

## Biosciences at IITA

### IITA partners with BecA in molecular breeding

IITA has partnered with the ILRI-Beca hub through its Integrated Breeding Service and Support (IGSS) platform, to apply molecular tools to speed up genetic gain for improved crops and livestock in Africa. The goal of IGSS is to enable any African breeder to utilize the newest molecular tools to improve crops and livestock. The platform provides genotyping, bioinformatics, genetic analysis, and breeding decision support services. IITA's molecular breeder, Morag Ferguson, will be working with IGSS to deliver some of these services. The core technology of IGSS is DArTseq, a reduced representation genotyping technology based on next generation sequencing. IGSS generates the data in Nairobi through a platform which it operates in conjunction with the private genotyping and information technology company, Diversity Arrays Technology Pty Ltd (DART), Canberra, Australia. The technology generates high quality data at an affordable price. Recent cassava DArTseq genotyping generated 16,000 SNPs and 16,000 InSilico DArT markers (a reflection of epigenetic variation). The technology easily deals with complex polyploids, a challenge to many other genotyping approaches. The extensive genotyping data can

be applied to Genome Wide Association Studies (GWAS) to identify quantitative trait loci (QTL) of interest, genomic selection (GS), prediction of performance of untested lines and breeds, gene mapping and gene tagging, analysis of genetic diversity, monitoring of varietal adoption through genetic identification and purity testing, quality control in seed production, rapid profiling of parental lines and breeds, and development of new markers and gene assays. Please contact Morag Ferguson ([m.ferguson@cgiar.org](mailto:m.ferguson@cgiar.org)) for more information.

### Molecular breeding in East Africa

To date molecular breeding in East Africa has focused on cassava. The main challenges to cassava in

the region are the virus diseases, Cassava Brown Streak Disease (CBSD) and cassava mosaic disease (CMD). Together these diseases cause over \$1 billion losses in production on the continent every year. These losses are predicted to escalate as CBSD spreads from East towards West Africa, the largest cassava-producing region in Africa. MAS for resistance to both diseases would enable preemptive breeding in West Africa in advance of the CBSD pandemic, and contribute efficiencies in breeding in East Africa. Field resistance to CBSD has been observed in landraces from Tanzania, possibly derived from an early breeding program at Amani (1930-40s) which included interspecific crosses. IITA has been working with the Agriculture Research Institute (ARI) in Tanzania to identify QTL associated with



*Martin Ngunjiri Kanyeki of IGSS, BecA and the Illumina HiSeq high-throughput sequencer used by IGSS*

both CBSD and CMD. Markers associated with the QTL have been identified and their efficiency at predicting field resistance to CBSD is currently being assessed. Work is continuing in both validation of markers as well as refining and improving these markers through further genetic mapping.

Molecular markers, particularly SNP markers, have also been applied to diversity assessment and for genetic identification. Recently 320 cassava landraces from Tanzania were genotyped using DArTSeq to identify distinct genotypes for entry into a genebank. To enhance the quality, accuracy, and efficiency of the molecular breeding activities several new tools and databases have been implemented. These include automated image analysis-based phenotyping, QTL analysis for clonal crops, implementation of barcoding, and the use of tablet-based tools such as the Fieldbook (phenotyping data) and Coordinate (sample tracking). In

addition, bioinformatics capacity has been established for analysis of GBS data as well as a pipeline for detection of polymorphism for the development of VIGS constructs. Trushar Shah supports molecular breeding data management and informatics more broadly through the Integrated Breeding Platform (IBP) and is based in Nairobi. He can be contacted for further information ([tm.shah@cgiar.org](mailto:tm.shah@cgiar.org)).

### A VIGS based approach to identify sources of genetic resistance to CSBD and CMD

Viral Induced Gene Silencing (VIGS) is an RNAi-based approach in gene silencing which enables systemic, long-term, knockdown of one or more target genes from a single vector. The Cassava VIGS project is a collaboration between IITA and The German Collection of Microorganisms and Cell Cultures (DSMZ) and is funded by The German Federal Ministry for Economic Cooperation and

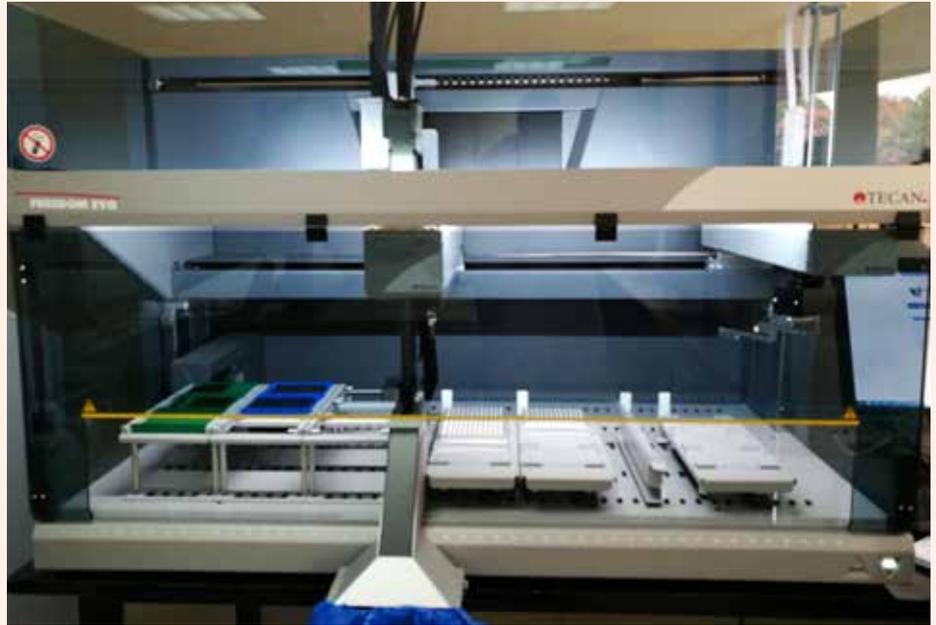
Development. The project aims to identify genes that provide naturally occurring resistance to CBSD and CMD. Genes thought to provide this resistance have been identified through previous QTL and transcriptomic research conducted by IITA as well as the general literature. Using the VIGS technique, these candidate genes are knocked down in virus resistant cassava varieties. Subsequent infection by the causative virus of either CSBD or CMD will provide insight into each gene's role in resistance to each disease. This information can then be used in breeding programs to contribute to improved cassava yields for regional farmers. The VIGS technique is not widespread in Africa and a further goal of the project is to increase its use locally. To this end, regular theoretical and practical training is being conducted for researchers and students from the national agricultural research systems (NARS). Please contact Rod Eyles ([r.eyles@cgiar.org](mailto:r.eyles@cgiar.org)) for more information.



*The East Africa hub – Nairobi team, largely based at the BecA-ILRI hub*

## Plant Transformation Platform

IITA has established 'Genetic Transformation Platform' for banana, plantain, cassava, and yam; the most important food crops in sub-Saharan Africa. Such platform is instrumental for genetically modified (GM) product development for Africa and transfer technologies to NARS in sub-Saharan Africa. The established genetic transformation systems have allowed us to develop improved varieties by incorporating agronomically important traits such as those conferring disease or pest resistance. IITA is working in partnership with National Agriculture Research Organization (NARO) in Uganda and Kenya Agriculture and Livestock Research Organization (KALRO) in Kenya for developing genetically modified banana resistant to *Xanthomonas* wilt (BXW) disease. IITA has developed nematode-resistant plantains in collaboration with University of Leeds, UK and NARO-Uganda. We have established proof of concept demonstrating field-based resistance to BXW disease and nematode. These technologies look so promising that we would like to move to multilocational field trials to test our resistant bananas in different environmental and climate conditions. Such resistant varieties would enhance production of banana and plantain; and save livelihoods in Africa, where the Green Revolution has had little influence. We are now expanding the transgenic technology developed on banana for control of bacterial wilt disease of enset in partnership with Ethiopian Institute of Agriculture Research (EIAR). We have also started developing virus-resistant plantains for Africa in partnership with Queensland University of Technology (QUT) Australia and



*Tecan robotics enables accurate and rapid movement of liquids ensuring assay reproducibility and providing efficient use of resources.*

Malawi Department of Agricultural Research Services (DARS). IITA is also working on genetic modification of yam. We are also interested in developing new crop improvement technologies like genome editing for vegetatively propagated crops. We are trying to establish genome editing tool for yam using CRISPR/Cas9 system in collaboration with Iowa State University (ISU), USA. Currently transgenic research at IITA is hosted by Biosciences for east and central Africa (BecA) hub, at the International Livestock Research Institute (ILRI), Nairobi, Kenya. Please contact Leena Tripathi ([l.tripathi@cgiar.org](mailto:l.tripathi@cgiar.org)) for more information.

## Quality Management System (QMS) in the Plant Transformation Laboratory

QMS is essential for programs that tie into crop improvement strategies. QMS is a collection of policies, procedures, plans, resources, processes, practices, and the specification of responsibilities and organization designed to achieve product and service quality levels, and company objectives. It

helps coordinate and direct an organization's activities to meet quality of product and regulatory requirements, and improve its effectiveness and efficiency on a continuous basis. Establishing a QMS requires a systems approach and is implemented in phases. The IITA Plant Transformation Laboratory started the process of implementing QMS. It has established a document control system and information management system to create traceability of laboratory and product information. Recently, the Plant Transformation Laboratory has been audited by a third party for quality assurance and quality check. There are many "off the shelf" QMS programs such as Excellence Through Stewardship (ETS) addressing several critical elements and critical control points. ETS guides and provides technical resources to understand and implement stewardship and QMS for the full life cycle of agricultural technology products. IITA has recently joined ETS. IITA's membership marks its commitment to the best quality management and product stewardship practices. Please contact Leena Tripathi ([l.tripathi@cgiar.org](mailto:l.tripathi@cgiar.org)) for more information.