Feature Stories

Cascadilla: A new tool for crop breeders to efficiently manage huge volumes of genomic data

To assist crop breeders to use huge volumes of genomic data effectively in breeding programs and significantly increase genetic gain in key crop performance traits, the Genomic Open-source Breeding Informatics Initiative (GOBII) released its first production version of a new tool ‘Cascadilla’. A team from Cornell University and ICRISAT developed the tool.

‘Cascadilla’ comes with improved loader and extractor user interface with improved workflow, usability and file transfer to extract genotype data by samples, markers and datasets. Earlier, GOBII had also launched breeders’ tools such as ‘Flapjack’ for Marker Assisted Backcrossing (MABC) and ‘Ped Ver’ for pedigree verification.

In his keynote address, Dr David Bergvinson, Director General, ICRISAT, highlighted the importance and timely intervention of the GOBII project. He said that the intersection of biological and computer science is where innovation is going to be the richest in several decades. “I believe GOBII is an example, where we bring together information technologists, data scientists, breeders and all supporting disciplines in an effort to unlock the genetic diversity of crops. Currently, only 1% of genetic resources are utilized,” he said. “Climate change is happening faster than most people actually appreciate, so we need to work with urgency to unlock the genetic diversity to address the challenge,” he added. Emphasizing the importance of behavioral change, he said, “Technology and structures are only 30% of the challenge, the biggest challenge will be the behavior change to use these tools and platforms.”

Dr Rajeev Varshney, Research Program Director - Genetic Gains, ICRISAT, said that the intended key contributions of GOBII to CGIAR breeding success include removing barriers to breeding innovation by having robust systems for handling high-dimension genomic data, efficient decision support tools and enabling scientists to focus their time on strategy development and execution. He said that the CGIAR’s Excellence in Breeding (EiB) Platform has been envisioned as a model for cross-institutional collaboration and for streamlining the use of genomic information to accelerate breeding progress in multiple crops. The aim, he said, is to make science and technology breakthroughs relevant to crop improvement communities serving the resource-poor worldwide.
‘Cascadilla’ was launched at ICRISAT headquarters on May 26. A team from Cornell University and ICRISAT worked together from 22-26 May for on-site deployment of ‘Cascadilla’. The team included Dr Yanxin Star Gao, Mr Yaw Nti-Addae and Mr Kevin Palis from Cornell University and Drs Himabindu Kudapa, Manish Roorkiwal, Abhishek Rathore, Santosh Deshpande, Ms Anu Chitikineni, Mr Prasad Bajaj, Ms Roma Rani Das, Mr S Sivasubramani, Mr Anilkumar V and Mr Chaitanya Sarma from ICRISAT. The workshop was attended by around 34 participants including breeders from ICRISAT, CIMMYT and IRRI.

About GOBII

Supported by the Bill & Melinda Gates Foundation, Genomic Open-source Breeding Informatics Initiative (GOBII) is the first large-scale public-sector effort to systematically apply high-density genotypic information to the breeding of staple crops in the developing world. The project aims to develop and implement genomic data management systems to enhance the capacity of public sector breeding programs to deliver increased rates of genetic gain. The initial focus is on rice, wheat, maize, sorghum and chickpea in South Asia and Sub-Saharan Africa. The genomic data management systems will include databases, data loader, data extractor, imputation systems, and decision support tools for plant breeders. GOBII involves a multi-disciplinary team of software developers and engineers, molecular biologists, geneticists, curators, breeders, and bioinformaticians from Cornell University, International Maize and Wheat Improvement Center (CIMMYT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and International Rice Research Institute (IRRI).
Nouhou Tigana, a farmer in rural central Mali, doesn’t know for sure what the weather will be tomorrow - other than that it’s likely to be blisteringly hot again.

“The heat is so bad now that we can’t work between noon and 3 p.m.,” he said, waving a skinny pigeon away from the chicken coop he is guarding.

Oddly, however, Tigana now has some idea of what conditions might look like 30 years from now in his village, near the southern fringes of Africa’s Sahel zone.

That’s because, with 30 other farmers, he last year climbed into a Jeep and headed off for a bit of “time travel”: A visit to the Mopti region, to the northeast, that today has the kind of conditions experts believe Kolondialan can expect in decades to come as climate change takes hold.

“The idea is to get communities to learn from each other by visiting an environment that is similar to their own – so based on farming – but not identical in terms of climate conditions,” said Bouba Traoré, a scientist at the International Crops Research Institute for the Semi-Arid Tropics, one of the organisations piloting the “farms of the future” project in Mali.

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“It’s like they are visiting their ‘future village’, if temperatures were to continue to rise and rainfall to decrease,” he added.

The initiative is part of the Building Resilience to Climate Extremes and Disasters (BRACED) programme, supported by Britain’s Department for International Development.

Kolondialan, like many villages in central Mali, is grappling with recurring periods of drought which destroy crops and make it increasingly difficult to work in soaring temperatures often reaching 45 to 50 degrees Celsius (113 to 122 degrees Farenheit).

“But we can’t sit here and do nothing. We have to find a way to get by,” Tigana said.

The farmers are working on ways to adapt to the changing conditions, such as experimenting with new crops and trying to find additional sources of income beyond crop farming, to build their resilience to worsening harvest losses.

But making those efforts effective for the long run will require adapting not only to the tougher conditions being experienced now but the even harsher ones to come, experts say.

Over the past year, with the help of climate experts and an online weather prediction tool, Tigana and other local farmers have helped identify villages further north - such as Bankass and Koro - that are experiencing the kind of climate conditions Kolondialan could face in 30 years’ time, mainly higher temperatures and less rain.
Men and women from Kolondialan and a nearby village have then traveled to visit them, to understand how residents there are coping with current weather.

After the visit, each of the project village has received a grant of 1 million CFA francs (about $1,700), which it can spend on any kind of adaptation effort its community groups decide on.

“We hope that by seeing how farmers have adapted to a hotter climate, for example through smarter farming techniques and new ways of sharing weather information, visitors will implement these innovations at home,” Traoré said.

PREDICTING THE FUTURE

The online weather tool used by the farmers, called Climate Analogues and developed by the Climate Change Agriculture and Food Security research programme (CCAFS), allows users to locate areas whose current climate is similar to the projected future climate of their own area, based on precipitation and temperature data.

“Although they are only a few hundred miles apart, a village like Kolondialan in the Koulikoro region receives on average about a third less rainfall than Bankass in Mopti,” said Traoré. “That makes a difference to what crops you can grow, and when.”

Maarten van Aalst, director of the Red Cross Red Crescent Climate Centre, said that improving Sahelian communities’ generally limited access to weather information is key. But even more important, he said, is placing it in the context of their lives, “so they can understand what’s coming”.

“Being confronted with the possibility that future climate conditions could be even more challenging than current ones is a good way to get communities to invest in resilience,” he added.

INVESTING IN CHICKENS AND STOVES

Tigana’s community has settled on one particular option to fight higher temperatures and crop losses: Chickens.

He stands in front of a group of men and women huddled together on a bright blue carpet.

“At the end of the month your household will get a loan of 50,000 CFA francs (about $85) for the next half of the year,” he tells the crowd, which greets the information with a murmur of approval.

“We recommend you use this money to buy chickens, which we will help you raise so you can sell them at a profit at the market,” he said.

The public meeting, chaired by Tigana, aims to share with the rest of the village the measures the village’s community group have decided on after their “future village” visit to the Mopti region.

These include buying and fattening animals like chickens and goats before selling them at a higher price, as well as protecting maize harvests more effectively by hanging them in trees, out of reach of pests, livestock and floods.

The activities vary from one village to another, said Traoré, depending on the farmers’ skills and the resources available.

For example, in the village of Sibougou – also in central Mali – the community has chosen to build stoves made of mud and straw, which burn less wood, as well as insulated baskets, which conserve heat to cook food even when there is no sun.

Mariam Touré, a farmer who has been using the improved stoves and baskets since the beginning of the year, says they have allowed her to start her own bakery business while still reducing her wood consumption by about 25 percent.

“God is angry at us for using so much wood so he sent us this drought,” she said, wrapping up loaves of bread in yellowing paper. “Hopefully we can change his mind by using less wood.”

SECURITY CHALLENGES

John Riley, project director at International Relief and Development (IRD), a charity managing the BRACED project in Mali, said the “farms of the future” approach aims to “help communities grow more independent in the long term, rather than rely on external assistance”.

But a recent rise in jihadist attacks in Mali’s north – and increasingly in the country’s centre – have hampered progress. A ban on motorcycle travel, aimed at reducing the attacks, prevents farmers and field agents from travelling to the villages they’re meant to visit or assist, Riley said.

“They [the bandits] aren’t necessarily against our work with farmers but they often think we’re plotting with the government to get rid of them,” he said.
“As a result we’ve had to stop or relocate activities in about a quarter of the villages we operate in,” he said. “That’s tricky because while we may leave, the communities are still there and grappling with the same challenges.”

For now, said Traoré, security and budget permitting, the project hopes to repeat the “farms of the future” experience in other regions in Mali, and in neighbouring countries.

(Reporting by Zoe Tabary @zoetabary, editing by Laurie Goering. The Thomson Reuters Foundation, the charitable arm of Thomson Reuters, covers humanitarian news, women’s rights, trafficking, resilience and climate change.)

The Thomson Reuters Foundation is reporting on the BRACED program to support the program’s goal to develop and disseminate climate resilience knowledge. Alex Potter reported from Mali with support from the International Reporting Project.

Dry landscape in Sibougou, central Mali.

This work contributes to the UN Sustainable Development Goal
Extension agents trained on groundnut technologies to help farmers improve their yields

Farmers examining a groundnut farm cultivating new varieties.

Groundnut cultivation in northern Nigeria can be a daunting task as the soils are generally poor. This is aggravated by the fact that farmers rarely follow the prescribed fertilizer recommendations. Three improved varieties of groundnut – SAMNUT 24, 25 and 26 – with a yield potential of 2.5 tons per hectare were released in Nigeria in the recent past, but farmers here get a yield that’s less than a ton per hectare. To address this issue and the other challenges of groundnut cultivation in the region, two training programs were organized for extension workers.

The major groundnut production challenges in the region include low yields, foliar disease, inadequate knowledge of improved varieties, limited skills and knowledge of extension agents on recommended production technologies, and aflatoxin infestation due to inadequate on-farm and post-harvest operations. In addition, groundnut is a self-pollinating crop, has a low seed multiplication ratio, requires a high sowing rate (70-80 kg/ha), and has a short germination potential when already shelled. Securing groundnut seed at the onset of the planting season is more expensive (about USD 1/kg) than other crops and ensuring farmer access to improved varieties remains a key challenge.

It was against this background that two training workshops were organized for extension agents and field assistants of the State where the Nigerian component of the USAID Groundnut Upscaling Project is being implemented. According to Dr Michael Vabi, Country Project Manager, Nigeria, ICRISAT, the two workshops were designed to help the extension agents improve their knowledge and skills to assist farmers in increasing farm yields through the use of both improved groundnut varieties and accompanying crop management practices.

The workshops addressed specific and general aspects of groundnut-based technologies from production through storage to the distribution and marking of seeds. The emerging trends and challenges of producing groundnut in the dry season and the underlying environmental concerns in groundnut production were also included in the trainings.

At the end of the training workshop in Kano, Mr Mallam Sanusi Dankowa, the Project Desk Officer of Kano State Agricultural Development Program, appreciated the project and ICRISAT for bringing together extension workers from different states and training them to become better technical advisors to the groundnut farmers in their respective areas of operation.

The first workshop was held in Kano city on 11 and 12 April for Kano, Katsina and Jigawa States; the second workshop was held in Sokoto on 26 and 27 April for Sokoto and Kebbi States. A total of 91 extension agents with 64 from the partner Agricultural Development Projects (ADPs), 6 from private seed companies and 21 from partner institutions benefited from the training. Only eight of the extension agents/field assistants were women. All sessions were conducted in the Hausa language by resource persons from ICRISAT-Nigeria.
Project: Increasing groundnut productivity of smallholder farmers in Ghana, Mali and Nigeria
Funder: United States Agency for International Development (USAID)
Partners: Institute for Agricultural Research (IAR) of the Ahmadu Bello University, National Agricultural Seeds Council (NASC), Centre for Dryland Agriculture of the Bayero University of Kano (CDA/BUK), Federal University of Agriculture, Makurdi (FUAM), Green Sahel Agricultural and Rural Development Initiative (GSARDI), Catholic Relief Services (CRS), Women Farmers Advancement Network (WOFAN) and the Agricultural and Rural Development Programs of Kebbi, Sokoto, Jigawa, Kano and Katsina.

This work contributes to the UN Sustainable Development Goals
Farmer’s perception of land degradation and solutions to restoring land fertility in Niger

One of the biggest challenges in West Africa Sahel countries like Niger is preventing soil fertility decline and land degradation under growing pressure on natural resources to meet food and animal feed demands. Assessing the perception of farmers and local communities to co-develop solutions for existing challenges is fundamental to ensuring the buy-in and commitment of communities to implement technological solutions and better practices. In the four target regions in Niger (Dosso, Maradi, Tahoua and Zinder), a team from ICRISAT organized individual interviews, brainstorming and focus groups discussions with 600 farmers in 25 villages. Through these engagements, farmers identified the causes of degradation of cultivated lands and expressed their desire to adopt science-backed solutions.

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Announcement

Role of IoT in Smart Agriculture

Dr Anthony Whitbread, Research Program Director - Innovation Systems for the Drylands, ICRISAT, will be speaking on the topic ‘Role of IoT in Smart Agriculture’ in one of the panel discussions at the first edition of Connected India - The Internet of Things Conclave.

The conclave, organized by CNBC-TV18 in association with Bosch, will see proactive collaboration from all stakeholders and industry leaders on harnessing the power of Digital Technologies for India’s future.

Date: 14 June 2017
Conclave begins: 5:30 pm (IST)
Panel discussion on Smart Agriculture: 6:05 pm to 6:55 pm (IST)
Venue: Hyatt Regency, Bhikaiji Cama Place, New Delhi
New Publications

Fertilizer micro-dosing in West African low-input cereals cropping: Benefits, challenges and improvement strategies

Authors: Blessing OC, Ibrahim A, Safo EY, Yeboah E, Abaidoo RC, Logah V and Monica UI

Abstract: Soil amendments are often unavailable in adequate quantities for increased crop production in smallholder cereal-based cropping systems in Africa. In order to increase crop yields and encourage farmers to apply inorganic fertilizers, fertilizer micro-dosing technology was developed. Fertilizer micro-dosing consists of the application of a small quantity of mineral fertilizer together with seeds of the target crop in the planting hole at sowing or 2-4 weeks after sowing. The objective of this paper is to review literature concerning crops responses to fertilizer micro-dosing in West Africa. The review also evaluates the benefits and challenges associated with nutrient management under fertilizer micro-dosing and supportive strategies for further improvement in the efficient use of limited nutrient sources of smallholder farmers were suggested.

http://oar.icrisat.org/9970/

Survey of Chickpea (Cicer arietinum L.) Ascochyta Blight (Ascochyta rabiei Pass.) Disease Status in Production Regions of Ethiopia

Authors: Tadesse M, Turoop L and Ojiewo CO

Abstract: Chickpea (Cicer arietinum L.) is one of the most important pulse crops in Ethiopia. A survey was conducted from August 2015 to February 2016 to determine the status of the blight disease in the major chickpea growing areas of Ethiopia. A total of 251 on-station and on-farm fields were surveyed. Ascochyta blight was observed in 30 of the 251 fields and incidence ranged from 0 to 45.6% with mean of < 10%. The severity varied from 1 to 7 with a mean severity of 1 to 3.2. The low incidence and severity of the disease observed in the 2015-2016 season was associated with the drought conditions caused by El Nino conditions.

http://oar.icrisat.org/9971/

Field persistence of Habrobracon hebetor (Say) (Hymenoptera: Braconidae) following augmentative releases against the millet head miner, Heliocicelus albipunctella (de Joannis) (Lepidoptera: Noctuidae), in the Sahel

Authors: Kabore A, Ba NM, Dabire-Binso CL and Sanon A
Published: 2017. Biological Control, 108: 64-69. ISSN 10499644

Abstract: Biological control by augmentative releases of the parasitoid wasp Habrobracon hebetor Say (Hymenoptera: Braconidae) is a promising strategy for controlling the millet head miner (MHM), Heliocicelus albipunctella (de Joannis) (Lepidoptera: Noctuidae). A current biological control program in the Sahel region involves inoculative releases of the parasitoid during each growing season, but this is prohibitively expensive. The present study aimed to quantify residual parasitism of MHM in years after augmentative release. We also investigated the impact of two successive annual releases of H. hebetor on MHM parasitism. The findings suggest that augmentative releases could be carried out biennially instead of annually. Possible means of enhancing parasitoid survival between seasons are discussed.

http://oar.icrisat.org/9975/

Can mobile phone-based animated videos induce learning and technology adoption among low-literate farmers? A field experiment in Burkina Faso

Authors: Maredia MK, Reyes B, Ba MN, Dabire CL, Pittendrigh B and Bello-Bravo J
Published: 2017. Information Technology for Development: 1-32. ISSN 0268-1102

Abstract: This article describes a randomized controlled field experiment conducted in Burkina Faso to evaluate the effectiveness of animated videos shown on mobile phone compared with the traditional extension method (live demonstration) in inducing learning and adoption of two post-harvest technologies among low-literate farmers. Results suggest that video-based training was as effective as the traditional method in inducing learning and understanding. For technologies that farmers were already aware of, animated video shown on the mobile phone was also as effective as live demonstration in inducing adoption. However, in transferring new technologies, the traditional method was more effective in inducing adoption at p < .10, but not at p < .05. Potential role of mobile phone-based videos as part of the agricultural extension system is discussed.

http://oar.icrisat.org/9973/

Crop health and its global impacts on the components of food security

Published: 2017. Food Security, 9 (2): 311-327. ISSN 1876-4517

Abstract: The literature on the importance of plant pathogens sometimes emphasizes their possible role in historical food shortages and even in famines. Aside from such major crises, plant pathogens should also be seen as important reducers of crop performances, with impacts on system sustainability, from the ecological, agronomical, social, and economic standpoints – all contributing ultimately to affecting food security. These views need reconciliation in order to produce a clearer picture of the multidimensional effects of plant disease epidemics. Such a picture is needed for disease management today, but would also be useful for future policies. This article attempts to develop a framework that would enable assessment of the impacts of plant diseases, referred collectively to as crop health, on food security via its components.

http://oar.icrisat.org/9976/
Soil Properties, Crop Yield, and Economics Under Integrated Crop Management Practices in Karnataka, Southern India

Authors: Wani SP, Anantha KH and Garg KK
Published: 2017. World Development, 93: 43-61. ISSN 0305750X

Abstract: Considering the importance of sustainable production practices with greater resource use efficiency, a study was conducted during 2009–12 to understand soil properties, crop yield, and economics as affected by the integrated crop management (ICM) practices under the Bhoochetana (soil rejuvenation) program in Karnataka, India. Results from 3776 crop-cutting studies on different crops (cereals, pulses, and oilseeds) revealed that there is a vast spatial variability in case of various soil nutrients across different taluks of Karnataka. Balanced fertilizer application, both in rainfed and irrigated areas, directly influenced crop yields. The findings suggested that there is a vast potential for crop productivity improvement through ICM practices across different soil types and rainfall zones of Karnataka, India.

http://oar.icrisat.org/9978/

Deciphering Genomic Regions for High Grain Iron and Zinc Content Using Association Mapping in Pearl Millet

Authors: Satyavathi CT, Srivastava RK, Anuradha N, Bharadwaj C, Nepolean T, Sankar SM, Singh SP, Meena MC and Singhal T
Published: 2017. Frontiers in Plant Science, 8 (412): 1-17. ISSN 1664-462X

Abstract: Micronutrient malnutrition, especially deficiency of two mineral elements, iron [Fe] and zinc [Zn] in the developing world needs urgent attention. Pearl millet is one of the best crops with many nutritional properties and is accessible to the poor. We report findings of the first attempt to mine favorable alleles for grain iron and zinc content through association mapping in pearl millet. An association mapping panel of 130 diverse lines was evaluated at Delhi, Jodhpur and Dharwad, representing all the three pearl millet growing agro-climatic zones of India, during 2014 and 2015. Findings from this study can help in breeding new lines with enhanced micronutrient content using marker-assisted selection (MAS) in pearl millet.

http://oar.icrisat.org/9979/

Soil health to human and animal health through breeding biofortified cultivars and balanced nutrient management for nutrition revolution in India

Authors: Wani SP and Govindaraj M

Abstract: India has larger prevalence of micronutrient malnutrition as 50% of children and women are suffering from one or more essential micronutrient deficiencies. Widespread multi-nutrient deficiencies in soil are resulting in nutrient deficient food leading to malnutrition. Feeding the children with supplements to address the issue is good to fix the issue quickly. However, in the long run, to find a sustainable solution, we need to adopt a holistic approach. Our approach is to provide a “proof of concept” to address the issue of malnutrition through soil health management and biofortification of staple food crops.

http://oar.icrisat.org/9983/

Genetic Variability, Genotype × Environment Interaction, Correlation, and GGE Biplot Analysis for Grain Iron and Zinc Concentration and Other Agronomic Traits in RIL Population of Sorghum (Sorghum bicolor L. Moench)

Authors: Phuke RM, Anuradha K, Radhika K, Jabeen F, Anuradha G, Ramesh T, Hariprasanna K, Mehtre SP, Deshpande SP, Anil G, Das RR, Rathore A, Hash CT, Reddy BVS and Ashok Kumar A

Abstract: The low grain iron and zinc densities are well documented problems in food crops, affecting crop nutritional quality especially in cereals. Sorghum is a major source of energy and micronutrients for majority of population in Africa and central India. Understanding genetic variation, genotype × environment interaction and association between these traits is critical for development of improved cultivars with high iron and zinc. A total of 336 sorghum RILs (Recombinant Inbred Lines) were evaluated for grain iron and zinc concentrations along with other agronomic traits for two years at three locations. The RIL population showed good variability and high heritabilities (>0.60, in individual environments) for Fe and Zn and other traits studied, indicating its suitability to map QTL for iron and zinc.

http://oar.icrisat.org/9985/