



A SCIENCE AND TECHNOLOGY NEWSLETTER

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PROMISING TECHNOLOGIES

Trichoderma viride isolate NRCL T 01 for managing litchi-wilt

Trichoderma viride isolate NRCL T 01 from the rhizosphere of the litchi-tree has been found promising to manage wilt caused by *Fusarium solani*. Under *in-vitro* conditions, this isolate was initially evaluated with four other *Trichoderma* isolates. In dual culture, inhibition of fungal colony growth was 61.5% with the isolate; the antagonist overgrew pathogen completely in six days. Further when tested under the glasshouse on potted trees challenged with *Fusarium solani*, this isolate was found significantly superior to all others as a biocontrol agent.



Tree with early symptoms of wilting (left) and healthy tree (right)

A talc-based formulation of the isolate has been developed having more than 2×10^6 cfu/g, which can be stored without loss of viability. During 2013-14, this formulation was applied on a pilot basis on the orchard-trees to apparently sick-trees; on the verge of wilting. It was applied after mixing with vermicompost. The sick-trees turned healthy after 20 days of application; restoring normal development of

Indian Council of Agricultural Research

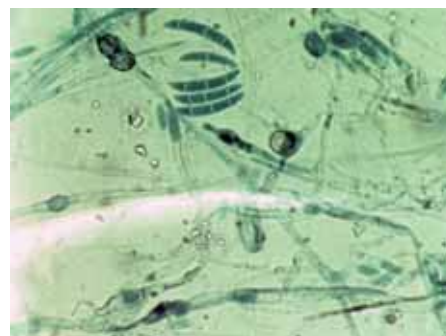
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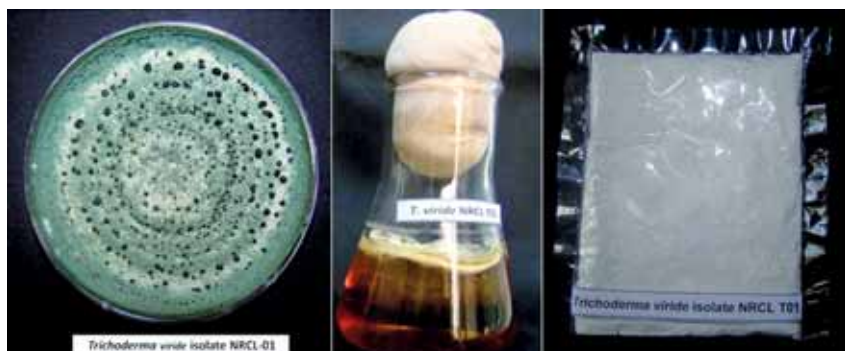
PROMISING TECHNOLOGIES

The isolate NRCL T 01 is novel in terms of unique growth habit, and tolerance to wide temperature regime (15-40 °C), pH (4.0-9.0) and salinity (can grow in medium having up to 1.5M NaCl concentration). It produces both volatile and non-volatile compounds inhibitory to pathogens. Besides, controlling soil-borne pathogens, it has also shown good plant growth promotion activity and helps in air-layering to be established in the field.

feeder roots in the affected trees. *Trichoderma* isolate could successfully establish itself in the rhizosphere of the inoculated trees after 20 days, exhibiting



Conidia and microsclerotia of *Fusarium solani*



Mass multiplication and formulation of efficient *Trichoderma viride* isolate NRCL T 01

counts in the range of $1.2-9.0 \times 10^4$ cfu/g. The technology has been scaled up for mass production of this efficient isolate for field application. The viable count in the formulation can be best maintained when stored at 4 °C without contaminants and moisture build-up in the pack.

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Production of surrogate carp through xenogenic transplantation of germ cells

Germ cell (GC) transplantation (GCT) is a powerful reproductive technique in which transplantation of the donor germ cells into the gonads of the surrogate animal for rapid and theoretically unlimited production of donor gametes is done. The technique has gained lot of attention due to its enormous potential for application in fish reproduction. Production of surrogate brood fish (host fish that receives germ-cell transplantation) and fry and fingerlings (seed produced from gametes of transplanted surrogate brood fish) of the carps was achieved; this was through successful xenogenic transplantation for the first time of the isolated germ cells (GCs) in the carps (Catla, *Catla catla*; rohu, *Labeo rohita* and common carp, *Cyprinus carpio*). With this technique, rohu GCs were transplanted into catla and *vice versa*. After fishes attained maturity, they were bred with each other, i.e., rohu (transplanted with GC of catla) × rohu female (normal without transplant) and *vice versa*. Similarly, a normal breeding was conducted between catla male (that received GC from rohu) and catla female. Offspring produced were either hybrids (rohu × catla;

catla × rohu) or normal catla or normal rohu.

This research has confirmed that donor-derived gametes can be produced in a related host species (carp to carp). Further, utilizing gametes of these GC recipient fish and a normal (non-recipient male or female), 30-40% surrogate carp fry and fingerlings could be successfully produced.

Similarly, catla and rohu GCs were transplanted to common carp, *Cyprinus carpio*, males and females, and induced spawning (stripping) was conducted between: male common carp × female catla; male catla × female common carp; male common carp × female rohu; male rohu × female common carp. Cross breeding of the carps also resulted in the production of hybrid fry and fingerlings from surrogate fishes.

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NEW INITIATIVES

Protecting plants from scorching along the West Coast

Scorching of leaves in most of the fruit-trees, vegetables, coconut and other trees was noticed during 3rd and 4th week of June 2015 along the West Coast of India, especially in Kerala and Karnataka. Ruling out acid rain, wind fire or heat burst, the cause of the leaf scorch has been observed to be owing to accumulation of high concentration of salt on the leaves.



Necrosis in coconut-palms in the West Coast of Kerala at Kasaragod

Every year, commencement of the monsoon in the region in June is with gusty winds and heavy rains. During 2015, it was unusual; wind speed was 30-40 km/hr with little rains (660 mm in June), as compared to the corresponding period of 2014, with wind speed of 22-25 km/hr and heavy rains (960 mm). In the dry weather, salt from the ocean evaporates as tiny droplets and gusty winds carry it to a long distance at the sea-shore and adjoining areas. Salt deposits on the leaves are seen in those plants which grow a few metres from the sea-shore all along the West Coast. Owing to lack of sufficient rains in 2015, salt on the leaves was not shed and affected tissues, causing browning, burning and eventually necrosis (cell or tissue death).

Ions sodium (Na) and chlorine (Cl), predominantly present in the sea-water, are highly injurious to plants. These ions enter leaves and cause osmotic imbalance, which dehydrates tissues and affects photosynthesis, protein synthesis, etc. Salt concentration is very high in the ocean, to the tune of 54 dS/m. Generally annual crops like cereals, pulses, oilseeds tolerate salt in the range of 2-4 dS/m, and fruit-trees tolerate 4-6 dS/m. Coconut is a moderately salt-tolerant crop, and can withstand salinity up to 8 dS/m. Similar is the case with guava, pineapple, cashew, sapota, arecanut, while banana, papaya, lime, mango are sensitive to salt. Trees like *Casuarina* have better excretion mechanism to salt and in them hardly any damage could be seen.

concentration. Leaf necrosis was more in plants near the sea-shore, and it declined gradually away from it. In some trees and shrubs necrosis was seen only on the windward side while the other side remained green. Plants with complete necrosis may die within a few days, while with a few green leaves may recover back slowly.

It is a natural calamity and its affects can be mitigated to a large extent by planting salt-tolerant wind barriers



Necrosis in *Acacia*-plants in the West Coast of Kerala at Kasaragod

like *Casuarina* as a border plant near the sea-shore. *Casuarina*-plants have evolved specialized mechanism by which they exclude or compartmentalize salt in the cells and thereby minimize salt affects on the organelles. The wind carrying salt would be deposited on these plants but the main crop would remain protected.

Salt affects can also be minimized by soil amendments such as organic manure, and freshwater sprays to young seedlings to wash-off salts etc.

The leaf analysis of the healthy and damaged plants is in progress to quantify salt concentration and to study mechanism of salt tolerance in different species.

P. Chowdappa

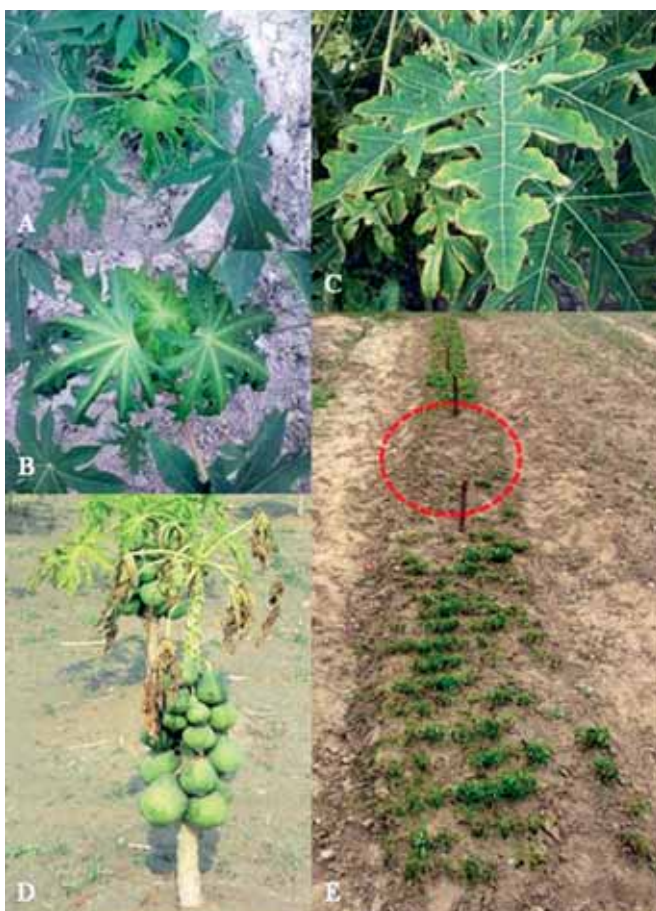
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Degree of scorching and necrosis depends on the salt

Phytotoxicity in papaya

Papaya suffers from a number of major and minor pests and diseases, and the extent of damage by them depends upon the agro-ecological regions. Proper timing, deposition and coverage of pesticides' application are critical for effective pest control. Besides, relatively small genome of papaya shows peculiarities in major gene groups involved in cell size and lignification, carbohydrate economy, photoperiodic responses and secondary metabolites, and that places it in an intermediate position between herbs and trees.



Symptoms of phytotoxicity in papaya — diamethoate (A, B), boron (C), chlorpyrifos (D) and propiconazole (E)

Papaya is comparatively sensitive to inorganic pesticides and nutrients. It is particularly sensitive to two pesticides — diamethoate, used for aphid control, and omite, for management of mites—which show phytotoxic effects on the young papaya-plants. High dose and repeated use of diamethoate (≥ 2.0 ml/litre of water) cause toxicity on newly emerged leaves, which show light-green coloured leaf-veins; the damaged leaves took 15-20 days to recover after the application.

Further, papaya is also sensitive to foliar application of chlorpyrifos (@1.5-2.0 ml/litre of water), used by farmers in papaya-orchards for mealy-bug control. It is also sensitive to soil application of boron (2.0 g/plant), especially in sandy to sandy-loam soils having higher pH. Basal application of borax at ≥ 6.0 g/plant causes burning of leaf-tip and margins. Seed-coating and treatment with propiconazole severely affected germination of papaya-seeds.

Calibration of equipment and chemical quantity of pesticides prior to each application are important to avoid heavy stresses, fruit damage and leaves burning in papaya. Proper labeling on pesticides is also needed to indicate whether they are phytotoxic or not and which plants or varieties are sensitive to them. It is always advisable to conduct a simple field bioassay by treating only a few papaya-plants, especially when growing new crops and cultivars.

Avoid use of diamethoate, omite, chlorpyrifos and propiconazole in papaya or carefully use recommended doses of these chemicals.

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White-grub management through community mobilization in Majuli, Asom

White-grub *Lepidiota mansueta* was first detected in October 2005 in farmers' fields of Majuli river island of Asom. Field surveys conducted during 2005 to 2007 revealed it as an extremely severe key pest in the river

island, and it affected severely potato, sugarcane, colocasia and greengram, registering damage varying from 42 to 48%, 15 to 20%, 35 to 40% and 30 to 35%, respectively. The menace was critical in areas where virgin

Local tribals also relished cooked/fried adults of *L. mansueta* as protein-rich food. Analysis indicates that beetles contain carbohydrate (10.93 %), fat (4.10 %), protein (76.83 %), fibre (5.16 %) and ash (2.98 %). They are also rich in dietary minerals like Na (0.28 %), K (0.14 %), Ca (3.33 %), Fe (16.41 ppm), Cu (64.66 ppm), Zn (155.32 ppm) and Mn (12.99 ppm). To improve the traditional rather crude method of cooking beetles, new concepts of "**Lepidiota Beetle Fry and Roasted Beetles**", were floated and both of these cuisines have been extensively accepted by the local people. The beetles are also used in pig-, dog- and poultry-feeding. Besides, the fishing communities of the island were also encouraged to explore possibility of using grubs of *L. mansueta* as fish-bait.



Lepidiota beetle fry dish

low grasslands (sand-bars) were converted into agricultural farm lands. In some endemic pockets, farmers discarded growing colocasia, which was considered otherwise as one of the most preferred vegetables among tribal communities. As majority of the farmers were not aware of the life-cycle of the white-grub, they mostly tried to suppress infestation with insecticides. Selection of inappropriate insecticides, their faulty and untimely application without proper knowledge about the biology further aggravated the pest problem.

Considering seriousness of the problem, bioecology of *L. mansueta* was studied. It has a biennial life-cycle, which is the first of its kind reported from the North-East India. Its third instar grubs are voracious feeders, causing extensive damage to underground parts of many crops. This species is unique as is the first Indian phytophagous white-grub species with non-feeding adults. Rush of adult emergence takes place for a short period in the evening during April-May. Except for this short aerial life for nuptial activity, this species has a subterranean life. Both sexes of the beetle are positively phototactic and hence they can be collected in huge numbers by operating light-traps in endemic pockets around sunset, i.e. 6 pm-7 pm. Scouting for hand collection is also effective since mated pairs are



Awareness on *L. mansueta*



Mass destruction of beetles

abundantly found on the selected sheltering plants in the field during 7pm to 8.30 pm.

Mass campaigning against *L. mansueta*

Community action programmes were explored for collecting and destroying adult-beetles during April-May in Majuli from 2010 to 2015 by sensitizing farmers through a combination of different extension, training and demonstration practices. Efforts have been made to disseminate technology through "*Farmers Participatory Approach for the Management of Lepidiota mansueta Adults through Light-trap and Scouting*", a nonchemical approach for management of this serious pest. Using this approach, gravid females are killed before egg-laying.

This mass campaign received overwhelming response leading

to capacity-building of farmers in white-grub endemic areas. The programme resulted into massive collection and killing of approximately 307,450 of *L. mansueta* beetles in Majuli river island during this period in an eco-friendly and cost-effective manner.

Badal Bhattacharyya

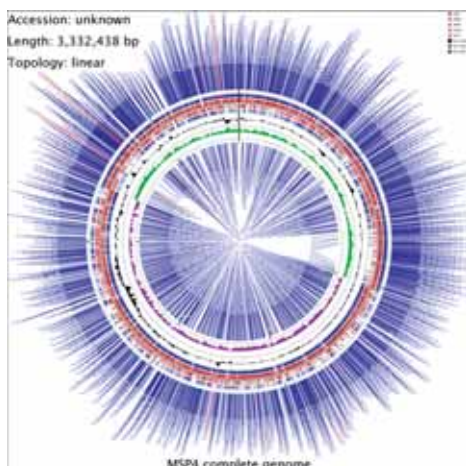
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First complete genome of the bacterium *Virgibacillus* sp. MSP4-1, an obligate halophile, cracked

The first complete genome of the genus *Virgibacillus*: *Virgibacillus* sp. MSP4-1, an obligate halophile, has been successfully sequenced and annotated. This organism requires a minimum of 8% salt, optimal level is 10%, and can tolerate up to 23.5% NaCl in the growth medium.



The bacterium was isolated from a salt-pan of the Rann of Kutch in Gujarat. The annotation of the complete genome of 3,332,438 bp of *Virgibacillus* sp. MSP4-1 has

revealed the presence of 420 subsystems and genes for 3,459 coding sequences (CDSs), and 90 RNA and 910 hypothetical proteins. Besides, there are 26 genes related to osmotic stress tolerance (osmoregulation, ectoine biosynthesis and choline and betaine uptake) and 37 for oxidative stress tolerance (protection from reactive oxygen species, oxidative stress and glutathione).

The obligate halophilism of this organism is being studied from the point of view of evolutionary, comparative and functional genomics. Exploring genome will pave the way for a comprehensive understanding of the mechanism of halophilism, i.e., the genes, the biochemical pathways, and the metabolites involved in imparting osmotolerance.

K.K. Pal and R. Dey

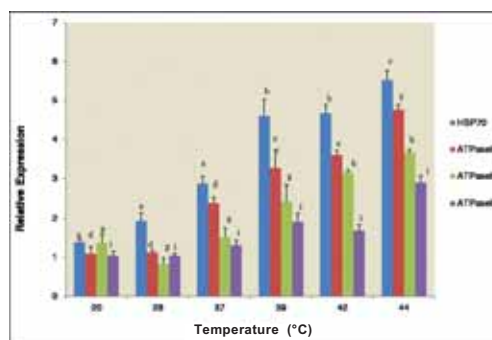
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Role of ATPase beta-family genes in cellular thermo-tolerance in cattle

Environmental heat stress negatively affects dairy parameters like milk production, feed intake, growth, fertility, conception rate and animal health. Global warming further accentuates selection of animals of high genetic merit suitable for adaptation to thermal stress. Searching of genes responsible for cellular thermo-tolerance and their positive association with milk production, if any, would enable selection of cattle with higher milk production traits suitable for hot climate.

Different genes have been identified which mediate cellular thermo-tolerance during heat stress. Beta-subunit genes are important components of Na⁺, K⁺-ATPase enzyme, which is essential for ion recognition and maintenance of membrane integrity.

In the present study, for the first time expression profile of ATPase beta-subunit genes (ATPase B1, B2 and B3) of crossbred bull has been characterized under different environmental temperatures to further crosstalk with expression pattern of HSP70. Results have demonstrated that among beta-family genes, transcript abundance of B1 and B2 is significantly ($P < 0.05$) higher during thermal stress. Degree of Pearson correlation coefficient studies have also revealed that expression of ATPase B1 and B2 is highly correlated ($P < 0.01$) with HSP70; indicating that the change in the expression pattern of these genes is



Relative mRNA expression profile (mean \pm S.E.) of HSP70 and ATPase Beta-subunit genes at different environmental temperatures. Different alphabetical letters within the bar for each family genes vary significantly at $P < 0.05$

positive and synergistic. This may help understanding the mechanism of ATPase beta-family genes for cellular thermo-tolerance in cattle.

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NATURAL RESOURCE MANAGEMENT

Indian jujube promising selection

Indian jujube or *ber* (*Ziziphus mauritiana*) is an economically important fruit-tree, which is grown all-over in the drier regions of India for its fresh fruits. The *ber*-tree has high commercial value as all its parts are useful. Its ripe-fruits are eaten fresh or after value-addition. It is a dominant component of the natural vegetation in Indian 'Thar desert'.

In nature, sometimes certain specific genotypes are found unexpectedly in the seedling population, which could be as the result of the natural cross pollination or mutation. Once a plant with desirable horticultural traits is identified, it can be propagated asexually for preserving its genetic identity. Native *ber* cultivars have generally been selections made by local people. Therefore, most of the present-day commercial cultivars are the selections from different regions.

A promising chance seedling of *ber*, CIAH *Ber* S15, has been identified. It is semi-erect, late maturing, and is free from pests (infestation under field conditions), and is potentially a high-yielding genotype (~ 65 kg/tree). It has cordate-shaped leaf, and its stone and fruit both are oval-shaped. Fruits of this selection turn greenish-yellow upon maturity and are with soft texture. Fruit pulp TSS,



Promising chance seedling selection – CIAH *Ber* S 15

acidity and ascorbic acid content was 18.3° Brix, 0.47% and 121 mg/100g fresh weight, respectively. Organoleptically, this selection has been favoured by tasters, and can also be consumed while slightly immature.

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High-yielding coconut hybrid VPM 5 for Tamil Nadu

To develop coconut hybrid with high nut yield, tender nut-water content, copra recovery and oil yield, 14 cross combinations involving high-yielding parents were evaluated since 1986 in different centres of the All-India Coordinated Research Project (AICRP) on Palms.

This resulted in the identification of a superior high-

yielding cross combination, LCOT × CCNT, at the AICRP-Palms Centre, Veppankulam (TNAU, Tamil Nadu). It is a Tall × Tall combination; first of its kind in the country as well as in the South Asia. This hybrid was released in May 2015 as VPM 5 during the 24th Annual Group Meeting of the AICRP, held at the ICAR-Central Coastal Agricultural Research Institute, Goa.



Crown view of the hybrid LCT × CCNT



Nuts of LCT × CCNT



Longitudinal section showing kernel thickness

NATURAL RESOURCE MANAGEMENT

Cumulative mean performance of VPM 5 (LCT × CCNT)

Character	VPM 5 (LCT × CCNT)	Hybrid check VHC 1	Local tall check ECT
Mean annual nut yield (nos/palm)	161	112	99
% increase over the check in nut yield		43.8	62.60
Nut yield/ha/year (in'000)	28.18	19.60	17.33
Copra content (g/nut)	149.80	142.80	133.10
Copra out-turn/palm/year (kg)	24.12	16.33	13.18
% increase over the check in copra out-turn		47.70	83.0
Copra out-turn (tonnes/ha/year)	4.22	2.86	2.31
Copra oil content (%)	70.0	69.5	68.4
Estimated oil yield (tonnes/ha/year)	2.95	1.99	1.58
% increase over the check in oil yield		48.2	86.70

oil content of 70% with higher quantity of tender nut water (368 ml /nut) of good quality (4.8 °Brix TSS).

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The mean nut yield of the hybrid during the stabilized bearing period was 161 nuts/palm/year, which was higher than ECT, VHC 2 and VHC 3 by 62.6, 43.8 and 11.0 %, respectively. It gave copra content of 149.8 g/ nut and

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Leafy vegetables of Nagaland for germplasm collection

Leafy vegetables play a unique role towards nutritional security of the tribals in the north-eastern hill (NEH) region. Keeping in view the biodiversity richness of the NEH region, two survey/ exploration trips were undertaken during 2013-15 in Dimapur, Wokha, Mokokchung, Tuensang, Longleng and Mon districts of Nagaland, including 15 local markets, for collection of crop genetic resource as well as for survey of leafy vegetables with the objective to collect systematically germplasm for conservation, popularization and use. Information was recorded on

local names, edible parts, period of availability, habitat and frequency of occurrence, diversity, use pattern, etc. Supplementary inputs from vendors and farmers/villagers across the region were also noted. Herbarium of selected

wild vegetables (18 spp.; 24 specimens) has been deposited in the National Herbarium of Cultivated Plants (NHCP), ICAR-National Bureau of Plant Genetic Resources, New Delhi.

An inventory of 36 local vegetables (24-wild, 12-cultivated) was prepared, of which ten were harvested exclusively from the wild,



Local vegetable market at Mon



Amaranthus cruentus: a homestead leafy vegetable



Onnü (Gynura cusimbua): a wild leafy vegetable in Dimapur market

Leafy vegetables of Nagaland – identified for germplasm collection

Species	Vernacular name (in different places)	Source* and period of availability	Remarks
<i>Amaranthus cruentus</i>	Chekoi, Phatakshii, Aaru (Tuli)	P/HC; throughout the year	Commonly cultivated in a kitchen-garden but is rare in market; not used as a pseudocereal
<i>Brassica juncea</i> var. <i>integrifolia</i>	Layeeppatta (all places)	C; throughout the year	Very common
<i>Chenopodium album</i>	Wathroi (Mon), Shinye (Tobu), Shizü, Nene, Shinge	C, also naturalized; rainy season	At young stage, leaves are cooked with pulse; not available in the market; with good diversity; used as a pseudocereal also
<i>Clerodendrum glandulosum</i> (syn. <i>C. colebrookianum</i>)	Wangpet (Mon), Orem (Mokokchung), Mokokmakup (Longkhim), Thinam (Longleng)	HW, cleared forest areas, P/HC; June-Sept.	Common in kitchen-garden; tender shoots are cooked or soup is prepared; is also of medicinal value
<i>Elsholtzia blanda</i>	Napa (Mokokchung), Lajing (Monyakshu)	P/HC; June-Nov.	Common in homestead-garden; leafy twigs and dried ones are used for garnishing
<i>Eryngium foetidum</i>	Dunia (all places)	C, also naturalized; throughout the year	Common in all places; is most preferred; is chutney flavouring agent and is spice-cum-culinary herb
<i>Gynura cusimbua</i>	Sille (Mon), Thruijan (Chen), Onnü (Mokokchung), Eneshi (Monyakshu)	P/HC; June-Nov.	Very common use is as soup as well as cooked vegetable
<i>Herpetospermum operculatum</i>	Thruinam (Mon), Chipatta (Dimapur), Rashipatta (Longkhim)	HW; June-Nov.	Recently described species; locally preferred for soup preparation in Dimapur, Mon and Longkhim
<i>Houttuynia cordata</i>	Kaiyukhing (Mon) Nuichua, Nokana	P/HC; almost throughout the year	Occasional in market; served as a leafy vegetable after cooking
<i>Plukenetia corniculata</i>	Meetha patta (Dimapur), Aochiang (Mokokchung), Nongrilla (Tuli)	HW, P/HC; June-Sept.	Very common in markets of Dimapur and Mokokchung; found in kitchen-garden; cooked vegetable is tasty

*HW-harvested from wild; C-(only) cultivated; P/HC-protected in wild/cultivated in homestead-garden

which include *Herpetospermum operculatum*, *Lasia spinosa* (*dhekiya/ tarangtong/ jorang*) and *Oenanthe javanica* (*pampong*); while 14 protected in wild and/or brought under homestead cultivation from the wild are *Garcinia cowa* (*lalpatta/ malim/ malbo*), *Gynura cusimbua* and *Plukenetia corniculata*. Most of these wild vegetables are commonly available for 4-6 months; with peak availability during rainy season. In case of non-native cultivated species, barring a few (e.g. *Allium* spp., *Eryngium foetidum*, *Brassica juncea* var. *integrifolia*), leafy shoots are vegetables, apart from their well-known use (e.g., fruit as in *Sechium edule*, *Cucurbita moschata*, *Passiflora edulis*, *Solanum macrocarpon*; seed as in *Chenopodium album*).

On the basis of the observed diversity, popularity and significance in the local diet, ten vegetables have been prioritized for germplasm collection. Some other interesting informations include: first report of edibility of *Adenia trilobata* (locally known as *korakla/ upsi/ uphai*; young leafy twigs occasionally cooked and eaten by Ao

tribes of Mokokchung district); many names for a particular vegetable within the same tribe, indicating local preference/importance; confirmation of the identity of two *Gynura* species (*G. cusimbua* and *G. nepalensis*), cultivated in these areas; and reporting of a new edible part (leafy shoot) of *Cucurbita ficifolia* (locally known as *tatansha/ malong*; soup prepared in Mokokchung and Mon districts) from India. The nutritive value of most of these leafy vegetables needs to be evaluated.

Species such as *Elsholtzia blanda*, *Eryngium foetidum*, *Gynura cusimbua*, etc. have potential for large-scale cultivation and popularization due to their high local demand.

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Plant wealth conserved in Home Gardens of Uttarakhand

Home gardening has attracted attention as a sustainable agriculture system in the recent years. This is an ideal approach for on-farm crop diversity conservation as well as for income generation.

A study was conducted in Naula gad watershed management of Dhari block (between longitude 29°52'47" N and 78°38'15" E latitude; the total geographical area of Dhari block is 238 km²) in district Nainital, Uttarakhand, to understand plant diversity available, especially with respect to Home Gardens. Using questionnaire and survey, the information was

collected from 6 villages and 30 households of Chaukuta, Dhanachuli, Gajar, Kasiyalekh, Podiyal and Pokhrar (situated at altitudes between 1,700 and 2,200 m asl). Information regarding the occurrence of plant species, their local names, parts used and formulation was recorded through interviews and discussions with elderly persons. Around 93 plant species could be documented, belonging to 79 genera and 51 families, ranging from forestry to horticulture and agriculture, including ethno-medicinal plants as grown in Home Gardens. These plant species are being used as cereal/ pseudocereal foods, fire-wood, fodder, fruits, leafy vegetables, ornamentals, spices, vegetables; and some are of cultural significance also.

During the survey, 20 were documented as ornamental species, 18 as fruits species, 13 as vegetables, 11 as medicinal plants, 7 as pulses and spices each, 6 as leafy vegetables, 4 as cereals, 3 as fodder species, 3 for use as fire-wood and 1 as pseudocereal.

In the case of fruits, a total of 18 species were recorded in the temperate Home Gardens of the Dhari block. Nearly 20 varieties of apple, apricot, peach, pear and plum were observed. Some of the promising varieties



Plant genetic resources maintained in the temperate Home Garden

noticed were: *Bar/Early/ 112, Bhura Delicious/Delicious/ D.K, Fenny, Hara Pichola/ Buckingham, King David, Red Golden, Rhymer/12, 22, 103* in **apple**; *Babbugosa/ Kakadiya/Tumadiya, Chusani/ Early, Gadmehal, Jagnail* in **pear**; *Badami, Chapta, Gola and Morpankh* in **apricot**; *Early Zone, Nactarine and Red Zone* in **peach**; *Centaroz, Jethiya, Jitua and Sarsoma* in **plum**; and they are all well acclimatized in the temperate climate of Dhari block.

The livelihood and culture of Dhari block is dependent on the natural resources, and in this regard, Home Gardens fulfill all basic needs of the local people. In addition, Home Gardens help in conservation of genetic diversity of useful plants, in food security, nutritional management, vegetable production, vermi-composting and soil fertility.

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PROFILE

ICAR-Central Island Agricultural Research Institute Andaman and Nicobar Islands

*To provide decent livelihood to farm-youth through agriculture
from the fragile island ecosystem on a sustainable basis*



This is a unique Institute engaged since its inception in the multidisciplinary research, devoted to the cause of the island agriculture and island ecosystem. It was established on 23 June 1978 by merging different Regional Research Stations of the ICAR Institutes — Central Marine Fisheries Research Institute, Indian Veterinary Research



Central laboratory

Institute, Indian Agricultural Research Institute and Central Plantation Crops Research Institute. The Institute has been renamed as the ICAR- Central Island Agricultural Research Institute (CIARI) during early this year, to be a model for the tropical Island agriculture research for short-term for the South-East Asian countries, and to the entire world for long- term.

The CIARI caters to specific needs of the agricultural research and development, and has been entrusted with the task of developing technologies to enhance productivity and production of crops, livestock and fishery, through adoptive and basic research, to bridge gap between requirement and local production. It has several accomplishments to its credit during the last thirty-five years.

The Institute has five divisions — Natural Resource Management; Horticulture and Forestry; Field Crop Improvement and Protection; Fisheries Science; and Animal Science; and one Social Science Section. Its main campus is located at Garacharma Farm, and is spread over 62 hectares. In addition, CIARI has three Krishi Vigyan Kendras,

located one each at Sippighat, Car Nicobar and Nimbudera, covering all the three districts of the Island; and an Out Reach Centre supported by the NABARD at Diglipur, North Andaman. The Institute and A&N Administration have evolved into establishing a cordial relationship and functional linkages for transfer of technologies, knowledge-sharing and addressing issues concerning development of Island agriculture.

With the well-established experience and expertise in the island agriculture, it is envisioned that the institution would make a major stride in the forthcoming years towards the cherished goal of emerging as the Institute of Excellence on the Tropical Island Agriculture for the Asian countries.

MANDATE

1. To provide a research base to improve productivity of the important agri-horticulture crops, livestock and fisheries of A&N Islands through adaptive and basic research for attaining economic self-sufficiency.
2. To develop appropriate plans for conservation of natural resources and their sustainable use.
3. To standardize technologies for animal-health coverage and livestock production.
4. To standardize techniques for capture and culture fishers, including coastal aquaculture.
5. First-line transfer of technology and training to relevant state departments.

SALIENT ACHIEVEMENTS

Biodiversity Conservation

- A total of 238 germplasm of indigenous and exotic horticultural crops — Fruits: 53, Vegetables: 77, Flowers: 03, Tuber crops: 33, Plantation crops: 36, Medicinal plants: 36 — is being maintained.
- Fifty-seven traditional vegetables were documented from the Islands, and nutritional profile of 16 predominant Nicobari traditional vegetables was developed, which are rich in micronutrients like Fe, Ca Zn Cu Mn, Mg and also in phenolics, ascorbic acid and in flavonoids.
- To strengthen minicore collection of pulse germplasm, 19 mungbean, 23 urdbean and 27 accessions of

pigeonpea landraces and advanced lines were collected and conserved. The wild relative of *Vigna* spp. namely, *Vigna marina*, was collected from different parts of the Islands, and is being maintained.

- Fifty-nine species of sponges were identified; of which, 44 have been reported for the first time from Andaman and Nicobar Islands; including 25 new distributional records from India. A total of 54 Voucher specimens of identified sponges have been registered and maintained at the A&N Regional Centre of the Zoological Survey of India.
- A total of 64 molluscan species were identified *in situ* from Nancowry group of Islands; 53 distributed under 8 phyla—Cnidaria (30), Echinodermata (7), Mollusca (5),



World Coconut Germplasm Centre

CIARI – Role in Island Agriculture

- Agriculture and rural development in future will essentially be technology-driven. The CIARI is well equipped with research facilities and scientifically ignited minds to address any future challenges concerning technology-led agricultural development.
- Three KVKs dedicated to the Institute (one in each district) and one Out Reach Centre at Diglipur are the functional link to several NGOs active in the Islands, and can be utilized for dissemination of agricultural technologies to farmers' fields. They can also play a significant role in capacity-building of farmers and stakeholders of A & N Islands even in far-flung areas.
- The CIARI, a partner of the vast network of the National Agricultural Research and Education System (NARES), and through the All-India Coordinated Research Projects, can bring appropriate technologies to benefit Island farmers with suitable modifications. The services of any expert in research and developmental activities can be utilized, and in all activities, line departments of A&N administration can be involved.
- The CIARI being multidisciplinary Institute can provide its expertise to address issues related to pests and diseases of agricultural crops, livestock, poultry and fisheries. Lately, the Institute has gained knowledge through experience on the degraded land and water resource management and integrated farming systems also. The CIARI can enhance cooperation with the National Bureaus of Plant, Animal, Fish and Insect Genetic Resources for documentation, registration and preservation of germplasm of Andaman and Nicobar Islands.
- The CIARI can provide breeder seed, truthfully labelled and quality seeds of different released varieties, and the same can be multiplied in the state farm for further distribution.
- Being situated at the very hub of the Island ecosystem, the CIARI has developed expertise on mangroves and coral ecosystems. Through National Agricultural Innovation Project, Farmers' Participatory Action Research Programme and Tribal Sub Plan, the Institute has already made significant impact among the Island farmers and tribals of the Nicobar Islands.

Vertebrata (Pisces) and Porifera (4 each) and Urochordata, Crustacea and Annelida (representing 1 species each) were recorded from the Great Nicobar Islands. From Car Nicobar Islands, a total of 70 species distributed under 6 phyla — Vertebrata (Pisces) (33), Cnidaria (28), Mollusca and Porifera, representing 3 species each, Crustacea (2) and Echinodermata (1)— were recorded. Two



Nicobari fowl



Teresa goat (Male)

Opisthobranchs, *Dolabrifera dolabrifera* (Cuvier, 1817) and *Hervilla mietta* (Marcus and Burch 1965) are new additions to Molluscan fauna from the Car Nicobar Islands.

- *Pemphis acidula* Forst. (Lythraceae), a species of mangrove, has been rediscovered after a lapse of 91 years from the Andaman and Nicobar Islands. Further, *Rhizophora* (a mangrove sp.)(Rhizophoraceae) hybrids have been reported for the first time from Hut Bay (Little Andaman).
- One hundred and forty-two Actinomycetes were isolated



Nicobari pig



Andaman wild pig

from the sediments and sea of the Andaman coasts. Most of the isolates belong to *Streptomyces* spp. (70%), followed by *Micromonospora* spp. (20%), *Streptovorticillium* spp. and *Nocardia* spp. (10%).

- Three new species of fruit-fly, *Bactrocera zonata*, *B. correcta* and *B. caudata*, and a new rodent *Bandicota bengalensis*, have been reported as new records from the Andaman Islands.

• Custodian farmers and communities of the biodiversity conservation and utilization in Andaman and Nicobar Islands have been recognized for the first time for cultivar/germplasm/landraces such as Andaman Coconut, Nicobari Aloo, Khoon Phal, Blue mango, Noni, Khushbayya rice, Black Burma, Mushley, Nyawin, White Burma, Nicobari fowl, Nicobari pig and Teresa goat.

Variety/Strain Developed

- Twenty-five varieties — four rice varieties (CIARI Dhan 6 and 7, CIARI Dhan 8 ,9), one brinjal (CIARI Brinjal1),

Tribal Sub Plan

- Tribal sub plan was implemented in Car Nicobar, Kamorta, Campbellbay and Hutbay of A&N Islands. Similarly, under the NEH component, works were carried out at Asom, Meghalaya, Tripura, Arunachal Pradesh, Manipur and in Bali Islands of Sunderban, West Bengal. Under these, a total of 93 training programmes in the field of fisheries, horticulture, field crops, animal husbandry, post harvest, crop protection and value-addition were conducted in collaboration with the State departments and KVKs, wherein a total of 4,622 farmers were benefitted. Twenty-three tribal farmers from the Car Nicobar were given exposure on goat and breeder management and hatchery operation. Inputs distributed to beneficiaries were vegetables seed-kit (2,050 in number), propagules of banana, pineapple, guava, mango, lime (9,100 Nos), tuber crops(4,000 Nos), coconut and arecanut (3,155 Nos), nutmeg, black pepper, clove (2,400 Nos), tuberose, Jasmine and gerbera (9,100 Nos), rice, maize and pulse (4,650 kg); goat, pig and poultry (5,509 Nos); cryocan (28 Nos); sprayer, conoweeder (40 Nos); power tiller (3 Nos); water pumpsets (10 Nos); coconut climbers (85 Nos); paddy thresher (10 Nos); fishing boats (6 Nos); life jackets (124 Nos); ice boxes (23 Nos); deep freezers (39Nos); GPS (20 Nos); elephant foot yam (225 kg); ginger (200 kg); CIARI Brinjal 1 seed (3 kg); biocontrol agent (100 kg); groundnut (20 kg); and black polythene (90 kg).
- Beside the assets were created at the community level as the demonstration units for the benefit of tribal farming community such as developed 2 homestead-based IFS of 50 m each for twenty-five beneficiaries of seven villages; twelve low-cost goat sheds; three low-cost poultry sheds; eight mini incubators for hatching of chicks; twenty rain-shelters for vegetable cultivation in off-season; water harvesting sintex tanks (10 Nos), out board engines (20 units of 4hp) and solar dryer (2 Nos).

PROFILE

four coconut (CIARI Anapurna, CIARI Surya, CIARI Omkar, CIARI Chandan), two each of sweet-potato (CIARI SP 1 and SP 2), poi (CIARI Poi 1 and CIARI Poi Red) and amaranthus (CIARI Lal Marsha and CIARI Shaan), three mungbean (CIARI Mung 1, 2, 3), one each of ground orchid variety (CIARI Pretty Green Bay), broad dhaniya (*Eryngium foetidum* L.)



CARI Dhan

variety (CIARI Broad Dhaniya) and greater yam (*Dioscorea alata*) variety (CIARI Yamini) and four of noni (CIARI Sanjivini, CIARI Rakshak, CIARI Sampada and CIARI Samridhi)—were developed and released.

- Dual-purpose Nicobari fowl developed for higher egg production (184 Nos/annum) and higher body weight (1.92 kg at 4 months age).
- Dweepika (White Nicobari × Vanaraja) developed as a cross of Nicobari fowl, suitable for backyard farming with higher egg production (185 eggs/annum) and higher body weight (1,923.10 g at 16 weeks of age) with better survivability.

Value-addition

- Two herbal-based formulations were prepared for poultry — **Grommune** for higher growth and immunity and **Morical** as a feed supplement for higher egg production and quality.
- Supplementation of developed mineral mixture, named as CIARIMIN, to basal diet significantly increased incidence of oestrous (9.66%), pregnancy rate (16.67%) and farrowing rate (16.67%) of sows.
- Kalmegh feed supplementation at the rate of 3 g per bird per day for breeder fowl improved humoral and cell-mediated immunity of breeders, and improved height and reduced depth of duodenal villi of progeny.

Technologies Transferred

Integrated Farming System (IFS): The CIARI has evaluated and transferred different IFS models for different micro-farming situations of the hilly uplands (plantation + dairy + backyard poultry), of medium



uplands (crop + cattle + fish + poultry and crop + cattle+fish+poultry+goat) and of valley areas (rice + vegetable + fish) at farmers' fields, which increased farm income (₹3.9 lakh/ha/year) besides additional employment generation (163 mandays / ha /year).

Broad Bed and Furrow (BBF) System : Since vegetables fetch higher price during monsoon season, broad bed and furrow system developed for growing vegetables on the bed and paddy + fish in the furrows gives better option for farmers for realizing higher income from the unit land area. In BBF system, okra-amaranthus-okra recorded maximum net returns of ₹106,134 from 4,000 m² area of beds in one ha, and ₹10,840 was earned from furrows. Thus, from one hectare of BBF, through adoption of okra-amaranthus-okra in beds, brinjal+moringa+banana in borders and rice + azolla +fish in furrows, ₹117,532/ha could be obtained, which was eleven times higher than the normal cropping of paddy, followed by pulses/fallow.



Broad Bed and Furrow

Homestead-based Integrated Farming System for Tribals: A small-scale homestead-based IFS model, comprising Home Garden (400 m²), backyard poultry (25 in number), goatery (3) and composting has been developed in participatory mode for tribals at the Car Nicobar. The Home Garden is used for growing seasonal vegetables, fruit crops, tuber crops. *Sesbania grandiflora* (agathi) and *Gliricidia sepium* were grown as border trees to act a bio-fence besides yielding green fodder and green leaf manure. Compost tanks are made at the corner of the homestead garden for composting. The manure obtained from goat and poultry along with the crop residues is used for making vermicompost. With this intervention, frequency of consumption of food items, greens, vegetables, fruits, meat, poultry, egg by the farm-family has increased. Twenty-five homestead-based Integrated farming system models have been developed for tribal farmers of Nicobar district, comprising Home Garden, goat and backyard poultry and tuber crops with

Impact of Technological Interventions in Andamans

The study revealed that composite fish culture with Catla, Rohu and Mrigal (CRM) could give an additional return of ₹19,450, followed by Broad Bed and Furrow system (BBF) (₹17,250), HYVs of rice of CIARI (₹9,400), Improved Nicobari fowl (₹7,100) and Pekin duck (₹3,210).

Horizontal spread of HYVs of rice was observed in year 2014. A total of 2,620 farmers adopted HYV's varieties in a total area of 1,219.64 ha, spread over 32 cluster of villages at the North Andaman after introduction of the promising seven rice varieties in 2010 through front-line demonstration in participatory mode to 313 farmers, which covered 70.18 ha till 2014 (in five years).



Homestead-based Integrated Farming System for Tribals piggery and poultry as a livelihood options at the Little Andaman.

Seed Village Concept: An innovative technology was introduced to provide truthfully labelled seeds (TLS) in participatory mode from 2011 to 2014. A total of 203 quintals of seeds were produced, which covered 19.51 acres (7.9 ha) of 33 farmers with seven HYVs of paddy — CSR 23, CARI Dhan 3, CARI Dhan 4, CARI Dhan 5, CSR 36, Gayatri and Ranjeet. Initially, seeds produced were purchased by neighbouring farmers and NGOs. Recently, the seeds have been given to Dept of Agriculture, A & N Administration, for multiplication in their farms and thereafter distribution to larger stakeholders; represented by different parts of the Islands.

Satellite Fish Nursery for Production of Freshwater IMC Seeds : Satellite Fish Nursery Technique was introduced for the first time in 2012 at Diglipur to raise nursery of freshwater fishes of exotic carps, which were made available on time to fishers. In a span of six months, a

farmer could earn ₹ 270, 000 by adopting the technology at the North Andaman, and many more youth have come forward to adopt the technology.

Pekin Duck under Backyard : Pekin duck, a demand-driven technology, for small farmers was introduced in 2011, by ORC with three ducklings to a single farmer. Over the time it could spread to 63 farmers with 3-5 ducklings in the backyard, totalling to 388 in number, spread over 15 villages by 2014. The farmer could earn ₹16 by selling eggs, ₹ 400-450 from adults and ₹ 50-55 for ducklings, when compared to *desi* duck for ₹ 5-7, ₹ 200, and ₹ 10, respectively. The duck would grow to an average weight of 2.637 kg with low level of mortality, when 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 *desi* birds (₹ 1,140) ; giving an additional income of ₹ 3,210. A total of 881 eggs of pekin duck were spread to fifteen cluster of villages by a single farmer, which is a remarkable achievement.

Water Users association (WUA): It was promoted by the CIARI for the development and efficient utilization of water, and was the first of its kind in the Manjeri village of the South Andaman. Its total membership has increased from initial sixteen farm- families to forty- five at present. Along with the area under cultivation of crops has also increased from 29% to 71%.

Weather-based Agromet Advisories : Potential Fishing Zone forecasts are periodically issued for the benefit of fishers of the islands , which could lead to 34.35% increase in catch per unit effort and reduced scouting time by 50%.

Micro Business Modules: To retain farm-youth in agriculture, an innovative approach of translating fourteen technologies in agricultural and allied fields as Micro Business Modules (MBM) for providing decent

livelihood options to the youth of the Island have been developed in association with the NABARD. The details are available on the website <http://icar-ciari.res.in>.

Tsunami and Technological Interventions : After the devastating Tsunami in December 2004, CIARI initiated rehabilitation programme in Manjeri village of the South Andaman, and under the National Agricultural Innovation Project, agriculture has been restored in 200 acres of the degraded coastal land, which has provided livelihood



Three-tier system – Rice-Fish-Vegetable system

support to more than 500 farmers through need-based integrated land improvement approach, comprising broad bed and furrow, rice-fish, three-tier farming, farm pond, paired bed and furrow and pond-nursery systems, covering 37.0 ha.

THRUST AREAS

Broad Research Programmes

- Characterization and bio-prospecting of natural Island bio-resources.
- Climate proofing island agriculture for improving productivity.
- Development of harvest and post-harvest management practices and value-addition.
- Policy support research for agricultural development in the Islands.

Beside three other programmes are as follows

- Flagship programme on the integrated agriculture system for tropical Island.
- Establishment of composite bio-security and quarantine facility.
- Tribal Sub Plan.

Urgent Attention of Contributors

For high quality presentation, designing and print quality of the **ICAR News**, We request all our contributors to make sure that following points are taken care of before sending the articles:

- Text matter with photographs and captions may be provided in **MS Word**; no PDF files please.
- Good quality photographs **in original form** i.e. **high resolution jpeg files** without any effects, need to be given separately also.

– Editor

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TIARA (JRF 2) — A flax fibre (linen) strain for high fibre yield

India's first high-yielding flax (*Linum usitatissimum*) fibre variety Tiara (JRF 2) was released in 11th Annual workshop on the AINP at the UBKV, Coochbehar, during 28 February to 1 March 2014. It is a selection from the progenies of the cross FT 889 × FT 895, following pedigree method for improving fibre yield with enhanced fibre quality.



Crop, flower and fibre of Tiara (JRF 2)

JRF 2 was tested in the initial evaluation trials (IET), advance varietal trials (AVT-I, AVT-II) and adaptive trials during 2008 to 2013 at the following locations—Pratapgarh, Coochbehar, Kalimpong, Jammu, Almora, Ranichuri and Barrackpore. It gave 26% higher fibre yield (12.9 q/ha) than JRF 4 (10.27 q/ha) under normal conditions with very good fibre quality. It produced 14.57% stronger fibre with fibre tenacity of 25.55 g/tex than JRF 4 (22.30 g/tex).

JRF2 is comparatively resistant to biotic and abiotic stresses and has been found to possess higher degree of resistant by 22.06% and 23.81%, respectively, to

Distinguishing morphological characters

- Stem:** cylindrical, completely green, smooth, basal diameter 4.0 – 4.5 mm
- Leaf:** Colour= green, Shape= narrow, Leaf length= 2.8cm, Leaf width= 0.4cm
- Flower:** Petal colour= white, Days of flowering = 85-90 days
- Fruit:** Indehiscent
- Seed:** Coat colour= Brown, 1,000 seed wt= 5.85g
- Yield potential:** 14-15 q fibre/ha

Fusarium wilt and *Alternaria lini* than JRF 4. It can be grown in rainfed/irrigated agro-ecological conditions in *rabi* season. It is suitable for growing in medium to low fertile soils, and has been found ideal for cultivation in Himachal Pradesh, Uttarakhand, north-east Himalayan region (Meghalaya, Sikkim and Arunachal Pradesh), Uttar Pradesh, Jammu and Kashmir and West Bengal.

Plant height of JRF 2 is 105-110 cm. It is an early-maturing variety; ready for harvest within 100-110 days for fibre purpose and 135-150 days for seed purpose.

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New IHR varieties/hybrids released of fruits and cut-flowers

Mango (Hybrid H 12)

Arka Udaya : This variety is a hybrid between Amrapali × Arka Anmol. It has good characteristics of both the parents— especially fruit quality of Amrapali and yield of



Arka Anmol. H 12 possesses high yield (75-85 kg/plant), semi-vigorous growth habit, medium-big fruit (235g), deep-yellow pulp, high TSS (24 °Brix) and uniform fruit size with better keeping quality.

Guava (H 3-29) Arka

Rashmi : It is a hybrid between Kamsari × Purple Local with good characteristics of both the parents. It yields 16.54 kg fruits/plant, and possesses higher ascorbic acid (235.5



mg/100g), medium to high lycopene content (4.93 mg/100g), high TSS (12-14%), medium soft seeds and round fruits. Further, canopy architecture makes it amenable for high density planting. It is a dual- purpose variety with better vitamin C content and rind thickness comparable to lately released variety Arka Kiran, but seed softness is on par with it. This selection also recorded a lower oxalate content of 28.30mg/100g fresh weight compared to 30.30mg/100g fresh weight of Arka Kiran.

Marigold hybrid selection, **Arka**

Alankara: It produces large, yellow (9A) coloured petaloid-type male-sterile flowers with ligulate florets. It yields 128.9 flowers/plant with a larger flower diameter of 7.0 cm. It is multiplied by stem-cuttings.



Marigold hybrid selection, **Arka Agni** : It produces large, orange (N25C) coloured petaloid-type



male-sterile flowers with ligulate florets. It yields 118.9 flowers/plant with a larger flower diameter of 6.8 cm, and this is also multiplied by stem-cuttings.

Gladiolus hybrid selection, **Arka**

Manorama : It is a hybrid selection from the cross Meera × Picardy. Its florets are red-purple (65.B) with red-purple (62.A) streaks, red-purple (67.B) splashes, are open-faced and are medium in texture. It takes about 72.25 days for flowering. It has long spike (123.11 cm) with good rachis length (46.77 cm), and bears 12.66 florets/spike. About 5 to 6 florets remain open at a time which makes it excellent for cut-flower, bouquet preparation, floral arrangement and for garden display.



Arka Manorama

Gladiolus hybrid selection, **Arka**

Aayush : It is a hybrid selection from the cross Gold Medal 412 × Poonam. Its florets are red (41.C) with red (41.A) margin, are blotch red (46.B) with yellow (13.C) border, are open-faced, thick, slightly ruffled and arranged in a double row. It takes 76.65 days for flowering. It has long spike (95.18 cm) with good rachis length (48.81 cm) and bears 17.54 florets per spike. About 6 to 7 florets remain open at a time, which makes it excellent for cut-flower, bouquet preparation, floral arrangement and for garden display. It is resistant to *Fusarium* wilt disease also.



Arka Aayush

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Tea mosquito bug: an emerging pest of red cherry pepper in Sikkim

Tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae), was considered a major pest of tea in the past; and it continues in the recent times also in the North-East India and West Bengal, causing heavy tea losses annually as it attacks only young shoots, which actually yield tea. Besides, considerable losses of tea-shoots, it causes deterioration in quality of prepared tea, lowering its market value. It was estimated that 90% of sub-Himalayan Dooars tea plantation was affected by this pest alone, which resulted in crop losses to the tune of 10-50 %.

In Sikkim, this pest has been recorded as an emerging pest of red cherry pepper, *Capsicum annum* var. *cerasiforme* (Dalle Khorsani, vernacular Nepali). Both young and adult mosquito bugs damage *Dalle Khorsani* plants by sucking sap from leaves. The affected part of

Tea mosquito bug is a destructive polyphagous pest. Besides, tea, it attacks cashewnut, guava, mango, *Jasminum scandens*, *Mikania micrantha*, *Acalypha*, *Gardenia jesminoid*, *Malastoma malabathricum*, *Eugenia jambolana*, *Rosa sinensis* etc. Till date 10 other hosts have been identified — *Hibiscus* spp., *Dahlia*, *Solanum* spp., *Salvia* spp., *Duranta* Gold, ornamental sweet-potato, *Chenopodium album*, *Chlerodendron* spp., *Houtoenia cordifolia* and large cardamom. Among these, *Duranta* Gold is the most preferred host, and is damaged to a large extent.



Helopeltis on red cherry pepper

the plant develops a dark- brown or black circular stain. Buds or shoots of this plant become curled, dried and black reducing growth and ultimately affecting yield. Badly damaged plants produce lesser shoots and thus, plant loses vigour and becomes stunted.

Tea mosquito bug female lays eggs inside tender shoots. After hatching, nymphs complete their one cycle through four instars. Spot size on the plant increases gradually with the development of instars. First and second instar nymphs can produce more than 150 spots in a day. The fully mature nymph or adult can produce at least 100 spots a day. The first and second instar nymphs mostly are on younger leaves (first and second leaves) and the later instars and adults are on comparatively mature leaves (third, fourth and fifth



Chenopodium album



Dahlia



Duranta gold



Salvia spp.



Chlerodendron spp.



Ornamental sweet-potato



Solanum spp.



Damage of *Helopeltis* in large cardamom



Other hosts of *Helopeltis theivora*

leaves). The average life-cycle of male and female is 38.9 ± 3.24 and 41.5 ± 3.36 days, respectively, during July-August. The pest first occurs in April; it causes major damage during June-August in Sikkim. Mosquito bugs start on a small area and then spreads to the entire area. It causes 25-30 % damage to shoots.

In Sikkim, large cardamom is the main cash crop, and this pest has been recorded on this crop for the first time. Its symptoms resemble leaf streak. In future, it

may pose a potential danger to tea industry and two most important spice crops of Sikkim, red cherry pepper (*Dalle Khorsani*) and large cardamom. Investigations on organic management of this pest have been initiated.

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Shelf-life and quality enhancement of betel leaves

Betel leaves (*meetha pan*) packaged in thermocol box as well as in bamboo basket (control/ commercial practice)



Betel leaves packaged and stored at ambient condition

had a storage life of 4 days under ambient conditions (Temp 29°C, RH 34%). At the end of the storage period, physiological loss in weight (PLW) and spoilage (%) in betel leaves packed in thermocol boxes were 17.7% and 26%, respectively, as compared to 23% and 28% for the leaves stored in bamboo basket (control). Moisture retention in the samples in thermocol box and control was 77% and 75%, respectively, after 4 days of storage.

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Litchi fruit-borers' infestation minimized through organic products

Litchi-crop is attacked by many insect-pests, which result reduction in yield and in marketable quality of fruits. Litchi fruit- and- shoot borer (*Conopomorpha sinensis*) is a major pest responsible for fruit losses and for leaf infestation to the tune of 24-32% and 7-70%, respectively.

During 2014-15 season, owing to unseasonal rains, egg hatching of the borer increased to 70-80% due to favourable environment, which increased severity in losses of the crop under the normal management practices. No doubt, insecticides are most widely

acceptable measure for controlling litchi fruit-borer but excessive reliance on insecticides poses several problems related to environmental pollution. To overcome ill-effects of chemical control, different organic products, *Panchgavya* 3% (locally made



A. Damaged fruit with larva, B. Pupae on leaves, C. Healthy fruit production

Effect of different organic products on litchi fruit- and shoot borer

Treatments	Fruit infestation (%)
<i>Panchgavya</i> 3% (30ml/litre)	4.0 -8.67
<i>Amrit Pani</i> 5% (50 ml/litre)	5.0 - 9.33
Biodynamic pesticide 5% (50ml/litre)	4.35 -12.67
Control	8.56 -18.33

product, containing cow products, like *ghee*, urine, dung, curd, milk besides, banana and sugarcane juice), *Amrit Pani* 5% (containing cow-dung, cow-*ghee* and honey) and biodynamic pesticide 5% (locally made with cow-urine, cow-dung, chopped leaves of *neem/madar* and water), were evaluated on Shahi litchi variety. (These locally made formulations are already standardized and utilized in organic production system

by various researchers/organizations).

Panchgavya 3% (30ml/litre) has been found most effective for healthy and quality litchi production. Four sprays at 10 days interval after fruit attains the size of a clove could check infestation below the threshold level. Moreover, pruning of infested twigs in June, followed by manuring of litchi-trees with 4 kg of castor-cake and 1 kg of neem-cake in the first week of July and spraying of neem-based formulations (*Nimbecidine*, *Neemgold*) have been recommended for keeping litchi defoliators and fruit- and- shoot borer at the minimum level during fruiting season.

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Tractor-operated small seed planter

Tractor (26- kW)- operated six- row planter for small seeds consists of an inclined plate- type metering mechanism, a seed hopper for each row, shovel-type furrow openers and three-point hitch system. Capacity of the seed hopper is about 1.5 kg. The row- to- row spacing of the machine is 150 mm, and plant- to- plant spacing can be adjusted.



Tractor-operated small seed planter

This machine was evaluated at forward speed of 2.0 km/h for seeding onion on beds having top width of 1 m to facilitate operation of vegetable digger

at the time of harvesting. There was a saving of about 50% in the cost of operation and 81% in labour requirement as compared to traditional method of onion cultivation. The field capacity and cost of operation of the machine are 0.16 ha/h and ₹5,090/ha, respectively.

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Power-operated onion detopper-cum-grader

Power-operated onion detopper-cum-grader consists of a feeding mechanism, a de-topping mechanism and a grading mechanism. The de-topping mechanism consists of spiral rollers and cutting unit. The grading mechanism consists of two divergent rollers made of PVC pipe with 70° slope and moving outward speed at 225 rpm. The average power requirement of the unit at full load is about 0.9 kW. The average output capacity of the manual onion de-topping and grading is 30 kg/h and 100 kg/h, respectively.



Manually guided power-weeder

The approximate cost of the onion de-topper-cum-grader is ₹85,000, and average cost of operation of the machine is ₹256 per tonne as compared to ₹813 per tonne of the manual operation.

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First report in India of disease outbreak in goldfish by Cyprinid herpesvirus 2

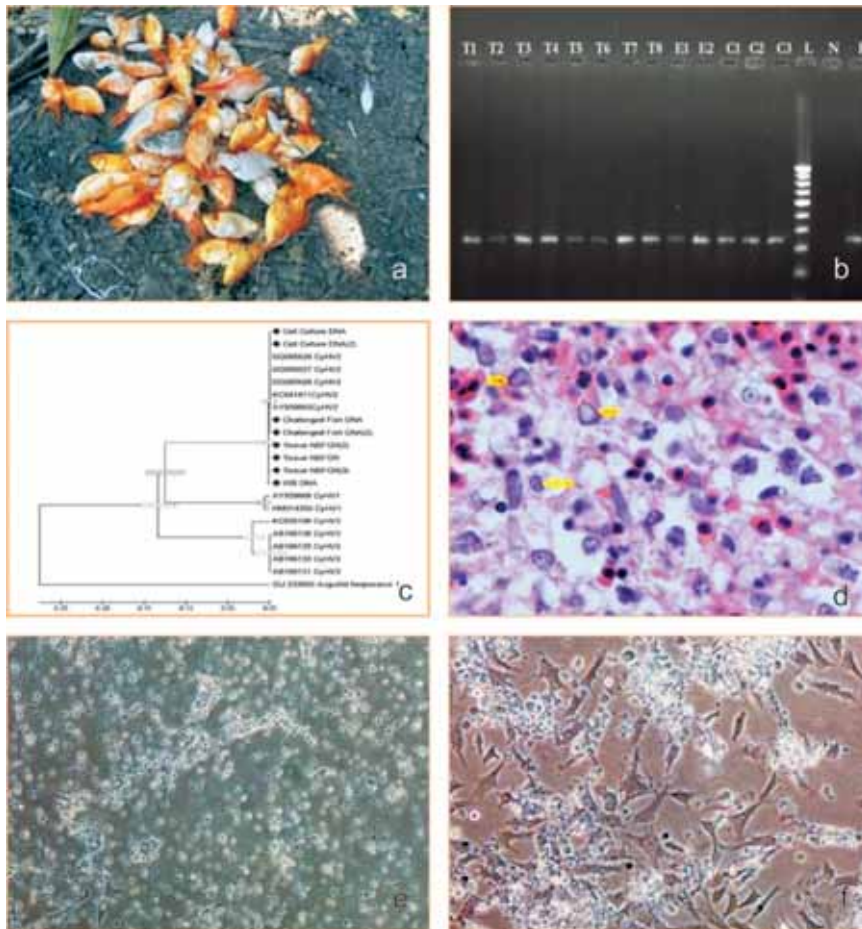
Large-scale mortalities of goldfish, *Carassius auratus*, in ornamental fish farms of Hooghly district, West Bengal, were noticed. On post-mortem examination, the affected fish exhibited protruding anus; haemorrhages on body, fins and gills; lepidodorthosis; necrotic gills and shrunken eyes. Internally, white nodular necrotic foci were observed in spleen and kidney. For laboratory investigation, tissue samples were collected in neutral buffered formalin, 95% ethanol and in tissue-culture medium. In addition, moribund fish were transported on ice for microbiological examination.

The samples were screened for herpes viruses, known to infect fishes by polymerase chain reaction. Amplification and sequencing of PCR products indicated infection with Cyprinid herpesvirus 2 (CyHV 2). The nucleotide sequence of the target band showed 99% similarity to CyHV 2 sequences in the NCBI GenBank. In addition, the tissue homogenate from the infected fish produced cytopathic effect (CPE) in fish cell-lines derived from the fin of goldfish and koi carp; showing focal areas of granulation, cell vacuolization and appearance of rounded phase-bright cells typical of CyHV 2 infection. The cell-culture supernatant as well as cells were also found positive for CyHV 2 by the PCR. Further, histopathological examination indicated degeneration and

focal areas of necrosis in the sections of spleen, kidney and gills; and nuclear content of the affected cells was replaced by fine, homogeneous basophilic material, which occupied entire nuclear space with margination of chromatin.

In bioassay, 95% mortality was observed in four days infection, and the fish showed typical signs of gill necrosis, enlarged kidney and spleen as observed in natural cases. Furthermore, PCR of the tissues (gills, spleen and kidney) of the experimentally infected fish was found positive for CyHV 2. The findings at different laboratories were also similar. Therefore, on the basis of the sequencing of amplified PCR products, histopathological examination, CPE in cell-lines and bioassay, it has been confirmed that disease outbreak in goldfish was caused by infection with

Cyprinid herpesvirus 2. This is the first report of Cyprinid herpesvirus 2 infection from India.



a) Dead goldfish on the affected pond site; b) Detection of Cyprinid herpesvirus infection through PCR; c) Phylogenetic analysis of the gene sequence with sequences available in the NCBI GenBank, suggesting infection with Cyprinid herpesvirus 2; d) Photomicrograph of the spleen from affected goldfish showing margination of nuclear chromatin and basophilic intranuclear inclusions (arrows); e,f) Cell-lines showing typical cytopathic effects, following inoculation of tissue homogenate from affected fish

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Monitoring growth performance of variedly stunted fingerlings of rohu using electronic tagging

Growth performance of rohu, *Labeo rohita* (Ham.), fingerlings stunted for 4, 6, 8, 10 and 12 months at 20 and 40 m² densities was evaluated against normal fingerlings (2 months stunted) through one year grow-out experiment to assess influence of density and duration of stunting on the subsequent growth. A second grow-out study, also for one-year, evaluated further growth performance of similar sized normal versus 12 months old stunted fingerlings. Ponds (0.09 ha) in Study-I were stocked with fingerlings of respective stunting duration at 8,000/ha, comprising seed from each density at 1:1 ratio. Twenty individuals from each density category from each pond were implanted with electronic tags to track their individual growth over time. Similarly in Study-II, a 0.09 ha pond was stocked at 8,000 seeds/ha, comprising 12 months stunted fingerling and similar sized normal fingerling at 1:1 ratio and 30 fishes from each group were tagged.

In the first study, survival at the end of one year grow-out phase varied between 85.6 and 96.3% in different treatments and showed positive correlation with the stunting duration. Similar growth (both length and weight) between the fish from the two density categories in every treatment revealed minimal influence of stunting density (up to 40 m²) on the subsequent growth ($P < 0.05$). Compensatory growth activity was observed in 4-month stunted seeds since their growth trajectory converged with that of control within six months of culture. Further, this group showed significantly higher harvested body weight (772.4±99.8 g) and higher biomass yield (5.35 tonnes/ha) over 2-months stunted control, suggesting full growth compensation. This was unlike other four

treatments (6- to 12-months stunted), where no convergence of growth trajectories was observed. The specific growth rate (SGR) for initial six months in these four groups was lower than control ($P < 0.05$) and reduced with increased stunting duration, suggesting increasing influence of crowding stress on the growth in post-stunting culture phase. However, their higher SGRs for the next six months compared to control ($P < 0.05$) implicated certain degree of growth compensatory activity. But in the second study, both normal and stunted seed showed identical growth trajectories and similar body weight attainment after six and 12 months culture; ruling out existence of such growth compensation in the stunted group. Thus, these studies revealed 4 months to be an ideal duration for seed stunting in rohu as stunting beyond six months did not lead to any significant compensatory growth during subsequent grow-out phase.

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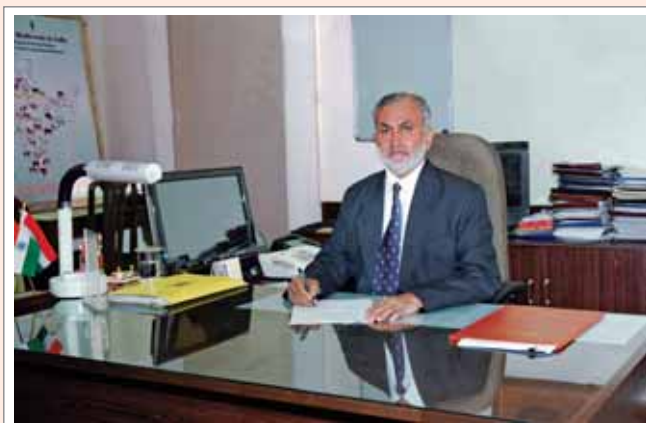
WAY FORWARD

THE Himalayan ecosystem, inhabited by over 51 million people, who are practicing hill agriculture for sustenance, is susceptible to a variety of natural and anthropogenic influences. Viewing fragility of the region, it has become necessary to maintain ecological security of this landscape. A National Mission for Sustaining the Himalayan Ecosystem (NMSHE) has been put in place under the National Action Plan on Climate Change (NAPCC) “to deliver better understanding of the coupling between the Himalayan ecosystem and climate factors and provide inputs for sustainable Himalayan development, while addressing also the protection of the fragile ecosystem”, by adopting a trans-disciplinary approach. Among others, the Mission is focussing on building institutional capacities in the areas of traditional knowledge system, Himalayan agriculture, eco-tourism and biodiversity. It is notable that the ICAR is the part of this Mission by heading a Task Force on the Himalayan Agriculture.

Only on the 13.6% of the geographical area of Indian Himalayan region, agriculture is practised; 65% is under forest-cover. The land-holdings in the hill areas are smaller (700-900m²) than national average (1,370 m²). Transmigration and environmental degradation due to soil erosion are other cardinal issues, which need to be dealt with in the region. Changing rainfall pattern and shifting seasons, prolonged dry spells, increasing frequency of droughts, landslides and flash floods, in particular, pose major threats to Himalayan agriculture.

Over-exploitation of natural resources in the region has resulted in severe land degradation, depletion of water resources, decreased productivity and recession in snow-covered area. Recent estimates indicate nearly 39% area of the Indian Himalayas has alarming erosion rate of more than 40 tonnes/ha/yr. Uttarakhand in the western Himalayas and Nagaland in the north-east has maximum area of 34 and 63.5%, respectively, under this severity category.

The long stretches of Indian Himalayas have different cold-water resources. There are 8,243 km long streams and rivers, 20,500 ha of natural lakes, 50,000 ha of reservoirs (both natural and manmade), and 2,500 ha of brackishwater lakes at high altitudes, which harbour large population of indigenous and exotic cold-water fish species. And rise in temperature by even 1 or 2°C may affect their growth, physiology, reproduction and behaviour, and consequently distribution pattern. Changes in rainfall pattern, especially decrease in precipitation, can also alter necessary water flow and turbidity, thereby affecting breeding patterns of fishes.



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Changes in thermal-physical dynamics would alter occurrence of microflora, and consequently may lead to eutrophication. Under such threats, monitoring of aquatic ecosystem is a must for formulating conservation policies and adaptive measures.



In-situ and *ex-situ* conservation of rainwater through a range of innovative techniques and enhancing rainwater-use efficiency through supplemental irrigation have led to the creation of a number of bright spots under different agro-ecologies. Sustainable agriculture and food security in cold deserts (Ladakh) are the need of the hour to intensify production of main staple crops, barley and wheat, and alfalfa for fodder. In this process, locally available underutilized and wild horticultural crops including invaluable medicinal and aromatic plants also need to be preserved. In the north-eastern Himalaya, shifting agriculture (*'jhum'*) is

predominant and efforts are being made to improve *jhum* system through balanced agroforestry. This indicates that agricultural practices are linked to socio-cultural diversity of the people living in the region; amounting to rich traditional knowledge systems, which are impediments in human-nature relationships. The UNESCO did promote the concept of cultural landscapes as the basis of biodiversity conservation and sustainable development in ecologically fragile zones in the north-western cold deserts and lush green north-eastern Himalayan region. While challenges are many, it is also important that we balance conservation with development to enable bountiful sources of livelihood by reinventing economically viable and socially acceptable agro-ecosystem models.

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