mushley, Nyawin, White Burma, Nicobari fowl, Nicobari pig and Teresa goat and were recognized for the first time.

Livestock: Nicobari pig, collected from the Nicobar Island are highly adoptive to intensive system of management under concentrate feeding. Genetic improvement of Nicobari fowl for short shank length was done through mass selection. Short shank length Nicobari fowl chicks (1,500) with improved antibody titer were produced from base population of 200.

Crop improvement

Varieties (10), two each in rice (CARI Dhan 6, CARI Dhan 7), one in sweet potato (CARI SP 1,2),

four in coconuts (CARI Annapurna, CARI Chandan, CARI Omkar, CARI Surya), one each in poi (CARI Poi 1) and brinjal (CARI Brinjal 1) were released by the Institute Variety Release Committee for the benefit of Island farmers of A & N Islands.

Raised bed technology for leafy vegetables: The technology was transformed to spinach cultivation in islands by increasing yield from 9 to 11 tonnes/ha (with single harvest) to 25.0–28.0 tonnes/ha (with multi-cutting).

Horticultural crops: Evaluation of pulses under coconut plantation in Island ecosystem, revealed that red gram variety, CO 6, recorded a yield of 544 kg/ha at a spacing of 75 cm × 45 cm, while greengram, ANM-11-12 and blackgram genotype, ANU-11-19, recorded a grain yield of 400 kg/ha and 354 kg/ha, respectively, with a spacing of 25 cm × 10 cm. Farming system characterization revealed that mixed farming predominates in South and North Andaman and vegetables accounted for more than 50% followed by plantation crops (33.3%) to the crop component. In Middle Andaman, arecanut contributed more than 50% of farm income from crop component followed by vegetables (31.8%). Rice–maize (16,773 kg/ha), and rice–okra (15,630 kg/ha) were more suitable cropping systems

Success story

Food and nutritional security of tribals of Car Nicobar

Considering the remoteness, dietary intake, limited land availability and lack of market for the farm produce, a small scale Homestead based IFS model comprising home garden (400 m²), backyard poultry (25 no's), goatary (3 no's) and composting were evaluated on participatory approach in farmers' field at Car Nicobar. In the home gardens, 100 m² area was used for growing seasonal vegetables, 125 m² area for fruit crops, 150 m² for tuber crops, besides, fruit trees and border trees were grown. Compost tanks were made at a corner of the homestead garden for composting crop residues and farm wastes. After these interventions, the frequency of consumption of food items, viz. greens, vegetables, fruits, meat, poultry, egg by the farm family increased. Employment of 80 man days was also generated by the system spread throughout the year.



Homestead IFS at Car Nicobar



Heliconia-An intercrop in coconut plantations

Heliconia, a popular ornamental plant and cut flower, is found as an ideal and profitable crop in coconut plantations.

A minimum income of around ₹ 25,000/ha to maximum of ₹ 90,000/ha could be realized depending upon the variety of heliconia planted. In addition to flower, production of sucker is an important income generation activity. An average of ₹ 10/sucker can yield up to ₹ 50,000/ha through sale of suckers.



Heliconia varieties

(A) Pedro Ortiz, (B) Tropics, (C) Wagneriana, (D) rostrata

for lowland valley areas with highest yield and net return than rice–greengram and rice–ground nut.

Land shaping under Island ecosystem through six different methods, viz. broad bed and furrow (BBF), rice–fish, three tier farming, farm pond, paired bed and furrow and pond–nursery systems, was evaluated to understand reclamation of coastal degraded areas. Salinity levels were lower in the beds of BBF system (1.5 dS/m) than the adjacent unreclaimed soil. Besides, 4,476 m³/ha water harvested in the furrows was used for

irrigating dry season crops, which increased cropping intensity of 170–218% from 90% in non intervention sites.

Managing bacterial wilt: Brinjal is cultivated in Goa during *rabi* season and the production is severely affected by bacterial wilt caused by *Ralstonia solanacearum*. The disease is soil-borne and the locally preferred cultivar, *Agassaim* is highly susceptible. A wild relative of cultivated brinjal was identified as

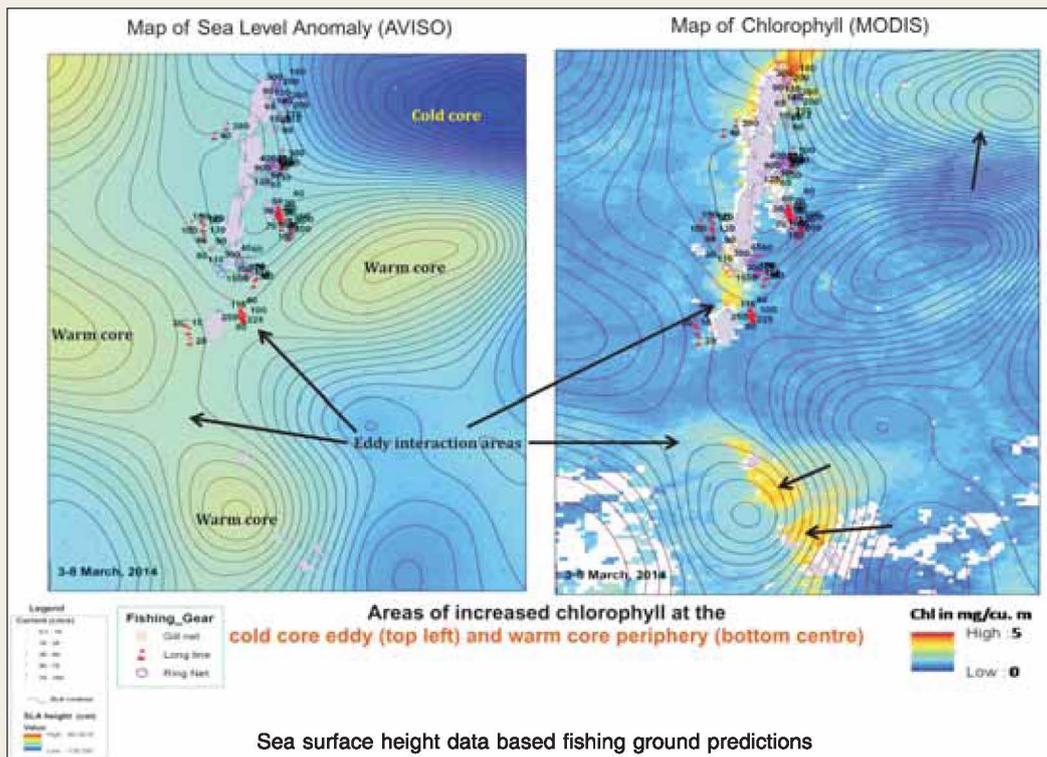


Fruiting of the brinjal grafts

resistant to this disease. The susceptible plants were grafted on the wild types. None of the grafts wilted upon pathogen inoculation and the histological studies indicated the failure of the pathogen to multiply sufficiently to cause wilt. Consumer preference for the fruits from grafts is similar to the fruits from the seedling type.

Altimeter (sea surface height) data based fishing ground predictions

To augment the potential fishing zone advisories based on chlorophyll and sea surface temperature data, sea surface height was evaluated in the Islands. Altimeter data were not influenced by cloud cover while traditional PFZ advisories are influenced by cloud cover, which prevails over six months in Islands.





Livestock and fisheries improvement

Nicobari pigs: Pigs adapted to the concentrate feed after two months of feeding. It consumed comparatively less feed (2.1 kg daily) as compared to Large White Yorkshire pigs. The reproductive traits of Nicobari pigs, such as age at puberty, age at first farrowing, litter size at birth and litter weight at birth were 106 days, 270 days, 6 number and 4.5 kg respectively. Piglets survived till the third day since its birth.

Production of bypass fat: Bypass fat is the best choice 'energy rich feed supplement' for sustainable milk production. A simple cost effective technology was developed for the production of bypass fat indigenously. Supplementation of bypass fat to dairy animals @ 15–20 g/kg milk production increases milk yield up to 20% and improves reproductive performances and health of animals. The Rashtriya Krishi Vikas Yojana (RKVY) had sanctioned ₹ 77.9 lakh for two years to promote the technology for enhancement of milk production and livelihood security of dairy farmers of Goa.

Post-harvest and value-addition

Value added products from nutmeg pericarp: Protocols for pericarp candy, pericarp jam and nutmeg syrup and ready-to-serve beverages were standardized. Cost of production of nutmeg pericarp candy comes to about ₹ 160/kg, while, about ₹ 140/kg for jam, and ₹ 70/litre for syrup. Candy has a shelf life of 12 months, while pericarp jam and syrup have shelf-life for 6 months under normal open cool conditions.

Value-addition in wax apple: Jam was prepared from the freshly harvested fruits of rose apple and the residue after juice extraction from wax jambo. Jam prepared out of 100% wax jambo was better over other types of jams prepared. Home scale value addition of these fruits will reduce the wastage and spoilage and also prevent the nutritional drain.

TRIBAL SUB-PLAN

Under TSP and NEH plan, empowerment of tribals was done through training cum sensitization for improvements in the existing practices of agriculture and allied sectors to improve production, income and quality of life.

Intervention and activities

Input distribution: Vegetable seed kit (1,000) comprising tomato, brinjal, chilli, amaranths, cowpea, okra, french bean and pumpkin were distributed to tribal farmers of Mandwi, South Tripura, Bali Island, Hut Bay and Car Nicobar. Seeds of improved rice varieties (CARI Dhan 5 and CSR 36) and quality protein maize and baby corn were distributed to the farmers of Campbell Bay and Little Andaman, and Andaman and Nicobar Islands.

Seeds of high yielding mungbean (Vamban 3, HUM 16, LGG 460, TM 96-2, IPM 02-3, Samrat), urdbean

Stakeholders meet in Ladakh

To develop the road map for improvement of yak husbandry as well as socio-economic upliftment of yak herdsman of Ladakh an interface meeting was organized in collaboration with Ladakh Autonomous Hill Council wherein farmers, researchers and development workers attended to exchange the knowledge. Technologies available with the ICAR institutes were showcased and constraints deterring improvement of yak husbandry were discussed. Complete feed block (CFB) technology was demonstrated and its beneficial effects were communicated to tribal yak farmers. The need for skill development of yak owners, methods for promoting marketability of yak products and organization of cooperatives for sale of yak products were highlighted.

(IPU 02-43, Uttara, VBN 4, VBN 5, ANU 11-29, LBG 645), cowpea (VBN 1, VBN 2), lentil (HUL 57, IPL 406, IPI 81, DPL 62) and pea (HUDP 15, Prakash) were distributed to farmers of Teetop Village, Car Nicobar. Planting material such as coconut, pineapple, elephant foot yam, banana, black pepper, clove and nutmeg were distributed to farmers of Car Nicobar. Planting materials such as tuberose bulbs, jasmine plants, black polythene mulching sheet (90 kg), suckers of Nendran variety of banana were distributed to farmers of Car Nicobar and Kamorta.

Livestock inputs namely goats, piglets, chicks, feed and medicines were distributed to the beneficiaries. Sprayer machines were distributed to the farmers of Campbell Bay, Great Nicobar. Cono weeder was distributed to the farmers of Campbell Bay, Great Nicobar.

Seeds of quality protein maize (QPM) and baby corn hybrids were also given to farmers of NEH regions.

Distributed planting materials such as coconut, arecanut, black pepper and cinnamon from CPCRI, Kahikutchi, for tribal farmers of NEH region. Distributed planting materials such as gerbera, banana and pine apple to the tribal farmers of NEH.

Besides, the institute also conducted training and distribution of inputs through three KVKs, established at South Andaman, N&M Andaman and at Nicobar districts. During the year, 62 training programmes were conducted wherein 1,484 farmers/stakeholders were benefitted. KVK also facilitated in distribution of 300 vegetable seed kits, 15 goats, 330 chicks, 35 pigs, 50 ice box, 7 deep freezer, 50 life jackets and 2 ring buoy to the Tribal farmers of Car Nicobar under TSP.

Demonstration and assets creation: Community based on-farm field demonstration of high yielding mungbean, urdbean and cowpea varieties were conducted at community village garden of Big Lapathy and Mus Village of Car Nicobar. Two units of goat sheds and three units of poultry sheds were established at Small Lapathy and Tamaloo village of Car Nicobar.

Adopting famers' yaks during winter to counter nutritional stress: The NRC on Yak under Tribal





Subplan (TSP) adopted 12 lactating yaks from the tribal farmers (*Brokpas*) to demonstrate the beneficial effects of complete feed blocks (CFB) on lactation yields and growth performances. The 112 days study under field condition during winter significantly improved the daily milk yields and prevented the loss in body weights of the lactating yaks.

Extension and Tribal Sub-Plan (TSP) activities: Brainstorming meet was held on “Functional value of camel milk as compared to different species—cow, buffalo, goat and sheep” at NRCC Bikaner followed by field activities of organization of health camp, training, front line demonstrations, and *Kisan Gosthies* in the areas of camel habitats in Jaisalmer district of Rajasthan.

Canal fisheries development in Bali Island, Sundarbans: Bali Island is vulnerable to climatic vagaries for livelihood support canal fisheries development was taken up. Advanced fingerlings of Indian major (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*) and minor (*Labeo bata*) carps were stocked in natural perennial canals. Field demonstrations on management and feeding of fishes were given to tribal fishermen and women. This activity in addition to livelihood support, ensures sustainability of canal fisheries and conservation of fish germplasm.

Crab fattening in Andhra Pradesh: Yanadi tribal families in village Sorlagondi, district Krishna, Andhra Pradesh were trained to undertake crab culture. Crab fattening cages were distributed and the tribals were able to grow crabs from a size of 300 g to 1 kg in three months. With sale of fattened crabs they generated additional income.

Organic farming system model for tribal areas: Promotion of organic farming in niche locations especially the low nutrient consuming tribal areas of the country offers great potential to enhance soil and crop productivity along with livelihood security for the people. A 0.43 ha organic farming system model was developed at Umiam for Meghalaya, which has

Trout farming in Leh for livelihood support

Trout farming programme was initiated in village Chushout Shamma, block Chushout, district Leh, Jammu and Kashmir located at 3,280 m above mean sea level. Initially five new raceways were constructed and three existing raceways were renovated. Seeds of rainbow trout were released in raceways and feed was provided. Women farmers are coming forward to undertake trout farming.



Trout raceway at village Chushout Shamma, Leh

low mean fertilizer consumption (18 kg of NPK/ha as against the national consumption of 144.35 kg/ha). The system comprised cereals (rice and maize), pulses and oilseeds (soybean, lentil and pea), vegetable crops (French bean, tomato, carrot, okra, brinjal, cabbage, potato, broccoli, cauliflower, chilli, coriander), fodder, fruits (Assam lemon and papaya), dairy cattle (1 cow + 1 calf) and a farm pond (0.04 ha with depth of 1.5 m for life saving irrigation and fisheries). Total net return of ₹ 58,321/year was realized, which is 5.7 times higher than existing system (rice-fallow + dairy (1 cow)) being practiced in the local areas. Crop components contributed 57% of net income, while dairy and fisheries contributed 22 and 21% respectively. The model is being up-scaled in Mynsain village in Ri-Bhoi district of Meghalaya under Tribal Sub-Programme. □