UENF
Universidade Estadual do Norte Fluminense Darcy Ribeiro

"Integrative Biology applied to plant breeding: New challenges for the future plant breeder"

Gonçalo Apolinário de Souza Filho
Lab Biotecnologia/Unidade de Biologia Integrativa

Campos dos Goytacazes
Rio de Janeiro
Brazil

A Brief History ... 10 thousand years!

-Since agriculture began around 10,000 years ago, best-performing plants that nature provided were selected and retained.

https://ceticismo.net/wp-content/uploads/2015/invento-agricultura.jpg

https://fthmb.tqn.com/sCXTECijGo-GQ8YaX0jK4Ll2xNo=/768x0/

-Traits that had appeared spontaneously were bred into certain crops by human selection, often by going against natural selection

A Brief History ... 10 thousand years!

-Traits that had appeared spontaneously were bred into certain crops by human selection, often by going against natural selection

http://sn.uagro.com.br/static//img/editor/660fc43d2b382f67d2e6ae2714cfc63a.jpg

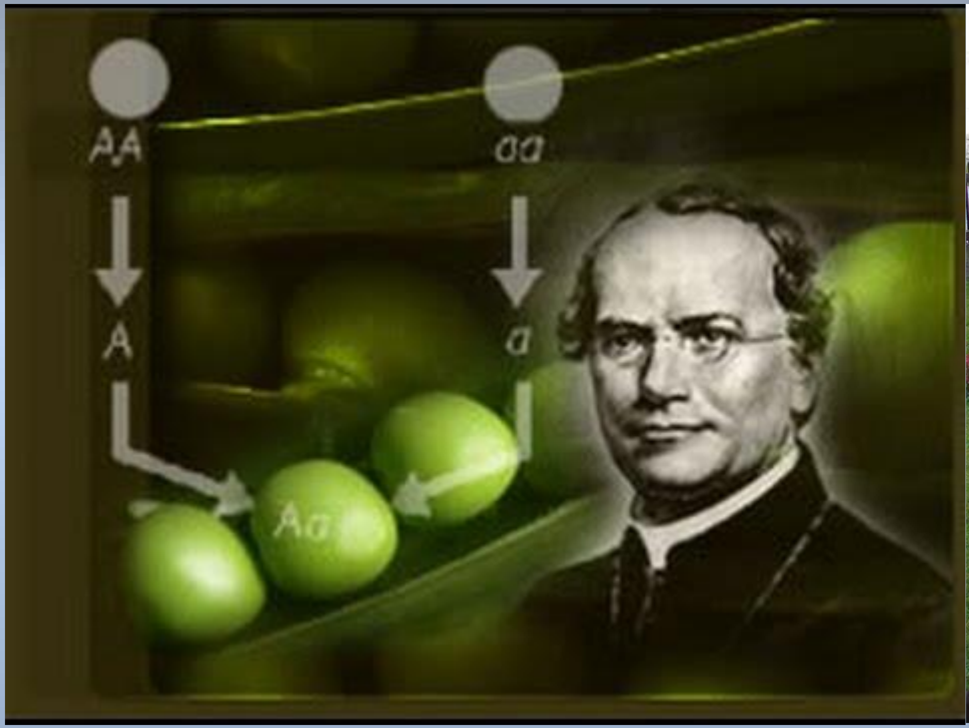
A Brief History … 10 thousand years!

THE FIRST HALF OF THE 19th CENTURY

- Great advances in plant breeding marked the first half of the 19th century
- **Thomas Andrew Knight** who purposely tried to obtain better varieties by crossing various cultivated crops
- He discovered in 1823 that the crosses of Pea white flower x purple flower yielded a purple Fl
- **Patrick Shirreff** began to breed wheat and oats in Scotland
- The first crosses in potatoes were carried out in the first part of the nineteenth century

Mendel’s laws of accelerated plant modification

-Mendel’s discovery of the laws of inheritance towards the end of the 19th century accelerated plant modification.

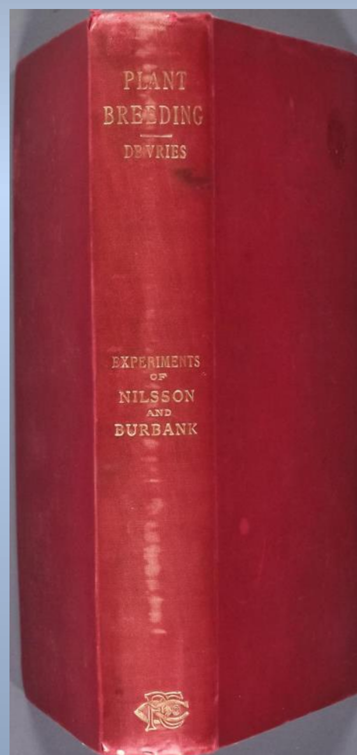


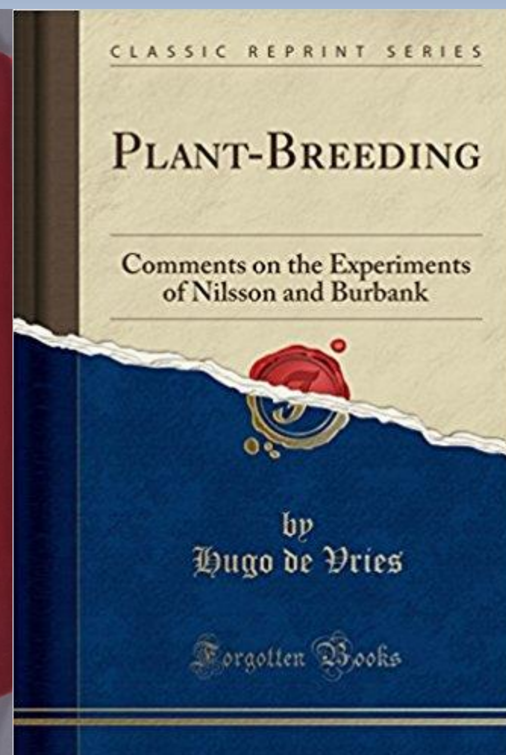
http://www.canil-boiadeiro.com.br/wp-content/uploads/2016/08/Mendel.jpg

https://faculty.uca.edu/johnc/Mendel's%20garden.JPG

Starting point e Plant Breeding

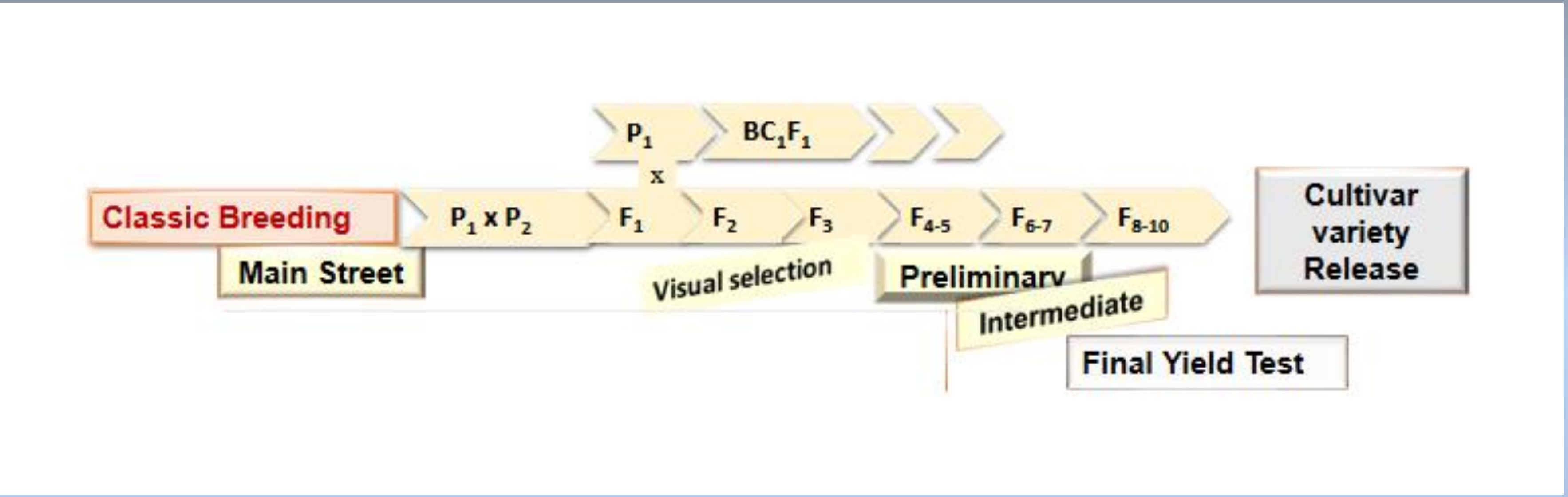
- **Hugo De Vries** published the book on "Plant Breeding" in 1907
- It may serve as a good starting point in the history of plant breeding





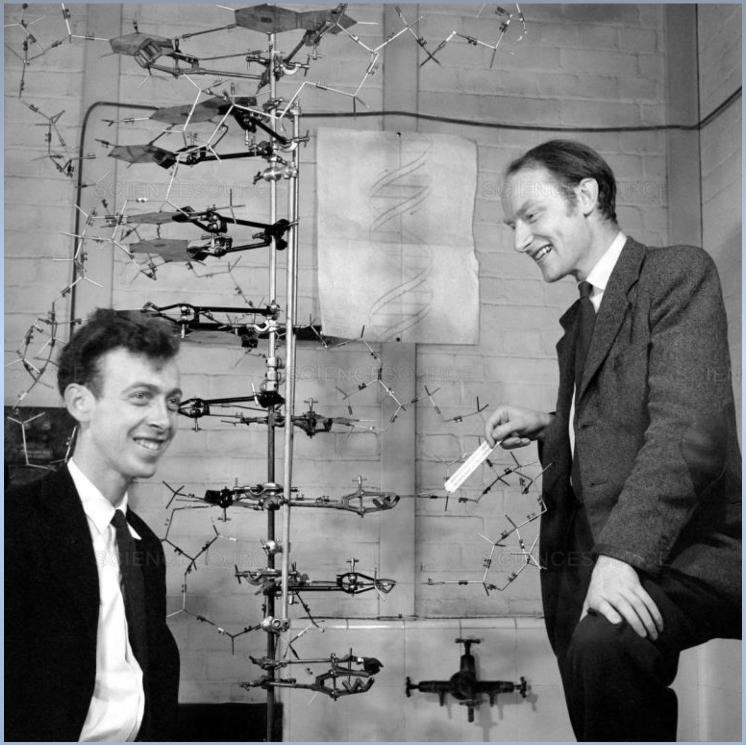
Amazon.com

Plant Breeding Approach



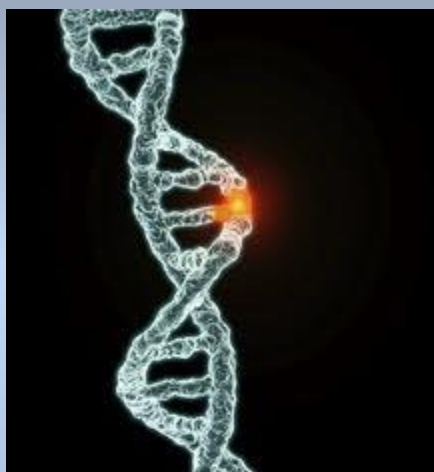
http://images.slideplayer.com/40/11135381/slides/slide_8.jpg

Plant Breeding Approach

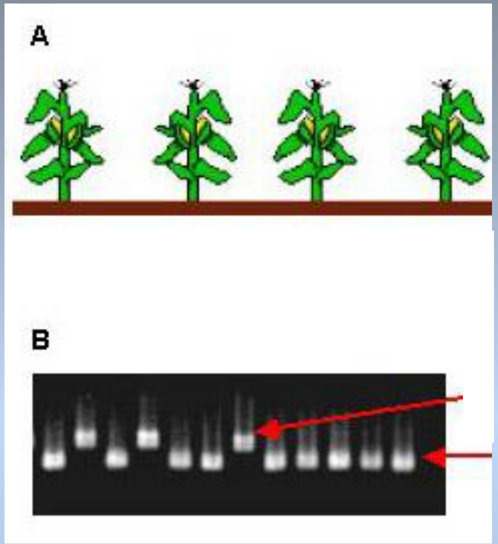


https://www.sciencesource.com/Doc/SCS/Media/TR1_WATERMARKED/d/1/3/5/SS2108529

FROM GENOME TO PHENOTYPE



Molecular Markers



"Associating phenotypic differences to polymorphisms of specific regions in the genome "

Molecular Markers

-Characterization of biodiversity (divergence and phylogeny);

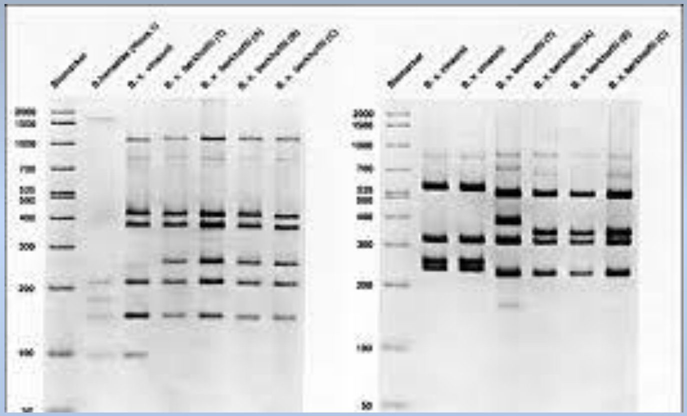
- Identification of markers associated with phenotypic characteristics.

Prediction of phenotypes Based on genomic information

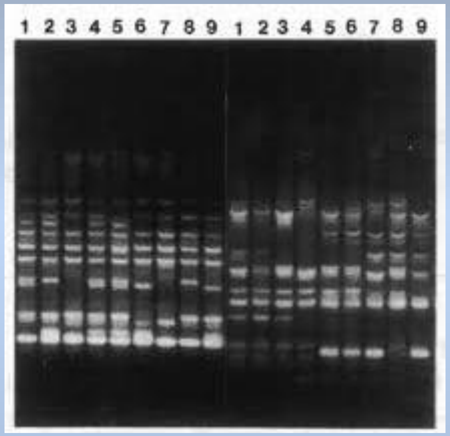
Molecular Markers

Over the last 4.5 decades, several techniques for detecting polymorphisms in DNA have been developed

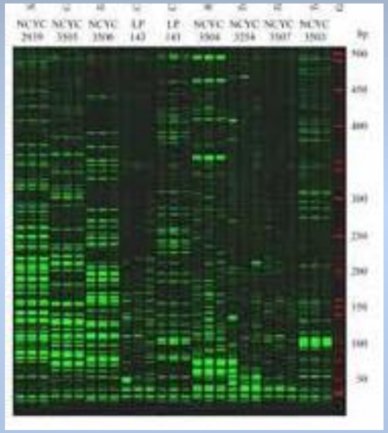
RFLP



RAPD

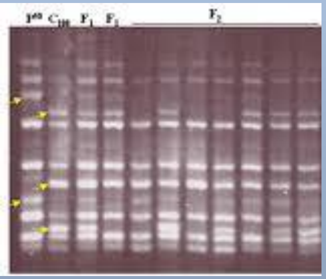


AFLP

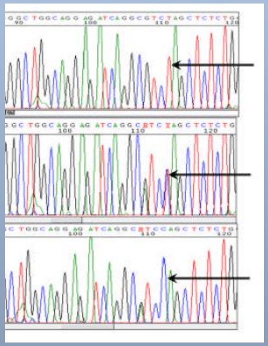


SSR

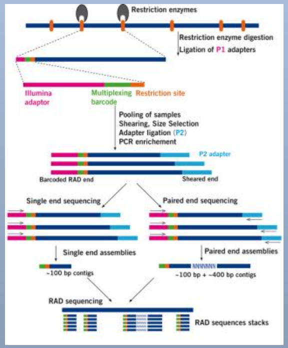
ISSR



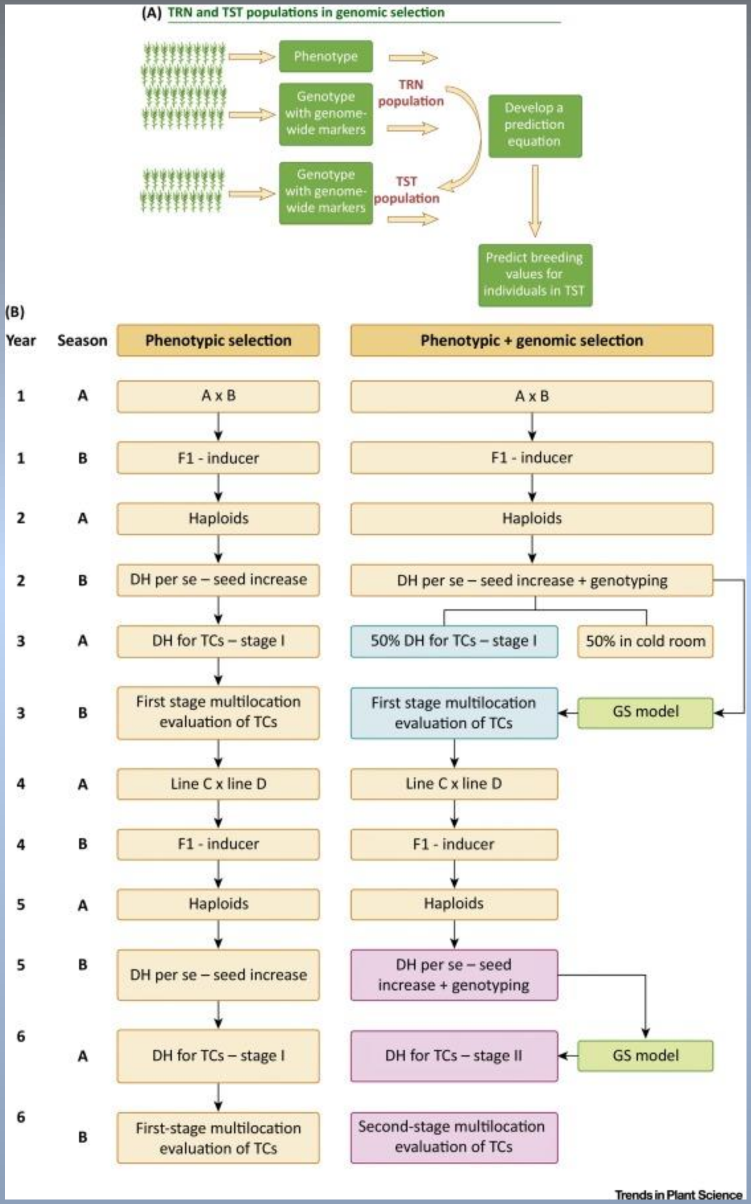
SNP



Rad-seq



Genomic selection (GS)

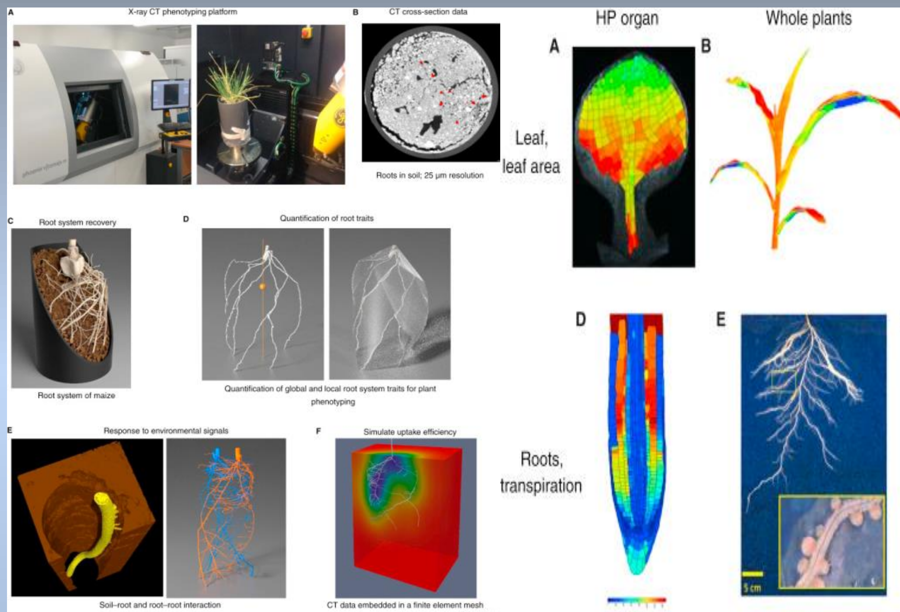


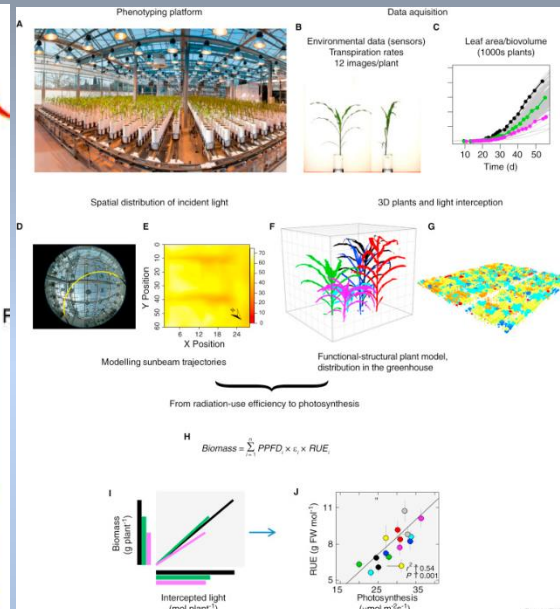
Crossa et al . Trends im Plant Science (2017)

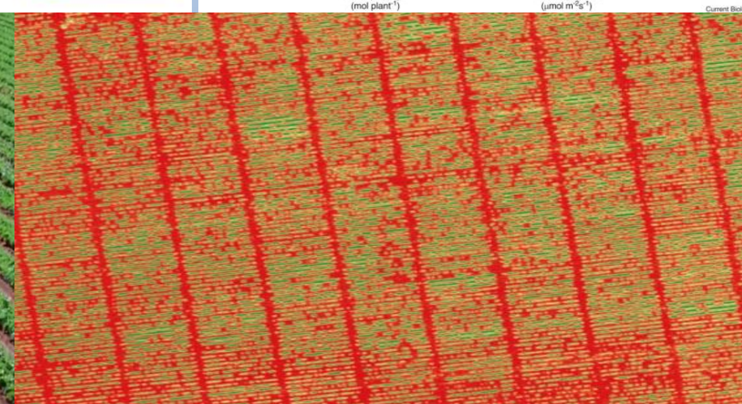
Facilitates the rapid selection of superior genotypes and accelerates the breeding cycle

Prediction of phenotypes

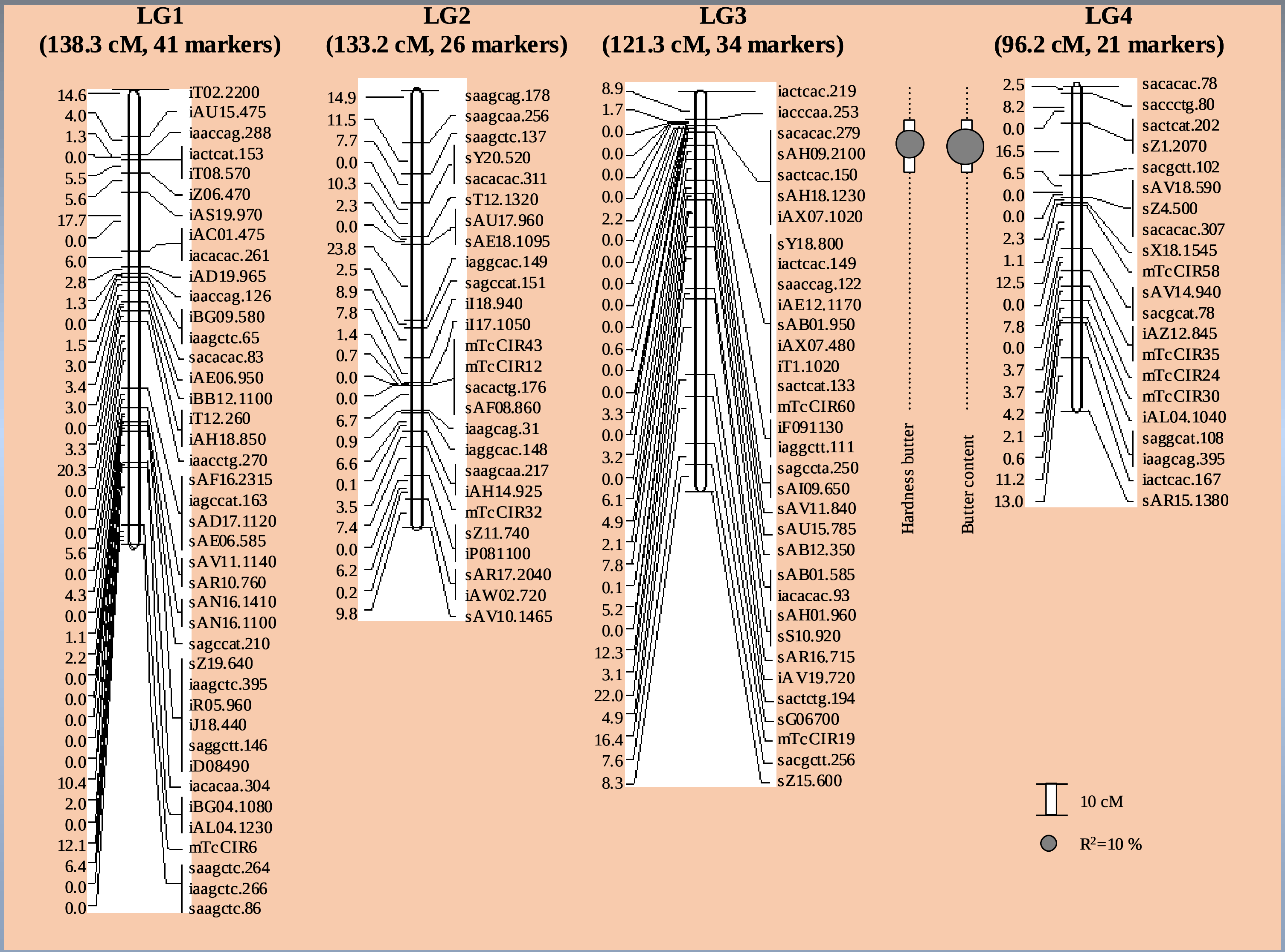
STRONGLY DEPENDENT ON FENOTIPING QUALITY (Phenomics)





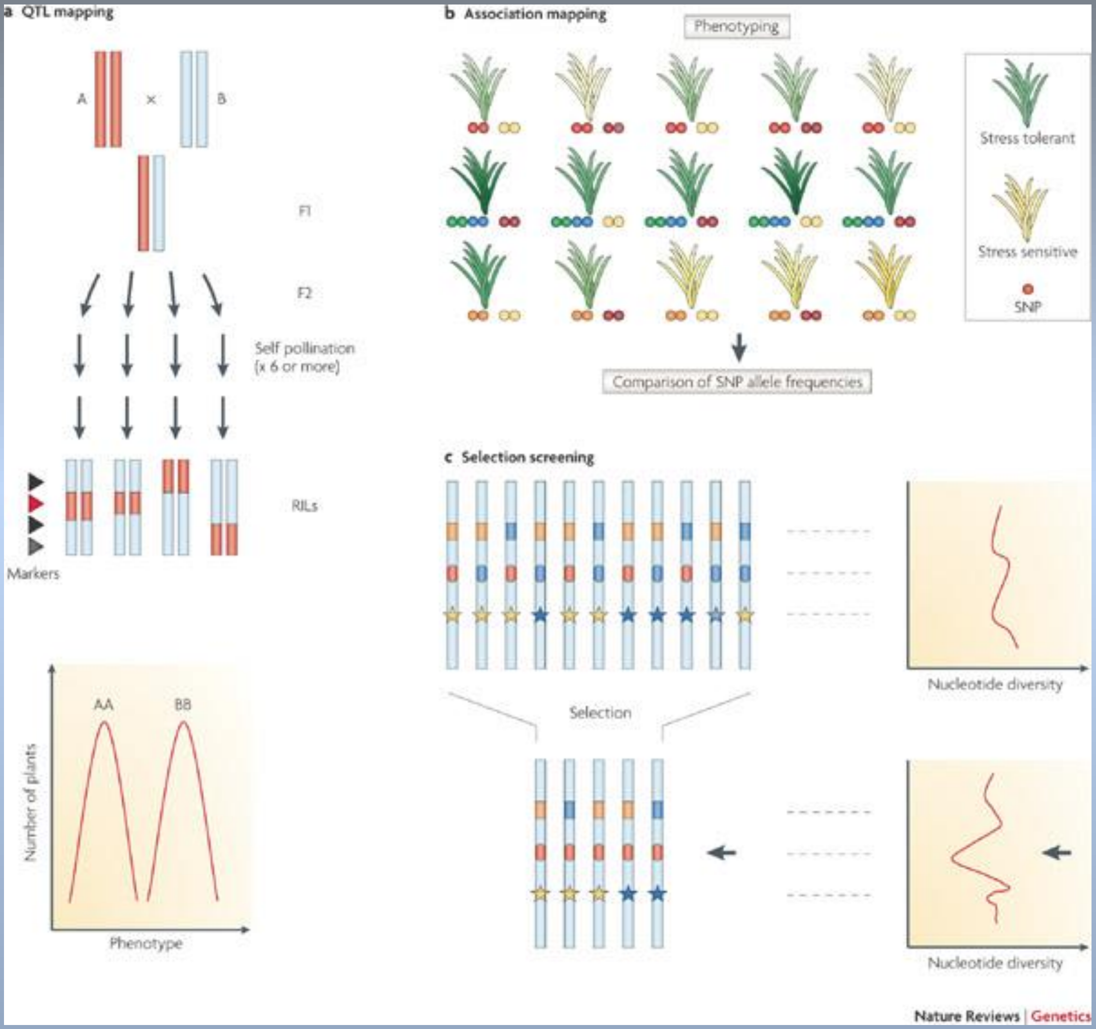


Molecular Markers



Araújo et al, 2008.

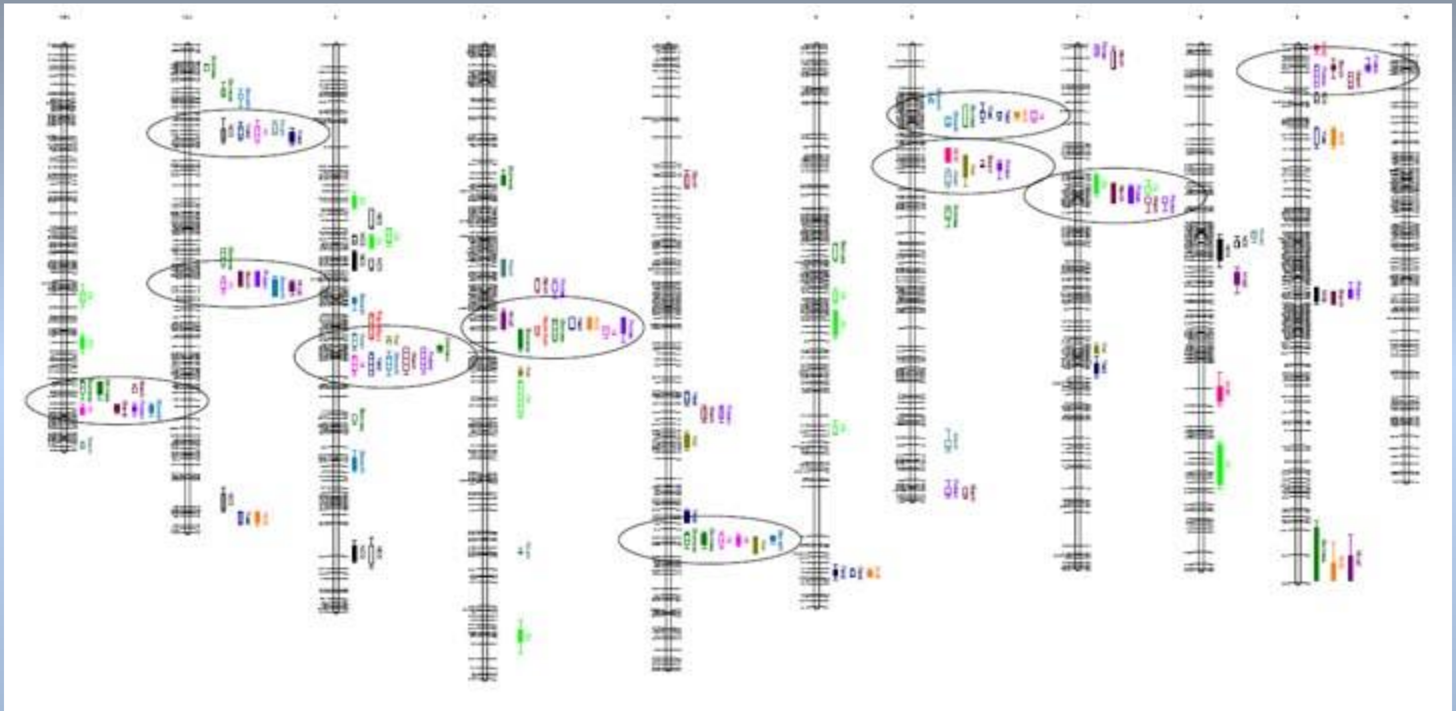
QTL MAPPING



Takeda & Matsuoka (2009) Nature Reviews Genetics 9.

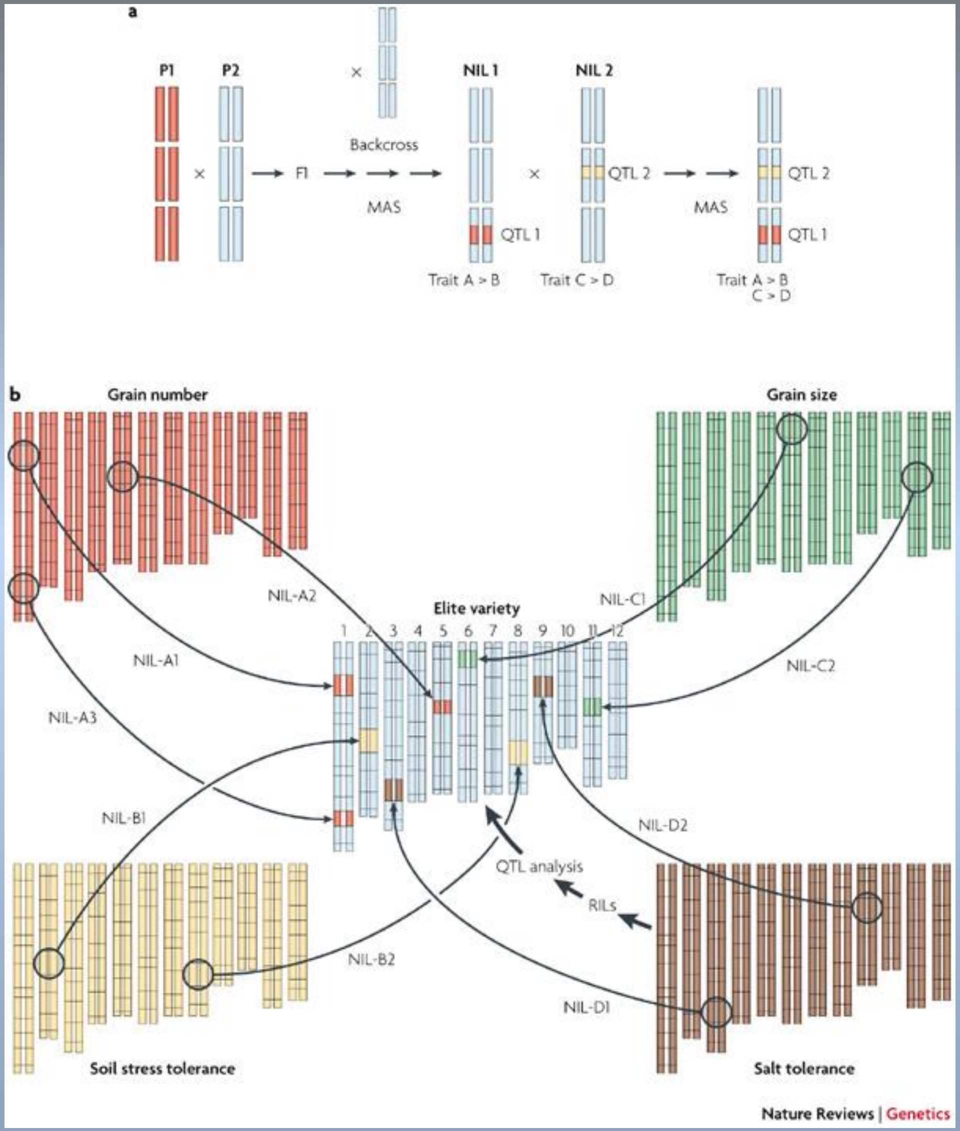
QTL MAPPING

Maize IBM genetic **map** showing locations of **QTL** for N-responsive traits



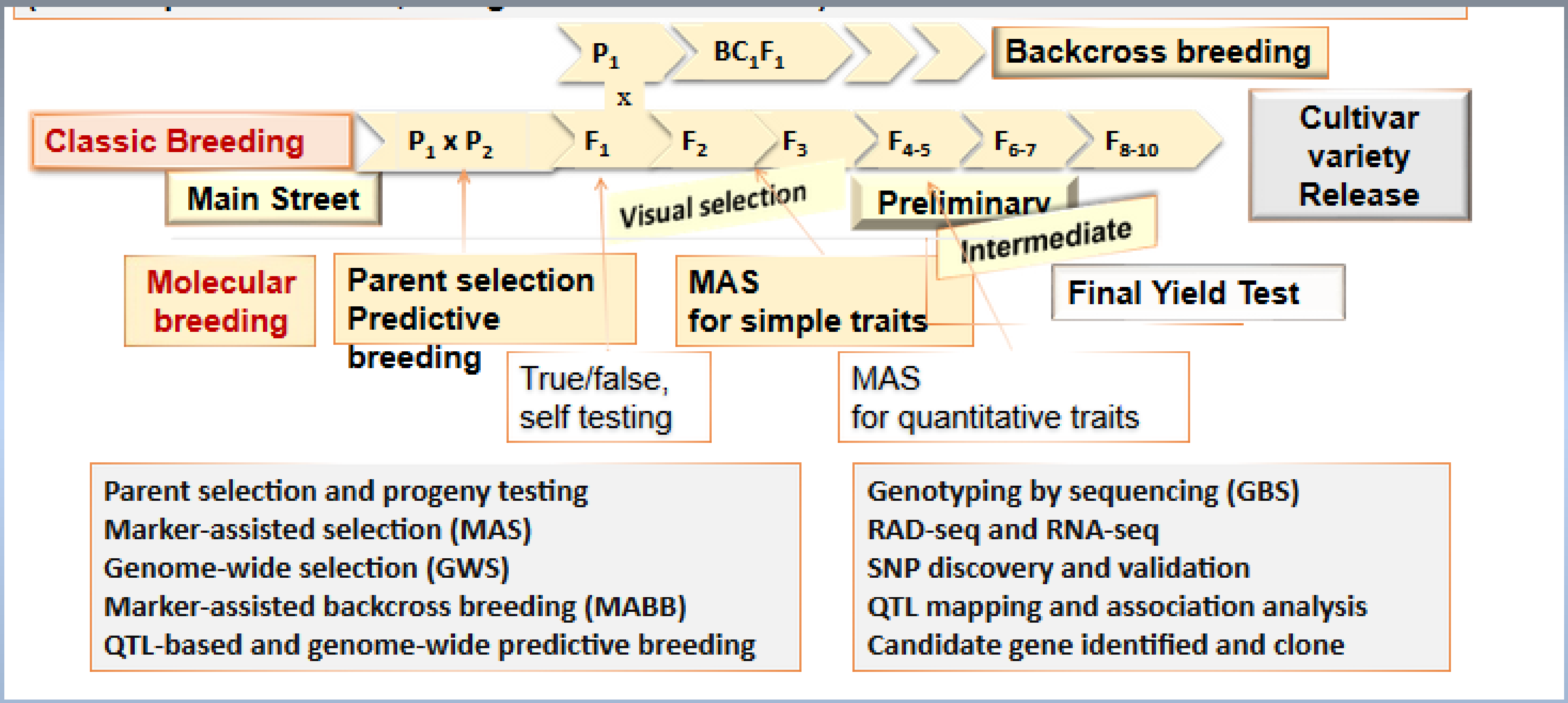
http://nitrogenes.cropsci.illinois.edu/projects.cfm?page=3

QTL MAPPING



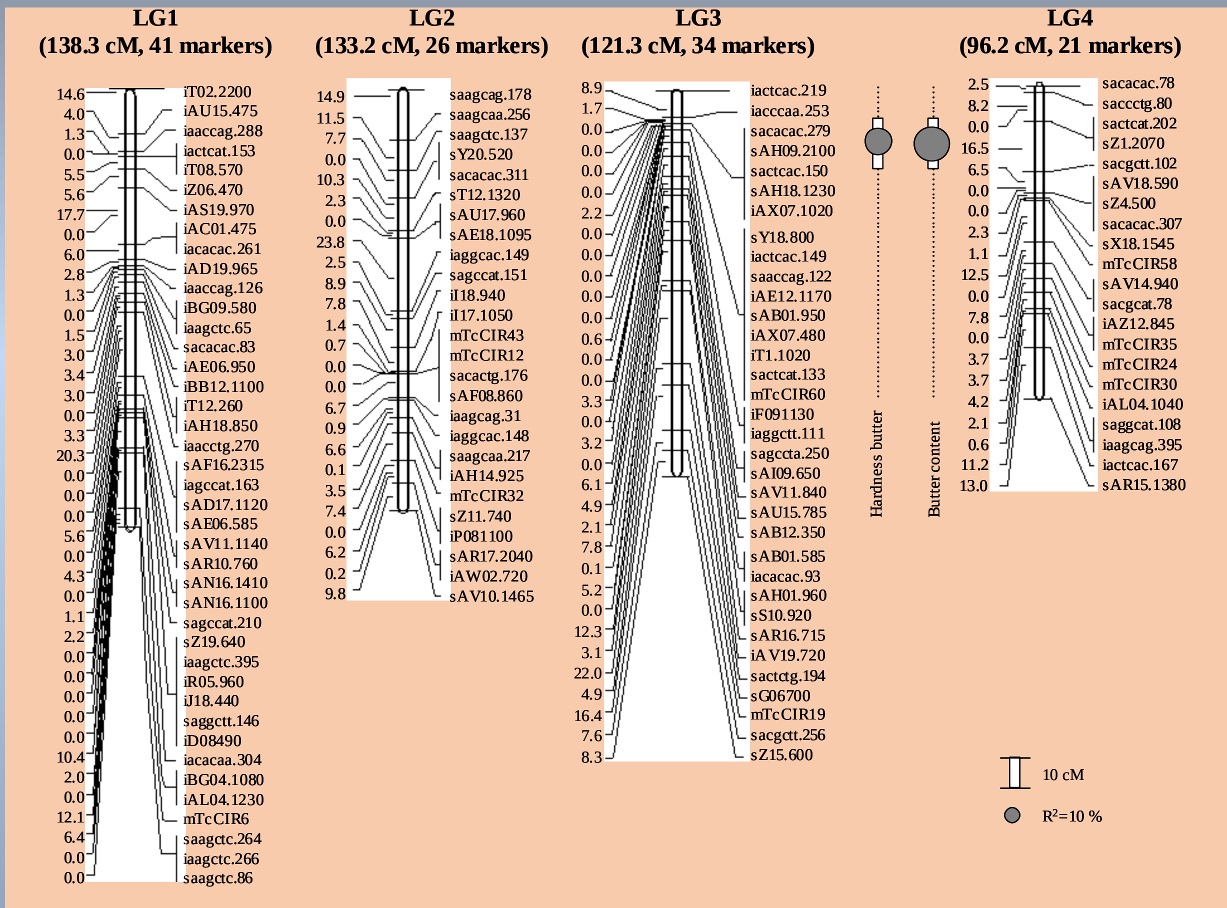
Takeda & Matsuoka (2009) Nature Reviews Genetics 9.

MOLECULAR PLANT BREEDING



Limitations for the application of QTLs

-Often, QTLs do not explain relevant part of the phenotype



-QUESTIONS:

1- Where are, in the genome, the other regions responsible for the phenotype?

2- Why were they not detected?

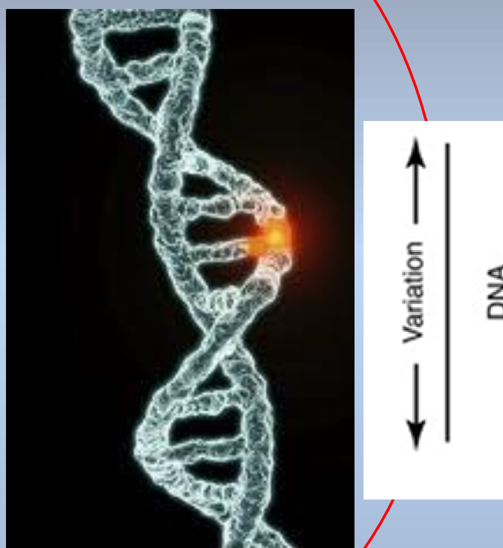
Limitations for the application of QTLs

1- Most marker techniques perform only genome samplings. Thus, even inserted into a binding map, many polymorphisms remain unknown;

2- Many QTLs have a "minor effect" on the phenotype, and are ignored during statistical analysis (influenced by segregating population size, heritability…).

3- Several QTLs are heavily affected by environment.

FROM GENOME TO PHENOTYPE

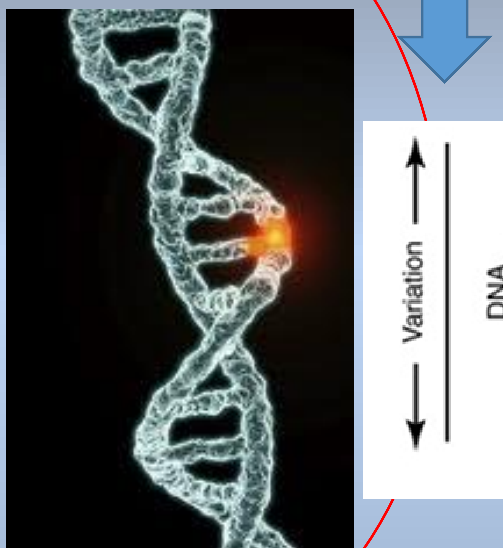


Plant Breeding Approaches and Tolls

FROM GENOME TO PHENOTYPE

Molecular Markers

Phenomics



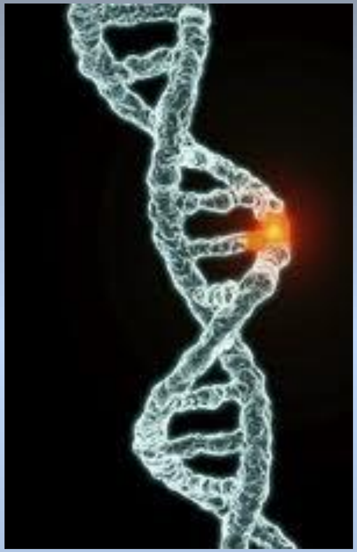
???

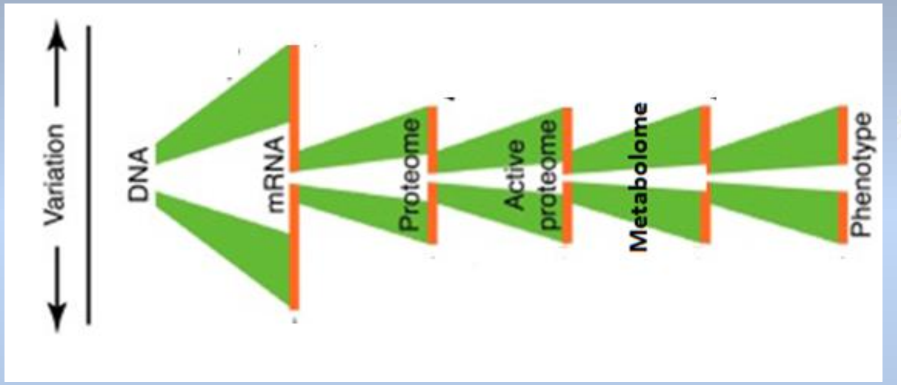
Plant Breeding Approaches and Tools

???

BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

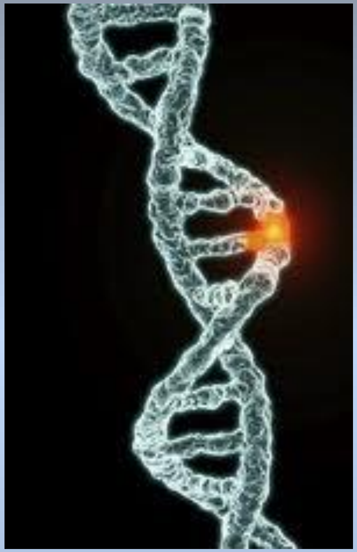


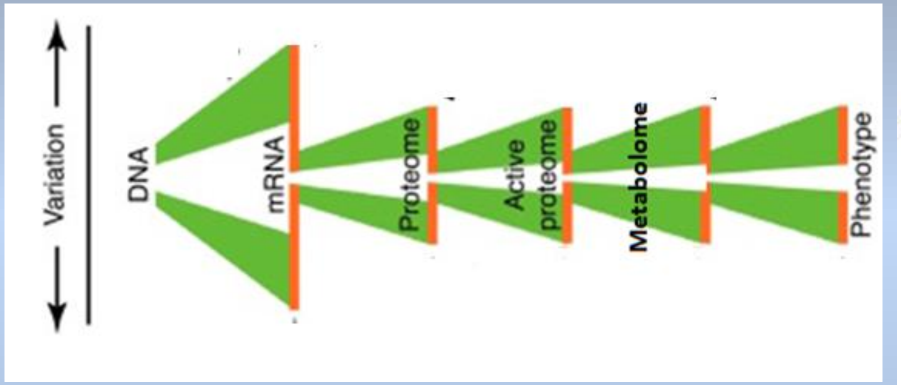


BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

Transcriptomics

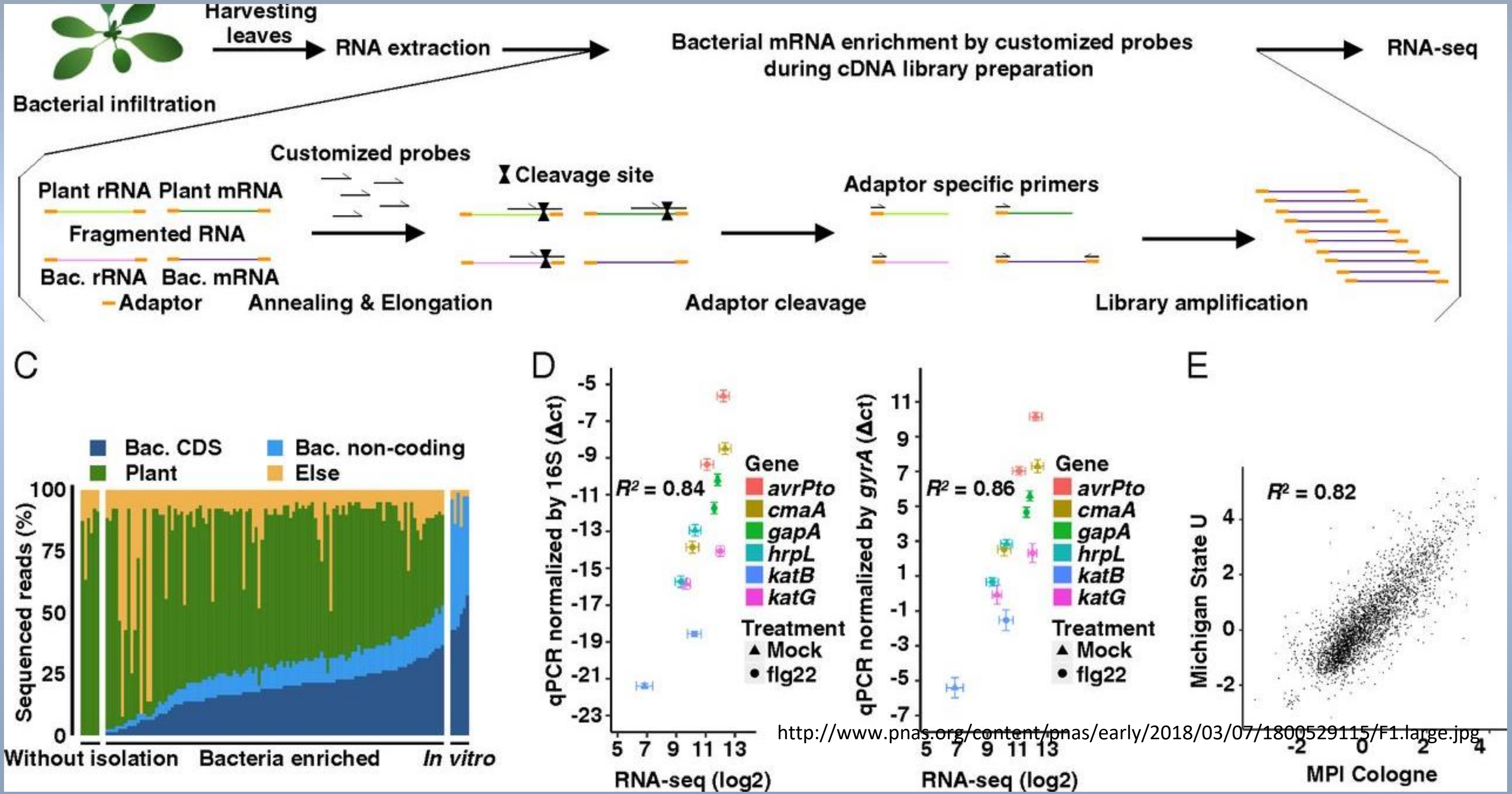




BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

Transcriptomics

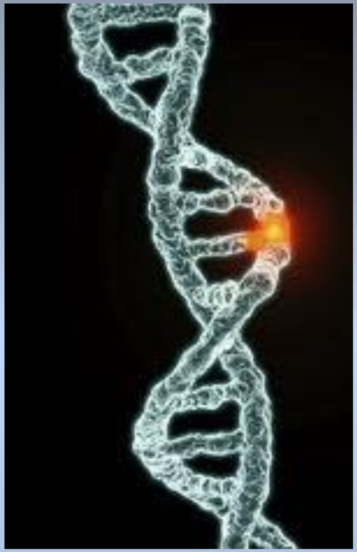


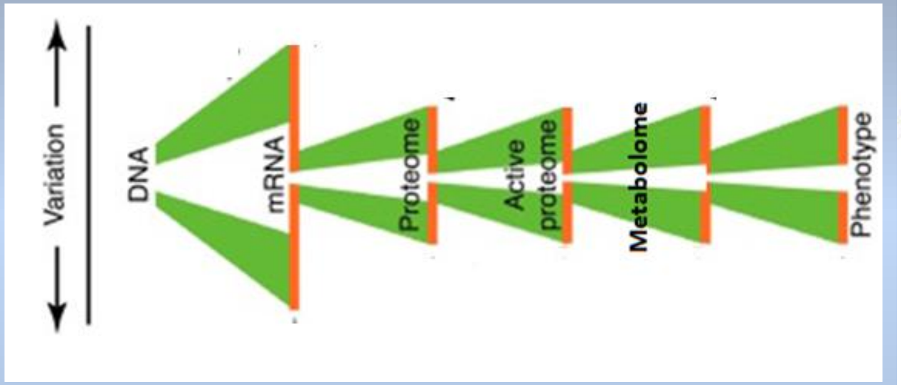
http://www.pnas.org/content/pnas/early/2018/03/07/1800529115/F1.large.jpg

BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

Proteomics

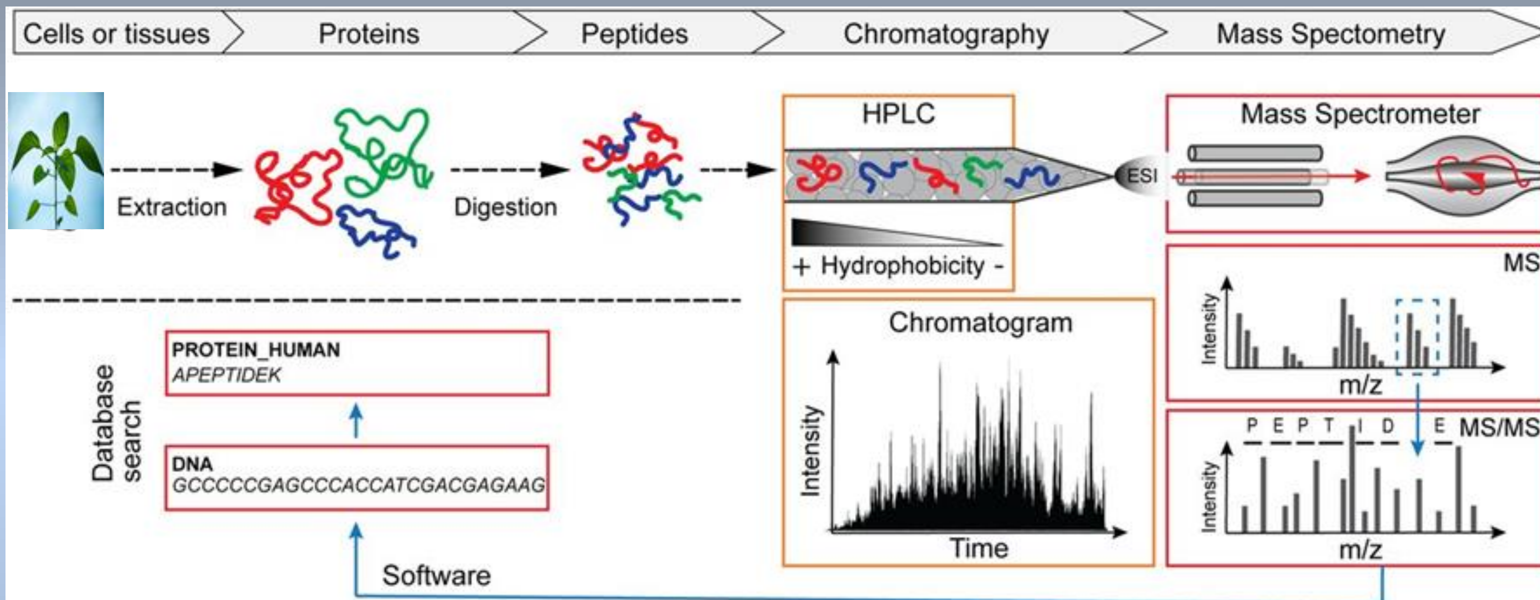


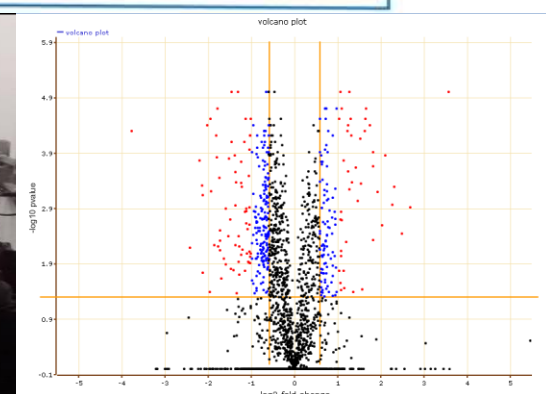


BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

Proteomics

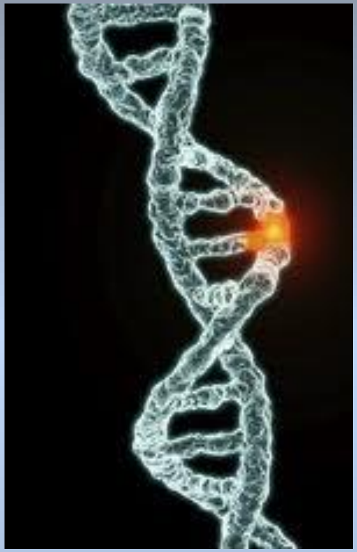


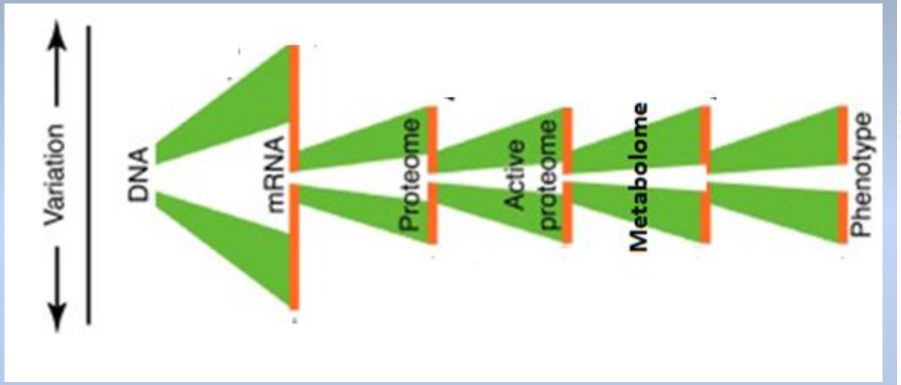


BETWEEN GENOME AND PHENOTYPE

Plant Molecular Biology and Biotechnology

Metabolomics

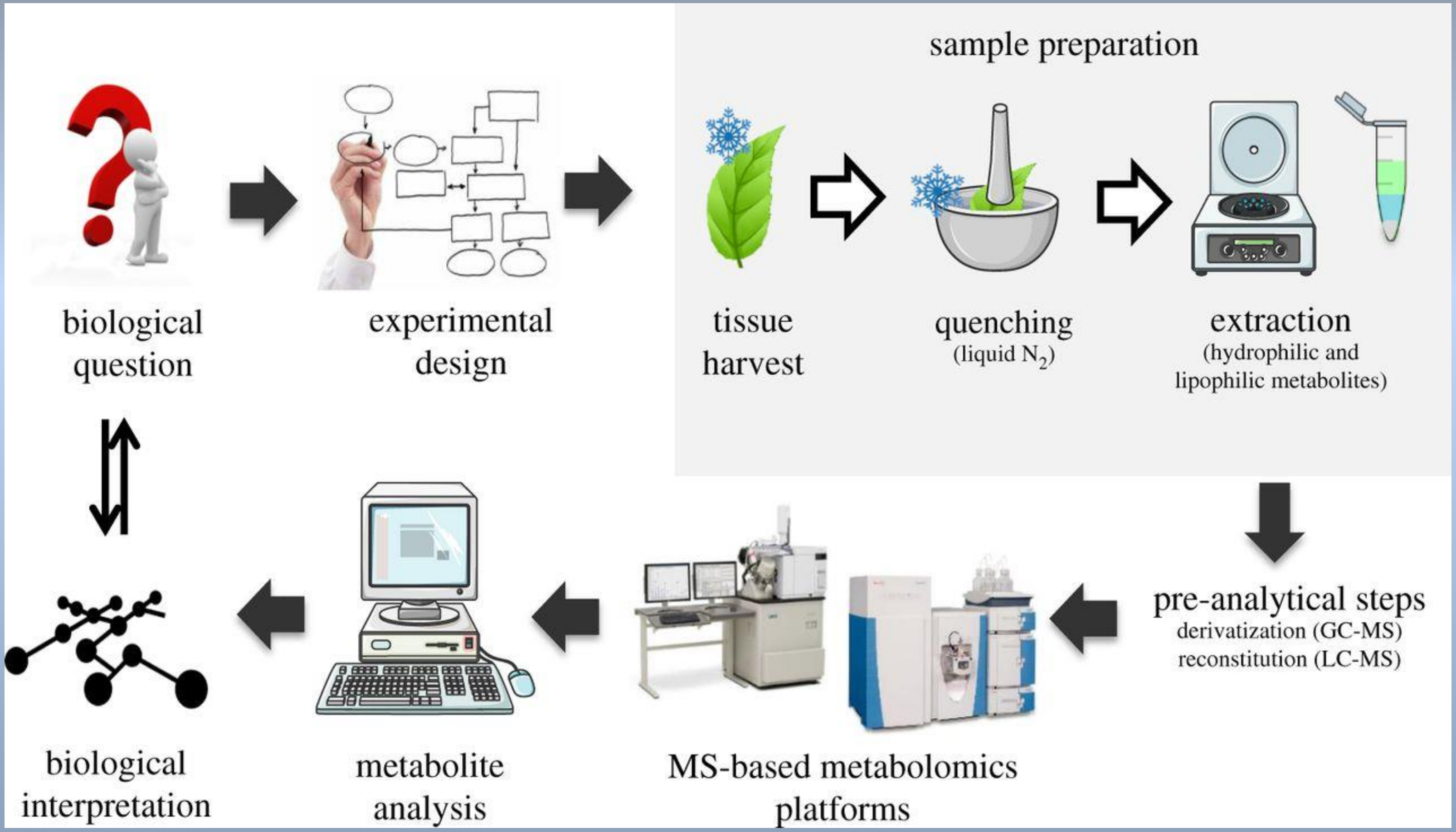




BETWEEN GENOME AND PHENOTYPE

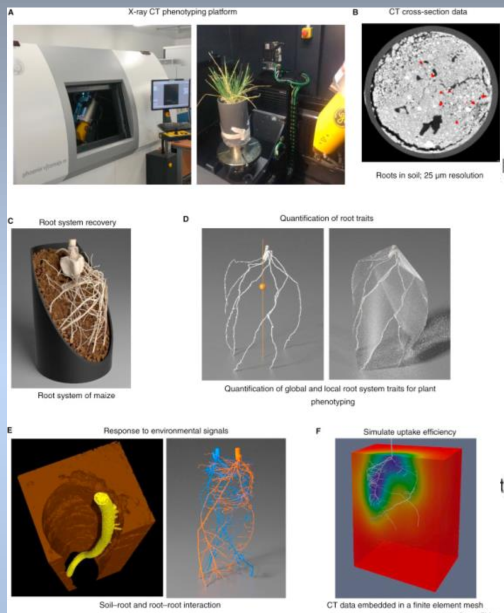
Plant Molecular Biology and Biotechnology

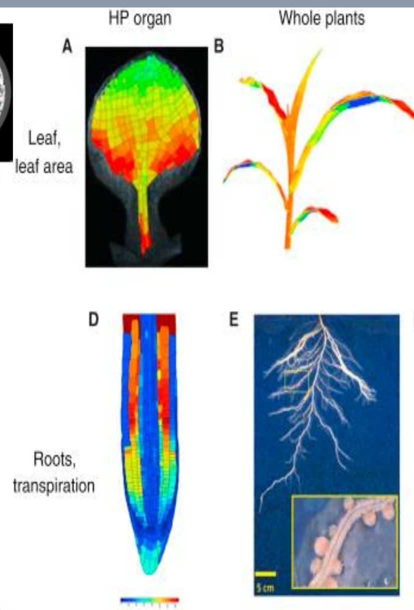
Metabolomics

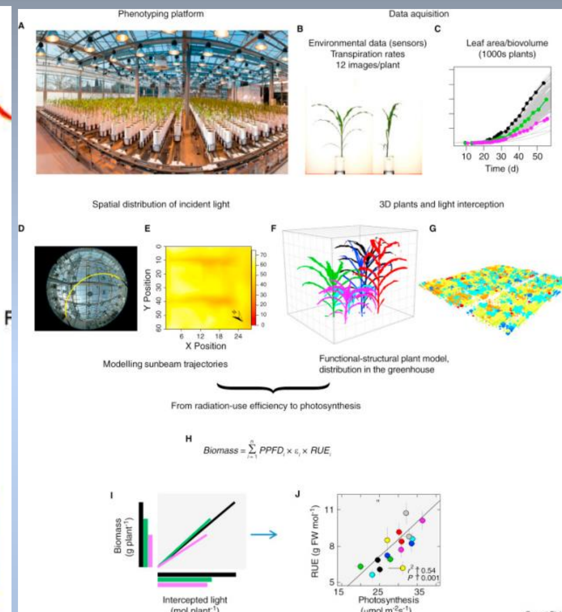


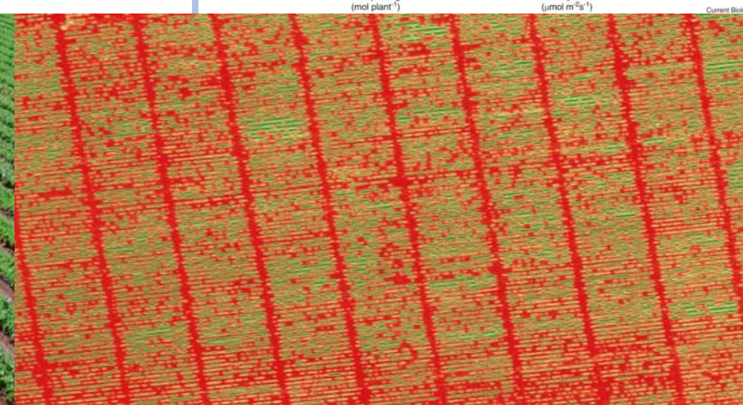
Prediction of phenotypes

STRONGLY DEPENDENT ON FENOTIPING QUALITY (Phenomics)

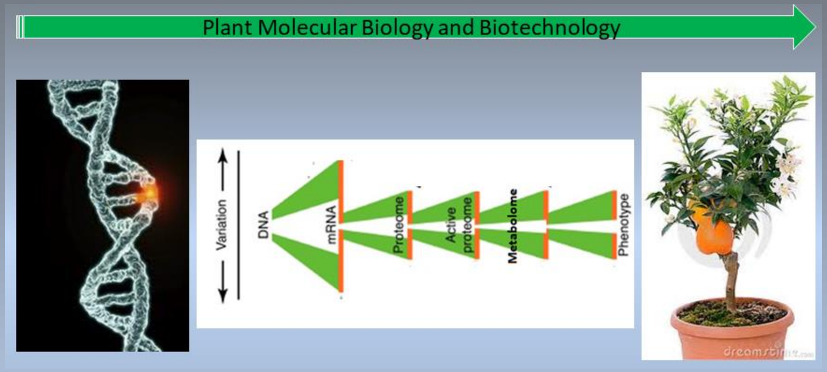








Products of Plant Biotechnology for Plant Breeding

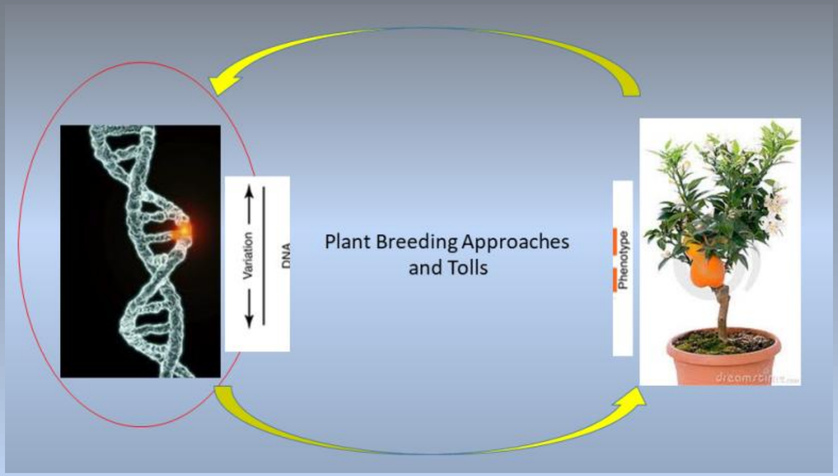


Discovery of Genes with Relevant Function

DEVELOPMENT OF GENETICALLY MODIFIED VARIETIES

Slow and expensive process. Effective for few qualitative traits.

Contribution of Genome Selection for Plant Biotechnology



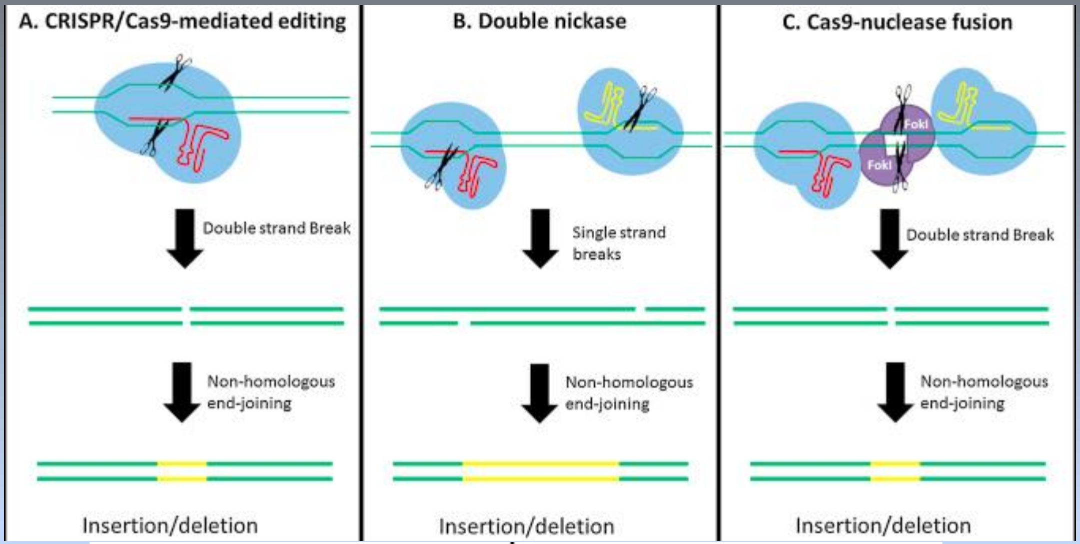
Genome Selection Approaches

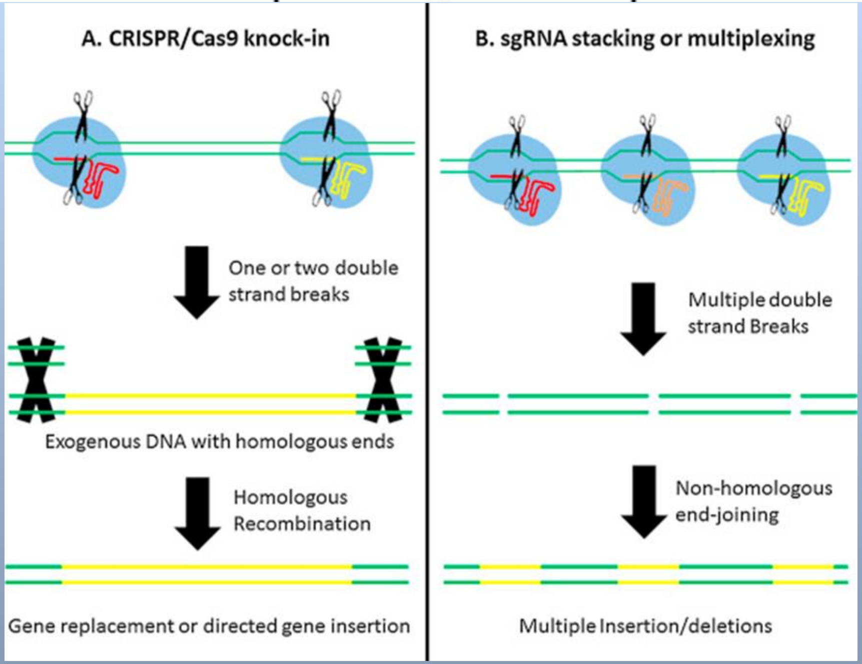
Discovery of Genes with Relevant Function

DEVELOPMENT OF GENETICALLY MODIFIED VARIETIES

Slow and expensive process. Effective for few qualitative traits.

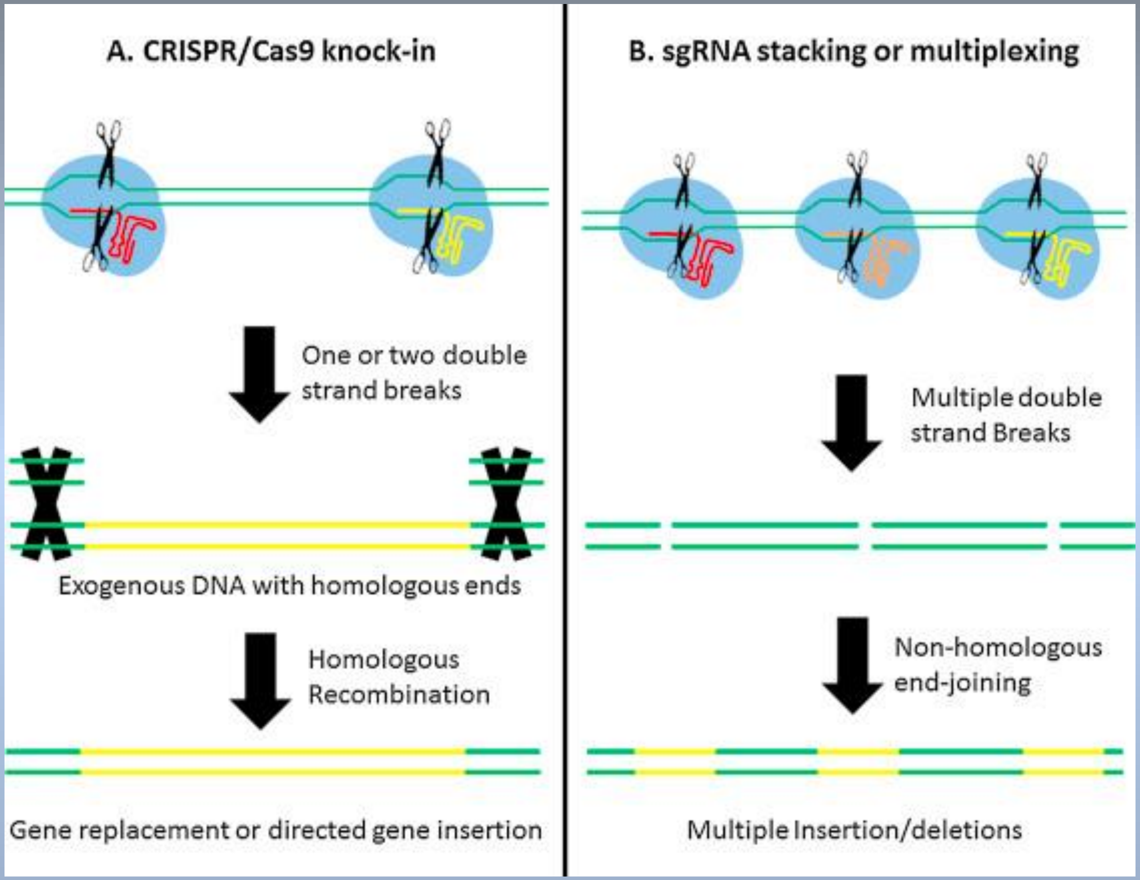
CRISPR/Cas9-mediated genome editing and gene replacement in plants: A promising point of convergence





Schaeffer et al, *Plant Science* 240 (2015): 130-142.

CRISPR/Cas9-mediated genome editing and gene replacement in plants: A promising point of convergence

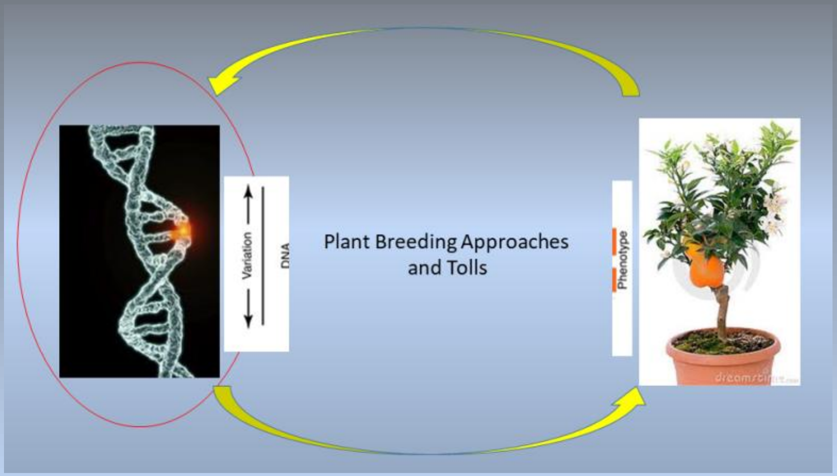


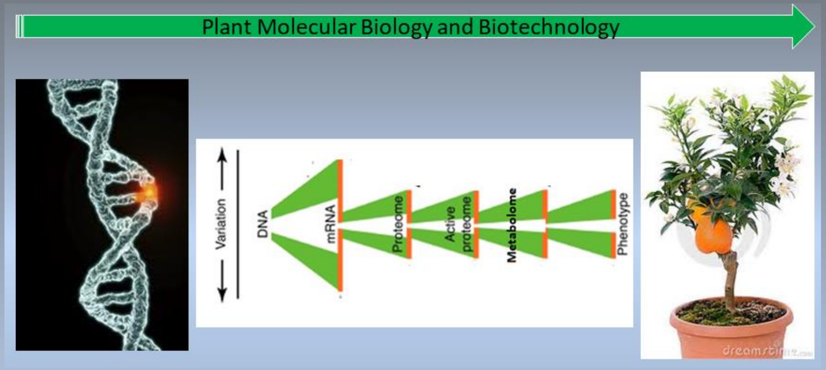
CRISPR/Cas9-mediated genome editing and gene replacement in plants: A promising point of convergence

Implementation of the CRISPR/Cas9 technology has been initiated in economically important crop plants:

Species	Gene(s) targeted	Editing efficiency[a]	Trait changed	CRISPR technique	Transformation/transfection technique
Glycine max	*GmDD1*	~0–14%	DNA Methyltransferase activity[b]	Single DS Break	Particle bombardment
Nicotiana tabacum	*NtPDS*	~82%	Etiolated leaves	Single DS Break	Agrobacterium-mediated transformation
Oryza sativa	*OsSWEET1a* *OsSWEET1b* *OsSWEET13* *OsSWEET11*	70% 20% 60%/100% 12.5%	Bacterial blight resistance	CRISPR multiplexing	Agrobacterium-mediated transformation
Solanum tuberosum	*StIAA2*	50%	Petiole hyponasty and shoot morphogenesis[b]	Single DS Break	Agrobacterium-mediated transformation
Triticum aestivum	*TaMLO-A1*	5.6%	Powdery mildew resistance	Single DS Break	Particle bombardment
Zea mays	*ZmIPK*	13.1%	Phytic acid synthesis	Single DS Break	Agrobacterium-mediated transformation

CRISPR/Cas9-mediated genome editing and gene replacement in plants: A promising point of convergence





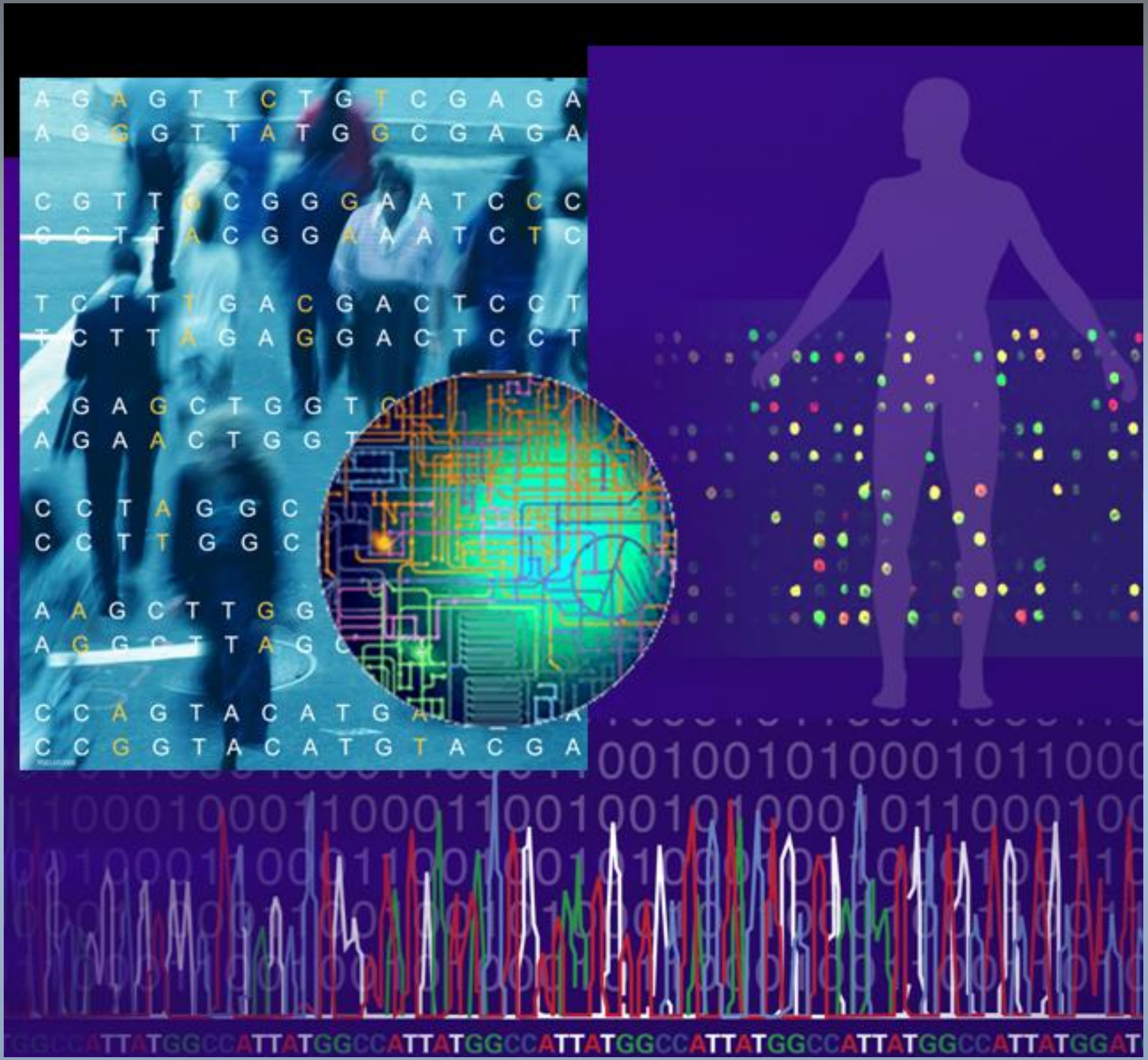
Discovery of Genes with Relevant Function

Discovery of specific specific alleles for Relevant Function

Multiplexed edition of such specific specific alleles in plants

Discovery of Genes with Relevant Function

DEVELOPMENT OF "GENETICALLY MODIFIED" VARIETIES



http://www.ornl.gov/sci/techresources/Human_Genome/posters/beyondhgp/index.shtml

"Integrative Biology applied to plant breeding: New challenges for the future plant breeder"

- Tools of genomics, epigenetics, transcriptomics, proteomics and metabolomics analysis have specific advantages and limitations.

-

- The combined use of these approaches and data is the way to understand biological systems and their interactions with the environment.

-

- The ability to analyze such data sets in integrative approaches tends to become an essential quality.

- Associative work is essential.

UENF

Universidade Estadual do Norte Fluminense Darcy Ribeiro

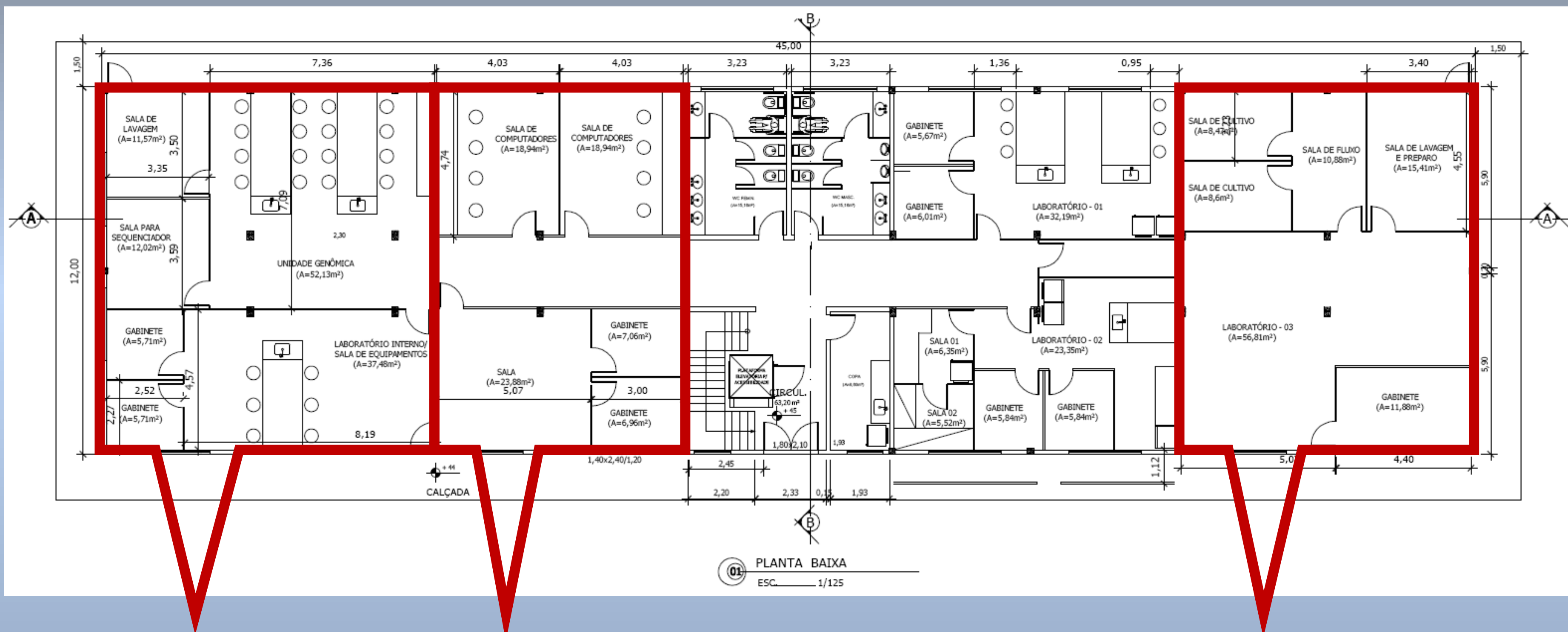
Integrative Biology Applied to Biotecnology & Crop Breeding

Integrative Biology Applied to Biotecnology & Crop Breeding

INTEGRATIVE BIOLOGY BUILDING- UENF



Integrative Biology Applied to Biotecnology & Crop Breeding

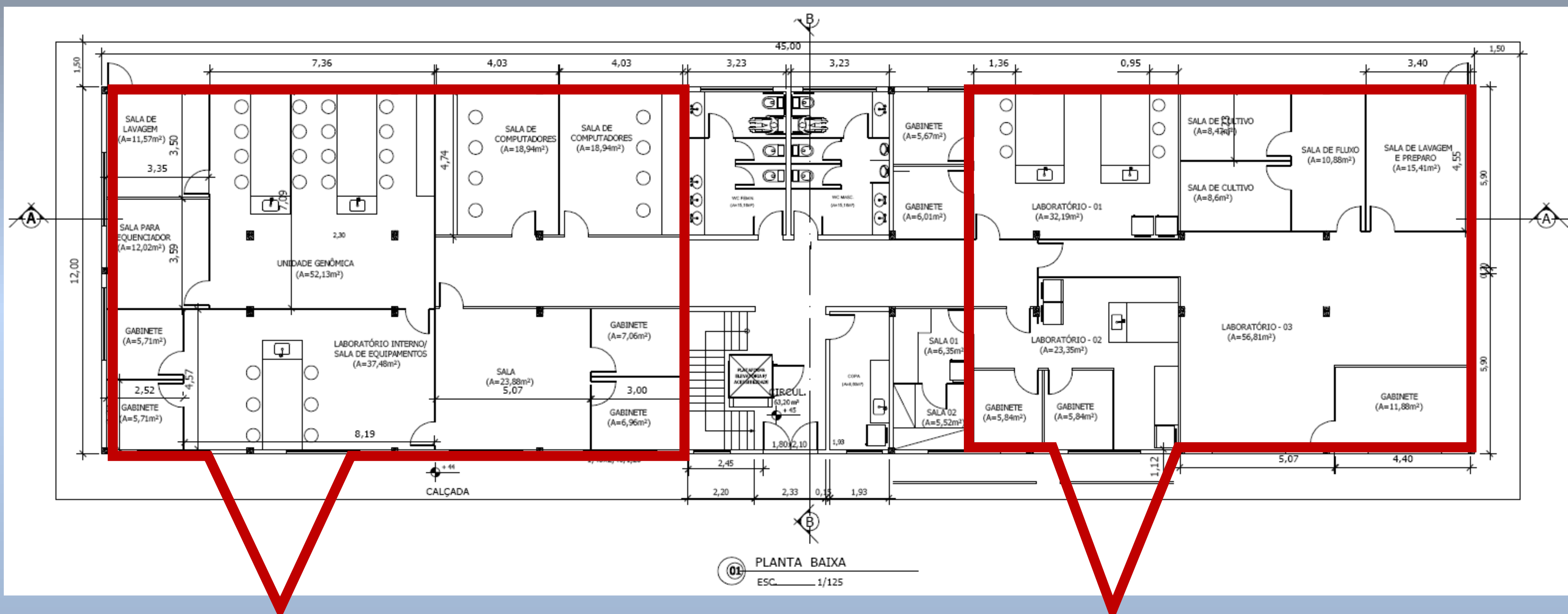


Genomics Lab

Proteomics Lab

Metabolomics Lab

Integrative Biology Applied to Biotecnology & Crop Breeding



Plant Physiology Lab

Plant Breeding Lab

Integrative Biology Applied to Biotecnology & Crop Breeding

Integrative Biology Applied to Biotecnology & Crop Breeding

GOALS

- New scientific information in Biotechnology and Plant breeding;

-Participate in the development of new cultivars of Maize, coconut, papaya, passion fruit and guava...;

-Integrate complementary research in multidisciplinary approaches;

-Improve the training of new professionals

Where do you want to go?

Where do you want to go?

Where do you want to go?

"Technology can help you go further, or go faster. But the decision will always depend on driver´s competence."

“Technology can help you go further, or go faster. But the decision will always depend on Breeder´s competence.”

UENF

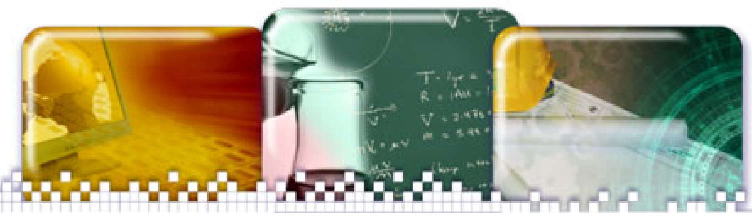
Universidade Estadual do Norte Fluminense Darcy Ribeiro

UENF

Intranet | Webmail UENF | Busca UENF

Pós-Graduação em

Genética e Melhoramento de Plantas



Idioma:

- Português
- English
- Español

- **Apresentação**
  - Histórico de Coordenações
- **Professores**
- **Comissão Coordenadora**
- **Linhas de Pesquisas/Projetos**
- **Seleção de Candidatos Regulares**
  - Inscrições e Edital de Seleção 1º/2017
  - Resultado Seleção 1º/2017
  - Inscrições e Edital de Seleção 2º/2017
  - Resultado Seleção 2º/2017
- **Seleção de candidatos Bolsa PNPD – 2013**

Buscar

Apresentação

O Curso: Objetivos, Área de Concentração e Linhas de Pesquisa

O Programa de Pós-Graduação em Genética e Melhoramento de Plantas (PGGMP) é resultado de uma ação interdisciplinar, reunindo diferentes Laboratórios (Departamentos) da UENF. O PGGMP foi criado em 2004 nos níveis de Mestrado e Doutorado e recebeu o **nota 6** da CAPES na última avaliação trienal (2010-2012).

II Meeting Genetics and Plant Breeding of Rio de Janeiro

O Programa é estruturado com base na colaboração entre professores da UENF nas áreas de Melhoramento de Plantas, Biotecnologia, Bioquímica, Fitopatologia e Estatística. Nossos estudantes têm acesso à infraestrutura laboratorial, casas de vegetação, áreas de campo e equipamentos para o desenvolvimento de suas pesquisas. Nossos professores têm obtido êxito na captação de recursos junto a agências de fomento como a FAPERJ, a CAPES e o CNPq para financiamento de projetos e bolsas.

Nosso objetivo central é formar geneticistas e melhoristas de plantas, com sólida formação científica e capazes de liderar programas de melhoramento, em instituições públicas e privadas, que objetivem o lançamento de novas cultivares, bem como ações de coleta, preservação e manejo de germoplasma

III ENCONTRO DE GENÉTICA E MELHORAMENTO DE PLANTAS DO RIO DE JANEIRO

UENF

Universidade Estadual do Norte Fluminense Darcy Ribeiro

UENF

Universidade Estadual do Norte Fluminense Darcy Ribeiro

UENF

Universidade Estadual do Norte Fluminense Darcy Ribeiro

“MUITO OBRIGADO”

Gonçalo Apolinário de Souza Filho

Lab Biotecnologia/Unidade de Biologia Integrativa

Goncalos@uenf.br

Campos dos Goytacazes

Rio de Janeiro

Brazil