# Plant Quantitative Genetics

The understanding of quantitative genetics is critical for the success of a modern scientific plant breeder or geneticist. This course focuses on both the basic theory of quantitative genetics and applied computational solutions. The course attempts to translate cutting edge technologies, such as Next Generation Sequencing (NGS), Genome-wide Association Study (GWAS), and Genomic Selection (GS), into plant breeding programs. From this course, core genetic concepts will be reinforced, such as **heritability**, **linkage disequilibrium**, **genetic diversity**, **population structure**, and **genetic effect**. After taking this course, students would be able to interpret results from association studies and to conduct association mapping independently.

## Schedule (with lab):

1. **Introduction**

   Historical overview of quantitative genetics. Introduction to R, probability theory and statistics.

   **lab1**: learning R, Rstudio, github

2. **Genetic and environmental variances**

   Genetic models for mean and variance, GxE, heritability

   **lab2**: phenotypic data plotting, calculate BLUE, BLUP, heritability

3. **Genetic diversity and relationships**

   Covariance among relatives, heterosis, combining ability, inbreeding coefficients, genetic distance

   **lab3**: SNP data manipulation, allele frequency, IBD

4. **Linkage and selection**

   Genetic drift, introgression, linkage and linkage disequilibrium (LD)

   **lab4**: calculate introgression, LD, plot pairwise LD

5. **QTL Mapping**

   Genetic map construction, single marker analysis, interval mapping, composite interval mapping

   **lab5**: QTL mapping with Rqtl

6. **Association Mapping**

   Population structure, sub-structure, kinship, genetic distance, mixed linear model

   **lab6**: GWAS using GenABEL and/or GAPIT. TASSEL, PLINK, GCTA

7. **Selection Mapping**

   Bulked segregant analysis (BSA), recurrent selection, selection scan, Fst, Tajima' D

   **lab7**: continuing lab on GWAS and introduce ANGSD for selection mapping.

8. **Genomic Selection**

   Marker assisted selection, genomic selection.

   **lab8**: GenSel for genomic selection.

9. **Summary**

   Put everything all together, review current progress in the field, and identify potential challenges.

**Textbooks:**


- DS Falconer, and TFC Mackay. 1996. **Quantitative Genetics, fourth edition**. Pearson Education Limited, Essex England.
- Lynch, M., and J. B. Walsh. 1998. **Genetics and Analysis of Quantitative Traits**. Sinauer Associates, Sunderland, MA.
- Bernardo, R. 2002. **Breeding for Quantitative Traits in Plants**. Stemma Press. Woodbury, MN.
- Gondro, C., Van der Werf, J. and Hayes, B. eds., 2013. **Genome-wide association studies and genomic prediction**. Humana Press.