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हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

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ICAR

ICAR NEWS

A SCIENCE AND TECHNOLOGY NEWSLETTER

RESEARCH UPDATE

Welcome and Greetings

The Indian Council of Agricultural Research welcomes Shri Radha Mohan Singh, Union Minister of Agriculture, and Dr Sanjeev Kumar Balyan, Minister of State for Agriculture.

Shri Singh belongs to a farmer family, and is known for his work for the welfare of the farmers. On taking over the new assignment as the Union Minister, he discussed various issues pertaining to agricultural research with the senior scientists and officials of the ICAR to have an overview of the on-going research, and to chalk out future strategies. While appreciating XIIth Plan initiatives, he expressed his satisfaction over the achievements so far, and appreciated that programmes are rightly oriented for farmers, students and youth.

He also stressed the need for speedy extension services for faster adoption of newer technologies by the end-users — the farmers. Along with he emphasized for strengthening of agricultural universities and Krishi Vigyan Kendras to help reach new technologies to farmers' fields.

Dr Sanjeev Kumar Balyan, a veterinary scientist himself, expressed happiness over new assignment of his interest and hoped that livestock would play an intensive role in the overall agricultural development and inclusive growth of the farming community.

Dr S. Ayyappan, Secretary, DARE, and DG, ICAR, welcomed new ministers on behalf of the ICAR and hoped that their experiences in farms, social work and administration would lead ICAR to a new horizon. He assured the leadership regarding realignment of the strategies as per the vision of the new government.

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A new dry-retting technology for jute

In India, jute is grown in about 9 lakh hectares, supporting directly or indirectly four million farm-families. Fibres are conventionally extracted by immersing harvested plants in water and allowing microbial action on them for about two weeks; fibres separate due to microbial action and are extracted. Owing to water scarcity, jute- farmers are practically forced for jute-retting in the same stagnant or muddy water for 3-4 sets of harvested plants. And thus the fibre quality deteriorates drastically, and farmers face heavy economic losses. In such a situation, a good water-saving technology for jute-retting can be very useful.

First attempt for water-saving technology was ribbon-retting. The main disadvantage of this technology has been the non-availability of the efficient ribboner machine. But the new fungal dry-retting technology works on a different principle. For this, fast-growing pectinolytic fungi are used. Four different pectinolytic fungi — *Aspergillus tamarii, Aspergillus flavus, Aspergillus niger* and *Sporotrichum thermophile* — isolated from different habitats, are used for dry-retting of jute. The fungi are maintained in the laboratory on the Potato Dextrose Agar (PDA) medium, and their mass culture is prepared on a mixture of rice-husk and wheat-bran. The slurry prepared from solid-base mass culture by mixing it with water is spread on the defoliated green jute-plants (4-5% of solid-base mass culture). The fungus inoculated plants are wrapped in polythene sheets and are incubated for about

Environmental parameters for dry-retting of jute

*p*H during fungal retting	8.7-9.2
Average day temperature	30-34^{0}C
Moisture in retting beds	33-35%
Moisture regain	50-54 %
Average atmospheric R_H	78%
Average retting time	10-13 days

Fungal dry-retted jute fibres and yarn parameters

Fibre character	
Fibre strength	20.5-24.8 g/tex
Fibre fineness	2.8-3.0 tex
Average root content	< 5%
Average fibre grade	TD - 4
8 lb yarn character	
Average tenacity	10.67 cN/tex
Work of rupture	0.86 mJ/tex M
Average hairiness index	11.90
Average breaking load	23.24 N
Um	24.4 - 27.8 %

10 days. The fungal growth is monitored in the intervals of 2 days to see for even growth on the plant surface, and if not, plants are over-turned and sprinkled with water. Inoculated fungi grow fast on the surface of the green plant in just moist condition, and feed on the inner gummy and pectin matter facilitating separation of jute fibres and sticks. After retting, fungal growth is removed by wiping with a torn- sack piece, and fibres are simply extracted be pulling them out. No water is required for extracting fibres. These fibres may be washed in water for brightness and for removing extra adhering gum, if any. The fibres and sticks are then dried in sun or in shade and preserved.

This technology can save on a lot of water; and is an aerobic process, unlike water-retting.

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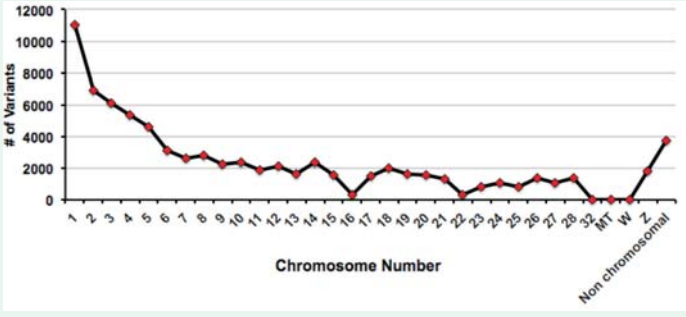
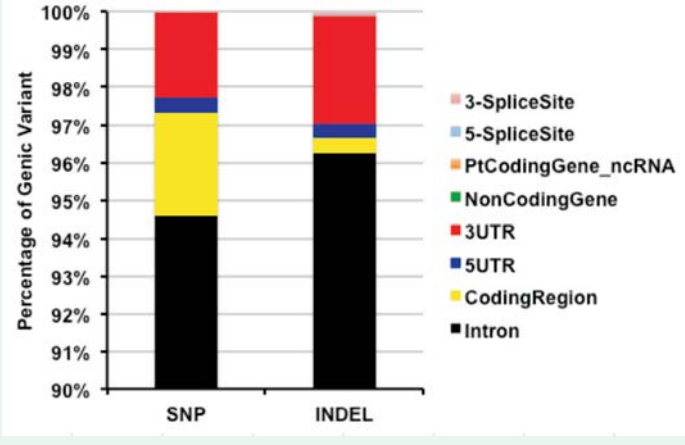
Whole genome sequence of 'Aseel', an indigenous chicken-breed, decoded

India is one among the places of origin of Jungle-fowls, from which all modern domestic chicken breeds have been developed. Aseel is one of the major Indian native breeds, found all-over India, but is abundant in the coastal areas of Telangana; and is famous to be used for cock- fighting. It is a poor layer breed, laying sometimes hardly 40 eggs per year, but its meat is very popular in India. Although it is a poor egg producer, still the eggs of the indigenous bird are preferred over commercial eggs by the consumers. This is the first time that a whole genome of an Indian native chicken Aseel has been explored.



Variants observed in different chromosomes of Aseel genome



Distribution of variants in different segments of genome

The sequencing was performed on Illumina HiSeq 2000 platform. Initially, DNA libraries were prepared, and accordingly, a total of 8pM library was developed, and its sequencing by synthesis was carried out to generate 100 bp sequence reads. GenomeAnalysis TKLite-2.3-9 toolkit was used to identify single nucleotide variants (SNPs) and short indels. Approximately, 297 million reads of 100×2 bp were sequenced, in which 86% reads showed more than 30 Phred score. The total amount of data generated was 59.4 Gb. The total GC content was 41%. Overall, 96.73% of the total reads were aligned to the reference genome, and 95.14% of the total reads were aligned pair-wise. More than 80% of the mapped reads gave Q30 score, which reflects good alignment quality.

All chromosomes, except chromosome 16, have coverage of 90%. Overall, 93.8% of the chicken genome was covered by at least one read. Majority of the chromosomes showed average depth of >40X. A total of 15,404 coding genes, 1,558 short non-coding genes, 42 pseudo-genes and 17,954 gene transcripts have been found in chicken genome, while Genscan gene revealed 40,572 genes in the genome. More than 6.5 million variants have been identified in Aseel genome. Around 90% of the variants are SNPs, out of which 51% are of homozygous type. Of the total variants identified, 45% of them are inside the gene. About 2.4% and 94.5% of SNPs are found in exon and intron region, respectively. Most of the coding variants are of silent type. Around 28% of the coding variants are of non-synonymous type, where changes in amino acid sequences exist. Overall, 6,145,838 SNPs and 50,802 indels have been observed in Aseel breed; of which 72.9% SNPs and 92.4% indel are of the novel type. In mitochondrial genome, 16 SNPs and 8 indels have been

observed, of which, all variants are of the novel type. The functional analysis has determined 94 nonsense, 53 start-loss, 20 stop-loss, and 623 frame-shift indels in the genome.

The genomic information explored in Aseel breed of chicken has developed the base- line information of genome sequences of the Indian native chicken-breeds, which would further lead to taking up functional aspects of genome for unraveling phylogenetic relationship of this breed with other chicken-breeds of the world to explore molecular mechanism of various physiological functions, including better adaptability and climate resilience of Indian chicken-breeds. The genomic information would also enable researchers to determine genetic markers for various economic traits to augment productivity of birds.

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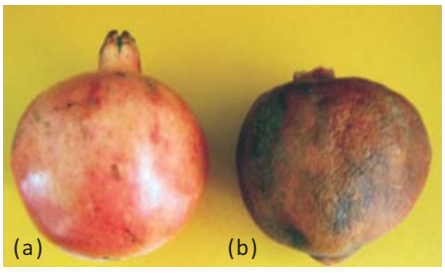
Shrink-wrap pomegranates for freshness and quality

Pomegranate has become a highly remunerative cash-crop in Himachal Pradesh. Its several varieties are grown there, but 'Kandhari' and 'Bhagwa' have excelled over others.



Appearance of (a) shrink-wrapped and (b) non-wrapped Kandhari pomegranate after 50th day of storage at ambient conditions

Physico-chemical characteristics of pomegranate fruits (wrapped and without wrapping) at room temperature

Attribute	Kandhari		Bhagwa	
	No wrapping	Wrapped	No wrapping	Wrapped
Loss in weight (%)	27.2	1.49	21.8	2.69
Weight of 100 arils (g)	41.3	42.6	30.4	32.8
Juice (%)	46.3	71.4	49.2	71.0
TSS (%)	13.2	14.8	13.7	15.3
Total phenolic content (mg/ 100 ml GAE)	19.9	28.8	22.4	37.1
Total anthocyanin content (mg/L)	285.7	337.5	367.9	435.6
Antioxidant capacity (µmoles Trolox/ml)	9.8	13.6	11.4	17.4

Shrink-wrap is a new packaging technique for post-harvest handing of fruits and vegetables. This delays physiological deterioration of the product and also prevents condensation of droplets within the package. Individual shrink-wrapping of fruits provides optimum gas and humidity for maintaining quality of the product during transit and storage.

For individual shrink-wrapping of pomegranate, initially individual fruit is packed loosely in a desirable heat-shrinkable film (9µ) and is then sealed with an impulse sealer. The produce is then placed inside the shrink-wrapping machine where temperature is maintained at 120^{0}C or so. The upper cover of the machine is pressed for 10-15 seconds to activate the fan that circulates hot-air around the produce, and tightens the film around the produce. In tray-wrap packaging, produce is first sealed in a consumer pack of suitable size and then passed through the wrapping machine. Shrink-wrapped produce is removed immediately from the machine and cooled for 2-3 hours at 5-10^{0}C. Finally, the produce can be packed in plastic crates for further storage or transportation.

Advantages of shrink-wrapping

- Enhances shelf-life of pome-granate by about 20 days.
- Shrink-wrapped fruits yield more juice and have high total phenolics and antioxidants.
- This can be very well adopted by small and marginal farmers/ or entrepreneurs.
- It adds very marginally to cost of produce.
- Shrink-wrapped pomegranates are hygienic.
- Delays deterioration of the produce during long-term storage.

In practice, the cost for wrapping one kilogram (2 fruits) is nearly Rs 0.80-1.00, which can be reduced further by tray-wrap packaging.

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An economical *aonla*-based horti-pasture system through innovative soil-water conservation in degraded lands

Horti-pasture system provides the best and an economical alternative to utilize lands suffering from erosion and are of rocky texture (class V and VI); unfit for arable farming. In India, central part of the semi-arid region has undulated topography and the soil texture is poor leading to non-availability of sufficient soil moisture that limits proper establishment of hortipasture system.

Aonla-based hortipasture system (*Aonla* + *C. ciliaris* + *S.seabrana)*

An *aonla*- based horti-pasture system could be established with innovative soil- water conservation practices. Soil at around 1.5-2.0- m depth is sandy-loam. Its initial soil composition was poor in available N (182.9 kg/ha), P (8.94 kg/ha) and K (248.7 kg/ha), and was low in organic-carbon (0.35%), *p*H (7.8) and EC (0.12 mmhos/cm).

For the establishment of the system, staggered contour trench of 0.75 m^3 (3m × 0.5m × 0.5 m) and a catchment of 25 m^2 was excavated at 2- m spacing with 5- m horizontal and 0.15- m vertical interval. These trenches accommodated easily 25 % of runoff generated from one day maximum rainfall with return period of 3 years. The staggered contour trench generated surface storage of about 273 $m^{3/}$ha. This measure made available soil moisture at soil depths of 0-15 cm and 15-30 cm during October, November and December in all the consecutive years. The pasture productivity recoded increasing trend from the first year (0.87 tonnes of dry matter (t DM) /ha) to 8.7 t DM/ha in 7th year. Fruit production started from 4th year of transplanting and a total of 0.5, 3.4, 3.4 and 9.4 tonnes/ha fruits were harvested in 4th, 5th, 6th and 7th year, respectively. This system proved appropriate for utilizing land not suitable for arable farming.

Pasture from *aonla*-based hortipasture system

Aonla, heavy fruiting

The grafted *aonla* (cv. NA 7) plants were transplanted at 8m ×8 m. The understorey was intercropped with anjan grass (*Cenchrus ciliaris*) + stylo (*Stylosanthes seabrana*) for pasture production. The new seedlings of *C.ciliaris* were transplanted in July 2007 at 100- cm row- to- row and 50- cm plant- to- plant, and *S.seabrana* were sown in lines at 4 kg /ha between 2 rows of grass under *aonla*- tree.

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Pollinators of buckwheat in Sikkim Himalayas

Buckwheat (self-incompatible) is one of the most important underutilized, multipurpose and nutritious cereal-crop of Sikkim Himalayas, and pollinators play a pivotal role in production of buckwheat varieties/ cultivars. Buckwheat (local cultivar *Mithey*) when cultivated inside the nylon-net, where no pollinators could visit, its seed- set was reduced (very low 0.98 seed/flower) and also yield (1.59 q/ha) in comparison to buckwheat cultivated in open field (8.39 seeds/flower and yield 10.24 q/ha). However, in case of local cultivar *Tithey,* no significant difference was observed inside the net and in open field in terms of seed-set (24.50 seeds/flower in open field and 13.32 seeds/flower in the net). This could be due to self- compatibility of the cultivar. Honeybees visiting buckwheat flowers collect both pollen and nectar. In Sikkim, 10 insect pollinators have been recorded for the first time. Some are nectar feeders and some are pollen robbers. Among the visitors, *Apis cerana indica*, *Eristalis tenax*, *Eristalis* spp., *E. himalayensis* and syrphid-fly were frequent. The maximum population of all the pollinators was observed between 10 AM and 11 AM. It was observed more in buckwheat- crop which attained flowering in January. The study also revealed that pollinator-complex of mustard and buckwheat is almost same. If there is synchronization of flowering of mustard and buckwheat crops cultivated in the adjacent fields, the pollinator population was observed very less in buckwheat than in mustard. The study indicates that if buckwheat and mustard are cultivated together in the same field, their flowering should not be synchronous.

Number of pollinators visiting mustard and buckwheat in synchronized flowering

Pollinators/visitors	No. of visitors/10 min/m²			
	Sole crop		Grown together	
	Mustard	Buck-wheat	Mustard	Buck-wheat
Apis cerana indica	10.12	7.34	9.84	2.20
Eristalis tenax	9.14	7.12	8.76	0.86
E. himalayensis	8.26	6.45	7.92	1.24
Eristalis spp	6.84	4.96	6.44	0.72
Syrphid fly	6.78	5.88	6.32	1.48

(a) *Apis cerana indica,* (b) *Eristalis tenax,* (c) *Eristalis himalayensis,* (d) *Eristalis* sp. (e) Syrphid-fly

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Participatory Water Resource Development in a village under Tribal-Sub Plan

A remote tribal village, Attal, situated in Tuni block of Dehradun district, was selected. There are about 300 households in the village, and more than half of them are engaged in agriculture, cultivating mostly cereals, pulses, vegetables and fruit crops. A huge potential exists for agricultural development in the village if water scarcity problem can be addressed.

Functional Water Resource Development in Attal Village

In the beginning, village community was organized in terms of nine user groups to establish group horticultural plantation as an alternative land-use in about 7.2 hectares. All groups were further organized as the Attal Fruit and Vegetable Grower Association. As per the area available with each group, a total of 3,250 fruit seedlings were distributed. Training was given to

all members . But there was a little success of survival (30 %) of horticultural plants due to water scarcity.

After conducting detailed field surveys and interactions with farmers, water resource development was taken up in Attal village. A HDPE pipe- line of 6.0- km length was laid to harvest water from a perennial source where sufficient discharge was available (15 lps). This pipe- line was connected to the water- tank. Huge seepage losses of stored water in the tank (3 cm per hour at 1.25 m stage or about 1.45 lps) were observed due to minor cracks, which were arrested by lining the tank with silpaulin sheet of 250 gsm. In these all activities, villagers contributed in labour required for trench-digging and burying pipe.

The intervention was taken up in a participatory mode with a total cost of ₹720,000, out of which about 21% (₹150,000) was contributed by farmers towards cost of digging trenches, manual labour required for transportation of pipes, laying pipe- line, cleaning tank and fixing silpaulin sheet. Till date, a total of 125 farmers are associated with this water resource development in Attal village. Tomato cultivation in about 20 hectares has been initiated, while total potential of this water resource is about 70 hectares.

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CIFT SUN BOAT for reservoir fishing and aquaculture

The annual fuel consumption by mechanized and motorized fishing fleet of India has been estimated at 1,220 million litres, which was about 1% of the total fossil fuel consumption of the country in 2000(releasing an estimated 3.17 million tonnes of CO_2 into the atmosphere at an average rate of 1.13 tonnes of CO_2 per tonne of live-weight of marine fish landed). Presently, a four-fold increase has been noticed in diesel price compared to 2000. India has around 150,000 number of motorized and mechanized boats in the marine sector. And the increased fuel cost has caused substantial losses to fishery industry by eating away from fisherman's income.

A fishing boat powered by solar energy, named CIFT SUN BOAT, has been developed. The boat is ideal for aquaculture, commercial fishing, as well as for recreational fishing in reservoirs and rivers. This boat meets the stability and safety requirements of the Kerala Inland Vessel Rules of the Government of Kerala.

Advantages	Specifications
• No fuel cost • No pollution from fuel burning • Less carbon footprints • No sound pollution • Clean FRP surface for fish handling • Twin hull with low rolling • More deck area • Suitable for shallow waters • Canopy for protection from rain and sun	LOA : 3.63 m Breadth: 1.75 m Depth : 0.60 m Power : 500 W Propulsion : 2 x 0.6 kW Battery :12 V Number of persons: 4(Max) Type of activities: Aquaculture, Gill-netting, lining,transportation and aqua-tourism

The boat can run for 2.5 to 3.0 hours at complete charging and has a speed of nearly 4.0 knots in calm waters. Its battery is separately placed in a compartment to be protected from water. The awning protects fishermen/ passengers from sun and rain, and is made of aluminium alloy, that does not require any maintenance.

Its twin hull construction gives great stability during fishing and it has wider deck area compared to a similar sized conventional boat. Its navigational lights also run by solar power that facilitates safe fishing during early morning and late night. Boat propellers are made of plastic composite and do not corrode; one of the propellers is steerable and is manoeuvred. Their height can be changed as per requirement.

The CIFT SUNBOAT is approximately 2 to 2.5 times costlier than the conventional boat. The additional cost is due to photovoltaic cells, battery bank and control system, and this can be compensated by minimum operational and maintenance costs.

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Effect of slope and land use on soil carbon stock and soil quality in Nilgiris

Plantation crops (tea and coffee) occupy 25% of the area in the Nilgiri district (Udhagamandalam). In the tea plantation, soils under slope class 11-33% recorded highest soil organic- carbon stock content (16.01 kg/ m^2), followed by <10% slope (14.02 kg/ m^2), and the lowest (13.20 kg/ m^2)was in the slope class >33%.

Under coffee plantation in the slope class <10%, highest soil organic carbon stock (11.50 kg/m^2) was recorded, followed by >33% slopes (10.89 kg/m^2) and the lowest (10.42 kg/m^2) was in slope class 11-33%. On an average, among plantation crops, soils under tea plantations recorded 14.41 kg/m^2 of mean soil organic carbon stock, which was 32% higher over coffee plantations.

0-10% slope | 11-33% slope | >33% slope

Effect of slope and land use on soil carbon stock and soil quality

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Litchi-based agri-horti systems on degraded lands of Dehradun

In intercropping with litchi *(Litchi chinensis* Sonn. cv. Rose Scented) in the first phase, annual mean cowpea equivalent yields harvested from cowpea - *toria*, okra - *toria*, blackgram - *toria*, sole pigeonpea and sesame - *toria* were 2.32, 2.31, 1.34, 0.76 and 0.75 tonnes/ha, respectively. Annual turmeric equivalent mean yields recorded with turmeric and colocasia under litchi were 7.9 and 7.0 tonnes/ha during the second phase.

Highest mean *litchi* fruit yield (3.6 tonnes/ha) was harvested with cowpea-*toria,* followed by blackgram - *toria* (3.4 tonnes/ha) in comparison to sole *litchi* (3.2 tonnes/ha) during the first phase. And during the second phase, maximum mean litchi-fruit yield with turmeric was 9.0 tonnes/ha, followed by 8.6 tonnes/ha in colocasia over sole *litchi* (8.03 tonnes/ha);during the second phase, intercropping enhanced *litchi*- fruit yield.

Net present value (NPV) achieved was in the order of *litchi* (cowpea - *toria*)/turmeric > *litchi* + (okra - *toria*)/ colocasia > *litchi* + blackgram - *toria* > *litchi* + pigeonpea > *litchi* + sesame - *toria* > sole *litchi* plantation. The benefit-cost ratio was > 5.0 in 10 years, followed by 15 years of intercropping with *litchi* (< 5.0) as compared to sole *litchi* plantation (3.50).

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Herpetospermum operculatum — first report to be used as a leafy vegetable

A new species of cucurbit *Herpetospermum operculatum* K. Pradheep, A. Pandey, K.C. Bhatt & E.R. Nayar, distributed in Sikkim and Nagaland, and extended to Myanmar and adjoining China, was found only in Sadam in South Sikkim distt of Sikkim and Mesulumi in Phek distt of Nagaland.

Herbarium studies at the Botanical Survey of India (herbarium acronym—CAL, ASSAM) indicated its occurrence in Arunachal Pradesh also (*G. Panigrahi 14568*, collected from Kheti-Tincha, Tirap distt; CAL , ASSAM). And studies done at the Forest Research Institute (—DD) and an exploration in Nagaland pointed it in Nagaland — Kohima(*N. L. Bor's Collector s.n.*, from Dzulake Valley; DD vide Herb. Reg. No. 95733), Zunhebhoto (*N. L. Bor 6635*, from Kilomi; DD) and Mon (*K. Pradheep* & *Soyimchiten 1551*; NHCP).

Bundles of *thruinam* (*Herpetospermum operculatum)* (*inset*: tender top used as vegetable)

In contrast to the earlier studies of it being under threat, a field study during November 2013 in Mon district of Nagaland, largely inhabited by the *Konyak* tribe, pointed that this dioecious tuber-bearing perennial climber frequently occurs in shady and moist areas, adjacent to watercourses, and also along the edges of forest-clearings in southern and eastern regions of Nagaland— Angphang, Chen, Chenwetnyu, Longching, Longwa, Mokok, Ngangchang, Phomching and S/Wamsa.

During exploration, young flush of *H. Operculatum,* tied in bundles, was noticed being sold in the main market of Mon as a leafy edible vegetable. Locally known as *thruinam* (*thrui* means vegetable, *nam* means pungent, referring to unusual odour of plant parts), its tender tops (25-30- cm long)with 2-3 juvenile leaves and tendrils were plucked from wild, especially during rainy season (May-September) for household consumption, and occasionally for sale in local markets. A bundle of 30-35 twigs costed ₹10-20. That the vegetable is a delicacy among locals is evident from the fact that even its pungent odour similar to fermented soybean, emanating from cooked product, does not deter them in eating it almost every day during its availability. The twigs are hand-torn into pieces of about 4-5 cm length and boiled in water with or without fermented bamboo shoots (*naisong*) with a pinch of salt. Cooked leaves are consumed along with the soup and generally preferred over *layeepatha* (*Brassica juncea* var. *integrifolia*). The cooked vegetable has been found to have a laxative effect, and is used in stomach disorders; and the soup is used for treating typhoid.

This species also has been found wild in adjoining Tuensang district of Nagaland, and is used similarly but is called *laishek*, and is sometimes sold in Kohima market. Analysis of its nutritive value would strengthen its potential for commercialization, particularly keeping in view foetid nature of immature fruits.

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Pentatomid bug, *Cyclopelta siccifolia* Westwood (Dinidoridae: *Heteroptera*) on pigeonpea in Gujarat

During the field visit at the farmer's field in Tapi district of South Gujarat ecosystem, adults of pentatomid bug, *Cyclopelta siccifolia* (Westwood) (Dinidoridae: Heteroptera), were observed feeding on pigeonpea in *kharif* 2013-14. Both nymphs and adults were found in colonies congregating on the main stem, side branches and leaf rachis. In this ecosystem, roughly 150-200 bugs were observed within first 1m from the base of the plant, and they were seen in clusters. These bugs appear to fly reluctantly even when disturbed, and preferred crawling. Even when dislodged, they crawled over the plant again. It has also been pointed out that the colony may be so crowded that bodies of bugs may overlap. The bugs appear to prefer green matter of the plant for feeding. Both nymph and adults suck sap from main stem, side branches and leaf rachis, and ultimately plant shows wilt-like symptoms (yellowing followed by wilting). Majority of the bugs actively fed on leaf rachis and small green stems. There were patches of bugs on the bark of the main trunk; most of the observed bugs were adults.

Maximum population of nymph and adults of *C. siccifolia* was observed on the main stem than side branches and leaf rachis. The peak population of 192.2 and 1.4 of nymphs and adults was observed during first fortnight of October on the main stem and leaf rachis. And in case of side branches, peak (21.2) was observed during second fortnight of September, and thereafter there was decline. This is the first report of infestation of these bugs on pigeonpea in Gujarat.

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CIAHZN-J — A low moisture-stress tolerant *Ziziphus nummularia* from Jaisalmer

An elite genotype CIAHZN-J of *Ziziphus nummularia* has been found growing wild in Jaisalmer district of north-western parts of Rajasthan, where average annual rainfall is less than 150 mm. CIAHZN-J seeds showed 67 % germination at 0.5 MPa, and were found to germinate at 0.73 MPa also. Its root length increased from 10 to12 cm and ratio of dry weight of root to fresh weight was found 0.5 at 0.5MPa. Withdrawing water up to 15 days in three months old seedlings of the genotype showed average cumulating morphological stress rating of 3.0, relative water content of more than 60%; downward rolling of leaves; besides maintaining membrane stability at the normal level during the moisture stress was also observed. Its stomatal conductance was 256.5 mmol/m^2/sec, and level of proline increased by 35 fold and catalase by two fold during the stress compared to control.

CIAHZN-J of *Ziziphus nummularia*

This genotype has higher tolerance to moisture stress compare to *Z. mauritiana* and *Z. rotundifolia*, and has been found suitable for bioprospecting genes for low moisture tolerance.

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Design and development of site-specific artificial groundwater recharge filters

Laboratory testing for hydraulic and filtering efficiency of different types of filters was conducted with different sediment loads at Vasad. Inverse filter for the direct well recharge was found hydraulically more efficient for agricultural runoff with acceptable-level chemical parameters. It is found suitable for area with slope < 4%.

Laboratory set-up for testing efficiency of filter system comprising gravel, sand and agro-net in case of upward flow of runoff through filter system

In this filtration system, runoff enters the filter system from the bottom under pressure head, taking advantage of gravity in sediment removal.

Attempts have been made to prefabricate components of down to up flow filter to save time and cost. There is also a provision of pressure head manipulation for cleaning filter system in the proposed design.

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Directorate of Poultry Research, Hyderabad, Telangana

To develop and to propagate improved chicken varieties for sustainable production under intensive and extensive systems

The Directorate of Poultry Research is a premier institute in applied poultry research, established on 1 March 1988 at Rajendranagar, Hyderabad, under the aegis of the Indian Council of Agricultural Research. The institute originated under the flagship of the All- India Coordinated Research Project (AICRP) on Poultry Breeding, an All-India Network Project, launched during the IV Five- Year Plan by the Indian Council of Agricultural Research with the objective of augmenting commercial poultry production.

Initially, the coordinating unit of the AICRP was located at the Poultry Research Division (till 1979) of the Indian Veterinary Research Institute, Izatnagar, which monitored activities of the AICRP centres, located in different State Agricultural Universities (SAUs) and ICAR Institutes. Later it functioned from the Central Avian Research Institute, Izatnagar, till it was raised to the status of the Project Directorate on Poultry.

The institute is situated in a strategic location at Hyderabad, the poultry hub of India. The Directorate has been playing a vital role in addressing issues related to commercial and rural poultry farmers spread across the country. Keeping in view the contribution to the poultry farmers and poultry industry, the institute has been elevated to the status of Directorate of Poultry Research in 2013. Presently the institute's activities are spread across 13 AICRP centres and 11 Poultry Seed Project centres, covering the entire country. The primary focus of AICRP centres is to develop location- specific rural chicken varieties and their propagation in the region along with the conservation and improvement of the local native and elite chicken germplasm. The poultry seed project centres are propagating improved rural chicken germplasm developed at the Directorate. The institute is supplying both parent stocks and commercial birds (4 to 5 lakh per year) to different states in addition to the supply provided by the centres.

The main activity of this Directorate is to coordinate and monitor ICAR sponsored network research programmes and to develop varieties suitable for rural poultry with supportive research in nutrition, health and molecular genetics.

MANDATE

- To coordinate and monitor ICAR-sponsored network research programmes.
- To undertake applied research on genetics and breeding, and conservation of improved chicken germplasm with supportive research on nutrition, disease control and management.
- To lay emphasis on development of chicken varieties for meeting needs of rural/tribal and other under-privileged sections of the society.

The Directorate has developed excellent chicken varieties — *Vanaraja*, *Gramapriya, Sreenidhi*, *Swethasri*, *Krishibro*

and Krishilayer for backyard and intensive poultry production, which have gained wider acceptability particularly among the rural and the tribal populations in different agroclimatic regions of the country. These varieties have potential to lay about 110 to 180 eggs and weigh up to 1.0-1.5 kg at 12 weeks of age, utilizing natural food base available under scavenging. Package of practices in nutrition and health- care for both intensive and backyard chicken varieties have been developed, which are being used by respective stakeholders.

About 62 lakh of germplasm, mainly of *Vanaraja,Gramapriya* and *Krishibro,* have been supplied to farmers across the country. In addition to the above, 2.13 lakh of parent chicks of the rural germplasm were supplied to different government organizations.

The main objective of the Directorate was to minimize malnutrition of protein in human-beings with availability of the poultry products at affordable cost and also to ensure supplemental income from poultry-rearing / farming, thereby improving economic status of mainly poor and landless farmers, weaker sections of the society and people residing in the tribal areas.

Centres of the All-India Coordinated Research Project on Poultry Breeding

- Sri Venkateswara Veterinary University, Hyderabad, Telangana
- Kerala Veterinary Animal & Fisheries Sciences University, Mannuthy, Kerala
- Anand Agricultural University, Anand, Gujarat
- Karnataka Veterinary, Animal and Fishery Sciences University, Bengaluru, Karnataka
- Orissa University of Agricultural Technology, Bhubaneswar, Odisha
- Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab
- Central Avian Research Institute, Izatnagar, Uttar Pradesh
- Madhya Pradesh Pashu Chikitsa evam Vigyan Viswa Vidyalaya, Jabalpur, Madhya Pradesh
- ICAR Research Complex for NEH, Agartala, Tripura
- Maharana Pratap Singh University of Agricultural Science and Technology, Udaipur, Rajasthan
- CSK Himachal Pradesh Krishi Viswavidyalaya, Palampur, Haryana
- Assam Agricultural University, Guwahati, Asom
- Birsa Agricultural University, Ranchi, Jharkhand

Poultry Seed Project

It is being operated at the following centres for supplying improved rural poultry germplasm.

- Bihar Agricultural University, Patna, Bihar
- West Bengal University of Animal & Fishery Sciences, Kolkata, West Bengal
- Chhattisgarh Kamadhenu Viswa Vidyalaya, Raipur, Chhattisgarh
- ICAR Research Complex, Nagaland Regional Centre, Jharnapani, Nagaland
- ICAR Research Complex, Sikkim Regional Centre, Gangtok, Sikkim
- ICAR Research Complex, Manipur Regional Centre, Imphal, Manipur
- Tamil Nadu Veterinary & Animal Sciences University, Chennai, Tamil Nadu
- ICAR Res. Complex for Western Region, Ela Goa, Goa
- Central Agricultural Research Institute, Portblair, Andaman & Nicobar Islands
- IVRI, Regional Campus, Mukteswar, Uttarakhand
- SKUAST, Srinagar, Jammu and Kashmir

INFRASTRUCTURE

The Directorate has facilities for carrying out research in Breeding and Reproduction, Biotechnology, Nutrition and Disease Diagnosis. In the breeding farm, about 10,000 adult-birds can be housed individually in cages and 15,000 chicks in brooder and grower houses. Additionally, battery cage facilities are also available to conduct sophisticated Nutrition and Health experiments. A feed-processing unit to compound about 70-80MT of feed per month and a Hatchery unit with the setter and hatcher's capacity of 27,000 and 18,000 eggs, respectively, are also available. In the Directorate are also a post-mortem room and an incinerator and a closed pit for safe disposal of dead birds.

DG, ICAR, inauguartes silver jubilee laboratory

A New laboratory block (Silver Jubilee block) with 6 labs and a demonstration Backyard Unit have lately been added. During the XII plan, a new campus with state-of-the art infrastructure would be developed.

TECHNOLOGIES DEVELOPED

- Developed *Vanaraja* and *Gramapriya* for rural poultry production. These chicken varieties are being reared in almost all areas of the country.
- *Sreenidhi,* a promising dual- purpose chicken variety, recently developed, is being propagated in Telangana and other adjacent states.
- Evolved a coloured broiler cross, *Krishibro*, which can attain 1,500g body weight at 6 weeks age.
- Developed *Krishilayer*, a promising commercial layer variety with a production potential of 280-290 eggs.
- *Swethasree,* a promising rural layer variety with a laying potential of about 180 - 200 eggs, has been developed.
- Promising broilers (B-77, IBL80, IBB-83 & IBI-91) and layer crosses (ILI-80, ILM-90 & ILR-90) have been evolved.

Vanaraja birds in Nagaland

- Molecular characterization of all poultry germplasm available at the Directorate has been carried out.
- Established tropical adaptability of major genes — naked neck and dwarf.
- The advantageous effects of dwarf dam line have been established.
- Maize, the expensive energy source in chicken-diet (of broiler and layer), could be replaced without affecting performance with foxtail millet, pearl millet and tannin-free sorghum.
- Similarly, soybean-meal could be replaced *in toto* with sunflower cake or low glucosinalate mustard cake or up to 67% with *til* cake.
- Evolved several effective and economic ways *of* detoxifying aflatoxins in poultry-diet.

Gramapriya female

Krishibro flock

IMPACT ASSESSMENT OF CHICKEN VARIETIES

The expected egg and meat production was determined by the standard production performance levels of these birds under field conditions.

Performance standards of the varieties

Parameter	Vanaraja	Gramapriya	Krishibro
Body weight			
Males (15 wks)	1.5	1.2	1.5 (6wk)
Females (72 wks)	2.5	2.0	3.0
Egg production (field)	100	160	—
Mortality %			
Commercial chicks	20	20	5
Parents	10	10	10
Hatchability	75	65	75
Cost of egg, ₹	5	5	—
Cost of meat/kg, ₹	100	100	120
Cost of spent meat	60	60	50

National impact (estimates) of the varieties

	Vanaraja	Gramapriya	Krishibro	Total
Chicks distributed (lakh)	180.44	170.15	129.11	479.71
Total profit (₹ in lakh)	450.28	612.35	64.96	1,127.59
No of families benefited	22.99	15.09	1.00	39.07

Chicken varieties economics

Vanaraja, a dual purpose variety for rural poultry

It is hardy and has better immune competence. Its body weight at 12 weeks of age ranges from 1.5 to 1.8 kg. Its annual egg production is about 100-110 eggs in free range conditions. The variety is well accepted in all states including Jammu and Kashmir, Andaman-Nicobar islands and the north-eastern region. About 19.84 lakh Vanaraja germplasm was supplied across the country.

Kashmir women with Vanaraja

Vanaraja economics per bird under free-range conditions

Input				Output	
Sex	Age of the bird	Cost (₹)*	Particulars/ details of the bird	Receipt (₹)	Profit (₹)
Male	12wk	100	Bird at 12wks (1.5-1.8 kg) @ ₹ 120/kg	180-240	80-140
Female	72wk	225	Eggs: 100-110 @ ₹ 3/egg Birds: 3.0 kg @ ₹ 80 kg Total	300-330 240 540-570	315-355
Total profit from a pair of birds		325		720-810	395-485

*Includes cost of day-old chick, feed, medicines and health-care etc.

The farmer can earn a net profit of about ₹100/bird on males and 325/bird on female birds by rearing Vanaraja chicken. A unit of 20 birds with 15 females and 5 males is ideal and viable for providing additional income for the family.

Gramapriya a prolific brown layer for rural and tribal areas

Gramapriya a layer-type variety has been developed for free- range farming in rural and tribal areas. It is a hardy breed. Its body weight at 12 weeks ranges from 1.2 to 1.5 kg. The annual egg production is about 150-160 eggs under field conditions in farmers' backyards.

Grampriya flock

Gramapriya is present in all parts of the country, starting from Kashmir to Kanyakumari and Gujarat and Andamans.

The farmer can earn a net profit of about Rs 100 /bird on males and 500/bird on female birds by rearing Gramapriya chicken varieties. A unit of 20 birds with 15 females and 5 males is ideal and viable for providing additional income for the family.

Gramapriya per bird economics under farmers' backyards

Input				Output	
Sex	Age of the bird	Cost (₹)*	Particulars/details of the bird	Receipt (₹)	Profit (₹)
Male	15 wk	90	Bird at 15wk (1.5-1.8kg) @ ₹ 120/kg	180-240	90-150
Female	72 wk	220	Eggs: 150-160 @ ₹ 3/egg Birds: 2.5kg @ ₹ 80 kg Total	450-480 200 650-680	450-480
Total profit from a pair of birds		310		830-920	520-610

*Includes cost of day-old chick, feed, medicines and healthcare etc.

Tribal women with Grampriya birds

Athulya (ILM-1990) layer chickens – A new hope for poultry farmers

Mrs Manimaran a marginal poultry farmer in Periyapetty village, Namakkal district, Tamil Nadu, India, has a poultry farm with 20,000 layer chickens capacity. Earlier, she was raising layer (egg layers) chickens purchased from the market. She came to know about the high producing heat-tolerant Athulya strain (ILM-90) cross of IWN and IWP lines of layer chicken developed for high egg production with desirable egg weight at Mannuthy.

Mrs Manimaran purchased 2,800 Athulya day-old chicks from Mannuthy centre and initiated rearing. She also noticed that chickens were heat tolerant during the summer months.

She earned a profit of approximately ₹292,100 from 2,800 of Athulya chickens. She spent ₹1,824,800 on feed, ₹56,000 for purchase of chicks, ₹54,000 for labour and ₹18,200 as miscellaneous expenses, and realized a revenue of ₹2,077,920 from sale of eggs, ₹148,200 from sale of spent hens, ₹2,600 from manure and ₹16,380 from sale of empty feed gunny bags.

FUTURE THRUSTS

- The research in genetics and breeding for varietal development suitable for rural and tribal areas would be strengthened with supportive research in nutrition, health and molecular genetics. In addition to this, research work on climate change, value -addition and contract research in health and nutrition would be focused in the XII plan. The AICRP on Poultry breeding would be reoriented towards rural/village poultry in a mission- mode to develop location-specific varieties suitable for village poultry across different agro-climatic regions of the country.
- The Poultry Seed project would be strengthened with some more centres during the XII plan for efficient and timely distribution of the improved rural chicken germplasm across the country. Special emphasis would be given towards the development of poultry farming in the North Eastern states.
- Public-private partenership linkages would be strengthened with commercial poultry industry and other stakeholders for augmenting poultry production through economizing on feed cost and by proper management of emerging and re-emrging diseases.

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ANKUR (SUIN 037) — A sunnhemp strain for high fibre yield

A high-yielding sunnhemp strain ANKUR (SUIN 037), released by the Central Varietal Release Committee, has been derived through mass selection. The strain was tested in the Initial evaluation trial (IET), advanced varietal trials (AVT)1 and AVT II, and is in adoptive trials at Rahuri, Pratapgarh, Kalyani and Aduthurai.

SUIN 037 out-yielded the national checks K 12 yellow and SH 4, and under normal conditions, it gave yield of 1.0-1.2 tonnes of good quality fibre/ ha. It showed fibre tenacity of 21.0 g/tex, far better than checks, K 12 yellow (15.8 g/tex) and SH 4 (15.6 g/ tex). The strain is comparatively more resistant to biotic and abiotic stresses, and possesses high degree of resistance to vascular wilt over both the checks. It is suitable mainly for rainfed mid-and high land agro-ecological conditions, where sunnhemp is usually grown. Early-sown crop is free from top shoot-borer, hairy caterpillar and other insect pests. Based on its performance the strain has been recommended for cultivation in Uttar Pradesh, Bihar, Rajasthan, Maharashtra, Odisha and Madhya Pradesh.

Its plant height is 2.80 m - 3.10 m. And it is an early- maturing strain, ready to be harvested within 90-100 days for fibres and 140-145 days for seeds.

ANKUR – A good strain for high fibre yield

Distinguishing morphological characters

- **Fruits and seeds:** fruits are indehiscent; and seeds are deep brownish and 1,000 seeds weigh 40.0g.
- **Stem:** is green, cylindrical, ribbed, its basal diameter is 8 - 11 mm, and it is less branched
- **Leaf:** is green, oblong, with length of 14.0 cm and width of 2.2 cm
- **Flowers:** Petals are yellow; flowering is for 65–70 days

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Safflower varieties for Shivalik Region — Chandigarh

Fourteen promising varieties of safflower were assessed for their performance under rainfed areas of Shivalik region for drought tolerance. Varieties were sown in lines after pre-sowing irrigation in the last week of November at 45 cm ×10 cm spacing with *deshi* plough. Single dose of NPK at 60: 30: 30 kg/ ha was applied at sowing.

Safflower varieties and their total biomass and grain yield

Varieties	Source	Total biomass (q/ ha)	Grain yield (q/ ha)
A 1	UAS, Dharwad, Agriculture Research Station, Annigeri	81.10	13.79
PBNS 12	AICRP on Safflower, Marathwada Krishi Vidhyapeeth, Parabani	62.10	13.58
A 2	UAS, Dharwad , Agriculture Research Station, Annigeri	67.22	17.10
NARI-NH 1	Nimbkar Agriculture Research , Phaltan	77.55	21.80
NARI 6		73.88	22.43
SSF 733	AICRP on Safflower, Mahatma Phule Krishi Vidhyapeeth,	69.33	10.12
SSF 708	Soil Testing Lab, ZARS, Solapur	66.99	20.96
SSF 658		60.55	18.83
Bhima		69.44	8.87
PHULE Kusuma		63.22	12.72
AKS 207	Oilseed Research Unit, PDKVV, Akola Maharashtra	68.44	19.41
PKV Pink		72.77	17.51
JSL97	AICRP on Safflower, AVSRW, College of Agriculture, Indore	62.77	18.82
JSF 1		62.44	13.30

Among the varieties, NARI 6 recorded higher grain yield of 22.43 q/ha, which was at a par with NARI-NH 1 (21.80 q/ha), followed by SSF 708 (20.96 q/ha), and the lowest was of Bhima (8.87 q/ha). Total biomass yield was not significantly different among varieties. NARI 6, NARI-NH 1 and SSF 708 are recommended for rainfed areas of Shivalik region, where soils are poor and stony.

Performance of NARI 6 and NARI-NH 1 at Chandigarh

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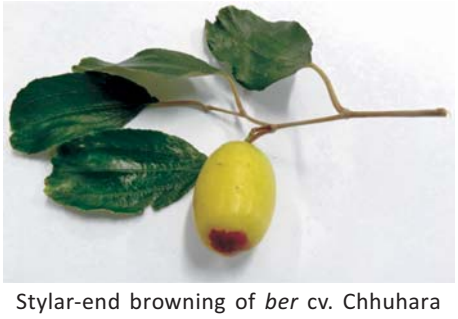
Physiological disorder in Indian jujube fruits

A physiological disorder 'stylar-end browning' of fruits has been observed in Indian jujube (*ber*) cv. Chhuhara, wherein tip (stylar end) of the fruits turns brown. This disorder has been observed to aggravate with advancement of fruit maturity. Affected fruits are similar in weight and appearance to normal fruits, excepting a brown tip at the stylar end. They have lesser soluble solids, sugars and ascorbic acid; and higher content of secondary metabolites and enzymes responsible for oxidative browning. Nutrient analysis indicated higher boron content in the affected fruits. Since, this disorder appears during late harvesting period, when atmospheric temperature is high, it can be concluded that high temperature and high illumination accompanied with low relative humidity may have resulted in boron accumulation beyond the threshold level, which might have led to browning of stylar-end of fruits.


Stylar-end browning of *ber* cv. Chhuhara


Increase in browning of Chhuhara fruits with maturity

Different nutrients in *ber* cv. Chhuhara

Nutrient	Nutrient contents in fruits	
	Healthy fruits	Disorder-affected fruits
Phosphorus (%)	0.200a	0.201a
Potassium (ppm)	81.2a	79.2a
Calcium (ppm)	178a	180.5a
Boron (ppm)	18.7b	30.8a

*Row values followed by the same letter are not significantly different.

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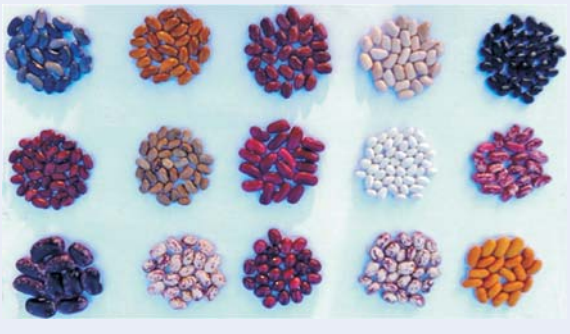
Diversity of common-bean in Jammu and Kashmir

Common-bean (*Rajmash*) genotypes maintained by the farmers of the Jammu and Kashmir over generations display a wide range of seed size and colour patterns. In high altitude dryland areas of the state, it is usually intercropped with maize. *Rajmash* is principally consumed as dry (mature) beans, shell beans (seeds at physiological maturity) and green pods.


Common-bean genetic diversity in Jammu and Kashmir

Genetically diverse 80 germplasm accessions of common- beans were collected mostly during 2013 from remote and hilly areas of the state, known for marginal and risk-prone farming systems. Seeds of a collection from a far-flung village Thakraie in Kishtwar have

been reported to be very tasty. Several villages located in the remote Keshwan hills near this village produce this, and refer it as *Keshwan rajma*. Common- beans in the state are often named according to the production area — *Shopian rajma, Machil rajma, Badherwah rajma, Warwan rajma* and *Poonch rajma*. Thirteen different colours were observed in the collected germplasm with predominance of red colour. Cuboid, kidney and oval shaped seeds were represented, respectively, in 61.25%, 25% and 13.75% of accessions; 100-seed weight varied between 14.4g and 145g ; 53.75% accessions showed 100-seed weight ranging between 25 and 40g.

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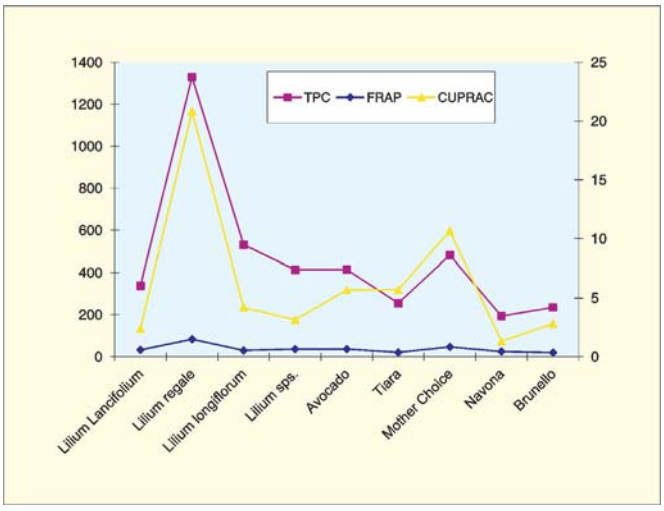
Lily-bulb extracts with antioxidant activity

Phenolic compounds are potent antioxidants, and play an important role in human nutrition as preventive agent against many diseases; and in protecting body tissues against oxidative stress. Methanol extracts of lily-bulbs have antibacterial and anti-inflammatory properties also. Due to health-promoting properties of lily - bulbs to treat bronchitis, pneumonia and in providing nourishment, it has extensively been used as food and as traditional medicine in China.



Antioxidant activities and total phenolic contents (TPC) of bulb extracts from four lilium species and five cultivars were studied. Antioxidant activity as well as total phenolic content of the extracts were assayed through FRAP (µ mol/g) and CUPRAC (µ mol/g). *Lilium regale* showed highest phenolic content and strongest antioxidant activity, followed by cultivar 'Mother Choice', while *Lilium lancifolium* and cv. 'Navona' had lowest phenolic content and weakest antioxidant activity. The results indicate that lily-bulbs are good candidates for developing nutraceutical supplements or antioxidant remedies.

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Makhana popping machine developed

Gorgon- nut (*Euryale ferox*) is a seed of an aquatic plant, mainly grown in Bihar, eastern Uttar Pradesh, Asom, West Bengal, Tripura and Odisha, and has been roasted and popped manually. The popped kernel, called *makhana*, is a nutritious dry fruit.

Traditionally, gorgon -nut seeds, cleaned, sun-dried, graded (according to size), are roasted in earthen-pot or cast-iron pan over fire for 4-5 minutes, and then roasted seeds are kept for tempering for 48-60 hours, which are then roasted again for specified time, and then individual hot seeds are hit manually using mallet. As the seed- coat breaks, expanded kernels come out, called *makhana*. This manual method causes burn

CIPHET Makhana popping machine

injury etc., and may yield low quality *makhana*.

A machine developed that handles roasting and popping operations has reduced processing time from 48 – 60 hours to 25 hours. The machine produces high quality popped as well as decorticated kernels, and has reduced drudgery of the manual method. The machine is manufactured commercially by M/s Jwala Engineering & Consultancy Services, Ambala.

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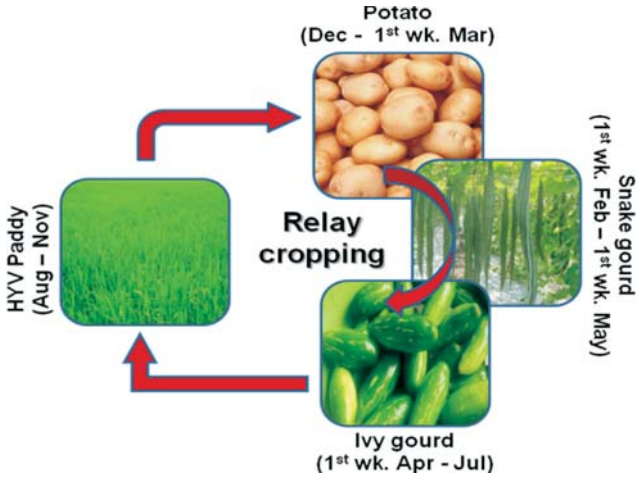
Relay cropping boosted cropping intensity

In medium to uplands of Sundarbans, most of the farmers used to grow only 2 crops per year— *kharif* paddy, followed by greengram in rainfed situation or *kharif* paddy, followed by a single vegetable in the irrigated area. After a significant improvement in the irrigation facility, this cropping pattern has changed to introduce a third or fourth vegetable as a relay crop.



Relay cropping reduces time of land preparation between two successive vegetables. Potato is planted in the 1st week of December after paddy harvest in November. During the 1st week of February, when potato is 60 days old, snakegourd seeds are sown at 6 ft × 6 ft spacing. By the next one month, when potato reaches maturity, snakegourd vines trail over bamboo - iron wire made structure (locally called "macha"). Potato is harvested during the 1st week of March. Snakegourd starts fruiting from the 1st week of April and continues up to the 1st week of May. Ivy-gourd stem cuttings are then planted in-between ivy gourd plants, at 4.5 ft x 4.5 ft spacing, in the 1st week of April. By the time snakegourd harvesting completes (1st week of May), ivy- gourd vines are on the same "macha". Ivy-gourd starts fruiting after 60 days and the harvesting is complete by the end of July. In medium land situation where water stagnation is likely

due to summer rain, ivy- gourd is not cultivated. In such cases, snakegourd vines are allowed to grow till May end. Some farmers even planted cow-pea or bittergourd along with snakegourd, at the periphery.

Presently 148 farmers (SHG and UG members) are following this intensive vegetable cultivation through relay cropping after taking loan from the watershed revolving fund.

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WAY FORWARD

WITH the National Food Security Act in place, the country's major concern is to ensure nutritional security through public distribution system, and we all know that it continues to be a critical challenge in the face of burgeoning population, reduced availability of land and water, and accelerated yield losses due to biotic and abiotic stresses. Thus agricultural research role is to augment production with nutritional enrichment, wherein biotechnology can be vital.

Genome science with its unparallel development has high application potentials not only in agri-sector, but also in industries. At present, over 1,200 eukaryotic genome-sequencing projects are operational worldwide. Similarly, the international consortium of scientists conceded a proposal, known as Genome 10K project, for assembling a 'genomic zoo' of vertebrate species. Introduction of genomics can help stocks identification, stock enhancement, genetic improvement and management for sustainable yields and preservation of genetic diversity of plants, animals, aquatic organisms, insects and microbes. In fact, molecular genetics and genomics tools can complement traditional selection programmes by bringing in accuracy in selection and in shortening generation interval.

Genomes of a number of agriculturally important species including rice, sorghum, maize, buffalo, pig, silkworm, rhizobium etc. are now publicly available. In the recent years, a number of initiatives have been taken for construction of large insert libraries and development of massive EST collections, genetic and physical molecular maps, and gene targeting systems.

Globally, single nucleotide polymorphism (SNP) technology is now being developed for plants, aquatic organisms and livestock species. SNP markers are used to design genotyping arrays containing thousands of markers spread over entire genome as well as to analyze large numbers of samples. However, the scarcity of available DNA sequence data for commercially important species can limit marker development. High throughput genomics is a promising approach that can aid in rapid identification and determination of functional genes associated with key traits, biotic and abiotic stress, and economic traits.

India's voyage in whole genome sequencing started with the joining in the Consortium of International Rice Genome Sequencing Project, led by Japan in 2000. The ICAR contributed in the Pigeonpea Genome Sequencing Project also. Presently, the Indian agricultural scientists are involved in decoding of wheat chromosome 2A.

Throughout the world, the improvement in animal genetic resources has been achieved by selective breeding. For cattle, buffalo, sheep, pig, horse and chicken, the genomic resources are already available, and can be tested directly on the Indian population for their suitability to apply for genomic selection. In this regard, the Buffalo Genome Sequencing Initiative of the ICAR is noteworthy.

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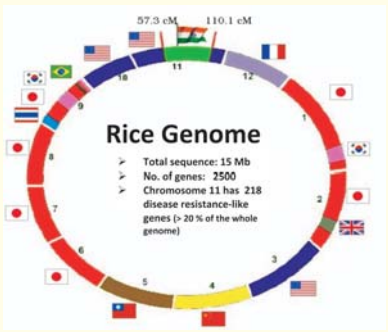

In comparison to plants, livestock and microbes, the genomics research in India in aquatic organisms and insect fauna is at infancy. For example in fisheries, it is limited to initial stages of DNA marker development.

Similarly, nutrigenomics contribution can be in producing new kinds of feeds for aquaculture species to select better performing genotypes.

There is a need to understand functional genomics of the pest. Pathogenomics attempts to utilize genomics, including metagenomics and transcriptomics data generated from high throughput technologies (e.g. sequencing or DNA microarrays), to understand microbe diversity, microbe-microbe interactions as well as host-microbe interactions involved in disease conditions.

In India, though 46 full genome projects are either underway or documented, but in terms of overall contribution, this is still small. There is urgent need of implementation of large-scale genomics research programme in agriculture and allied fields to address problems related to genetic improvement and overall productivity and to support conventional improvement system in an appropriate way. To consolidate and enhance efficacy of Genomics in Agriculture, the ICAR is implementing a Consortium Research Platform (CRP) on Genomics in the XII Five year Plan to have lead in genomic revolution in agriculture for the betterment of the society in a balanced way.

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