

# Molecular Breeding Capacity Building Workshop

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## **Supported by**

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## **Co-sponsored by**

*CIMMYT, IITA and Beca*

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## Course Content

<p><b>Lecture 1</b> Overview of molecular breeding</p>	<p>Genetic variation from phenotype to molecular variation; genetics and breeding populations; genetic recombination and selection; molecular breeding approaches (genetic transformation and marker assisted selection); basic procedures in MAS applications; genotyping systems; capacity building; decision support tools.</p>
<p><b>Lecture 2</b> Molecular markers and genotyping systems</p>	<p>Overview of marker types and their use in molecular breeding; what is a marker and how can they be used? what is DNA and what are DNA-based markers? why use DNA-based markers? pros and cons of each type; how do we measure variation using molecular markers: theory; how do we measure variation using molecular markers: techniques, limitations and interpretation; practical interpretation using real data; genotyping: putting theory into practice, methods, scale and cost.</p>
<p><b>Lecture 3</b> Genetic diversity analysis: theory</p>	<p>What is diversity assessment and why is it important; principles of diversity assessment; use of genetic diversity assessment for conservation; analysis and interpretation of genetic diversity; use of genetic diversity information in plant breeding; tools for genetic diversity and population structure analysis.</p>
<p><b>Lecture 4</b> Genetic maps and marker-trait association –how agronomic traits can be mapped</p>	<p>What is a linkage map; an overview of the statistical theory behind linkage map construction and practical considerations; combining map and phenotype; concepts of QTL analysis, including the definition of a quantitative trait, genetic variance associated with QTL and gene action, linkage and linkage disequilibrium mapping; what can breeders contribute to genetic mapping.</p>
<p><b>Lecture 5</b> Marker-assisted breeding - theoretical issues</p>	<p>A to Z of marker assisted breeding; theory of marker-assisted selection, including single-, interval- and multiple- marker based MAB; populations used for MAB; MAB for multiple traits; marker-assisted gene introgression; marker-assisted background selection; marker-assisted gene pyramiding; marker-assisted recurrent selection; MAB for quantitative traits; and response to MAB; management of heritability, population size, and selection intensity in mapping experiments and MAB.</p>
<p><b>Lecture 6</b> Marker-assisted selection – putting it into practice</p>	<p>Why marker-assisted selection (time, money and opportunities)? What should my breeding program look like; experimental design and examples for marker-assisted backcrossing; experimental design and examples for advanced backcrossing QTL analysis; the traits suitable for MAS; MAS for specific traits: quality and heterosis as examples; experimental design and examples for marker-assisted recurrent selection (MARS); experimental design and examples for whole genome selection; comparison of MARS and whole genome selection; whole genome selection for gene pyramiding; marker validation; genetic background effects; benefit-cost analysis.</p>

<b>Lecture and demo I</b> DNA extraction and PCR	Tour to lab and facilities; demo from DNA extraction to PCR to genotyping (agarose gel and PAGE gels)
<b>Lecture and Demo II</b> Genetic diversity analysis: software and demo	Use of freely available software for the analysis of genetic diversity within one breeding system; discussion on result interpretation and methods for improving breeding program based on results; software demo.
<b>Lecture and demo III</b> Breeding informatics (data collection, data management, data mining)	Information collection-germplasm information (passport data, pedigree and genealogy, genetic stocks), pedigree information management; genotypic information (DNA markers, sequences, expression information), phenotypic information, and environmental information; information integration-data standardization, generic databases, controlled vocabularies and ontologies, interoperable query system, redundant data condensing, and database acquisition, storage and integration; information retrieval and mining; information management systems – breeding information management systems, international crop information systems.
<b>Lecture and demo IV</b> Data analysis and utilization for MAS and breeding	Step-by-step data analysis for marker-trait association, and MAS; allele frequency analysis; haplotype analysis; integrated phenotypic and genotypic selection; selection response and prediction of selection results; simulation and MAS.
<b>Activity I</b> Starting a real molecular breeding program	Small group discussions on breeding program structure and utilization of molecular breeding
<b>Activity II</b> Prioritizing target traits and donor germplasm	Prioritizing target traits and donor germplasm based on their economic importance, feasibility for marker-assisted selection, availability of favourable alleles and germplasm. This will be done for drought tolerance and adaptive traits most important to Drought Tolerance Maize for Africa project.
<b>Activity III</b> Planning on population development and collection of the target populations	Planning and information exchange on population development for genetic mapping, molecular breeding and integrated mapping and breeding efforts. Collecting of the target populations and genetics and breeding materials generated across breeding programs for genetic mapping of target traits.

<b>Activity IV</b> Developing strategies for phenotyping and multi-environment trial	Developing strategies for phenotyping and multi-environment trials for the traits with worldwide interest, including standardizing phenotyping methodologies and protocols, analyzing GxE interactions, utilizing GIS data with other sources of breeding information, and sharing information.
<b>Activity V</b> Developing genotyping systems	Genotyping support systems (including sampling, packaging, shipping)
<b>Activity VI</b>	Course evaluation and discussion
<b>Open Session</b>	Discuss / troubleshooting of any workshop topics and issues brought up by participants