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A SCIENCE AND TECHNOLOGY NEWSLETTER

RESEARCH UPDATE

PROMISING TECHNOLOGIES

Inducing pollen formation in *pisifera* oilpalm for hybrid-seed production

There are three fruit forms available in oilpalm — *dura*, *pisifera* and *tenera*. *Teneras* are cultivated commercially, and are produced by controlled crossing of selected *dura* (thick-shelled) and *pisifera* (shell-less) types. *Pisiferas* are usually derived from the high-yielding *tenera* × *tenera* populations. They have consistently high sex ratio associated with bunch failure and low fruiting due to pollen shortage of the desired palm, thus affecting adversely hybrid-seed production. Various methods were tested to induce male inflorescence in *pisifera* for hybrid-seed production; and a new method ***"frond pruning and stress technique"*** has been found promising to induce male inflorescence and pollen production.

Male inflorescence production after stress treatment in *pisifera*

Leaf takes 2-3 years to develop from the initiation to the time when leaflets unfold in the centre of the palm-crown. Inflorescences are formed throughout the year in an acropetal order in the axil of the subtending leaves. Inflorescence development takes over 2 years, and most of the time, organ is completely enclosed at the base of the subtending leaf.

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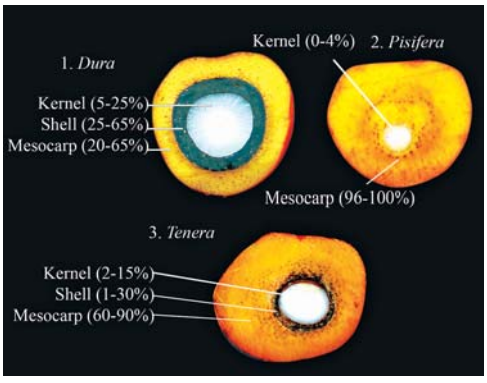
Oilpalm produces separate male and female inflorescences on the same palm in an alternating cycle of variable durations depending on the genetic factors, age, and more particularly on the environmental conditions; male inflorescence production is generally favoured by water stress. The earliest stage at which the inflorescence bud is visible by the light microscopy is in the axil of the fourth youngest leaf, close to the vegetative shoot apical meristem. At this stage, inflorescence consists of a group of few cells localized in the axil of the partly formed leaf. The inflorescence bud is visible to the naked eye from the stage corresponding to 12th youngest leaf onwards. For most of its development, the inflorescence is completely enclosed in two fibrous spathes. And the development of the male inflorescence and the female inflorescence appears identical up to the point where bracts are initiated on the spikelet.



Tenera hybrid production by crossing *dura* and *pisifera*

Frond pruning and stress technique

Various treatments were used for inflorescence development and yield components' studies; most were aimed at modifying carbohydrate balance between the source and the sink. Heavy pruning and high-density planting or pruning of the neighbouring palms results in an abrupt increase in the source activity. Partial or complete inflorescence removal changes the sink demand. When palms are irrigated, there is reduction in the number of male flowers per palm; indicating effect of water on the sex differentiation. Reduction in photosynthesis caused by water stress tends to lower carbohydrate status of the palm. Defoliation and intense competition for light in the high-density planting reduce dry matter production per palm and also cause reduction in sex ratio. By taking into account these observations, frond removal and stress induction technique was imposed in *pisifera* palms. Before pruning fronds, soil of the palm-basins at 2.0-feet depth and 2-metre diameter was tugged out. Most of the feeder roots were pruned from the base towards the periphery of the basin. And plastic sheet of 500-gauge thickness was spread along the base of the basin, and was covered with the excavated soil. Small drainage was made along the basin edge to drain-out rain-water, thus ensuring non-entry of the water to palm-basin. All the open leaves of the palm were cut, excepting spear and nine fronds around the spear leaves. The treated *pisifera* palms were observed for male-inflorescence formation. The duration and the frond number in which first male inflorescence was produced and the total number of the male inflorescences were recorded since the initiation of the male inflorescence cycle. Treated palms showed response as early as 14-16 months after pruning. Initially hermaphrodite inflorescence appeared in 18th frond axil. It is in confirmation with the earlier report that treatment effects will not be seen at stage 5 (4th bract initiated), but it is possible that mixed inflorescences are the result of the late changes. Sex is determined at about stage 3 (inner spathe initiated) and changes in carbohydrate status (because of frond pruning and stress technique and fruiting activity) can still influence sex up to stage 5. After sex change from female to male, inflorescence sex is fixed. Pruning done earlier resulted in the production of male inflorescences about 18-20, 22-24 and 11-13 months after treatment.

Frond, root pruning and stress treatments showed positive response for male inflorescence cycle initiation and pollen production in *pisiferas* with stubborn character of producing only female bunches. However, duration required for treatment response depends upon the age of the palm, genotype and variations.

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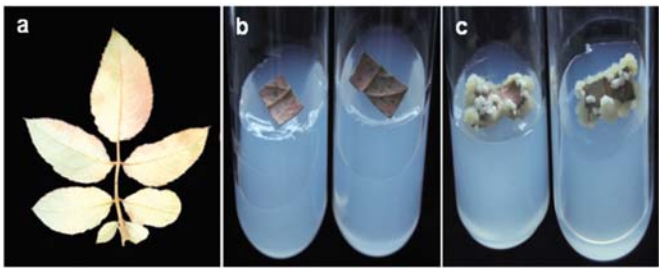
Happy New Year
2012
To All Readers
& Contributors

In-vitro anthocyanin production from rose

In the present era, synthetic coal-tar-based artificial food colourants are being extensively replaced with the natural colourants from fruits, vegetables and flowers. Natural pigments like anthocyanins, carotenoids, betalains, shikonin, and other pigmented phytochemicals are found in many plants.

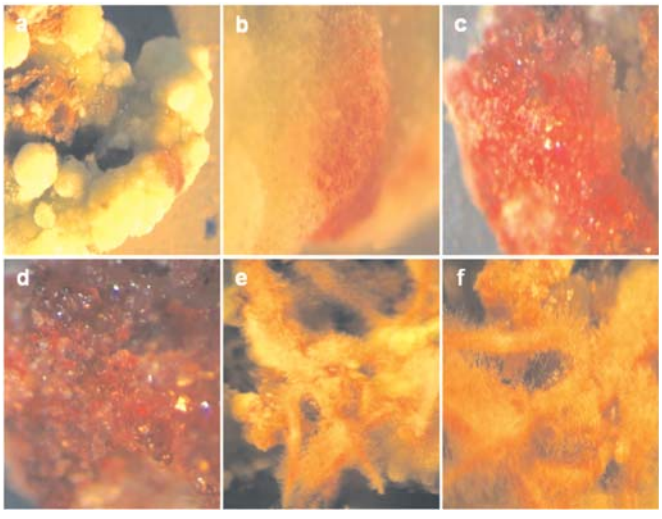
Anthocyanins are water-soluble vacuolar pigments of diverse flavonoid groups, which are responsible for giving blue, purple, red and orange colour to higher plants. The natural colours imparted by anthocyanins can be used as food and beverage additives to obtain attractive colours. Anthocyanins can also be used as nutraceuticals as they possess strong antioxidant properties. Positive role of anthocyanins in mitigating vision disorders, neuroprotection, cancer, cardio- vascular diseases is well documented. Plant pigments are generally localized in flowers and other young vegetative parts and thus restrict their availability during the cropping season. Therefore, there is a need to develop a system so as to freely induce and express such nutraceutical pigments at will in the conditioned environments too.

In-vitro anthocyanin production in cell-lines from grapes, oxalis, carrots, radish, strawberry and sweet-potato is well documented. Earlier reports on roses also indicated *in-vitro* anthocyanin production in cell cultures in suspension cultures but not from the solid calli.



In-vitro callus induction on leaf explant of *Rosa hybrida* cv. Pusa Ajay—(**a**) Ideal stage of leaf for culture; (**b**) Leaf segment on culture medium; (**c**) callus induction on leaf segments cultured on MS medium supplemented with 4.0 mg/litre of 2,4-D (25 days)

In roses, anthocyanins are distributed in leaves, stems, sepals, and of course, flowers. A reliable protocol has been standardized for *in-vitro* induction and expression of anthocyanin pigments from calli cultures of rose cv. Pusa Ajay. Of the two explants, petal and leaf-discs under light and dark, leaf-discs have been found promising for callus initiation. Profuse and early callus induction was observed when leaf-discs were cultured under total darkness on the solid Murashige and Skoog (MS) medium supplemented with 4.0 mg/litre of 2,4-dichlorophenoxyacetic acid (2,4-D). Early pigment initiation and enhancement and maximum anthocyanin production from calli were recorded when leaf-discs were cultured on *Euphorbia millii* (EM) medium supplemented with 7% sucrose compared with calli cultured on 4% sucrose concentration under 16/8 hr (light/dark) photoperiod regime. Reducing



Stereomicroscopic observation of *in-vitro* anthocyanin induction and indirect rhizogenesis in rose-leaf calli cultured on EM medium supplemented with different sucrose concentrations—(**a**) 4%, (**b**) 5% (control), (**c**) 6%, and (**d**) 7%. Pigmented rhizogenesis at 6% (**e**) and 7% (**f**) sucrose. (Bars: 2 mm)

concentration of NH_4^+ nitrogen in the solid MS medium resulted in slight improvement of anthocyanin production in the calli.

The protocol standardized for *in-vitro* induction of anthocyanin pigment will help produce this nutraceutical pigment without seasonal boundaries, and can also yield pigment of defined purity and standard in a short span of time. Such pigment production can be more reliable, simpler and predictable.

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Cryobanking of non-orthodox seed species

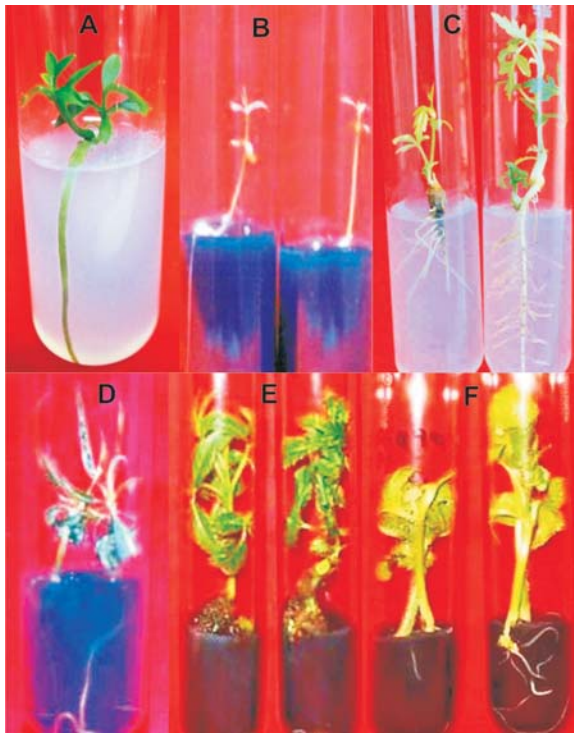
Realizing that cryopreservation at –196°C is the only current alternative for long-term conservation of the strictly recalcitrant seeds originating from the tropical and subtropical climates, studies were carried out for ascertaining desiccation and freezing tolerance of whole seeds and other explants like zygotic embryos and embryonic axes (wherever whole seeds do not survive cryo-exposure) of several Indian plant species. **Cryopreservation is widely adopted for ensuring maximum genetic stability, which is the highest priority of genebank**. Simple technique of desiccation of embryos and embryonic axes under sterile conditions to moisture content of 9 to 18 %, followed by fast freezing has proved satisfactory. Cryobanking of diverse germplasm as seeds and embryos, embryonic axes necessitates their *in-vitro* regeneration into healthy plants and plantlets before and after storage.

In-vitro recovery methods, mainly using MS medium, have been standardized for the non-orthodox seeded species — tea (*Camellia sinensis*), almond (*Prunus amygdalus*), *Citrus* species (12 spp.), *neem* (*Azadirachta indica*), walnut (*Juglans regia*), apricot (*Prunus armeniaca*), jatropha (*Jatropha curcas*), pongam (*Pongamia pinnata*), *pilu* (*Salvadora persica*), *mahua* (*Madhuca indica*) and *khirni* (*Manilkara hexandra*). The explants before and after storage were *in-vitro* planted in optimized conditions to trigger rapid and direct growth without intervening callus.

Tea embryonic axes were cultured on modified Nakamura medium with 0.1% yeast extract. The axes of *Citrus* spp., neem, walnut, apricot, *pilu* and almond were cultured on the medium defined by Chin *et al.* containing Murashige and Skoog's macro and microelements, 0.17 g /litre NaH_2PO_4, vitamins, iron, 1 mg/ litre each of benzyl aminopurine and naphthalene acetic acid and 2 g/ litre of activated charcoal. Jatropha embryos were cultured on the MS medium with 1 mg/ litre of benzyl aminopurine. Cultures were maintained at 25±2°C with a 16 hr photoperiod under light intensity of 35 $mE/m^2/sec$, unless specified otherwise. Axes that formed a well-defined root and a shoot were considered viable. Survival of the explants at the first instance was recorded after about 24 to 48 hr of cryostorage. Later, testing intervals were increased to 5 months and 5 years.

Cryovials and polyolefin tubings containing explants were rapidly thawed in a water-bath at +37°C for 5 min, and subsequently explants were used for regeneration. After 3 months in culture, development of surviving axes was examined by assessing shoot and root emergence percentage.

Embryonic axes desiccated to 11-16% moisture of *Citrus*



Recovery of plantlets from cryostored embryonic axes of different species. (**A**) *Citrus latipes* (**B**) *Salvadora oleoides* (**C**) *Azadirachta indica* (**D**) *Prunus armeniaca* (**E**) *Juglans regia* and (**F**) *Jatropha curcas*

limonia, C. grandis and *C. aurantifolia* and *C. jhambiri* could be successfully cryopreserved. Desiccated controls showed high viability values ranging from 90 to 100%. The cryopreserved axes showed growth within 5 days of culturing and their viability ranged from 80 to 90%. Well-formed shoots and roots were apparent within 20 days of culturing. In a few cases, where regrowth was suboptimal, cultures were placed in the dark or under reduced light for about 7 days before transferring to normal light regime. In *Salvadora* sp., *in-vitro* recovery of embryonic axes, excised from cryostored seeds, was found essential as cotyledons and endocarp impeded growth of viable embryonic axes. In temperate species, walnut and apricot, need to subject seed materials to pre-chilling for several weeks was obviated. In all the cases, normal healthy plants could be recovered and transferred to field after different cryostorage periods of 1 to 24 years.

In all, more than 600 germplasm have been cryostored as embryos and embryonic axes. Studies indicate that cryopreservation of embryos and embryonic axes is a successful and reliable method for long-term conservation of non-orthodox seed species.

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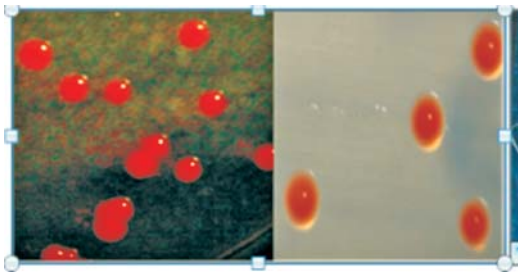
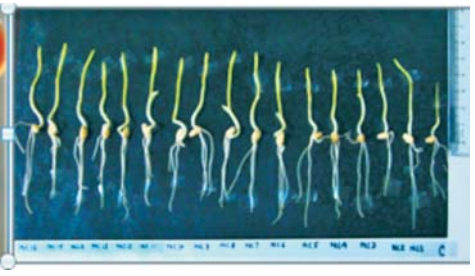
Epiphytic methylobacteria for crop-health

A distinct group of pink-pigmented facultative methylotrophic (PPFMs) bacteria were isolated, and were functionally characterized from the phyllosphere of sugarcane, pigeonpea, mustard, potato and radish. Sixteen potential cytokinin (phytohormone)-producing organisms that were identified with the amplification of the functional *mxaF* gene showed similarity with *Methylobacterium radiotolerans, M. mesophilicum, M. hispanicum, M. organophilum, M. suomiense, M. oryzae, M. salsuginis, M. phyllosphaerae*.

The PPFMs are phylogenetically diverse proteobacteria that utilize formate, formaldehyde and methanol as the sole source of carbon. Their habitat includes phyllosphere, root nodules, dust, freshwater, drinking water and lake sediments. *Methylobacterium* species are commonly leaf epiphytes.



Typical pink-pigmented facultative methylotrophic bacteria from phyllosphere of different crop-plants



Effect of PPFM cell extracts on wheat-seed germination

Secretions of the culture filtrate of *M. mesophilicum* (NC 4) enhanced seed germination (98.3%) of wheat (*Triticum aestivum*) in comparison to control (85.0%). Seedling length and vigour enhanced positively by the bacterial extract. Maximum shoot length (6.20 cm) was observed with *M. radiotolerans* and root length (5.13 cm) with *M. mesophilicum*. Targeted metabolomics of the extracts with HPLC profiling for phytohormone production by the strains quantified cytokinin secretion in the range of 1.09 to 9.89 µg/ml of the culture filtrate; which by many methylobacteria was fairly higher than that produced by *Bacillus* species.

Epiphytic phytosymbionts consume plant by-products like methanol and synthesize variety of metabolites that help plant grow, are possessed with the ability to alter physiological traits like branching, seedling vigour, root differentiation, tolerance to heat and cold. With this wide array of functionalities, the cytokinin-producing beneficial methylotrophic bacterial community can be useful in developing next-generation microbial consortia-based foliar bio-inoculants for phyllosphere applications. Co-inoculating PPFMs with other compatible bacterial communities will enhance possibility of better efficacy over conventional species-specific single-microbial bio-input.

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Conservation tillage and cowpea + castor intercropping for high returns

Green cowpea pod yield (1,348 kg/ha) and castor grain yield (3,100 kg/ha) were recorded with 4.56 kg/ha-mm water-use efficiency at Vasad. This intercropping system has given gross returns of ₹78,838/ha and a net economic returns of ₹56,838/ha to farmers, as against a net return of ₹32,000/ha under the traditional cropping system. An additional monetary benefit of about ₹25,000/ha has been observed over the traditional castor-based cropping system. The technology tends to reduce soil loss due to adoption of conservation tillage practice and moisture conservation, as is reflected by the better water-use efficiency.

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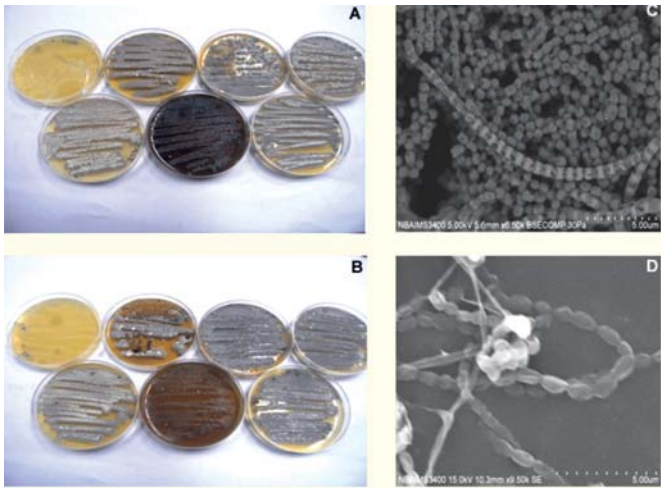
Novel value-added extremophilic actinomycetes

This study included three extremophilic regions — Rajgir thermal springs (Bihar, India) with recorded temperature of 55°C, followed by Sambhar salt lake (Rajasthan), producing 8.7% salt for India, and lastly Pangong cold lake (Leh and Ladakh), the largest brackish snow-capped lake in India, which freezes completely during winter despite being saline—to decipher actinomycetes diversity, and isolated 46, 41, 25 isolates, respectively .



Characterization of extremophilic actinomycetes from Rajgir thermal spring, Pangong cold Lake and Sambhar salt lake (**A, B:** morphological characterization of actinomycetes on ISP medium; **C, D:** Scanning electron microscopy of actinomycetes from extreme regions)

Rajgir hot-spring representative isolates could grow above 40°C, and Sambhar salt lake isolates tolerated 12% NaCl stress.

Plant-growth promoting attributes of isolates such as phosphate solubilization, ammonia production and siderophore production from these regions have revealed that a total of 5, 3, and 1 isolates, respectively from Rajgir hot- spring, Pangong cold lake and Sambhar salt lake regions can be utilized in agricultural practices. The isolates are also known to be involved in the production of various industrial enzymes such as amylase and protease. Studies showed that thermophilic niche (Rajgir hot-spring) harboured maximum number of amylase(4) and protease (4) isolates, followed by Leh region, 3 and 2 isolates, and the least number of isolates (2, 1) were from saline (Sambhar salt lake) ecosystem.

Molecular diversity with the amplified rDNA restriction analysis (ARDRA) revealed that a total of eight, seven and five clusters were found from Pangong cold-lake, Rajgir hot-spring and Sambhar salt lake. However, 16S rDNA gene sequences alone can be misleading due to intraspecific variations and sequence heterogenicity. So DNA directed RNA polymerase gene (*rpo* β) has been taken as a potential biomarker to overcome identification problems due to high level of conservation of 16S rDNA gene. Phylogenic characterization and taxonomic affiliation of extremophilic actinomycetes have revealed that strains from Rajgir hot-spring are *Streptomyces griseolous*, *S. sapproverrucosus*, *S. sporoclivatus*, *S. albospinus*, *S. ocharcecrius*, *S. sclerotilus* and *S. globisporous*; from Pangong psychrophilic lake are *S. albidoflavus*, *S. oderiflavus*, *S. globosus*, *S. asiaticus*, *S. limosus*, *S. hygroscopicus*, *S. nitrosporous* and *Streptomycetes* sp.; and from Sambhar salt-lake are *S. hygroscopicus*, *S. melanosporofaciens*, *S. lydicus*, *S. macrosporus* and *S. endus*. The analyses have also demonstrated that *rpo*β is another important ecological marker with equal importance as 16S rDNA.

Actinomycetes are cosmopolitan in nature and encompass >80 genera and provide 80% of bioactive compounds as well as 3,500 antibiotic secondary metabolites. They are also used for management of pests and pathogens, bioleaching of metals, increasing soil fertility, generating biofuels, monitoring pollutants and waste treatment. The necessary extreme adapations of extremophilic organisms to all aspects suggest that a wide variety of biomolecules may find application in existing and future biotechnological processes.

It is still not clear how microbial diversity influences environmental functions such as nutrient cycling, degradation of xenobiotics, and ecosystem stability. Many workers have reported that environmental heterogeneity is the main cause of diversity, and it directly influences spatial heterogeneity in the microbial communities. On the basis of the results of this investigation, we conclude that the *Streptomyces* diversity in the Pangong cold lake is high at species level, followed by Rajgir hot-spring and Sambhar salt-lake. So far, only a few reports were available on the systematic investigation of the actinomycetes diversity from exotic lakes (cold lake, hot spring and salt lake) of India.

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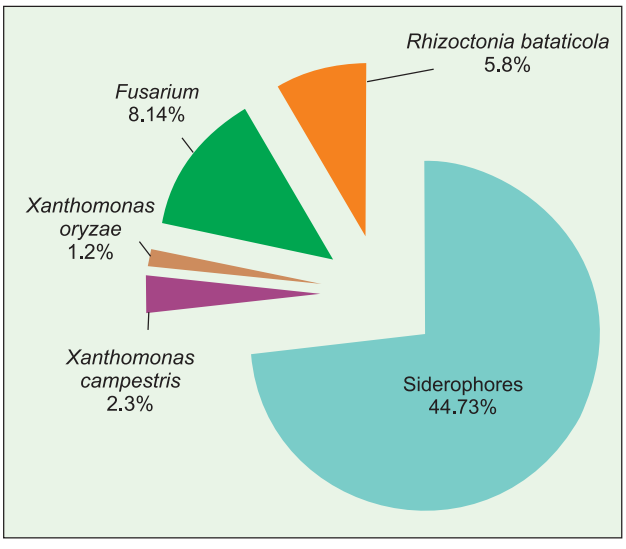
Siderophore-producing bacteria for containing pathogens

Around 270 bacterial isolates from wheat rhizosphere were isolated and screened under *in-vitro* conditions for plant-growth promoting traits like indole acetic acid, HCN production, P-solubilization, and siderophore production. Forty-seven isolates (44.73%) were found siderophore positive. *In-vitro* bioassay was carried out



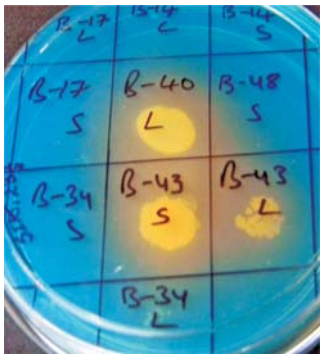
Per cent functional diversity of siderophore producers

with these isolates against two fungal and two bacterial pathogens— *Fusarium verticilloide* (fungal pathogen of wheat and maize), *Rhizoctonia bataticola* (fungal pathogen of pulse crops) and *Xanthomonas oryzae* (bacterial pathogen of rice) and *Xanthomonas campestris* (causative agent of cabbage black-rot disease). Eight isolates showed inhibition against *F. verticilloide*, and five against *Rhizoctonia bataticola*. *In-vitro* inhibition for bacterial pathogens was low; only one isolate inhibited *X. oryzae* and two to *X. campestris*. Antibiosis or biocontrol by the bacterial isolate generally is because of metabolites production like peptides and other hydrolytic enzymes that can lyse fungal cell-walls.

Microorganisms have developed various mechanisms to overcome low bio-availability of iron, involving synthesis and secretion of low molecular weight iron-specific chelators, known as "siderophore".

These iron chelators or siderophores would thus make iron unavailable to pathogens that need iron in the soil, thus creating a transient 'Fe deficiency' which would inhibit pathogen growth, thereby reducing disease incidence.

In-vitro bioassay against *Fusarium verticilloide*



Siderophore +ve bacteria

Bacteria can employ another devise, siderophores, which chelate Fe in the vicinity of the growing pathogen and create Fe-deficient conditions. Pathogens like *Fusarium* need Fe for the growth, and their growth gets inhibited in the absence or due to low availability of Fe. Siderophores contain pathogens, and thereby improve plant growth. This study is exploring development and utilization of effective bacterial siderophore bioinoculatnts.

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Soil test and fertilizer recommendation meter

This meter is a low-cost, user-friendly digital system embedded instrument, which can estimate quantitatively in the soil available nutrients organic carbon, nitrate, phosphorus, potassium, sulphur, zinc and boron. Soil is extracted with an appropriate extractant, and subsequently by the addition of the appropriate reagents colour is developed in the extract. Colour intensity is proportional to the amount of the nutrients, and is measured by this meter. After estimating all nutrients, fertilizer recommendations can be obtained for a selected crop. At present, this instrument has a provision for fertilizer recommendations for wheat and maize.

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Bombus braviceps: a new pollinator of large cardamom

Large cardamom (*Amomum subulatum*) is a highly cross-pollinated crop; its capsule production is dependent on the population density of the pollinator. On the basis of the visitation frequency and foraging time, a native bumblebee (*Bombus braviceps*) was identified as the major pollinator of the large cardamom. It showed high foraging time (cumulative time – 118.93 sec) and the highest pollination potential (PP) index score (0.88). In contrast, PP index score of honey-bee (*Apis cerena*) was comparatively low. Bumblebee was found effective pollinator as it delivered relatively higher number of pollen on the stigma even though percentage deposition was only 4.5%. Pollination efficiency of the bumblebee was as high as 75% with its first visit, and it increased with subsequent visits. Contrary to this, pollination efficiency of the honey-bee was low (8.5%) even after five visits. Microscopic observations of the pollinated stigma showed difference in the mode of pollen delivery—bumblebee delivered pollen mostly inside the receptive cup of the stigma that assured high rate of fertilization, while other visitors deposited pollen around the non-receptive stigma hairs; present on the margin of the stigma-cup.

Bombus braviceps pollinating flower

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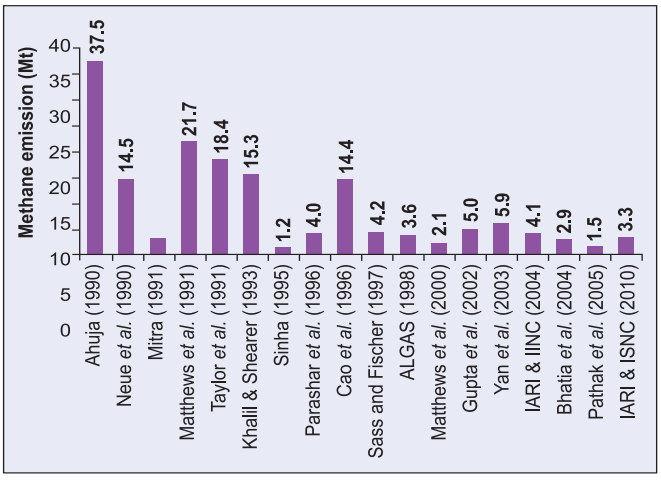
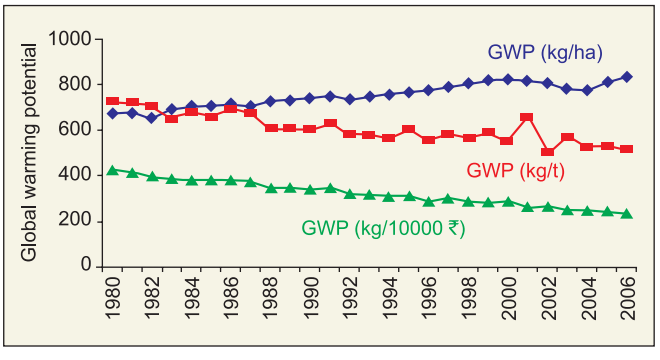
Greenhouse gases emission trends in India

Increased concentration of greenhouse gases (GHGs), carbon-dioxide (CO_2), methane (CH_4) and nitrous-oxide (N_2O), in the atmosphere are responsible for global warming and climate change. The estimates of 2010 showed that Indian rice fields covering 43.86 million hectares emitted 3.33 million tonnes of methane. Nitrous-oxide emission from Indian agricultural soils was 0.14 million tonnes. Methane emission from the rice fields has remained almost static over the years. However, emission of nitrous-oxide is increasing over the years as a result of the higher use of nitrogenous fertilizers. Therefore, total global warming potential (GWP) in India (methane × 25 + nitrous oxide × 298) per unit area (kg CO_2 eq./ha) is increasing. But, GWP per unit of produce (kg CO_2 eq./ tonne) is decreasing. Also GHG intensity per unit agricultural gross domestic product (Ag-GDP) has declined. This decline is due to increased agricultural production by the adoption of high-yielding varieties and better crop-management practices without increase in area. Though application of nitrogen fertilizers has increased agricultural GWP, but increase in yield, and thereby agricultural GDP, has been greater because of higher N-use. This analysis has shown that there is enough scope for improving agricultural production without off-setting GHG emission.



Estimates of methane emission from Indian rice fields



Trend in greenhouse gases emission intensity in Indian agriculture

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Directorate of Wheat Research, Karnal

To ensure food security of India by enhancing productivity and profitability of wheat and barley on an ecologically and economically sustainable basis

Though wheat research in India had started during the early 20th century, the major jump in wheat yield potential was realized only after 1960. In 1961, All-India Coordinated Wheat Improvement Project (AICWIP) was initiated by the Indian Council of Agricultural Research (ICAR), and in 1965, it was formally launched with the financial support by the centre to strengthen wheat-research activities in the country. Establishment of the project was an important milestone in the history of wheat-improvement programme in India to meet the growing demand of the burgeoning population. The dwarf wheat varieties, improved under the AICRIP exceptionally yielded high under the better management production conditions and led to the "green revolution" in India. With the addition of the Barley Network, the project was renamed as the All-India Coordinated Wheat and Barley Improvement Project (AICW&BIP). The project was elevated in 1978 to the status of the Directorate of Wheat Research, and it was moved in 1990 to its present location at Karnal.

Regional Station, Flowerdale, Shimla

A national facility for screening material against rusts has been established at Flowerdale, Shimla. In addition to monitoring, the station helps in screening advanced generation materials, postulating rust-resistant genes in the test lines; and it acts as a repository of rust pathotypes. It has collection of more than one hundred-and-twenty-five rust pathogens identified since 1930.These are maintained as live-cultures as well as stored in the short-and long-term storages.

The Directorate of Wheat Research has six major disciplines—crop improvement, crop protection, resource management, quality and basic sciences, statistics and computer cell and social sciences—and also a network project on barley.

Wheat-crop is exposed to a wide array of agroclimatic changes in the country. Considering agroclimatic conditions and based on the land-use planning, the

Regional Station, Dalang Maidan, Lahaul & Spiti

This station has been established as a summer nursery facility for generation advancement and evaluation of breeding material (growing two crops in a year, during winter in the plains and another in the summers at this station) to reduce time lag in the development of a variety. Multiplication of important cultures/varieties for use/distribution; attempting corrective crosses to speed-up development of superior lines;and for conducting high altitude wheat and barley varietal evaluation trials are other activities assigned to the station. In addition, the station serves as one of the national wheat and barley repository, maintained under the natural conditions in a cost-effective manner. At present, about 7,691 wheat and 2,000 barley accessions are conserved, and the accessions have the germination capacity under desired level even after 10 years of conservation in the natural conditions.

Regional Station, Flowerdale, Shimla

Regional Station, Dalang Maidan

MANDATE

- Organize, coordinate and monitor multilocational and multidisciplinary research for developing and identifying superior wheat and barley varieties with better quality and tolerance to biotic and abiotic stresses under varied agroclimatic zones.
- Collect, acquire, evaluate, catalogue, maintain and share working germplasm collections of wheat and barley with focused attention on identifying suitable donors for yield components, biotic and abiotic stresses and quality traits.
- Undertake basic and strategic research for a major advance in genetic yield potential, quality, and durable disease resistance through utilization of genetic resources and genetic enhancement.
- Mobilize genetic diversity from national and international sources for developing new genetic stocks for distribution to cooperating centres in different zones.
- Develop strategic research, which will lead to precision farming, enhanced input-use efficiency, optimal use of renewable resources, and enhanced sustainability of wheat-based cropping systems.
- Monitor obligate parasites, e.g. rust pathogen dynamics, and develop strategies to mitigate crop losses due to pests and diseases.
- Establish national and international linkages for strengthening wheat and barley improvement programmes.
- Provide off-season nursery facility for rapid generation advancement and seed multiplication.
- Serve as a core facility for data analysis, documentation and information management, so that the directorate becomes national repository for all wheat and barley databases.
- Coordinate and organize nucleus and breeder seed production.
- Impart training/education related to wheat and barley improvement, production, protection, utilization and trade.

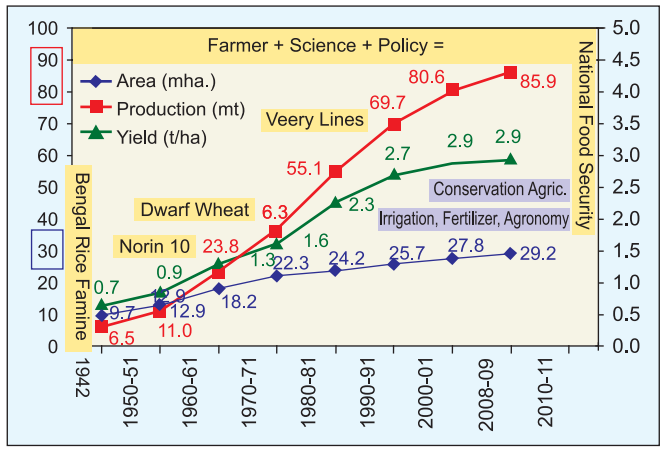
country has been divided into : (i) Northern Hills Zone (NHZ), (ii) North Western Plains Zone (NWPZ), (iii) North Eastern Plains Zone (NEPZ), (iv) Central Zone (CZ), (v) Peninsular Zone (PZ) and (vi) Southern Hills Zone (SHZ). **A wide network of 31 funded and 131 voluntary centres are located in different state agricultural universities (SAUs), autonomous institutions and central universities for supporting multidisciplinary research on wheat.**

ACHIEVEMENTS

Crop improvement

Wheat varieties released

So far, 378 improved varieties of bread wheat, *durum* wheat, *dicoccum* wheat and triticale have been released for commercial cultivation.



Overall increase in area, production and productivity of wheat

DPW 621–50

Wheat and triticale varieties released during 1965 to 2011

Species	Released by CVRC	Released by SVRC	Total
Bread wheat (*Triticum aestivum*)	208	111	319
Durum wheat (*T. durum*)	25	24	49
Dicoccum wheat (*T. dicoccum*)	05	-	05
Triticale	04	01	05
Total	**226**	**152**	**378**

The Directorate has developed and registered 136 trait-specific genetic stocks of wheat. Seeds of all these stocks have been maintained in the National Gene Bank at the NBPGR, New Delhi, and in the germplasm repository of the Directorate.

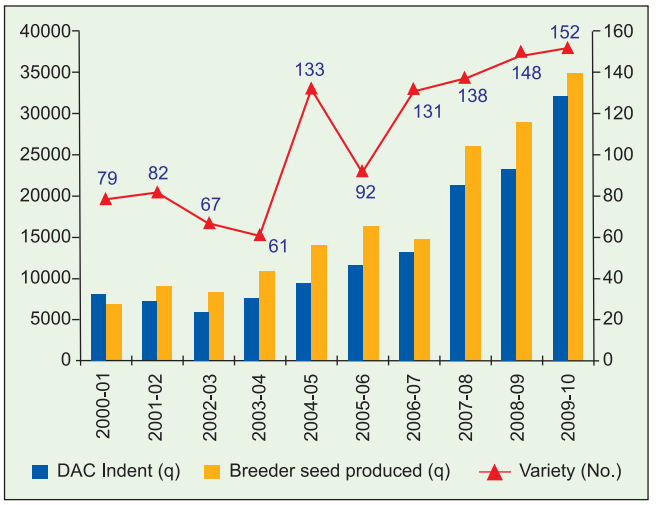
Biotechnology

Marker-assisted selections have been performed in the early segregating generations to select plants generated in the background of the popular cultivars, PBW 343, HD 2733, WH 147, HUW 234, Lok 1 with different effective leaf rust (*Lr24, Lr28, Lr34, Lr35, Lr37*) and

stripe rust (*Yr10, Yr15*) resistant genes. Successful introgressions of these genes using molecular markers have been accomplished. Plants having gene combinations *Lr24+Lr37, Lr24+ Lr28, Lr24+Lr28+Yr15* have been confirmed.

Breeder seed production

Presently, India is producing more than 35,000 quintals of breeder seed of wheat varieties, fulfilling national requirement of 32,000 quintals breeder seed; that is indented annually through the Department of Agriculture and Co-operation.



Crop protection

Pathogenic and genetic variations in wheat pathogens—*Tilletia indica*, *Fusarium* spp. and *Bipolaris sorokiniana*—have been resolved on host differentials and through use of molecular markers.

Approximately 50 lines are supplied to breeders every year through the National Genetic Stock Nursery for incorporating resistance.

There has been a strong system of development of rust-resistant varieties in India ever since the All-India Wheat Coordination was initiated. Rusts pathotypes/races collected through the extensive surveys are identified at the RRS Shimla and Mahabaleshwar and deployed for resistance screening of breeding materials and advance lines.

Resource management

To achieve sustainable wheat productivity, efficient resource-management technologies have been developed.

- For dwarf varieties, seed rate of 100 kg/ha is required for a proper crop-stand; it may be suitably modified for different cultural situations. Seeding depth should be 5-6 cm with an inter-row distance of 17.5-22.5 cm for the timely sown and 15-17.5 cm for the late sown wheat.
- Application of 120 kg nitrogen, 60 kg phosphorus and 30 kg potash per hectare is required for optimum productivity. New wheat varieties have responded up to 180 kg N /ha, with an optimal at around 150 kg/ha in the NWPZ and NEPZ. And 25 kg zinc /ha has been found to increase yield substantially in rice-wheat system.
- Zero-tillage technology was developed, and has been adopted by the farmers of the NWPZ and NEPZ for producing wheat at lower cost. The laser-land leveling is paying rich dividends in the NWPZ by enhancing input-use efficiency. The other technologies that can be adopted by the farmers in the near future are FIRB, Rotary-Till Drill, Strip Till Drill and Rotary Disc Drill. Adopting conservation agriculture, i.e. seeding into surface-retained residue will help improving sustainability of soil and water resources by avoiding crop residue burning; and thus leading to healthier environment as well as enhanced productivity with lower external inputs.
- The alternative cropping systems which are found more remunerative with accompanying changes in tillage options (FIRBS) are as follows: rice-vegetable pea-winter maize, rice-wheat-greengram, rice-vegetable pea-wheat for one-year rotation and pigeonpea-wheat-rice-wheat and rice-mustard-greengram-rice-wheat for two-year rotation.

Barley improvement

- A number of good two-row and six-row malt feed and dual type barley varieties have been developed for commercial cultivation in India.
- Several barley genetic stocks have been registered for malt-quality traits, disease and pest resistance.
- More than 6,000 barley accessions including exotic and indigenous collections have been evaluated and maintained in the barley repository at the Directorate.
- Reduced row-to-row spacing for two-row malt barley has been recommended for higher yields as well as good quality.
- A numbers of lines have been identified possessing resistance to major diseases, rusts, leaf blights, nematodes, insect pests and also with multiple disease/ multiple pest resistance.
- Linkages have been established with the Indian Malting and Brewery Industries for popularization of malt barley in country.

XII PLAN RESEARCH PRIORITIES

Flagship programmes: Pre-breeding for broadening

Action plan to contain yellow rust in 2011-12

In 2001, a new yellow rust pathotype, 78S84 virulent, was detected on wheat PBW 343. Stripe-rust pathogen survives in the north hilly areas, and as the result of the continuous growing of the susceptible varieties in the major wheat-growing areas of the north-western plains zone, inoculum built-up increased in the hilly areas also. Timely action by the Directorate by resorting to spray of propiconazole in the affected areas, could avert losses of 2-3 million tonnes. Following action plan was formulated for crop-season 2011-12.

Stripe rust

- Rust situation was monitored extensively in off- season at Leh (Ladakh) region of Jammu and Kashmir and in high hills of Himachal Pradesh during July-September 2011. Rust samples were analyzed for the pathotype identification. A joint survey by Indian wheat scientists in collaboration with the CIMMYT South Asia office, Nepal, and NARC, Nepal, was undertaken during October 2011 in Nepal hills for understanding epidemiology.
- A special session on stripe rust was organized at New Delhi in September 2011. Three teams were constituted for monitoring rusts in the NWPZ. In addition to propiconazole (Tilt 25 EC), two other fungicides, tebuconazole (Folicur 250 EC) and triademefon (Bayleton 25 WP) at 0.1 % gave excellent stripe-rust control at the multilocational testing.
- New molecules for stripe rust management are being tested.
- Trap- plot nurseries were planted at 37 locations, including Nawa Shahar (Punjab), Khudwani (Srinagar) and Yamunanagar (Haryana), where high incidence of the disease occurred usually.
- Off-season Disease Monitoring Nursery are planted in Dalang Maidan, Kukumseri, Sangla, Sarahan (Himachal Pradesh) and Leh (Jammu and Kashmir).
- SAARC- Nurseries have been planted at 15 Indian locations—Ludhiana, Delhi, Dhaulakuan, Gurdaspur, Dera-Baba-Nanak, Abohar, Sri Ganganagar, Chattha, Kathua, Rajouri, Almora, Durgapura, Faizabad, Pantnagar and Wellington.
- Breeder seeds of rust-resistant varieties, DPW 621-50 and HD 2967 have been distributed to replace stripe-rust susceptible variety PBW 343.
- Resistance is being incorporated in the high-yielding wheat varieties using *Yr10* and *Yr15* through molecular markers. Progenitors and other related species are also being deployed for transferring resistance in the high-yielding genotypes.

genetic base by integrating conventional and biotechnological approaches; Security of wheat against rust; Conservation agriculture for enhancing benefits to farmers and environment.

Critical areas to be addressed: Bridging yield gaps; Breaking yield barriers; Combating threat of rusts and other diseases; Mitigating effects of climate change; Conservation agriculture to address issues of resource sustainability.

Wheat: *Improvement*. Enhancing yield and adaptability of wheat varieties under changing climate; Developing genotypes resistant to new virulent races of rusts including Ug99; Strengthening of hybrid wheat programme; Characterization of genetic resources for useful traits; Creation of new variability from unutilized genetic resources and their utilization; Utilizing molecular approaches for precision breeding; Enhancing seed production for increased seed replacement of older varieties; Breeding for heat-stress tolerance, water- and nutrient-use efficiency using marker-assisted selection.

Crop protection. Survey-surveillance, crop-health monitoring and undertaking challenges of new races of rust; Creating national repository of pathotypes of different rust pathogens; Epidemiological studies in relation to changing climate; Host resistance – identification of new and diverse sources of resistance with emphasis on multiple diseases/pests resistance; Devising eco-friendly management of diseases and pests and to promote IPM; Integrating molecular tools for understanding variability in pathogens

Resource management. Develop and fine-tune package of practices and varieties specific to RCTs—zero tillage, bed planting, need-based application of nutrients (N) using leaf colour charts; Evaluating long-term effects of tillage and residue management options on soil properties, pest dynamics and productivity of wheat;

Preparedness for new wheat stem-rust race, Ug 99

In 1999,a new race of stem rust evolved in Uganda (Africa); this is known as Ug 99 or TTKS. The most important thing about Ug is that it has rendered *Sr31* gene ineffective, located on 1BL/1RS (*Sr31, Lr26, Yr9, Pm 8*) chromosome along with a group of other important stem-rust resistant genes. Since over the last four decades, the serious epidemic of the stem rust was kept under control with the extensive use of *Sr31* and *Sr2* complex of resistance genes, hence, the defeat of the important stem rust resistance gene *Sr31* and some of the other known *Sr* genes has become the cause of great concern world over. Seven variants of Ug 99 (TTKSK, TTKSF, TTKST, TTTSK, TTKSP, PTKSK and PTKST) have been reported from Uganda, Kenya, Sudan, Yemen, Iran, South Africa and Zimbabwe. The TTKST is the most virulent form of Ug 99, present in Kenya. The Directorate of Wheat Research with Borlaug Global Rust Initiative (BGRI) took timely steps and evaluated Indian wheat material for Ug99 at Kenya (2005-2011). This has resulted into identification of the resistant varieties in seed-chain and genetic stocks.

Focused attention on integrated nutrient and water management; Diversification/intensification through integration of legumes in rice-wheat system to improve profitability and sustainability; Integrated weed management strategies for wheat; Emphasis on conservation agriculture to address issue of climate change and ill-effects of residue burning.

Quality improvement. Development of product-specific varieties with enhanced nutritional quality; Understanding genetics of quality traits and their molecular basis; Development of micro-level tests to expedite breeding efforts; Enhancing bio-availability of micronutrients (Fe and Zn) and increasing antioxidant activities.

Barley: *Improvement.* Improvement for malt under high-input conditions and for dual-purpose (feed and fodder) in rainfed and restricted irrigated areas; Germplasm enhancement through pre-breeding, involving wide crosses and winter × spring hybridization; Incorporation of diverse resistance for stripe and leaf rusts, leaf spot and aphid; Use of MAS in resistance breeding and malting quality improvement; Molecular diagnostics of pathogens (race identification) and host resistance; Biochemical basis of malting and nutritional quality in Indian barley; Nutrient management of dual-purpose barley and also in saline-sodic soils.

Priorities for AICW&BIP centres

- Mechanization facilities for improving precision in conduct of trials
- Facilitate quick exchange of germplasm
- Strengthen breeder seed production of released varieties

Zone-wise research priorities

Northern Hill Zone. Wheat improvement for rainfed areas, high altitude and early sowing, longer duration and cold tolerance; Undertaking challenges of yellow rust and powdery mildew; Pre-breeding efforts involving winter × spring hybridization.

North Western Plains Zone. Enhancing yield potential through strong pre-breeding efforts utilizing genetic resources including diploid progenitors and synthetic hexaploids; Managing biotic stresses mainly yellow and brown rusts; Residue management, tillage practices and balanced fertilizer-use technologies; Improving processing and nutritional quality of wheat; Developing doubled haploid production facilities at lead centres; Strengthening CCN facility in Rajasthan.

North-Eastern Plains Zone. Development of short-duration wheat cultivars; Developing tolerance to post-harvest sprouting for far-east region of the country. Major emphasis would be put on heat stress, leaf blight resistance, salinity stress, waterlogging and micronutrient deficiency/toxicity.

Central Zone. The main emphasis will be on heat and drought tolerance with a special emphasis on development of varieties for restricted irrigated areas; undertaking challenge of brown and black rust and leaf blight; Strengthening *durum* wheat breeding to improve quality.

Peninsular Zone. Improving resistance for brown and black rust; Developing wheat having heat and drought tolerance; Improving *durum* and *dicoccum* quality; Strengthening rust screening and pathotyping studies.

Southern Hill Zone. Major emphasis will be on rust screening and pathotyping to develop resistance stocks.

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Varieties released for the National Capital Region, Delhi

The Delhi State Seed Sub-Committee has released four varieties of vegetables, four hybrids of mango, five varieties of flowers and two varieties of chickpea for the National Capital Region, Delhi.

Pusa Vrishti is the first high-heat, humidity tolerant tropical carrot variety of 90-95 days duration with obtriangular shape and self-red coloured roots, suitable for early sowing under the North Indian plains. Its average root weight is150-200g (25 tonnes of root yield /ha), and it is rich in carotenoids (867 µg/100 g), lycopene (405 µg/100gm) and β-carotene (144 µg/100 g). **Pusa Nayanjyoti,** the first F_1 hybrid of orange-coloured temperate carrot, developed using CMS system, is suitable for all carrot-growing areas (of 75-85 days duration) with average root yield of 39.6 tonnes/ha. It has uniform, attractive, smooth, cylindrical, stumpy roots, rich in carotene (7.552 mg/100 g FW). **Pusa Shukti**, a December-January maturity-group cauliflower variety, characterized by medium green coloured leaves with broad lamina and rounded top, bearing cream-white compact curds, takes 80-85 days to reach marketable stage with harvesting duration of 14-15 days. It has average curd weight of 800-900 g, and is tolerant to downy mildew and black-rot. Ridge-gourd variety **Pusa Nutan** has long (25-30 cm), straight, attractive green fruits with ten longitudinal angular ridges and a tapered neck, tender flesh, having an average fruit weight of 105 g, and it is suitable for spring-summer and *kharif* season. The variety is ready for first harvesting in *kharif* in 45-50 days and in 55-60 days in spring-summer. It is field-tolerant to luffa yellow mosaic virus.

Four mango hybrids, Pusa Pratibha, Pusa Shreshth, Pusa Lalima and Pusa Peetamber, are semi-vigorous, regular bearers and are suitable for closer planting and have high amount of pulp, rich in vitamin C and β-carotene, and has longer shelf-life. **Pusa Pratibha** bears uniform oblong fruits with bright-red peel and orange pulp having good sugar: acid blend. **Pusa Shreshth** bears elongated shaped fruits with red peel and orange pulp,

Chickpea-Pusa Bheema

Mango hybrid Pusa Shreshth

with excellent sugar: acid blend and also has pleasant gustatory aroma. **Pusa Lalima** is with jasper red peel and orange pulp, and has good flavour. It yields four times higher than *Dushehari*. **Pusa Peetamber** has bright-yellow peel with juicy pulp with appealing flavour.

Pusa Centenary, a mutant of cv. Thai Chen Queen**,** is a vigorous-growing chrysanthemum variety, produces very big yellow flowers, blooms in 100-110 days after transplanting, and is ideal for cut-flowers. Another mutant of cv. Ajay, **Pusa Anmol,** is highly floriferous bushy variety with yellowish pink flowers, is thermo- and photo-insensitive, flowers in 85-100 days after transplanting and produces three flushes of flower, in a year (October-December, February-March and June-July). It is ideal for loose flowers and whole plant cut-flower. **Pusa Arpita**, a French marigold, is a selection from local collection that produces medium-sized yellow flowers during December-January.

Chickpea **Pusa Shaktiman** is an extra bold seeded *kabuli* variety having 100-seed weight of 50 g and is resistant to *Fusarium* wilt/dry root rot, and **Pusa Bheema** is the first *Desi* extra- large light brown seeded variety, having 100-seed weight of 40 g, and is resistant to *Fusarium* wilt rot and drought.

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Apricot fruit-bar

For preparing best quality apricot fruit-bar, fruits should have ideal colour, texture and flavour. Fruits should be ripe but not over-ripe. Selected fruits are washed and treated with 100 ppm sodium hypochlorite for a minute. Stems, stones are removed, and bruised portion of the fruits are discarded. Apricot halves are dipped in ascorbic acid (5% w/v) and citric acid (5 % w/v) for 30 seconds. Then they are steam-blanched for 5 min. Make a puree in a blender or a processor. The puree is drained and passed through a screen pulper. The final puree is concentrated with sugar up to 55±2° Brix. And the final concentrate is spread in the food-approved plastic or steel trays of about 4-mm thickness in the tunnel dryer (sun-drying) for 22-24 hours (temperature 48-50° C

Apricot *(Prunus armeniaca* L.) is an attractive, delicious and highly nutritious fruit, rich in vitamin A and contains good quantity of carbohydrates, phosphorus and niacin. In India, it is grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand and to a limited extent in the north-eastern hills. Apricot and its pulp can be made into a number of dehydrated products, which are appealing, nutritive and are with excellent flavour and aroma.

and relative humidity of 30%). The dried spread is uniformly cut into shape of small fruit bars in different layers and packed in 25 µ polyethylene film or foods approved plastic cups and finally shrink wrapped.

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Economic empowerment in Senapati district of Manipur

The hilly regions of India, especially of the North-Eastern Region, are treasure-trove of germplasm of horticultural crops; many of which are underutilized and underexploited. The cultivation and value-addition of underutilized crops will add to food basket.

Purul is one of the remote villages in Senapati district of Manipur. The village and its surrounding areas have all the pre-requisites for successful cultivation of passion-fruit and *Prunus nepalensis.* They have a great potential in the region due to their fruit quality, unique colour and flavour. There are no established orchards of these in the state and they are mostly grown in homestead yard and as wild crops in the forest. The centre has developed value-added products from these two potential fruits, and has disseminated technology to farmers.

The ICAR launched "*Community Based Value Addition Programme*" under the Horticulture Mission for the North Eastern and Himalayan States, in which Mr Peter,

a very laborious and progressive farmer from Purul Akutpa Village in Senapati district, was one of the local organizers as well as the trainee. Mr Peter along with some farm-women has started a small-scale community fruit processing unit and started producing passion-fruit and prunus squash and jam. He is also preparing vermicompost out of the waste products from passion-fruits using RC Vermi Bin.

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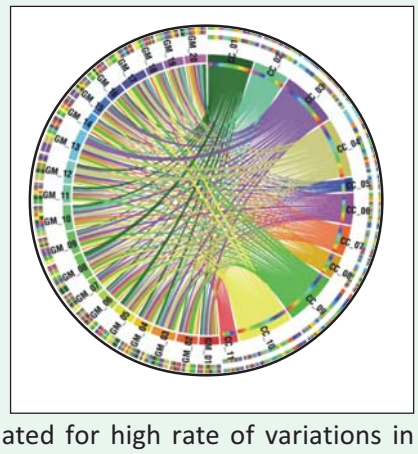
Indian scientists decoded pigeonpea genome sequence

Pigeonpea or redgram is an important grain-legume crop. Availability of pigeonpea genome sequence will accelerate development of its new varieties and hybrids.

A group of thirty-one Indian scientists from the ICAR Institutes, State Agricultural Universities and Banaras Hindu University have decoded genome of pigeonpea, the second most important pulse-crop of India. This is the first plant genome,sequenced entirely through a network of Indian institutions. Availability of its genome sequence will accelerate development of new varieties and hybrids with enhanced productivity by making use of germplasm resources in a way similar to rice genome. A total of 47,004 protein-coding genes have been identified in the pigeonpea genome; of which 1,213



are for disease resistance and 152 are for tolerance to drought, heat and salinity. The genome sequence has been used to develop a large number of pigeonpea DNA markers, which have been experimentally validated for high rate of variations in pigeonpea varieties.

Source: www.icar.org.in

Simple antigen-based latex agglutination test leptospirosis diagnosis

Routine serological diagnosis is done by testing a serum or a blood sample with a panel of different strains by Microscopic Agglutination Test (MAT). It is also possible to culture organism from blood, serum, fresh urine and possibly from fresh kidney biopsy. The MAT (microscopic agglutination test) is considered gold standard in the

+ve –ve

Latex agglutination test

diagnosis of leptospirosis. As large panels of different *Leptospira* need to be subcultured frequently, this is a laborious and expensive test. Besides, MAT test can only be performed in a very specialized laboratory with skilled personnel.

As an alternative, a latex agglutination test (LAT) has been developed using recombinant leptospiral protein. The *LipL41* gene from *Leptospira interrogans* serovar *canicola* was cloned and expressed in *Escherchia coli* system using pProEXHTb expression vector. Recombinant protein was purified using a single step affinity chromatography. The yield of recombinant protein was approximately 10-20 mg/litre. A large number of sera samples from different species of animals (including zoo animals) and humans were screened by the LAT and the results were compared with the gold standard (MAT). The LAT showed high sensitivity and specificity in detection of leptospirosis in animals. This test is very simple and suitable for field use, as pen-side test. Results of the LAT can be noticed within 5 minutes without any specialized equipment.

Leptospirosis is a bacterial zoonotic disease caused by spirochaetes of the genus *Leptospira* that affects humans and a wide range of animals, including mammals, birds, amphibians and reptiles. Leptospirosis is transmitted by the urine of an infected animal. Rats, mice and voles are important primary hosts. It is also transmitted by semen of infected animals. Humans become infected through contact with water, food or soil containing urine of infected animals. Occupational risk factors include veterinarians, slaughter-house workers, farmers and sewer workers.

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Development of herbo-mineral acaricide to control ticks

Ticks and tick-borne diseases (TTBDs) ranked high in terms of their impact on the livelihood of resource-poor farming communities in the developing countries, including India. TTBDs affect 80 % of world's cattle population causing significant economic losses and a major constraint on profitable livestock production and productivity. Economic impact of TTBDs has been estimated at Rs 2,000 crore annually in India.

An ideal poly-herbo-mineral acaricide was developed using locally available plant materials and commonly known minerals with a low cost. The ingredients can be procured easily by farmers and dairy owners from local market and can be prepared easily for the application on the tick infested animals. Cost of herbal preparation at the farm level is very low. Uniqueness of the newly developed herbo-mineral acaricide is that it possesses remarkable antifeedant, anti-ovipositional and

fecundity reducing property and thus has population limiting property even in the next generation or future generations of the survived ticks that were in partial contact with the herbo-mineral acaricide.

Present formulation of the herbo-mineral acaricide is

Widespread and indiscriminate use of chemical acaricidal compounds has led to the development of resistance in ticks, an inherited phenomenon, to all existing classes of acaricide. Alternative approaches involve use of eco-friendly cost-effective sustainable methods in a strategic integrated manner like integrated tick control (ITC) or otherwise integrated pest management (IPM) and refers to a system where multiple approaches for control are utilized, considering economic factors, epidemiology, resistance status, and the production and management structure in place. As a component of ITC, use of botanical acaricide can be an appropriate sustainable environment friendly and cost-effective alternative.

against *Boophilus microplus* ticks and is also found effective on other species specific ticks infesting other animals and/ or other livestock and even companion animals during cross validation study. This may be the first unique herbo-mineral formulation for effective control of tick infestation in bovine and has been prepared under enhanced quality control without sacrificing therapeutic quality and with a strict vigil for trial as an acaricide.

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RT-PCR kit for diagnosis of Viral Nervous Necrosis in finfish

Viral Nervous Necrosis disease has been reported from more than 35 species of fishes in both tropical and temperate waters around the world, including India, and most of them are from aquaculture facilities. Clinical disease is most commonly observed in larval and juvenile finfish, but an adult fish surviving infection can become asymptomatic carrier. Mortality rate of up to 100% is most commonly seen in larval fish and tends to decrease as the size of the infected fish increases. The most common mode of transmission appears to be vertically from sub-clinically infected broodstock to progeny during spawning in hatchery facilities.

A molecular diagnostic kit based on the reverse transcriptase polymerase chain reaction (RT-PCR) for early detection of *Betanodavirus*, the causative agent of the viral nervous necrosis disease in finfish has been developed.

- The kit offers a rapid, specific and sensitive detection system based on the amplification of the coat protein gene of the virus genome segment RNA2.
- The assay has been validated extensively using field samples from clinically and sub-clinically infected fish from wild and culture facilities across the country.
- The kit can be used for routine diagnosis of disease, besides as a management tool to screen broodstock, larvae, and even trash fish used as feed in fish hatcheries and selective breeding programme for pathogen-free stock development in freshwater, brackishwater and marine ecosystem.

Viral Nervous Necrosis (VNN) or Viral Encephalopathy and Retinopathy (VER) is a serious viral disease of finfish caused by *Betanodavirus* of the family Nodaviridae. The virus is non-enveloped, icosahedral in shape with a diameter of approximately 25 - 30 nm and contains two segments (RNA1 and RNA2) of the positive sense single-stranded RNA (ssRNA); the RNA2 segment contains sequence for the viral coat protein.

The kit is the first of its kind indigenously developed in the country, and is a good substitute for the imported technology in terms of cost-effectiveness and easy availability. The technology is available for commercialization.

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Is modern milk-supply chain inclusive?

Growing middle class with increasing income and expanding urbanization is likely to boost demand for formally processed milk products, which, generally, are not catered to by the traditional markets. This will fuel the growth of the modern, formal, organized milk markets.

Internationally, one of the most controversial issues is the rise of the modern marketing chains (especially under the private ownership), excluding small-holders from emerging market opportunities. In India, there is an ongoing debate, and the concern is on the prospects of the modern-supply chains in the country.

Recent researches indicated that emergence of the modern food-supply chains improved linkages between buyers and poor farmers in the developing countries, and thus were beneficial for small-holders.

In India, majority of the milk producers are small-holders and contribute to more than 70 % of the total milk production.

In the country, some of the issues have been examined empirically in the case of modern milk-supply chains. According to the data, there is no evidence that small milk-producing households are relegated to traditional supply chains or are excluded from the modern supply chains. The same appears to be true on examining relationship between the size of the farm and the choice of the marketing channels of the milk-producing households. Largely, the same was also true when proportion of milk sold by different categories of farmers to alternative milk marketing channels was examined. There is no evidence that landless or small landholder dairy farmers are getting lesser access to modern chains.

This empirical analysis clears several points and provides evidence that can help clarify one of the debates about the effects of the emerging market integration models and changes in the downstream segment of the milk-marketing chain.

The milk production and the marketing structure exhibit significant regional variations. The dominance of landless, marginal and small-holders in the milk production is weak in Punjab as compared to Bihar. In an agriculturally-developed state like Punjab, modern milk-supply chain is quite important, while traditional milk marketing supply chain continues to play a dominant role in Bihar, which is yet to catch up to the same extent in agriculture and dairy development, as is witnessed in Punjab. Finally, it is observed that there is no distinguishable difference in terms of who is selling to different chains, land-size or herd-size. In other words, landless, small farmers face a few, if any barriers, in accessing India's emerging modern milk markets.

The modern milk-supply chains appear to be inclusive, and resource-poor dairy farmers are not excluded from

Choice of marketing channels by milk producers in Bihar and Punjab

Size group	Share of farmers selling milk to marketing channels (%)			
	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
Land-size				
Landless	93.8	6.3	14.3	85.7
Marginal	77.4	22.6	7.8	92.2
Small	61.5	38.5	13.6	86.4
Medium	60.0	40.0	3.1	96.9
Large	20.0	80.0	10.7	89.3
All	72.0	28.0	8.8	91.2
Herd-size				
One animal	73.8	26.2	2.7	97.3
Two animals	63.2	36.8	12.1	87.9
Three animals	77.8	22.2	4.0	96.0
More than three animals	80.0	20.0	13.5	86.5
All	72.0	28.0	8.8	91.2

Proportion of milk sold by farmers to different marketing channels in Bihar and Punjab

Size group	Share of farmers selling milk to marketing channels (%)			
	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
Land - size				
Landless	98.0	2.0	14.3	85.7
Marginal	62.3	37.7	9.9	90.1
Small	63.9	36.1	39.3	60.7
Medium	73.3	26.7	2.2	97.8
Large	6.6	93.4	6.4	93.6
All	59.8	40.2	11.2	88.8
Herd - size				
One animal	63.4	36.6	4.8	95.2
Two animals	58.5	41.5	7.0	93.0
Three animals	70.8	29.2	3.2	96.8
More than three animals	47.8	52.2	14.3	85.7
All	59.8	40.2	11.2	88.8

them. The traceability and food safety issues may further consolidate position of the modern milk-supply chains. Expansion of the modern milk-supply chains, by and large, is dependent on the development of milk collection infrastructural facilities at the doorstep, incentive pricing and rewards for the quality produce.

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Hybrid solar dryer for hygienic preservation of fish

A hybrid solar-dryer developed with alternate electrical back-up for preservation of fish and agro-products enables continued drying of fish even under unfavourable weather like rain, clouds, and also for round-the-clock drying, so that bacterial spoilage due to partial drying does not occur. This dryer reduces labour requirement considerably compared to open sun-drying in beaches/ on coir-mats, because of the elimination of the cleaning process due to sand and dust contamination; of the re-handling process like spreading, sorting and storing. Time for drying is reduced considerably with improved product quality. Products are with improved shelf-life and fetch higher income.

Mechanical dryers using electricity or fossil fuels (diesel oil and furnace oil) as the energy sources are also available. But they are energy-intensive and also emit CO_2.

This eco-friendly solar-drying system reduces fuel consumption, and can have a significant impact in energy conservation.

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Compost mixer for saving time

Compost making and handling is strenuous and labour-intensive process. The unit operations involved are mixing of different constituents including water and microbial culture for fast decomposition and turning of heap of cow-dung, biomass and other materials, and they are to be done at definite intervals.

Compost mixer is a trailing-and-offset-type machine used for thorough mixing of cow-dung, farm- residues and biomass for manure preparation. The main equipments are mixing rotor, hydraulic system to operate rotor, water-tank to store water and culture, and side-tank for weight balancing. A total of 42 blades arranged in a helical path facilitated thorough mixing and turning of the material. The helical arrangement helped in reducing load with appropriate compost-mixing. Rubber pads are provided for partially covering mixing unit to prevent spillage of compost while mixing. To facilitate safe transport of the equipment, both off-and on-the road, the rotor unit is hinged at one end to be lifted vertically with the hydraulic system. A water pump is provided to facilitate sprinkling of water over compost material. As this machine is an offset-type, a side-tank full of dead weight of concrete helps counter-balancing weight of rotor unit, particularly while lifting and lowering. The equipment is operated by a 70-hp tractor.

The capacity of the machine is 5,000 tonnes per annum and it costs Rs 4 lakh. The estimated income/saving is Rs 10-15 lakh per annum. The significant advantage is saving of a month's time in compost-making as compared to the traditional method.

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Correction

In *ICAR NEWS* Vol. **17** No. **3**, p. 19, last item, 2 column, last para, please read address as **A.R.T. Arasu, CIBA, Chennai (Tamil Nadu) 600 028** in place of Ambekar E. Eknath, CIFA, Bhubaneshwar (Odisha) 751 002

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WAY FORWARD

NATURAL events, drought, flood, cold wave, heat wave, storm, cyclone, landslide, earthquake and tsunami, and pest and disease epidemics cause immense damage and lasting impacts on the life and property. Observations indicate their increased occurrences in the recent years.

Areas prone to drought, flood, cyclone and landslides in India are about 16%, 12%, 8% and 2% of the total area of the country. Landslides though constitute a small fraction of the total land degradation, cause serious impacts on the hilly agricultural land. In India, about 68.4% (82.57 million ha) of the total degraded lands is affected by water erosion only, followed by chemical degradation (24.68 million ha), wind erosion (12.40 million ha) and physical degradation (1.07 million ha).

Around 50 million people are affected by droughts annually in the country; and 68% of the total sown area is susceptible to droughts at one time or the other. As many as 27 out of the 35 states and union territories are drought-prone. Under the latest dispensation, 'sub-humid' category, having adverse water balance, has been added to arid and semi-arid categories for drought purposes. Animals are the worst affected by droughts as thousands of cattle perish because of deficient drinking water and fodder.

Of the total 62 major rivers in India, 8 major river valleys are flood-prone, affecting 45 million hectares. On an average, 60% of the total damage due to floods annually is in Asom, Bihar, Uttar Pradesh, West Bengal, Odisha and Andhra Pradesh. However, moderate floods benefit areas like Sabarmati basin, as alluvial soil brought by floodwaters fulfils moisture requirement for raising crops. During *rabi,* cold waves in the northern and north-eastern regions result in mortality of crops. On many occasions, drop in temperature lasts for many consecutive days, damaging crops and orchards. Every year, pests cause 5-10% losses in wheat to 50% in cotton. Climate change is likely to have an impact on the insect pests, particularly on those that feed on nitrogen-rich foliage, and have higher consumption rates and assimilation efficiencies.

The scientific predictions are that temperature rise will be in more extremes along the coasts, and could cause major changes in India's hydrologic cycle, thus would threaten water supplies as well as agriculture. Consequently, design procedures for water-harvesting structures need to be revisited to harvest inevitable runoff from a few high intensity storms in the monsoon season for providing supplemental irrigations during winter.

Degradation of our limited land resource (2.3% of the global land and over 11% of the arable land) due to anthropogenic processes, deforestation, overgrazing and unsustainable agricultural practices, is posing a major threat to sustainability of our natural resources. The production losses in rainfed areas due to soil erosion by water, which can be enormous on the cumulative basis, will significantly affect agrarian economy over years. These need to be brought within permissible limits, to prevent further decline in productivity by adopting appropriate soil-and-water conservation strategies. Conservation agriculture needs to be adopted to provide adequate cover on the land surface and to avoid even minimum disturbance to soil to achieve long-term objectives of profitability and sustainability.

Dr S. Ayyappan, Secretary (DARE) and Director General (ICAR)

The best way to deal with disasters is to be prepared for any eventuality. Keeping this in mind, the ICAR is in the process of developing contingency plans for farmers at the district level to challenge natural disasters. The Council has already launched a National Initiative on Climate Resilient Agriculture (NICRA) to assess impacts of climate change on agriculture and allied sectors and to evolve cost-effective adaptation and mitigation strategies. The ICAR is also setting up a state-of-the-art National Institute on Abiotic Stress Management. Effective-and-swift response requires building-up of capacity to anticipate problems through effective monitoring and for taking judicious and timely decisions through people's participation. Disaster education needs to be innovated for all stakeholders, who must address their specific needs as individuals and or as groups. While India needs experts on all aspects of disaster mitigation and management, for which enough scope exists in our universities and higher institutes of learning, but much broader framework alone can meet the demands for disaster education for all. The greatest challenge before us is to change-over from conventional chalk-and-talk or power-point-disaster-education in piecemeal to education that breeds holistic perception and culture of disaster safety by selling excitement and joy of learning in live-laboratories of Nature, and not in the confines of the classrooms. Disaster management education should become a bridge between the research and development especially on the issues leading to sustainable protection of natural and built-in environment on the one hand and resolving real-life problems on the other.

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