Focusing on sorghum as health food and forage

Scientists at ICRISAT-India were encouraged to focus on developing high-Zn sorghum lines for processed foods and also sorghum varieties as forage with higher digestibility. From traditional uses of sorghum for food, feed, starch and alcohol, the market demand is gradually shifting towards sorghum to be used as high-quality forage and as a health food. This was the key message at the Sorghum Scientists Field Day recently held at ICRISAT-India.

At the plenary session, participants called for introducing new concepts in post-rainy sorghum parental lines and hybrids development. They recommended a greater focus on forage research, particularly single-cross forage hybrids with higher digestibility. Representatives from the processing industry requested a supply of high-Zn sorghum lines from ICRISAT for developing improved processed foods for various commercial end uses. Participants also called for retaining the stover yield in genotypes of both rainy and post-rainy season sorghum while improving grain yields.

Dr Vilas A Tonapi, Director, Indian Institute of Millets Research, called for development of all-season hybrids to maximize sorghum adoption rates and crop productivity. Dr David Bergvinson, Director General, ICRISAT, urged the scientists to increase breeding efficiency in product development by sharing materials, best practices, locations and knowledge. He suggested that scientists migrate their data to the Breeding Management System for efficient storage and utilization.

The field day was conducted under the aegis of the Sorghum Hybrid Parents Research Consortium (HPRC), which has been operational at ICRISAT for the past 17 years. HPRC partners with private sector seed companies in hybrid cultivar development, seed production and marketing of hybrid seeds. Ten companies from Asia, Africa and South America are currently members of the consortium.

The Sorghum Scientists Field Day was held on 20-21 February at ICRISAT-India and was attended by 72 members. Participants at the field day included 25 members from the public sector, 20 from private sector (including a breeder from Seed Co Limited, the largest seed company in Africa), seven researchers from various ICRISAT-Africa locations, a five-member high-level delegation from Iran, and ICRISAT scientists. Dr Rob Bertram, Chief Scientist, Bureau of Food Security, United States Agency for International Development (USAID), and members of the Breeding Program Assessment Tool (BPAT) team – Dr Christopher Lambrides, Senior Research Fellow, University of Queensland; and Dr Yilma Kebede, former Senior Program Officer, Bill & Melinda Gates Foundation, also attended the field day. The plenary session was co-chaired by Dr Belum VS Reddy, Principal Scientist (retired), ICRISAT, and Dr Sujay Rakshit, Principal Scientist, Indian Institute of Millets Research.

More on ICRISAT’s work on sorghum here

This work contributes to UN Sustainable Development Goals
Mainstreaming biofortification of pearl millet to tackle malnutrition

Dr David Bergvinson, Director General, ICRISAT; Dr Wolfgang Pfeiffer, Global Director, Product Development and Commercialization, HarvestPlus; Dr Peter Carberry, Deputy Director General – Research, ICRISAT; and Dr KV Raju, Theme Leader, Policy and Impact, ICRISAT, at the review and planning meet for the Pearl Millet Biofortification project.

Mainstreaming of nutrients (e.g. iron) in hybrid cultivars of pearl millet is being taken up on high priority by NARS partners, private sector seed companies and ICRISAT, given the alarmingly high levels of malnutrition across India and Africa. According to a recently released report*, 58% of children in India under five years of age are anemic.

At a recent review and planning meeting of pearl millet researchers at ICRISAT-India, participants discussed the performance of pearl millet biofortification trials during 2016 and created follow-up plans for the 2017 crop season.

Dr Wolfgang Pfeiffer, Global Director, Product Development and Commercialization, HarvestPlus, discussed a strategic shift in the program and future targets of global biofortification efforts to reach one billion people by 2030, of which 80% would be in Asia. He recommended that mainstreaming of nutrients at all levels was of utmost importance for a nutritionally secure future in the dryland regions, and said that varietal release committees should make minimum levels of minerals and vitamins a requirement for approval of cultivar release.

Dr David Bergvinson, Director General, ICRISAT, recounted ICRISAT’s significant progress in collaborating with public and private sector partners for pearl millet biofortification. The high-iron (71 mg/kg) pearl millet variety (Dhanashakti), developed in collaboration with partners, has been adopted by over 65,000 farmers in India. Another high-iron, high-yielding variety (ICMH 1201) was widely adopted by over 35,000 farmers in Maharashtra and Rajasthan.

Dr Bergvinson further stated that consumer markets need to be created for long-term adoption of biofortified cultivars by farmers and consumers.

Dr KV Raju, Theme Leader, Policy and Impact, ICRISAT, highlighted the feasibility of incorporating biofortified food products in the public distribution system and the midday meal scheme in India. He also mentioned that commercial food industries have great potential for developing Smart Food products for markets. National-level progress on pearl millet biofortification was detailed by NARS partners. The Indian Council of Agricultural Research’s encouragement for a focus on breeding high-iron pearl millet in the All India Coordinated Millet Improvement Project (AICMIP) centers was also mentioned.

The main objectives of the Pearl Millet Biofortification program are:

- Precision screening and phenotyping of breeding materials and pipeline cultivars
- Evaluation and identification of diverse high-iron sources
- Strategic research and strengthening of partnership-based cultivar development and delivery
- Development of high-iron and high-yielding breeding lines and hybrid parents.

Dr M Govindaraj, Scientist, Pearl Millet Breeding, ICRISAT, urged the group to make use of high-iron breeding lines of ICRISAT and to share the feedback to improve data quality and the breeding program. He finalized the 2017 trials and nurseries in consultation with partners.

Mr Binu Cherian, Country Manager, Pearl Millet Delivery, HarvestPlus, briefed the audience about biofortified pearl millet delivery strategy and adoption plans, and also informed the group about a consortium of biofortification markets involving seed and food industries.

The Pearl Millet Biofortification program review and planning meet, held on 3 March, was attended by 53 researchers as well as representatives from HarvestPlus, public and private sector organizations and state seed corporations.

Partners: Karnataka State Seeds Corporation Limited and Maharashtra State Seeds Corporation Limited; CCS Haryana Agricultural University, Junagadh Agricultural University, Vasantrao Naik Marathwada Agricultural University, Mahatma Phule Krishi Vidyapeeth College of Agriculture, Prof. Jayashankar Telangana State Agricultural University, Sri Karan Narendra Agriculture University; and 15 seed companies

Funder: HarvestPlus
CRP: A4NH

More on ICRISAT’s work on pearl millet [here](#).

This work contributes to UN Sustainable Development Goals.
Farmers in Mali to benefit from advanced satellite imagery technology

Images from Sentinel-2 Agriculture (Sen2-Agri) satellite will enable scientists to help smallholder farmers by tracking changes in land use, estimating crop area and monitoring crop condition in near-real time.

A stakeholder consultation meeting was held recently to present the Sen2-Agri project to Mali stakeholders; review and collect feedback on initial Sen2-Agri products for Mali (2016 season); and understand and develop demand for three use cases:

- **Improving agricultural statistics**: Mali’s Cellule de Planification et de Statistiques (CPS/SDR) is responsible for the annual implementation of the permanent ‘Enquête Agricole de Conjoncture’ (EAC), and the periodic implementation of the ‘Recensement Général de l’Agriculture et de l’Élevage’ (RGAE) following a list sampling frame. In a developing economy with high land use change dynamics, Sen2-Agri may unlock a number of improvements such as the use of area sampling frames.

- **Enhancing yield forecasts**: Earth observation performs a central role in statistical estimation of crop area and yields. However, in smallholder agriculture these estimates are strongly constrained by spatial resolution. In Africa, the advent of Sentinel-2 increased the percentage of farm plots amenable to earth observation monitoring from 20% to 70%. This is a quantum leap in the granularity and temporality of observations, allowing earth observation to transition from a research effort to an operational production process.

- **Scaling agricultural insurance**: The Sentinel missions provide an unprecedented opportunity to monitor crop condition in near-real time. They also hold potential for the monitoring at scale of smallholder agronomic practice and damage to crops. This will support the development of smallholder agricultural indemnity insurance alongside traditional weather and area yield index insurance. Sen2-Agri will thus help design and test new portfolios of socially differentiated insurance products to open business opportunities in smallholder markets.

Sen2-Agri builds on the capabilities of the Sentinel-2 mission, providing multispectral images with 10 m resolution on a five-day repeat cycle. The Sentinel program is part of a series of earth observation missions, managed by the European Space Agency (ESA).

During the consultation meeting, the products and services of Sen2-Agri were demonstrated to users of the agricultural community.

The four products of Sen2-Agri include:
- Monthly cloud-free surface reflectance composites
- Dynamic cropland masks
- Main cultivated crop type maps at the middle and at the end of the cropping season
- Vegetation status indicators (vegetation index, leaf area index).

These products (with up to 100 data points) can be provided on any smallholder farm, at an interval of every 5
days in the absence of cloud cover. Building on the experience, partnerships and legacy from the Bill & Melinda Gates Foundation-funded STARS project (Spurring a Transformation for Agriculture through Remote Sensing: 2014-2016), ICRISAT and partners successfully registered Mali as one of the three worldwide Sen2-Agri country pilots alongside Ukraine and South Africa. The pilot system covers about 500,000 sq km and represents a raw volume of approximately 4 terabytes of imagery per season.

At the meeting, Mr Abdrahamane Kouyate, Deputy Director General, SabuNyuman Assurances, stressed the enormous promise of Sen2-Agri for the deployment of smallholder crop insurance, given its potential for monitoring recommended agricultural practices and thus isolating the actual impact of insurable hazards.

Dr Pierre Sibiry Traore, National Pilot Coordinator (Sen2-Agri), commented on the transformative power of Sen2-Agri, stating that the era of data scarcity was over, and that a paradigm shift was required to mainstream earth observation in agricultural and development practice – from the ‘first mile’ to the national scale, and back.

The National Stakeholders Consultation was hosted by ICRISAT-Mali on 21 March. It was co-chaired by HE Mrs Dicko Bassa Diané, Deputy Minister in charge of Food Security, and attended by 75 participants including representatives from the Ministries of Agriculture and of Livestock and Fisheries and from non-governmental, public and private sectors.

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**Project:** Capacitating African Smallholders with Climate Advisories & Insurance Development (CASCAID)

**Funder:** Climate Change, Agriculture and Food Security (CCAFS)

**Partners:** The Institut d’Économie Rurale (IER) and The Cellule de Planification et de Statistiques (CPS), both under the Ministry of Agriculture, Mali. Global partners for Sen2-Agri are the Université Catholique de Louvain (Belgium), Center for the Study of the Biosphere from Space (CESBIO) France and CS-Romania.

**CGIAR Research Program:** CCAFS

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This work contributes to UN Sustainable Development Goals
Developing climate-smart crops focus of ICAR and ICRISAT partnership in India

Climate-smart crops, Smart Food and modernization of breeding database are some of the core areas of research in a new agreement between the Indian Council of Agricultural Research (ICAR) and ICRISAT.

“ICAR wishes to see this collaboration benefitting the Indian farmers and we will achieve this through partnership and continuous monitoring by both sides to achieve real impact,” said Dr Trilochan Mohapatra, Director General, ICAR.

ICAR and ICRISAT will continue to work together on crop improvement and agronomy programs for grain legumes and dryland cereals. Other areas of focus over the next three years include: Integrating systems modelling tools enabling informed decisions for upscaling climate-resilient agriculture, developing genetic and genomic resources of finger millet and enhancing genetic gains for priority traits.

“Dryland cereals and grain legumes are branded as Smart Food – good for consumers, farmers and the planet – as they diversify farming systems and help smallholder farmers adapt to climate change. We enjoy a strong partnership with ICAR so we can deliver real results to improve the lives of farmers and their families in the harsh drylands,” said Dr David Bergvinson, Director General, ICRISAT, at the signing of the agreement in New Delhi, India.

A very successful example of the years of partnership between ICAR and ICRISAT is the release of 42 improved and short-duration varieties of chickpea. ICAR-ICRISAT varieties now make up 53% of chickpea breeder seed indent in India. The collaboration has also successfully developed a machine-harvestable chickpea that has been released in Andhra Pradesh and Maharashtra. This reduces harvesting time and drudgery for farmers, thus increasing their profits from the crop. Read full story.

In addition to setting the terms of the collaboration from 2016 to 2018 and the transfer of agricultural technologies between the two institutes, the partnership includes funding for research on grain legumes and dryland cereals and support for the Smart Food initiative to deliver sustainable and nutritionally rich products to consumers.

On the crop improvement front, the agreement will also facilitate research activities on transgenic pigeonpea and chickpea for insect resistance.

The agreement was signed on 15 March. Also present at the occasion were Mr C Roul, Additional Secretary, Department of Agricultural Research and Education (DARE) and Secretary, ICAR; Dr S Sandhu, Deputy Director General, ICAR; and Dr Arvind K Padhee, Director, Country Relations and Business Affairs, ICRISAT.
Charting a course for doubling farmers’ income in India

As a definitive step towards realizing Indian Prime Minister Narendra Modi’s vision of doubling the income of Indian farmers by 2022, a blueprint of recommendations was drawn up for establishing pilot intervention projects in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh (UP). These would then serve as examples for transformation of a further 11 districts in Maharashtra and 7 districts in UP in a phased manner by 2022.

At the National Workshop on Doubling Farmers’ Income through Scaling-up, participants discussed regional agroecological interventions, taking into account climate change impacts such as increasing water scarcity and land degradation.

- An innovative model for farmers – Knowledge-based Integrated Sustainable Agriculture Network - Mission India for Transforming Agriculture (KISAN-MITrA) – was presented at the workshop. The KISAN-MITrA model aims at increasing productivity by efficiently using available resources, reducing cost of cultivation, minimizing post-harvest losses, processing for value addition, developing value chains and linking them to markets. Another goal is to increase employment options for women and youth through skill development employment by creating microenterprises and industries in rural areas.

- Workshop participants debated the use of mechanization and information technology in agriculture (remote sensors, unmanned aerial vehicles (UAVs) for precision farming, etc.) in order to attract youth to agriculture and to multiply benefits.

- They recommended applying the principles of Ease of Doing Business to the agriculture sector, implying a convergence and simplification of all schemes to a single online form (or digital app) that farmers could access and utilize easily. With the interlinking of bank accounts with Aadhaar (Unique Identification Number) and mobile numbers, farmers could receive remittances in their bank accounts directly. Subsequently, availing loans at low interest rates and with affordable collaterals could be made possible, especially for women farmers.

- A vital step would be to identify partners (public and private; financial, scientific and community-based institutions) to fund, implement and scale up the pilot sites. This would include using scientific innovation including integrated watershed management methodology, along with digital agriculture, market linkages and risk mitigation strategies.

- A Special Project Vehicle (SPV) for design, execution, monitoring and learning, and funding of the KISAN-MITrA was suggested to be set up.

The National Workshop on Doubling Farmers’ Income through Scaling-up was organized in New Delhi on 15-16 March by ICRISAT along with Vivekananda International Foundation (VIF) and J Farms.

Sixty selected participants representing the Department of Agriculture Cooperation and Farmers Welfare (DoAC&FW), national research institutions (National Bureau of Soil Survey and Land Utilisation Planning, India Meteorological Department, Indian Institute of Millets Research), state agricultural universities (Mahatma Phule Krishi Vidyapeeth, Rahuri), corporates (Tractors and Farm Equipment Limited, Mahindra & Mahindra, Jain Irrigation Systems Limited) not-for-profit foundations (Sir Ratan Tata Trust, JSW Foundation), international research centers (International Food Policy Research Institute, World Food Programme), non-governmental groups and lead farmers participated in the workshop.

Among the key speakers were General NC Vij, Director of VIF; Mr Vijay Kumar, Former Lieutenant Governor, New Delhi; Mr Dhirendra Singh, VIF; Mr SK Pattanayak, Secretary, DoAC&FW; Dr Ashok Dalwai, Additional Secretary, DoAC&FW; Dr David Bergvinson, Director General, ICRISAT; and Dr Suhas Wani, Director, ICRISAT Development Centre, ICRISAT.
Increasing adoption of improved varieties that meet the needs of farmers and consumers was the focus of a review and planning meet of the project Harnessing Opportunities for Productivity Enhancement for Sorghum and Millet Phase II (HOPE II) held recently.

Focusing on developing a seed road map, discussions were organized on how teams could better organize seed delivery for each country. The discussions were led by Dr Henry Ojulong, Senior Scientist, Finger Millet Breeding, East and Southern Africa Program, ICRISAT and Dr Prakash Gangashetty, Scientist, Pearl Millet Breeding, West and Central Africa Program, ICRISAT. This exercise helped participants draw up proper and consistent seed road maps including plans for certified, breeder and foundation seed production and supply, so as to meet the needs of farmers and the market.

The goal of this meeting was to assess progress and facilitate exchange of experiences, mutual support and learning among HOPE II partners, and collective review and planning of activities. More specifically, it provided an opportunity to:

- Share and learn from the project partners’ experiences over the last 12 months, including their achievements (knowledge, processes and innovations) and impacts
- Create a better understanding of the project objectives and strategies among the partners
- Strengthen the sense of teamwork by identifying ways through which cross-country, collective and individual sharing and learning can be improved
- Review plans of activities for the next year at country, region and project levels.

“We experienced great progress during the first phase of the project,” said Mr Roger Kabore, President of an innovative farmer-producer association called Association Minim Song Panga in Burkina Faso. “For example, we selected together with male and female farmers a new variety of pearl millet ‘Misari-1’, adopted by many farmers. Four new varieties of sorghum were disseminated in the north-central part of Burkina Faso. And for the first time, we were able to start the production of pearl millet seed, and four years later went from nil production to 120 tons of pearl millet seed. Although we used to produce sorghum seed, we experienced a major leap in sorghum also, producing up to 170 tons. Our dissemination strategy has improved tremendously, including the usage of mini-packs to sell more seeds through the network of agro-dealers, with more farmers using a combination of improved seeds and fertilizers to increase their yields. It is obvious that we need to continue those efforts to better production systems.” He added, “Our ambition is to reach a larger scale beyond the villages and townships, up to thousands of women and men producers. Partnership and linkages between producers, processors and the market is key that will get us there with sustainable impacts.”

“Partnership with producers’ organizations and with national and private seed companies is an important determinant to making improved seed more affordable and accessible,” emphasized Dr Ramadjita Tabo, Director, West and Central Africa, ICRISAT. He outlined the importance of sorghum and millets in the context of adaptation to climate change and their high iron and zinc content for better nutrition. This echoed a remark during the opening ceremony by Dr Hamidou Traore, Director, Institut de l’Environnement et Recherches Agricoles (INERA), Burkina Faso, who spoke about the linkages and opportunities that the project could seize and harness, particularly in the areas of processing.

The participants were introduced to ‘mugudugu’ and ‘bassi’, two pearl millet-based products made from Misari-1, a pearl millet variety selected and disseminated during HOPE I. The two traditional recipes were improved as part of the sorghum and pearl millet grain processing project funded by the McKnight Foundation and implemented by the food technology laboratory of the Institut de Recherche en Sciences Appliquées et Technologies (IRSAT) in Lebda, about 100 km north of Ouagadougou, the capital city of Burkina Faso.

“Our focus on pearl millet-based products comes from the evidence that it is a cereal that has very interesting nutritional qualities that we need to optimize and gain...
It was after we characterized about 20 millet varieties to determine their nutritional values, and following culinary testing with the target community in Lebda that Misari-1 was chosen as the most adapted for mugudugu and bassi” said Dr Fatoumata Ba Hama, researcher in nutrition and food science at ICRISAT.

“The women who are part of Association Minim Song Panga were provided with Misari-1 pearl millet variety, which they grew and processed into mugudugu and bassi, primarily for their communities. Work is now underway to further enrich these products and, at the same time, improve the packaging for sales in the supermarkets of the city of Ouagadougou,” said Dr Ba Hama.

“Getting out the technologies is in our best interest and during the coming 12 months we shall do what we commit to do” said Dr Moses Siambi, ICRISAT Regional Director, East and Southern Africa and Principal Investigator of the project as he pointed out that ownership will be a key for success.

The meeting revealed that although improved technologies were disseminated during the previous phase of the project, more effort is needed on increasing availability and accessibility to the end users. It emerged that labor-saving technologies and efficient technology delivery systems need to be developed. Researchers should create competition by involving more stakeholders in the programs. Finally, it is important to integrate production, processing, nutrition and diversity in all research and dissemination of technologies.

The accomplishments of each country, the challenges faced and lessons learned were discussed on the first day; working groups were set up to provide inputs into each country’s review. On the second day, project leaders made presentations and provided feedback on issues raised by the country teams in their presentations.

Also, during the second day, participants had the opportunity to briefly interact with Dr David Bergvinson, Director General, ICRISAT, and Dr Jeffrey Ehlers, Program Officer, Bill & Melinda Gates Foundation. Talking to the participants remotely, they both stressed on genetic gain and the need for improving efficiency of the breeding programs.

The third day focused on external communication strategy and identifying key activities and opportunities for more visibility. This was led by Ms Agathe Diama, Head, Regional Information, ICRISAT, and included presentations from working groups for each country. Dr Esther Njuguna and Dr Jummai Yila, Gender Specialists, ICRISAT, spoke about provocatively questioning the mainstreaming of gender in HOPE II. During parallel sessions, teams of ICRISAT scientists under each objective met with each country team to closely work on addressing needs for improvement, discuss plans for Year 2, as well as identify specific needs for backstopping.

This annual review and planning was facilitated by Dr Hamado Tapsoba, HOPE Project Coordinator, and Ms Diama.

The meeting was held from 20-22 March, in Ouagadougou, Burkina Faso, and was attended by 37 participants drawn from national agricultural research institutions, farmers’ organizations and private seed companies from the six countries involved (Burkina Faso, Mali, Nigeria, Ethiopia, Tanzania and Uganda) as well as scientists from ICRISAT.

Project: Harnessing Opportunities for Productivity Enhancement (HOPE II) for Sorghum and Millets in sub-Saharan Africa

Funder: Bill & Melinda Gates Foundation

Partners: Institut de l’Environnement et Recherches Agricoles (INERA), Burkina Faso; Institut d’Economie Rurale (IER), Mali; Institute for Agricultural Research (IAR) of Ahmadu Bello University (ABU) and Usmanu Danfodiyo University of Sokoto (UDUS), Nigeria; Ethiopian Institute of Agricultural Research (EIAR), Ethiopia; Department of Research and Development (DRD), Tanzania; National Semi-Arid Resources Research Institute (NaSARRI) of the National Agricultural Research Organization (NARO), Uganda.

CGIAR Research Program: Dryland Cereals

This work contributes to UN Sustainable Development Goals
High-oleic groundnut varieties – with oleic acid content of up to 80% in Spanish and Virginia bunch types – show exciting potential for the processed food industry due to their longer shelf life and consumer health benefits. Groundnut researchers discussed this and other technological advances in groundnut breeding at a recent meet. Normal groundnut cultivars have 35-45% oleic acid content. Oleic acid has 10-fold higher oxidative stability compared to linoleic acid; therefore, higher-oleic groundnut is preferred by processors for creating processed groundnut products that will stay fresh for longer periods.

Representatives from the private sector noted the usefulness of good management practices to limit Aspergillus infection in groundnuts, the value of cost-effective aflatoxin detection kits to monitor contamination along the value chain, and experiments on developing seed agronomy to overcome serious limitations of seed multiplication ratio.

Groundnut researchers demonstrated standard operating practices for collecting leaf samples for the high-throughput genotyping platform (HTGP) using a paper punch. This year, a total of 18,000 leaf samples from early generation populations were sent to Intertek for genotyping on a 10-SNP (Single Nucleotide Polymorphism) panel, which has SNPs for three traits: high oleic acid, resistance to rust and resistance to late leaf spot.

At the Groundnut Researcher’s Field Day organized at ICRISAT, processors, exporters, policy makers and researchers discussed the four high-oleic groundnut lines – ICGVs 15073, 15103, 15074 and 15083 – which have also demonstrated higher pod yield across three test locations.

Participants also discussed:
- New lines with high oil content; early maturing lines with foliar fungal disease resistance; and confectionery lines
- Drought-screening nursery under well-watered and water-deficit stress employing empirical approach to select drought-tolerant lines
- Trait-specific evaluation trials and breeding populations
- New transgenic events derived using HIGS (Host-Induced Gene Silencing) technology.

Deliberations among the scientists underlined that the following were critical traits to develop in the Spanish type of groundnut:
- Early-maturing types for large growing regions of Eastern and Southern Africa (ESA), Western and Central Africa (WCA) and India
- Resistance to rosette disease (in ESA and WCA) and foliar fungal disease
- Fresh seed dormancy.

Groundnut breeders presented various breeding methods, viz. Single Seed Descent (SSD), Marker-Assisted Selection (MAS) and Marker-Assisted Backcrossing (MABC) methods, as well as Breeding Management System for data management, and devices and barcode labels for data collection.

Researchers also presented their methods to maximize genetic gains, which included:
- Use of precise genotyping and phenotyping tools for selection
- Rapid generation advancement to take three cycles per year
- Recycling of elite parents in hybridization based on data on parents from multi-location testing
- Early generation testing in target sites.

During the field trip, participants were shown the Multiparental Advanced Generation Inter Cross (MAGIC) and Nested Association Mapping (NAM) populations on display at the experimental plots.

Dr David Bergvinson, Director General, ICRISAT, noted that demand-driven innovations such as high-oleic groundnut varieties were needed to enhance profitability of groundnut cultivation to smallholder farmers in Africa and Asia. Mr Tushar Patel Thumar from Khedut Feeds & Foods Private Limited, Gujarat, noted that the Field Day was a
great opportunity for him to learn about the research carried out at ICRISAT for the progress, benefit and betterment of the farmers. He said, “We are motivated and inspired, and now it is our responsibility and duty to extend this great research and hard work to our farmer community. We will be glad to be a part of this and would like to work with you in your journey and mission of all the people having the right to nutritious food and better livelihoods.”

Among the participants were Dr SN Nigam, former groundnut breeder from ICRISAT and Dr AL Rathnakumar, the All India Coordinated Research Project – Groundnut National Coordinator from ICAR-DGR (Indian Council of Agricultural Research-Directorate of Groundnut Research).

The Groundnut Researcher’s Field Day was organized at ICRISAT Headquarters on 28 February. Over 90 participants from India, Uganda, Mali, Burkina Faso, Ghana, Tanzania and USA; private sector partners involving processors, exporters, and seed producing companies; policy makers; and ICRISAT scientists from India, Malawi, Mali and Nigeria participated in the Field Day.

To know more about ICRISAT’s work on groundnut, click here.
Mapping the dynamics of urban sprawl and its impact on agriculture

In a rapidly urbanizing global economy it is critical to identify the resilience and adaptive capabilities of arid and semi-arid agroecological systems to urbanization. A joint project between the Swedish University of Agricultural Sciences (SLU) and ICRISAT on “The Dynamics of Urban Sprawl: Land-use changes, Food Supply & Sustainable Agriculture Production Systems in the Arid and Semi-Arid Zones” aims to do just that.

The project selected two growing mega cities: Cairo in Egypt for the arid ecology and Hyderabad in India for the semi-arid ecology. The project will investigate and compare agronomic, institutional and regional variations in these two agroecologies. A system-resilience framework will be developed and used to study the interlinkages and impacts of urban sprawl on land use, changes in resource use, agricultural production and food security, which in turn affects the competing use of natural resources such as land and water. Adaptation and resilience of the food supply and sustainable agriculture production systems to urban sprawl will also be examined using the framework. The results will strengthen the understanding of urban system resilience as well as generate knowledge in relation to how land use, agricultural production and food security interact in the crop-livestock systems in the arid and semi-arid regions. This will help direct attention of researchers and policy makers to this issue.

The project kick-off meeting was held recently at ICRISAT-India from 20-22 March. Participants of the project include Prof Carl Johan Lagerkvist, Professor and Head-Department of Economics, SLU; Prof Ayman F Abou Hadid, Arid Lands Agricultural Graduate Studies & Research Institute (ALARI), Ain Shams University, Cairo; Dr Ranjan Kumar Ghosh, Assistant Professor, Indian Institute of Management, Ahmedabad; and Ms Maria Eduarda Rigo Cavinato, Research Assistant, SLU. The project team also visited Dokur village in Mahbubnagar district, Telangana, on 22 March and interacted with the farmers to better understand how they have responded to the growing urbanization. Read about their visit [here](#).

Project: The Dynamics of Urban Sprawl: Land-use changes, Food Supply & Sustainable Agricultural Production Systems in the Arid and Semi-Arid Zones

Funder: The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS)

Partners: Swedish University of Agricultural Sciences (SLU), Sweden; ALARI, Faculty of Agriculture, Ain Shams University, Cairo, Egypt

CRP: Policies, Institutions And Markets

This work contributes to UN Sustainable Development Goals

11. SUSTAINABLE CITY AND COMMUNITIES
12. RESPONSIBLE CONSUMPTION AND PRODUCTION
15. LIFE ON LAND
17. PARTNERSHIPS FOR THE GOALS

Photo: S Punna, ICRISAT

Project team members at the kick-off meeting.

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Sorghum seed consortium boosts adoption of improved cultivars in India

In order to increase the uptake of improved post-rainy sorghum cultivars in India, a Sorghum Seed Consortium has successfully promoted the distribution of seeds of improved cultivars among thousands of farmers in Maharashtra, India. So far over 40,000 farmers in Maharashtra have benefitted from the improved cultivars: Parbhani Moti, Parbhani Jyoti, Phule Vasudha and Phule Revati.

As a result of the efforts of the consortium, the production of improved sorghum seed has increased from 300 tons in 2013 to 3000 tons in 2016. The improved varieties are now widely used in the Western Maharashtra and Marathwada regions of Maharashtra. The traditionally popular post-rainy sorghum cultivar M 35-1 (Maldandi) is being replaced with improved varieties, resulting in enhanced crop productivity. Grain yields have increased by 40% and stover yields by 30%. Economic analysis of seed production showed that seed growers get a return-cost ratio of 2.21 compared to 1.44 for grain producers.

Currently, seed production of improved sorghum cultivars is taking place on 3000 farmers’ fields in Maharashtra and the improved seeds are delivered to 300,000 farmers across India (8% of total post-rainy sorghum farmers in India) annually. Being open-pollinated cultivars, these seeds are reused and exchanged with fellow farmers. Indian national agricultural research systems (NARS) and ICRISAT also support the farmers with improved management practices.

The consortium has brought seed farmers, NARS institutions, agricultural universities, Indian Institute of Millets Research (IIMR), Maharashtra State Seed Corporation (Mahabeej) and Maharashtra State Seed Certification Agency (MSSCA) and ICRISAT on a single platform. The role of the various partners in the consortium is:

- Universities supply breeder seed of improved post-rainy sorghum cultivars and train the farmers.
- MSSCA certifies all the seed plots.
- Mahabeej procures the seeds at a price which is 25% higher than the market price of grain, processes them and commercializes them across post-rainy sorghum states in India.
- ICRISAT monitors the entire activity and provides some financial support for capacity building of seed farmers and seed plots registration with a certification agency.

Post-rainy sorghum is grown on 4 million ha in India. Although sorghum is prized for its grain and fodder, in the past few decades, terminal drought stress, low temperatures at flowering and farmers’ preference for the bold, lustrous white grains in adapted landrace cultivars had limited the genetic variability in sorghum crops. This, coupled with limited efforts for hybrid development, had resulted in a low acceptance (20%) of improved cultivars of sorghum in India.

To improve this situation, the consortium was formed as an exit strategy in 2013 when the Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets project, funded by the Bill & Melinda Gates Foundation, completed its activities in India.

On 4 March, Mahabeej conducted a farmer’s field visit to seed production plots and arranged an interaction meeting in Dhanegoan village near Nanded, Maharashtra. Over 100 seed growers participated in the events, including Dr A Ashok Kumar, Principal Scientist - Sorghum Breeding, ICRISAT, and Dr HV Kalpande, Senior Scientist along with Mr Rushikesh Aundhekar, Senior Research Associate from Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani. ■

Project: HOPE
Partners: Indian NARS, IIMR, Mahabeej, MSSCA, agricultural universities
Funder: Bill & Melinda Gates Foundation
CRP: Dryland Cereals

Read more about sorghum [here](#)

This work contributes to UN Sustainable Development Goals

1. No Poverty
2. Good Health and Well-being
3. Gender Equality
4. Economic Growth
5. Innovation and Infrastructure
6. Partnerships
Tropical Legumes III: Strategies for wider reach and deeper impacts

During the recently concluded Tropical Legumes III (TL III) annual meeting, plant breeding programs were assessed and specific product concepts were discussed for all mandate crops of the project in every target country. Special attention was paid to communicating the research work and its effects more effectively across the globe.

Following were the project outputs:

- Generated self-assessment tools for each crop breeding program – Breeding Program Assessment Tools (BPAT) – in every target country to identify areas of strength to capitalize on, and areas of weakness to improve upon, in order to realize enhanced genetic gains
- Successfully developed product profiles and worked out breeding pipelines towards achieving specific product concepts for each crop in each target country
- Updated the seed production targets and outlined adoption road maps for new varieties
- Received feedback on gender integration activities along the legumes value chains
- Mapped out publications, communications and data-sharing plans to enable a wider audience for the work done by TL III and its impacts

The team also agreed to work on a special issue of tropical legumes publication highlighting learning, experiences and impacts of the TL III project over the years.

Dr Chris Ojiewo, Project Coordinator TLIII, outlined the specific objectives of the meeting:

1. Discussing breeding program self-assessment of each NARS program and setting baselines for program improvement
2. Developing product concepts for more focused breeding and improved breeding process pipelines
3. Updating seed production targets and gender-responsive variety adoption road maps
4. Devising a plan for data sharing, management, analysis and publication of project achievements in various forms of communication products, with an emphasis on scientific journals.

Dr Jeff Ehlers, Senior Program Officer, Bill & Melinda Gates Foundation, emphasized the need for NARS partners to objectively evaluate their breeding programs, work out strategies for improvement and also to implement action plans on the seed road maps while working towards digitalizing the process. He underlined the importance of shared learning and experiences between the TL III and HOPE (Harnessing Opportunities for Productivity Enhancement for Sorghum and Millets) projects.

Mr Sory Diallo, representing the NARS, outlined the great support that they have been receiving over the years partnering with the CGIAR centers in the Tropical Legumes Project to access genetic and genomic resources as well as advanced breeding lines. He also appreciated the support for putting in place proper structures for functional legume seed systems by establishing up-to-date seed production plans and adoption road maps.

The TL III initiative, conceived in 2007-08, aims to develop improved cultivars of common bean, cowpea, chickpea and groundnut, and deliver their seed at scale to smallholder farmers. The annual meeting of TL III was held at ICRISAT-India on 26-27 February, and was attended by over 90 participants from the participating countries.

**Project:** Tropical Legumes III  
**Funder:** Bill & Melinda Gates Foundation  
**Partners:** CIAT, International Institute of Tropical Agriculture and National Agricultural Research System (NARS) institutions in Ethiopia, Tanzania, Uganda, Burkina Faso, Ghana, Mali, Nigeria and India.

This work contributes to UN Sustainable Development Goals

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Partnerships for better results

Just ahead of the forthcoming cropping season, detailed road maps were created for a synergized work plan to increase production and productivity of groundnut and cowpea in Nigeria. During a combined Review and Planning Meet of the Tropical Legumes III and the United States Agency for International Development (USAID) Cowpea Upscaling projects, researchers from both projects discussed ways to pool their resources in order to have a greater impact in scaling out the individual project goals for both the crops.

In particular, the following points were emphasized:
1. Need to leverage resources between the two projects for improved efficiency and effectiveness of seed delivery and scaling out
2. Joint capacity building of national partners
3. Alignment of the Bill & Melinda Gates Foundation seed sector development activities with national priorities.

Challenges to higher production of groundnut and cowpea include limited use of data capturing tools, under-reporting of seed production by seed companies and late submission of project reports by project partners.

Scientists debated on the ways to eliminate the above challenges and fine-tune technology delivery systems for both groundnut and cowpea.

It was agreed that there is a need to re-strategize to increase seed production and also encourage wealthy individuals to invest in legume seed production business.

Project: Tropical Legumes III and USAID Cowpea Upscaling projects
Funders: Bill & Melinda Gates Foundation; USAID
Partners: International Center for Tropical Agriculture (CIAT), IITA and National Agricultural Research System (NARS) in Ethiopia, Tanzania, Uganda, Burkina Faso, Ghana, Mali, Nigeria and India.

This work contributes to UN Sustainable Development Goals

Photo: Lucky O. Omoigui
InterDrought-V calls for modern agriculture technologies to combat drought

At the recently concluded InterDrought-V conference, participants deliberated on the use of modern technologies to help smallholder farmers combat drought. “Harnessing modern tools is critical to help farmers overcome the devastating effects of drought,” said Mr Krishna Byre Gowda, Minister of Agriculture, Government of Karnataka. He stressed that, with agriculture in India being dependent on the ‘wager of monsoons’, he was heartened by the community of scientists collaborating on one of the most important issues affecting farmers.

In Karnataka, India, 160 of 176 blocks in the state are currently drought affected. Mr. Gowda looked forward to technologies and solutions to be developed by scientists to tackle the problems faced by farmers due to greater variability.

Every year, drought-related disasters affect vast regions that impact food production. InterDrought conferences serve as a platform for presenting and debating key issues and strategies relevant for improving tolerance to drought and other stresses in crops.

In his inaugural address, Dr Rob Bertram, Chief Scientist, Bureau of Food Security, United States Agency for International Development (USAID), said, “A combined approach including crop improvement, agronomic practices and irrigation needs to be used for mitigating drought stress in developing countries.”

“By using a holistic approach, organizations like ICRISAT need to work together and contribute to this important international food production constraint to feed the world. Prime Minister Modi has laid before us the challenge to double the income of farmers. It will be essential to enhance crop production and link farmers to markets,” said Dr David Bergvinson, Director General, ICRISAT.

“Given the severity of drought, a central challenge for researchers and policy makers is to devise technologies that lend greater resilience to agricultural production under this stress. Therefore, participants from 56 countries have assembled here to address this important issue,” said Dr Rajeev Varshney, Conference Organization Chair and Research Program Director, ICRISAT.

“Farmers need to be placed at the centre of research and development activities related to drought so that they can have more produce and better incomes,” said Mr S Pattanayak, Secretary, Ministry of Agriculture and Farmers Welfare, Government of India.

“Drought research needs to be handled from different angles. We need breeding, physiology, biotechnology and agronomy to make crops resilient,” said Dr JS Sandhu, Deputy Director General (Crop Science), Indian Council of Agricultural Research (ICAR).

Dr Francois Tardieu, Research Director, INRA-Montpellier, and Chair, InterDrought-V, highlighted that this conference is in continuation of earlier InterDrought Conferences held in France (ID-I, 1995), Italy (ID-II, 2005), China (ID-III, 2009) and Australia (ID-IV, 2013), and invited all participants to the next conference in 2021.

He further added that from one year to the next, weather variability was identified as the critical risk to farming. This needs urgent solutions, and the conference served as an important call to action.

A Climate Smart Agriculture workshop, held during the conference co-chaired by Dr David Bergvinson and Dr RS Paroda, former Director General, ICAR, has come up with a declaration on Climate Smart Agriculture. This will be circulated widely to funders and policy makers.

InterDrought-V conference was held in Hyderabad, India from 21-25 February, 2017. The conference had 23 invited presentations and 26 contributory presentations across eight sessions. In addition, 55 presentations were delivered in eight workshops. Young scientists from developing countries interacted with eminent scientists and policy makers during the event.
Women’s empowerment is a major cross-cutting area of ICRISAT’s holistic approach. Various ICRISAT centers celebrated International Women’s Day (IWD) on 8 March by reiterating the importance of gender inclusiveness and economic and social empowerment of women in rural as well as urban areas.

Bamako, Mali: As part of the IWD celebration, ICRISAT Women’s Forum in Mali visited the Centre d’Accueil et de Placement Familial (CAPF) known as “La Pouponnière”. During the visit, the forum presented Mrs Diarra Aminata Diabate, Director, CAPF, with various donations including diapers, powdered milk, sugar and flour made of whole grains (millet, sorghum, maize, fonio and cowpea). This flour was prepared by members of the forum for the children.

According to Ms Agathe Diama, Leader of the Forum, the choice of the nursery for its first external activity emerged as a priority because it is in line with ICRISAT’s mission and its belief that all people have the right to nutritious food and a better livelihood.

The enriched flour was especially appreciated by the staff of the center. “We have a great interest to collaborate with ICRISAT Women’s Forum and explore ways to improve children’s nutrition. Cereals such as millet and sorghum are accessible, healthy and easy to cook. Most imported products are expensive and often outdated. We look forward to working together with the Forum,” said Mrs. Konate Marie Anne Berthe. “By collaborating with ICRISAT, we expect to improve and bring more nutritious food to cover the nutritional needs of the children in this center,” added Mrs Diabate.

The members of the forum also visited the Point G University Hospital Center (CHU), where they met with women who are suffering from obstetric fistula. A donation including grains of millet, sorghum and rice, with few other products was made. Also, a financial contribution was given to the hospital.

All donations were made out of savings of the forum members from the USD 20 given to each ICRISAT female staff member on the occasion of IWD for organizing an activity of their choice. Both visits are a demonstration of the love, compassion and support that the forum has for the women and the children visited.

Elsewhere, to emphasize the importance of empowering and encouraging women to play a larger role in society, ICRISAT-Mali chaired a panel discussion, ‘They Inspire’, between award-winning women and young girls, as part of IWD celebrations. The dialogue was moderated by Ms Agathe Diama, Head - Regional Information, ICRISAT - West and Central Africa. Dr Jummai Yila, Gender Scientist, ICRISAT, also attended the event where prominent women achievers of Africa spoke about inspiring and nurturing young African women for greater participation in decision-making systems.

The event was organized by AllAfrica Global Media Group, in partnership with the United Nations Secretary-General’s High-Level Panel (UNHLP) on Women’s Economic Empowerment, on 7 March in Bamako, Mali. The UNHLP was created by UN Secretary-General Ban Ki-moon in January 2016, with the aim of placing women’s economic empowerment at the top of the global agenda to accelerate progress under the 2030 Agenda for Sustainable Development.
Maharashtra, India: In Jawhar, Palghar district, 30 Self-Help Groups (SHGs) for women have been promoted. These SHGs were trained and are now managing seed banks in their villages. This will help address the issue of seed availability. Seven SHGs were trained in gliricidia nursery raising, which is helping these groups earn an average profit of Rs. 35,000. The nursery interventions have helped them gain confidence, and these SHGs have now started working on agricultural production. Three SHGs were supported to buy irrigation pumps for supplementary irrigation. The pumps are also being given on rent to other farmers, generating additional income for the groups. One SHG initiated cultivation of cash crops under shade net with drip irrigation. Three groups were supported to buy power tillers under a farm mechanization initiative. These tillers too are being rented out, generating additional income for the SHGs. These income-generating activities have resulted in financial independence and increased confidence for the rural women.

Karnataka, India: In Bellary district, women have successfully made use of various income-generation schemes. Activities such as raising gliricidia nurseries, vermicomposting and running grocery shops have provided additional incomes of Rs. 1000 - 1500 (USD 15 - 23) per month to women in rural areas.

In Vijapura district, women SHGs were supported with revolving funds. The SHGs further distributed this fund as loans to individual members for income-generation activities, which includes goat rearing, tailoring, running grocery shops and preparing and selling homemade food items. This has helped members earn an average of Rs. 1500 - 3000 (USD 23 - 45) as additional income.

Hyderabad, India: IWD was celebrated at ICRISAT-India through a creative workshop that fostered self-reliance, teamwork, self-awareness and health among the female employees. As part of various workshop activities, participants were encouraged to work in teams to put forward competitive and creative ideas for excellence in personal and professional life. There was a special focus on women’s health and well-being. Every participant was presented with a sapling at the end of the session. The event resulted in great camaraderie and cooperation among the participants.

At a panel discussion on ‘Women in the Changing World of Work: Planet 50-50 by 2030’ organized by the National Academy of Agricultural Research Management (NAARM), participants discussed (i) Gender equality for boost in economic growth ii) Challenges at workplace/home and iii) Technological advances and digital change for empowering women at work. ICRISAT was represented by Ms Joanna Kane-Potaka. Other members on the panel were: Dr Jayasree Subramanian, Associate Professor, Tata Institute of Social Sciences; Ms Manvitha Reddy, Agri-entrepreneur; and Dr M Krishnan, Senior Faculty, NAARM. The session was moderated by Dr Kalpana Sastry, Director (Acting), NAARM. ■
Auditing the auditors

ICRISAT became the first CGIAR center to successfully undergo a Quality Assurance Review (QAR) of its Internal Audit department in December 2016. The review was conducted by The Institute of Internal Auditors (IIA), a global professional body for internal audit practice. QAR is required to be performed by all internal audit functions once in five years in order to be eligible to certify themselves as conforming to the IIA’s international professional practice standards. These standards are very detailed and evaluate the audit function on various aspects, such as independence and objectivity, proficiency and due professional care, managing the internal audit activity, and the IIA Code of Ethics. The review was performed by Mr Deepak Wadhawan, Chief Executive, IIA, and Mr S Bhaskar, an independent validator with rich internal audit experience, under the leadership of Mr TN Menon, erstwhile Head of Internal Audit, ICRISAT.

My wish for the drylands

On the occasion of our 45th anniversary, our staff share their wish for the drylands. Visit this link to see the latest videos of our staff’s vision for smallholder farmers and people living in the drylands.

ICRISAT’s CSR partnerships on watersheds

“Water is the driving force of all nature.” — Leonardo DaVinci

ICRISAT, with its CSR partners, has strived to provide low-cost and effective solutions for increasing water-use efficiency and conservation in seven Indian states. March 22 being World Water Day, we bring you a short video ‘ICRISAT’s CSR partnerships on watersheds’, to underscore the importance of conserving this precious natural resource. Click here to view the video.
Young Scientist Award for ICRISAT scientist

Dr Rachit K Saxena, Senior Scientist, Genomics and Trait Discovery, Research Program Genetic Gains, ICRISAT, was awarded the Young Scientist Award for his contributions in decoding pigeonpea and chickpea genomes and understanding the genetics behind genomic controls of economically important traits.

The NAAS Young Scientist Award is awarded to scientists below 35 years of age. The prize comprises of a citation and a gold medal.

Dr Saxena was conferred the award by the National Academy of Agricultural Sciences (NAAS) at the XIII Agricultural Science Congress on 21 February.

Award

Dr Rajeev K Varshney, Research Program Director, Genetic Gains, ICRISAT, was recognized and felicitated for his leadership in the development and application of genomic tools and pipelines that facilitate sequence-based breeding methods for improvement of *Arachis* cultivars. The award was presented by The Peanut Genome Consortium and the International Peanut Genome Initiative (IPGI) during the 9th Advances in Arachis through Genomics & Biotechnology (AAGB) meeting held in Cordoba, Argentina, during 14-17 March.

IPGI is a multinational group of crop geneticists with 39 scientists from 26 organizations in six countries engaged in the groundnut genome sequencing project.

Dr Rajeev K Varshney with award of recognition for leadership and contributions to peanut research, during the 9th AAGB in Cordoba, Argentina.
New projects

**Project title:** Identification of candidate genes and development of markers for molecular breeding of early flowering in chickpea (*Cicer arietinum* L.)

**Funder:** Science and Engineering Research Board, Govt. of India

**Grant duration:** Feb 2017 - Feb 2020

**Project title:** Nutritional and nutraceutical properties of cereal and legume-based traditional foods from India and South Africa and their role in addressing malnutrition, hidden hunger and chronic non-communicable diseases

**Funder:** Department of Science & Technology, Govt. of India

**Grant duration:** Feb 2017 - Feb 2020

**Project title:** Pyawt Ywar Pump Irrigation Project

**Funder:** IWMI

**Grant duration:** Dec 2016 - Mar 2019

**Project title:** The dynamics of urban sprawl: Land-use changes, food supply and sustainable agricultural production systems in the arid and semi-arid zones

**Funder:** Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS) through Swedish University of Agricultural Sciences (SLU)

**Grant duration:** Jan 2017 - Dec 2020

**Project title:** Exchange of genetic resources and experts between the ICRISAT and National Institute of Agricultural Science of RDA

**Funder:** National Institute of Agricultural Science of the Rural Development Administration (NAS, RDA), the Republic of Korea

**Grant duration:** Jan 2017 - Dec 2019