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RESEARCH UPDATE

PROMISING TECHNOLOGIES

Water stress management in muskmelon

Muskmelon *(Cucumis melo)* is an important fruit-crop of summer, and is often grown in the drought-prone regions. Optimization of water use at different growth stages of the crop can enhance profits of farmers. Hence, possibilities have been explored to reduce water use of the crop without much losses in the yield.

An experiment was conducted with muskmelon F_1 hybrid 'Kundan' in the farmer's field during January 2012, which continued till end of April 2012. While preparing land, ridges were covered with a black-IRT plastic mulch with 8-cm diameter holes for seedling planting. Drip irrigation system was also set under the plastic mulch. Laterals were placed near the root zone for uniform application of water and fertigation. Row × row 2.1-m distance and plant × plant 0.37-m distance with plant population of 12,870 plants/ ha were maintained.

Water stress of 7 days to plants at the flowering phase

The plant recovered fully; after 7 days water stress at the flowering phase

Water stress of 14 days and control at the flowering phase

Fruits collected from plants under 7 days water stress condition in the flowering phase

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Water stress of 7 days at the fruiting phase

Plants showing severe impact of water stress during the fruiting phase

Fruits collected from plants under 14 days water stress during the fruiting phase

Experiment was designed in a split-plot design with four replicates. A separate block was maintained for flowering and fruiting phases as the control. Two soil moisture stress levels (7 days and 14 days) were applied to each plot of 120 plants during two critical growth phases — flowering and fruiting. Drip irrigation system was installed with a discharge capacity of 4 litres/hr/ drip/plant. The amount of water required was calculated by collecting water discharge/hour. In a complete life-cycle of the plant, 884 litres of water per plant was given from I to V growth stages [Phase – I, crop establishment (35 days after sowing, DAS), Phase – II, from the onset of blooming to early fruit-setting (55 DAS), Phase – III, from early fruit- setting to setting of the first two fruits (70 DAS), Phase – IV , fruit swelling (90 DAS) and Phase – V, from fruit ripening to harvesting (120 DAS)]. In the initial stage of establishment, 1 to 1.5 hours irrigation was applied. Later on plants were irrigated 2 hours per day till the end of the harvest; 7 days and 14 days water stress was given when control soil reached at the field capacity after the establishment of the irrigation. The effectiveness of muskmelon-crop to use water during its complete growth period (control) and 7 days and 14 days stress was studied and calculated as water-use efficiency (WUE).

Flowering phase was considered from the onset of blooming to early fruit-setting; 50 % flowering, recorded after 45 days of seedling transplanting, was used for 7 days and 14 days water stress as the flowering phase. In control treatment, water was continued throughout the crop season. The fruiting phase was considered when plants bore first two fruits after 20 days of flowering. In 7 days' stress treatment, water supply was restricted to 56 litres / plant (7 days stress × 8 litres/ day/ plant water requirement). For 14 days, supply was restricted to 112 litres /plant (14 days stress × 8 litres /day/ plant water requirement). The water applied in control was 113.80cm. Water applied for 7 days and 14 days water stress treatments was 106.6cm and 99.4cm, respectively. To mitigate water stress after its imposition for 7 and 14 days, water stress hormonal sprays of 6-BAP @ 10 and 20 ppm, GA_3 @ 50 and 100 ppm were applied. Application of GA_3 @ 50 ppm mitigated water stress.

Three factors analysis indicated interactions of growth phase × moisture stress [GP × MS], growth phase × growth regulators [GP × GR], moisture stress (MS) × growth regulators [MS × GR] and growth phase × moisture stress × growth regulators [GP × MS × GR]. Water stress significantly affected number of fruits/ plant, fruit weight, yield/ plant and WUE. At the flowering stage, brix level went up from 10.97 (control) to 13.40 in 7 days and 13.72 in 14 days water stress. Total soluble sugars were significantly higher in water-stress treatment (13.82). The WUE of control was 0.23 tonne/ ha/cm, and it was reduced by 8.69 % in 7 days and by 69.56% in 14 days stress during flowering. In fruiting phase, WUE was reduced by 78.26 % in 7 days and by 82.60 % in 14 days stress. WUE reduction was lowest in 7 days stress at the flowering stage, where plants recovered fully and maintained also yield level; this was more effective in water-saving management. The impact of water stress at the fruiting stage was more severe than that on the flowering stage, and when it was given for a longer period (14 days), it reflected on the morphological traits and yield.

By stopping 7 days irrigation at the flowering phase, WUE improved and farmers could save on 56 litres of water/ plant, and 720,720 litres of water with population of 12,870 plants/ha (from 11,377,080 litres water requirement/ha). As a realistic approach if there is 7 days water saving during the flowering stage, additional 816 plants or 0.06 ha can be irrigated.

This farmers' oriented water-saving technology may save water in muskmelon cultivation whenever there is a closure of irrigation source (Nira canal) in the Deccan plateau semi-arid region of Maharashtra.

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Mechanized urea treatment on wheat-straw

Process of urea treatment on the wheat-straw has been well established, and is recommended for nutritional enhancement of the straw. Urea acts on the ligno-cellulosic complex of the straw; it increases crude protein (N × 6.25) content from 3.5-4.0% to 8.0-9.0%, and also results in enhanced microbial activity and ruminal digestion of the straw, and in a way improves nutritive value of the straw.

In India, urea treatment on wheat-straw in the field has been limited; as farmers faced difficulty to carry out technical job of the treatment along with the high labour cost in spreading, sprinkling urea solution and in heap-making etc. A gadget was added to the existing threshing mechanism used in the wheat-fields for making urea-treatment process simple and easy. This lead to wheat-straw treatment in the field without any additional cost.

Manual process of urea treatment on wheat-straw

Urea solution spray attachment fitted to thresher

A commercial-type thresher, operated by a 45-hp tractor with the capacity of 6q/hour to 9q/hour, was used. Urea solution was prepared (by dissolving 4 kg urea in 50 litres of water for 100-kg straw treatment) in 1,000- litre plastic tank and was supplied to nozzles (2 numbers) through a pressure hose (Inlet) connected to a plunger pump (three pistons) with rubber-pipe outlets. Adjustable valves were fitted with nozzles to control spraying rate of urea solution. The plunger pump was mounted on the thresher body and two nozzles were placed on the specially designed straw outlet. The outlet was bolted on the thresher in such a way that it was confined to the already built-in two straw outlets, provided by the manufacturer, and all the straw generated after threshing was carried out with the air through this specially designed single outlet. To operate the pump and thereby initiate spray of urea solution, the power from the tractor was transmitted from the PTO shaft of the tractor to the thresher, and thus rotated the thresher shaft; resulting in threshing operation and also simultaneously angular movement of the pump. The harvested wheat-plants were fed manually to the inlet hopper of the thresher, and grains were separated from the crop and were collected through an outlet in the gunny-bags. The threshed crop residues were blown away through a single specially designed straw-outlet with two nozzles. The nozzles sprayed urea solution over the straw particles. Care was taken to confine all straw into a closed boundary and a heap was made to cover it with a commercially available polythene sheet for a reaction period of 21 days for completing ammoniation.

This process would save on labour and water requirement compared to the conventional method. The treatment cost with the developed prototype was about half of the manual method (₹25.72/q vs ₹49.98/ q). And the farmer can save on the concentrate in the diet of the lactating animals through feeding of the treated straw.

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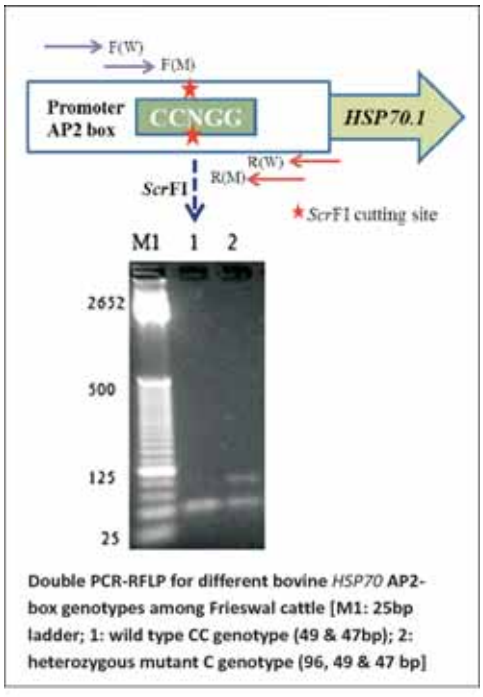
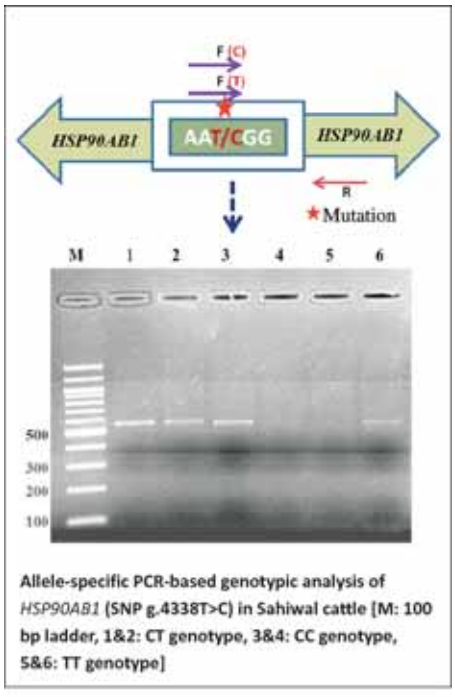
Diagnostic methods developed for identifying genetic markers within *HSP* genes in Indian dairy cattle

Heat shock proteins (HSPs) play a major role in protection of cells from thermal stress. Diagnostic methods, double PCR- RFLP and allele-specific PCR (AS-PCR), have been developed to identify nucleotide polymorphisms (SNPs) within *HSP 70.1* and *HSP 90AB1*. The genetic markers are associated with relative thermo-tolerance and milk- production traits in Indian dairy cattle.

The present study was designed to develop molecular tools to identify genetic markers within the *HSP* genes in Indian dairy cattle — Sahiwal and Frieswal. The association studies involving physiological parameters like rectal temperature (RT), respiration rate (RR), heat tolerance coefficient (HTC) and milk production traits



Double PCR-RFLP for different bovine *HSP70* AP2-box genotypes among Frieswal cattle [M1: 25bp ladder; 1: wild type CC genotype (49 & 47bp); 2: heterozygous mutant C genotype (96, 49 & 47 bp]



Allele-specific PCR-based genotypic analysis of *HSP90AB1* (SNP g.4338T>C) in Sahiwal cattle [M: 100 bp ladder, 1&2: CT genotype, 3&4: CC genotype, 5&6: TT genotype]

(total milk yield) were found significantly associated with the genetic markers. Double PCR-RFLP was used to identify deletion of cytosine within the AP2 box of *HSP70.1* promoter. A set of primers were used to generate specific gene fragment. Mutated set of primers were then used to re-amplify gene, keeping single *Scr*FI restriction site intact. The RFLP generated DNA band pattern that helped diagnose animal genotypes.

The other method was allele-specific PCR that identified genotype of intronic region within *HSP 90AB1*. A set of two forward primers with the mutation at 3' end and common reverse primers were used in two separate reactions to generate a partial gene fragment. Amplification clearly indicated animal genotypes with respect to SNP within *HSP 90AB1*.

Double PCR-RFLP and allele-specific PCR could easily detect genotypes of *HSP* genes in cattle. These techniques can be employed to study heat-stress response in dairy cattle and their selection for better relative thermo-tolerance and milk-production traits.

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Increasing meat production using RNAi

India possesses world's largest goat population, constituting 17.93% of the total goat population of the world. Goat- meat (i.e., chevon) is the most acceptable among many communities without any socio-religious bias. But India has a small market share of 11.66% of the total world's goat-meat production; primarily because of lower yield.

Fast socio-economic changes, rising per capita income and growing urbanization have boosted demand for meat, which has consequently increased the cost of goat-meat also.

A variety of different approaches, including selective breeding and better nutritional and management practices have been explored over the years to improve goat-meat productivity. With the advent of molecular genetics approach, attempts are being made to alter expression of various genes that regulate muscle mass. Myostatin (*MSTN*), a member of TGF-β superfamily, a negative regulator of the skeletal muscle mass, is considered as an important candidate gene.

The coding as well as 5' upstream region including promoter sequence of *MSTN* gene have been cloned and characterized in different Indian goat-breeds for the first time. And several small-interfering RNAs (siRNAs) have also been designed, which have the potential to knock-down *MSTN* gene.

To validate these siRNAs, an *in-vitro* culture model of muscle cells, using myoblasts from goat-foetus, has been developed. Foetal myoblasts cells are found superior to fibroblasts and adult myoblasts. Efficiency of different synthetic siRNAs was assessed in knocking-down *MSTN* gene using caprine foetal myoblasts. These siRNAs could cause 89% knock-down of the *MSTN* gene without any adverse response on interferon. These functional siRNAs against *MSTN* gene can be used for *in-vivo* application including making transgenic goat having knocked-down *MSTN* gene for enhancing muscle mass.

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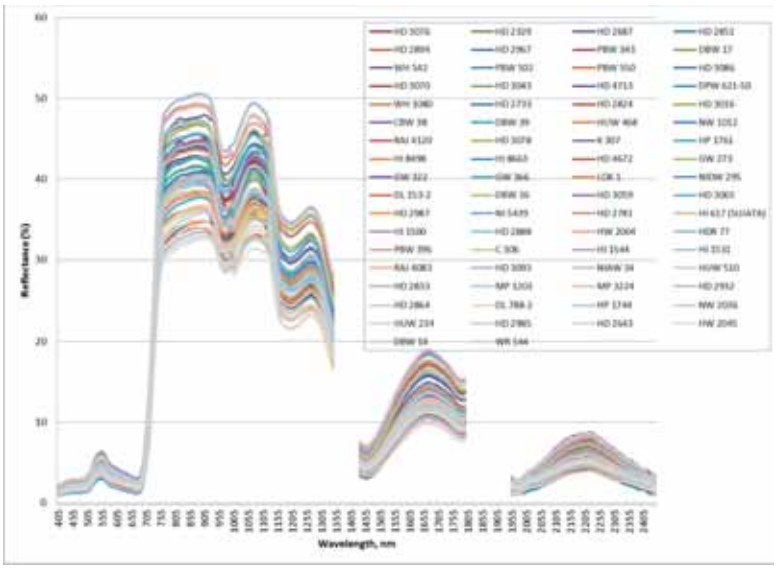
Wheat genotypes discrimination through Hyperspectral Remote Sensing

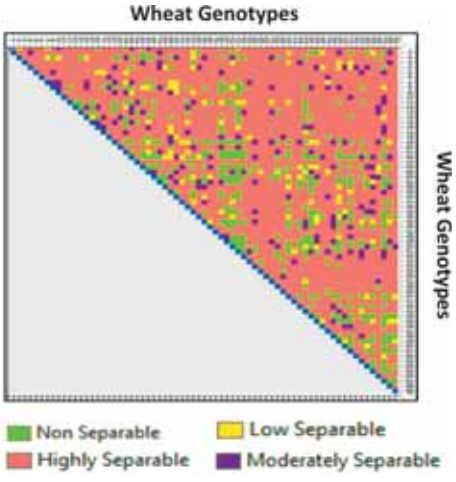
Discrimination of the wheat genotypes through conventional methods involves exhaustive and time-consuming field work, and they can hardly be extended to cover larger areas. Remote sensing has the potential to improve collection of information on the composition of the genotypes and hence also discrimination.

Broad band remote-sensing sensors, which are used extensively for mapping vegetation, are, however, not sufficiently sensitive to discriminate individual genotypes. Technological advancement and the advent of hyperspectral sensors with high spectral resolution sensors have raised expectations about the possibilities for spectrally discriminating plants at the genotypic level. This is achievable as the hyperspectral data contain information related to important biochemical properties of the plant.



Spectral signature of 70 genotypes of wheat grown in the IARI experimental farm

Spectral observations of 70 wheat varieties grown in the experimental field were taken using Fieldspec 3 Spectroradiometer in the spectral range of 400 to 2,500 nm. Spectral separability analysis was done for all combination genotype pairs, (i.e. 2415 pairs) using stepwise discriminant analysis and Jeffries-Matusita (JM), distance as a measure of separability. Analysis of JM distance matrix for 2415 pairs of genotypes based on the hyperspectral data revealed that 378 pairs were not separable; rest of the genotype pairs were classified quantitatively to low, moderate and highly separable pairs, and they were 119, 167 and 1,751 pairs respectively. The genotypes listed in the graph were serially numbered from 1 to 70, and were plotted in both the axes for interpretation. Also most sensitive 10 bands found in visible and shortwave infrared (SWIR) range could be used to discriminate 70 wheat genotypes. The discrimination was possible due to variations in the biophysical composition of the genotypes captured through hyperspectral data. The technique is in use as a tool for crop phenotyping for detailed characterization of plant growth and stress response.



Separability matrix of wheat genotype pairs based on JM distance values

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Scented *Cymbidium* hybrids

Unlike the native species of the orchids, all commercial *Cymbidium* hybrids are non-fragrant in nature. The newly developed hybrids are moderately scented, similar to their male parent, *Cymbidium iridiodes.* For the genetic improvement of the native species, two exotic hybrids — *Cymbidium* "Concerto" and *Cymbidium* "Nonina Paleface"— were used as a female parent to develop export-oriented standard type of spikes for cut- flower production.

Orchid-breeding programmes are mostly designed to improve size and colour of the flowers as well as for the following characteristics — spike longevity, stalk length, leaf shape, ease in cultivation, disease resistance and number of viable seeds through proper selection of parents for hybridization.

Two best clones were selected with attractive colour and graceful appearance. They have a potential to create a new trend in the market with a value-addition of natural fragrance, besides early- to mid-flowering trait that fulfills off-season demand.

PBX 05-772 clone has been derived from *Cymbidium* "Concerto" × *Cymbidium iridioides* cross. It is suitable for potted cultivation, and is an evergreen plant with long leaves, yellow green sepals (RHS 53D to N 144D), petals with red/purple spots (dense at the base) and stripes from the base and an attractive lip; leaves are 8 -11, are linear, lanceolate with pointed tips; peduncle length varies from 57 to 61 cm with 6-8 fragrant flowers; flower size is 10.2cm × 5.2 cm (approx.). Its blooming ranges from 29 to 35 days, and the clone is suitable for subtropical climate under the protected cultivation.

Another clone (PBX 05-751) from *Cymbidium* "Nonina Paleface" × *Cymbidium iridioides* cross is also suitable for cut-flower and has 12-13 florets. It has bright yellow-green flowers (RHS 153A) with a spike length of > 70 cm. Its approximate flower size is 7.8 cm × 4.9 cm with a prominent lip of 3.2 cm × 1.8 cm and a typical white margin.

Source of fragrance

The native species, *Cymbidium iridiodes* D. Don, used as a male parent is a threatened orchid, native to the North-East India, Myanmar, Nepal and South West China; found at an elevation of 1,000 to 2,800 MSL. It grows in warm to cool regions, and is an epiphyte in tropical moist forests. In Sikkim, the species is reported in Dickchu, Rakdong-Tintek and Rongli; and is maintained under the germplasm collection (NAGS) at the NRCO.

Scented *Cymbidium* hybrids

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Rohu induced to breed during November

Indian major carps (IMCs), catla, rohu and mrigala, contribute to more than 80% of the freshwater fish basket of the country; and the seed is one of the critical inputs for their culture. Fry production in hatcheries is either through induced breeding or seasonal activities during monsoon months. Winter breeding of carps has also been made possible during January and February.

This year, for the first time, rohu, *Labeo rohita,* has been induced bred during November. The monsoon-spent rohu was reared in indoor-rearing system under the controlled photo-thermal conditions. These spent broods rematured within 120 days of the indoor-rearing. During the first week of November, males oozed out milt. Females were seen gravid with prominent secondary sexual characteristics like bulging pelvic abdomen and reddish protruding vent.

Fish were induced bred on 23 November 2013 in the FRP hatchery and around 1.8 lakh rohu spawn were recovered from the incubation pool. This is the first-ever report of the IMC breeding during November. Earlier, IMCs were bred in all the quarters of the year, excepting October-December. This demonstrates that rohu can be bred round the year, which will be a boon for seed producers and would also enhance scope of carp aquaculturists to increase their earnings.

Rohu brood- Ready for breeding

Protruding vent of gravid female

Rough pectoral fin of matured

Intramuscular administration of inducing agent

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Rice landraces in West Bengal

Rice is cultivated in over 65% of the area under agricultural crops in West Bengal, and therefore the state is also called 'bowl of rice' with over 450 rice landraces. Two explorations were undertaken during October-November 2012 and April 2013 in *kharif* and *rabi*, and a total of 76 rice accessions were collected from the region, comprising 23 distinct rice landraces, from the parts of Malda, Dakshin and Uttar Dinajpur districts. Some of the most popular landraces — *Binnidhan*, *Red hirasail*, *Kartiksail*, *Chini sakkar*, *Kalonunia*, *Kanakchur*, *Tulaipanji*—are grown only in small pockets.

Variability in grain shape, size and colour in rice from Uttar Dinajpur, Dakshin Dinajpur and Malda districts, West Bengal

Kalonunia and *Tulaipanji* are the most common traditional rice landraces (more than six accessions). Eighteen accessions were with grey-orange and grey-yellow husk. Seed-coat colour of the landraces ranged from white, brown, golden-yellow, light-brown and red. Eighteen accessions were aromatics. 17 were awnless, and six were with awns. Maximum awn length (19 mm) was recorded for *Swarna* and minimum (6 mm) was of *Lalcholis*. Maximum 1,000-kernel weight (24.7 g) was of *Lalcholis* and minimum (9.3 g) was of *Jeerasail*.

Cluster analysis grouped 23 accessions into two clusters. Cluster - I included: *Dangi basful, Purnima, Kala mogha, Gogal sail, Kalonunia, Binnidhan, Gujinina, Jearasail, Radhunitilak, Gujanonia, Red hirasail, Chiniatap* and *Tulaipanji* (mostly aromatic types with smaller grain size). Cluster II included: *Lalcholis, Swarna, Tejasili, Gauchi*, *Kartiksail, Magursail*, *Nagra dhan* and *Kanakchur* (similar in taste and 1,000-kernel weight). Despite poor yield and small- to medium- sized grains, these landraces are being conserved for religious significance and local use by the farmers. Collection of these landraces and their identification for desirable traits is to be done in future.

Local people specifically grow *Tulaipanji* (soft-kernelled aromatic rice with good digestibility) and use it in marriage ceremony or *annaprasan* (when infant is offered food for the first time). Like-wise landraces, *Chini sakkar* (taste- like sugar) and *Kalonunia* (black- textured small rice) are also used for religious ceremonies in Raiganj area of Uttar and Dakshin Dinajpur districts. In Uttar and Dakshin Dinajpur districts, use of broken rice (boiled and fermented) with *Coccinia grandis* (vern. *jungli kundri*), *Clerodendrum viscosum* (vern. *ghato*), *Plumbago zeylanica* (vern. *chitawar*) and *Vernonia cinerea* (vern. *chhepra*) has been reported for preparing local rice beer (*Jhara)* or wine (*Haria*). A landrace, *Binni dhan,* mainly grown in Dakshin Dinajpur, has been mostly used during Kali puja (for worshipping Goddess Kali). Generally, aromatic rice, *Magursail,* is preferred for preparation of *kheer* (sweet meal) in Dakshin Dinajpur and adjoining regions. A distinct landrace, *Kala mogha* (black- scented rice named after a region), is also used for sweet meal preparation by local people in Uttar Dinajpur districts, particularly in Majlispur and Maldwar villages. In Uttar Dinajpur district, local people boil *atop* (soaked rice) of *Kalonunia* in milk and sugar or molasses to prepare a delicious dish known as *Payas*. Parboiling of different rice landraces is common practice in West Bengal.

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Cucumis metulifer, a potential alternative to cucumber

Plant of *Cucumis metulifer* is an annual monoecious scandent herb with a stem reaching several metres in length. Its leaves are shallowly palmate, 3-5 lobed; flowers are yellow; male flower is mostly solitary and short- stalked, and female flower is solitary with a very long stalk and a large soft-spined pale-green ovary; fruits are 12-15 -cm long and 6-7 -cm wide, bluntly 3-chambered, dark-green, mottled paler grey-green, almost orange-coloured when ripe, and are ornamented with stout fleshy spines. Its seeds are sown in late March, and when seedlings are with two true-leaves, they are transplanted. As they grow, enough support is

During exploration for cucurbits germplasm collection, *Cucumis metulifer*, an African horned melon, a native of tropical and subtropical Africa, was observed under cultivation in Sikkim. Its immature fruits are valued as a vegetable (salad). Though cultivated in a few countries, Australia, Chile, France, Israel, Japan, Kenya, New Zealand, USA and Zimbabwe, it was introduced into India in 1959, as per the records, primarily for research through Germany and the USA. Though no records are available of its cultivation in India, it was found grown in polyhouses as well as in open areas of Rukdong-Kyong and adjacent areas in East Sikkim district and occasionally was being sold at the roadside shops. Local residents informed that its cultivation has only been 3-4 years back, through the seeds brought from the North Sikkim district. It was seen in cultivation in other areas such as Khamdong-Singtam (East Sikkim), Chumbong and Soreng (West Sikkim), Dzongu and Mangan (North Sikkim) as well as in a few localities in Darjeeling under the names, *kitanu*, *ban kakra* and *dulley kakra*.

Cucumis metulifer in a roadside shop in Rukdong-Kyong

Leaf, male and female flowers and fruit

Fruit bearing plant inside a polyhouse

Dehorned longitudinally cut fruit ready for consumption

provided; flowering starts two months after transplanting; male flowers appear first, followed by female flowers after two weeks. In polyhouses, pollinators need to be introduced for good results. Fruits are ready for harvesting in 40-45 days after pollination; an individual plant bears 15-20 fruits, each weighing about 150-200 g. In Rukdong-Kyong, plant may yield fruits till November-end, and bruise-free fruits can be stored for 3-4 months without refrigeration.

Immature fruits are dehorned using knife, and longitudinally cut- pieces are served as salad. They are slightly acidic; otherwise the taste is exactly like cucumber, hence can be a substitute for salad- cucumber. Owing to its unique appearance, blend of taste and extended keeping qualities, *Cucumis metulifer* deserves to be promoted as a decorative and speciality fruit-vegetable. **Its resistance to root-knot nematodes indicates its potential to be cultivated in the nematode-infected soils.** Though cross-incompatible with commercially cultivated *Cucumis* species, it can serve to be a rootstock for them in such problematic soils.

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Wet banana-pseudostem chipper for compost industry

In a banana plantation, usually there are about 2,500-3,000 plants per ha. After the harvest of the fruits, outer sheath of the plant is used for fibre extraction; the left-over biomass (pseudostems) containing high moisture and 3-4% solid matter remains in the fields.

Farmers usually leave pseudostems in a corner of the field for natural drying, after which they are burnt. This results in loss of valuable organic matter, nutrients, and also causes environmental pollution. To use pseudostems for composting, their chipping is required, which is a labour-intensive and an uneconomical proposition. A continuous-type power-operated banana-pseudostem chipper has been developed to provide a suitable substrate to be used for compost production.

Wet Banana-Pseudostem Chipper

A large number of wet pseudostems are

(*Continued on page 9*)

Puakzo: Indigenous pop-corn maize of Mizoram

In Mizoram, various landraces of maize, locally known as *"Vaimim"*, are being grown from ancestral time, and of "*Puakzo Vaimim*" (*Puak*-pop, *zo*-all), which is exclusively used for popping, also are cultivated in *Jhum* areas.


Puakzo eng kawmlian


Puakzo eng kawmte


Puakzo eng kawmlian tial


Puakzo eng kawmsei


Puakzo eng kawmsei

Ear and kernel characters of maize (*Puakzo*) landraces

	Landrace and morphological characters	Ear length (without husk) (cm)	Ear dia. in middle (without husk) (cm)	Ear shape	Appro. nos of grains/ cob	Ear colour	100-kernel weight(g)
1.	*Puakzo eng kawmlian* (*lian*–big, *eng*–yellow, *kawm*-cob,most popular popping maize)	16.33	3.81	Conico-cylindrical	592	Deep-yellow	12.8
2.	*Puakzo eng kawmte*(*te*-small cob, *eng*-yellow)	12.00	3.46	Cylindrical	535	Yellow	12.6
3.	*Paukzo eng kawmlian tial*(*eng*–yellow, *lian*–big cob and *tial*-variegated)	15.86	3.36	Cylindrical	636	Yellow, variegated with light-brown kernel	13.1
4.	*Puakzo eng kawmsei* (*sei*-long cob, *eng*-yellow)	13.8	3.15	Cylindrical	462	Yellow	10.4
5.	*Puakzo eng kawmsei* (deep yellow and long cobs)	17.23	0.93	Conico-cylindrical	439	Deep-yellow	16.7
6.	*Paukzo engdal kawmte tial* (lightyellow with short cob and varigated)	11.76	2.64	Cylindrical	381	Light-yellow	11.4
7.	*Puakzo sen kawmte* (*te*-small, *sen*-red, smallest in size)	3.83	2.65	Cylindrical	295	Dark-red	11.8
8.	*Puakzo sen kawmlian*, (*lian*-big, *sen*-red)	12.93	2.72	Cylindrical	379	Dark-red	10.4
9.	*Puakzo var kawmsei* (*var*-white, *sei*-long)	14.2	2.59	Cylindrical	324	White	10.2
10.	*Puakzo var kawmlian tial*(*var*-white, *tial*-variegated cob)	13.83	3.10	Cylindrical	337	White, variegated with light-brown kernel	12.1


Paukzo engdal kawmte tial


Puakzo sen kawmte


Puakzo sen kawmlian


Puakzo var kawmsei


Paukzo var kawmlian tial

A total of 65 accessions of local maize were collected and broadly categorized as *Mimban*-sticky/ starchy (37), *Mimpui*-big grain (13), *Puakzo*-pop corn (10) and others (5). Ear and kernel characters of pop-corn maize accessions have been recorded.

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available in the freshly harvested banana fields, and can be fed in the machine for size reduction. The machine is a horizontal free-standing unit, mounted on four legs, and consists of 3-hp motor, feeding chute, a pair of rotors with blades and an outlet. By adopting optimum diameter of rotors and specific geometry of shredder blades, rotors pull-out pseudostems and press them against the cutting-bars and then they are shredded. Aggregate analysis, degree of shredding, and other physical parameters of the machine-made cut- pieces are at the recommended

Diversity in pop-corn maize

level as well as on a par with the manually-made pieces. High proportion (85.3%) of desirable level of 25-50- mm final fragments was achieved with machine compared to manual method (78.4%), thus resulted in improved quality of ingredients for compost production.

A machine unit costs ₹60,000. The chipper carries out chipping at the rate of 6,000 kg per hour. Size-reduction with machine costs ₹28.20/tonne while manually it is around ₹17/tonne; thus there is 93.2% saving in the processing cost and 98.0% in time through machine. Break-even point for the utility of this machine is 1,540 tonnes per annum and its pay-back period is 0.76 year. The machine is also gender-friendly, is cost-effective as compared to the manual method, is portable and is suitable for on-farm task by unskilled workers, besides reducing drudgery in the traditional method. Its maintenance is simple, and is recommended for compost industries as the machine can provide chopped ingredient of 1,000 tonne per month in a commercial compost industry and would also help in disposal of pseudostems from 20 hectares of banana plantation per month.

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Commodity-market outlook on major cereals in India

A far-sighted food policy is essential for India to facilitate efficient functioning of the food production and management systems, especially where household-level food security still remains elusive. In this context, reliable mechanisms for generating outlooks on key variables such as demand, supply, trade, prices, etc. of important food commodities form an essential basis for planning. Accordingly, an attempt was made to develop 'Outlook Models' that would generate future projections on the food demand and supply. A dynamic, partial equilibrium model, *Cereal Outlook Model*, has been developed for generating future outlooks on the major cereals in India. With this, demand- and supply-side outlooks for wheat, rice and maize have been generated with projections extending up to 2025-26.

The projections indicate fast growing trends in demand and supply of these three cereals. At the all-India level, the area under wheat is projected to increase marginally from the base-year level of 29.04 million hectares (M ha) to 30.11 M ha by 2025-26. This implies that the scope for area increase in wheat is limited, and thus the production increases should mainly come from yield improvement. The yield projections indicate that wheat yield in the country would increase modestly from the base-year value of 2.99 tonnes/hectare to 3.39 tonnes/ha in a span of 15 years. Consequently, the national production of wheat will increase around 16 million tonnes during 2010-11 to 2025-26 with the respective production projections being 90.87 million tonnes for 2015-16, 95.59 million tonnes for 2020/21 and 102.08 million tonnes for 2025-26. As in wheat, area gains in rice would also be marginal, and within the range that has existed in the recent-past. The model indicates an area increase from 42.5 M ha in the base-year to 44.5 M ha by 2025-26. Yield gains in rice would be modest from 2.25 tonnes/ha to 2.61 tonnes/ha during the period. Consequently, the total rice production is projected from 95.7 million tonnes to 116.06 million tonnes. The area under maize is projected to increase at a higher rate than that of wheat and rice. An increase in area is projected from 8.61 M ha in the base-year to 9.14 M ha by 2025-26. The yield of maize is slated to increase perceivably from 2.54 tonnes/ha to 2.98 tonnes/ha during the period. Both area and yield gains would increase maize production from 21.8million tonnes to 27.19million tonnes between the base-year and terminal-year. Such gains in

Commodity	Variable	2010-11 (Base-year)	2016-17	2020-21	2025-26
Rice	Area	42.51	44.20	44.34	44.53
	Yield	2.25	2.37	2.47	2.61
	Production	95.74	104.82	109.60	116.07
	Total consumption	90.21	100.81	105.72	112.03
	Net trade	2.77	4.04	4.03	4.04
Wheat	Area	29.04	29.37	29.68	30.11
	Yield	2.99	3.09	3.22	3.39
	Production	86.76	90.87	95.59	102.09
	Total consumption	81.61	90.80	95.52	102.01
	Net trade	0.68	0.07	0.08	0.08
Maize	Area	8.61	9.26	9.19	9.14
	Yield	2.54	2.73	2.86	2.98
	Production	21.84	25.26	26.31	27.20
	Total consumption	18.10	22.55	23.50	24.34
	Net trade	3.48	2.72	2.81	2.86

production would be appreciable for a marginal crop like maize, and indicate the future potential of this important low value staple crop.

In nutshell, the outlooks on rice, wheat and maize indicate that, though demand for these crops would increase considerably as the result of growing per capita income, population and urbanization, supply would keep pace due to the emergence of new areas, contributing towards incremental production. Consequent to the considerable supply response projected against the growing demand, the net trade of all the three commodities would remain positive, though some signs of tapering off in the net trade are expected in wheat and maize. Accordingly, no serious supply deficits are anticipated in the case of three cereals; at least for next one and a half decades in the country.

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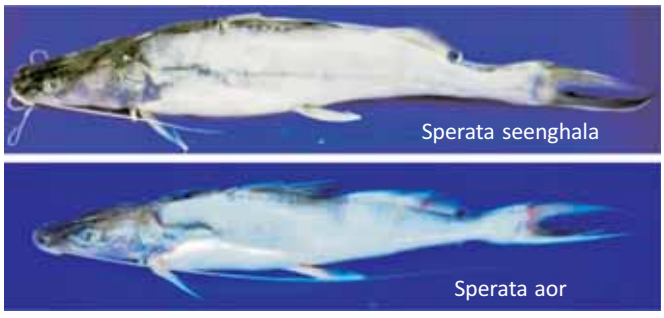
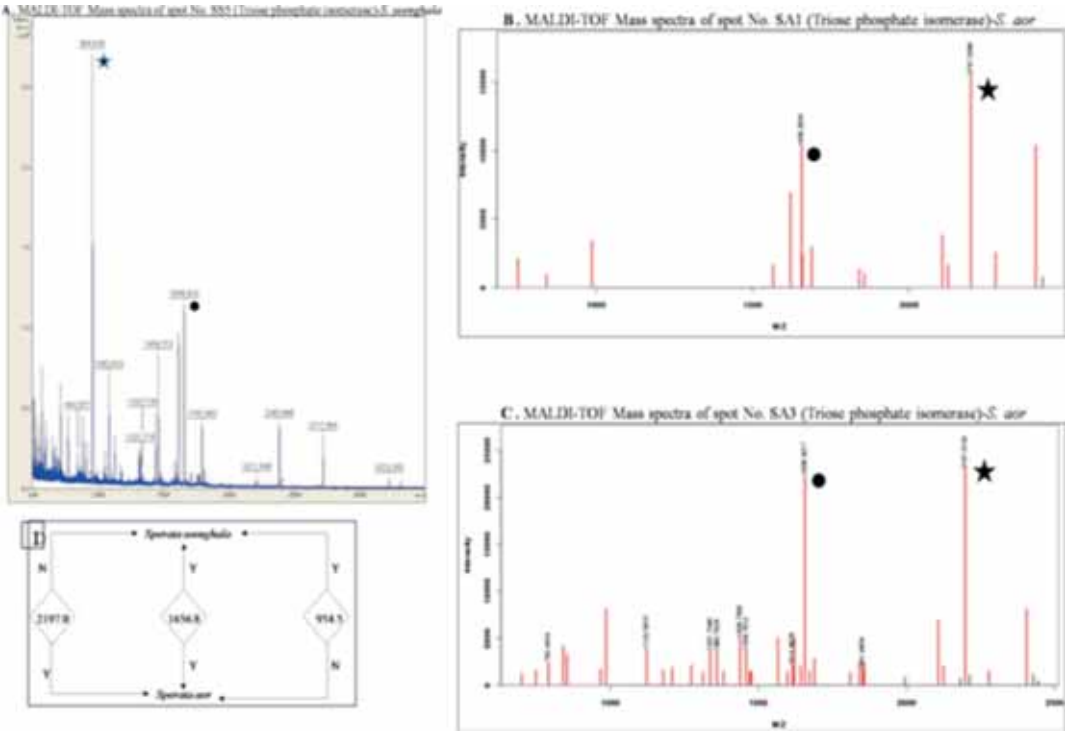
Proteomics applications for fish food authentication

To avoid cases of substitution of certain fish species by others of less commercial value, a number of global regulations have been implemented, guaranteeing market transparency. As a consequence of these regulations, development of analytical tools for distinguishing between the closely related fish species has become mandatory.



Proteomics technology was employed for differential characterization of sarcoplasmic peptides of the two closely related fish species, *Sperata seenghala* and *Sperata aor*.



One of the proteins identified as triose phosphate isomerase (TPI) has three positional variants; out of which two are specific to *S. aor*, and one is specific to *S. seenghala*. All the three TPI variants were present in the mixed samples of raw protein extracts of *S. seenghala* and *S. aor.* There were subtle differences in the peptide mass fingerprints (PMF) of these positional variants which enabled identification of the source of origin. Such studies can be exploited to differentiate between species and detection of deceptive practices of fraudulent substitution of commercially valuable fish species with the inferior ones.

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National Research Centre on Litchi, Muzaffarpur, Bihar

The NRCL acts as a premier Centre for conducting research on litchi. It also acts as a national repository of information on litchi production, processing and value-addition

The National Research Centre on Litchi (NRCL) was established on 6 June 2001 under the aegis of the Indian Council of Agricultural Research. The Centre started functioning in March 2002. The lease deed for 40 hectares was signed on 25 June 2002 between the ICAR and the Government of Bihar, and it was transferred to the Centre at Mushahri, Muzaffarpur. The Centre was strengthened during 2005 and onwards for developing infrastructural facilities and to carry out research. The research farm of the centre is spread over an area of 35 ha.

MANDATE

The centre has mandate to act as a repository of litchi plant genetic resource and to provide single-window solution for crop production and post-harvest management to growers, industries and exporters in a mission- mode.

Litchi Scenario

Litchi is an evergreen subtropical fruit, known for its delicious, flavoured and juicy aril, highly nutritive and refreshing taste. Currently, Bihar contributes to 45% of total litchi production, and occupies nearly 50% of the area under litchi plantation in the country. India is the second largest producer of litchi after China, and has the highest productivity.

FUNCTIONS

- To undertake basic, strategic and applied research for enhancing productivity, quality and utility of litchi.
- To act as the repository of genetic resource and scientific information on all aspects of litchi.
- To undertake frontline demonstrations in newer technologies and to impart training for upgrading scientific knowledge.

INFRASTRUCTURE

Its research farm has a good number of modern propagation structures, screenhouses, glasshouses, irrigation networking and water sources.

Many equipments, GCMS, AAS, UV-VIS spectrophotometer, leaf area meter, portable photosynthesis meter, horizontal electrophoresis unit, nitrogen analyzer, flame photometer, trinocular phase-contrast upright microscope, trinocular compound microscope, stereo binocular micro-scope, ultracentrifuge, high speed centrifuge modified atmospheric packaging unit, hydro-cooling system, forced-air cooling system, litchi grading machine, plastic strip sealing and packaging machine, shrink wrapping machine, texture analyzer, sulphitation chamber, honey- processing unit, litchi-peeling machine, cool- storage chamber, bottle-washing machine, litchi harvester- cum- pruner, power sprayer and mist chamber, have been procured, and a state-of-art glasshouse facility has been established for different research and supportive activities.

Library: It has more than 1,500 books including recent editions of 400 reference books. At present, 11 Indian and 11 international journals are being subscribed.

Central Instrument facility

Plant Protection Laboratory

Post-harvest handling laboratory

Nursery for quality plant regeneration

The centre has an e-granth project of the NAIP.

Agricultural Knowledge Management Unit: To manage knowledge database, the Unit has softwares of international repute — SAS, CAB abstracts and horticultural abstracts. It has broadband facility from the BSNL for internet connectivity, and its website is being accessed worldwide by many stakeholders (*http://nrclitchi.org)*.

SALIENT ACHIEVEMENTS

Genetic resource management and crop improvement

- Collected fifty-two accessions of litchi and allied species from indigenous sources and planted in the germplasm repository.
- Eight cultivars collected from Spain under the FAO Project.
- Molecular characterization of 20 litchi cultivars completed in collaboration with the CISH, Lucknow, using RAPD and ISSR markers.
- Fifty-six superior clones of litchi identified and propagated.
- Developed hybrid progenies involving litchi cultivars, Shahi, China, Bedana and Kasba; and they are being evaluated.

Crop production

- Rejuvenation technique standardized for old senile orchards.
- In cv. Shahi, 75:50:100 g NPK/plant/year and in cv. China, 100:50:100 g NPK/ plant/year have been found most effective for vegetative growth.
- Inter-space utilization protocols for young non-bearing litchi orchards have been developed with (i) Litchi-Banana (ii) Litchi-Cowpea-Potato-Onion (iii) Litchi-Okra-Gladiolus models with high B: C ratio of 2.38, 1.53 and 1.37, respectively.
- Foliar application of Planofix @ 2.5 ml/10 litres or NAA 20 mg/ litre of water one week after fruit-set, checked fruit drop significantly.
- Two sprays of KNO_3 (4% and 2%) after 20 and 30 days of fruit- set delayed colour-break by 5 days in litchi cv. Shahi.
- Bagging individual litchi bunches of cv.Shahi with perforated butter paper was found best for production of class-I category fruits with reduced sun-burn and cracked fruits.
- Covering plants with 30% green-and 50% white-shade nets extended harvesting period up to 16 days with slight decrease in TSS and acidity.
- Studied biodiversity of arbuscular mycorrhiza in litchi rhizosphere. Three species of *Glomus* were found predominantly associated with the plant.

Crop protection

- Identified major pests of litchi prevalent in the area.
- *Trichogramma* @50,000 eggs/ha at flower initiation and at fruiting, and Cypermethrin @0.005% and Nimbicidine @0.5% were effective in minimizing damage caused by fruit-borer.
- Three new pest threats in litchi identified are: red weevil (*Apoderus blandus)*, semilooper (*Anisodes illepidaria)* and bagworm (*Eumeta crameri*).
- Observed a 'twig blight' disease (symptoms appeared as death of leaves on new shoots), and a leaf blight

VNSDASU1, litchi clone

A promising clone, VNSDASU 1, has been identified. The fruit of this clone has about 83 % pulp and approximately 30g fruit weight. The yield potential of the clone (about 60-year tree) is 2.0-2.5 q/plant per year.

This is regular in bearing and develops crimson-red colour fruits. The plant is comparatively free from pests and diseases. This clone has been regenerated for detailed characterization and multi-location testing.

a. Plants in bearings; **b.** A bunch of fruit; **c.** Longitudinal section of fruit showing small seed and high pulp

Technologies beneficial

Rejuvenation of unproductive senile orchards

Unproductive orchards (>40 yrs) of litchi were rejuvenated through heavy reiterative pruning and other

Old unproductive litchi orchard

Canopy development in rejuvenated trees

cultural practices. Rejuvenated trees produced quality fruits within a minimum period of three years. Suitable intercrops for this gestation period have also been identified that would give income to farmers in addition to the income from sale of pruned wood. The likely cost of adoption of technology is ₹25,000/ ha.

Potting mixture for propagation of quality planting material

A potting mixture for healthy and vigorous growth of litchi air-layered seedlings has been developed for profuse root development; this leads to high survival of air-layers in the nursery and in the fields. The cost of production of gooties with this method is ₹ 16.5/ gootie.

Freshly cut air-layers

Plants after establishment in potting medium

Off- season layering technique

A technique for raising air-layered litchi planting material through temperature regulation and selection of non-bearing twigs of desired thickness during spring (off-season) has been standardized. This gives good quality planting material with advantage of quick establishment and low gestation and maintenance period.

Gootie in off-season

Red weevil

Semilooper

Bagworm

and tip dieback, which were difficult to separate. The leaf blight appeared as tan spots on leaves. The afflicted leaves look-like scorched from the sun.

- At post-harvest stage, fruit-rot caused by several fungi (*Colletotrichum gloeosporioidis, Aspergillus flavus, Alternaria alternata)* is found severe.

Post-harvest management and value-addition

- Physico-chemical studies of litchi- fruits indicated that 3rd week onward of May is the best time for harvesting litchi, *cv.* Shahi.
- The combined spray of boric acid (0.2 and 0.5%) + Carbendazim (0.1%) + GA_3 (50 and 100 ppm) + KNO_3 (2 and 4%) or $CaNO_3$ (1%), twice during fruit-development stage gave higher and good quality yield with less sun-burn and cracked fruits of cv. Shahi.

Major litchi-producing belts in India

- Bihar (Muzaffarpur, Vaishali, Samastipur, East Champaran, West Champaran, Sitamarhi, Bhagalpur, Begusari and Seohar)
- West Bengal (Murshidabad, 24-Paraganas)
- Asom (Kamrup, Sonitpur, Bongaigaon, Tejpur)
- Uttarakhand (Dehradun, Udham Singh Nagar, Pithauragarh, Nainital, Haridwar)
- Punjab (Gurdaspur, Ropar, Pathankot, Hoshiarpur)
- Uttar Pradesh (Saharanpur, Kushinagar, Meerut, Muzaffarpur)
- Jharkhand (Ranchi, Gumla, Hazari Bagh, Lohardaga)
- Tripura (South and East Tripura)

- Thermocol packaging enhanced shelf-life of litchi-fruits by 6-8 days.
- Wine from litchi-fruits with high nutritional value was produced by fermentation with wine-yeast, *Saccharmoyces cerevisiae* var. *bayamus*.
- Good quality litchi-nuts were produced by treating them with KMS (0.1%), followed by citric acid (2%), and drying alternatively in sun/shade-oven-sun for specific periods.

for litchi-growers

Litchi-based cropping systems

Three intercrop models — Litchi+banana, Litchi+okra-gladiolus and Litchi+cowpea-potato-onion have been identified for utilization of interspaces in the pre-bearing orchards.

Banana and potato as intercrops in young litchi-orchard

Bio-intensive management of fruit-borer complex

Fruit- and seed-borer is a major pest of litchi. Several species of *Conopomorpha* damage litchi-fruits. An ecofriendly technology for its control has been developed, which involves application of *Trichogramma* and organic products — Nimbicidine, vermiwash and kamdhenu keet niyantrak.

Infested fruits at initial development | Mature infested fruits | Trap to control borer stage

Wine preparation

A protocol for production of litchi- wine has been developed. The wine thus produced has a typical litchi aroma, 10-12% alcohol, and is rich in natural antioxidants. Raw material and wine production cost is about ₹120 per 750 ml of wine.

Fermentation of pulp | Finished product

Litchi-nuts preparation

A simple technology for preparation of dehydrated litchi-nuts from fresh fruits has been developed with a shelf-life of 10-12 months. One kg of litchi-nuts can be obtained from 4 kg of fresh litchi-fruits.

Externally Funded Projects Outcomes

- Ten genotypes of pummelo and 14 of mango identified from Pusa cluster.
- Good agricultural practices for litchi demonstrated.
- Studied pollination behaviour in litchi.
- Standardized intercrops for grown-up orchards.
- Biodiversity studies of arbuscular mycorrhiza in litchi.
- Under Mega Seed Project, about 25,000 quality litchi saplings are being produced every year.

THURST AREAS FOR XII PLAN

- Systematic collection, conservation, characterization and documentation of litchi germplasm for breeding purpose.
- Undertake basic and strategic research to enhance productivity, processing qualities and value- addition along with protected cultivation of litchi.
- Develop centre as an excellent centre for litchi research, and it should be a repository/data base on litchi.
- Act as a centre for HRD and capacity-building in modern technologies on all aspects of litchi and also should provide need-based consultancy services.
- Establish linkages with national and international organizations working on litchi.
- Set-up a referral laboratory for quality analysis and certification of new cultivars of litchi.

Flagship programmes

- Shoot physiology in relation to flowering and fruiting in litchi.
- Post-harvest management with respect to pericarp browning and fruit decay.

Platform/outreach programmes

- Agro-biodiversity management
- Plant architecture and canopy management
- Nutrient dynamics in horticulture crops
- Seed and plant
- AMAAS

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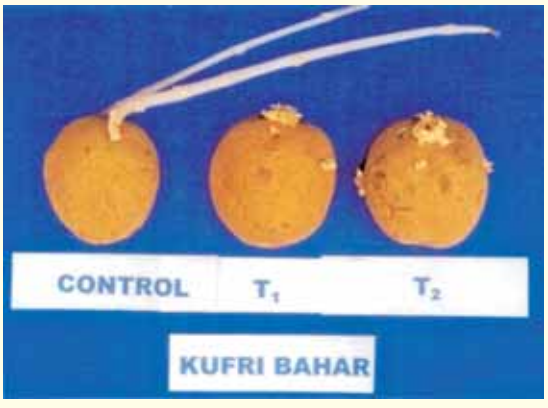
Glyphosate as a sprout suppressant for potatoes during storage

In India, storage of potatoes in cold stores at 10-12°C and 85-90% relative humidity has become popular as at this temperature accumulation of sugars is lowest, and potatoes remain suitable for further processing. But, the temperature is favourable for sprout growth also, and therefore, use of a sprout suppressant becomes a necessity. Isopropyl *N*-(3-chlorophenyl) carbamate (CIPC) is the most commonly used sprout suppressant on potatoes. Alternative suppressants to CIPC which are safer and can be applied easily and are also cost-effective were being searched for.

The possibility of using glyphosate [*N*-(phosphono-methyl) glycine] as a pre-harvest foliar application on the potato-crop to check subsequent sprout growth of potato-tubers during storage was explored. Haulms were cut at crop maturity of 100 days. Potatoes were harvested 12 days after haulm-cutting (DAHC) to facilitate skin-set (curing). The harvested tubers were cured further at room temperature (min. 10.2 °C, max. 27.6 °C) for 25 days and then stored at temperature of 18 ±2 °C (RH 85 ±5 %).



Effect of pre-harvest foliar spray treatment of glyphosate on sprouting of stored potato-tubers in variety Kufri Bahar. **Control** (only water), $\mathbf{T_1}$: one spray with 0.694 kg of glyphosate (a.i.)/ha at 60 days after planting (DAP) and $\mathbf{T_2}$: Two sprays of 0.694 kg (a.i.)/ ha, first at 60 and then second at 65 DAP

Results showed that foliar application of glyphosate at sub-lethal dose [0.694 kg (a.i.)/ ha] was effective in suppressing sprout growth on potatoes during storage. A single pre-harvest foliar application of glyphosate at 60 days after planting was found most effective in retarding sprout growth with no adverse effects either on potato-crop or on yield. When compared to control, sprout length of tubers from glyphosate treated plants was reduced by 86 % (2.3 cm in treated and 17.0 cm in control) at 135 days after cutting of haulms.

Glyphosate exhibited a good potential as a sprout suppressant of potato-tubers. With further research, glyphosate can possibly emerge as an alternative/ supplementary to CIPC, thus reducing long-time over-dependence on CIPC as a sprout suppressant on potatoes during storage.

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Treatment effects on seed hardness in *Clitoria ternatea*

Titaly matar (*Clitoria ternatea*) is an important range-legume. It is perennial and hardy in nature and can survive well in low fertility semi-arid areas. Drymatter production potential of this legume ranges from 3 to 5 tonnes/ha. It has high protein content of 16-18% and digestibility of about 80 %. Due to seed hardness, seedling emergence from its fresh seeds is low and/or delayed, resulted in poor plant population.

Fresh seeds (<3 month age) of *C. ternatea* were treated with sand-paper scarification and nicking, chemicals (seed soaking in H_2SO_4), and soaking in hot- water (80°C) and boiling water for 5 minutes to reduce seed hardness. Along with the effects of ageing of seeds(one-, two-, three- and four- year- old) were also studied.

Highest germination (90%) was noticed by nicking (making cut on the seed-coat) against 7% in control. Scarification of seed with sand-paper increased germination up to 76% and with H_2SO_4 (10 min.), it was at a par with sand-paper but proportion of the abnormal seedlings also increased (6.8%).

Normal seedlings, hard seeds and abnormal seedings of *C. ternatea*

Highest normal seedlings could be observed in two-year-old seeds (74%) and lowest were in fresh seeds (7.0%) due to higher proportion of hard seeds (88%). The proportion of hard seeds decreased up to 6.5% in four- year- old seeds but germination was also reduced up to 64%.

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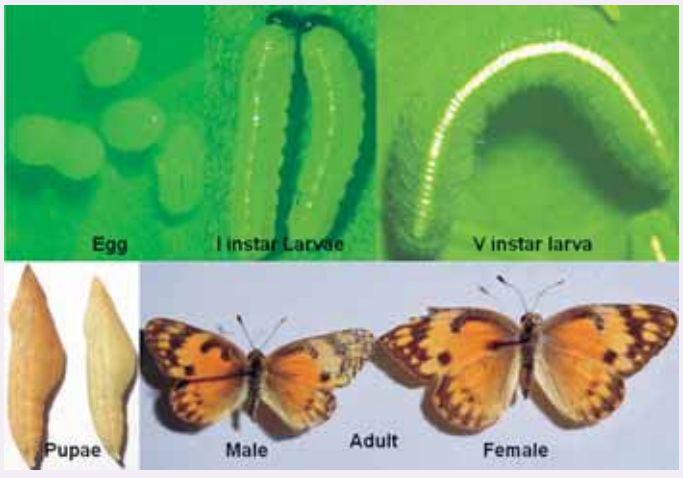
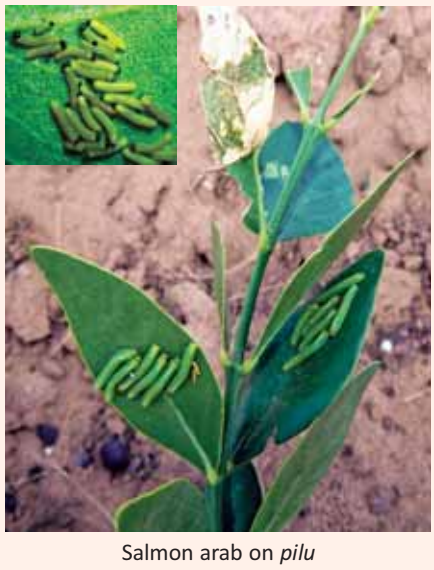
Small salmon arab on *pilu* in arid region of Rajasthan

Colotis amata, a small butterfly of family Pieridae, is found in Asia. Eggs are laid singly on leaves or young shoots. They are 0.58 mm to 0.72 mm in length; 0.38 mm to 0.43 mm in width and white when first laid; and develop later red blotches. Adult has a salmon-pink ground colour with female body length of 9.71 mm and width of 33.62 with wing expansion. The male body length is 7.59 mm and width is 25.67 mm with wing expansion. The costa on the forewing is black and thickly overlaid with greyish or pinkish scales. The length of the male and female antenna is 4.63 mm and 5.46 mm, respectively.



Biological stages of small salmon arab

The small salmon arab *Colotis amata* F. was first recorded on *pilu* (*Salvadora persica*) in 2012 at the experimental farm at Bikaner. Larvae fed on the sprouting tender shoots, leaves and flower-buds; and average larval incidence on the plants ranged between 16.67 and 80.00 %. Attacked leaves dried up and tender shoots did not grow properly. An infested leaf appeared whitish owing to feeding on chlorophyll. The incidence and the number of larvae were higher in December than during other months, and were lower in September. The highest mean number of this butterfly per 3 leaves was recorded in December (22.30), followed by in January (16.77), and the lowest was in September (7.63).



Salmon arab on *pilu*

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Value-addition of minor forest produce — *Adda* leaves

'*Adda* leaf-plate making unit' was introduced at Devarapalli, a tribal village of Maredumilli mandal of the East Godavari District, for the benefit of the Self- Help Groups.

During off- season, tribal women stitch *adda* leaves together with small sticks to form leaf-plates. Value-addition was done to the products by stitching leaves with sewing machines and making gorgeous plates out of the leaves with the advanced machinery. Five different types of units — *adda* leaf-plate unit, cup-making unit, buffet-plate unit, tiffin-plate making unit — with necessary machinery were established that reduced time and drudgery, and added value to the finished products. Through this activity, 20 tribal women could make about 20,000 buffet-plates, 10,000 meal-plates and 10,000 cups per day. And during the year, an additional family income of ₹8000 p.m. per group (four members) was obtained by selling of plates and cups. Thus, by utilization of the natural resource, this eco-friendly unit is self-sustainable.

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Novel immunomodulator from marine mollusc — *Telescopium telescopium*

Telescopium telescopium, a marine mollusc (snail), has shown antimicrobial, antiprotozoal, reversible antifertility, anticancer and a strong immunomodulatory effect on the female reproductive system of the rat and agglutinating, immobilizing, and spermicidal properties on the mammalian sperms. Hence, the extract was analyzed and evaluated in goat model for its immunostimulation property.

The adult snail *T. telescopium was* collected from the estuaries of Bay of Bengal, near Sagar Island (22° 19 N; 80° 03 E), West Bengal, India. Extract was prepared according to the self-patented process; biochemical analysis was done with commercial kits. Total 200 healthy adult black Bengal goats of either sex were considered and dividing in two equal groups. Gr-II was considered as a treatment group and was given a single dose of intramuscular injection of lyophilized spermatheca extract @ 3mg/kg body weight, and Gr-I was as a control.

The extract increased total leukocyte count but did not alter differential leukocyte count. This strongly suggests that the compound possesses a strong immunostimulating property that plays a vital role in immunological control of the diseases. This immunostimula-tion property has been reconfirmed by increased bone-marrow count in the treated group. The extract did not show any toxicity at hematopoietic system at the serological as well as the cellular level. Therefore, this unique and novel crude extract isolated from *T. telescopium,* can be developed in future as a potent and effective immunomodulator against different disease conditions.

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Semen diluents for poultry

Poultry-semen is very concentrated, and is of low volume containing 6 (roosters) to 12 (toms) billion spermatozoa/ml. Spermatozoa start dying by dehydration at the ambient temperature, owing to water evaporation; so there is a need that the semen be diluted and kept at a low temperature.

There is no universal diluent for poultry-semen owing to differences in morphological and biochemical characteristics of the sperm from different species/breeds. Variations in physical and biochemical composition of breeds require different semen diluents and storage environments to retain viability of spermatozoa.

Diluents are essential for poultry-semen to : *i)* increase semen volume , *ii)* increase number of birds inseminated per unit volume of semen, *iii)* spermatozoa are uniformly distributed in the diluent, making artificial insemination (A.I.) easy , *iv*) finally, it prolongs sperm survival for short and long term preservation of semen *in-nvitro*. Using the poultry- semen diluents, service of superior male can be used optimally for artificial insemination. The ultimate goal of the diluent is to improve reproductive efficiency of the cock, and also to reduce cost of poultry production.

Commonly available chicken semen extenders (dilutors) are of complex composition and need adjustment in *p*H and osmotic pressure; thus it results more time in preparation and are expensive. Such dilutors are not suitable in the field also. For successful preservation of chicken (WLH) semen at a low temperature for 24hr, a diluent has been prepared. It does not require adjustment in *p*H and osmotic pressure, as desired *p*H (7.20) and osmotic pressure (332 m.Osm/kg H_2O) is automatically achieved. Semen-diluent ratio can be kept at 1:2 to 1:4, depending upon the number of spermatozoa in the fresh semen and storage duration; this can express good fertility (95 %) even after 24 hr of storage at a low temperature. Fertilizing ability of the preserved semen was comparable to the fresh semen.

Along with, a semen diluent for Japanese quail has also been developed; quail spermatozoa cannot withstand storage outside body. They are also prone to agglutination in physiological solutions or diluents that are commonly used for diluting bird's semen. A non-invasive fertility prediction test for Japanese quail has also been developed.

Semen diluent advantages

Semen transport: *Transportation of birds from one region to another is difficult but diluted semen can be transported easily and at a large scale*. Frozen semen can provide relatively cheaper transport of a desirable gene on the world-wide basis and offer improvement in poultry production at a low cost. Semen cryopreservation is the success behind the semen bank (gene bank) that may be less expensive than maintaining experimental lines.

Use of older males: Older male birds with good genetic traits can be used for several generations.

Increased mating ratio: Under natural conditions, one male is required for mating to cover 6 to 7 hens. By adopting A.I. technique associated with proper semen diluent in chicken, the number of males required per flock is reduced by tenfold, and subsequently, the best genotypes inheritance for high egg yield and meat production can be used more extensively in each generation.

Various species crosses: *Breeding programme can be facilitated in* chickens, turkeys, guinea-fowl, ducks, geese, quail and wild species through intra-species and inter-species insemination experiments. A.I. has been used to produce crosses of various species such as: chicken / pheasant, chicken /turkey, turkey /pheasant.

Prevent disease spread: *Prevention of vertically and sexually transmitted diseases can be achieved* in a poultry flock if properly certified and good quality of diluted semen is used. There is reduced chance of transmission of infectious and contagious diseases, apart from those transmitted through semen, from tom or cock to hens.

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WAY FORWARD

CONSERVATION Agriculture practices are gaining increased attention worldwide. In India, a large amount of crop residue is produced annually (500-550 million tonnes),and a major portion of this residue (90-140 million tonnes) is burnt on-farm to clear fields for timely planting/seeding of the succeeding crops. Residue retention in the field,instead of its burning, would increase soil-carbon and nitrogen stocks, provide organic matter, and would foster cellulose-decomposing fungi, and thereby carbon cycling.

In India, Conservation Agriculture(CA) technologies are mostly spread in the irrigated areas of the Indo-Gangetic plain (~5 m ha). These technologies have, so far, not been promoted in the rainfed semi-arid tropics, arid regions and mountain agro-ecosystems. Rainfed areas cover up to 60-70% of the net sown area and are mostly single cropped in alfisols, while in vertisols, a second crop is generally taken. Leaving crop residue on the surface is a major concern in these rainfed areas due to competing use of the residue as a fodder also; leaving a very little or no residue for surface application. Agroforestry and alley-cropping systems are other options for CA practices. This clearly indicates that the concept of CA has to be adopted in a broader perspective in the arid and semi-arid areas.

In a network project on the tillage conducted since 1999 at various centres of the All- India Co-ordinated Research Project for Dryland Agriculture (AICRPDA), it was found that rainfall and soil type had a strong influence on the performance of the reduced tillage; in arid regions (<500 mm rainfall), low tillage was found on a par with conventional tillage and weed problem was contained with it in arid inceptisols and aridisols; in semi-arid (500-1,000 mm) region, conventional tillage was found superior. Low tillage and interculture were superior in semi-arid vertisols and low tillage and herbicides application was better in aridisols. According to a study, zero tillage farming on 1.2 million hectares of the Indo-Gangetic plain saved 360 million m^3 of water. It also reduced number of operating hours of pumps, thus reducing CO_2 emission and consumption of electrical energy also. No-tillage practice saved approximately 2,500 MJ energy compared to the conventional tillage practice; conservation tillage saved about 20 litres of diesel and 187,331 kcal of energy/ ha over the conventional system. This has raised hope of success of reduced tillage in alfisols, if practised over for a long-term.

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

Overall, the CA systems are quite different from the conventional practices, and the futuristic agriculture advocates for (a) development, standardization and adoption of farm machinery for seeding amidst crop residues with minimum soil disturbance; site-specific crop combination; soil and pest management strategies, which will optimize benefits of the new systems, and (b) training of manpower for adoption of new techniques that also need new skills and management strategies.

Considering the long-term benefits, CA is definitely a sustainable production system, which sequesters carbon and also enhances productivity and soil quality as well as promotes ecologically and economically sustainable production system. While the limiting factors in adoption of residue incorporation systems in the Conservation Agriculture by farmers include additional management skills, apprehension of lower crop yields and/or economic returns, negative attitudes or perceptions and institutional constraints, location-specific technology/ machinery generation-dissemination-adoption of CA practices have to be looked into for broader perspectives in closer partnership with farmers. CA can only be successful in integration with plant-nutrient management, integrated pest management and weed and water management.

Realizing the potential of the CA, a Consortium Platform on Conservation Agriculture is being implemented in different agroclimates during the XIIth Plan to fine-tune region-specific CA package of practices. This will lead to ecologically efficient, economically sound and sustainable farm productivity, and would also bring in prosperity for our farmers — our grounded professionals.

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