Volume 24 No. 2 ISO 9001:2008 Organization ISSN 2394-3289 April-June 2018

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

भाकृअनुप
ICAR

# ICAR NEWS

A SCIENCE AND TECHNOLOGY NEWSLETTER

## RESEARCH UPDATE



## PROMISING TECHNOLOGIES

# CAZRI gum inducer for gum production from *Acacia senegal*

Under natural conditions, about 10-15 g gum-arabic (acacia gum) is generally harvested from each tree of *Acacia senegal*. Gum-arabic is considered as best edible gum and is used in preparation of variety of sweets, confectionery items, ice-cream, herbal medicines etc. and commands a high market price (₹1,000 to 1,200/kg).

CAZRI has developed a technique by which gum production from each tree can be enhanced by more than ten times. The technique is widely accepted by farmers of the region. Our assessments have shown that in the last decade, farmers in more than 45 target villages have earned additional income of more than ₹4.32 crore through the sale of gum-arabic produced by using CAZRI technology. During the period (2016-17), 20, 180 trees of *A. senegal* were treated by CAZRI gum inducer, resulting in production of approximately 8.72t of gum-arabic.

Induced gum exudation from *Anogeissus rotundifolia* trees for enhanced income generation

**Indian Council of Agricultural Research**
Krishi Bhavan, New Delhi 110 001, India
www.icar.org.in

The technique is now being further improved to enhance gum exudation from *Anogeissus rotudifolia*, *A. pendula*, *Acacia nilotica*, *A. tortilis* to further enhance production of edible gum in the region.

**JC Tewari, K Shiran, Archana Verma, Kamlesh Pareek** and **Praveen Kumar**
ICAR-CAZRI, Jodhpur
praveen.kumar@icar.gov.in

## Design development of photovoltaic-thermal (PVT) hybrid solar dryer

A photovoltaic-thermal (PVT) hybrid solar dryer was designed and fabricated in such a way that it enabled the combined production of electric energy and thermal energy from the photovoltaic panel and flat plate collector. The dryer consists of a collector unit, drying chamber, DC fan, PV panel and PCM chamber for thermal storage. The PV module was provided at left side of solar collector to operate a DC fan for forced mode of operation. The dryer having a size 1,250mm × 850mm has been made by galvanised steel sheet (22 gauge), which consisted of four drying trays. The clear window glass (4mm thick) is provided at the top of box. The area of collector designed for the dryer is 1.06 $m^2$ with a DC fan of 10 watt, which will be used for exhausting moisture with the help of a solar panel of 20 Wp.

PVT hybrid solar dryer installed at CAZRI solar yard

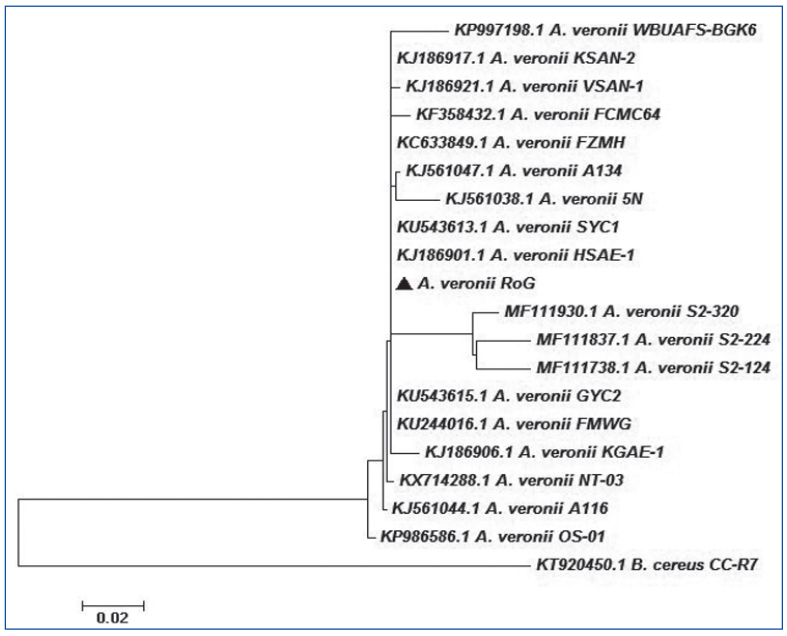
The dimension of two drying trays made of stainless steel angle frame and stainless steel wire mesh was 0.84 × 0.60m and that of two half trays was 0.40 × 0.60m. The drying material can be kept on four trays and placed on angle iron frame in the dryer through an open able door provided on the rear side of the dryer. Six plastic pipes are fixed in the back wall of the dryer just below the trays to introduce fresh air at the base. The maximum stagnation temperature recorded was 70°C when the outside ambient temperature was 27°C. The PCMs used were paraffin wax (melting temperature 44°C), lauric acid and capric acid which can extend drying hours till late night.

**Surendra Poonia, AK Singh** and **Dilip Jain**
ICAR-CAZRI, Jodhpur
surendra.poonia@icar.gov.in

## Characterization of *Aeromonas veronii* isolated from rohu, *Labeo rohita*

A study was conducted to identify and characterize bacterial isolates from rohu, *Labeo rohita,* particularly from gill on the basis of biochemical and molecular (16S rRNA) tools. Among few isolates, one isolate was found to be, gram–negative short rods, and showed positive reaction towards oxidase, catalase and utilize citrate for growth.

Further, 16s ribosomal regions were amplified by using universal primer in PCR. The extracted PCR product showed band at 1500 bp and subjected to Sanger di-deoxy sequencing. The sequence information was found to be of *Aeromonas veronii,* and phylogenetic analysis revealed cluster within same species reported from elsewhere. Furthermore, *in-vitro* antibiotic sensitivity test was performed by disc diffusion assay and found that isolated *A. veronii* RoG is sensitive against selected antibiotics viz., ceftazidina (30 mcg), nitrofurantoan (300 mcg) and resistance against ciprofloxacin (5 mcg), amikacin (30 mcg), netillin (30 mcg) and nalidixic acid (30 mcg) in varied level.




Phylogenetic analyses of *A. veronii* isolate (*A. veronii* RoG) using 16s rRNA partial sequences were already available with our obtained sequence.

The sequences, aligned to construct the neighbour-joining phylogenetic tree by using Molecular Evolutionary Genetics Analysis (MEGA) Version 6.0 Scale bar, indicated the genetic distance.

**Dr SS Mishra**
Director, ICAR–CIFA,
Bhubaneshwar, Odisha
director.cifa@icar.gov.in

# IIHR brings high yielding varieties of beans and tomatoes

In tomato, high yielding advanced breeding line IIHR-2892 (derivative of Inter-specific cross 15SB SB x *Solanumhabrochaites* LA-1777) expressed resistance to ToLCNDV under New Delhi conditions. On validation with molecular markers linked to ToLCV resistance, it expressed Ty3 in heterozygous condition. Seeds were collected for further advancement to get homologous lines with Ty3.


In tomato new $F_1$ hybrids *viz*; H-385, H-387, H-391, H-392 and H-397 with high yield and fruit quality attributes have been developed with resistance to ToLCNDV + BWR + EBR.

Four varieties of velvet bean (*Mucuna pruriens* var *utilis*) viz., Arka Shubra, *Arka Charaka*, *Arka Shukla* and *Arka Daksha* were identified for release by the Varietal and Technology Identification Committee (VTIC) of ICAR-IIHR, Bengaluru, in view of high yield and high L-Dopa Mucuna attributes.

**Dr MR Dinesh**
Director, ICAR-IIHR, Bengaluru
director@iihr.res.in

# Captive breeding of *Pethia narayani* – indigenous ornamental fish

The Narayani barb, *Pethia narayani* was collected from river Sita, located in Shimoga district, Karnataka, India. The average weight recorded at the time of procurement was 1.0-1.25 g and length recorded was 2.5-3.0 cm. After procurement, fishes were acclimatized and stocked in quarantine tanks for a period of 15 days. After 4 months of rearing, the fishes showed the secondary sexual characters (male is more colourful and having white line at pelvic fin) and were separated sex-wise.

The further rearing was done in separate tanks for male and female. Breeding was done in big glass aquaria (200 litre) capacity. Male and female were collected from broodstock tanks and maturity for breeding was ensured. The breeding tank was filled with seasoned water and breeding hapa (specially designed at ICAR-CIFA for breeding of ornamental barb fishes) was placed in the tank. Since the size of brooder was very less (approx. 1.5 g), fishes were not induced with any kind of inducer. The brooders were released in breeding hapa in the ratio of male: female, 2: 1 respectively. The confinement was ensured for better mating of the brooder. After 36 hours the eggs were seen at the bottom of the tank. The brooder were taken out and released back in brooder tank after proper treatment. Natural *infusoria* were allowed to produce in the tank. Mild aeration was given for better hatching. Hatching of eggs occurred after 48 hours. The newly hatched larvae were microscopic. The absolute fecundity was recorded in the range of 380-643.

**Dr SS Mishra**
Director
ICAR-CIFA, Bhubaneshwar, Odisha
director.cifa@icar.gov.in

# Development with Farm Development Card

Agriculture in South Asia is at cross-roads in terms of achieving sustainability, mainly for reasons that the region is finding it difficult to generate adequate income and employment for its vast farming population, failing to achieve environmental and energy security at the farm level, and failing to cope with climate change. Besides, the agriculture of South Asia including India suffers from dominance of disciplinary and commodity approaches, which is not conducive or allowing for the growth of agriculture in the region, where small and marginal farmers constitute major section of farming community. Sustainable development of small and marginal farmers is only possible through systematic and holistic approach. Faced with this situation, agricultural strategies need to be explored that increase productivity and generate adequate or double the income and employment for the small-holder farmers, as well as generate renewable energy on the farm, and stem the erosion of biodiversity and offset carbon emissions. The economic limitation of small-size land operations is the main challenge to sustainable farming in the 21st century. This calls for structural and organizational changes in managing the farm sector in South Asia. The important issue is how to develop institutional mechanisms so that farmers get higher incomes by realizing the advantages of beneficial technologies, aggregation of inputs and outputs, and value addition and marketing. A new concept has been developed by considering these factors, namely the "Farm Development Card", which addresses such problems simultaneously by redesigning the farming system.

## Farm Development Card (FDC) and its main focus

Farm Development Card (FDC) is a farm plan or business plan, which is based on holistic and system approach for the development of a farm. FDC considers overall situations of the farm including the resource-base, knowledge and skill possessed by the farmer, constraints and market opportunity. FDC is based on the following

principles : (i) Optimization of the activities/enterprises at the farming system level for a sustainable farming system model; (ii) Optimization or optimal allocation of the resources available at the farming system level fulfilling the requirement of various enterprises/activities operated at the farm level; (iii) Providing farmers an improved plan of activities for achieving the objectives/ goals vis-a-vis an existing plan; (iv) Fitting the modern technology/technologies in a compatible manner in a farming system for bringing sustainability to the system (i.e building a system out of various components).

## Components of FDC

FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity. FDC accommodates soil health card and soil management aspects also.

**(i) Ecological development:** In the context of the farmers in eastern India, the cultivation of rice - rice has resulted in a high level of productivity, but the injudicious use of pesticides is a problem contaminating ground-water and food chain. Besides, by substituting rice- rice with rice – pulses may bring N economy in cereal-based system through incorporation of legume residue, biological N fixation and also economic use of water. Water productivity can be enhanced through involvement of pulses. Residue burning may be checked for environment protection.

**(ii) Economic development:** Farmer's income needs to be enhanced, while meeting the family requirement of food, fuel and fibre for a better livelihood. In this case, the cropping pattern of the farmers needs to be changed with involvement of remunerative field crops (pulses (green gram), *rabi* maize, oilseeds (groundnut, sesamum)) and high value vegetable crops (okra and brinjal). Besides, other enterprises like fishery, dairy are to be managed properly in order to enhance the fish biomass and production.

## Energy security

Energy has been the major driver of the farming systems. Conventional agriculture involving intensive tillage by tractor consumes a lot of diesel and energy. Besides, cooking of food for farm family members and electric consumption for lighting the house and lifting the water for irrigation are the major energy consumptions at household level. This aspect needs to be addressed since energy is the major culprit of global warming. At the farm level, there is need to depend more on renewable in comparison to non-renewable energy. In the farm level, there is scope of going towards conservation agriculture (zero tillage practice + crop residue recycling (avoiding) residue burning). Biogas production through introduction of dairy enterprise. In FDC, provision can be made to include renewable source of energy compared to renewable source of energy.

**(iii) Enhancing water productivity:** Farmers have the perception that water is a free item in nature. However, he does not have the idea that for 1kg production of rough rice, he is consuming around 3,000 - 4,000 litres of water. Similarly, for production of other items farmers enjoy a subsidy for power consumption for agriculture. There is ample scope that he can partly shift his irrigation practice towards drip system to irrigate the fruit crops. Thus, enhancing water productivity is an important aspect, while developing the FDC.

**(iv) Soil health management:** Soil health management is a very vital aspects of the farm. However, farmers are more concerned how the deteriorating soil can be improved. For this the deficiency in the soil needs to be identified. Farmer provides the soil for its analysis, but getting results takes time. Besides, farmers are also reluctant in applying the micronutrients and chemical fertilizers by purchasing from outside. Rather they are more concerned for their development in traditional/ indigenous way. Recycling of wastes and by-products in the system in an integrated farming system mode can better address the soil degradation issues of a farmer.

**(v) System productivity and sustainability:** FDC takes care how the production efficiency of the system can be enhanced and profitability of the system can be increased. System productivity in terms of enhancing total economic yield of various crops, profit maximization, energy production maximization, system water productivity etc. are given emphasis in FDC. The guiding principles should be to enhance the resource use efficiency through recycling of farm by-products and wastes in the system; use of more renewable and depending less on fossil fuels and chemicals; diversification of enterprises to minimize risks; and maintain biodiversity at the farm level as a mitigation strategy to climate change.

## Objective of FDC

To provide a precise model for development of the small and marginal farmers fitting to his resource-base, infrastructure available and market opportunity. DFM goal is to develop a strong foundation of Indian agriculture by properly designing the individual farming systems. It is difficult to establish a strong building upon a weak foundation.

# FARM DEVELOPMENT CARD
## To double the farm income

Farm development card (FDC) is a tool which is based on holistic approach to farm development by considering the overall situations of the farmers including the knowledge and skill he possess. FDC takes into consideration the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity.

**Advantage of FDC : Additional income, additional employment, allows inclusive growth, climate change mitigation and adaptation, farm sustainability and better livelihood security.**

### Description of the farmer

| | |
|---|---|
| Name: | Mr. Lambodar Nayak |
| Village: | Dandika |
| G. P : | Bahanda |
| Block: | Basta |
| District: | Balasore |
| Pin code: | 756029 |
| Adhar card No: | 738402541650 |
| Mobile No: | 7504846347 |
| Farm holding : | 1.25 ha + 0.15 ha home-stead land |
| Irrigated : | 4.4 ha |

### Present existing farming System

| | | |
|---|---|---|
| X1 (Rice *kharif*) | = 2.4 ha | Resource available |
| X2(Rice *rabi*) | = 1.4 ha | Land: 4.4 ha |
| X3 (Fishery) | = 0.4 ha | Labor: 507 |
| X4 (Horticulture) | = 0.2 ha | Capital: Rs. 162,699 |

Present farm income = **Rs 47699**
Present expenditure = Rs 162,699
Expected net returns: **150,000**

### Present farm ecological problems

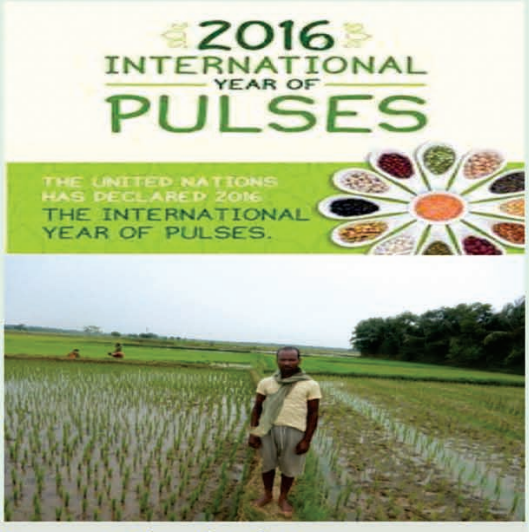
- **Monoculture of Rice–Rice**
- **Rice straw burning**
- **No manure use and heavily dependant on chemical fertilizer**
- **Flooding under heavy rain**
- **More pesticides use**

### Soil Fertility status

| | |
|---|---|
| Available K, kg /ha | : 105.1 |
| Available P, kg /ha | : 24.1 |
| Available N, kg /ha | : 162.8 |
| Available Zn, ppm | : 1.25 |
| Organic carbon ,% | : 0.38 |
| Soil pH | : 7.30 |
| Ec | : < 4.0 |

### Recommendations

**INM for improving soil health**
**Cereal-cereal crop rotation may be replaced with cereal legume (Rice-greengram/blackgram)**
**For rice : N:P:K:: 80:30:40 + FYM @ 5 t/ha**
**For legumes: N:P:K:: 25:60:30**




### Improved farming System

**X1 (Rice *kharif*) = 2.4 ha**
**X2(Rice *rabi*) = 0**
**X3 (Fishery) = 0.4 ha**
**X4 (Horticulture) = 0.2 ha**
**X5(Greengram) = 0.3 ha**
**X6 ( Brinjal) = 0.05 ha**
**X7 (Okra) = 0.05 ha**
**X8 (Mustard) = 0.10 ha**
**X9 (Greens/kalamsaga) = 0.05 ha**
**X10 (Groundnut) = 0.0 ha**
**X11 (Blackgram) = 0.50 ha**
**X12 (Cucumber) = 0.1 ha**
**X13(Bittergourd) = 0.10 ha**

### Income Generation: Rs. 151,316

### Resources used

Land : 4.3 ha
Labor : 501 man-days
Capital : Rs. 163,000

### Recommended varieties

Rice : Swarna, Pratikshya
Greengram : T 44, K-851, SML-668
Blackgram: T9, PU-30, Sarala
Mustard : JD-6, Parbati, M-27, Pt-303
Groundnut: Smruti
Bittergourd: Co-Long, Arka harit
Cucumber: Local (improved)
Tomato: Roma, Pusa Ruby, BT var.
Brinjal: PPL, PPR, Green Star
Okra : Pusa Swani, IIHR-20, Mahyco 8
Fishery : Composite Pisciculture
(Stocking density , 5000 fingerlings/ha)

Sample of FDC

The vision behind the FDC is to provide the farmers of South Asia and other developing regions with the opportunity to have their own model of development. This takes full account of the fact that all farms are not alike. Hence, with the FDC approach, we visualize providing each and every farmer with a model of their farm for their development.

**FDC is an improvement over Soil Health Card:** In FDC, soil health issue is addressed. It covers the soil health card also. It is a holistic approach and more beneficial for the farmers' development. Soil health card is just a soil fertility card, which provides information on nutrient status of the soil of the farm/field. It is a component approach and does not consider the associated links and work in isolation. It does not provide a concrete recommendation what farmers should do to enhance the farm income, ecology and biodiversity, while FDC provide a precise recommendation for the development of farmer.

### Advantage of FDC

- **Doubling the farmers' income:** FDC is a great tool for doubling the farmers' income by providing a viable and acceptable business plan based on the strength of the farm, need of the farm family, market opportunity and resource-base of the farmers. Hence, it is sustainable.
- **FDC will promote entrepreneurship:** It is recognized that only a small section of the population (around 5%) have the entrepreneurial skill and can be entrepreneurs. However, doubling farmers' income is a big campaign, which needs to promote entrepreneurship to large mass of farming population. For entrepreneurship development a business plan is the first step. Hence, FDC, which is a business plan can help in promoting the entrepreneurship to large population.
- **Attracting Rural Youth to Agriculture:** FDC will assure income and employment for the rural youth and help in making them entrepreneurs. This will create employment opportunity for the rural youth.
- **Addressing climate change issues:** FDC will help in promoting agricultural diversification and biodiversity, thus providing viable strategy for the farm to mitigation and adaptation to climate change.
- **Synergy and collaboration:** For implementation of FDC, a holistic and system approach will help to collaborate, link and come together of the various agencies/organizations working at the ground (village, block and district) level. This will bring synergy in agricultural development programmes resulting in more output and saving money for the country.

Farm Development Card is a business plan for the small and marginal farmers of South Asia including India. FDC is highly potential in doubling the farmers income with due consideration to farm ecology and sustainability. Implementation of FDC can help in achieving synergy among the net-work of agencies/ organizations operating at the ground level, thus bringing more out to the expenses made on agricultural development issues and save billions of rupees of the country.

**UK Behera**
IARI, New Delhi
ukb2008@gmail.com

# New Indigenous ornamental fish species *Parasilorhynchus swaini* discovered in Odisha

The Institute has recently found a rare freshwater ornamental fish, *Parasilorhynchus swaini* from a stream near Harishankar in the Mahanadi river basin. It differs from other species of the genus in having following combination of characters: elongated and slender body (depth at dorsal fin origin 16.9-18.7% SL); narrow and slender head (width 60.0-68.7% HL, height at occiput 40.0-50.0% HL); narrow inter orbital space (46.6-50.0% HL); 33-34 lateral line scales; 3 simple pectoral fin rays, poorly developed callous pad behind lower lip, which is not delimited posteriorly, pectoral fin longer than head length, presence of tubercles on snout and a black bar on the anal fin. With the description of this new species, distributional range of the genus *Parapsilorhynchus* is extended further north in the Eastern Ghats to the Mahanadi river drainage of Odisha. The maximum length of the fish is 32 to 42 mm. The species spawned in and around the Mahanadi river and its tributaries. The slender bodied fish prefers fast flowing, shallow and clear water and is found only in unpolluted areas. With discovery of this new species, it is evident that the bio-diversity of the river is rich and worth investigating.

**Dr SS Mishra**
Director, ICAR-CIFA, Bhubaneshwar, Odisha
director.cifa@icar.gov.in

# Particle films for production of quality pomegranates

Owing to change in the distribution pattern of precipitation and snowfall, and non-availability of sufficient chilling hours, there has been a dramatic shift from apple to pomegranate cultivation in lower valleys of Himachal Pradesh, India. As a result, several hectares of apple land have been covered with pomegranate plantations. Although, pomegranate is considered as one of the most money earning fruit crop but it also has several inherent production problems, which distracts growers from its cultivation. For instance, bacterial blight is a major issue in different parts of India, and as yet there is no concrete measure to control this dreaded disease. Similarly, fruit borer, commonly called as pomegranate butterfly (*Virachola isocrates*) is also an alarming problem. In addition, pomegranate fruits also suffer badly from the problem of cracking, especially during summer. Researchers have attempted several measures including the use of pesticides and/or several integrated practices to reduce these problems but no foolproof measure/technique has yet been developed.

Imported Particle Films

With increasing awareness among consumers about the harmful effects of residues of chemicals and pesticides, there has been a persistent search for some developing alternative approaches to reduce use of toxic chemicals. Development of a processed particle film technology (PFT) is one of them. It requires development of aqueous formulations from chemically inert mineral particles specifically formulated for fruit coating as protective films. Many countries have commercialized films such as


Pomegranate plants sprayed with particle films

**Table 1.** Effect of particle films on colour and total anthocyanin content in pomegranates

| Particle film | Hunter 'a' value | | Total anthocyanin content (mg/L) | |
|---|---|---|---|---|
| | Kandhari | Bhagwa | Kandhari | Bhagwa |
| Surround | 46.4±2.0 | 49.5±1.8 | 132.0±5.5 | 146.5±8.2 |
| Raynoux | 42.4±2.2 | 44.5±2.1 | 130.0±5.1 | 142.5±7.6 |
| Control | 36.2± 1.4 | 30.2±1.5 | 112.0±4.1 | 130.5±6.2 |

**Table 2.** Influence of particle films on sun burn and fruit cracking in pomegranate

| Treatment | Sun burn (%) | | Fruit cracking (%) | |
|---|---|---|---|---|
| | Kandhari | Bhagwa | Kandhari | Bhagwa |
| Surround-treated | 2.2± 0.4 | 2.9±0.4 | 2.5±0.5 | 2.2±0.2 |
| Raynoux-treated | 6.5± 1.2 | 8.4±1.0 | 5.5±0.4 | 5.8±0.6 |
| Unsprayed | 36.5± 2.2 | 18.3±1.4 | 15.2±0.8 | 15.3±0.7 |

**Table 3.** Incidence of bacterial blight and *Anar* butter fly after spraying of particle films

| Particle film | Bacterial blight (%) | | *Anar* butterfly (%) | |
|---|---|---|---|---|
| | Kandhari | Bhagwa | Kandhari | Bhagwa |
| Surround | 12.6±2.4 | 15.5±2.2 | 7.2±0.6 | 5.2±0.5 |
| Raynoux | 15.1±1.4 | 17.2±1.3 | 9.8±0.7 | 9.8±0.6 |
| Control | 29.4 ±3.3 | 27.8±3.2 | 16.4±2.6 | 12.6±2.8 |

**Table 4.** Effect of particle films on juice content and quality of pomegranates

| Treatment | Juice content (%) | | TSS (%) | | Total phenolics (mg/100 ml GAE) | | Antioxidant activity (µmoles Trolox/ml) | |
|---|---|---|---|---|---|---|---|---|
| | Kandhari | Bhagwa | Kandhari | Bhagwa | Kandhari | Bhagwa | Kandhari | Bhagwa |
| Surround | 58.3±6.3 | 62.2±8.2 | 13.2±1.0 | 15.5±1.2 | 118.2±8.6 | 136.3±9.2 | 18.2±1.5 | 22.4±1.5 |
| Raynoux | 56.3±6.6 | 60.4±8.8 | 12.8±1.1 | 15.0±1.2 | 116.6±83 | 133.2±9.6 | 16.4±1.6 | 20.3±1.2 |
| Control | 52.3±5.3 | 58.2±7.4 | 12.5±1.0 | 14.2±1.0 | 112.4±7.0 | 130.6±8.8 | 14.6±1.4 | 18.4± 1.0 |

Surround, Raynoux, Eclipse, Cocoon, Parasol, Anti-stress-500, Purshade, Screen, but there was no attempt from India. Thus, two films (Surround and Raynoux) were imported, and a systematic study was done on their effects on 'Kandhari' and 'Bhagwa' pomegranates.

A view of a full bearing pomegranate orchard

## The technology

Three sprays each of Surround (3%) and Raynaoux (1%) were given to 'Kandhari' and 'Bhagwa' trees at fortnightly interval at Bajaura, (Himachal Pradesh) starting from 15 June 2015. All the routine cultural practices were followed except use of fungicides and insecticides. The pomegranates were harvested on 15 October, 2015, and observations were regularly recorded. Results indicated that particle films (PFs) developed very good red colour (Hunter 'a' values) than untreated (Control) fruits in both the varieties (Table 1). Similarly, accumulation of anthocyanin was higher in the particle film-treated fruits. Interestingly, the incidence of sun burn and fruit cracking was drastically reduced in PF-treated pomegranates (Table 2). Sprays of particle films also influenced the incidence of bacterial blight and anar butter fly, which are major problems in pomegranate (Table 3). The fruit size and quality of pomegranates was also better in PF-treated pomegranates (Table 4). PF-treated pomegranates have higher amount of TSS, phenolics and antioxidant activity. Hence, it can be concluded that this technology has great future and can become an integral part of organic pomegranate production in India.

Colour development in surround-treated and untreated pomegranates

A view of cracking and sun burning in pomegranates

A view of bacterial and *Anar* butter fly affected fruits of pomegranates

## Advantages of particle films

- These films are developed from kaolin-based material, hence there is no risk of pesticidal residue.
- It is very easy to apply such films in the field.
- It is a farmer-friendly and envoronment-friendly technology.
- Use of these films brings effective control on important insects such as anar fruit fly and diseases such as bacterial spot of pomegranate.
- It decreases the incidence of sun burn and fruit cracking considerably.
- It produces russet-free fruits.
- It improves the fruit colour, cosmetic appeal of the fruits and attracts consumers.
- It helps in maintaining firmness of fruits and thus increases shelf-life.
- There is a significant improvement in fruit size and quality of pomegranates.
- It protects the fruits from bird damage.

**RR Sharma**[1] and **SC Datta**[2]
ICAR-IARI, New Delhi
rrs_fht@rediffmail.com

## PROFILE

# ICAR-National Research Centre on Camel, Bikaner

***Developing technologies to enhance the utility of camel – the ship of desert***


The camel is an important animal component of the fragile desert eco-system. With its unique bio-physiological characteristics, the camel has become an icon of adaptation to challenging ways of living in arid and semi-arid regions. The proverbial Ship of Desert earned its epithet on account of its indispensability as a mode of transportation and draught power in desert but the utilities are many and are subject to continuous social and economic changes. The camel has played a significant role in civil law and order, defense and battles from the ancient times till date. The world famous Ganga-Risala of erstwhile Bikaner State was accepted as Imperial Service Troup and participated in World War I and II. The camel helped the engineers while constructing the Indira Gandhi Canal in Western part of Rajasthan. Presently, the camel corps constitutes an important wing of Border Security Force of Indian Para-Military Services.

Considering the importance of camel in the socio-economic development of arid and semi-arid zones, the Government of India established a Project Directorate on Camel at Bikaner (India) on 5 July 1984 under aegis of Indian Council of Agricultural Research (ICAR), which was upgraded to National Research Center on Camel (NRCC) on 20 September, 1995. The Centre is located in the Jorbeer area of Bikaner city. It is situated at Latitude: 28° 01' North and Longitude: 73° 11' East with Timezone: GMT +05:30 hours. The soil type is loose and sandy. The climate is mostly dry and hot with annual rainfall in the range of 260-440 mm. The temperature ranges between 30-48°C in summer and between 4 to 28°C in winter. The Centre has about 650ha of land in which administrative-cum-library, research laboratories, camel dispensary, camel corrals, farm office, camel museum, camel milk parlour, community centre, guest house and the residential complex have been developed.

The Centre's camel herd consists of about 350 elite camels of four different genetic groups namely Bikaneri, Jaisalmeri, Kachchhi and Mewari. Two species of the family camelidae viz., *Camelus dromedarius* and *Camelus bactrianus* are present in our country and are focused by NRCC for basic and applied research. The camel production system which is in flux these days due to other reasons also need specific research attention in bringing forward the issues of camel health, nutrition, breeding and management. Looking into the production potential and utility and also to maintain diversity NRCC is undertaking conservation efforts of all the regional breeds.

The work is being carried out in the concerned areas as in camel breeding and genetics, camel physiology, camel biochemistry, camel reproduction, camel health, camel nutrition, camel management and extension, camel products technology, camel farming and agro-forestry and AKMU (agricultural knowledge management unit) and PME (priority setting, monitoring and evaluation) cell.

The Centre was established with the mandate of conservation and preservation of existing breeds of camel and to generate baseline research data on camel. The mandate was revised from time to time taking into consideration the achievements done by the scientists of the Centre and development in the field across the globe. The Centre has now been given the new responsibility to explore the utility of camel in ecotourism for which necessary infrastructure and facilities are being created at the Centre. This may prove to be an alternate source of income for camel farmers in near future.

## MANDATE

The existing mandate is:

- Basic and applied research for improvement of camel health and production.
- Information repository on camel research and development.
- Development of camel eco-tourism.

## OBJECTIVE

- The mandate of the Centre is achieved by carrying out- basic and applied research on camel production and health as influenced by different farming practices; base line survey of camel genetic resources in India; research on draught ability; milk production potential; research for improving reproductive performance; management of camel diseases through surveillance, monitoring and control measures; research for enhancing productivity by nutritional intervention; exploration of camel immune system and its applicability in the diagnosis and therapy of human diseases; technology validation and its impact on socio-economic status of camel keepers; act as a repository of information on camel research and development; collaboration with national and international resources; development of human resource in the area of camel health and husbandry.

## LARGEST COLLECTION OF CAMEL SPECIES AT ONE PLACE

Bikaneri breed of camel, one of the major camel breeds found in India, derives its name from the city Bikaner, and is known for better draught potential. The home tract of this breed is arid and sandy with extreme hot and cold climates. The camels of Bikaneri breed are heavily built and are attractive with a noble look. The colour of the coat varies from brown to black, however in some animals reddish tinge is also found. They have symmetrical body and slightly dome shaped head. The forehead has a well-marked depression above eyes, which is characteristic of this breed. Nose is long and extends up to two-third of the head. Some camels of this breed have a luxuriant growth of hair on their eyebrows, eyelids and ears, they are called *'jheepra'*. The chest pad is well developed and placed between angles of elbow. The shoulders are strong, broad and well set to chest. Neck is thick, fairly erect, with a marked curve giving a graceful carriage to the head. The udder is well developed in females.

Bikaneri Male

The breeding tract of Jaisalmeri breed is Jaisalmer, Barmer and part of Jodhpur district in Rajasthan, with very poor vegetation. Sand dunes are the typical features of the tract. The Jaisalmeri camels are of active temperament and are quite tall with long and thin legs. They have small head and mouth with narrow muzzle. The head is well carried on a thin neck and the eyes are prominent. The forehead is not dome shaped

Jaisalmeri

and is without any depression above eyes (stop). The body colour is predominantly light brown. The udder is mostly round in shape. It is a medium size breed of camel.

The Kachchhi breed inhabits the *Rann* of Kutch in Gujarat. The major breeding tract is the Kutch (also spelled as Kachchh) and Banaskantha districts of Gujarat. The camels are generally brown to dark brown. The body hairs are coarse. Head is of medium size without distinct "stop". Body size is medium. Camels of this breed are heavy and dull in appearance. They are stouter and little shorter. They have strong hindquarters, heavy legs, hard and thick foot pads and are well adapted to the humid climate and marshy land of Kachchh. The udder is well developed and mostly round in shape.

Kachchhi Male

The Mewari breed of camel has derived its name from the Mewar area of Rajasthan and is well known for milk production potential. The major breeding tract of the breed is Udaipur, Chittorgarh, Rajsamand districts and adjoining Neemuch and Mandsour districts of Madhya Pradesh. The camels of this breed can also be seen in Bhilwara, Banswara, Dundarpur districts and Hadoti region of Rajasthan, which can be considered as a minor breeding tract of the breed. The tract consists of hills of the Aravali in Mewar area. Mewari camels are stouter and a little shorter than Bikaneri. They have strong hindquarters, heavy legs, hard and thick foot pads. Well adapted to travel and carry loads across hills. The body hairs are coarse, which protects them from the bites of wild honeybees and insects. The body colour varies from light brown to dark brown but some animals are almost white, such variation in body colour is generally not seen in other breeds of camel. The head is heavy, set on a thick neck. Ears are thick and short, set well apart, tail is long and thick. The milk vein is prominent and the udder is well developed in females.

Mewari Male

A small population of bactrian camel exists in the Nubra valley of Ladakh (J and K). The humps are plump and pliable. During the late winter when pastures are scanty, the humps collapse.

- Skull bone is comparatively shorter and wider than dromedary camel.
- The body of the camel is short and stout.
- The body color varies from light brown to dark brown.
- Long hairs grow on the top of the head, along lower part of the neck, hump and legs.
- The adult body weight varies from 450 to 550 kg. The male animals are heavier than female.

Double Humped Camel

## RESEARCH ACHIEVEMENTS

- Hair quality attributes suggested very fine quality fibers. Hair is used for preparation of various items viz. shawls, pullovers, sweaters, winter garments, coats and caps.
- The high staple length and quality of wool fiber indicated its usefulness in fiber processing for the village cottage industry.
- Genetic polymorphism between two species of camel (*Camelus dromedarius* and *Camelus bactrianus*) was found by PCR-RAPD technique.
- Comparative study on haematological and mineral profile of dromedary and bactrian camel showed higher concentration of haemoglobin, calcium, phosphorus, zinc, iron and copper.
- The important diseases prevalent are actinobacillosis, pneumonia, eye diseases associated with corneal opacity, hydro-pericardium and ectopic pregnancies.
- Commonly available feed/fodder plants utilized by the camels have been evaluated for various nutritional parameters. The highest CP content is in the leaves of *Chhowk* tree followed by alfa-alfa, changama and beecho. However, CF was higher in alfa-alfa grass followed by longtol.
- The bactrian camels are seasonal breeders and the breeding season extends from January to March.
- Reproductive behaviour in the males during rutting indicated biting, active secretion form the poll glands and frothing.

## MAJOR ACHIEVEMENTS

### Conservation of Dromedary and Bactrian camels

The Centre is having elite herd consisting of Bikaneri, Jaisalmeri, Mewari and Kachchhi breed of camels. The molecular characterization of above breeds of

dromedaries has been accomplished. The Bikaneri camels as draught pupose, Jaisalmeri as race purpose, and Mewari and Kachchhi as Milch purpose were identified. Conservation strategies were devised and for these breeds, breed descriptor were established. For genetic improvement of camels in the breeding tract of various breeds elite 105 male camels have so far been distributed in the field to improve the field germplasm. Conservation efforts for Bactrian camels also initiated by the Centre and there is an increase in double hump camel population from 57 in 2004 to above 200 in 2018.

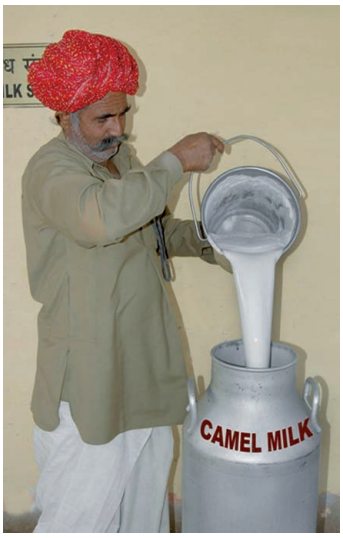
## Promoting camel as milch animal for the arid region

The reasons for decline in camel population from 1.0 million to 0.40 million in the last 40 years led to shift focus of camel research from its traditional use of draught to finding alternate uses for camel-including exploring its milk production potential. The following activities were therefore initiated to establish and accept camel as milch animal in the society

**Establishment of elite camel herd and camel milk dairy:** An elite herd of Indian camel breeds viz. Bikaneri, Jaisalmeri, Kachchhi and Mewari has been established following continuous selection for last two decades. The Bikaneri, Kachchhi and Mewari have been found to be good milch breeds. The camel dairy has been established at NRCC.

**Improvement of milk production potential:** The milk production potential of Indian dromedary breeds was evaluated which was found to be 7 litres/day with some of the best milkers producing more than 10 litres of milk/day. The peak yield was achieved in 5th month of lactation. Although camels continue giving milk up to 24 months the average length of lactation was found out to be 16 months.

**Study of beneficial properties of camel milk:** Beneficial compositional value of Camel milk was established to record lower percentages of fat with high quality higher chain fatty acids, higher percentage of free calcium, protective proteins, vitamin C, and micro minerals viz., iron, copper and zinc as compared to the cattle and buffalo milk. The shelf life of raw camel milk was 8 hours at 37° C and more than 3 weeks at 4-6°C. Extension of shelf life of raw camel milk can be possible up to 20 hours by using LP system activation. Better Immunoproteins status for IgG, IgA, IgM, C3 and C4 in camel blood, colostrum and milk. Effectiveness of camel milk in decreasing cholesterol deposition in liver & increasing cholesterol excretion in faeces. Feeding camel milk to diabetic rats proved its anti-diabetic effect. Hypo-glycemic potential (decrease in blood glucose and glycosylated Hb and increase in insulin level) observed only in rats fed on camel milk. The camel milk was found to have higher anti-oxidative potential in management of Type-1 diabetes as compared to goat, cow and buffalo milk. The camel milk was also found beneficial in recovery of autistic and mentally retarded children. The camel milk consumption as an adjuvant for 3 months along with other forms of treatments indicated positive change towards ATEC scales indicating recovery in Autistic children.




## CAMEL MILK PRODUCTS

**Value added camel milk products developed:** In pursuits of transforming camel into a milch animal three had been continuous efforts in terms of selling camel milk as health drink, value added camel milk products like falvoured milk, tea, coffee and kulfi. Such technological advancement has commercial bearing on health and food industry which ultimately helps the camel owners.

The following value added camel milk products have been developed, standardized and evaluated in order to promote camel milk and its products for their commercialization.

1. Camel fermented milk product (lassie)
2. Camel milk soft cheese
3. Camel flavoured milk
4. Camel milk tea and coffee


5. Camel milk ice-cream (kulfi)
6. Camel milk gulab jamun
7. Camel milk peda
8. Camel milk barfi
9. Camel milk paneer
10. Camel milk butter and ghee
10. Camel milk mawa
12. Camel milk rabri

## Technologies developed for industries/ researchers

1. Camel milk powder
   Lyophilized skim milk powder was prepared from the raw, pasteurised and boiled camel milk.
2. Camel milk skin cream

## Early post parturient breeding

The long gestation period (390 days approximately) coupled with seasonality of breeding (December to March) makes camel reproduction less attractive economically. Traditionally the female camels are bred in one season, calve in subsequent breeding season and then remain sexually quiescent until the following breeding season, leading to long inter-calving period and significant economic losses. The research by reproduction unit of the Centre has revealed that it is possible to breed the female camels during early post-parturient period. The breeding at 30, 50 or 70 days after parturition have resulted in successful conception in 20-25% of the parturient females. The inter-calving period was reduced by at least 300 days, by less this unorthodox way of breeding. The adoption of this technique/ practice can yield 20% more calves from the present adult breedable female camels. This technique does not involve costly chemicals or inputs, and only require examination of females by expert.

**Efforts for propagation and dissemination of camel milk at milk parlor:** The following infrastructure facilities have been developed which serve to educate the camel farmers and also to promote use of Camel milk and its products by the visitors.

1. Camel Museum
2. Camel Milk parlour
3. Camel Dairy.

**Training and extension activities:** The activities of holding extension camps, milking competitions and training programmes for value addition to camel milk to promote the concept of rearing camel for milk purpose in the camel rearing people are regularly conducted by the Centre. For treatment and technological advice the routine activity of ambulatory clinic have been initiated in the villages for the benefit of camel rearing farmers. Stakeholders meets are being organized involving people from other states like Gujarat, Haryana, J&K and Uttar Pradesh, government and Non-government organization people to understand the major issues of camel rearing and policy requirement from the government departments. The meetings with religious heads and camel rearing communities are held to clear social and religious taboos from the minds of camel farmers (Raikas) leading to acceptance by people of Raika community to trade the camel milk.

## Feed technology initiatives for camel

Complete feeds as blocks and pellets were prepared by proportionate mixing of fodders, agricultural by-products and concentrates for various classes of Camels like calves,

lactating females and working camles. The same have been found useful for rearing camels under semi-intensive and intensive feeding system.

## Camel Clinic

The Centre has started Camel Ambulatory Clinic to have the better interface with camel farmers and to give on the spot health services. Scientists of the Centre visit the villages thrice in a month.

## A mini feed plant established at the centre

A mini feed plant to prepare different fodder and concentrate combination has been installed at the Centre. Now the researchers and camel owners have the privilege to get the feed prepared as per their requirement.

## Camel milk processing unit

In the Camel milk processing unit, Milk analyser, Ice Cream Making plant, Mini spray dryer were added to the unit.

## Complete feed block for camels developed

The Centre has developed complete feed blocks for camels. These blocks are highly palatable, digestible, easy to store and transport.

## Electric indicators for camel cart

Centre has developed technology for generation of electric current using 12 volt dry battery which can generate current easily for 20-22 hrs with the movement of camel cart wheel and it provides 2 to 5 amp. current which can be utilised easily for domestic use in villages as well as during night transport in order prevent accident etc. The cart can move smoothly without any additional stress.

## Electric generated through camel draught

A power generation and agro-processing unit have been set up for studying camel draught ability and its utility in agricultural operations at the centre. This system offers a viable source of eco-friendly energy in the non-electrified rural areas with camel population.

## Area specific mineral mixture

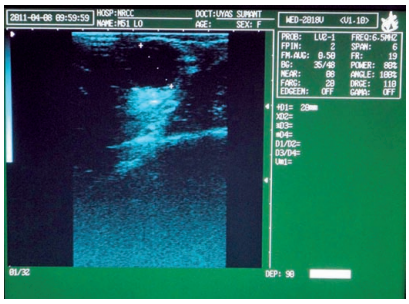
Determination of Region specific Status of trace elements in soil, feed and blood for Arid western plain (Bikaner, Jaisalmer), irrigated northwestern region (Hanumangarh, Sri Ganganagar), transitional plain of inland drainage (Churu, Nagaur) and Transitional plain of Luni basin (Pali, Jodhpur) designated as zone I, II, III and IV. Mineral


analysis of samples revealed that Ca, P, Mg, Fe and Mn were sufficient in soil, feed as well as blood. In soil, Cu was deficient in all zones and Zn was deficient in zone II and IV. In feed, Zn was deficient in straw and leaves and Cu was deficient only in straw. Cu and Zn were found deficient in blood except zone II and Co was deficient in zone III and I. Rations were formulated accordingly. Based on the above observations Area specific Mineral Mixture was prepared for growth and lactating camels

## Optimum reproduction measures

Ultra-sonography based observation of follicles in the ovaries of post- parturient female camels, breeding and successful conception indicated good prospects of early postpartum breeding for improvement of reproductive efficiency.

The collection of semen in camel have been perfected and the semen was successfully cryo-preserved. Artificial insemination has been attempted using liquid semen with initial success. Early rut in adult mature breedable male



Ovarian Sonograph Follicle

camel can be aroused by giving a regular exposure for 20 to 30 minutes in front of adult female camel at least for two to three weeks during onset of winter season.

## Surveillance and monitoring of camel diseases

The Centre is conducting research on management of camel diseases through surveillance, sero-monitoring, prophylactic and control measures. Similarly efforts are going on for development of diagnostic protocols for important camel diseases. Research on feasibility and efficacy of contemporary alternate medicine in different camel diseases such as fungal skin infections, mange and trypanosomosis is under progress. One patent application has been already been filed on herbal formulation for treatment of dermal mycoses in camels in Indian Patent Office (App.No. 201611041317). The Centre also has collaborative research project on exploitation of camel immune system for diagnostic and therapeutic uses. In collaboration with BARC, Mumbai -single domain antibody of camels was used to produce antibodies against Tg – a protein for diagnosis of thyroid cancer and indigenous IRMA diagnostic kit was developed and the said nanoantibodies are also being used to identify the protein of Tuberculosis organism.

## Awards and recognitions

ICAR-National Research Centre on Camel, Bikaner awarded with Krishi Samman, Certificate of Recognition for contribution towards field of Animal Husbandry by ZEE Krishi Awards. The Centre has also awarded with "*Ganesh Shankar Krishi Patrika Puruskar*" for *Hindi Patrika Karabh* published annually. In addition the Centre received Nagar Rajbhasha Award for special work in Rajbhasha Hindi. With the efforts of NRCC the camel milk has got approval from FSSAI. The Centre was awarded ISO Certification 9001: 2008.

## Collaborations

The Centre is having research collaborations with RAJUVAS Bikaner, SKRAU Bikaner, MGS Bikaner, AAU Anand, SDAU Dantewada, MAFSU Nagpur, Calcutta university Kolkata, BITS Pilani, Vanasthali Vidyapeeth, BARC Mumbai, AIIMS New Delhi, SP Medical college Bikaner and Ayurved University, Jodhpur.

## Tourist attraction

NRCC has been identified as one of the important tourist


places of Bikaner and is one of the tourist preference places. The tourist can see hundreds of camels of different breeds and their behaviour. A camel museum showing developmental and research aspects of the camel in the desert ecosystem is an attraction for viewers. Facilities of camel riding, safari and video/ photography are available for the visitors. Camel milk parlour is a special attraction where unique value added camel milk products like ice-cream, hot and cold beverages are available. Every year thousands of foreign and Indian tourists visit the centre and enjoy the experience.

**Director**
ICAR-National Research Centre on Camel
Post Box- 07, Jorbeer, Bikaner (Rajasthan) 334 001
nrccamel@nic.in

# Huge potential for value added products from banana

The ICAR-National Research Centre for Banana has developed many value added products such as fig, juice, bar, jam, jelly and sweet c*hutney* from pulp of ripe banana; flour, baby food, health drink, soup mix, *pazham pori* mix, sauce, pickle and chips from pulp of unripe banana; pickle from flower (male bud) of banana, candy and pickle from centre core stem of banana, pickles from matured green fruits and its peels and fibre from pseudostem sheath of banana. Most of these processes do not require heavy investment and can be set up in cottages to small scale sector. Other parts like flower and true stem are also used traditionally for cooking in south and east India. Its leaves are used as hygienic bio-plates and pseudostem for making threads and fibres. Banana fibre and fibre-based products are gradually becoming popular.

Sugar content of fully ripe banana is so high that it makes an ideal substrate for wine making. Banana contains considerable amount of resistant starch (non-digestible starch) and non-starch polysaccharides, which have low glycemic index and this property makes it an appropriate ingredient for different functional and convenience foods like cookies, bread, cake, extruded foods and chips, *etc*. The ripe fruit made into fine pulp (*puree*) is utilized for the preparation of jam and sweet chutney. Enzymatic clarified banana juice was produced from banana pulp using pectinase enzyme and this clarified juice was found to be highly appropriate for the production of banana juice based beverages (ready-to-drink, cordial, squash, crush and syrup) and banana juice based jelly. The ripe pulp contains 0.7 to 1.2 per cent pectin and gel forming pectin is widely used as additives in jams, jellies and marmalade and also used as thickeners, texturizer, emulsifiers and fat or sugar replacer. Fully ripe bananas are used for production of dehydrated banana fig. Banana is highly nutritious fruit and pulp (edible portion) of ripe fruit is rich in vitamin A, B-complex (thiamine, riboflavin, niacin, pentothenic acid, pyridoxine and folic acid), ascorbic acid and micro (iron, copper and zinc) and macro minerals (potassium, calcium, phosphorus and magnesium). The banana is made into powder and can be used in preparation of baby foods and healthy drinks.

Various value added products developed from different parts of banana plant can be divided into three categories (i) Plantain (raw)-based value added products, (ii) Banana-based value added products and (iii) Products from other parts of the plant. In addition, banana pseudostem outer sheath fibre based handicrafts were also developed.

**Plantain based value added products – Banana Chips:** Chips is the only processed banana product widely manufactured on commercial scale in India and Philippines. 'Nendran' banana is widely used for preparation of banana chips. Cooking varieties like 'Monthan' are also used in for chips making. Varieties like 'Zanzibar' or 'Mindoli' or 'Popoulu' can also be used. Banana chips manufacturing have developed into a cottage industry in Kerala and Tamil Nadu.

**Banana flour:** Banana flour/powder can be made from both ripe as well as unripe fruits of banana and plantain. Even immature fruits of banana can be converted into flour that would form raw material for products like baby food, health drink and soup mix. 'Nendran' is the best variety suitable for flour preparation. Banana flour is prepared from mature green bananas with high starch content, which can also be blended with other cereal flours for making bread, unleavened *chapattis* and *rotis*. Banana flour is an intermediary product used in preparation of several products like biscuits, cakes, bread, custard, *chapattis*, *papads*, baby food, health drink, soup-mix, '*pazham pori*' ready to mix, snack foods, extruded products, *etc*.

**Banana for babies:** Excess banana can be converted into flour that would form raw material for products like baby food which could fetch a premium price in the market. A highly nutritious baby food formula has been developed

by supplementing banana flour with suitable natural sources of proteins, minerals, fats and vitamins. Banana flour from mature fruit is fortified with milk, green gram and sugar for baby food preparation. The products can be stored upto six months. It is highly energetic and nutritious (rich in carbohydrate, vitamins, minerals and dietary fibre) and are cheaper than existing baby foods.

**Banana health drink:** This is suitable for growing children while the health drink and soup mix is suitable for all age groups. Highly nutritious health drink formula has been developed by fortifying banana flour with suitable natural sources of proteins, minerals, fats and vitamins. It has a shelf life of six months and is suitable for all. It provides necessary energy required on a day to day basis similar other popular health drinks. Highly energetic and nutritious drink, much cheaper than existing health drinks in the market. Availability of raw materials is at a cheaper cost all through the year. It helps in generating additional income to farmers over the existing system of selling raw fruits as such. Farmers can earn more profit by starting a cottage industry or by selling the produce to the entrepreneurs.

**Banana soup mix:** Banana flour is used as main raw materials for making soup mix by mixing with other ingredients. Flour based soup-mix involves mixing of banana flour, corn flour, dried vegetables and spices in various proportions. It can be prepared easily and marketed and is highly suitable for rural enterprises. It can be adopted by food processing industries for commercial manufacture of banana soup. It is tasty and stable for a period of six months.

**Banana biscuits:** Flour made from unripe green bananas is used as major ingredient along with other ingredients in making biscuits. 'Nendran' is highly suitable making this product. The high starch, fibre and mineral content of banana flour make the biscuits wholesome. They are an alternative source for *maida*-based biscuits and provide employment to rural and urban sectors and can be adopted by small scale industries.

**Banana healthy products:** Extrusion is one of the most energy efficient and eco-friendly processes to produce pre-cooked, ready-to-eat products. The extruded products will give more energy to our body with reduced cooking time. Pasta is traditional and its consumption has increased due to its ease of transportation and cooking. Low in sodium and lipid, it has no cholesterol and is a rich source of complex carbohydrates. Banana flour based pasta products were standardized with banana flour and *maida* in the ratio of 30:70. Banana flour based extruded products such as pasta enriched with carrot and beet root juices (70 to 100% each) were standardized and developed. Low glycemic and slow calorie release bread and cookies were prepared with various mixtures of wheat: banana flour and resistant starch. Addition of banana flour and resistant starch increased the antioxidant capacity and mineral content. The bread prepared with 15% replacement with banana flour and 10% with modified starch better than other combinations.

**Banana based value added products – Banana fig (dehydrated ripe banana):** Banana fig is a dehydrated fruit prepared immature or mature unmarketable ripe fruits of banana. Figs are prepared by peeling, disinfection and dehydration in hot air oven or solar dryer. Dried/ dehydrated bananas can also be prepared by dipping in

honey. The product is tasty, nutritious and stable. Figs are highly nutritious and help in providing nutritional security by supplying all the nutrients of banana in a concentrated form. It can be adopted by small and medium scale entrepreneurs/industries. 'Udhayam' and 'Karpuravalli' are best varieties suited for fig-making although other sweet varieties like 'NeyPoovan', 'Rasthali' and 'Poovan' can also be utilized. This ready made energy food is suitable for children, sports persons, army personnel and mountaineers. The Ecuador is the leading producer of fig in the world. It can be incorporated in many recipes such as cakes, biscuits, *payasam*, *kesari* and ice creams as a substitute for raisin. The product can be recommended particularly for school and adolescent children and can provide employment to rural youth.

**Ready-to-Serve (RTS) Clarified Juice:** Banana is a pulpy fruit with high pectin content and is difficult to convert into a clear beverage. During the market glut, the excess production of banana can be converted into value added product. A process was standardized for conversion of banana pulp into a clarified juice through enzyme liquefaction and protocol for different beverages. It can be adopted by food processing industries for commercial manufacture of banana beverage. It is good source of employment to farmers. The RTS has greater nutritive value than that of synthetic / aerated products available in the market, which is having option of blending with other fruit juices such as *jamun*, litchi, tomato, *etc.*

**Beverages:** Banana based alcoholic beverages like wine and beer are delicious beverages with low alcohol content. Banana wine is a delicious beverage with low alcohol content (12-14%). It is obtained by fermenting clarified juice with wine yeast for a period of 2 - 3 weeks at controlled temperature. Banana wine is much cheaper than other fruit wines.


**Products from flower, peel and centre core stem – Banana flower pickle:** The banana male bud is a waste material produced during crop production with less economic value. It is converted into a high value added product by making pickle (*thokku*). The process involves removal of pistil, blanching, grinding and addition of spices and oil. The recipe of *thokku* from flower was standardized. It is delicious, rich in dietary fibre and stable for a year at room temperature. The technology can be adopted in all banana growing regions of the country.

**Banana peel pickle and fruit (raw) pickle:** Banana peel pickle is made from the green peel of bananas under wealth generation from waste. Nearly 25% of the green fruit is constituted by peel, which is utilized as source of raw materials for producing peel pickle by adding spices and preservatives. The peel is packed with nutrients and antioxidants. The peel of culinary purpose varieties like 'Nendran', 'Monthan', 'Saba' can be utilized for making this product. It has good taste, is rich in dietary fibre, helps in digestion and is stable for one year at room temperature.

**Banana stem pickle:** About 25-30 tonnes of pseudostem waste is produced after harvest of the crop, of which about 5-7 tonnes of central core can be extracted from one hectare depending upon the variety. Banana stem is a waste material produced during crop production with less economic value. It can be converted into a high value added product by making central core stem pickle. The product is tasty and stable for one year at room temperature.

**Post-harvest Technologies commercialized**

| Sl. No. | Product Name | No. of MoUs |
|---|---|---|
| 1. | Banana flower pickle | 8 |
| 2. | Banana fig | 20 |
| 3. | Banana flour based baby food | 7 |
| 4. | Banana flour | 6 |
| 5. | Stem thokku | 3 |
| 6. | Banana pulp based RTS beverage | 2 |
| 7. | Flour based biscuit | 2 |
| 8. | Post-harvest handling, packing, storage and ripening of banana for domestic and export markets | 2 |
| 9. | Post harvest handling, packing and storage of banana central core stem | 2 |
| 10. | Banana flour based health drink | 4 |
| 11. | Banana central core (stem) juice. | 1 |
| 12. | Soup mix | 1 |
| 13. | Banana peel pickle | 1 |
| 14. | Banana chips | 1 |
| 15. | Banana fibre products | 1 |
| | **Total** | **61** |

**Banana juice:** The juice is extracted from the central core stem either manually or mechanically. The stem is rich in fibre and potassium. It has a property of dissolving kidney stone. About 80-95% juice could be recovered from central core stem of commercial banana varieties. The process involves extraction of central core from pseudostem, slicing and cutting into small pieces, removal of fiber, extraction of juice, pasteurization, packing, sterilization and storage. It should be served as a chilled drink. Banana central core (stem) juice based syrup and squash were developed by blending stem juice with sugar and citric acid.

**Banana candy:** About 5-7 tons of central cores can be extracted from one hectare. Central core (true stem), is rich in dietary fibre and believed to have the properties to dissolve kidney stones. Banana central core stem based ginger candy can be prepared by mixing syrup and ginger in certain ratios. Central core stem slices are soaked in syrup-ginger extract mixture and dried in hot air oven overnight after draining excess syrup.

**Banana handicrafts:** Fibre is a non-edible product obtained from the sheath of pseudostem of banana plant, which yields high quality banana fibre. Banana fibre is extracted from the sheath of banana pseudostem by hand or machine or microbial retting. The fresh pseudostem yields about 1-1.5% of fibre. While coarse fibre is used for tying garlands, the fine fibre is used for

making handicraft items and textile fabric. Both chemical retting (NaOH) and machine extraction were proved to be better for yield and quality (based on biochemical constituents) of fibre obtained from pseudostem sheath of banana.

The natural fibre has multifaceted uses in preparing many value added products such as handicraft items (table-mat, bag, wall hangings and other fancy articles, etc.), ropes, craft paper, etc. Other uses of banana fibre are making products like marine cordages, high quality currency papers, cardboards, tea bags, string threads and fabric material.

**Banana business:** In banana and plantain, value addition through processing have resulted in development of various products such as fig, RTS beverage/juice, bar/leather, jam, jelly and sweet chutney from pulp of ripe banana; flour, flour based baby food, health drink, soup mix and extruded/pasta products, sauce, pickle and chips from pulp of unripe banana; pickle from flower (male bud) of banana; candy, pickle, RTS beverage and jelly from the central core stem of banana; coarse and fine fibre from the pseudo-stem sheath of banana and fibre based handicrafts by ICAR-NRCB. These processes do not require heavy investment in machinery. It can be set up in micro, small and medium enterprises. Several products have been commercialized to various stakeholders through licensing of technical know-how. 15 value added products of banana have been commercialized to 60 clients.

**P Suresh Kumar*, KN Shiva, M Mayil Vaganan** and **S Uma**
ICAR-NRCB, Tiruchirapalli, Tamil Nadu 620 102.
psureshars@gmail.com

# ICAR-IISR develops speciality soybean

Soybean was introduced in India with the expectation that the crop being one of the most economical sources of protein (approximately 40%) would combat rampant protein malnutrition among masses. However, soybean did not gain popularity as a protein source despite the declining per capita availability of pulses, the staple source of protein in Indian diet. Presence of anti-nutritional factor, namely, *kunitz trypsin* inhibitor and off-flavour generating lipoxygenases in soybean grains constrain their utilization in food uses. *Kunitz trypsin* inhibitor present in soybean seeds affects the digestibility of proteins and if left active in the soy products may cause pancreatic hypertrophy. Lipoxygenase is the off-flavour generating enzyme which exists in 3 isozymic forms, namely, lipoxygenase 1, lipoxygenase 2 and lipoxygenase 3 in soybean seed.


Field view of NRC 142

Close view of seeds of NRC 142

These isozymes act upon polyunsaturated fatty acids, when the seeds are crushed to process soy food products, thereby releasing aldehyde and ketone compounds. Of these 3 isozymes, lipoxygenase 2 is the principal contributor to the off-flavour. Though both kunitz trypsin inhibitor and lipoxygenase 2 are heat labile but the heat treatment incurs extra cost and affects the solubility of proteins. Genetic elimination of these two formidable undesirable components from soybean seeds is the dire need of soy food industry.

ICAR-IISR has already developed and commercialized Kunitz trypsin inhibitor free soybean genotypes, namely, NRC 101 and NRC 102. The institute has developed NRC 127, which is free from Kunitz trypsin inhibitor and identified for release to farmers of Central zone. The institute has also developed and commercialized lipoxygenase 2 free soybean, namely, NRC109 to soy food industries. However, soy food industries are demanding soybean genotypes free from Kunitz trypsin inhibitor as well as lipoxygenase 2.

To cater to this need of soy food industries, NRC 142 was developed from a triple cross JS 97-52 x PI 596540 x PI 542044, through marker assisted forward breeding. PI542044 and PI 596540 were the donors for null alleles of kunitz trypsin inhibitor and is lipoxygenase 2, respectively.

The plant of this genotype produces white flowers in 40 days, attains height of 75 cm, and reaches harvest maturity in 98 days. The seeds are of light-yellow colour with black hilum, and weight of 100 mature seeds (10% moisture) is 14.4 g. The yield potential of this genotype is 3.2 tonnes/ha. The genotype would serve as excellent raw material for soy food industry, and more importantly, being high yielding with additional quality traits can fetch better prices to farmers.

**Dr Anita Rani** and **Dr Vineet Kumar***
ICAR-IISR, Indore
*vineetksahni@yahoo.com

# Two improved varieties of cucumber

## CUCUMBER-6

Pusa Seedless Cucumber-6 is developed from commercial hybrid through reverse breeding. The improved line of parthenocarpic gynoecious cucumber is suitable for cultivation in protected condition for North Indian plains. Its average fruit yield is 126.0 t/ha (1,260 kg/ 100 $m^2$) during winter (off-season, November-March) under low cost polyhouse which is 32.2%, 29.8% and 21.5 % and is superior over Pant Parthenocarpic Cucumber-2, Aviva ($F_1$) and Asma ($F_1$), respectively. Its fruits become ready for first harvesting in 40-45 days after sowing during winter (off-season, November-March) under low cost polyhouse. The fruits have desirable marketable attributes and are attractive, uniform, dark green, glossy, cylindrical, straight, slightly ribbed, non-hairy, non-warty, slightly striped

Pusa Seedless Cucumber-6

at blossom end and have tender skin and crispy flesh, which is highly acceptable to the growers. The shape of peduncle end and blossom end of fruit is obtuse. The average fruit length is 14.24 cm and width 3.45 cm and average fruit weight is 105 g.

### Commercial potential

In the seed market, only $F_1$ hybrids of gynoecious parthenocarpic cucumber, imported by private seed companies are available at a very high price

(average ₹ 5-10 per seed). There is no $F_1$ hybrid developed by indigenous seed industry. The proposed variety can be utilized as parent by the indigenous seed industries and also can be sold as an open pollinated variety which leads to availability of seeds to the farmers at much cheaper rate.

### Geographical potential

Protected cultivation of gynoecious parthenocarpic cucumber has become very popular in rural and peri-urban areas of Uttar Pradesh, Punjab, Haryana, Rajasthan, parts of Madhya Pradesh and plain areas of Himachal Pradesh. Being cheaper with superior horticultural traits and prolific bearer this line will expect to cover large areas of the country. It is recommended for growing in winter under polyhouse and during spring summer under insect-proof net house.

## DGC-102

Most of the gynoecious lines utilized by private seed comapnies for development of $F_1$ hybrids are exotic

in nature, temperate in origin,dark green in colour with spines and their stability breaks down if day temperature exceeds 35°C. The hybrids developed by utilizing the lines lack tenderness, crispiness and flavour and are least preferred by the consumer. The proposed line is an indigenous type having light green skin colour with greenish white stripes, cylindrical (12-15 cm) smooth skin and tender and crispy flesh. This line is highly stable at high temperature and show true gynoecious expression even at the temperature of 40-45°C.

## Commercial potential

Most of the gynoecious hybrids marketed by the private seed companies are imported one. They are dark in colour with spines having mucilaginous flesh, lack crispiness and are not preferred by the consumer. The proposed gynoecious line is preferred by the seed industry since it is highly stable under high temperature, indigenous type and light green colour with tender and crispy flesh. The line will facilitate development of gynoecious hybrids and their hybrid seed production, easy and economically. The hybrid seed developed by utilizing the

gynoecious line can be produced under sub-tropical/ tropical climate and farmers can get the hybrid seeds at much cheaper rate. Since, gynoecious traits in cucmber is governed by single dominant gene, the hybrids developed by utilising this line will be predominantely gynoecious prolific bearing in nature and early in maturity.

## Geographical potential

Being tropical and gynoecious in nature, the $F_1$ hybrid developed by utilizing this line will be having heat tolerance capacity and can be successfully

grown under tropical and subtropical region of the country.

**Dr AD Munshi, Dr TK Behera, Dr AK Sureja, Dr Balraj Singh, Dr AK Singh** and **Dr BS Tomar**
IARI, Pusa, New Delhi
head_veg@iari.res.in,



Published by Dr Satendra Kumar Singh, Project Director, Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi 110 012. *Phone:* 011-25842787; *Fax:* 011-25843285; *e-mail:* director.dkma@icar.gov.in. Lasertypeset by M/s Print-O-World, Shadipur, New Delhi 110 008, and printed in India at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase I, New Delhi 110 028.

***Editing :*** **Seema Burman** ***Design & Production :*** **Dr VK Bharti and Punit Bhasin**

# WAY FORWARD

Agriculture is the single largest employer in the world, providing livelihoods for 40% of global population, 500 m small hold farmers worldwide, mostly rainfed, providing up to 80% of food in the developing world. India being one of the largest agriculture economy, has now achieved highest ever foodgrain production of over 259 mt, 262 mt of horticulture produce, 132 mt of milk, 6 mt meat and 90 mt fish. Indian agriculture is the saga of millions of farmers in most diverse agro-ecological conditions, sustaining a billion plus human and half a billion livestock population. Studies on estimations of food demand by 2020 indicate that our national requirement would be about 280 million tonnes (MT) for food grains including 22 MT pulses, 35 MT oilseeds, 96 MT fruits, 152 MT for milk and milk products, and 87 billion eggs.

The natural resources in some of the most productive regions of the country are under immense pressure. In 110 out of 142 blocks of the Punjab, groundwater pumping is much more than its rechargeable capacity and the water table is receding fast. The water table has depleted to more than 10 m in 97 % of its cultivated area endangering sustained production of not only rice but even the traditional crop of the region – wheat. Similar is the situation in Haryana, Rajasthan, Andhra Pradesh and Tamil Nadu, *etc*. A balance needs to be maintained between withdrawal and recharge of ground water resources. Enactment of 'Sub-soil Water Preservation Act', in Punjab which bans rice planting before 10$^{th}$ of June every year is an example of a welcome decision to check excessive use of groundwater. Promotion of resource conservation technologies well supported by precision farming like laser land leveling, direct seeding of rice, *etc*. saves water and energy costs by more than 25%. These technologies also help farmers to minimize the adverse impact of climate change induced weather aberrations especially temperature variations that are likely to be more severely felt in North Western Region of the country.

Another important aspect of intensive cultivation relates to deteriorating soil health. For instance, the partial factor productivity of NPK for foodgrain production in Punjab has declined from 81 kg grain per kg of NPK in 1966-67 to 15 kg in 2009-10. Though the cropping pattern and use of fertilizers changed entirely over the period of time, the decline in factor productivity largely happened due to imbalanced use of nutrient and depleting soil organic carbon. The deficiency of multiple micronutrients such as Zn, Mn and Fe has become rampant and has further aggravated the situation. Today's Soil Health Card Scheme has been a boon for farmers for optimized nutrient management.

India has been a mega biodiversity centre and rearing of domesticated animals. There are about 140 well documented and defined domestic breeds. The Indian Council of Agricultural Research at the helm of the nation's agro-initiative technology generation has the formidable task by 2025 to feed the estimated livestock population of about 600 million-comprising crossbred

**Dr T Mohapatra, Secretary (DARE) and Director General (ICAR)**

cattle (14%), indigenous cattle (27%), buffalo (20%), sheep (12%), goat (24%) in carbon constraint economy. The livestock sector accounts for over 25% of the agricultural GDP and is crucial for livelihood security of rural households, especially for the small or landless farmers in the rainfed areas. The country remains to be the highest milk producers in the world, second in fish and fifth in egg production. Research efforts on breed improvement, health and nutrition have been instrumental in improving productivity of livestock and fisheries. India has earned the distinction of being free from dreaded animal diseases namely rinderpest, African horse sickness and bovine pleuropneumonia. The upcoming poultry sector received a setback on account of avian influenza that affected birds in epidemic form.

In fisheries sector, developing culture and breeding protocol of golden mahseer and rainbow trout, composite carp culture technology based on exotic carps for mid altitude, multiple breeding of Indian major carps are being developed for easy and round the year availability of quality seeds. Further, sea cage farming of seabass; breeding of cobia; technique for off season spawning of carps are also being strengthened for integrated fish farming in the country.

Besides, food security and nutritional security is also of paramount interest as anaemia is increasingly engulfing rural India owing to iron deficiency. Vitamin A and zinc deficiency are becoming common in India. This scenario has provided us with a lot of opportunity for crop diversification and integrated farming systems to translate the mundane agriculture into remunerative agriculture; to embark on secondary agriculture to minimize production losses through effective post-harvest technology and also to do good agri-business. To feed India's swelling population, heavy investments for developing requisite infrastructure and other areas of agriculture are essentially required to have linkages from 'seed to market' and efficient 'lab to land' transfers to meet the ends of the recently enacted National Food Security Act 2013.

**(T Mohapatra)**
*e-mail:* dg.icar@nic.in