



3. Research for Tribal and Hill Regions

The Indian Council of Agricultural Research (ICAR) through the Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, the ICAR Research Complex for North-Eastern Hills Region, Umiam, Meghalaya and the Central Agricultural Research Institute (CARI), Port Blair, evolve 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, sericulture, horticulture, animal husbandry, poultry and fisheries.

VIVEKANANDA PARVATIYA KRISHI ANUSANDHAN SANSTHAN, ALMORA

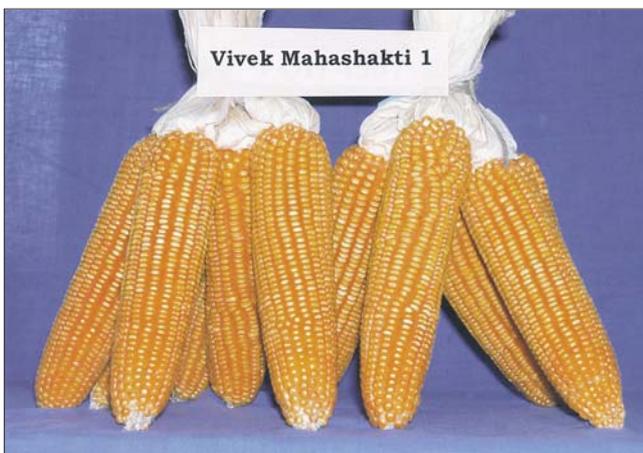
Released new varieties

During the reported year, 9 varieties of different crops were released for Uttarakhand, Himachal Pradesh, Jammu and Kashmir, and North-eastern hills.

First extra-early yellow quality protein maize hybrid 'FQH 4567' (Vivek Mahashakti 1) identified

The extra-early, yellow, quality protein maize (QPM) single cross hybrid FQH 4567 was identified by Varietal Identification Committee. It is the first extra-early quality protein maize single

First extra early QPM hybrid



- Released nine varieties of different crops for cultivation
- Developed first extra-early yellow quality protein maize single cross hybrid in country through marker-assisted selection
- Registered two land races—one each of wheat and soybean

SUCCESS STORY

Water resource development and protected cultivation in Bhagartola village

Development of water resource by harvesting surface runoff and perennial hill streams in LDPE lined poly-tanks and protected cultivation of off-season vegetables utilizing the harvested water have helped in transforming the hill economy of Bhagartola village, located around 60 km away from District HQ Almora (Uttarakhand State). In this village, 20 low-cost poly-tanks and 22 low-cost poly-houses were



Protected cultivation under polyhouses at Bhagartola village

constructed with full partnership of farmers. Cultivation of off-season vegetables (tomato, capsicum, cauliflower, french bean, vegetable pea, summer squash) utilizing the water harvested in these poly-tanks resulted in net return of Rs 10,000 to 12,000 per year from each poly-house of 100 m² size.



New varieties released

Variety (yield, tonnes/ha)	Adaptation region/ Agro-ecology	Duration	Other salient features
'VL Dhan 85' (4.0–4.5)	Irrigated valley and hilly areas of Uttarakhand	Early maturing (118–120 days)	Resistant to leaf blast, neck blast, brown leaf spot and tolerant to leaf scald, leaf folder and stem-borer
'VL Dhan 207' (2.0–2.4)	Rainfed upland areas of Uttarakhand for direct seeded condition	Medium maturity (160–165 days)	Spring-sown variety, resistant to stem-borer and leaf-folder
'VL Dhan 208' (2.0–2.5)	Spring-sown rainfed upland conditions in Uttarakhand	Medium maturity (160–165 days)	It is resistant to stem-borer and leaf-folder, major insects of the area. It outyielded checks Majhera 7 and VL Dhan 206
'VL Gahat 8' (1.2–1.4)	Timely sown conditions of Uttarakhand	Medium maturity (120–125 days)	Shows significant yield superiority of 24.89% to check VL Gahat 1 and higher degree of resistance to anthracnose disease and stem-borer
'VL Matar 42' (1.2–1.4)	Timely sown conditions of Uttarakhand	Full season maturity (146–155 days)	It (25.8%) has higher protein content than VL Matar 1 and shows higher degree of resistance against pea rust and powdery mildew
'VL Mandua 324' (2.0–2.1)	Mid-hills, rainfed conditions of Uttarakhand	Medium maturity (100–105 days)	It has 20.43% higher fodder yield than check VL Ragi 146. Finger and neck blast incidence is less in this variety than resistant check VL Mandua 149
'VL Chua 44' (1.3–1.4)	Uttarakhand hills	Short-duration maturity (90–120 days)	It has 14.1% protein and 12.2% oil content and is easily threshable. Matures in 116 days thereby escapes from the leaf web infestation
'VL Masoor 125' (1.6–1.7)	Timely sown rainfed conditions of Uttarakhand hills	Medium maturity (140–160 days)	Small black-seeded variety and resistant to wilt
'VL Masoor 507' (1.0–1.2)	Timely sown rainfed conditions of hills of Uttarakhand, Himachal Pradesh, Jammu and Kashmir and north-east hills	Full season maturity (140–209 days)	Bold, brown seeded variety exhibits high degree of resistance to wilt



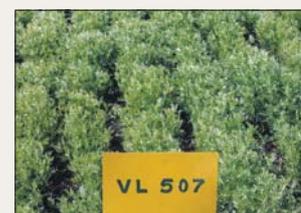
Field pea variety VL Matar 42 having good looking quality



Medium-maturing variety VL Mandua 324 of finger millet



Amaranth variety VL Chua 44 possesses tolerance to viral disease mosaic



VL Masoor 507, shows high degree of resistance to wilt

cross hybrid developed in the country through marker assisted selection. It is the quality protein maize version of the Vivek Maize Hybrid 9. It possesses 40.7% higher tryptophan than Vivek Maize Hybrid 9. This quality protein maize hybrid was identified for release in zone-I (average yield: 6,118 kg/ha) and zone-IV (average yield: 3,531 kg/ha).

Registration of 2 Land Races

'Tank' - A long awned local land race of wheat not preferred by monkeys (INGR No. 06006; IC 398287)

A local land race 'Tank' was collected from village Godiadhar, Block Kapkot, District Bageshwar, Uttarakhand (30° 00'N,



SUCCESS STORY

Adoption of micro-irrigation system (MIS) in Darim village

Lack of efficient irrigation system is a major hindrance to increase the productivity of hill agriculture. The lift irrigation system demands high investment in the hills, where lift varies between 40 and 80 m. This high cost makes the agriculture in the hills a risky proposition. The frontier technologies like micro-irrigation system (MIS) not only helps in utilizing water efficiently (90–95%) but also minimizes the other problems associated with the flood irrigation system. Such advanced irrigation technique was explicitly installed in 0.64 ha in Darim village of Naini Tal District with farmers' contribution. The farmers' contribution was 47% of total MIS set up cost. The perennial stream (18 litres/min) passes at 1.5 km distance from



LDPE-lined tank (280 m³ size) constructed at Darim village for micro-irrigation system

the field was harvested to the 2 separate LDPE film-lined-tank, gross capacity 280 m³ and 160 m³ respectively. The micro-irrigation system was attached to these tanks separately such that gravity pressure was obtained. The irrigation system was used to provide irrigation to the garden pea. The water-use efficiency of the irrigation system was increased by 69% over the flood irrigation. The saving in the irrigation system was 41.1%. The B : C ratio was 2.62 when only tangible benefits were taken into account. The system was found functionally and economically feasible in the hilly region of north-west Himalaya. Consequent upon the successful operation of the system, several enquiries from the farmers were received. Therefore, additional 20 LDPE tanks were constructed in the village to put another 6 ha land under irrigation. Thus 50% area of the village (total arable land 12 ha) was under irrigation after technology intervention from 5% area. The gravity based MIS technology has vast scope in enhancing water productivity in irrigated hill agriculture.

79° 52' E, 1,270 m amsl). It is exclusively being grown as border rows in wheat fields in this area to save the main wheat crop from monkey damage. This land race has long awns and small grains and due to this, monkeys do not damage wheat field under the impression that whole field is sown with the small-seeded land race 'Tank'. 'Tank' is tall wheat (140-145 cm) with long and thin peduncle (52.7 cm) compared to 35.5 cm of 'VL 829'. Its spikes are small with long awns (7.03 cm), brown glumes, seed is red with intermediate plumpness, small (100 seed weight=3.17) with narrow grain width (2.74 mm) compared to 3.45 mm of 'VL 829'. It has long maturity duration of 200–210 days.

SUCCESS STORY

Management of white grub beetles through light traps

White grubs are the cosmopolitan insect pests of agriculture, forest and pasture lands. The pest causes severe economic loss in upland paddy, finger millet, barnyard millet, maize, potato and many other vegetables, fruits and fodder crops in the hills of north-western Himalayan region, where nearly 40 species of this phytophagous pest were recorded. The beetles emerge from soil from May to October. To combat the problem, VPKAS, Almora, designed a user-friendly low cost (Rs 570), light trap for efficient mass trapping of beetles, to reduce the population of white grubs in soil. Deployment of 61 light traps in different villages of Almora district on community basis led to trapping of beetles 114,000 in



Light trap at farmer's field

Darima, 67,900 in Chausali, 46,600 in Tipola-Tunakot, 88,900 in Daulaghat-Govindpur, 76,100 in Manan and 31,400 in Bhagartola village from June to September 2006. These light traps have become popular amongst the farmers of this region, as a result of which 250 units of the trap were sold to the farmers and other agencies.

VLS 59 - A soybean line

A soybean line (INGR No. 06015; IC 471839) registered for low linolenic acid (3.96%) that improves oxidative stability of soybean oil and hence has high commercial value.

ICAR RESEARCH COMPLEX FOR NEH REGION, UMIAN

Preparation of climatic atlas and Productivity Zoning

A detailed digitized climatic atlas covering all growing seasons was prepared for Meghalaya. Productivity zoning of three categories

- Prepared digitized climatic atlas of all growing seasons for Meghalaya
- Developed a genotype-independent multiple shoot induction protocol for pigeonpea
- Evolved raised and sunken bed technology for increasing cropping intensity using marshy land
- Developed seed drill for high slope condition
- Developed protocol for sex diagnosis of ducks and duck embryos through multiplex method
- Achieved captive breeding of chocolate mahaseer



of rice was also completed. The 'Cumulative Total Method' indicated suitability of climate and soil conditions for rice cultivation in four districts of the state.

Plant regeneration and transformation protocol for pigeonpea

A genotype-independent multiple shoot induction protocol for pigeonpea was developed. The protocol can be successfully combined with *Agrobacterium*-mediated and biolistic transformation protocols for transfer of new genes. Transformation with marker gene using the protocol resulted in transformed shoot buds. A protocol for plant regeneration from petioles of mature leaves was also developed.

Identification and multiplication of suitable Kiwi fruit variety

Kiwi variety Abbott was found suitable for agroclimatic conditions of Sikkim and Arunachal Pradesh. Three varieties were successfully propagated through semi-hard wood cutting with the use of indolebutyric acid (IBA) @ 5,000 ppm and rooting success was 68.2%.

Development of raised and sunken bed technology for increasing cropping intensity using marshy lands

Through research on utilization of marshy land, raised and sunken bed technology at the ratio of 1:4 ratio was found suitable for both rice- and maize-based cropping systems, giving rice and maize-equivalent yield of 35.94 tonnes/ha and 13.48 tonnes/ha respectively.



Rice in sunken and okra in raised bed

Farm implement

A seed drill was developed for high slope condition. The drill can be operated by two persons and is suitable for sowing of maize, pulses and some oilseeds crops. A 4-row pre-germinated paddy



A 4-row pre-germinated paddy seeder



Operation of manual seed drill for hill slope

seeder for wetland paddy in valley and terraces was developed and demonstrated.

Biological control using tree bean extracts

Seed and leaf aqueous extracts (15 – 20% concentration) were found effective against rice root-rot nematode. Exposure for 96 hr caused 100% mortality. Aqueous seed and kernel extracts were also effective against rice blast fungus and showed dose-dependent activity.

Simple multiplex PCR for rapid diagnosis of sex in ducks and duck embryos

Protocol for sex diagnosis of ducks (*Anas platyrhynchos*) and duck embryos through multiplex method was developed. The PCR primers to amplify 335 bp PCR product of *W* chromosome specific DNA sequence in female sex and another set of primers to generate a 468 bp PCR product both in male and female sex as an internal control were designed. Using this protocol sexing of embryos utilizing DNA extracted from embryonic tissue samples and amniotic fluid cells and also ducks of any age using DNA extracted from whole blood could be done.

Captive breeding of chocolate mahaseer

Captive breeding of chocolate mahaseer was achieved using the broodstocks from Umiam river of Meghalaya. Hatching was 85%. Fingerlings raised in ponds attained 150 g weight in a year.

CENTRAL AGRICULTURAL RESEARCH INSTITUTE, PORT BLAIR

Crop sciences

The breeding lines and somaclones of Annada rice developed *in situ* gave yield 6 to 8 tonnes/ha respectively. BTS 24, a salt-tolerant line developed *in situ*, showed 3.7-4.0 tonnes/ha at farmers' fields under large-scale cultivation. F₄ mapping population of IR 28 × Pokkali was pheno-typed under artificially simulated saline soil condition and were molecularly profiled through RAPD and SSR analysis for molecular tagging of salt-tolerant genes.

Molecular characterization of an important endemic medicinal plant species, *Dioscorea vexans* through RAPD analysis revealed



ample genetic divergence among diverse collections. Micropropagation of *Dioscorea vexans* and *Costus speciosus*, collected from different locations of Bay Islands, was done using juvenile shoots as the source of explants.

The developed IPM module for brinjal has reduced the damage 74.52% compared to control plots. There was 2.3-fold increase in yield in IPM practised fields compared to control.

Five local isolates of *Pseudomonas* species, viz. C13, C21, C27, C28, C29, were found effective as biocontrol agent against all the pathogens of solanaceous vegetable crops.

Undisturbed mangrove areas exhibited relatively higher urease content than disturbed mangrove areas.

Energy ratio was best in line method of transplanting, whereas CIAE designed manually operated paddy transplanted method reduced drudgery and saved time and energy for cultivation of rice.

Sesbania aculeata (*dhaincha*) can be recommended for intercropping in wet-seeded rice under island conditions for realizing better productivity, profitability and energetics of rice. The soil health can also be improved through intercropping *dhaincha* and incorporating it using cono weeder. Artificial Neural Network (ANN) has high potential for the application of rice yield forecast.

The maximum benefit : cost ratio was recorded in amaranth-*bhindi*-ratoon *bhindi* (2.4) followed by hybrid Napier.

Cost of drying coconut using low cost solar dryer system was Re 0.64/kg which was one-fourth of conventional mechanical driers.

Enterprise combinations for slopping valley (short and medium duration paddy, vegetables, floriculture, plantations, fodder, backyard poultry, fish-cum-poultry-cum-duckery and cattle) and valley (long and short duration paddy, vegetables, backyard poultry, fish-cum-poultry and cattle) areas were identified.

Rice yield was significantly reduced (59% as compared to the unaffected areas) in areas where the *tsunami* damage was estimated to be severe. Moderate reduction (though significant) was observed in areas delineated as moderately affected (37%).

Animal sciences

The relative humidity (RH) and sunshine hours significantly influenced milk production during dry and monsoon season. Supplementation of propionate chelated organic trace minerals significantly improved the daily milk production in crossbred cows.

In the Islands ecosystem Turkey birds were highly suitable under this hot and humid climate. Successfully produced Boer goat cross kid (F₁ generation) through artificial insemination technology. Population status and phenotypic characterization of Nicobari pig and Terssa goat has been documented.

Controlled breeding programme was found to be a successful reproductive management tool to enhance productivity in a dairy herd. Real time B-mode Ultrasonography proved a valuable

- Five local strains of *Pseudomonas* species proved effective as biocontrol agents against pathogens of solanaceous vegetables
- *Sesbania aculeata* intercropping in wet seeded rice proved beneficial in island
- Propionate chelated organic trace mineral supplementation improved the daily milk production in crossbred cows
- Identified enterprise combinations for slopping valley and valley areas
- Documented diverse fishery resource of Andaman and Nicobar islands

diagnostic tool for early pregnancy diagnosis (25–30 days) in cows and early detection of non-pregnancy state could help in reducing the inter-calving interval. Artificial insemination technology in turkey was standardized and employed as an effective technique for improving the fertility and hatchability. Ultrasonography was found to be valuable diagnostic technique for early pregnancy diagnosis (25 days) in goat.

The prevalence of aflatoxin F₂ was found to be more followed by B1, B2 and G1 in the paddy samples affected with the tsunami waves. Overall analysis of feed revealed that the aflatoxin level was within permissible level.

The survey revealed that the deficiency of mineral was the major cause of infertility in dairy cows. Status of macro- and micro-mineral in soil, water and fodder was found to be varying; however the level of C, Zn P, Co was lower than the normal range.

Azolla (*Azolla pinnata*), an aquatic fern, was introduced and found to be feed supplemented for livestock and poultry. The quail reared under deep litter system fed with protein level of 27% in the starter (0–3 weeks) and 24% in growth (4–5 weeks of age) phase performed better.

Post-tsunami survey revealed that 19.35, 10.3, 37.75 and 83.55% of poultry, cattle, goat and pig, respectively, were lost during tsunami.

Impact assessment studies on mangroves, coral reefs and other coastal resources were carried out. Resource survey in the post-Tsunami scenario was also carried out.

Several production cycles of *Macrobrachium rosenbergii* was done and training programme for farmers were conducted. A hatchery cycle of *Penaeus monodon* was done successfully up to PL 20.

Fisheries Science Division in collaboration with other mainstream Fisheries Research institutes and ICAR, New Delhi prepared 'ANFISH- a road map for the development of fisheries in A&N Islands keeping in view the potential of the resources, the livelihood and employment opportunities of the stakeholders in the islands post-tsunami and current trends in global fisheries



development. Diverse fishery resource of Andaman and Nicobar Islands were documented.

Analysis of economic status and scope of dairy farming in Andaman & Nicobar Islands revealed a negative correlation between the percentage of local cows and farm size and positive correlation between percentage of crossbred cows and farm size.

A study on economics of milk production of dairy cattle revealed that the total cost per day in local cows was Rs 21.45, whereas for crossbred cow it was Rs 39.75. Major constituent of the variable cost was on feed in both the breeds.

Total returns from local cow per day was Rs 39.91 and for crossbred cow Rs 60.86. The major contribution for returns (about 97.74% and 98.88% in local and crossbred cows respectively) was from sale of milk, the remaining through sale of manure. The net returns in dairy farming was Rs 18.47 and Rs 21.10 in local and crossbred cows respectively. In crossbred cows, positive trend was noticed between the net returns and size of farm. Benefit : cost ratio was found to be 1.92 and 1.53 for local and crossbred cows respectively.

The average buffalo holding of the study areas was 3.6. On an average, large farmers owned 8.00 milch animal per farm followed by medium farmers and small farmers with average holding of 2.00 and 1.14 milch animals respectively. The study of economics of buffalo milk production revealed that the total cost of maintaining a milch buffalo was Rs 56.30 per day. Total variable cost was 70.43%, of which feed cost was the major component accounting to the tune of 62.34%. A negative correlation was evident between the size of the farm and cost of milk production, which was highest with small farmers (Rs 14.976/litre) followed by medium farmers (Rs 13.62/litre) and large farmers (Rs 10.93/litre). The major constraint was the lack of fodder in Andaman, more so in non-rainy season followed by rainy season followed by insufficient land/space for dairy farming in their farm household.

Effect of tsunami

Socio-economic impact assessment on Agriculture, Animal Husbandry and Aquaculture in the tsunami-hit Andaman was done to assess the damage to the field and loss to the farming community; to analyze the change in cropping pattern/livestock holdings.

Changes after tsunami are as follows:

- share of income from agriculture reduced drastically for the farmers. Share from animal husbandry and aquaculture increased.
- reduced share of agriculture compensated by the increased contribution from service, which included the cash-for-work programmes.
- the agricultural activities were stand-still but now slowly gaining some momentum.
- percentage of farmers cultivating paddy drastically reduced due to non-availability of land because of inundation and salinity.
- majority of the land dried off in the sample area due to the raising of bunds along the sea shores and in the present scenario, on an average only 1.62 acres of land/farmer is still inundated.
- time spent by the farmers in agriculture, animal husbandry and aquaculture farming activities drastically reduced immediately after tsunami and after a year, their man-hours were again reaching about half the time they used to spend during pre-tsunami days.
- considerable loss of livestock and indigenous poultry birds per farm family during tsunami.
- pasture lands available affected severely, resulting in starvation and reduced yield of livestock enterprises due to non-availability of green fodder.
- significant drop in the production level of milk/day, egg/day and live adult goat sold/month per farmer in the study area.