



A SCIENCE AND TECHNOLOGY NEWSLETTER

RESEARCH UPDATE

Promising Technologies

- ◆ Zero-energy, low input-based composted substrate for growing *Agaricus bisporus* 1
- ◆ Aseptically breaking seed dormancy in oilpalm 2
- ◆ "Mahima" born from cloned buffalo "Garima" 3

New Initiatives

- ◆ Mango-chloroplast genes sequence characterization and genome mapping 4
- ◆ Indian Agricultural Research Content Management 4

Natural Resource Management

- ◆ Bougainvilleas—Glory of the Garden 6
- ◆ High temperature stress-responsive proteins identified in rice-leaves 8
- ◆ Bamboo plantations in gullied lands, Vasad 9
- ◆ Endemic *Dawkinsia tambraparniei* bred successfully 9

Profile

- ◆ National Bureau of Soil Survey and Land-Use Planning, Nagpur 10

Spectrum

- ◆ Cropping management factor (C) for crops and cropping systems 14
- ◆ Hybrid-seed production of bottlegourd on vertical trailing 15
- ◆ Pomegranate fruit-bagging enhances desirable fruit characteristics 15
- ◆ Protected cultivation technology for women 16
- ◆ Production of bypass fat indigenously for dairy animals 17
- ◆ Quadruplets calving in *deshi* cattle 18
- ◆ Srinidhi—a promising dual-purpose poultry breed for rural areas 18
- ◆ *Puntius* spp. lineage through whole mitochondrial genome sequencing 19
- ◆ Developed Fish Mitochondrial Genome Resource Database 19

- ◆ Way Forward 20

PROMISING TECHNOLOGIES

Zero-energy, low input-based composted substrate for growing *Agaricus bisporus*

A novel composting technology for small-scale seasonal button-mushroom growers

Majority of the seasonal mushroom-growers make compost by the traditional long method of composting. Cost and time involved in the preparation of the compost are the two major constraints in the production and productivity of button- mushrooms. The existing long method (30 days) is laborious and time-intensive, and the short method, two-phase composting method (20 days), is of high cost and energy requirement. Boiler for pasteurization and blower for conditioning of the compost in two-phase tunnel method are energy-consuming operations with the additional bunker cost.

Zero-energy polytunnel (using perforated HDPE pipes, 10% perforated area; iron frame; and HDPE polysheet, 100-150



Zero-energy polytunnel

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PROMISING TECHNOLOGIES

GSM), a novel composting method, has been developed for faster substrate preparation for *Agaricus bisporus* cultivation. Wheat-straw (60%), wheat-bran (5.5%), chicken manure (31%), urea (0.5%) and gypsum (3%) were used as composting ingredients. The design of the polytunnel was based on the basic ingredients and on the desired physico-chemical characteristics required in the composted substrate.



Zero-energy polytunnel with mixture of ingredients (inset: *Agaricus bisporus* on the composted substrate)

This zero-energy composting procedure was evaluated and standardized in terms of compost quality, number of turnings, composting period and yield of button-mushrooms. The appropriately designed polytunnel structure reduced time of composting, increased compost yield and mushroom yield, and reduced labour requirement for turnings. The technology was also tested at the seasonal/commercial grower's farms.

It has been found that zero-energy polytunnel method reduced 50% and 37% compost-production cost as compared to short and long methods. It also reduced 60% and 40% of composting time as compared to the long and short methods.

This natural and environment-friendly 12-15 days

composting process, based on the principle of natural passive aeration and heat-mass transfer of composted substrate, requires 2-3 manual turnings without additional infrastructure of tunnels, boiler, blowers and compost yard. Besides, the heat generated during the composting process is used for pasteurization and conditioning, hence it is an energy-free process; so is named as the zero- energy polytunnel method.

Mushroom is an important horticultural cash crop that provides nutraceutical food. Majority of the button-mushrooms (*Agaricus* spp.) are grown on the compost; a specially prepared substrate from bioconversion of agro-industrial, forestry and household organic/inorganic matter. Availability of quality compost is one of the important pre-requisites to harvest quality mushrooms.

The current technology would allow cultivation of *Agaricus bisporus* on a ligno-cellulosic, naturally pasteurized, conditioned composted substrate, and would significantly improve compost production (3-3.5 times of compost ingredients) and yield of *Agaricus bisporus* (up to 22-25%).

This technology can be a next generation technological package for small-scale button-mushroom growers of the country in all agroclimatic regions. With slight modification, it can also contain foul odour in phase-I of short method, thereby addressing problem of pollution. It will reduce cost of cultivation of white-button mushrooms.

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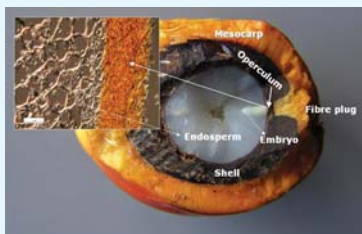
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Aseptically breaking seed dormancy in oilpalm

Oilpalm is undoubtedly a social-and-environmental panacea, a sustainable food-crop and a source of bio-fuel. It reduces emission of greenhouse gases. Its cultivation in India is being promoted by the Government to bridge supply and demand of edible oils; to save on precious



Oilpalm seed dormancy due to mechanical barrier to embryo



Germinated seeds from dry heat method

foreign exchange on oil imports. It is estimated that around 5 million germinated seeds are required per year to meet oilpalm planting material requirement; indigenously around 2 million seeds are produced from seed-gardens. There is a need to strengthen seed-gardens to

augment seed production. At present, main source of planting material for commercial planting of oilpalm is germinated seeds. Strong seed dormancy (physical dormancy due to mechanical barrier to embryo) in oilpalm causes indirect delay in nursery operations and wastage of precious crossed seeds (owing to delayed or no germination).

Seed dormancy was usually overcome by “dry heat method”; subjecting seeds to 39°–40°C for 40–60 days. In this, large quantities of seeds were wasted. Moreover, it was a cumbersome process and required continuous supply of electricity.

A faster method in place of dry heat would reduce cost of seed treatment as well as time necessary to stimulate germination.

Aseptic de-operculum seed germination technique

As is in the normal “dry heat method”, seeds in this technique are extracted from artificially pollinated fresh fruit bunches (FFB) and are surface-air dried after soaking in water for 4 days by daily changing water until seed moisture content of 22% by dry weight basis is attained. Thereafter, seeds are thoroughly cleaned and treated with 0.1% Bavistin solution for 5 minutes and surface dried for two hours. Surface dried seeds are packed in polythene bags and heat-treated for two days to extract only kernels; removing entire endocarp without damaging kernels. Kernels (seeds) of hybrids are extracted manually by cracking endocarp using hammer.



Aseptic de-operculum germinated seeds

The plate-like structure of the operculum is removed of an individual seed using “aseptic sterile blade” without damaging embryo. The naked and de-operculated seeds are cleaned in filtered water and dipped again in the fungicide. Treated seeds are placed inside the High Density Plastic Containers of required size. Two layers of water-soaked germination papers are kept at the bottom of the container and de-operculated seeds are kept on the germination paper and covered with one more layer of germination paper. Such an arrangement is for incubation at 25-28° C; the germination starts within a day, and completes within 5-7 days. Meanwhile weak, abnormal, damaged seeds could be easily identified from the lot, and the seeds which showed normal, uniform and vigorous growth were selected for planting in the nursery.

While practising above method, it is desirable to maintain hygiene in the seed-processing lab, equipments etc., and work should be carried out only by experienced persons to avoid damage to embryo and endosperm. Seeds (kernel) with well differentiated plumule and radicle alone should be planted in the primary nursery. This method can be adopted in the commercial seed-production centre as a routine technique.

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"Mahima" born from cloned buffalo "Garima"

On 25 January 2013, a female-calf was born from the cloned buffalo Garima. It was named “Mahima”, and it weighed 32 kg. It is the first report in the world of calf born from cloned buffalo; produced through hand-guided cloning technique. The newborn “Mahima” started suckling milk within 30 minutes of birth.

The Garima, born on 22 August 2010, attained sexual maturity early, at 19 months of age, compared to normal buffaloes (around 28 months), and was inseminated with frozen-thawed



semen of a progeny tested bull of the NDRI No. 1875 on 27 March 2012. She was maintained under the standard scientific management system during the gestation. On 25 January around 1.00 PM, she showed symptoms of second stage of parturition, and calved normally with slight Veterinary medical assistance.

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NEW INITIATIVES

Mango-chloroplast genes sequence characterization and genome mapping

For isolation of mango cpDNA(chloroplast DNA), a protocol was standardized that yielded between 100 and 150 ng from 100 g of leaf tissues/ml. Eight mango cultivars were characterized for *trnL* and *trnF* genes (transfer RNA). Universal primers were used for



trnL gene sequence in mango cultivar Arunika

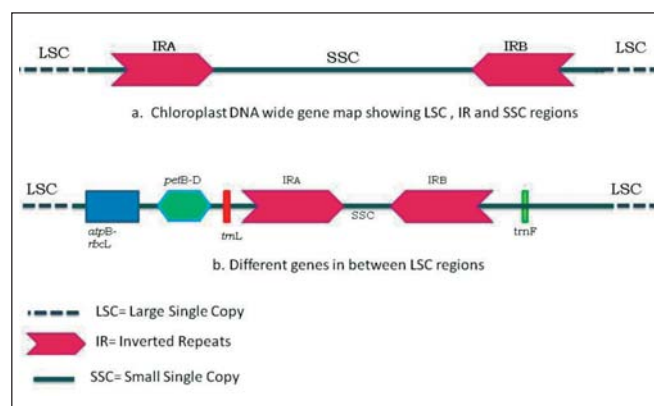
amplification of these genes, which produced amplicons of 550 bp and 400 bp, respectively, of all mango cultivars. Sequence of mango-hybrid, Arunika, showed maximum similarity with pollen parent Vanraj for *trnF* gene among the 8 sequence-characterized samples. Phylogenetic analysis of five chloroplast gene sequences has revealed the evolutionary pattern and the varietal divergence that have occurred. Variations in *trnL* and *trnF* genes in eight mango cultivars could be ascribed to indels and SNPs.



SNPs and Indels in *trnF* gene

Attempts were made to map physical position of certain chloroplast genes reported in mango — *trnL*, *trnF*, *petB*-

petD, *atp-rbcL* —using partial chloroplast genome for sequence alignment and then positioning genes. The partial chloroplast genome consists of a partial LSC (Large Single Copy) region, complete IR (Inverted



Physical map of *trnL*, *trnF*, *pet B-pet D*, *atp-rbcL* genes on chloroplast DNA

Repeats) regions and SSC (Small Single Copy) regions. Conserved domains were used as motif to align genes and for positioning them exactly on the mango partial chloroplast genome. The linear map of chloroplast, positioned inverted regions A and B flanked by *trnL* and *trnF* on the two sides. Two other genes, *petB-petD* and *atp-rbcL* were placed ahead of *trnL*.

This mapping study is an effort towards understanding molecular phylogeny using cpDNA markers. This would be a valuable tool for developing sequence-based markers for cultivar identification.

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Indian Agricultural Research Content Management

The Indian Council of Agricultural Research has taken up many initiatives for development and management of digital content of agricultural research, including digitization of publications — research journals, books, presentations, grey literature etc. — to enhance access to Data/ Information/Knowledge. It has adopted the Open Access Policy for ICAR's online Research Journals in March 2010.

Some of the important initiatives are as follows.

Consortium for e-Resources in Agriculture – CeRA (<http://cera.jccc.in>)

Online journals from a consortium of nine publishers — Springer, Annual Reviews, CSIRO, Elsevier, Taylor & Francis, Oxford Journals, American Society of Agronomy, Informatics, and Indian Journals — have been

NEW INITIATIVES

subscribed centrally in the ICAR, which provides online access to over 2,700 journals to 124 libraries in the NARS. There has been *unprecedented research information access by the researchers in the NARS; over 5,000,000 articles were downloaded (2008-2012) by researchers.*

e-Granth (<http://egranth.ac.in/AgriCat.html>)

AgriCat, a Union Catalogue (subset of WorldCat), has been developed including holdings of 12 major libraries combined together at the ICAR Institutes and SAUs. AgriCat has 0.4 million records. More than 10 million pages have been digitized. And an online repository (D Space) is being implemented at the IARI, New Delhi.

Krishi Prabha

Under this initiative, digitization of over 7,376 Ph.D. theses was undertaken, and these are being hosted online. These theses have been integrated with e-Granth repository for centralized access. *Online access to research facilitates better research reviewing and it also checks duplication in research.*

Agropedia (<http://www.agropedia.net>)

Under this, extensive knowledge maps have been developed for Rice, Pigeonpea, Sugarcane, Chickpea, Litchi, Groundnut, Sorghum, Safflower, Vegetable-pea and Wheat. This has multilingual editor (11 Indian languages) and includes semantic search on Indian agricultural research content.

Rice Knowledge Management Portal (www.rkmp.co.in)

A portal has been developed to create, manage and share scientific-, technology- and market-related informations for the benefit of rice as a sector, and for the information system for Services, Extension, Research, Farmers and for Non-formal Learning.

ePrints@CMFRI – Open Access Repository for Fisheries Research

Open Access repository for fisheries research content includes research articles (6,244), books (280), book section (500), conference or workshop items (826), datasets (14), monographs (270), others (44), teaching resources (168) and theses (166).

e-Courses in Agriculture

e-courses have been developed in agriculture for providing effective and low-cost methods to outreach to students/colleges/universities and to provide uniform and quality learning material both online and offline to complement formal education. It involved 100s of

teachers from 12 SAUs and a Deemed University. *There are 426 undergraduate courses in Agriculture, Horticulture, Veterinary and Animal Husbandry, Dairy Technology, Agril. Engg., Fisheries Science and Home Sciences streams.*

e-Publishing of Agricultural Research Journals (epubs.icar.org.in/journal)

To improve visibility of and access to Indian agricultural research, e-publishing system has been implemented in the ICAR. The e-publishing platform has been implemented centrally, and provides hosting of research journals published by agricultural research institutions and societies. IT is being used to host following journals: Indian Journal of Agricultural Sciences; Indian Journal of Animal Sciences; Indian Journal of Fisheries; Indian Farming; Indian Horticulture; Fisheries Technology; Indian Phytopathology; Journal of Horticultural Sciences; Journal of the Indian Society of Soil Sciences; Journal of Agricultural Engineering; Indian Journal of Veterinary Medicine; Indian Journal of Veterinary Anatomy; Journal of Cotton Research and Development; Indian Journal of Dairy Science; Journal of Medicinal and Aromatic Plants.

Indian agricultural research articles are being accessed globally from 182 countries. Top twenty countries include China, Iran, Turkey, United States, Pakistan, Mexico, Egypt, Brazil, Bangladesh, Canada, United Kingdom, Philippines, Japan, Nigeria, Thailand, Malaysia, Germany, Indonesia, Australia (>40% online readers)

Article downloads and access (August 2010 to till date)

	Indian Journal of Animal Sciences	Indian Journal of Agricultural Sciences
Registered Readers, online version	6,790	10,351
Abstract View, online	324,451	298,106
No. of Article Downloads	71,899	72,552

ICAR website (www.icar.org.in)

The ICAR website has been developed, and it provides access to Success Stories, Agricultural Technologies developed by research institutions and other Open Access publications of the ICAR. It also provides access to agricultural technology videos through ICAR Video Channel on YouTube.

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Bougainvillea, a popular ornamental plant, belongs to family Nyctaginaceae, and is grown throughout the tropics and sub-tropics. It is a native of South America, from Brazil west to Peru and south to southern Argentina (Chubut Province). It was first introduced into Europe; and subsequently into India as *B. spectabilis* in 1860 at the Royal Horticultural Society of India, Calcutta, presently known as Kolkata. It has a unique capacity of absorbing pollutants and in tolerating all environmental fluctuations. It flourishes well in all places; in polluted areas of big cities and industrial towns, and that is why it is called as the 'Glory of the

A large number of varieties have been developed at the NBRI, Lucknow, BARC, Mumbai, and IIHR, Bengaluru.

Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi, is the International Bougainvillea Registration Authority, appointed by the International Society for Horticultural Science, Belgium, for registration of bougainvillea germplasm since 1966, and again in 2007 by Wageningen, the Netherlands. At present, the repository maintains more than 95 varieties. A new concept of **Walk and Learn Path** has also been

VARIETIES IN THE REPOSITORY

Abraham Kavoor, Alick Lancaster, Arjuna

B.T. Red, Bangalore Glabara, Blondie, Bougainvillea Gold, Bougainvillea Silver

Cascade, Chandrabieri, Chennai Formosa, Cherry Blossom (Multi-bract), Chitra (Bi-coloured), Cleopatra

Dr B.P. Pal, Dr Bhaba (Variegated), Dr H.B. Singh, Dr Hado, Dr R.R. Pal, Dr Rao (Variegated), Dream

Elizabeth Angus, Enid Lancaster

Fantasy, Flame, Flomen

Gangawamy (Variegated), Garnet Glory, Gladys Heburn, Glorious, Gokul, Gopal

Hewin White

Isabel Greensmith

Jayalakshmi

Killi Campbell, Krumbiegal

Lady Hope, Lady Hudson, Lady Mary Bearing, Lady Richards, Lakshmi, Los Banos Beauty (Multi-bract), Los Banos Variegata Jayanti (Multi-bract & variegated

leaves), Los Banos Variegata (Multi-bract & variegated leaves), Los Banos Variegata (Variegated), Los Banos Variegata Jayanti (Variegated)

Mahara (Multi-bract), Mahatma Gandhi, Manohar Chandra, Mary Palmer Special (Bi-coloured), Mataji Agnihotri, Meera, Mrs Bakery Mrs Butt, Mrs Fraser

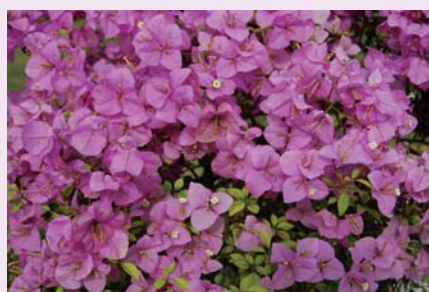
Padmi, Pallavi, Partha, Pink Beauty (Thornless), Poultoni, Poultoni Special, Profusion

R.S. Bhatt, Radha, Red September (Variegated), Refulgens, Rosea Fuchsia, Roseville's Delight (Multi-bract)

Sanderiana, Sensation, Shubhra, Shweta, Singapore Red, Sofia Mutant, Sonnet, Souva, Spectabilis, Splendens, Spring Festival, Stanza, Summer Time, Superba, Sweetheart

Tetra Mrs Mc Clean, Thimma (Bi-coloured), Thimma (Variegated), Tomato Red, Torch Glow (Thornless)

Versicolour, Vishakha, Zakiriana



Dr H.B. Singh



Lady Mary Baring



Mahara

Garden'. Its varieties belong to four basic species — *Bougainvillea spectabilis*, *B. glabra*, *B. peruviana* and *B. buttiana*. India is one of the major repositories of a wide range of bougainvilleas, and approximately 50 % of the present-day cultivars have been evolved in India.

introduced for identification of varieties of bougainvillea at the repository.

Propagation: Bougainvillea can be propagated from seeds, cuttings, and by layering or budding. Seeds are

Glory of the Garden

sown in June, and seedlings are transplanted during August. Pencil-thick cuttings of 20-30-cm thickness made from hardwood are planted in February–March and July–August. For better root initiation, treat cuttings with 2,000-4,000 ppm NAA. The varieties which are difficult to root are propagated by air-layering. And varieties which are neither propagated by cuttings or layering are propagated by T or shield budding. For budding, best time is February–March and best rootstock is Dr R R Pal. If the bud is established, sprouts will develop within 2-4 weeks.

Cultivation tips: It requires sunny situation (at least five hours of bright sun) for blooming; Best planting time in Delhi is July - September, however, it can be planted in spring also; Size of the pot should be 30 cm or more; Potting mixture should contain 3 parts of loam soil, 1 part of well-rotten farmyard manure, ½ part sand, ½ part leaf mould and a tablespoon of bone-meal; Apply water soluble fertilizers (20:20:20) at 200 ppm concentration with watering at 15 days interval; For profuse flowering, stop watering a few weeks before flowering; Prune plants during May–June, and apply manure to plants after pruning; Avoid waterlogging in root zone as it causes

VARIETIES FOR VARIED USES

Hedges: Partha, Sanderiana, Dr R.R. Pal, Mary Palmer, H.C. Buck, Thimma

Shrubs: Thimma, Mary Palmer, Sonnet

Slopes and Mound: Palekar, Shubhra, Mrs H.C. Buck, Mary Palmer, Dr R.R. Pal

Tree or Stump: Thimma, Palekar, Dr R.R. Pal, Mrs H.C. Buck, Glabra, Shubhra

Bush: Asia, Bondie, Bois de Rose, Dr R.R. Pal, Flame, Glabra, Lady Mary Baring, Mary Palmer, Mahara, Roseville's Delight, Shubhra, Thimma, Zakiriana

Climber: Chitra, Dr R.R. Pal, Lady Mary Baring, Mrs Butt, Mrs H.C. Buck, Shubhra, Rosalane, Lilac Queen, Mahatma

Standard: Begum Sikander, Formosa, Glabra, Isabel Green Smith, Lady Mary Baring, Louise Wathen, Mary

Palmer, Mrs H.C. Buck, Mahatma Gandhi, Refulgens, Sensation, Shubhra, Spring Festival, Thimma

Pot Culture: Dr R.R. Pal, Lady Mary Baring, Mahara, Mary Palmer, Roseville's Delight, Sonnet, Spring Festival, Summer Time, Thimma, Blondie, Tomato Red

Ground Cover: Dr H B Singh, Shubhra, Splendens, Helen Johnson

Hanging Baskets: Scarlet Queen Variegated, Glabra Variegated, Dr H.B. Singh, Isabel Green Smith, Palekar, Sanderiana

On Arches and Pergolas: Mahara, Dr R. R. Pal, Shubhra, Mary Palmer, Cherry Blossom

Bonsai: Thimma, Mahara, Chitra, Begum Sikander

Cascade: Begum Ali Yawar Jang, Palekar, Isabel Greensmith



Hedge

Shrub

Potted

Arches and Pergolas

Pruning: At the end of the flowering season, pruning is generally done in May–June. If pruning is done after rains, it discourages flowering. The potted plants are pruned to a height of 20-45 cm, retaining only 4-5 main shoots.

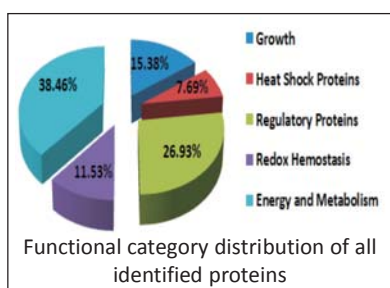
death of plant; Plants are frost-sensitive.

T. Janakiram, Ritu Jain, Kishan Swaroop
and **Nikhil Dileep Narkar**

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High temperature stress-responsive proteins identified in rice-leaves

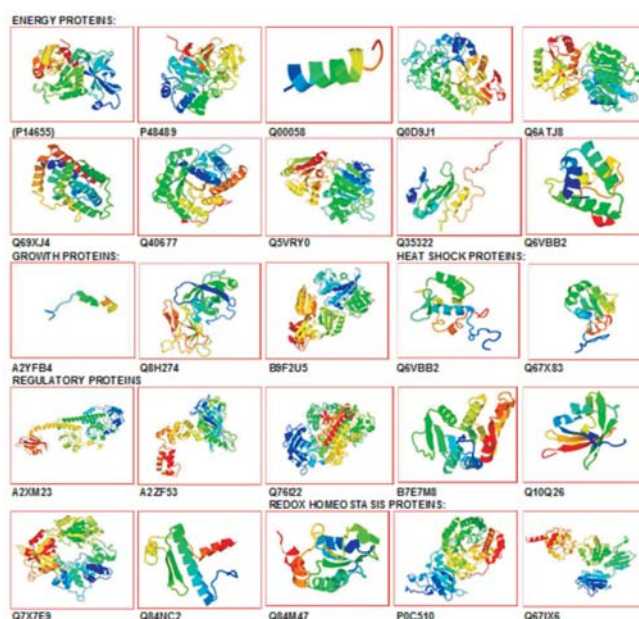
Plants of high temperature stress-tolerant rice cultivar N 22 were subjected to 28 °C (control) and 42 °C (high-temperature stress) at the flowering stage. Leaf samples were collected at 24 hr after the temperature treatment. Increased relative ion leakage and antioxidant enzyme activities indicated that high-temperature stress affected metabolic processes of rice-leaves.



Two dimensional gel electrophoresis (2-DE) coupled with Mass Spectrometry (MS) was used to identify high temperature stress-responsive proteins

in rice-leaves. Leaf protein extracts were separated by 2-DE, and visualized by staining with coomassie brilliant blue. Approximately 800 protein spots were detected on each gel, wherein 120 proteins were differentially expressed between two temperature regimes. Among the differentially expressed proteins, a total of 75 and 55 protein spots were found in the control and high-temperature stressed leaf samples, respectively. Using MALDI-TOF MS in conjunction with the MASCOT protein database search, 25 of the proteins that appeared only in the high-temperature stressed leaves were positively identified. According to the putative physiological functions, identified proteins were grouped into — (i) Growth proteins (ii) Heat shock proteins (HSPs) (iii) Regulatory proteins (iv) Redox homeostasis proteins and (v) Energy- and metabolism- related proteins. The largest functional category was that of energy-and-metabolism proteins (38.46%), followed by regulatory proteins (26.93%), growth proteins (15.38%), redox homeostasis proteins (11.53%) and heat shock proteins (7.69%). This suggests that energy-and-metabolism and regulatory proteins may play a pivotal role in saving cells from damage under high-temperature stress. Since the 3D structure of many of these differentially expressed proteins was not known, their 3D structures were predicted from amino-acid sequences, identified using MALDI-TOF MS with the PYRE-2 software.

Two of these differentially expressed proteins were of heat shock proteins, with heat stress transcription factor of A-2b and weight of 26.2 kDa. These are located in nucleus and in mitochondria, respectively, and function as sequence-specific DNA-binding transcription factor



Functional proteins of cultivar N22 of rice leaves under high temperature

and stress response factor, respectively. Similarly four other proteins identified were: B3 domain-containing protein, fructose-bisphosphate aldolase, alpha-amylase isozyme 2A and putative potassium transporter 8; they are categorized as regulatory proteins. These are actively involved in potassium-ion transport activity, enzymatic activity and DNA binding. Non-symbiotic hemoglobin and probable protein phosphatase grouped under the redox homeostasis proteins are involved in oxygen binding and metal-ion binding, respectively. Proteins of spots 43, 82, and 112 were found involved in the energy metabolism with various functions like metal-ion binding, ATP dependent and lipid binding.

Thus the results of the present study suggest that plants cope with high-temperature stress in a complex manner, where not only the HSPs but many other functional proteins play an important role in the complex cellular network. Hence in view of the global warming, besides genomic studies, there is a need for advanced knowledge on proteins responsible for high-temperature stress tolerance in crop-plants.

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Ridge-and-furrow method increased water-use efficiency of maize-crop

In Shivalik region (Chandigarh), ridge- and- furrow method of sowing maize-crop resulted in mean maximum grain yield of 2.91 tonnes/ha, and it also reduced runoff (12.8%) and soil loss (2.02 tonnes/ha) as compared to farmer's practice (maize yield of 1.92 tonnes/ha, runoff of 31.8% and soil loss of 6.45 tonnes/ha). If sowing could not be done with ridge-and-furrow method, ridges and furrows should be formed manually within a month of sowing by a spade or by opening a single furrow with a bullock- driven locally fabricated plough in between the interspaces of maize-rows, ensuring width of ridges and furrows 30 cm each with 25-cm height from the bottom of the

furrow to the crown of the ridge.

Demonstration of this technology on farmers' fields showed 29% increase in maize yield over the farmer's practice. Along with water-use efficiency increased from 3.341 kg/ha/mm under farmer's practice to 4.311 kg/ha/mm with this technology.

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Bamboo plantations in gullied lands, Vasad

Under the National Bamboo Mission, a study was conducted for reclaiming degraded gully-beds with 3 types of bamboo-based interventions (bamboo plantations with staggered contour trenches; supported by *bori bund* and as live checkdams). In all the three, absorption of rainfall was more than 80% and soil loss was reduced from 15.57 to 5.25 tonnes/ha. Economic indicators for the bamboo plantations in different treatments revealed that for a production span of 20 years, the net present value varied from ₹ 222,588/ha in bamboo live checkdam treatment to ₹ 319,731/ha in *bori bund* reinforced with bamboo. B: C ratio worked

out to be 2.09, 2.05 and 1.96, respectively, in the three treatments. Bamboo performance in 'trenching' gave the best internal rate of returns (20.2%) as compared to *bori-bund* reinforced with bamboo (19.7%) and bamboo live checkdam (19.3%).

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Endemic *Dawkinsia tambraparniei* bred successfully

The ornamental fish breeding-and-rearing unit successfully bred *Dawkinsia tambraparniei*, an endemic fish from the Western Ghats. Due to its declining population trend, the IUCN Red List categorized this fish species as endangered. Its population has been decreasing mainly due to the habitat losses by many anthropogenic activities.

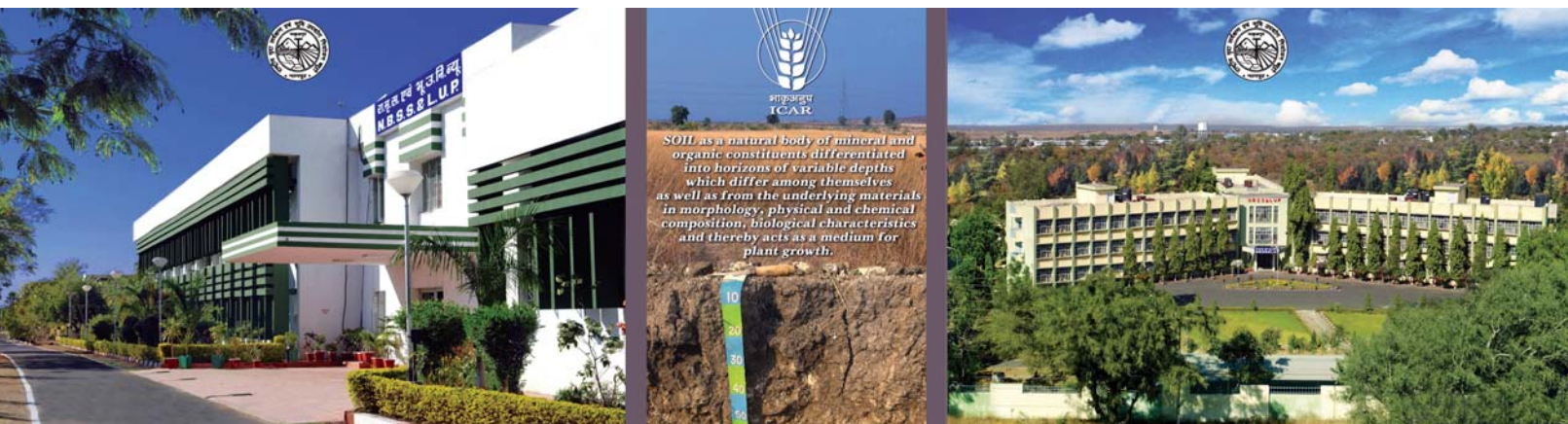


new captive environment could be successfully bred three times in the hatchery. At present, standardization of breeding and larval rearing technology is being perfected before its commercialization among fish-farmers. Indigenous ornamental fishes are gaining importance rapidly in domestic and international markets.

Its broodstock development (induced breeding and larval rearing in captivity, far away from its natural habitat) has been achieved. The fish acclimatized in the

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National Bureau of Soil Survey and Land-Use Planning, Nagpur



The Bureau is the country's premier national institute for conducting research, development and training (RD&T) in Soil Survey, Remote Sensing Applications to Soil Resource Mapping, Land Evaluation, Land-Use Planning and allied aspects

GENESIS AND GROWTH

In 1947, subsequent to the recognition of the Soil Survey as a national priority through the recommendations of the Stewart Committee, a need was felt for creating a centralized information warehouse to assimilate, verify and disseminate information on the nature, extent and distribution of soils in the country. Consequently, an All-India Soil Survey Scheme was launched in 1956. The same expanded in 1959 as the All-India Soil and Land-Use Survey Organization (AIS&LUS).

In 1969, the AIS&LUS was bifurcated into two wings; one under the ICAR was entrusted to conduct research in soil survey and mapping, soil correlation and soil classification. Through a Presidential Notification in 1973, the wing under the ICAR, Department of Agricultural Research and Education (DARE), was reinstated as a Directorate. This Directorate was given the status of a Bureau in 1976, and was named as the National Bureau of Soil Survey and Land-Use Planning (NBSS&LUP) with Headquarters at Nagpur (Maharashtra). The Bureau houses Division of Remote Sensing Applications, Division of Soil Resource Studies and Division of Land-Use Planning, engaged in basic, strategic and applied research in the mandated areas. The five regional centres, that came into existence subsequently, located at Bengaluru, Delhi, Jorhat, Kolkata and Udaipur, undertake soil-resource inventory in their respective areas (with the Division of Soil Resource Studies) and address region-specific issues. In addition, there are important sections like Geographic Information Section (GIS) and Cartography at the headquarters and the regional centres for providing

scientific and technical support for accomplishing varied tasks in addition to conducting research in the mandated areas. From a modest beginning, the Bureau has expanded considerably in terms of infrastructure and human resource.



Soil-survey being conducted

The role of the National Bureau of Soil Survey and Land-Use Planning (NBSS&LUP) becomes all the more important in view of the serious challenges of shrinking soil-and-land resource base, soil/land degradation, depleting nutrient stock, deterioration in soil/land quality, changing climate, land-use conversion and non-judicious planning of land-use. The Bureau addresses these challenges through inventorying soil-and-land resources of the country to facilitate development of repository, generating reliable information on the nature and extent of degraded soils, conducting research in pedology, remote-sensing applications, land evaluation, land-use planning and allied fields.

The Bureau is also involved in soil correlation, classification and also in characterization of benchmark soils at the soil series level in liaison with the state soil-

MANDATE

- To undertake soil survey and mapping of soils of the country to promote scientific and optimal land-use programmes in collaboration with relevant institutions and agencies.
- To conduct and promote research in the National Agricultural Research System in the area of pedology, soil survey, land evaluation and land- use planning.
- To impart training and education and promote awareness on the soil resource and its state of health and utilization.

survey organizations. Over the years, the Bureau has excelled as a centre of RD&T in Soil Survey and Land-Use Planning at the national and international levels.

INFRASTRUCTURE

The Bureau has many state-of-art laboratories. The infrastructure **facilities available in the micromorphology and GIS laboratories are the best in the country and match with the international standards.** Some of the modern and sophisticated equipments are:



Scanning Electron Microscope ; Inductively coupled Plasma Spectrometer; Atomic Absorption Spectrophotometer; Spectroradiometer; Advanced Remote

Sensing and GIS softwares.

COLLABORATIVE PARTNERS

The Bureau maintains close linkages with many national organizations like ICAR institutes, State Agricultural Universities and post-graduate teaching departments, and the National Remote Sensing Centre (NRSC), Hyderabad, for procurement of satellite data.

It maintains close linkages with the international organizations also—ICRISAT, Hyderabad, CYMMIT, New Delhi and ISRIC, ITC, the Netherlands.

Library: The Bureau headquarters has a fully computerized library. It subscribes to as many as 27 national and 15 international journals in pedology, land-use planning, remote sensing and GIS applications.

Soil museum: Kolkata and Bengaluru Regional centres and the headquarters house soil museums that depict various activities and achievements of the Bureau along with some very useful basics on soils and their applications.

Agricultural Knowledge Management Unit: The Bureau has been connected recently with 100 mpbs lease line under the National Knowledge Network (NKN), provided by the ICAR. In 2010, the unit had designed and developed Bureau’s website. A Video Conferencing system has also been installed. The website is being accessed worldwide by many stakeholders (<http://www.nbsslup.in>).

NEW INITIATIVES

District Land-Use Planning

A National network project on the “District level land-use planning and policy issues under different agro-ecosystems of the country” has been taken up by the Bureau involving its Hqrs and regional centres. The project aims at developing methodology for generating district- level land- use plans and delivering a decision support system that will provide uniform land- use decisions.

The districts identified for the project are Mysore in Karnataka, Nadia in West Bengal, Jorhat in Asom, Bundi in Rajasthan, Gondia in Maharashtra and Almora in Uttarakhand.

Soil Resource Mapping for Farm Planning and Development of National Portal on Soils

Lack of site- specific data, particularly on soils, and of situation-specific recommendations, were the causes of failure for most of the development schemes that operated in the past. This project plans to fill this vital gap by generating site-specific soil and other land- resource data. The project would be executed by using modern techniques, tools and facilities in a **consortia mode** by involving State Departments of Agriculture, State Agricultural Universities, State Remote Sensing Applications/Service Centres, National Remote Sensing Centre, Soil and Land Use Survey of India and State Land Use Boards. The **National Bureau** will act as a nodal agency by providing required scientific/technical back-up and the **National Informatics Centre** will facilitate establishment of the National Portal of Soil and other land resources of the country for effective dissemination of information.

Soft Computing Techniques in Land Evaluation

Land evaluation, the process of assessing land for the defined uses, is an important prerequisite for undertaking land-use planning. The Bureau, in keeping with the latest developments in land evaluation, has initiated a research programme on the applications of soft-computing tools viz., fuzzy logic and artificial neural networks in this field.

SOFTWARE SOLUTIONS

The Bureau has developed software solutions for soil correlation and land evaluation. The Regional Centre, Bengaluru, has developed a land-evaluation software that has replaced age-old, tedious and time-consuming manual method.

SIGNIFICANT ACHIEVEMENTS

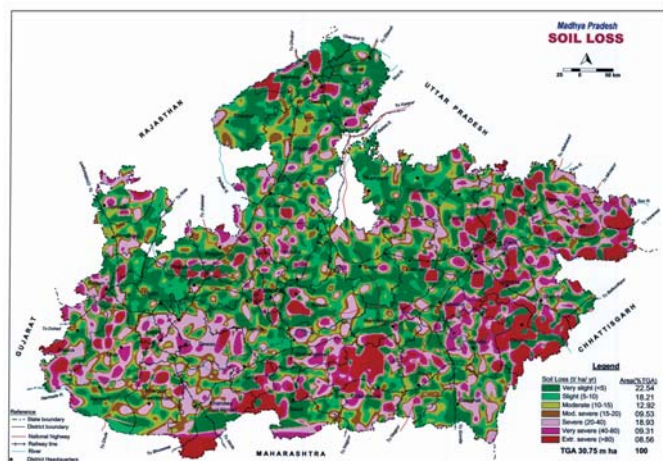
- Soil Resource Map of India (1:1 m scale):** Under the Soil Resource Mapping project, state- level soil-resource mapping on scale 1:250,000 was completed following 3-tier approach, involving image processing; field surveys and laboratory analysis; cartography and printings. The state-wise spatial and attribute data on the soils were processed and generated in a GIS platform to generate soil and related thematic maps.



Soil map of India (1:1 m scale)

An outstanding achievement was the development of a Soil Resource Map of the country on 1:1 million scale (on 1:500,000 scale) through categoric and cartographic generalization.

- A 20-unit Agro-ecological region map and a 60-unit Agro-ecological sub-region map of the country have been generated.
- A land-degradation map of the country on 1: 4 m scale has been developed.
- Soil-erosion maps of different states of the country



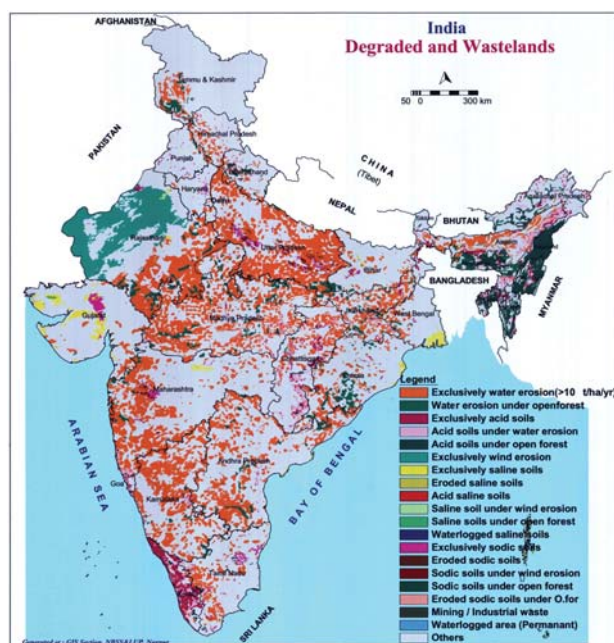
Soil erosion map of Madhya Pradesh

FARMERS' FIRST

A Farmer's advisory service has been developed to guide growers of vegetables, rice, fruits and pulses of West Bengal on the soil-fertility management, and has been hosted on www.wbagrisnet.gov.in of the NIC server, and is linked with the mobile cell-phone

have been generated. Reportedly, as much as 95 m ha in the country are eroded.

- In the National Register, 273 Benchmark soil series have been established and entered.
- Soil reflectance properties have been successfully used as a potential tool to provide information on a wide range of soil properties.
- A consultancy project, soil survey and mapping of rubber-growing soils of Kerala and Tamil Nadu on 1:50,000 scale, has been completed by Bengaluru Centre, with the Rubber Research Institute of India, Kottayam, for generating detailed soil information for assessing suitability of existing rubber-growing areas and for refining basis for discriminatory fertilizer recommendations on rubber.
- The Bureau has been an active partner in generating data on harmonized degraded and wastelands in the country, and has reported that about 121 m hectares are under different categories of degraded lands and wastelands.
- As per estimates made, the total carbon stocks in Indian soils at 150- cm depth are up to 64 pentagrams (pg) ($1 \text{ pg} = 10^{15}$), with considerable amount in inorganic form. This is the first- ever estimate made on the soil-organic carbon (SOC) stocks at the national level.
- Developed land-use options for 5 agro-ecosystems of



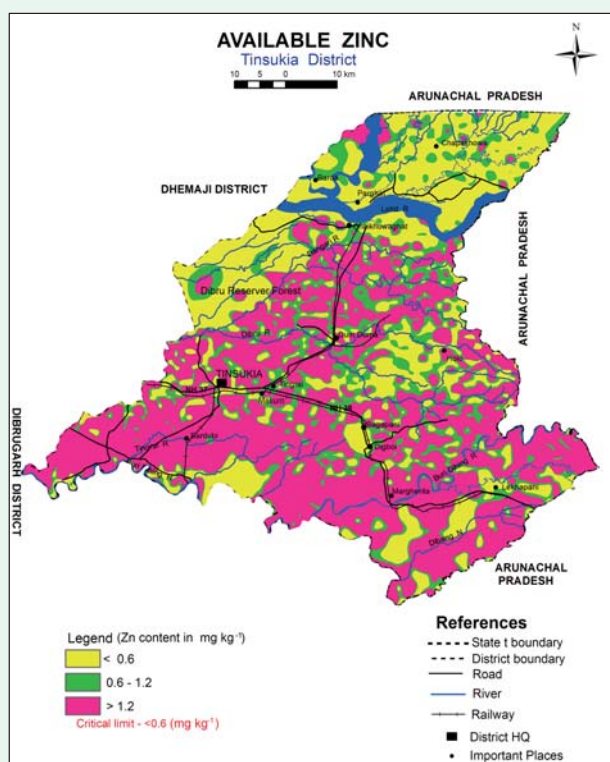
Harmonized degraded and wastelands of India

SOIL NUTRIENT MAPS

Soil (macro and micro) nutrient mapping has been undertaken by the respective Regional Centres of Kolkata and Jorhat at different levels of priority — districts, blocks, watersheds, villages and farms of the eastern and north-eastern states of the country. This activity has generated high utility soil-nutrient maps and revolutionized soil- fertility management in the states.



Available phosphorus status in Jharkhand



Available zinc (Zn) in Tinsukia District, Asom

the country—Rainfed, Irrigated, Arid, Hill and Mountain and Coastal.

- A geo-referenced soil information system has been developed for two major food-growing regions of the country — the Indo-Gangetic Plain (IGP) and Black Soil Region (BSR). The system would aid in

systematically undertaking land-use planning and monitoring of soil quality in the regions.

- The Agro-ecological sub-region (AESR) map published by the NBSS&LUP in 2002 has been modified in the IGP and BSR regions with the latest soils data (generated by the Bureau), and newly calculated LGP data and sHC (estimated from pedo-transfer function developed by the Bureau). The modification will aid in realistic regional- level planning
- A Decision Support System has been developed for Land-Use Planning for Mysore District, Karnataka; first such achievement since its inception.

THRUST AREAS FOR XII PLAN

- Development of land-resource inventory for farm planning in India to provide site-specific database and recommendations.
- Development of demand-driven soil-resource inventory of disadvantaged districts, command areas, prioritized watersheds, villages and farming systems.
- Conducting basic and strategic research in pedology, remote sensing applications using GIS to soil-resource mapping, land evaluation, and land-use planning using new science and emerging technologies.
- Assessment and monitoring of soil quality including soil-carbon stock assessment.
- Assessment of degraded lands in the country at different levels for updating their status.
- Preparation of blue prints for efficient land-use planning at different levels.
- Implementation of Tribal Sub Plan programme to provide soil-based land-use planning, and to impart training in the selected tribal areas.

Flagship programmes

- Development of land-quality indicators for sustainable land management in dominant land-use systems of the selected agro-eco sub-regions of India.
- Development of Decision Support System (DSS) for land-use planning at the watershed level.

Platform programmes

- Conservation Agriculture
- Water Platform
- National Initiative on Climate Resilient Agriculture (NICRA)

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Cropping management factor (C) for crops and cropping systems

The cropping management factor for successive growth stages was estimated for different crops and cropping systems in Kota (south-eastern Rajasthan). Crop growth period varied between 60 and 70 days for leguminous crops (cowpea, blackgram, greengram and groundnut) and between 90 and 120 days for cereal crops (sorghum and maize). C value for leguminous crops varied between 0.3511 and 0.6058; its range is small for the crops, owing to their faster establishment. Leguminous crops provide good soil cover to minimize soil erosion. Among legumes, cowpea was the least susceptible crop to erosion (0.3511) and clusterbean was the most

erosive crop. The C value for intercropping ranged between 0.3084 and 0.3718, and maize-crop registered the highest C value of 0.5236, which was attributed to wider plant- to- plant and inter-row spacing. C factor, a proper vegetative cover, plays a vital role in minimizing soil erosion at a given location.

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Four novel genetic stocks of rapeseed-mustard registered

Four novel genetic stocks of rapeseed-mustard have been approved for registration by the Plant Germplasm Registration Committee of the NBPGR in its XXVI meeting held on 31 January 2013. Three genetics stocks

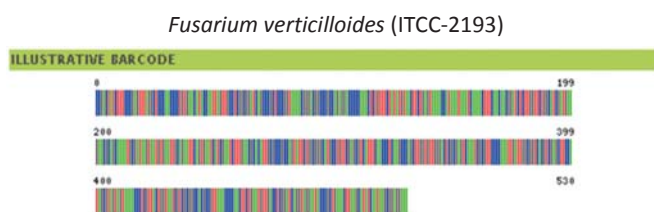
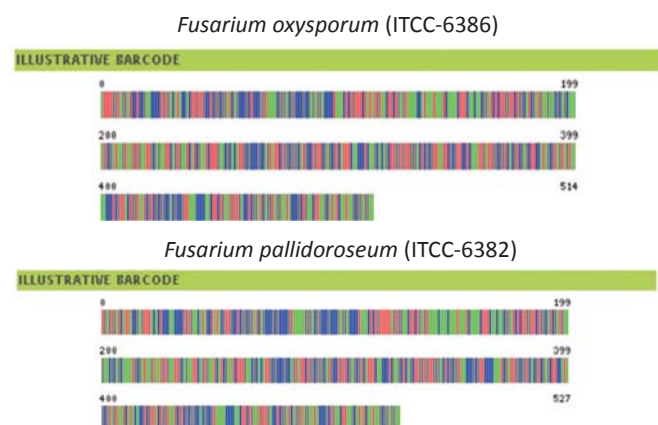
— BPR540-6, BPR549-9 and WF yellow sarson—were developed by the DRMR, Bharatpur, and one genetic stock NUDHYJ-6 was developed by the Department of Botany, RTM Nagpur University, Nagpur.

Genetic stock	Species	National identity	Special characteristics
NUDHYJ-6	<i>B. juncea</i>	IC 0595268 (INGR 13015)	Yellow seeded, high oil content (45.7%), low glucosinolate content (9.9 μ mole/g of seed) and white rust resistant
BPR549-9	<i>B. juncea</i>	IC 0595525 (INGR 13016)	Salinity tolerant during juvenile stage and high water -use efficient
BPR540-6	<i>B. juncea</i>	IC 0593927 (INGR 13027)	Salinity and thermo tolerant during juvenile stage
WF yellow sarson	<i>B. rapa</i> var. yellow sarson	IC 0393515 (INGR 13028)	White flowered

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DNA barcoding of *Fusarium* spp.

The Indian Type Culture Collection (ITCC) of fungal species is a national repository for research and academic purpose. Efforts have been made to document available fungal biodiversity with the Indian Type Culture Collection (ITCC) through DNA barcoding. DNA barcoding of *Fusarium* has been launched for the first time from India at the



DNA Barcode of Life Data System (BOLD).

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Hybrid-seed production of bottlegourd on vertical trailing

Traditionally, hybrid seed of bottlegourd is produced by allowing the vine to grow horizontally on the ground. This system requires labour in pollination management (in moving over distance); and it hampers uniform growth and development of fruits, and may cause more incidences of diseases and pests. On the contrary, vertical trailing pollination management has been found easier and efficient with a fewer incidences of diseases, and it allows better fruit development with minimum fruit-rot.



Traditional method



Trailing method

Even the economic analysis of hybrid-seed production showed B:C ratio higher (3.87) in the trailing system as compared to the traditional method (2.10). Estimated production cost in trailing and traditional methods were ₹320,525 and ₹195,375 per acre, respectively, and estimated net returns of hybrid-seed produced were ₹920,935 and ₹215,529, respectively.

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The number of fruits set and maturing per vine of bottlegourd cultivar Pusa Hybrid 3 as well as the fruit- development attributes such as fruit weight, fruit length and fruit width were significantly higher in the trailing system than the traditional method. The seed-quality attributes including seed health were also significantly superior in the trailing system.

Pomegranate fruit-bagging enhances desirable fruit characteristics

During the last one- and- half decades, pomegranate has witnessed a steady growth in area and production. Pomegranate- crop has also shown growth potential in non-traditional areas like Punjab, Himachal Pradesh, Karnataka and south western part of Haryana also. But its growers faced losses in its yield due to internal breakdown of fruits, aril-browning, sun-burning, fruit-cracking, and also due to fruit-fly and bacterial blight disease. On-farm losses by these were very high, ranging from 12 to 18%. By adopting fruit-bagging, growers could minimize losses and get an additional premium price of Rs 8-10 /kg over unbagged fruits.

Pomegranate is ideal for fruit-bagging as it is a bushy plant, and bagging can be done while standing on the ground or by using tri-pod ladder. Bagging enhances fruit quality as follows.

Colour improvement: Dark rose-pink colour of the peel and arils is preferred by consumers. As temperature increases, aril colour decreases. Fruit-bagging with white colour cellulose-based bags or butter-paper provides



protection to fruits against sun and lowers down heat accumulation inside the fruits. Optimal temperature through bagging helps biosynthesis of pigments and prevents their denaturation during hot months. In comparison to unbagged fruits, 10-12% higher anthocyanin was observed in the arils of bagged fruits. **Total Soluble Solids (TSS):** Total solids indicate

pomegranate-fruit maturity; should be more than 15°brix in mature fruits. The level of TSS is found to be influenced by several pre and post harvest factors. But fruit-bagging exerts least impact on the fruit juice TSS.

Sunburn control: Fruits affected by sunburn, rot internally. Bagging has been found in minimizing fruit spoilage due to sun- scorching. White colour bags reflect sunlight and guard fruits against sun radiation.

Thrips control: Thrips primarily attack tender pollens and later growing fruits. Colonies of thrips feed on fruit-rind, and thus fruits lose their physical appeal, and are not acceptable to consumers. Fruit-bagging provides physical barrier against insects.

Bacterial spot control: This disease poses a major threat to all pomegranate-growing areas in India. The pathogen attacks all aerial parts of the plant, including fruits, leading to considerable reduction in fruit quality and market value. The bacterial spot damage to fruits can be minimized through fruit-bagging. Plant should be sprayed with a mixture of copperoxichloride and streptocyclin solution (2.0g copper oxychloride +0.5g streptocyclin per litre of water) also.

Fruit-cracking: Under subtropical climate, there is frequent fluctuation in atmospheric humidity and a steep variation in day and night temperature. This phenomenon makes pomegranate suture (rind) prone to cracking. Bagging film acts as a physical barrier and regulates water loss as well as temperature fluctuations, and thus prevents fruit-cracking.

Time and method of bagging

Pomegranate-fruits should be bagged with white cellulose/ butter-paper at least 85-90 days before

Precautions while bagging fruits

1. Use white-coloured bagging material.
2. Both ends of the bag should be properly sealed to avoid sheltering of insects inside the bags.
3. Bag fruits one day after fungicide spray in bacterial blight-prone areas.
4. Bag only disease-free and healthy looking fruits.

Physico-chemical status of bagged and unbagged pomegranate-fruits

Component	Bagged fruits	Unbagged fruits
Fruit-cracking (%)	2.5	9.5
Sun burning (%)	0	4.0
Scratches (%)	3.15	25.4
Thrips attack (%)	-	5.2
Bacterial spot (%)	2.0	16.0
Juice recovery (%) (whole fruit basis)	60.10	61.18
TSS °Brix	15.5	16.0
Acidity (%)	0.39	0.37
Total anthocyanin(mg/100 g)	178.25	162.35
No. of marketable fruits harvested/tree	84.60	71.40

harvesting. Zipped polyethylene bag of 15cm×15cm size can also be used; that is cheap, rain-proof and convenient. Bagging should be done during sunny bright day when there is no moisture deposition on the fruit surface. Healthy looking fruits should be gently inserted (individually or in bunches) in bags and their opening should be tied properly with thread.

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Protected cultivation technology for women

Under the hot- and- humid tropical conditions of Odisha, vegetables cultivation is affected in summers and in monsoon. Considering the potential of vegetables in the state, protected cultivation of high-value vegetables has been promoted among the farm-women to add to their source of income. Horticulture can be economically viable for the poor



farmers also if protected cultivation is made an integral part of their farming system, considering potential of vegetables. Technologies have also been standardized for protected cultivation of off-season tomato and

cucumber, which give ₹250-400/m² annually.

The farm-women are being trained to upgrade their skills so that they can earn more returns from the unit area of polyhouse/net-house. Furthermore, low-cost polyhouses give an option to rural women to enhance their entrepreneurial ability.

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Production of bypass fat indigenously for dairy animals

Bypass fat (rumen-protected fat) is the dietary fat, which does not degrade in the upper part (rumen) of the digestive tract of the dairy animals; is digested in the lower part of the tract, and therefore is the best 'energy-rich feed supplement' for sustainable milk production. Although bypass fat products are available commercially, but they are out-of-reach to dairy-farmers, being costly.

A simple indigenous technology has been developed for the preparation of palm-fatty-acids-based bypass fat. With this technology, dairy-farmers can themselves prepare the fat in their farms as per their daily requirement. Supplementation of indigenously prepared bypass fat to dairy animals @ 15-20g/ kg of milk production increases milk yield by 7-20%, and thus gives additional profit of about ₹ 12-40 per cow

per day, and also improves reproductive performance and health of animals. It is estimated that by feeding bypass fat to dairy-animals, milk production of the country can be increased by 10.85 million tonnes; even if 10% increase in milk production is considered. Further, losses due to cows not coming to heat may also be curtailed. This indigenous technology of preparation of bypass fat (rumen protected fat) can improve socio-economic status of dairy-farmers.

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Broiler rabbit achieved record body weight in 12 weeks age

A broiler rabbit male (B-2309) of Black Brown strain achieved a record body weight of 2.835 kg in 12 weeks (84 days). It showed exceptional growth at every stage (4 weeks-0.7 kg; 6 weeks-1.3kg; 8 weeks-1.8kg; 10 weeks-2.350kg and 12 weeks-2.835kg), and achieved a body weight that is normally achieved at 24 weeks of age (168 days). The broiler strain also showed potential of increased carcass yield from 1.0 kg to 1.5 kg/animal.



to its coat colour, and gives high performance in all parameters. It can be used to produce elite progenies to improve further performance of broiler rabbits at the Institute, which is the sole repository of high-quality broiler rabbit germplasm in the country. The strict selection programme resulted in around 50% of the growers achieving > 2.0kg overall weight at 12 weeks.

This record body weight has been achieved for the first time in Black Brown strain through intensive inter se mating and selection over years. The strain breeds true

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Captive breeding of striped murrel *Channa striatus*

This fish has high consumer preference because of its high nutritional value. Its broodstock was developed in the cement cisterns with proper diet management and hormone pellets implantation in the muscle of the fish.

Hormone pellet implantation resulted in better gonad development, and the fish responded well upon induced breeding in the hatchery condition. In 2012, about 1.5



lakh of hatchlings were produced. Its successful captive breeding would help in supplying quality and quantity seed to fish-farmers.

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Quadruplets calving in *deshi* cattle

A *deshi* cow gave birth to live-quadruplet calves on 1 March 2013 in the village 'Kanjialshi' (a very interior, undeveloped, resource-poor village, located in the northern border area of West Bengal and Bangladesh) in Dakshin Dinajpur district of West Bengal.

The owner reported that this was the cow's fourth calving; during earlier three, she had given birth to only a single calf. The cow was not given any hormones and was inseminated through natural heat. Among the quadruplets, three are females and one is male. So far, there was no such recorded live-quadruplets calving case in India.



The experts opined that most likely three oocytes were released from ovaries, and were fertilized; one of which divided, producing two identical calves. The quadruplets in cattle are reported to be rare —1 in 700,000. And quadruplets born alive are rarer; generally found in the ratio of 1:11.2 million.

All quadruplets in this case are alive but one she-calf is a bit weak. It may be due to the poor genetic production potentiality and imbalanced feeding practice.

The KVK expert has advised the owner to strip out the milk and feed evenly (1/10th of body weight) to all calves for their survival and better performance. Fifty kilogram of low-cost concentrate feed (LCCF) with locally available resources, dewormer, antibiotic medicine as protective and vitamin-mineral supplement have been provided by the KVK. The KVK also assured the owner to render all types of technical assistance in any emergency for survival of all calves. This incidence may be useful for the advancement of future veterinary genetic research.

Sukanta Biswas

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Srinidhi—a promising dual-purpose poultry breed for rural areas

This evolved poultry breed has been found with optimum body weight and better egg production. It was selected from six test crosses developed at the Institute.



It was evaluated twice for full length of production cycle of 72 weeks at the Institute Farm. Its juvenile body weight at 6 weeks of age was 650 g, and males weighed 2,353 g at 15 weeks of age. Its age at sexual maturity was 161 days. Egg production (in number) up to 40 weeks of age was 90; and annual egg production of 228 eggs was under intensive system of rearing with survivability of more than 95%.

Salient features in rural backyards

- Multi coloured plumage
- Longer shanks
- Coloured and bigger eggs (53-55 g)
- Juvenile b.wt. : 500-550 g at 6 weeks
- Early maturing : 175 days
- Annual egg production : 150 eggs

Subsequently, it was also evaluated under field conditions in Tripura, Jharkhand and Andhra Pradesh.

In the backyards, its juvenile body weight at 6 weeks of age was 500-550 g; age at sexual maturity was 170-175 days and egg production up to 40 weeks of age was 55-60 eggs. The bird has shown potential to lay 140-150 eggs per year in the backyards.

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Puntius spp. lineage through whole mitochondrial genome sequencing

Puntius denisonii (Day), a freshwater fish, belonging to the family: Cyprinidae, is listed as vulnerable in the IUCN Red List of Threatened Species. It is endemic to hot spot of Western Ghats in Peninsular India. Popularly known as 'Ms Kerala' or 'Red-lined torpedo', this brilliantly coloured native barb has become one of the India's largest exported ornamental fish in the recent times.

Three distinct genetic stocks of *P. denisonii* (Chandragiri, Valapattanam and Chaliyar), using twelve polymorphic microsatellite and mitochondrial DNA (mtDNA) markers, have been identified.

Whole mitochondrial genome sequence information would be needed to analyse genetic lineage between closely related species and for deeper phylogenetic analysis. The whole mitochondrial DNA sequencing of *P. denisonii* and of a closely related species, *P. chalakkudiensis*, has been generated jointly by the NBFGR and CIFT, Kochi. The circular mtDNA of *P. denisonii* is of 16,899 bp and that of *P. chalakkudiensis* is of 16,989 bp; showing a difference of 90 bp, mainly



in the control region. Both the species exhibited an overall divergence of 7.79% with the highest divergence of 11.3% in the control region and of the least in the tRNA genes. The initial analyses of amino acid differences of 13 protein-coding genes of these two species in comparison with other *Puntius* spp., point out the need to revalidate generic status of *P. denisonii* and *P. chalakkudiensis*.

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Developed Fish Mitochondrial Genome Resource Database

Fish Mitochondrial Genome Resource database (FMiR) has been developed under the aegis of the NABG Fisheries domain. The database contains mitochondrial genome sequence of 85 commercially important fish species from the Asian region. The data were obtained from the Ref_Seq of the NCBI, and the database was designed using MySQL, PHP, Perl technology. Different types of analytical modules like similarity search, microsatellite analysis, primer designing, genetic diversity estimation, phylogenetic analysis have been implemented in the database.

The analysis of the mitochondrial genome has revealed that average size of fish mitogenome is 16.6 kb with base composition of nearly 55% with AT and 45% with GC bases. The presence of TA/AT di-nucleotides repeat motifs are common in the control region with varying length of 7-14 repeats. Different analytical modules of FMiR will help researchers in species characterization, estimation of genetic diversity and phylogenetic analysis.

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WAY FORWARD

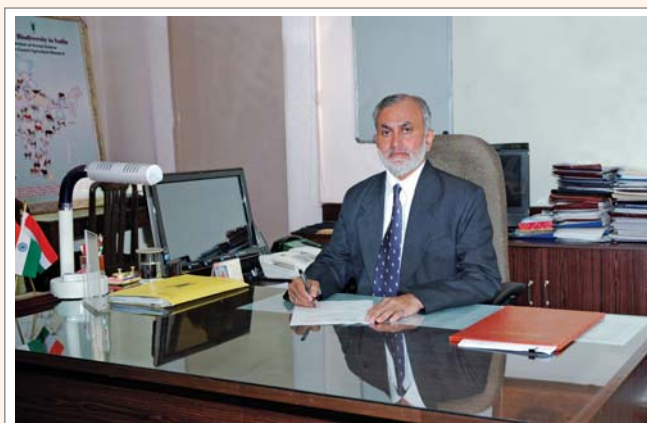
THE livestock population is expected to grow at the rate of 0.55% in the coming years, and the population is likely to be around 781 million by 2050. Though India is among the leading producers of milk, meat and eggs; productivity of our animals is 20-60% lower than the global average due to improper nutrition, inadequate health-care and management, and also due to the lack of scientific breeding of animals. Half of the total losses in livestock productivity are contributed to by the inadequacy in supply of feed and fodder.

Forage-based economical feeding strategies are required to reduce cost of quality livestock products; as feed alone constitutes 60-70% of milk-production cost. At present, the country faces a net deficit of 35.6% of green fodder, 26% of dry-crop residues and 41% of concentrate feed ingredients.

India has nearly 4.9% of the total cropped area under cultivated forages. Among the *kharif* forage crops, sorghum, maize, pearl millet, cowpea and guinea- grass are popular, and in *rabi* season, cultivated forages are oat, lucerne and berseem. Intricate technologies have been developed for increasing fodder production in different situations with stability and sustainability of cultivated and non- cultivated fodder crops. This includes intensive forage production in different agroclimatic situations (75-255 tonnes of green fodder/ha/year), sustainable forage production from rainfed lands (50-80 tonnes of green fodder/ha/year), integration of the forages in the existing cropping systems, forage-production technology for the customized situations like under plantation crops, rice fallows and non-competitive land-use, and forages from acidic, salino-sodic and waterlogged pedoforms.

For management of pastures also, certain approaches such as protection for vegetation recovery, soil-and-water conservation, reseeding, improved range expression and grazing management techniques have been developed. Introduction of pasture legumes, such as *Stylosanthes*, *Macroptilium atropurpureum*, *Cajanus scarabaeoides* syn. *Atylosia scarabaeoides*, has improved pasture productivity and quality (crude protein) by 2-7 %. In addition, agroforestry systems have been designed and developed on the degraded lands for optimizing land productivity and production of forage, timber and firewood on a sustainable basis.

To meet current level of livestock production and their annual population growth, strategies are needed to include measures that improve availability of quality fodder as well as for designing suitable models for fodder-based economic



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milk production. Better genetic resources of fodder crops, including grasses, have to be collected and conserved. And at a large- scale, food-fodder cropping systems need to be encouraged to provide balanced nutrition to livestock in the mixed farming situations. To diversify basket of feed resources, nonconventional/underutilized feed resources like *azolla* (humid and sub humid conditions), turnip, fodder beets, and cactus need to be evaluated for their inclusion and effective utilization in livestock diets. Concerted efforts by plant breeders' concomitant with animal nutritionists are vital to recalibrate plant composition for traits like higher nutrition concordance and digestibility for meeting requirement of animals with moderate production level. Popularization and adoption of fodder- and feed-enrichment technologies to increase nutritive value of fodders at the farmers' doorstep is another option for increasing livestock production. There is impelling exigency to promote 'fodder bank' concept for preserving surplus from rangelands during rainy season to be used during lean periods in post-monsoon and summer months.

The ICAR is addressing feed and fodder issue in a mission-mode way to cater to the challenges of fodder-seed production, of area expansion under green fodder, fodder conservation and of establishment of fodder-seed bank in different locations, besides capacity-building and extension. The Government is administering convergence of policies with the developmental and livelihood supporting projects such as Horti-Mission, MNREGA and the National Rural Livelihoods Mission, together with credit and market linkages. All these efforts are to support forage-based livestock production, and to make animal husbandry *per se* a remunerative venture for livestock-keepers.

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