Volume 16 No. 4 October-December 2010

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
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A SCIENCE AND TECHNOLOGY NEWSLETTER

RESEARCH UPDATE

PROMISING TECHNOLOGIES

Predicting yields of rainfed maize and wheat

The low productivity of maize and wheat grown in rainfed areas is a matter of great concern. Their productivity is affected by the distribution of seasonal rainfall and soil fertility, apart from applied fertilizer nutrients.

In rainfed areas, 30 - 50% loss in maize yield during *kharif* 2008 and 70 - 100% loss in wheat yield in *rabi* 2009, owing to reduced rainfall, were observed. Use of **Yield Predictor for Rainfed Areas (YPRA) Model**, a software application, can predict yield reductions owing to rainfall variations, and/or different rainfall scenarios can be predicted for planning and implementing crop contingency plans for maize and wheat.

This model is a desktop-based software application, developed using VB DotNet programming language with user-friendly and self-defining menus. This YPRA is the positive modification and conversion of the 'Relative Production Efficiency Index (RPEI)-based yield prediction concept' into a 'user-friendly software application'. Regression equations developed on the basis of the RPEI were taken to predict yields. The RPEI is governed by various easily determinable physiographic, soil physico-chemical, biological and climatic parameters.

The Expert System has two drag-down options for crop selection and soil texture. It has data entry boxes for slope, organic carbon, available N, P, K, cation-exchange capacity, *p*H, average seasonal temperature and seasonal cumulative rainfall. The YPRA has four command options — Bulk input, View graph, Calculate and Reset. For displaying output, it has two output boxes labelled as the Relative Production Efficiency Index (RPEI) and Yield. To minimize chances of error for selecting crop, image of the crop selected gets displayed on the Expert System.

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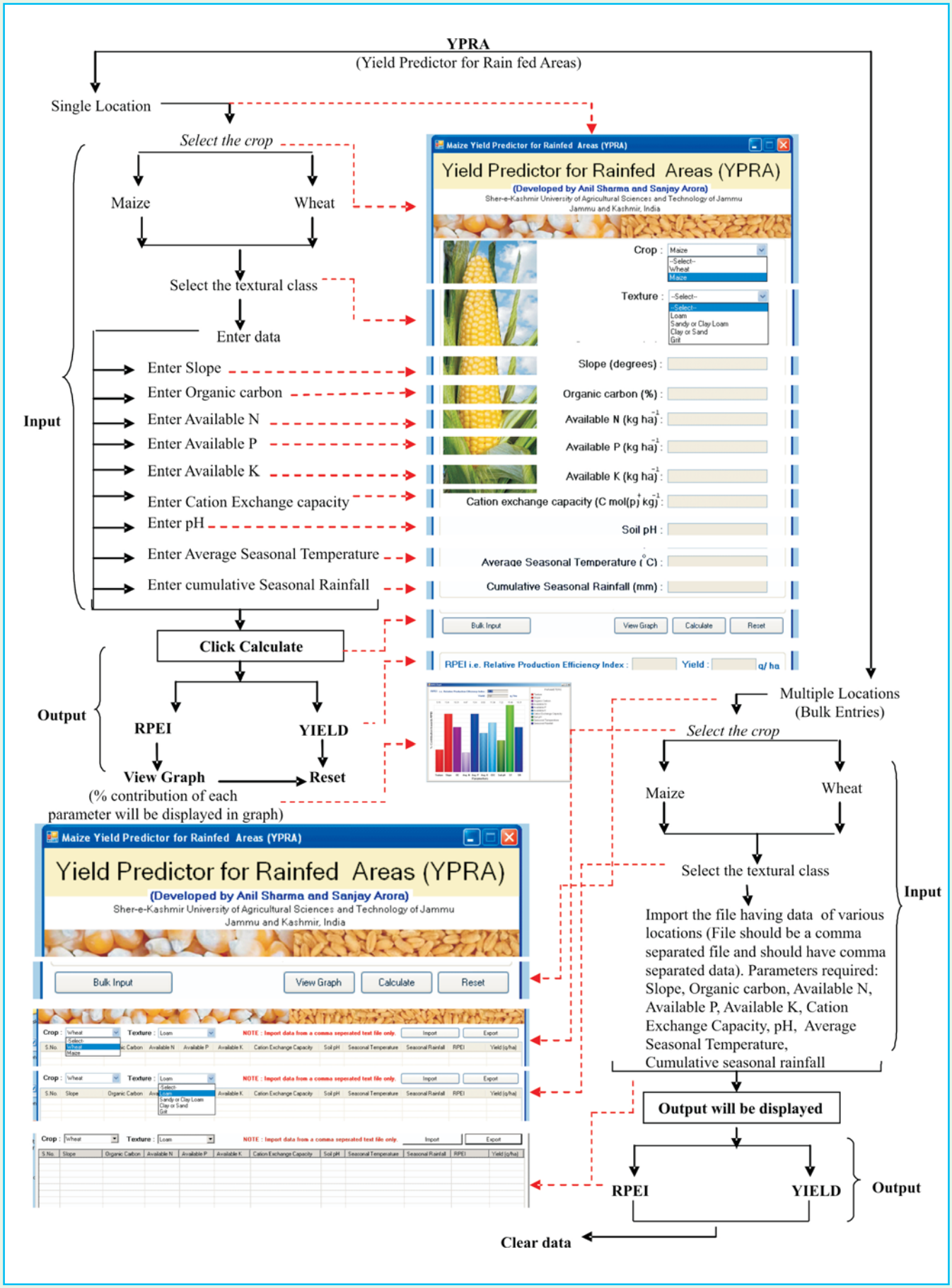

Operational diagram of the YPRA

The value of the RPEI can be compared with the suitability classes given in this software application. If the RPEI value is extremely low and the area or soil is not suitable for the crop, a message will be displayed as "RPEI very low, not suitable for maize/wheat crop". The yield predicted in the YPRA is on the basis of the RPEI. After getting the RPEI value and the predicted yield, a graph (click view graph) reflecting % contribution of each of these entered/selected parameters towards the RPEI can also be obtained.

Yield prediction and RPEI evaluation of more than one/ multiple locations, having textural similarity, collectively can also be observed.

The model has been validated with results of many of the experiments under different schemes in the rainfed areas of the foothills of Siwaliks in Punjab, Himachal Pradesh, Uttarakhand as well as Jammu and Kashmir, where maize-wheat system is prevalent. The software or model is an expert- based decision making powerful tool that allows user to predict crop yields in rainfed regions and also guides for soil management to optimize yields.

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Health beverages from *Rhododendron*

Rhododendron has long been regarded as the rich source of secondary metabolites such as phenols, phenolic acids, flavonols and flavonoids. Its flowers contain anthocyanins and flavonols as the major pigments. Its three major species (*Rhododendron arboreum* Smith, *R. anthopogon* D. Don and *R. campanulatum* D. Don) have been reported from the western Himalayas– *R. arboreum* is the predominating species found in the hills of Uttarakhand; from 1,500 to 3,500 m above mean sea level.

Rhododendron beverage locally prepared in Uttarakhand is of higher price, and is preferred for medicinal purposes by the consumers of the region. This has a slightly bitter taste, and is not much relished by consumers. And this is the main reason that the beverage has fewer takers beyond the region, despite its nutritoinal and medicinal properties. Higher medicinal and therapeutic values of the plant are attributed to presence of several antioxidants.

New methods for preparation of *Rhododendron* squashes have been developed. The resultant squashes have attractive dark-red colour combined with appealing taste and pleasant aroma. Two *Rhododendron* squashes prepared, one plain and another blended with ginger juice, were compared for the physico-chemical characteristics, antioxidants and sensory quality attributes with *Rhododendron* beverage collected from the market (locally available) as the control. Both squashes registered higher values for most of the parameters as compared to the control; the ginger blended squash was adjudged best upon sensory evaluation.

Squash preparation

Washing, cleaning and sorting *of Rhododendron* petals (@ 250 g /Litre of finished product)

↓

Heating with water at 80°C for 20 min and leaving for 3 hours at room temperature, followed by filtration through muslin cloth

↓

Preparation of sugar syrup, followed by cooling

↓

Mixing *Rhododendron* extract with sugar syrup to make final TSS 45° brix

↓

Addition of 2.5% ginger juice (v/v) (in case of blend)

↓

Addition of citric acid for 1% acidity and sodium benzoate (600 ppm)

↓

Storage in bottles

Quality attributes of different squashes of *Rhododendron*

Attributes	Plain *Rhododendron* squash	Blended *Rhododendron* squash	Locally available Squash
Soluble solid content (°Brix)	45.00b	45.00b	49.00a
*p*H	2.40a	2.38a	3.81b
Reducing sugars (%)	13.43c	13.59b	18.31a
Total sugars (%)	44.47b	44.63b	47.14a
Acidity (%)	1.03a	0.99a	0.27b
SSC: acid ratio	43.68a	45.45a	175.25b
Ascorbic acid (mg/100ml)	2.30b	2.36b	3.11a
Total carotenoids (µg/100ml)	787.46a	776.20b	675.54c
Flavanols (mg/100ml)	59.30a	54.46b	51.38c
Total flavanoids (mg/100ml)	476.0a	429.26b	398.6c
Total anthocyanins (mg/L)	20.58a	20.16b	8.47c
Total phenols (mg/100ml)	5140.60a	4960.82b	4786.06c
Total antioxidant capacity (mM Trolox equivalent (TE)/L)	19.67a	19.48b	12.93c

Row values followed by the same letter are not significantly different ($P < 0.05$)

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National Agricultural Innovation Project

Value-chains on horticultural crops and their produce

- In Kadambur hills (Tamil Nadu), the area at present under **marigold cultivation** is 85 acres, and this has improved livelihood of farmers who were traditionally involved in millets cultivation.

  Initially, the net returns per acre through millets cultivation was ₹4,000/acre, which increased to ₹6,000 –7,000/acre through conventional methods of marigold cultivation ,and has reached ₹10,000–14,000/acre with improved marigold production and post-production technologies; disseminated through the project. Significant increase in xanthophyll content from 1.40 to 1.75 g/kg of flowers has helped to increase profit to the company by approximately 10-15% that prompting it to hike price of flowers paid to farmers from ₹2.30/kg in 2008 to ₹2.75/kg in 2009 and to ₹3.75/kg in 2010.

- For improving keeping quality and export potential of **jasmine flowers**, innovative export packaging technology was developed and refined using boric acid 4% + polypropylene bags 60 m + CFB boxes. It helped keeping flowers fresh for 72 hr with negligible damage, and the flowers could be exported to the USA markets also, besides Dubai-flower market. Jasmine export volume of the Consortium Partner M/s Vanguard Exports of the project increased from 192 tonnes/year to 217 tonnes/year.Adoption of the packaging technology increased export volume of jasmine to Dubai market from 600 kg/day to 900 kg/day, and to the US market from 500kg to 1,000kg/week.

- Integrated management methods in **carnation** comprising pre-planting fumigation of greenhouse with Dazomet at 30g/m^2, followed by treatment of rooted cuttings of carnation with biological control agent *Pseudomonas fluorescens* at 0.5% reduced fusarium wilt incidence from 30-40% to 20%. The management method for calyx split involving spraying of 0.1% borax at fortnightly intervals reduced yield losses from 20-30% to 15%. This technology helped obtain a higher proportion of superior quality 'A' grade flowers and lower proportion of 'B' grade flowers with no 'C' grade flowers.

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RT-PCR kit for viral nervous necrosis diagnosis in finfish

The viral nervosus 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 aquacultural facilities. Clinical disease is most commonly observed in larval and juvenile finfish, and adult fish surviving infection can become an asymptomatic carrier. Mortality rates up to 100% are most commonly seen in the larval fish, and tend 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.

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, isohedral with an approximate diameter of 25 - 30 nm and contains two segments (RNA1 and RNA2) of positive sense single-stranded RNA (ssRNA) with RNA2 segment containing sequence for viral coat protein.

A molecular diagnostic kit based on reverse transcriptase polymerase chain reaction for early detection of betanodavirus, the causative agent of viral nervous necrosis, in finfish has been developed.

Betanodavirus assay (β-NOVA) prototype kit

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

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

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Union Cabinet approved the National Initiative on Climate Resilient Agriculture

The Union Cabinet in its meeting held on 15 December 2010 approved Council's proposal to launch a new project *National Initiative on Climate Resilient Agriculture* (NICRA) with an outlay of ₹350 crore for 2010-12. Its main objective is to assess the impact of climate change on agriculture and allied sectors and to evolve cost-effective adaptation and mitigation strategies. Its components are: (i) vulnerability assessment of agro-climate regions and production systems including crops, livestock and fishery sectors for formulation of a long-term research plan for the country; (ii) strategic research on adaptation and mitigation measures for natural resources, major food crops, livestock, marine and freshwater fisheries; (iii) demonstration of available climate-resilient practices on farmers' fields in 100 most vulnerable districts of the country; and (iv) strengthening of research infrastructure and capacity-building of scientists for undertaking long-term research on climate-change adaptation. The small and marginal farmers in rainfed, coastal and hill areas will be specially benefited with focused attention. About one lakh farmers will be directly benefited through on-farm demonstrations of climate-resilient technologies while the long-term strategic research will evolve climate-coping technologies that will be used by millions of farmers in the country. The technology demonstration will be carried out in 100 districts of 27 States (Andhra Pradesh, Asom, Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and West Bengal) and one Union Territory (Andaman and Nicobar Islands).

Chemical characterization of aromatic plants from Central Himalayas

Heavy demands from pharmaceutical industries for the aromatic plants have led to their over-exploitation, destruction of their habitats and unsustainable practices for their harvesting. So there is at present an urgent need for systematic approach to collect and cultivate these valuable herbs of Uttarakhand.

A study was undertaken to collect these plants occurring wild in the forest and introducing/acclimatizing them in the kitchen-gardens/door-yards and back-yards. Some wildly grown and introduced aromatic plants from the exotic sources — *Rosmarinus officinalis, Pelargonium graveolens, Salvia officinalis, Lavendula angustifolia, Lavendula stoechas, Artemisia annua, Artemisia dracunculus, Marjorana hortensis, Origanum vulgare, Thymus serphyllum* and *Satureja montana* —have also been collected from the temperate region of the Central Himalayas. These plants are being cultivated, maintained and conserved in *ex-situ* field Gene Bank of the NBPGR Regional Station at Bhowali. The plants have been analyzed for essential oil contents by hydro-distillation. Gas chromatography profiles of these essential oils have revealed presence of aroma constituents. These can be used in perfumery, cosmetics, pharmaceutical, and food and flavour industry. Both oils and aroma constituents are of great commercial value. And the current surge of interest for herbal products in preference over synthetics has changed trade scenario much in favour of the natural essential oils and aroma chemicals. There has also been incurring interest in the biological effects of these herbal

Chemical composition of volatile essential oils from introduced aromatic plants

Plant name/trade name, vernacular name/family	Oil content (%) *FWB/ DWB	Active chemical compounds (%)	Uses
Artemisia annua (Chinese worm weed) EC 415012 Asteraceae	1.6-3.0 (DWB)	*Artemisia* ketone (36.76), camphor (12.85), pinene, β-caryophyllene	Anti-malarial drug plant; considered stomachic and diuretic
Artemisia dracunculus (Tarragon) NIC 23429 Asteraceae	2.00 (DWB)	Sabinene (61.03), myrcene, terpinene-4-ol, methyl chavicol, elemicine, terpinen-4-ol	Plant used in seasoning and fragrance industry. Also possesses antifungal, antitumor, stomachic, febrifuge and antiepileptic properties
Cymbopogon flexuosus (Lemon grass/Adrakh ghass/Neembu ghass) IC 212825 Poaceae	0.87 (FWB)	Citral α (46.02), citral β (33.62), geraniol, linalool, geranyl acetate, limonene	Essential oil is used in perfumes, flavours, soaps, cosmetics and in mosquito repellents. Dried leaves are used in herbal tea. "Citral" is used as a source for synthesizing vitamin 'A'
Lavendula angustifolia (Lavender) IC 212822 Lamiaceae	1.00-2.51 (FWB); 1.90-5.50 (DWB)	Linalool (21.64), linalyl acetate (25.77), cis -ocimene, myrcene, borneol, 1,8-cineole, caryophyllene oxide , geraniol	Essential oil is used in perfumes, flavour and pharmaceutical and insecticidal preparations
Lavendula stoechas (French or camphor lavender) IC 449512 Lamiaceae	0.86-1.27 (DWB)	Camphor (52.12),fenchone, 1,8-cineole	Essential oils are important for perfumery, cosmetics, flavouring, food manufacturing and pharmaceutical industries
Marjorana hortensis (Sweet marjoram) NIC 23428 Lamiaceae	0.37 (FWB); 0.80 (DWB)	Terpinene-4-ol (31.15%), cis-sabinene hydrate (15.76%), γ-terpinene, citronellol, geraniol, p-cymene	Leaves are used as flavouring agent and in perfumery. It is also used in the treatment of asthma, is carminative and is expectorant

Origanum vulgare (Oregano/Van tulsi) NIC 23718 Lamiaceae	0.14-0.37 (DWB)	Thymol (33.92), γ-terpinene (17.67), p-cymene (11.99), carvacrol (6.90)	It is used as a flavouring agent ; is famous as a pizza spice. Oil is carminative, stomachic and diuretic
Pelargonium graveolens (Rose geranium) IC 212823 Geraniaceae	0.15-0.32 (FWB)	Citronellol (25.79), geraniol (24.84), 10 epi-γ-eudesmol, geranyl tiglate, isomenthone, linalool, citronellyl formate, geranyl butyrate, neryl acetate, geranyl formate	Essential oil is valued for expensive scents, cosmetics, for flavouring tobacco and pharmaceuticals preparations
Pogostemon cablin (Patchouli) IC 211253 Lamiaceae	0.87 (FWB); 2.60 (DWB)	Patchouli alcohol (37.72), α-guaiene, seychellene, δ-guaiene, seliene, pogostol	Patchouli oil is used in perfumes, cosmetics, soaps etc. It has strong fixative properties
Rosmarinus officinalis (Rosemary) IC 449513 Lamiaceae	0.27-1.47 (FWB)	α-pinene(21.24),1,8- cineole (20.79), camphor(11.85), camphene, β-pinene, borneol, linalool, bornyl acetate, β-caryophyllene, limonene	Essential oil is used in cheap cosmetics, soaps, hair tonics, room fresheners, flavouring food products, aromatherapy and for antimicrobial and antioxidant activities
Salvia officinalis (Garden sage) EC 403008 Lamiaceae	0.27-7.0 (DWB)	α-thujone (46.02), camphor (10.62), virdiflorol, β-thujone, pinene,1,8-cineole	Essential oil is used in food, perfumery and herbal products. It is also used in treatment of nervous system, gastrointestinal disorders and skin disorders
Satureja montana (Winter savory) N 2705 Lamiaceae	0.50-0.88 (DWB)	Carvacrol (77.23), p-cymene, γ-terpinene	The herb is used as a flavouring agent,is antibacterial, antispasmodic, astringent, carminative, digestive, diuretic, expectorant, laxative, stomachic, sedative and antifungal, vermifuge
Skimmia laureola (Skimmia/Patrang/ Kedar pati) IC 201958 Rutaceae	0.70-5.20 (FWB)	Linalool (13.03), linalyl acetate (26.40), geranyl acetate, pregeigerene, geraniol, neral	Oil from leaves is used in high-grade perfumes. Leaves are used as an incense fire
Thymus serphyllum (Wild thyme) IC 334545 Lamiaceae	0.57-0.60 (DWB)	Thymol (39.70), γ-terpinene (11.27), p-cymene, carvacrol	The herb is used for treatment of whooping cough, epilepsy, stomachic, tonic, vermifuge, spasmodic and expectorant

* FWB: Fresh weight basis; DWB:Dry weight basis

spices — they are safe and cause no side effects to humans; are used extensively in traditional system of medicines: Ayurveda, Sidha and Unani. Besides, aromatherapy with rosemary, eucalyptus and sage oil is gaining overwhelming attention as an alternative healing modality. Many chemical compounds present in these herbs have antioxidant, antiseptic and antimicrobial properties.

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PROFILE

National Institute of Research on Jute and Allied Fibre Technology

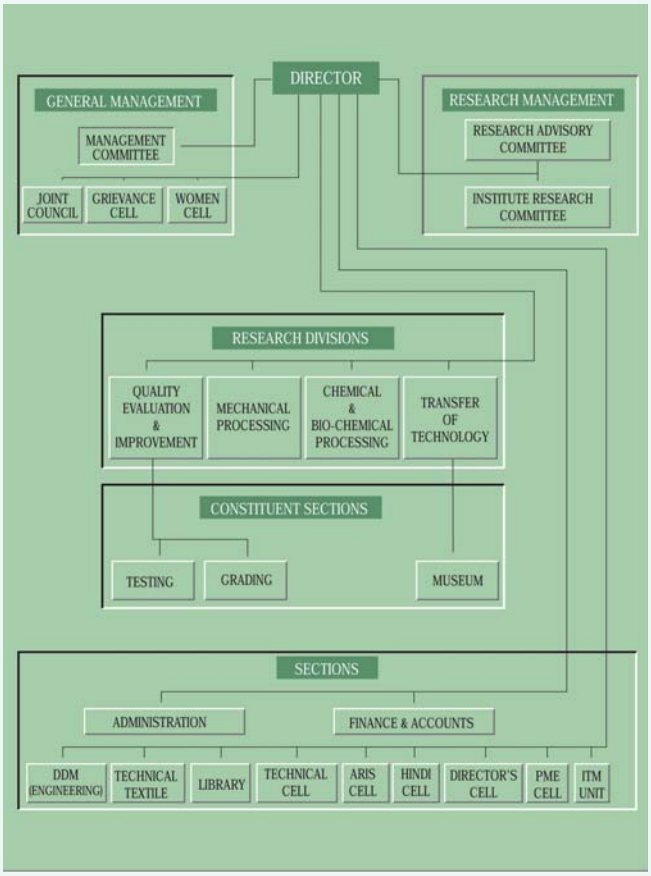
NIRJAFT research is committed to knowledge transfer and engages in technology transfer and economic development activities that benefit local, regional and national constituents

The Indian Central Jute Committee was constituted by the Government of India on the recommendation of the Royal Commission on Agriculture in 1936 to set up a Jute Technological Research Laboratory in Calcutta. The institute was officially established on 3 January1939 by Lord Linlithgow, the then Viceroy and Governor-General of India. In 1965, it became a constituent unit under the centralized administrative control of the Indian Council of Agricultural Research.

The institute has been rechristened as the **National Institute of Research on Jute and Allied Fibre Technology** (NIRJAFT), and carries out basic and technological research on jute and allied fibres such as mesta, linseed/flax, sisal, ramie, banana, sunnhemp, pineapple leaf fibre, dhaincha, and to some extent on coconut fibre also.

Mandate

- To promote production of good quality fibres
- To upgrade fibre and product quality
- To develop various natural fibre-based technical textiles and to promote their use
- To find diversified uses of the plant fibres, their agricultural by- products and industrial wastes in large scale and decentralized sectors
- To act as a repository of scientific and technological information on jute and allied fibres
- To act as a centre of human resource development in relation to jute and allied fibres and establish linkages among different scientific and industrial organizations through exchange of scientific and technological knowledge



The institute is thriving with the co-ordination of four divisions along with some essential Service Sections.

Quality Evaluation and Improvement Division: The key areas of this division are to carry out basic and technological research on extraction of jute and allied fibres, to upgrade fibre quality and to promote production of good quality fibres, to carry out research on physico-chemico properties and chemical modifications of jute and allied fibres for diversified uses, to develop and maintain culture bank, and to find useful chemicals from agricultural byproducts.

Mechanical Processing Division: The division carries out basic and applied research on production of good quality fabrics, application of natural fibres in geo-textile and agro-textile through woven and non-wovens, and design and development of efficient machinery and jute-based technology for small and large entrepreneurs and industries.

Chemical and Biochemical Processing Division: It is working on five broad areas — pulp and paper; bleaching, dyeing and finishing; particle and fibre board; composites; and biomass utilization.

Transfer of Technology Division: The mandate of the division is to transfer institute's technologies, and development of entrepreneurship.

Some Service Sections which render specialized services are Design, Development and Maintenance, ARIS Cell, Scientific Co-ordination Unit, Library, Jute Museum, Accommodation, Health-Care Centre, Jute Goods Exhibit Corner, Demonstration and Training.

Significant Research Achievements

- According to quality and yield performance, four *olitorius*, two *capsularis* , four mesta and one sunnhemp varieties were released— *olitorius* – S 19, JRO 128, JBO 2003 H and NOJ-Plan 1 ; *capsularis*— CO 80, CO 28 ; mesta NBR 4, GR, JBM 89-13063 and MT 1504 and sunnhemp SH 4.
- Chemical-free, hand-made paper from date-palm fibres has been made. The technology for this can be transferred to rural sectors at a low capital investment.
- A simple and user-friendly process suitable for small-scale industry has been developed for preparing pulp and paper from jute residues. It is environment-friendly as it replaces wood used as a raw material. Tissue papers (9-10 GSM) and high permanence paper used in preservation of documents are also being developed.
- Low-density particle boards (0.4 g/cm^3) made from jute-sticks have huge demand to be used as false ceiling. Technology for converting jute whole plants, both green and dry, to elongated particles of suitable size has been developed, and medium-density particle boards (0.6 g/cm^3) from jute whole plant and bamboo have been made and used for making furniture.
- Particle-boards have also been developed from date-palm leaves. Impact strength and tensile strength of these boards are found marginally better than those of jute- stick particle boards, and swelling % of date-palm boards is lesser compared to those made from jute-sticks.
- With general purpose polyester resin as matrix and jute (fabric and nonwoven) as reinforcement, various utility items of daily use have been made. Products like flush door, table tops, boxes for storage and transportation have huge demand.
- Composite boards can be prepared out of jute whole plant alone or in combination with open-structure mats out of bamboo strips. Highest flexural strength of the composite was achieved when bamboo was used as a lightly-woven mat. The properties of the boards (density 0.52 g/cm^3 to 0.65g/cm^3) were found to meet BIS specification (BIS: 3087-1985).

Flower vase and tray from jute composite

Energy from jute residues

Jute-sticks are being used as a domestic fuel and for thatching purposes, and jute-caddies are used in mills for direct burning in boilers. Calorific value of jute-sticks and jute-caddies was estimated at 4,400 kCal/kg and 3,900 kCal/kg, respectively. Considering calorific value of coal as 4,600 kCal/kg and mineral oil as 10,000 kCal/kg, 1 kg of coal is equivalent to 1.05 kg of jute-sticks and 1.2 kg of jute-caddies and 1 kg of mineral oil is equivalent to 2.28 kg of jute-sticks and 2.6 kg of jute-caddies.

- An alternative chemi-microbial process of retting could reduce water requirement from 1:20 to 1:2.5. In this, the concept of conventional retting has been changed totally; it is predominantly a chemical process, and in this, fibre quality is assured and time required is reduced.

Accelerated retting technology

Development of different instruments

- Thermal insulation value tester has been fabricated. The instrument displays digitally temperature at different sensing zones at every 10 seconds and of ambience along with testing time. A computer interface circuit along with dedicated PCB has been made.
- A portable digital moisture measurement instrument has been developed to measure accurately moisture content. A computer interface circuit has been developed which can download test results into a PC in the laboratory environment.
- *End breakage recorder.* It appears to be useful in the industry for controlling and monitoring spinning process as well as to read number of breaks.
- *Speed reduction device on jute flyer.* The device is used to identify threshold limit of 15 breaks after which as per the industrial practice and requirement, speed of the frame is reduced to avoid multiple breaks.

- **Value-added products:** *Jute covered yarn.* Covered yarns were successfully spun from jute fibre core and texturized multifilament as covering material after standardization of spinning parameters. Yarns of 2-ply and 3-ply were made with suitable twist for manufacturing knitted fabric. Light weight fancy fabrics with three different jacquard designs are also weaved.

Winter fabric from polyester blend. Polyester (hollow) fibre and raw jute are used for development of jute-polyester blended yarns using conventional jute-spinning system. Three different types of jute-polyester and cotton blended jacket fabric were developed in handloom with jacquard attachment. The jacket showed 30% and 62% higher thermal insulation value compared to commercial acrylic and cotton jacket fabric respectively. And this fabric has been found 8% and 27% lighter in weight compared to commercial acrylic and cotton jacket fabric, respectively.

Novelty decorative jute blended yarn

Shawl from jute blended fabric

Culture bank of fungi and bacteria

A culture bank with sixty-two fungi and fifty-four bacteria has been created exclusively for jute and allied fibre crops. The fungi have been grouped into four categories on the basis of their action on different substrates such as hard barks and jute-sticks—retting, bio-softening, bio-pulping and bio-finishing.

Home textiles from jute-based blended yarn. Jute-polypropylene (65:35) blended yarn has been optimized in terms of yarn properties and fabric feel so that it can be used in upholstery, furnishing and bedding material. It is prepared in the conventional jute-spinning system. Blending has been done in 1st drawing stage, and yarn has been prepared in apron-draft spinning frame. The fabric samples have been tested in terms of area density, thickness, tenacity, elongation-at-break, cover factor, flexural rigidity etc.

The jute-polypropylene blended fabric with cotton warp was compared with similar type market-sample made of cotton. The developed fabric was found about 10% heavier, 14% thicker, and 7% stronger compared to market sample. The cover factor of the developed fabric was also around 7% higher compared to similar market fabric samples.

Development of handloom system for ornamental jute fabric

A novel handloom has been developed with jacquard shedding arrangement to weave jute-based ornamental fabrics. Besides jute, 100% cotton, 100% synthetic and jute/cotton union or jute/synthetic union fabrics may also be produced. The fabric developed in the machine is elegant, ornamental and excellent in texture having good export potential. The fabrics are suitable for upholstery, furnishing, outer garments and other lifestyle applications.

New handloom for making ornamental jute fabric

Ornamental Jute fabric

Jute geo-textile. Jute-HDPE union blended woven geotextiles can successfully be prepared on automatic high-speed weaving machine. Jute blending with synthetics resulted in higher performance in productivity at weaving machine for manufacturing jute-based geotextiles as compared to all-jute geotextiles.

The jute-HDPE union fabric manufactured from specific yarn and fabric parameters is suitable to be used as separation layers as well as reinforcing material for construction of medium traffic-volume paved and unpaved road.

Riverbank protection by geotextile

Rural road construction by geotextile

Different types of geotextiles have also been developed for soil-erosion protection including river banks. Structural parameters of composite structured geotextiles (using jute, polyolefin, coconut fibre) for protection of river-bank have been identified and their performance has been tested through large-scale field trials at the rivers, Mayurakshi and Brahmani at West Bengal.

Jute-coconut fibre blending. The processing technique for blending jute and coconut fibre has been standardized in the conventional jute system and it was found that by such blending a wide spectrum of products could be made by taking advantage of higher strength and durability of coconut fibre and finer structure and drapability of jute. For commercial exploitation of the jute-coconut fibre blends, suitable spinning machines are being developed.

Technology ready for transfer

Jute reinforced plastic; Development of handloom system for ornamental jute fabric production; Geotextiles; Biomass energy from jute residues; Jute-based agrotextiles; Bleaching, dyeing and finishing of jute; Paper and pulp from jute residue; Degumming of ramie; Integrated technology of biogas and high-yielding mushrooms; Particle boards from jute and other agro-residues

New Research Initiatives

- **A value chain for coconut fibre and its byproducts:** Manufacturing diversified products of higher value and better marketability to enhance economic returns of farmers.
- **Sustainable rural livelihood empowerment project for** northern disadvantaged districts of West Bengal.
- The Zonal Technology Management & Business Planning and Development (ZTM-BPD) unit at the NIRJAFT is working in a catalytic role to start agribusiness. This is by supporting entrepreneurs with technology, consultancy venture capital funding and marketing.

Thrust Areas of XII Plan

- Post-harvest extraction of good quality fibre by improved retting technology for jute and mesta, and by biotechnological degumming for ramie.
- Quality management of jute fibre and development of an image processing system for quality assessment and grading of jute.
- Development of ramie grading system.
- Development of natural adhesives for application in composite manufacturing industry.
- Intervention of nanotechnology in surface modification of jute and allied fibres/fabrics for value-addition by developing technical textiles.
- Development of various natural fibre-based technical textiles including geo- and agro-textiles.
- Development of various natural fibre-based diversified textile products including ornamental cloth and life-style products.
- Improvement of existing fibre-processing technology and machinery.
- Development of textile testing instruments for jute and allied fibres.
- Processing technology devlopement for lesser used natural fibre.
- Packaging of textiles.
- Development of composites based on jute and allied fibres by improving their compatibility with composite-forming resin systems and through development of resin systems based on natural and synthetic sources.
- Development of composite wood substitute like fibre-board from whole plants of jute and allied fibres, and of speciality paper from jute and allied fibres.

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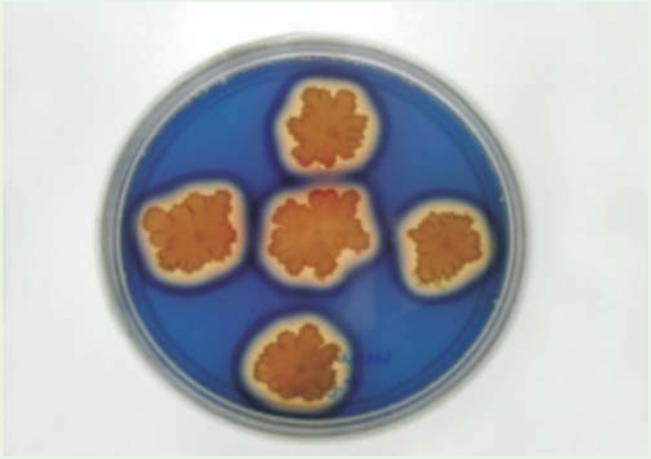
Plant-growth promoting *Bacillus amyloliquefaciens* from soybean roots

From the diseased roots of soybean, grown in the Malwa region of Central India, a bacterium was isolated on the potato dextrose agar (PDA). The isolate identified based on the morphological and biochemical characteristics and 16S rRNA gene sequencing showed 98.7% similarity with *B. amyloliquefaciens* sequences. It was found positive to IAA production (18.54 ± 0.19 µg/ ml), zinc solubilization, ACC deaminase activity (358.0 ± 8.69 NH_4^+/mg/hr), acid-and alkaline- phosphatase activity, phytase activity (423.4±12.59 pKat/ml) and siderophore production (21.45±0.49 µM DFAM/ mg) under *in-vitro* conditions.



Siderophore production by *B. amyloliquefaciens* on potato dextrose agar supplemented with chrome azurol S

Bacterization of soybean seeds with this bacterium enhanced significantly soil enzyme activities, soil microbial biomass, seed yield, and amount of P, K, Zn and Mn in seeds over control. Till now, two plant growth-promoting *B. amyloliquefaciens* strains IN937a (GB99) and B94 from the USA and one strain KPS46 from Thailand were reported from rhizosphere and roots of soybean.

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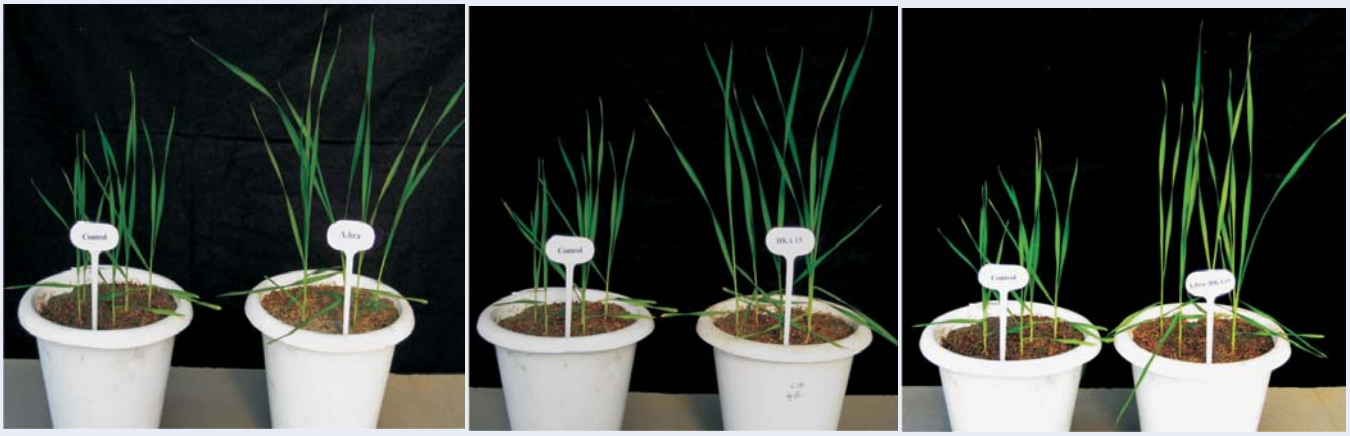
Effect of plant-growth promoting rhizobacteria in wheat

Plant-growth promoting rhizobacteria: *Pseudomonas*, *Bacillus*, *Azospirillum* and *Azotobacter* have been used as bioinoculants for different crops for disease control as well as for growth and yield increase.

Rhizobacteria *Azospirillum brasilense* and *Paenibacillus polymyxa* HKA-15 and their combinations were evaluated on wheat var. HD 2733 in pots.



Control *A. brasilense* Control HKA-15 Control HKA-15 + *A. brasilense*

After 45 days, chlorophyll content of the plants was measured by Spad Colorimeter. Inoculation with *Azospirillum brasilense* alone increased chlorophyll content as compared to *Paenibacillus polymyxa* HKA-15 and uninoculated control, owing to its biological nitrogen-fixing ability. Increased fresh and dry weights were observed in the plants inoculated with *Paenibacillus polymyxa* HKA-15.

Co-inoculation of wheat-plants with *P. polymyxa* HKA-15 and *A. brasilense*, besides enhancing chlorophyll content increased fresh and dry weight of shoots, and resulted in better tiller formation as compared to single inoculation. Selecting combination of bacterial strains with individual plant-growth promoting traits like *A. brasilense* for nitrogen fixation and *P. polymyxa* HKA-15 for antifungal activity as bioinoculants would help in crop growth and in yield increases under sustainable agriculture systems.

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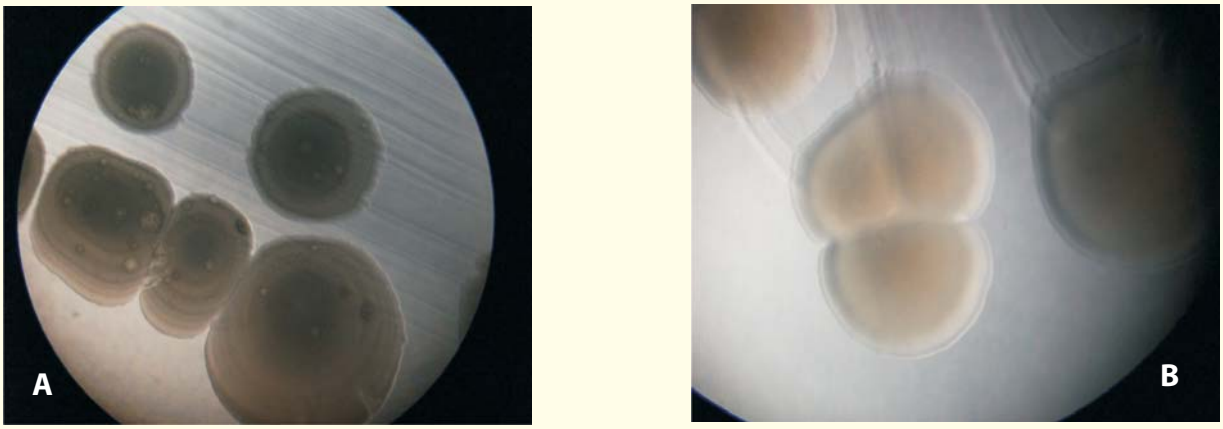
Promising phytate-mineralizing bacteria from soybean rhizosphere

Seven promising phytate-mineralizing bacteria were isolated from the rhizosphere of soybean cultivars. These isolates were identified and found closely related to *Bacillus aryabhattai* (MDSR 7, MDSR 14), *Enterobacter ludwigii* (MDSR 4, MDSR 9, MDSR 19), *Bacillus megaterium* (MDSR 11) and *Enterobacter cloacae* (MDSR 17). All these strains mineralized sodium phytate ; indicated by the formation of a clear halo zone around rhizobacteria colonies. These strains possess multiple plant-growth promoting traits — siderophore production, indole-3-acetic acid production, solubilization of insoluble zinc compounds and tricalcium phosphate. This is **possibly the first report** of the existence of *B. aryabhattai* in the soil. *Bacillus aryabhattai* was earlier reported from the stratosphere. Therefore, its existence in the soil needs further verification by characterization through polyphasic approaches of microbial identification. Similarly, *Enterobacter ludwigii* has also not been reported till date to be present in soybean rhizosphere ; was found in the rhizosphere of *Lolium perenne* (Chile) and rice (India).



Colony morphology of (**A**): *Bacillus aryabhattai* MDSR 7; (**B**): *Enterobacter ludwigii* MDSR 4

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Power-operated machine for filling poly-bags with potting mixture

Power-operated potting machine of continuous type is capable of mixing, pulverizing, sieving and filling potting mixture (soil: granite powder: compost at 2:1:1 ratio v/v) in poly-bags at the desired quantity (250, 500, 1,000g).

The machine installed at the Peruvannamuzhi Research Farm at Calicut consists of 3-hp motor (3- phase), paddles for mixing and pulverizing, sieve attached in slider-crank mechanism for sieving, and electronic instrumentation including load cell for dispensing potting mixture at a set quantity and timing. In addition to the electronic dispensing unit, a pedal has also been provided for operator to manually control quantity of potting mixture.

Germination studies conducted in the mist chamber using machine-made potting mixture and the quality of the potting mixture based on the textural analysis were found encouraging. The electronic vending unit fills desired quantity with 90% accuracy, and this is acceptable in nursery practices.

The cost of the unit is approximately ₹1.00 lakh, and its capacity is 100 kg/hr— about 1,600 bags of 500-g capacity can be filled in 8 hours by engaging two labourers, while only 300-350 bags were filled in the conventional method. Cost of bagging by machine is ₹320 per 1,000 bags, and it is ₹1,140 in the manual method. There is about 70 % cost saving and 80 % time-saving through machine-filling.

Potting machine

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Therapeutic biscuits production

Biscuits, being convenient, economical, and hygienically safe and in the ready-to-eat form can be considered as a means of nutritional supplementation. Their value-addition can be done using fruits and vegetables rich in vitamins, minerals and antioxidants.

Carrot is a rich source of β-carotene (pre-cursor of vitamin A). Beet root is rich in Betaine (betacyanin). Betaine supplements have been found to play an important role in lowering potentially toxic levels of homocysteine, a naturally occurring amino acid.

Dried beetroot supplemented defatted soy fortified (5% in flour formulation) biscuits have got sensory acceptability at 6% level (flour formulation basis) of beetroot. They provide approximately 8.25% protein, 0.9% dietary fibre and 483 Kcal / 100 g. And dried carrot supplemented (5% in flour formulation) biscuits containing 7.5% dried carrot were also liked on sensory evaluation.

Carrot fortified biscuits

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Novel design for low-cost tray dryer

This tray dryer has a unique design for the plenum chamber, which facilitates horizontal as well as vertical hot-air movement. That has minimized problem of non-uniform drying of food materials in different trays. The overall dimensions of the dryer are 2,700 mm × 600 mm ×2,300 mm (L × W × H). Drying chamber has 925 mm × 600 mm ×1,120 mm outside and 760 mm × 570 mm × 1,020 mm inside dimensions. The chamber has racks to hold 14 trays of 750 mm × 550 mm × 25 mm dimension. The total surface area of the tray is 5.775 m^2 — sufficient to load about 30 kg of fresh, sliced fruits and vegetables for drying in a thin layer. Trays are made up of aluminium- frame to hold heat- resistant nylon mesh, which helps easy removal of moisture-laden air from food products and accelerates drying.

Dryer consists of microchip processor-based heat controller system for switching on/ off of the heaters. Heated air from heating chamber to drying chamber is carried and circulated by different split sections with the help of 1-hp motor-operated blower at 2,800 rpm. Blower outlet and heating chamber inlet (diameter 10 cm) are to be connected before heating elements. This equipment can be useful in drying

vegetables for soup-making, fruit-pulp for making fruit-leather, and drying of spices and condiments for their better quality. The design of the dryer is ready for transfer for its manufacturing on a commercial scale.

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Software for rainfed natu tobacco germplasm

Among different tobacco types grown in India, rainfed natu tobacco is an indigenous-type tobacco, mainly used for domestic consumption; 81 rainfed natu tobacco accessions are being maintained at the CTRI gene bank.

Based on the data available on various parameters of these accessions, a knowledge-base system has been developed with user-friendly menus using RDBMS technology VB.Net as Front-end and Oracle as Back-end application. This software helps store and retrieve data of tobacco germplasm lines. The software consists of 40 parameters classified into 15 groups.

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Published by Dr T.P. Trivedi, Project Director, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi 110 012. *Phone:* 011-25842787; *Fax:* 011-25843285, *e-mail:* tptrivedi@icar.org.in. Lasertypeset by M/s Print-O-World, Shadipur, New Delhi 110 008, and printed in India at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase I, New Delhi 110 028.

Editing : **Dr R.P. Sharma and Shashi A. Verma** ***Design & Production :*** **V.K. Bharti and Punit Bhasin**

WAY FORWARD

PLANTATION crops constitute an important component of an average diet and also remain inter-woven with the cultural heritage in several parts of the country. They have also lend major support to rural economy and sustained livelihood of millions who are engaged in their cultivation, processing and trade. Being perennial, they play a vital role in preserving ecological balance, and in the recent times, they have been recognized for their high potential of carbon sequestration.

Among the plantation crops, coconut occupies a premier position, covering about 1.90 million ha both under plantation and homestead management systems. The palm is venerated as *Kalpavriksha* – the tree of life in Indian classics – owing to versatility and usefulness of this crop in daily life as the source of nutritious food, oil for edible and non-edible uses, natural fibre of high commercial value, alcoholic beverage, timber and an array of products for commerce and trade. Coconut sector contributes about ₹8,000 crore per annum to the national GDP, and earns about ₹800 crore as foreign exchange; primarily through export of coir and coir products.

In the past decades, research efforts in coconut have yielded fruitful results in terms of increasing production and productivity through high-yielding varieties, development of farming systems for increased profitability in different agro-ecological zones of the country, technologies for value-addition, and farm mechanization for production and processing. Varieties with considerable degree of resistance and management package aimed at plant health improvement can help to a great extent in reducing production losses due to devastating root (wilt) disease.

The recently concluded International Conference on *Coconut Biodiversity for Prosperity* (ICCBP) at the CPCRI, Kasaragod, provided the much-awaited platform for stakeholders at the national and international levels to come together, discuss and plan future actions. In the present global scenario, it has now become evident that coconut requires to be promoted as a food crop for nutrition, health-care and environmental services to safeguard interests of millions of people.

It has become imperative to gainfully utilize new frontiers of science and technology for understanding structural and functional genomics, long-term conservation of genetic resources through cryopreservation, increased use of nanotechnology in disease diagnostics, targeted delivery of bio-molecules, bio-processing and smart packaging of value-added products, unravelling health benefits of coconut, problems associated with diseases of coconut like wilt and its management, leveraging environmental benefits through sequestration of carbon as net carbon sinks and its benefit, product diversification and mechanization for sustainable use of coconut to provide quality life to people.

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

Similarly, arecanut plays a prominent role in the religious, social and cultural milieu and economic prosperity of the Indian people. Stagnating market prices and increasing cost of production owing to lack of skilled labour required have raised livelihood concerns of arecanut farmers.The future programmes in arecanut research will focus on developing high-yielding, dwarf, adaptable for high-density planting varieties and hybrids.

Cocoa another plantation crop is mainly cultivated as a mixed crop in coconut and arecanut gardens, mainly in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. Considering the current market growth of about 20% of the chocolate industry in India, it has great potential for growth, both in terms of area expansion and increasing productivity. Promoting area expansion of cocoa as an ideal mixed crop in arecanut and coconut gardens to meet the growing market demand, characterization of compounds contributing to flavour and therapeutic properties and identification of clones for specific flavour and further studies for quantifying the carbon sequestration potential of cocoa will receive renewed impetus for the development of this sector.

In the present global scenario, these crops are facing many challenges owing to fluctuating farm-gate price, climatic changes and biotic and abiotic stresses impacting production and productivity. Cost-effective technological innovations are vital to address the challenges and to make these crops widely competitive.

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