



## 15.

# 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 Institute, Port Blair and ICAR Research Complex for Goa) are engaged in area-specific research.

### NORTH-WEST HIMALAYAS

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

#### Seed production

Breeder seed (192.36 q) of 48 released varieties/inbreds (19 varieties and 6 inbreds of cereals, 4 of millets, 11 of pulses, 4 of oilseeds and 4 of vegetable crops) was produced. A total of 252.455 q breeder seed was supplied to different seed producing agencies to take up further multiplication. Around 18.75 q nucleus seed of 43 released varieties was also produced following standard methods to maintain genetic purity. In addition to this, 16.265 q Truthfully Labeled (TL) seed of 34 varieties (13 cereals, two of millets, 2 of pulses, 4 of oilseeds, 12 of vegetables and one each of buckwheat and amaranth) was produced to meet the demand of the institute extension activities. A total of 15.832 q TL seed was supplied.

Under farmer participatory seed production programme, 72.45 q TL seed of wheat (VL Gehun 907 and VL Gehun 892), lentil (VL Masoor 126) and garden pea (Vivek Matar 10) was produced, and 39.88 q was supplied from the seed procured.

#### Carbon sequestration with FYM application in mid Himalayas

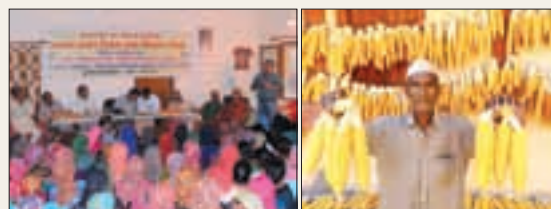
An experiment was conducted for six years with different levels of FYM and recommended NPK in gardenpea-French bean cropping system. There was 133 kg more CO<sub>2</sub> emission through fertilizer manufacture with application of recommended NPK fertilizer than soil C sequestration. The CO<sub>2</sub> emission for FYM preparation was very less than sequestration. Application of 5.04 tonnes FYM/ha was able to nullify the 62 kg CO<sub>2</sub> emitted during FYM preparation through soil C sequestration.

#### Vivek Maize Hybrid 45 – A stay green maize hybrid for the tribals of Jaunsar, Uttarakhand

Jaunsar tribal area in Uttarakhand comprising block Kalsi and Chakrata in the district of Dehradun is traditionally a maize growing area. Of the total 27,895 thousand hectare area under maize cultivation in Uttarakhand, the Dehradun district with a total area of 9,115 thousand hectare accounts for about 33 per cent of the total maize area in the state. Of this, about 45 per cent is located in the hill region of the district represented mainly by the tribal blocks of Kalsi and Chakrata. The contribution to maize production from the hill region, however, is only 30 per cent due to lower productivity (976 kg/ha) compared to the plains of the district (1,879 kg/ha). This productivity level is even below the average for the entire hill region of the State (1,187 kg/ha).

Training and FLDs of maize hybrids were organized in this area during *kharif* 2015 to enhance the production and productivity of maize.

Vivek Maize Hybrid 45, an early maturing (85-90 days) and high yielding (5-5.5 tonnes/ha) variety tolerant to *Turcicum* and *Maydis* leaf blight, was released by Central Variety Release Committee in 2013 for cultivation in Jammu & Kashmir, Himachal Pradesh and Uttarakhand. The plant height is 200-205 cm; long cylindrical cobs with good husk cover; grains are bold (average 1,000-grain weight, 335 g) yellow and semi-flint in texture. The 'stay-green trait' makes the plant suitable for use as green fodder after harvesting of the mature cobs.



According to the farmers, the yield of Vivek Maize Hybrid 45 was about double that of their local cultivar (this is corroborated by the preliminary assessment of the scientists as well) despite less than normal rainfall during the crop season. They also reported that damage due to high speed winds was also less in this hybrid. The 'stay-green' trait of the hybrid was particularly appreciated by the farmers.

Hence, application of more than 5.04 tonnes FYM/ha provided net positive C sequestration. The highest net positive C sequestration (1,585 kg CO<sub>2</sub>/ha) and the highest C sequestration (1,792 kg CO<sub>2</sub>/ha) could be achieved by application of 16.6 and 17.1 tonnes FYM/ha, respectively. The highest net positive C sequestering FYM application rate provided 1,443 kg CO<sub>2</sub>/ha higher C sequestration than recommended NPK. It also provided



48% higher pod yield of gardenpea-French bean cropping system than recommended NPK.

## EASTERN HIMALAYAS

**Maize production in *jhum* condition:** ICAR Research Complex for NEH Region, Umiam, Meghalaya in a participatory production technology development to identify efficient varieties and improved agronomic management practices (IAMP) for maize production in *jhum* condition, evaluated nine varieties (Hemant, Vijay Composite, DA 61A, RCM 1-1, RCM 1-3, RCM 75 and RCM 76, SaruTangring, SaruBhoi) and compared with farmers' practice at *jhum* field of Sonidan Village of Meghalaya.



Activities in *jhum* farm

Grain yield (3.22 tonnes/ha) and all other parameters were significantly higher in IAMP compared to farmer's practice (grain yield 1.96 tonnes/ha). DA 61 A (3.78 tonnes/ha) and RCM 75 (3.67 tonnes/ha) performed better over other varieties.

**Maize and French bean under organic farming:** Eleven varieties of maize and 10 varieties of French bean were screened under organic farming in NEH Region. In maize, green cob yield was highest in RCM 1-3 (6.40 tonnes/ha) followed by RCM 75 (6.03 tonnes/ha) and DA 61-A (5.95 tonnes/ha). On the other hand, seed yield was recorded maximum in DA 61-A (3.61 tonnes/ha) followed by RCM 75 (3.29 tonnes/ha) which was closely followed by Vijay Composite (3.26 tonnes/ha).

In French bean, highest green pod yield was recorded in Naga local (4.36 tonnes/ha) followed by RCM-FB-18 (4.11 tonnes/ha) and RCM-FB-19 (3.93 tonnes/ha). Seed yield also showed similar trend as in green pod which had recorded highest in Naga local (2.40 tonnes/ha) and lowest in Maram (0.41 tonne/ha).



Cobs of different varieties of maize under organic farming

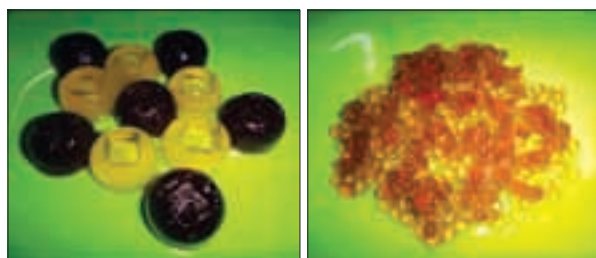


Seed of different varieties of French bean under organic farming

**Ramie cultivation in Garo Hills:** Under *Jhum* improvement programme Ramie (*Boehmeria nivea*) crop was introduced in Garo Hills. Ramie was planted in collaboration with DAO, West Garo Hills in 8 ha area benefitting 57 farmers. Three Ramie Growers Associations were formed. Seeing the growth of the plants and interest of beneficiaries, Meghalaya Government initiated 'Ramie Mission' with an outlay of ₹ 40 crore targeting 2,000 ha area.

### Value-addition

Four different new generation value-added products were developed from Manipuri black cherry (*Prunus nepalensis*), passion fruit and pineapple. Passion fruit juice was converted to a semi-solid gel and shaped into small balls using silicon mould. In pineapple, the juice was converted to soft gel and the product can be used as



Value added products from passion fruit and *Prunus nepalensis*



### Vatieties released and notified

Variety	Adaptation region/ agro-ecology	Yield (tonnes/ha)	Duration	Salient features
Vivek Maize Hybrid 47	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Asom, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim	6.686	90-95 days in hills, 85-90 days in plains	An early duration, high yielding single cross hybrid, which is moderately resistant to <i>Turcicum</i> leaf blight, <i>Maydis</i> leaf blight and common rust, and resistant to brown stripe downy mildew and post flowering stalk rot.
Vivek Maize Hybrid 51	Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	5.084	85-90 days in hills, 80-85 days in plains	An extra early duration, high yielding single cross maize hybrid, moderately resistant to post flowering stalk rot, Rajasthan downy mildew and <i>Chilo partellus</i> .
Vivek Maize Hybrid 53	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Asom, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim	6.638	85-90 days in hills, 80-85 days in plains	An extra early duration, high yielding single cross hybrid, moderately resistant to <i>Turcicum</i> leaf blight, <i>Maydis</i> leaf blight and common rust, brown stripe downy mildew and post flowering stalk rot.
VL Dhan 157	Lower hills of Meghalaya and medium elevated hills of Uttarakhand under direct seeded, rainfed upland June sown condition	2.336 and 1.822 in lower and medium hills, respectively	100-110 days	This variety is developed from cross VR 9588/A-57. It has light yellow, short bold grain, plant height of 95-105 cm; and is resistant to leaf and neck blast.
VL Dhan 68	Irrigated transplanted conditions in medium hills of Uttarakhand and Meghalaya	4.947	125-130 days	VL Dhan 68 is derived from the cross VL 3861/ SR 1818BF-4B-1-2-1-2. It has long bold grain, 110-120 cm plant height; and is resistant to leaf and neck blast.
VL Mandua 352	All finger millet growing states except Tamil Nadu and Maharashtra	2.541	<100 days	It is an early duration, high yielding variety, which is moderately resistant to finger and neck blast and is suitable for those areas where monsoon gets delayed or intermittent drought occurs, hills or areas where crop growth period is limited.



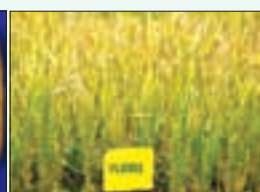
Vivek Maize Hybrid 47



Vivek Maize Hybrid 51



Vivek Maize Hybrid 53



VL Dhan 157



VL Dhan 68



VL Mandua 352

sweet or soft candy. All the products can be served instantly, kept in a refrigerator or packed in food grade polyethylene pouch.

**Nutrient and antioxidant diversity among the land races of common bean:** Pole-type common bean (*Phaseolus vulgaris*) landraces (23), which were consumed locally as seeds and pods, were collected from different districts of Lushai hills in Mizoram. Seeds were multiplied and evaluated for nutrient and antioxidant

diversity. A significant diversity was found for seed, N, P, K, Cu, Zn, Mn, Fe, ash content, total phenol, diphenyl-2-picrylhydrazyl (DPPH) and azinobisethylbenzothiazoline-6-sulphonic acid (ABTS) radical scavenging activity. Principle component analysis (PCA) resulted in patterns of variation by taking all the nutrient variables together. The first four PCs accounted for 74% of the total variation. PC1 (26%) and PC2 (21%) showed the highest variability among all the PCs. Landraces





MZFB-47, MZFB-41, MZFB-83, MZFB-116, MZFB-52, MZFB-28, MZFB-116 and MZFB-85 were the most promising ones with highest N, P, K, Cu, Zn, Mn, Fe and ash content while, total phenol, DPPH and ABTS radical scavenging activity were found maximum in MZFB-97.

**Year round vegetable cultivation:** The production technology of 14 high value vegetables, viz. broccoli, cauliflower, cabbage, coriander, lettuce, fenugreek, spinach, raya sag, pakchoi, garlic, pea, beet root, carrot, and radish were standardized under low cost plastic tunnels. All the 14 vegetables grew successfully year round in various cropping sequences and has shown significant increase in earliness with higher production and productivity. This combination of earliness and higher yield can significantly increase profit for the growers. The tunnels also protect plants from unfavorable abiotic and biotic stresses like high rainfall, hail, low temperature, frost, wind, insect-pests, etc. Plastic low tunnels are less expensive as compared to the plastic greenhouses, however, bed preparation, planting and harvesting need more effort under the tunnels.



Production of year round vegetable under low cost plastic tunnels

**Rice-fish-pig-tuber crop based farming system:** The ICAR Research Complex for NEH Region, Tripura Centre demonstrated rice-fish-pig-tuber crop based IFS on eight house hold. The whole system having an area of 0.736 ha requires a total cost of production of ₹ 45,000 during a year and provides the net income of ₹ 124,800 under rainfed situation. Therefore, this was the most suitable farming system model for marginal farmers of Tripura under rainfed ecology.

**Fish seed production and distribution:** During the period, 5 lakh fingerlings were produced of which 295,000 fingerlings were distributed to 285 tribal farmers of West Tripura and Khowai district under farmers income improvement programme organized by ICAR, Tripura Centre. The farmers were demonstrated with the practices of scientific fish culture such as regular feeding, fertilization, manuring, plankton checking, water and soil quality monitoring, harvesting, etc.

**Establishment of hygienic meat processing unit and preparation of added products:** The small scale modern hygienic meat processing unit includes raw

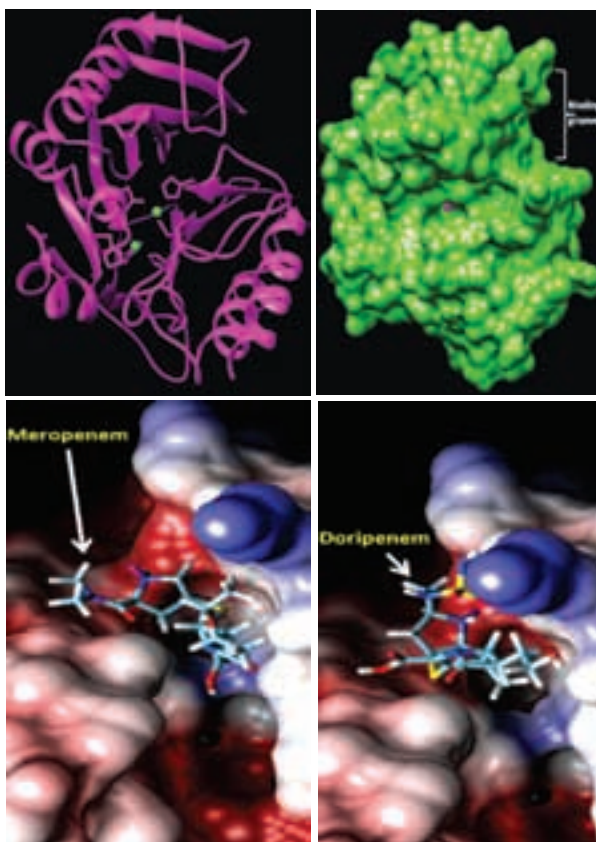


Various packagings for meat and value added meat products

meat area, processing area, cold storage facilities, laboratory and equipment like portioning machine, meat slicer, meat mincer, planetary mixer, sausage filling machine, deep-fridge, ice flaking machine and vacuum packaging machine. The consumer preference was highest for plastic tray packing, followed by vacuum packing. The shelf-life was better in vacuum packing as compared to others.

Different value added products like pork sausage, pork nugget, pork breakfast nugget, pork pickle and chicken products like sausage and nugget blending with traditional herbs and bamboo shoots were prepared and attracted revenue to the institute. These products were exhibited in different agri-fairs for popularization.

**Molecular modeling of New Delhi metallo- $\beta$  lactamase-5 of bovine origin:** Present study was undertaken to investigate the structural basis for increased resistance of NDM-5 with a molecular



*In silico* modeling and docking characteristics of NDM-5. (a) NDM-5 monomer (magenta) attached with Zinc ions (green); (b) NDM-5 surface properties; (c) Meropenem and (d) Doripenem docked to NDM-5.



modelling and docking approach. Full length of the *bla<sub>NDM</sub>* gene was sequenced (Acc No. KC769583.2) and 3D model was computed. Results indicated 2 substitutions (Val88Leu and Met154Leu) compared to NDM-1. Modelling experiment generated a reliable model with zinc ions coordinated in trigonal bipyramid geometry. Carbapenem drugs (doripenem and meropenem) interacted within the largest cleft. Results provided possible explanation for wide range of antibiotics catalyzed by NDM-5 and likely interaction modes for 2 carbapenem drugs.

## ISLAND AND COASTAL REGION

### Germplasm and Crop Improvement

Twelve varieties of crops, viz. two each in rice (CIARI Dhan 8 and 9) and amaranthus (CIARI Lal Marsha and CIARI Shan), one poi (CIARI Poi Red), three mung (CIARI Mung 1,2 and 3) and four in noni (CIARI Sanjivini, CIARI Rakshak, CIARI Sampada and CIARI Samridhi) were developed and released by the Variety Release Committee of the Institute for the benefit of the farmers.

Germplasm (57), viz. French marigold (2), African marigold (7), *Jasminum sambac* (1), Tania (1), sweet potato (1), alacasia (1), *Casuarina equisetifolia* seeds (11), *Calophyllum inophyllum* (1), *Calophyllum soulattri* (1), *Aphanomixis polystachya* (1), papaya (4), banana (2), coconut (13), *Cinnamomum* (3), *Calophyllum inophyllum* (12) and one each of Korangi, Crossandra, *Casuarina equisetifolia*, *Bixa orellana*, *Sesbania grandiflora* and *Lucaena leucocephala* were collected from different parts of Andaman and Nicobar Islands.

Tomato variety Ayush gave 18 tonnes/ha followed by Arka Vikash (12 tonnes/ha), Arka Rakshak (11 tonnes/ha) and Arka Samrat (10 tonnes/ha); chilli variety 2011/CHIVAR-8 gave 8.1 tonnes/ha followed by 2012/CHIVAR-5 (7.6 tonnes/ha) and 2013/CHIVAR-4 (7.4 tonnes/ha). Brinjal variety Arka Nidhi gave 19.2 tonnes/ha followed by 2013/BRLVAR-5 (16.5 tonnes/ha) and 2013 BRLVAR-4 (15.0 tonnes/ha) and ridge gourd variety Arka Sujat gave 95.0 q/ha and Rama (90.0 q/ha) and 2012/RGVAR-3 (85.4 q/ha), respectively. All these varieties were quite promising.

Sweet potato leaf beetle pest was observed for the first time and the incidence and damage is very severe. Two species of Hadda beetles, severely damaged cucurbits and brinjal. Chrysomelid pest of cole crops, *Phyllotreta* spp. was observed for the first time. One unidentified Cerambycid pest of fruit trees was also collected. Besides, one new species of rat, *Rattus norvegicus* was observed as a pest of paddy.

Kalmegh supplementation in feed @ 3 g/bird/day reduced the serum cholesterol by 15%.

Inter-se mating and selfing was done in coconut at World Coconut Germplasm Collection, Sippighat farm and 1,811 female flowers were pollinated.

Successful captive breeding of sebae anemone fish,

*Amphiprion sebae*, skunk anemone fish, *Amphiprion akallopisos*, red saddle anemone fish, *Amphiprion ephippium* was achieved for the first time in Andaman and Nicobar Islands.

Altogether, 72 species of true mangroves and mangrove associates distributed among 37 families and 68 genera were reported from the identified contiguous patches.

Nicobari pigs were successfully reared and bred under intensive system. Six piglets successfully weaned after two months without any piglet mortality.

*Pemphis acidula* (Lythraceae) was rediscovered after a lapse of 91 years from Andaman and Nicobar Islands. Further, *Rhizophora* (Rhizophoraceae) hybrids were reported for the first time from Hut Bay (Little Andaman).

### First record of shovel nosed lobster, *Thenus unimaculatus* from Andaman and Nicobar Islands:

Of the 30 species of lobsters belonging to 5 families occurring in India, 11 species belonging to three families (Palinuridae, Scyllaridae and Nephropidae) were reported from Andaman and Nicobar Islands. Shovel nosed lobsters are one of the components in multiday demersal trawlers operating in Andaman and Nicobar Islands. The only species of shovel nosed lobster belonging to family Scyllaridae reported from the islands till date is *Thenus orientalis* (Shanmughan and Kathirvel 1983). Fisheries Division of ICAR-CIARI submitted 5 nucleotide sequences of *Thenus unimaculatus* from Andaman and Nicobar Islands in NCBI GenBank, USA and accession numbers (KT362350, KT362351, KT362352, KT362353, KT362354) were provided by NCBI GenBank, USA.



*Thenus unimaculatus* with typical purple spots on pereopods and carapace

**Rice land race Aath Number Dhan released:** Less management requirement, resilience to biotic and abiotic stresses, good source of fodder due to high plant stature and late maturity synchronizing with onset of dry season to facilitate hassle free harvesting enables C14-8 (*Aath Number Dhan*) to be quite popular in Andaman and Nicobar Islands. About 40% of the total rice area in these islands is occupied by this popular variety but it is marred





by less grain yield (2.7 tonnes/ha) and intra-varietal admixture. A pure line selection program was started leading to the purification and development of high yielding strains CIARI Dhan 8 (IET 25010) and CIARI Dhan 9 (IET 25019). Both of these varieties give about 20-25% higher yield compared to the parental population.

**High yielding strains of indigenous mungbean land races:** Collection, characterization, purification and evaluation of local germplasm resulted in the identification of pure and stabilized varieties of mungbean, which have also out-yielded National check varieties. Three varieties CIARI Mung 1, CIARI Mung 2 and CIARI Mung 3 were released by Institute Variety Release Committee, ICAR-CIARI.



CIARI Mung 1 (top), CIARI Mung 3 (bottom)

**Captive breeding of skunk clownfish:** Marine ornamental fish *Amphiprion akallopisos* (skunk clownfish) was successfully bred in the Islands. Mature brooders were collected by scuba diving from North Bay, Port Blair along with their associated anemone *Heteractis*



One month old juveniles of *A. akallopisos*

*magnifica*. They were introduced into the broodstock maintenance facility after proper quarantine and were fed with squid meat and shrimp meat at morning and evening hours. The fecundity was around 550-600 number of eggs and larval survival was 40%. Attempts are being further undertaken to breed these marine ornamental fishes in low salinity waters, so as to utilize the *Tsunami* affected areas of Andaman and Nicobar Islands for developing marine ornamental fish hatchery and to transfer the technology to unemployed youth. ICAR-CIARI is also planning to ranch the seeds of *Amphiprion akallopisos* in the wild for augmenting the population of this marine ornamental fish.

**Hepatoprotective and hypocholesteric effect of Kalmegh in Nicobari fowl:** Enrichment of poultry egg with *Andrographis paniculata* (kalmegh) was studied for enhancing the immunity and lowering the cholesterol content in the Nicobari fowl. Breeding Nicobari fowls fed dried Kalmegh powder had significantly lower cholesterol. The SGOT significantly lowered in birds fed with kalmegh powder in water as well as through feed. The serum bilirubin level was significantly reduced on fifth and seventh day of supplementation in both water and feed as compared to control group. The level of iron, copper and zinc was significantly higher with supplementation of *Andrographis paniculata* extract as compared to control. *Andrographis paniculata* showed hepatoprotective and hypocholesterlemic effect in Nicobari fowl. The circulation of andrographolide in the serum after feeding of *A. paniculata* in Nicobari fowl clearly indicated that it is getting deposited in the developing yolk.

**Immunomodulatory effect of noni and kalmegh on Nicobari fowl:** Supplementation of 10 ml Noni + 200 mg Kalmegh significantly increased TLR 4 gene expression. The increased TLR 3, TLR 4 and TLR 5 gene expression and decreased TLR 7 gene expression in gut associated caecal tonsil in chickens fed dietary noni and kalmegh indicated that combination of herbal extracts have better immunomodulatory properties.

In conclusion, the selectively increased level of TLR 3, TLR 4 and TLR 5 and decreased TLR 7 gene expression indicated that supplementing noni and kalmegh induces antiviral and antibacterial responses in chicken.

#### Rural poultry farming for empowerment of women

Smt. Bichithra Biswas, a resident of Ferrargunj, South Andaman, is a landless housewife. She was one of the adopted farm women by ICAR-CIARI to empower them on improved rural poultry farming with Nicobari fowl. She did training on improved poultry technologies. ICAR-CIARI supported her to establish rural poultry farming by constructing elevated poultry shelter with 25 Nicobari fowls (20 female and 5 male). She started preparing her own poultry feed ration using locally available rice, wheat, dry fish and coconut as per the specification given by scientists of ICAR-CIARI. She devised the feeder using wooden material, bamboo and used plastic cans, bottles and waste plates for making

## Success stories

### Organic nutritious kitchen gardening at Car Nicobar

Per day consumption of vegetables in Car Nicobar is far short of the requirement and availability depends on other islands as the people of Car Nicobar purchase vegetables, which grow in Andaman by using imbalance chemical fertilizers and heavy pesticides. During shipment, vegetables loose nutritional quality and palatability due to lack of refrigerated transportation facilities.

KVK-CIARI, Nicobar, since 2011, has conducted 13 trainings in the field of scientific vegetables and fruits cultivation for establishment of organic nutritious kitchen gardens for nutritional food security. A total 325 farmers and rural youths including 224 males and 101 females got benefitted. In the year 2012, KVK, Nicobar adopted traditional farmer Shri. Petrik of Car Nicobar to establish organic nutritious kitchen garden. The entire programme gave emphasis on practical skill and knowledge development to start scientific vegetable cultivation with full confidence.



waterer. She vaccinated birds herself after learning the technique of vaccination in poultry. By adopting the scientific management of rural poultry instead of backyard farming, she could be able to get 910 eggs in 9 months duration from 15 numbers of hens only. She was empowered to meet out the ICMR recommendations of egg consumption of 180 eggs/year/person for her whole family. In addition, she was able to earn ₹ 3,700 by selling eggs. She is presently running the rural poultry farm successfully being motivating and inspiring factor to other women folks for being empowered to strengthen the nutritional requirement of the family through improved rural poultry farming practices with Nicobari fowl. More and more farmers are coming to CIARI to adopt the same.



### Horizontal spread of HYVs of rice at North Andaman

A total of seven (7) promising rice varieties identified by CIARI in 2010, were introduced through front line demonstration by Out Reach Centre of CIARI supported by NABARD, in participatory mode to a total of 313 farmers covering 70.18 ha till 2014 (Five years).

To assess the adoption of rice varieties, PRA was conducted in December, 2014 at Diglipur, North and

Middle Andaman, and it was found that a total of 2,620 farmers have adopted the HYV's varieties of rice in the total area of 1,219.64 ha spread over 32 cluster of villages at North Andaman compared to 313 farmers covering 70.18 ha. Among the total area adopted, rice variety Gayatri shared 713.53 ha of area followed by CARI Dhan 5 (146.17 ha), CSR 36(132.14 ha), CARI Dhan 4 (90.71 ha), CARI Dhan 3(60.63 ha) and Ranjit (20.68 ha), respectively. This indicates good adoption rate and horizontal spread of the varieties, which was only possible due to FLD, availability of improved varieties and quality seeds produced through seed village concept, which led to replacement of farmer varieties over the period. There is good potential for increasing the production and the productivity by adopting CIARI recommended rice varieties by the farmers in the coming years.

### Pekin duck under backyard in North Andaman

Pekin duck a demand driven technology for small farmers introduced in July 2010 by ORC of CIARI to a single farmer, could spread to 63 farmers with 3-5 ducklings in the backyard totalling to 388 numbers, spread over 15 villages by 2014. The farmer, could earn ₹ 16/egg by selling eggs, ₹ 400-450 from adults and ₹ 50-55 for ducklings, compared to desi adult duck which were sold for ₹ 200, ducklings at ₹ 10 and eggs @ ₹ 5 to 7/egg, respectively. The duck would grow to average weight of 2.637 kg with low level of mortality, compared to desi, i.e. 1.975 kg of weight with high mortality rate. Pekin duck under backyard with a unit size of 3 birds could give a net return of ₹ 4,350 against the desi birds (₹ 1,140) thus giving an additional income of ₹ 3,210. Pekin duck eggs (2013 to 14) were provided to fifteen cluster of villages by a single farmer Shri E D Menon of Keralapuram, Diglipur, North and Middle Andaman, and earn ₹ 13,215 as an additional income, which is a remarkable beginning of a credible technology of the Institute.



Pekin duck white



Shri. E.D. Menon the change agent

### Production of seeds and planting material

Production of quality planting materials of coconut and arecanut (3,102), black pepper rooted cuttings (6,100), elephant foot yam (1.5 tonnes), 4.6 tonnes of truthfully labelled seeds of rice and ginger (250 kg) was achieved. Besides 29,900 fish fry of Indian major carps were produced and distributed to fish farmers of Port Blair and Hut bay. During this season 1.9 lakh spawn of Indian major carps (IMC) of rohu (*Labeo rohita*) and 1.1





lakh spawn of catla (*Catla catla*) were produced and stocked in nursery tanks for successive rearing.

### Tribal Sub-Plan (TSP) Programme

**Establishment of vaccine bank under TSP:** In Nagaland, a vaccine bank for maintaining cold chain and supply of different vaccines for livestock and poultry, free of cost to the beneficiaries directly or through the KVKs and State Department was set up under Tribal Sub-Plan. During the reporting year 4,000 doses of swine fever, 20,000 doses of FDRD (F strain), 6,600 doses of FDRD (R<sub>2</sub>B strain), 200 doses of goat pox vaccines were distributed to the KVKs, farmers, NGOs of Dimapur, Kohima, Wokha, Phek, Peren, Mokokchung, Zunheboto and Longleng districts of Nagaland.

**Water transfer through gravity fed HDPE pipe line:** In participatory mode under Tribal Sub-Plan (TSP) project of ICAR, water resource is developed through water transfer in Hattal and Sainj villages (*jaunsar* tribal region) in Dehradun, Uttarakhand where water is being transferred from surplus watershed to deficit watershed in a cost effective manner and on a sustained basis. It was done by laying gravity fed HDPE pipe lines of 6.0 km in Hattal and 5.6 km in Sainj through difficult hilly terrain to harvest and transport water from perennial springs. In both villages, farmers are organized in terms of User Groups (9 in Hattal and 6 in Sainj) and Fruit and Vegetable Grower Association.

Agri-horticulture system (12 ha) was introduced as low water requiring alternative land use system in Hattal village. Developed water resources are being properly managed by village level institution, i.e. Farmers' Associations created in these villages with effective local leadership. Presently, 670 m<sup>3</sup> water is available to the



Rainwater harvesting tanks of 21,000 liters capacity at Bernia watershed (Dungarpur)

farmers in 24 hr in these two villages. As a result, farmers in Hattal and Sainj are now cultivating off-season vegetables in about 30 ha area.

**Training programme for farmers of Lahual Spiti, Himachal Pradesh:** A farmers' training programme under TSP was organized. The training emphasized on role of agroforestry in providing livelihood support and income generation in the cold desert area of Himachal Pradesh and utilization of different species of the trees and resistant clones of willow to solve the problem of willow mortality in the area.

**Integrated watershed development with the help of tribal community:** In Bernia watershed, Rajasthan, 100 farmers were selected for demonstration of improved *kharif* crop production practices under TSP project. Seeds (paddy-Pusa Sugandha and urd-IPU 94-1 in *kharif* and wheat-Raj 4037 and gram-RSG-888 for *rabi*), horticultural plants of mango (Mallika), DAP, urea and NPS were the inputs distributed to farmers. For capacity building of the farmers, a 3-day training course was organized. For solving the problem of drinking water in the project area, three rainwater harvesting tanks of 21,000 litres capacity were constructed at selected locations. Soil samples were collected from different locations to prepare soil health cards.

**Effect of elevated temperature on soil carbon sequestration, microbial biomass and enzymatic activities:** Soils from variable land use under 3 soil orders (Entisols, Inceptisols and Alfisols) were collected and samples were incubated in BOD incubator at different temperatures for one month. As compared to the samples incubated at ambient temperature, the 39°C treated samples showed higher labile carbon, at 42°C the same decreased again. Total organic carbon content decreased during that time and the lowest was recorded at 42°C. This suggested that the decomposition of resistant soil organic matter is more temperature sensitive than labile organic matter. The exposure of soil samples at 42°C showed both decrease in TOC and LC, which may be due to release of C as CO<sub>2</sub> at that temperature. Dehydrogenase activity increased with increasing temperature up to 39°C. It slightly decreased at 42°C, but the effect was at par with 39°C. Phospho-mono esterase (acid) activity is reduced at increased temperature.

### Increasing apple production with pollinators in tribal district of Kinnaur

Poor fruit set on account of scant pollinating agents is a major constraint in successful production of world famous apple in Kinnaur district of Himachal Pradesh. Farmers from Village Telangi were trained under Tribal Sub Plan Programme on beekeeping. Subsequently the 40 ha area of the village was mapped by GPS to facilitate placement of honeybee boxes evenly to achieve optimum pollination activity. To augment pollination efficiency 60 beehive boxes of *Aphis*



Organised pollination in apple improved productivity as well as farmer's income due to honey production

*mellifera*, pollination activity was monitored. Colonies were monitored and maintained ensuring proper hygiene and nutrition. The intervention resulted in enhancement of apple yield (20%) during the season. Additionally 2.1 q of pure white organic honey was extracted from the bee hives with a net return of ₹55,000.

