Next-generation genomics key to global food and nutritional security

Over 300 delegates from 30 countries worldwide representing, both private and public sector, convened at ICRISAT-India to deliberate on future collaborations and ways to integrate next-generation genomics into the future of crop improvement to contribute to global food and nutrition security.

“Making a hunger- and malnutrition-free society is the ultimate goal of every agricultural scientist and stakeholder. Next-generation genomics backed by strong technological advancements will facilitate science-based agricultural innovations such as the development of nutrition-rich crops to eradicate hunger,” said Dr MS Swaminathan, renowned agricultural scientist and Father of India’s Green Revolution at the three-day ‘5th International Conference on Next Generation Genomics and Integrated Breeding for Crop Improvement (NGGIBCI-V)’.

Genomics – or deciphering the genomic content of crop species using high-throughput and next-generation approaches – allows the scientific community access to ‘good genes’ to speed up breeding for superior crop varieties with agronomically important traits.

“It is not so much a question of more food. It is more a question of better food,” said Dr Howard-Yana Shapiro, Chief Agricultural Officer, MARS Inc. USA, in his talk on genomics interventions to ensure food and nutritional security in developing countries.

In his capacity as lead of the African Orphan Crop Consortium, Dr Shapiro highlighted the work of...
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sequencing 101 genomes of orphan crops to improve the nutritional content, productivity and climate adaptability of some of Africa’s most important food crops, providing a fundamental step in helping to eradicate chronic hunger, malnutrition and stunting among children in Africa.

“Next-generation sequencing technologies are vital in feeding the ever growing global population,” said Dr Asis Datta, Founder and Former Director, National Institute of Plant Genome Research (NIPGR), India.

Dr Surinder Vasal, World Food Prize Laureate, in his inspirational message said: “Crop productivity is directly related with hunger, poverty and sustainability, and next-generation sequencing technologies are what will enhance global food production by increasing crop yield and reducing production losses.”

“It is important to train the next generation of breeders to deploy modern technologies for crop improvement,” stressed Dr Jean-Marcel Ribaut, Director, CGIAR Generation Challenge Program (GCP), Mexico, in highlighting successful case studies in translating genomics research for crop improvement and the GCP’s role in providing the platform.

Dr Gary Atlin, GCP Senior Program Officer, emphasized the need to strengthen the breeding pipeline within CGIAR Centers and national programs for enhancing genetic gains. “It is imperative to use low-cost and high-density genotyping technologies for crop improvement, if we are to see a food-secure world,” he added.

“The challenge of producing more nutritious food to feed 9 billion people in 2050 amid the threat of climate change is enormous. Next generation genomics is one of the ‘best bets’ for sustainably eradicating hunger, malnutrition and poverty. This powerful tool can dramatically increase our capacity to utilize genetic diversity and develop highly nutritious, stress tolerant crop varieties faster and cheaper than conventional crop improvement practices,” emphasized Dr David Bergvinson, Director General, ICRISAT.

“NGGIBCI-V is the largest conference in its series, successfully bringing together about 340 delegates from over 30 countries, and providing an excellent platform for researchers all over the world to share ideas and take breeding for crop improvement to the next level,” said Dr Rajeev Varshney, conference chair and Director, Centre of Excellence in Genomics, ICRISAT.

Dr Peter Carberry, Deputy Director General-Research, ICRISAT, said, “The NGGIBCI-V is an ideal platform to harness the potential of next-generation sequencing technologies in breeding climate smart crops towards contributing to food and nutritional security in developing countries.”

ICRISAT organized the NGGIBCI-V in partnership with the Bill & Melinda Gates Foundation and the CGIAR Generation Challenge Program with support from several other organizations and companies. The three-day conference witnessed presentations from 40 leading experts from all over the world, and 80 poster presentations from young researchers.

ICRISAT is one of the pioneers and leading CGIAR centers in deploying high-end next-generation sequencing technologies for crop improvement. The institute led the international consortia that decoded the genomes of chickpea and pigeonpea in 2013 and 2011, respectively. It has also developed superior lines of chickpea and groundnut by molecular breeding approaches that are now exhibiting higher yields in farmers’ fields.

The conference was held on 18-20 February at ICRISAT-India.
Developing climate-resilient chickpea based on genetic potential of natural populations

The University of California (UC), Davis, and ICRISAT will work together on developing climate resilient chickpea from germplasm that includes cultivated chickpea introgressed with the wild ancestor of chickpea (*Cicer reticulatum*) from unique, diverse, and recent collections in Turkey.

ICRISAT will phenotype a range of chickpea materials for climate resilience using specialized phenotyping platforms (LeasyScan and LysiField). Both revIL lines and advanced backcross material will be phenotyped for climate resilience.

In the first phase, using a representative set of genotypes in 20 wild populations, the broad differences between wild populations for traits that can affect their response to drought, heat and climate-resilient nitrogen fixation will be studied. The second phase will target the revIL populations selected by UC Davis.

First phase trials would likely take place in the October 2015 – March 2016 period (which covers the usual chickpea growing season in India).

For wild populations, the LeasyScan facility at ICRISAT will be used whereas for the revILs both LeasyScan and lysimetric assessments will be used.

“LeasyScan, a high-throughput phenotyping platform, was designed with a clear research target – to measure leaf area quicker so as to access the dynamics of leaf development and leaf conductance, traits that are the focus for plant drought adaptation,” said Dr Vincent Vadez, Principal Scientist - Plant Physiology, ICRISAT.

The high throughput computerized platform based on 3D images allows scientists to analyze the phenotypes of plants in greater detail, and conduct large-scale screening of plants. This can be linked and integrated into genomics and breeding works to speed up the development of improved, drought-adapted crops. The high throughput scanning equipment can scan between 3,200 to 4,800 plots every 2 hours. LeasyScan was established at ICRISAT-India last year.

Crop adaptation to drought is to a large part an exercise of fitting crop water demand (of a given genotype) to water available in any given scenario. The important features to determine crop water demand are size of the crop canopy (leaf area), the rapidity at which a crop canopy develops, and the canopy conductance to water. The LeasyScan facility at ICRISAT allows the determination of these parameters quickly, efficiently and in a non-destructive manner.

The lysimetric assessments will provide data on total plant water use (the sum of water use data across the entire life of the crop), and transpiration efficiency (the ratio between total biomass produced (pods and vegetative parts) and total plant water used. The evaluation of total plant water use gives an accurate estimate of the fitness of each genotype to given environmental conditions.

**Climate-resilient nitrogen fixation**

Chickpea as a crop has not been selected to increase its capacity to fix N symbiotically. However, studies indicate it is likely that there is a large genetic variation in chickpea in their capacity to fix N symbiotically, especially in the early stages after sowing. LeasyScan will allow (a) quick measurement of leaf canopy development in both low N soil and high N soil and (b) measurement of maximum nitrogen concentration in the leaf tissue and stem tissues, at flowering time (when it is considered to be the highest) in the revILs.
5th International Conference on Next Generation Genomics and Integrated Breeding for Crop Improvement
Indian government recognizes ICRISAT’s work in integrated watershed management

ICRISAT received the Abhinav Puraskar (Innovative Award) in Integrated Watershed Management. The award was received by Dr Suhas P Wani, Director, ICRISAT Development Center on behalf of ICRISAT.

The watershed management approach pioneered by ICRISAT has had major impacts. It has changed the emphasis of watershed programs from soil and water conservation to productivity enhancement and livelihood options. The consortium approach of ICRISAT led to new guidelines being released by the Government of India in 2008 for integrated watershed management programs in India.

The important lessons learnt are:
1. The principle of one size fits all did not work in all agro-eco zones. Different interventions or approaches were needed for high rainfall and low rainfall zones because the current practices are best suited for zones that have 700 to 1,000 mm rain.
2. There was a need for holistic systems support with complete participation from the community, for which partnerships with different organizations and stakeholders were needed. The compartmental approach did not show any impact.
3. Women and landless households need to be involved. Adopting the livelihood approach ensured the involvement of this 60% of the population (50% women and 10% landless people) in the watershed activities.
4. Unless tangible economic benefits are provided, participation of the community will not be forthcoming.
5. Adopting a science-led approach was needed for not only conserving water but also for its efficient use thereby increasing the incomes of farmers.

Building and fostering partnerships through a consortium approach

The consortium approach was started in 1999 bringing together government line departments, non-government organizations, research organizations like ICRISAT, Central Research Institute for Dryland Agriculture, Remote Sensing Agency, etc., and community-based organizations together for watershed management.

Talking of ICRISAT’s role as a consortium partner, Dr Wani said, "We are the catalyst for implementation
of the program as well as providing technical guidance like developing new models of watershed management. We also contribute capacity building, scientific monitoring and evaluation, using new science tools like remote sensing, geographic information systems and hydrological monitoring. We have also introduced agricultural production enhancement which was missing in earlier watershed projects.”

Earlier, government departments, research organizations and non-government organizations worked in silos. Ms Rani Kumudini, who was then Rangareddy District Collector, helped in developing the consortium model and encouraged innovation in the Kothapally watershed in India.

The consortium approach has now been adopted by the Andhra Pradesh Rural Livelihoods Programme and the Sujala projects of Government of Karnataka.

Another major change in terms of partnerships was the involvement of research organizations in the activities of the watershed projects. Earlier research organizations restricted themselves to capacity building and monitoring and evaluation activities. The emphasis now is on research organizations helping the community improve their livelihoods, productivity and incomes. Thus a science-based participatory research for development approach was adopted.

Ongoing monitoring and evaluation was a missing component in watershed programs, but with the involvement of scientific institutions, now there is concurrent monitoring and evaluation. Course corrections are being undertaken during the program itself rather than doing a post-mortem analysis after completion of the program. All watershed programs now have an ongoing monitoring and evaluation component conducted by an external agency and a complete evaluation undertaken at the end of a program.

The award instituted by the Department of Land Resources, Ministry of Rural Development, Government of India was presented by Mr Birender Singh, Minister of Rural Development, Panchayati Raj, Drinking Water and Sanitation at a ceremony held in New Delhi on 19 February.

The 4Cs of integrated watershed management
- Convergence
- Consortium
- Collective action
- Capacity building

Providing livelihood opportunities through the watershed project ensures community participation.
Developing climate-resilient chickpea... from page 3

This work is being undertaken as part of the project “Global Hunger and Food Security Research Strategy: Climate Resilience, Nutrition, and Policy – Feed the Future Innovation Lab for Climate Resilient Chickpea” supported by the United States Agency for International Development (USAID).

Read more information on chickpea at EXPLOREit@ICRISAT http://exploreit.icrisat.org/page/chickpea/685

New projects

**Project title:** Strengthening Impact Assessment Methods in the CGIAR Consortium.

**Principal Investigator:** K Mazvimavi

**Investor:** CGIAR Consortium

**Aims:**

This project aims to enhance impact assessment capacity of CGIAR Centers through a workshop, and implementing selected case study analyses addressing specific methodological issues using long-term panel data. The activities proposed in this project are expected to:

- Establish a community of interest for agricultural scientists to engage in discussion and collaboration on impact assessment activities, and help establish operating procedures and create an environment for consistent, credible impact evaluation at ICRISAT and other CGIAR consortium members.

**Project title:** Advancing the Productivity Frontier for Sorghum

**Principal Investigator:** S Deshpande

**Investor:** USAID through University of Georgia Research Foundation, Athens

**Aims:**

- Advancing the productivity frontier through improved drought and heat tolerance of sorghum
- Transforming production systems to reverse losses of ecological capital through multiple crops from single plantings of sorghum

Reader’s comment

ICRISAT’s contribution to the Primary Sector development in Andhra Pradesh in the areas of soil health assessment and drought proofing the state for improving crop productivity and increasing farm incomes is well received. Hope these initiatives would answer the chronic problems of the state agriculture sector particularly in dryland areas.

P Gurumurthy, Senior Scientist & Coordinator, DAATT Centre, Vizianagaram, Andhra Pradesh, India.

NASI-Scopus Young Scientist Awards 2015

The National Academy of Sciences India (NASI) and Elsevier have announced the NASI-SCOPUS Young Scientist Awards 2015. There are nine categories including Agriculture; Biological Sciences; Earth, Oceanography and Environmental Studies.

**Eligibility:**

- An Indian citizen residing and working in India
- Completed at least PhD/MD or equivalent degree
- Must be born on or after 1 January 1975.

The last date for physical receipt of the application is 15 April 2015.