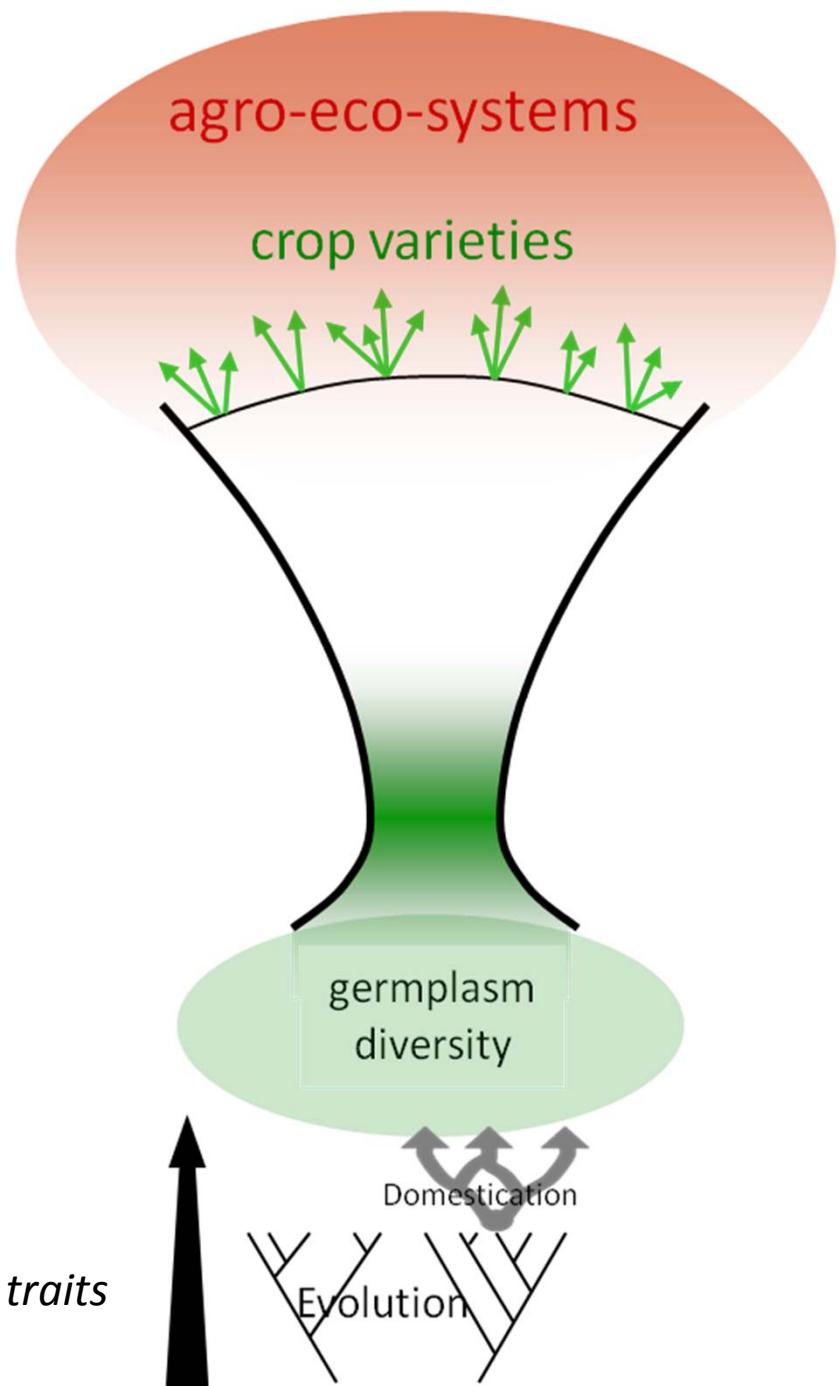
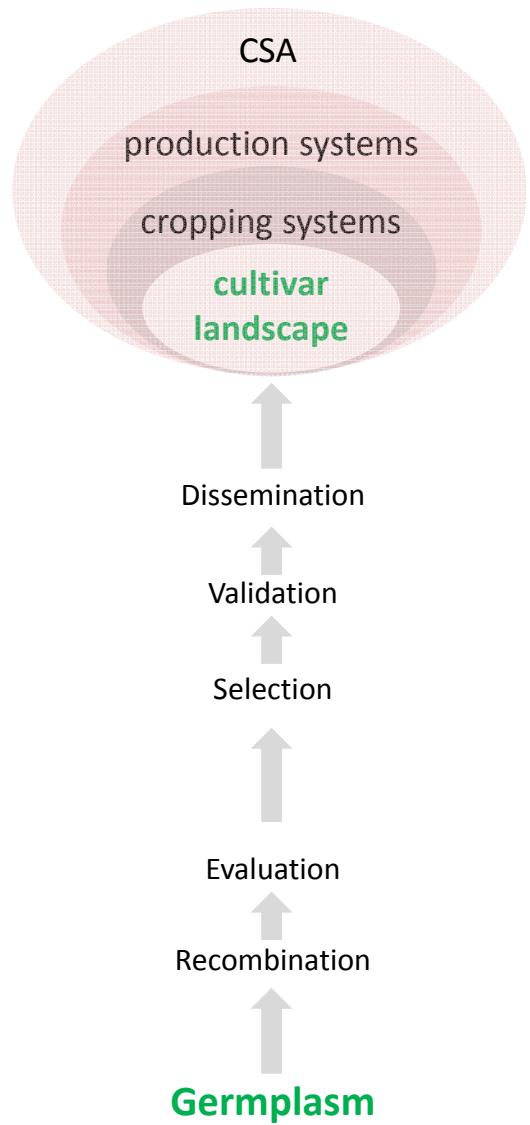


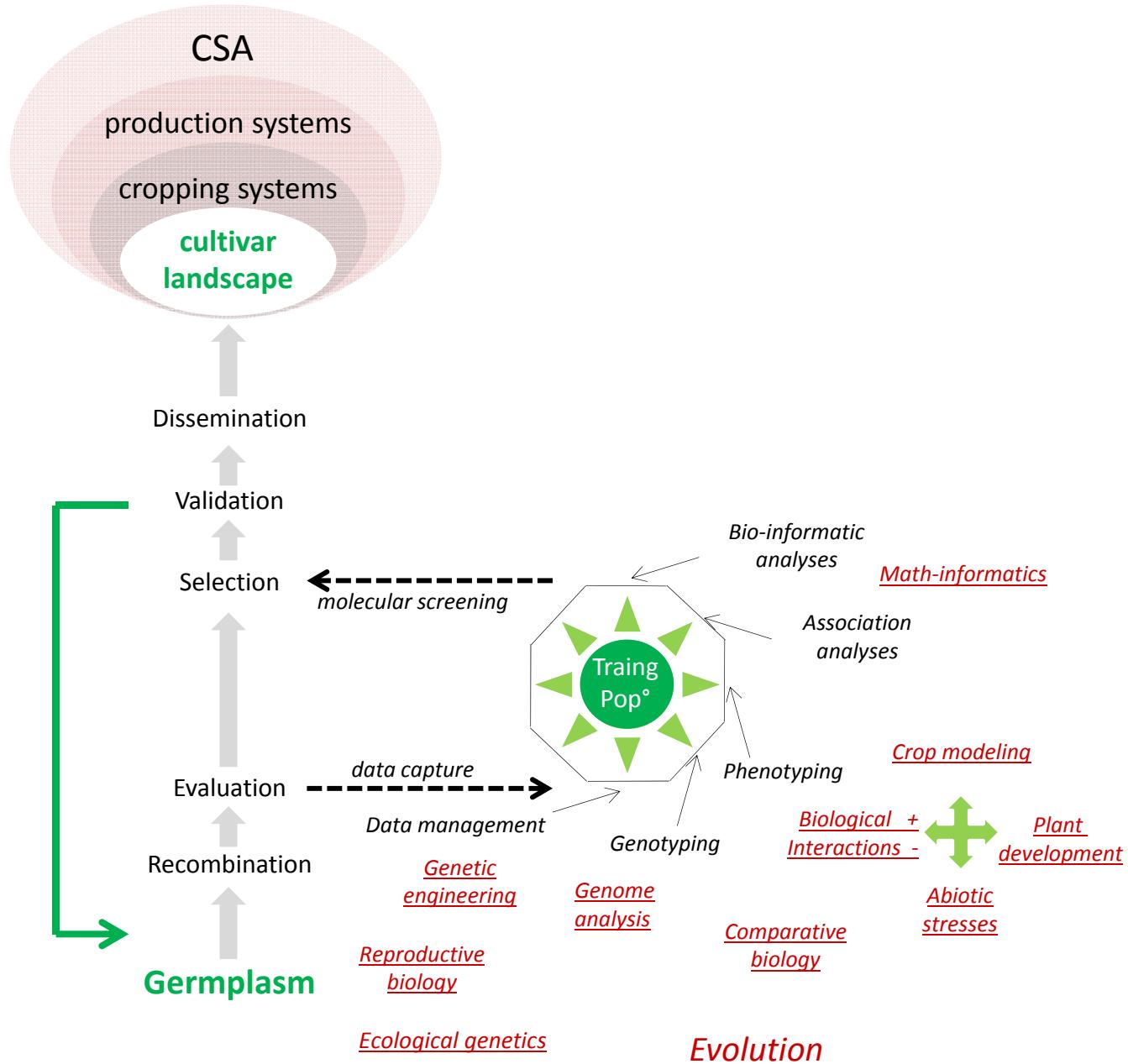
# Breeding for climate-smart agriculture

Jean Christophe Glaszmann  
Cirad, Montpellier





***“Plant breeding, the art and science of changing the traits of plants in order to produce desired characteristics”***



**About :: Climate change genomics**

www.climatechangegeonomics.org/index.php

Global science confere... Les plus visités Débuter avec Firefox À la une Hotmail Personnaliser les liens Windows Media Windows Débuter avec IE8 Galerie de composants... Agenda

About Members Advisory Board Coordinators Links White Paper

## Climate change genomics



If we have missed a link to your site, please contact the [web admin](#).  
The site is supported by funds from the [University of Queensland](#) and the [Australian Research Council](#).

## About

Climate change poses a major challenge for global food security. Climate influences both yield and quality of crop plants. The application of genomics will be a key strategy to tackle this challenge. Development of crop varieties that will be productive in harsh and variable environments will therefore be imperative.

Genomics-based breeding and transgenic approaches result in a better understanding of crop performance in a changing climate while supporting crop improvement programs.

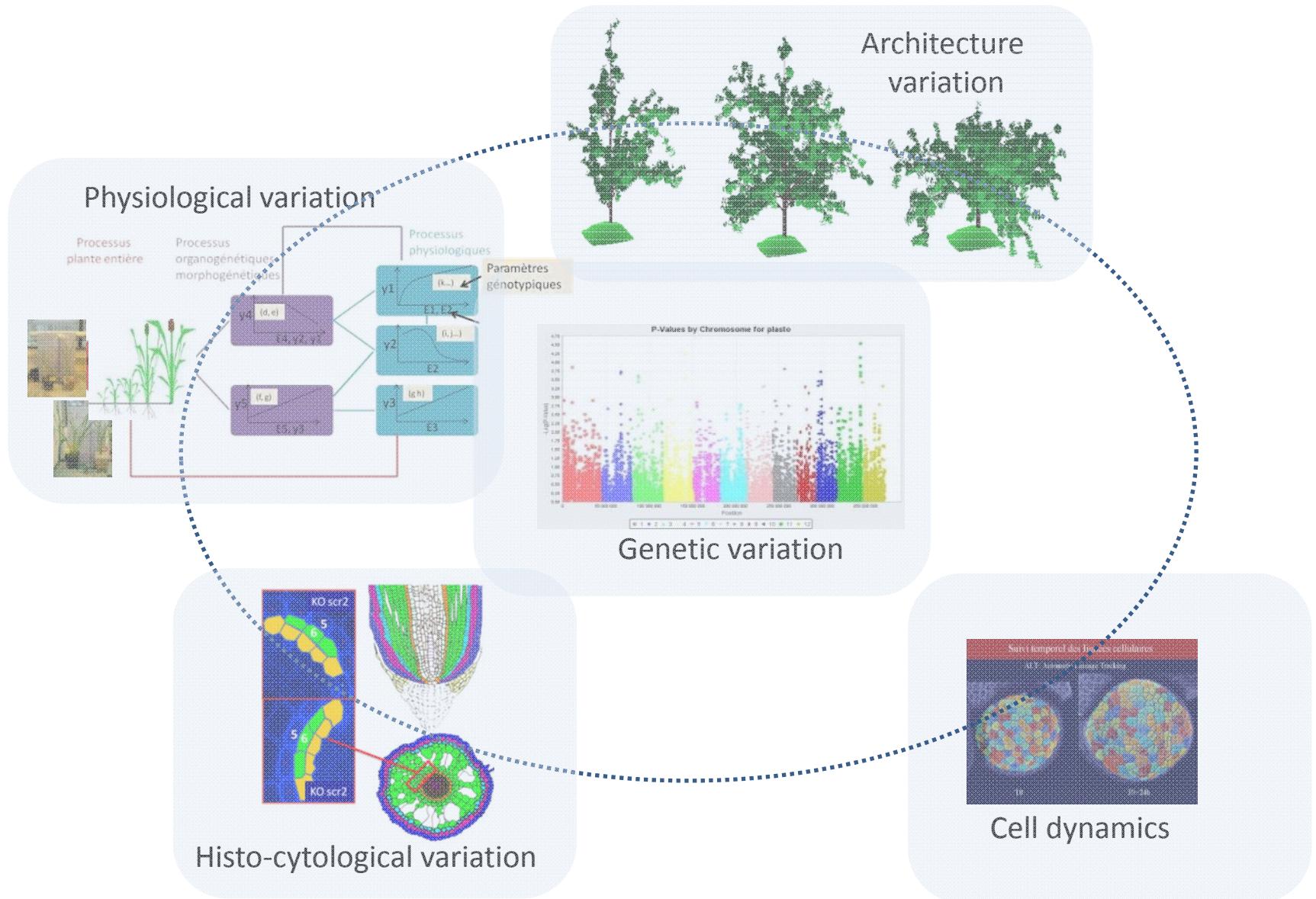
Characterization of available germplasm and exploration of wild crop genetic resources will greatly benefit from the utilization of genomics tools.

Research needs to target appropriate traits, species and regions to achieve optimal impact on food security.

Coordination of international research efforts will be instrumental to better define and faster advance the priority objectives.

The formation of this consortium proposed as a forum and network to accomplish this important mission. We currently have a membership list and [an advisory board](#).

# Confluences...



# Anchoring in a common past



D.A. Vaughan et al. / Plant Science 174 (2008) 394–408

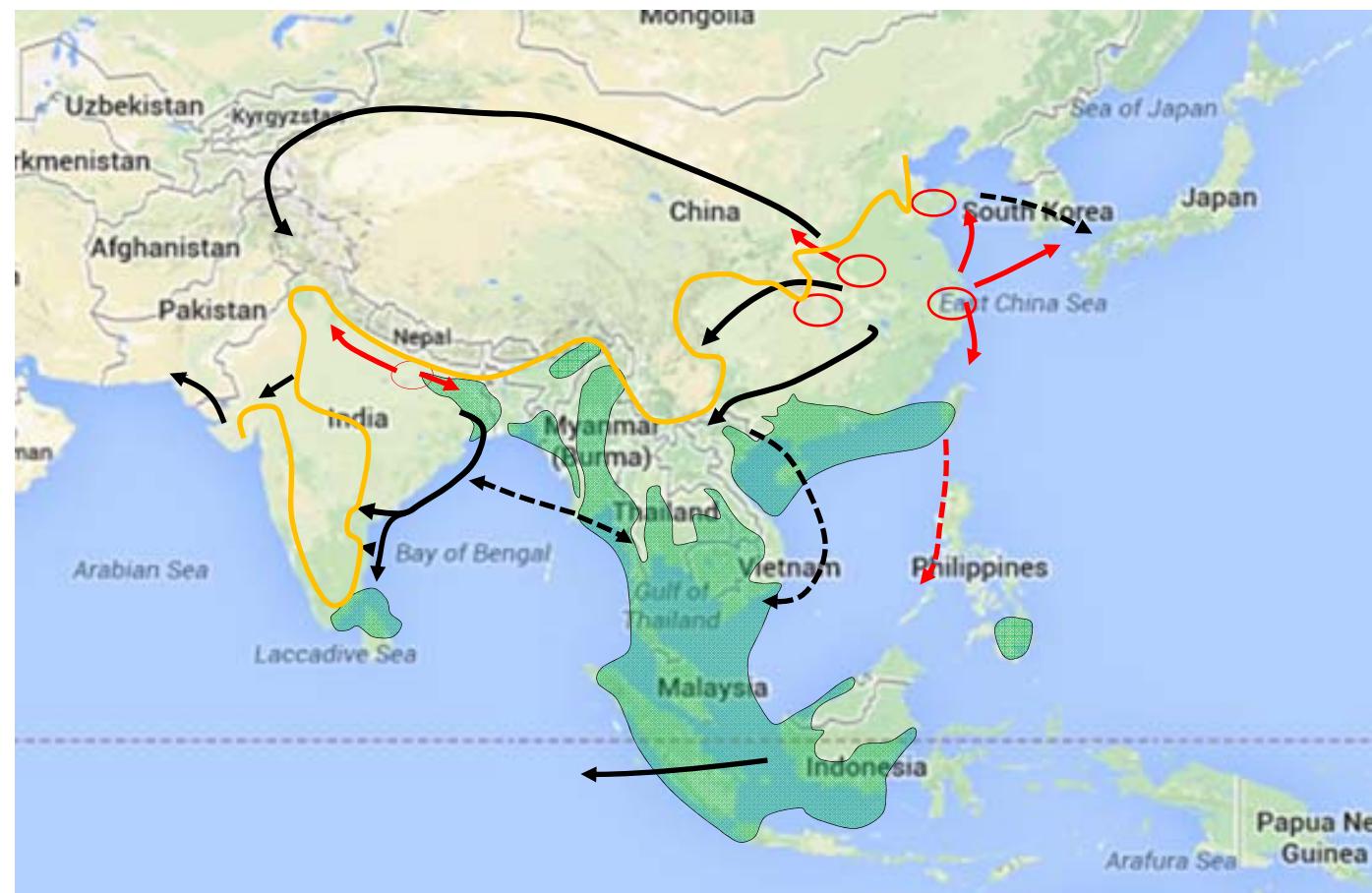




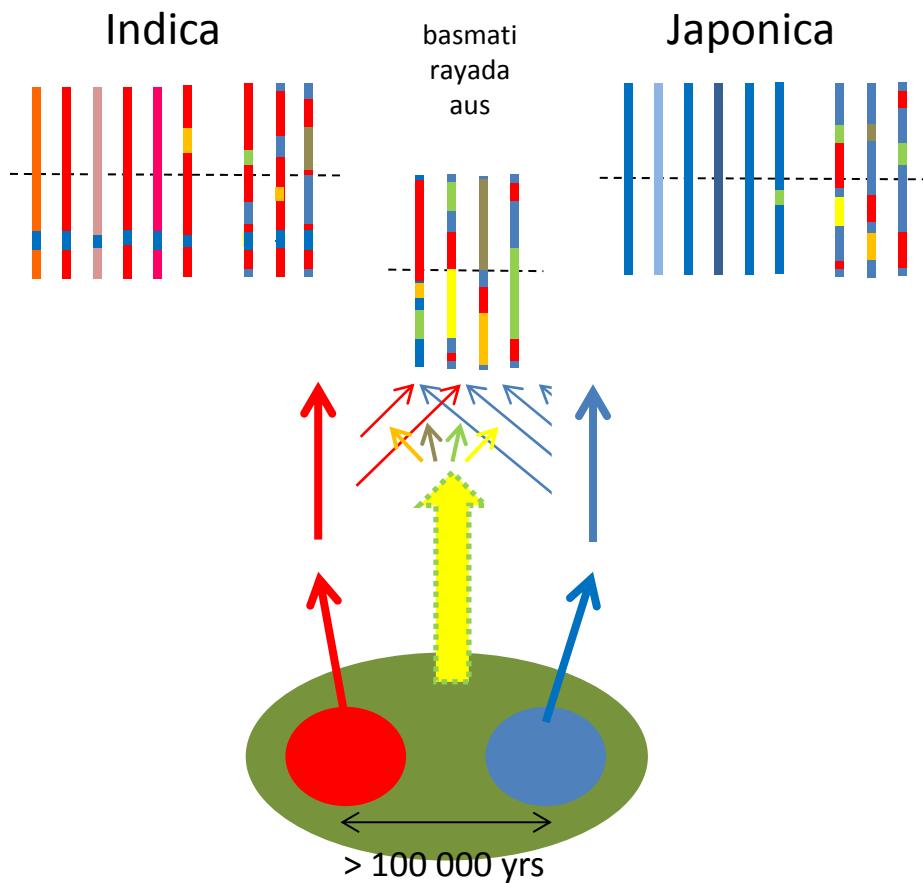
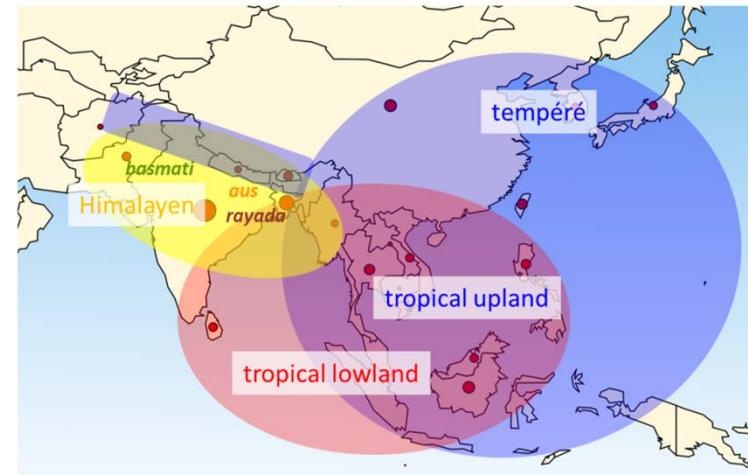
Likely Pleistocene refuge area

cultivar movements

< 2500 BC then



(from Fuller et al. 2011).



# Rice diversity and genetics for future plant breeding

R. S. Zeigler

Director General

International Rice Research Institute



**IRRI**

INTERNATIONAL RICE RESEARCH INSTITUTE

## Update on IRIC Portal and Consortium

Nickolai Alexandrov  
T.T.Chang Genetic Resources Center  
IRRI



## Cannot overestimate central role of Genetic resources for coming generations

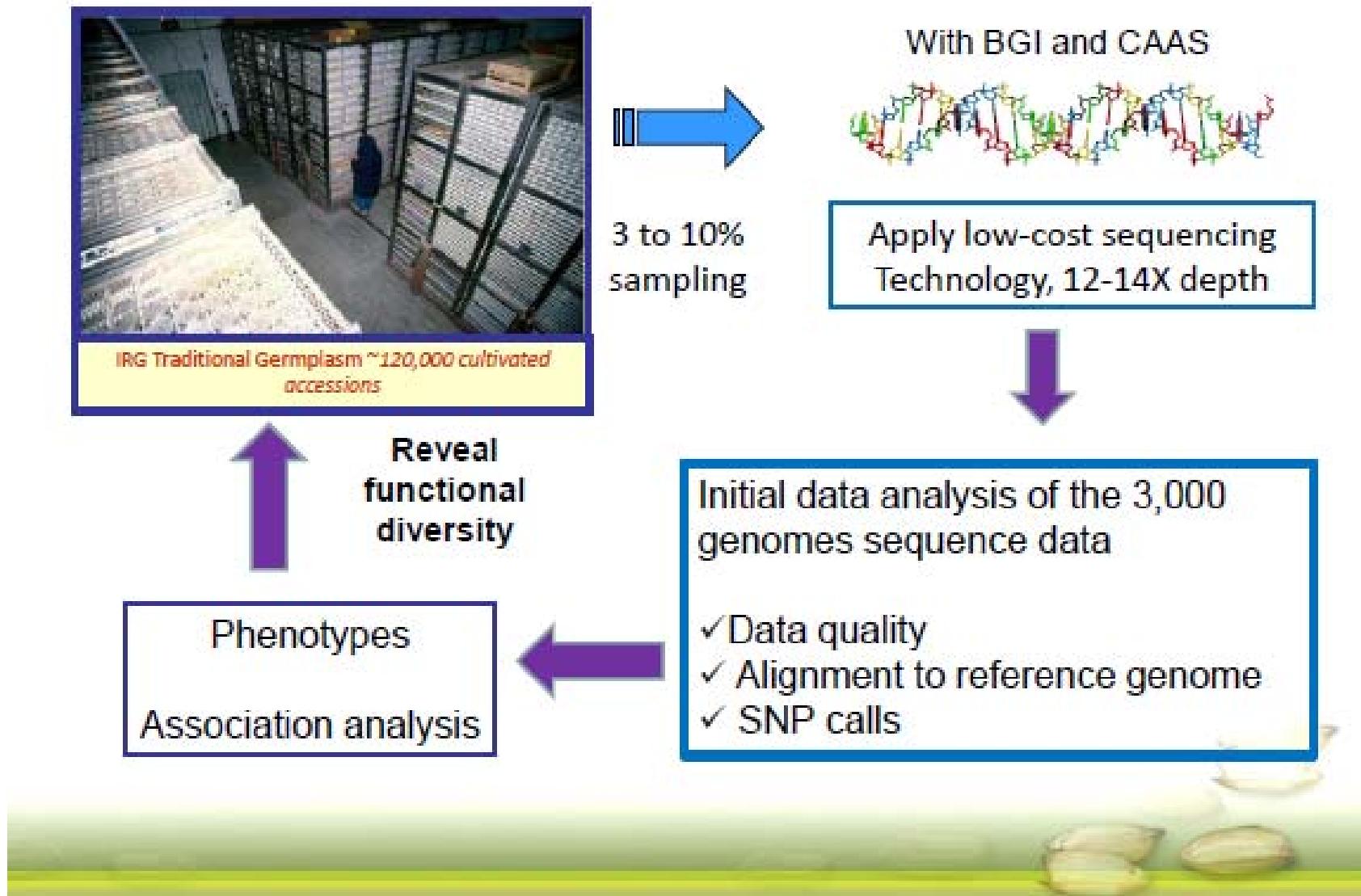
IRRI holds in trust the world's largest collection of rice varieties...> 110,000 accessions



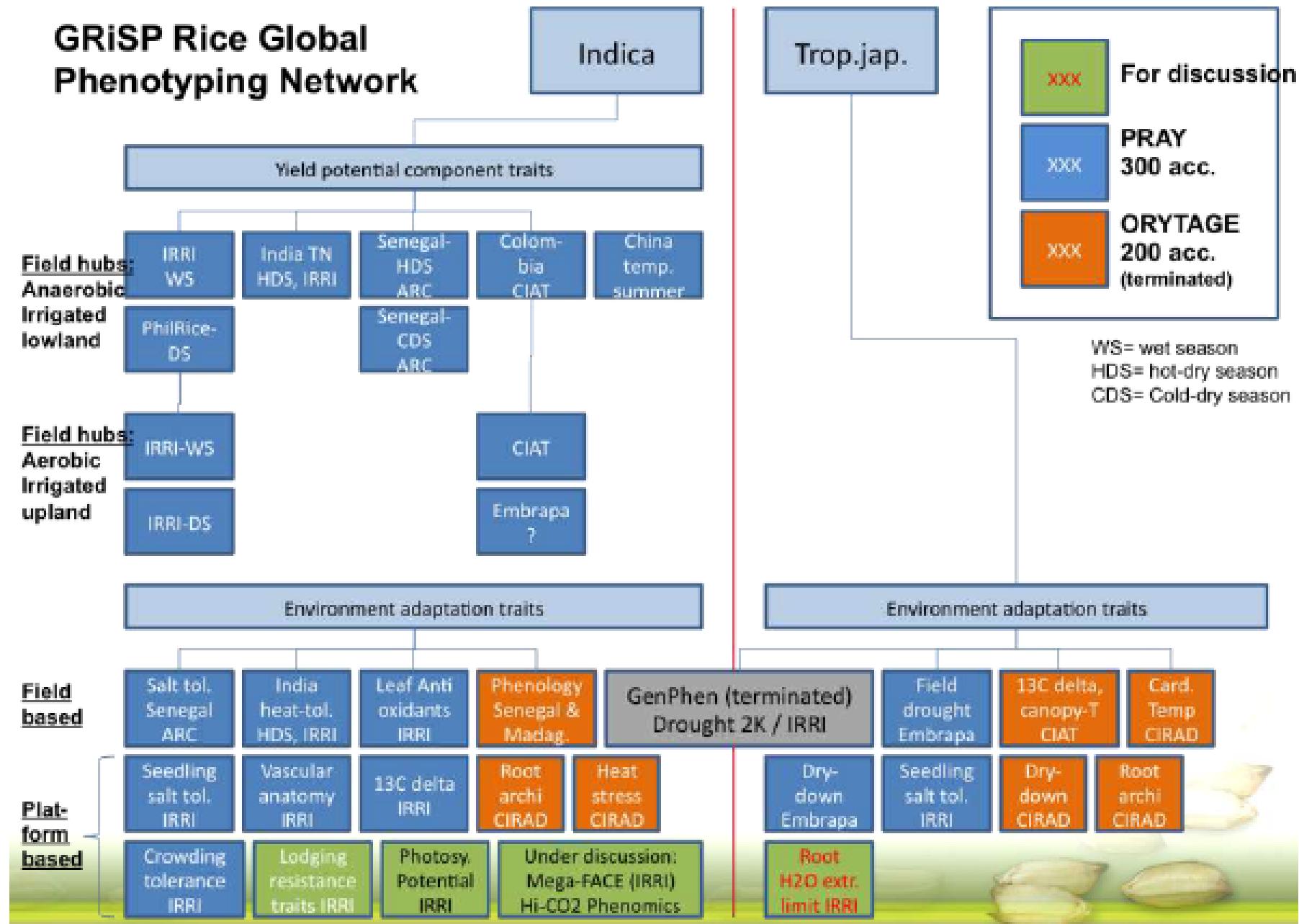
Less than 5% has been used in breeding programs



## Relate phenotype to genotype



# GRiSP Rice Global Phenotyping Network



# IRIC Information page

<http://iric.irri.org/>

**IRRI** International Rice Informatics Consortium

Search this site

Home IRIC Members Projects News Resources Contact us



**Navigation**

- About IRIC
- Members
- Projects
- News
- Resources
- Contact us
- Sitemap

**Important dates**

14 January 2015 [IRIC Workshop at PAG XXIII \(Pacific Salon 2\)](#)

**Interact with us**

[!\[\]\(709a9f847fb90730c9f39ec6858c704b\_img.jpg\)](#)

**ABOUT**  **OBJECTIVES**  **PROJECTS**  **RESOURCES**  **CONTACT US** 



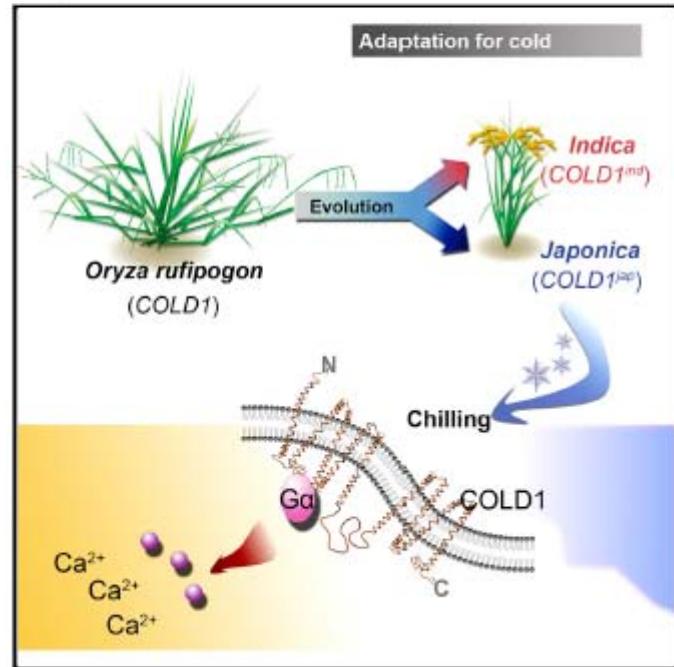
# Toward a new International Rice Informatics Consortium (IRIC)

Excite the minds of young  
scientists



**COLD1 Confers Chilling Tolerance in Rice**

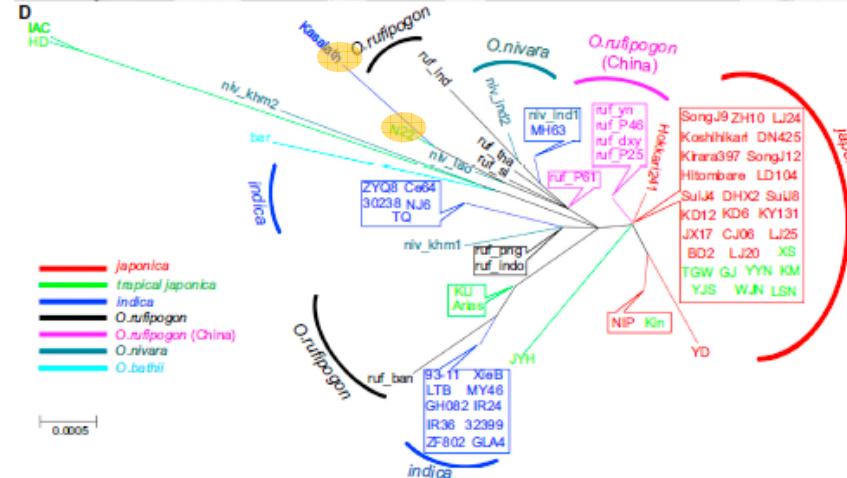
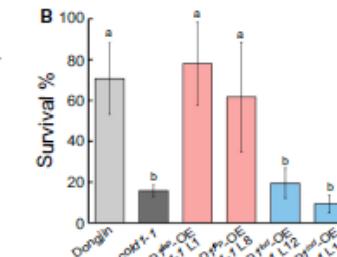
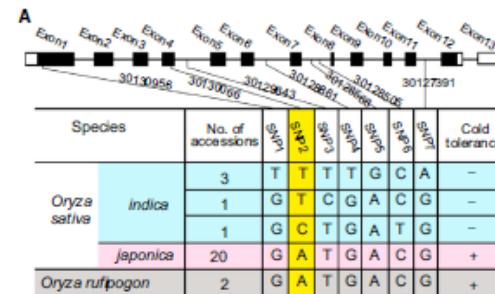
## Graphical Abstract



Rice is sensitive to cold and can be grown only in certain climate zones. Human selection of *japonica* rice has extended its growth zone to regions with lower temperature, while the molecular basis of this adaptation remains unknown. Here, we identify the quantitative trait locus *COLD1* that confers chilling tolerance in *japonica* rice. Overexpression of *COLD1*<sup>hap</sup> significantly enhances chilling tolerance, whereas rice lines with deficiency or downregulation of *COLD1*<sup>hap</sup> are sensitive to cold. *COLD1* encodes a regulator of G-protein signaling that localizes on plasma membrane and endoplasmic reticulum (ER). It interacts with the G-protein  $\alpha$  subunit to activate the Ca<sup>2+</sup> channel for sensing low temperature and to accelerate G-protein GTPase activity. We further identify that a SNP in *COLD1*, SNP2, originated from Chinese *Oryza rufipogon*, is responsible for the ability of *COLD1*<sup>hap</sup> to confer chilling tolerance, supporting the importance of *COLD1* in plant adaptation.

## Authors

Yun Ma, Xiaoyan Dai, ..., Song Ge,  
Kang Chong



# Anchoring in a common past

## perennial crops

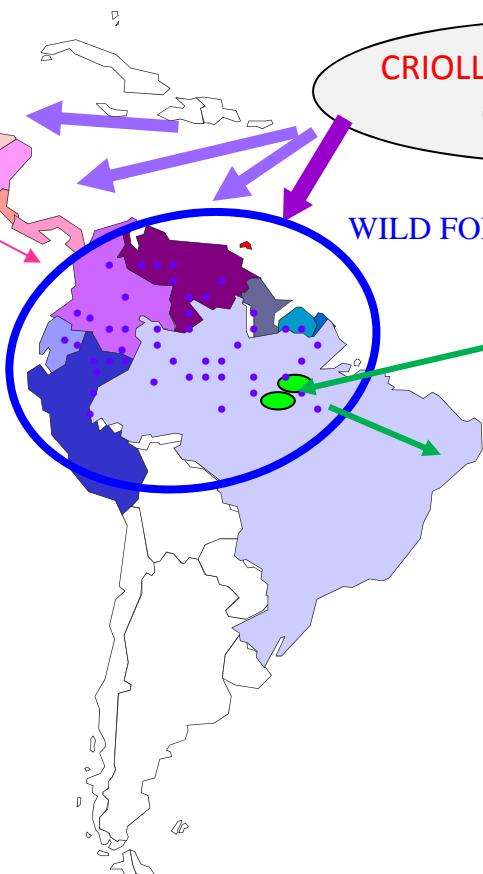
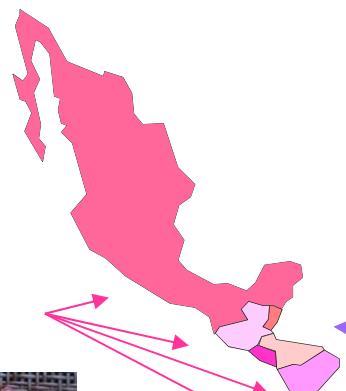




CRIOLLO



NACIONAL



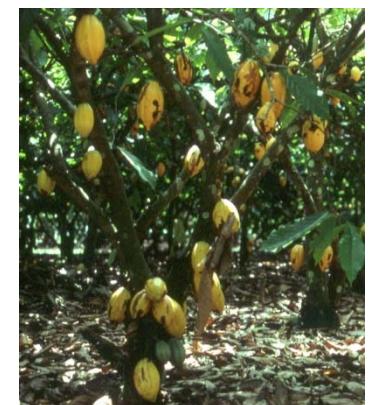
Before 1950, a few main types at the origin of all cocoa cultivated all around the world

TRINITARIO

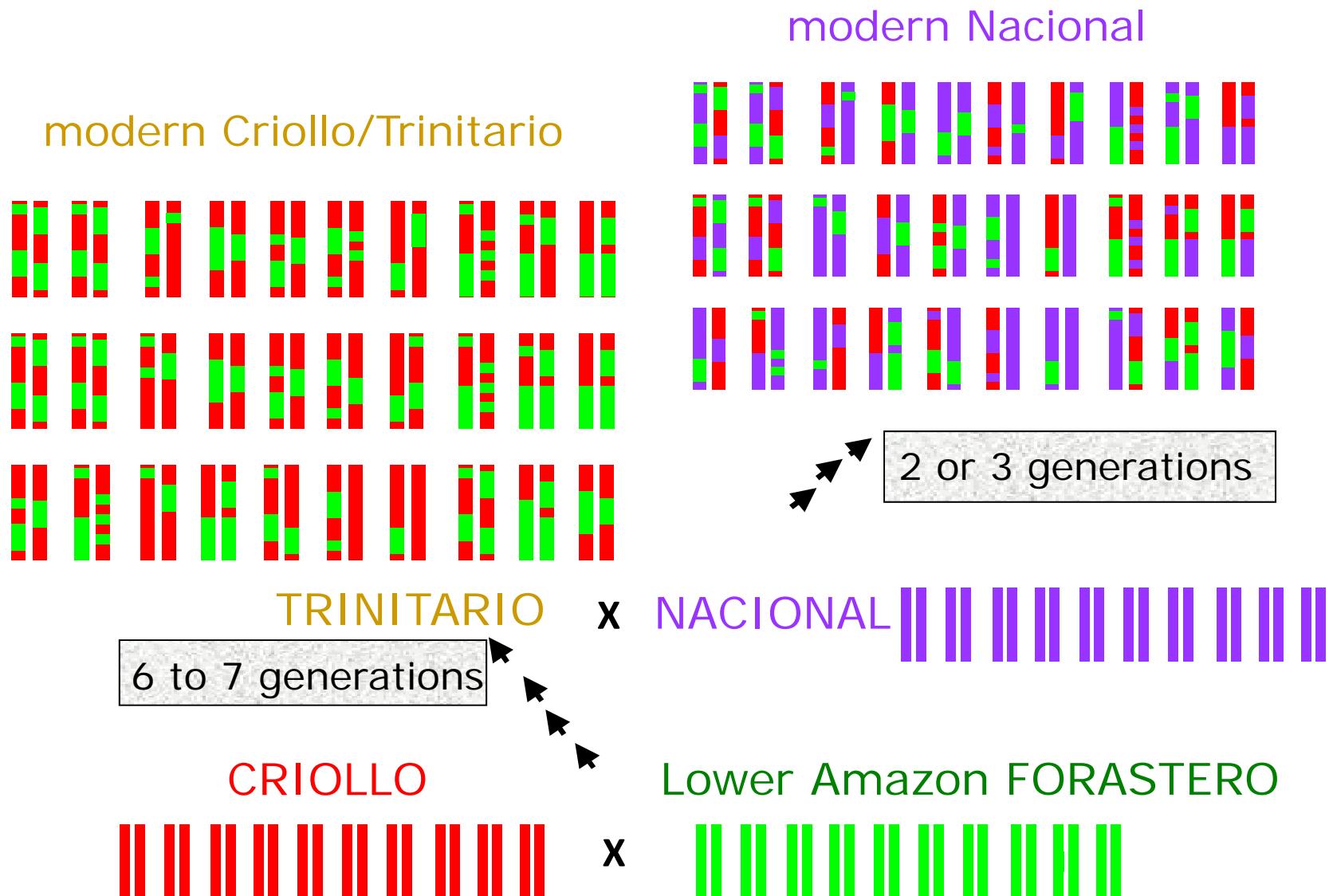
CRIOLLO x FORASTERO  
( 250 years)

WILD FORASTERO POPULATIONS

L.A. FORASTERO  
domesticated for 250 years(1750)

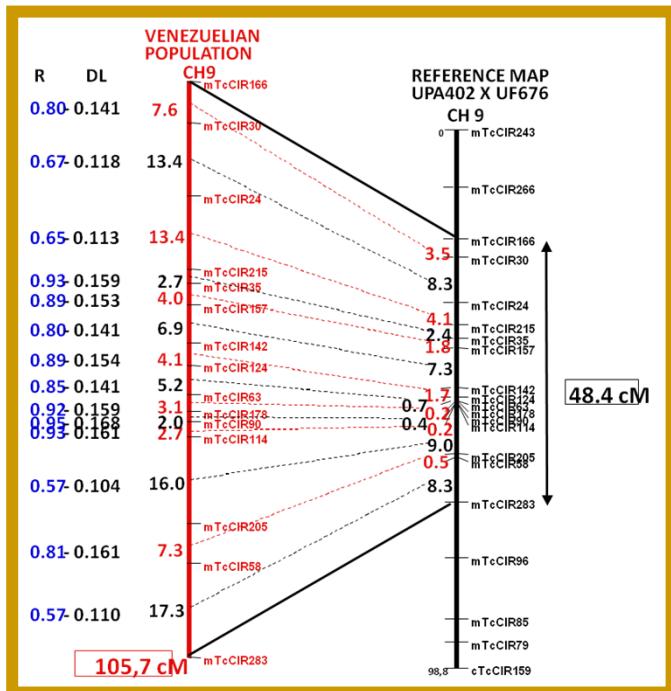


# The modern cultivated Nacional pool



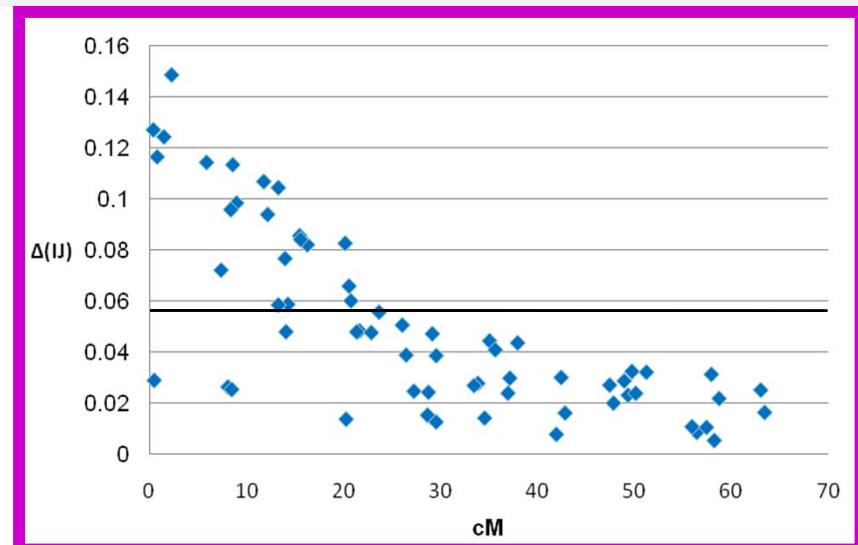
Three main ancestors

# Diversity and linkage disequilibrium within Venezuelan germplasm and Ecuadorian “Nacional” germplasm



Apparent recombination rate in Criollo-Trinitario germplasm in Venezuela genotyped with 180 SSR markers

LD variation with genetic distance among 200 individuals from the INIAP germplasm collections genotyped with 180 SSR markers



## Germplasm collections established in all producing countries

- Local collections established in each producing countries
- International collections
  - CRU, Trinidad and Tobago (2300 accessions)
  - CATIE, Costa Rica (1150 accessions)



- Phenotypic characterisation already carried out for many cocoa useful traits
- Data could be exploited to conduct GWAS

Examples of associations for fruit and seed traits identified in the CATIE collection (*Marcano et al., TAG 2007, 2008*)

*Availability of the sequence , December 2011  
Argout et al, Nature Genetics vol 43-2, 2011*





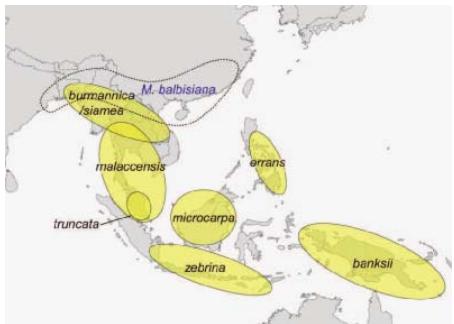
# Socializing diversity: banana

The integration of archaeology, genetics, and linguistics provides robust insights into the history of banana domestication

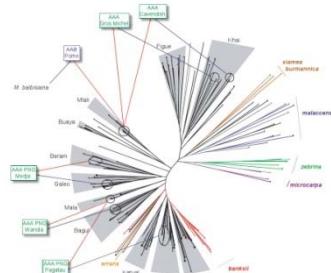
## Multidisciplinary perspectives on banana (*Musa* spp.) domestication

Xavier Perrier<sup>a</sup>, Edmond De Langhe<sup>b</sup>, Mark Donohue<sup>c</sup>, Carol Lentfer<sup>d</sup>, Luc Vrydaghs<sup>e</sup>, Frédéric Bakry<sup>a</sup>, Françoise Carreel<sup>f</sup>, Isabelle Hippolyte<sup>a</sup>, Jean-Pierre Horry<sup>a</sup>, Christophe Jenny<sup>g</sup>, Vincent Lebot<sup>h</sup>, Ange-Marie Risterucci<sup>a</sup>, Kodjo Tomekpe<sup>a</sup>, Hugues Doutreléont<sup>e</sup>, Terry Ball<sup>i</sup>, Jason Manwaring<sup>i</sup>, Pierre de Maret<sup>i</sup>, and Tim Denham<sup>k,1</sup>

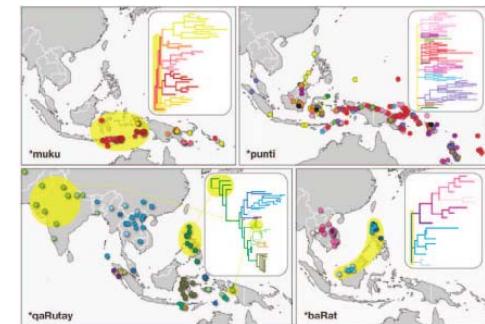
<sup>a</sup>Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Amélioration Génétique et Adaptation des Plantes, F-34398 Montpellier, France; <sup>b</sup>Laboratory of Tropical Crop Improvement, Katholieke Universiteit, 3001 Leuven, Belgium; <sup>c</sup>Department of Linguistics, Australian National University, Canberra 0200, Australia; <sup>d</sup>School of Social Science, University of Queensland, St. Lucia 4072, Australia; <sup>e</sup>Research Team in Archaeo- and Palaeosciences, 1160 Brussels, Belgium; <sup>f</sup>Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Biologie et Génétique des Interactions Plantes-Parasites, F-34398 Montpellier, France; <sup>g</sup>Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Amélioration Génétique et Adaptation des Plantes, F-97130 Capesterre-Belle-Eau, Guadeloupe, France; <sup>h</sup>Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Amélioration Génétique et Adaptation des Plantes, Department of Agriculture, Centre Agronomique de Recherche et de Formation du Vanuatu, 946 Port Vila, Vanuatu; <sup>i</sup>Department of Ancient Scripture, Brigham Young University, Provo, UT 84602; <sup>j</sup>Secrétariat, Centre d'Anthropologie Culturelle, Université Libre de Bruxelles, 1000 Brussels, Belgium; and <sup>k</sup>School of Geography and Environmental Science, Monash University, Victoria



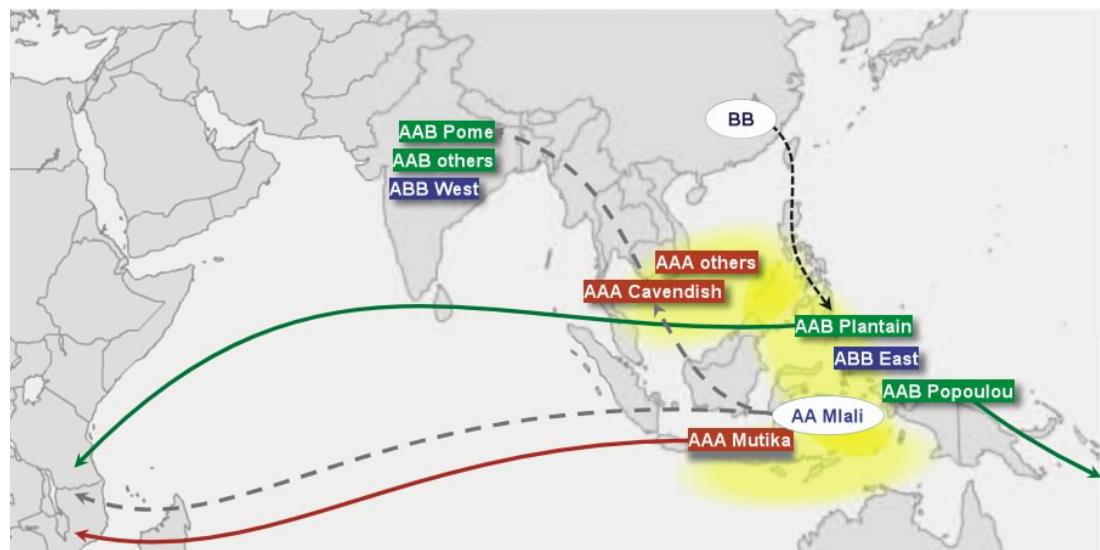
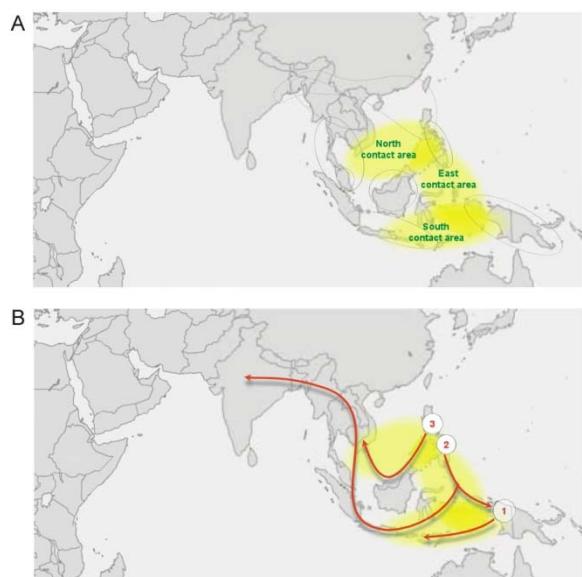
Spatial data



Crop genetic data



Linguistic data



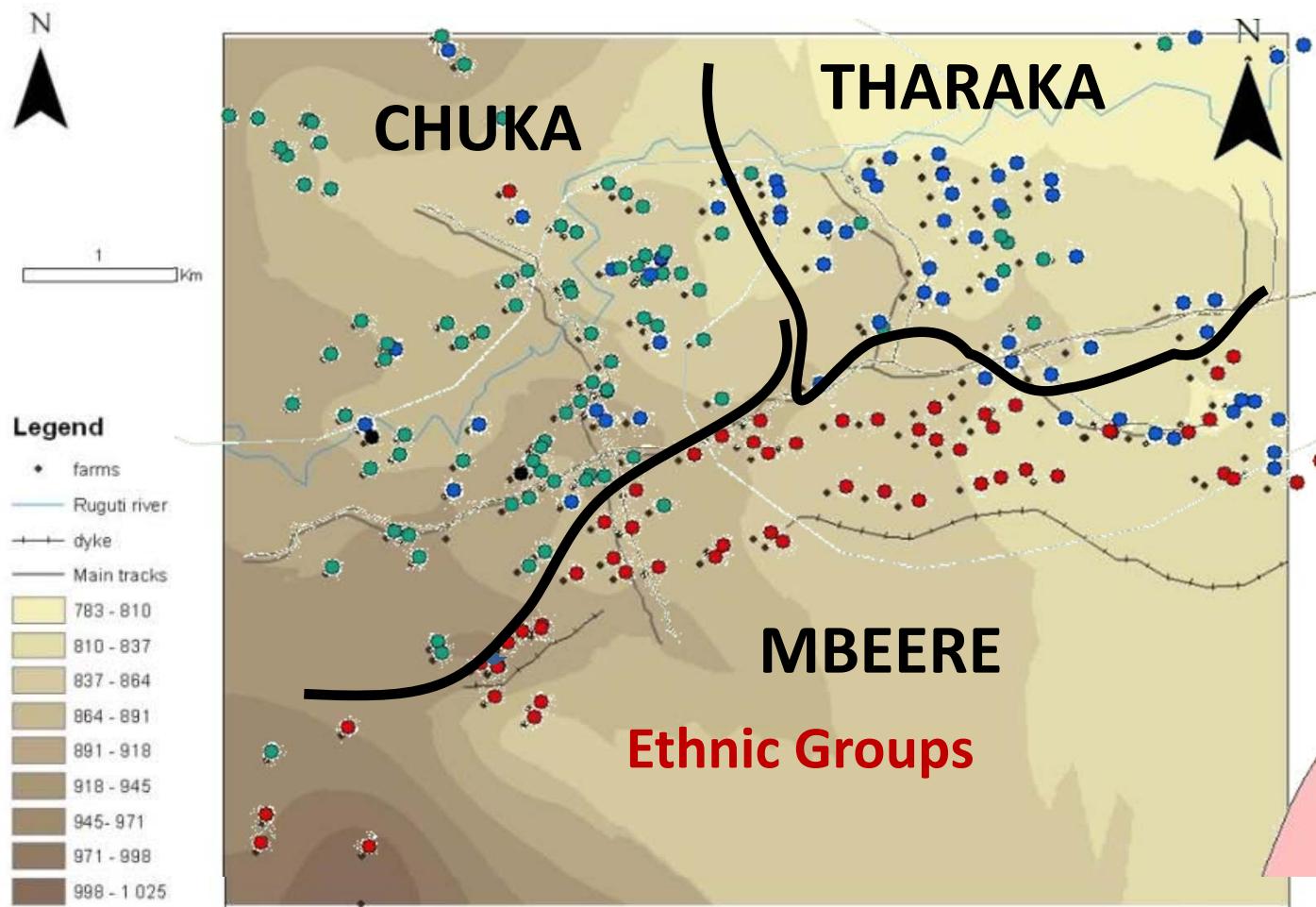
A geographical reading of the linguistic paths illustrates  
the movements of banana genotypes

(Perrier et al. 2011)



# Socializing diversity: sorghum

Is there a relation between Farmer social organisation and the Crop Genetic diversity?



# Socializing diversity: sorghum

The spatial distribution of landrace names and the overall genetic spatial patterns were significantly correlated with ethnolinguistic partition in Kenya.

OPEN  ACCESS Freely available online



Influence of Ethnolinguistic Diversity on the Sorghum Genetic Patterns in Subsistence Farming Systems in Eastern Kenya

Vanesse Labeyrie <sup>1\*</sup>, Monique Deu <sup>1</sup>, Adeline Barnaud <sup>3</sup>, Caroline Calatayud <sup>1</sup>, Marylène Buiron <sup>1</sup>, Peterson Wambugu <sup>2</sup>, Stéphanie Manel <sup>4,5</sup>, Jean-Christophe Glaszmann <sup>1</sup>, Christian Leclerc <sup>1</sup>

<sup>1</sup> UMR AGAP CIRAD, Montpellier, France, <sup>2</sup> National Genebank of Kenya, KARI, Nairobi, Kenya, <sup>3</sup> UMR DIADE, IRD, Montpellier, France, <sup>4</sup> UMR LPED, Université Aix-Marseille/IRD Marseille, France, <sup>5</sup> UMR MAP, CIRAD Montpellier, France

Seed exchange is oriented more within than between linguistic communities.

The usual GxE interaction was decomposed in a three ways interaction model, GxExS, where S stands for the social factors

*Diversity* 2012, 4, 1-32; doi:10.3390/d4010001

OPEN ACCESS

*diversity*

ISSN 1424-2818

[www.mdpi.com/journal/diversity](http://www.mdpi.com/journal/diversity)

Article

**Social Organization of Crop Genetic Diversity. The G × E × S Interaction Model**

Christian Leclerc <sup>1,\*</sup> and Geo Coppens d'Ecckenbrugge <sup>2</sup>

## Social Process of Adaptation to Environmental Changes: How Eastern African Societies Intervene between Crops and Climate

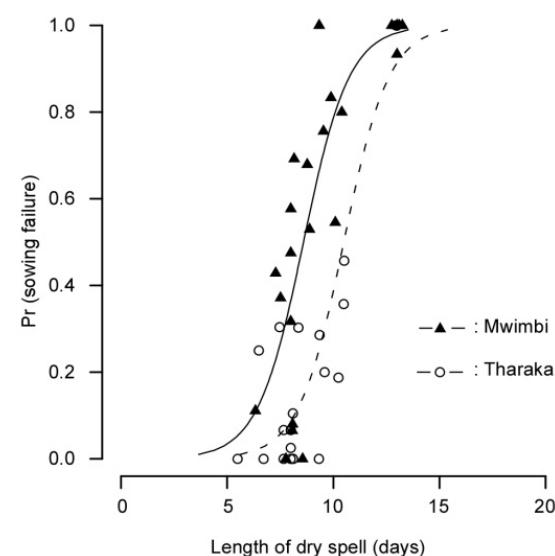
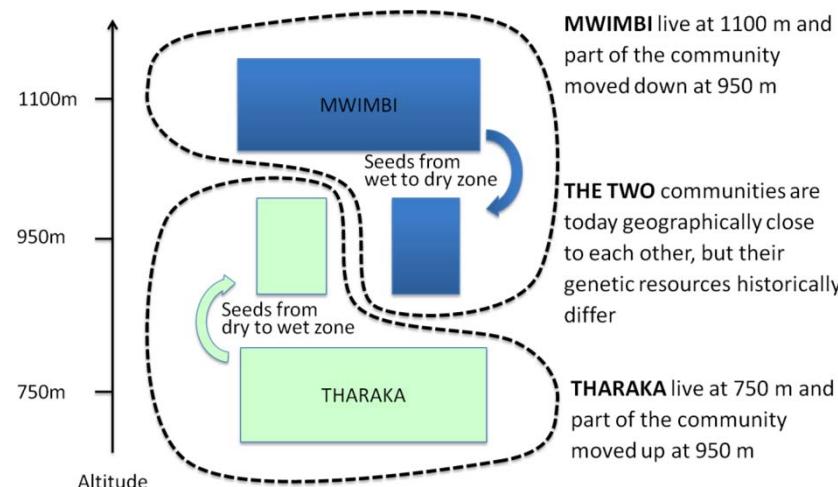
Caroline Mwongera *Montpellier SupAgro, UMR AGAP, Montpellier, France*

Joseph Boyard-Micheau *CRC, Biogéosciences, UMR 6282 CNRS/ Université de Bourgogne, Dijon, France*

Christian Baron *CIRAD, UMR TETIS, Montpellier, France*

Christian Leclerc\**CIRAD, UMR AGAP, Montpellier, France*

### Context



extracted from  
*Nature Climate Change* May 2014

### research highlights

ADAPTATION  
Adapting sowing in east Africa  
*Weath. Clim. Soc.* <http://doi.org/10.1175/WCAS-D-13-00034.1>



Climate variability increases farmers' risk of sowing failure by challenging their ability to anticipate rainfall and synchronize sowing accordingly. Observing changes in the practices of farming communities is crucial to better understand adaptation to future climate change, but requires costly long-term studies.

Caroline Mwongera, of AGAP Joint Research Unit, France, and colleagues used a space-and-time substitution approach to observe adaptation to climatic change. They compared two communities that migrated along the slope of Mount Kenya, Africa: the Tharaka community moved from the lowlands (750 m) to the midlands (950 m) and the Mwimbi went from upland (1100 m) to the midlands. Here, changes in location corresponded to changes in time, as induced by environmental alteration. The researchers



## Temporal gradients: pearl millet in Niger (1976-2003)

1976 germplasm collection

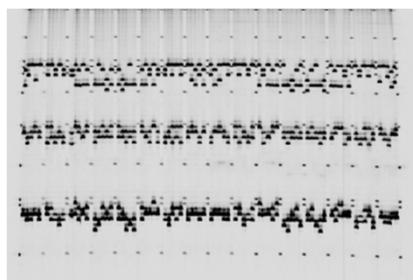


2003 Samples



Information  
on varieties

Conservation at 4°C  
for 27 years

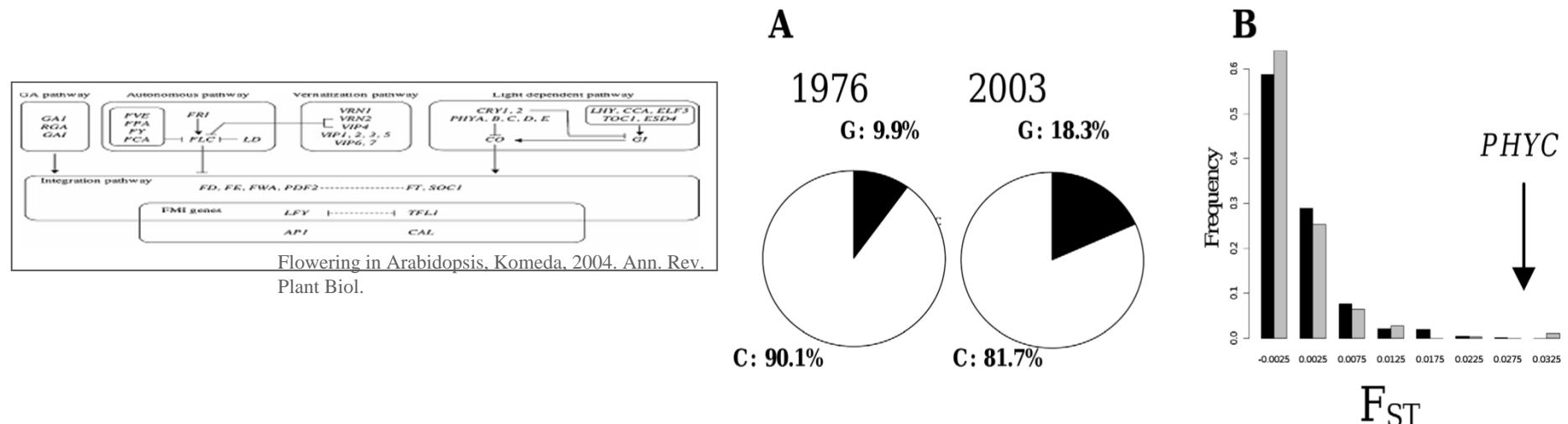


DNA marker  
analysis



Morphological  
and  
phenological  
analysis

# Temporal gradients: pearl millet in Niger (1976-2003)



1976- 2003 :

Increase in the frequency of the early-flowering allele of the *PhyC* gene

OPEN ACCESS Freely available online

PLOS one

2011

## Selection for Earlier Flowering Crop Associated with Climatic Variations in the Sahel

Yves Vigouroux<sup>1,2\*</sup>, Cédric Mariac<sup>1,2</sup>, Stéphane De Mita<sup>1</sup>, Jean-Louis Pham<sup>1</sup>, Bruno Gérard<sup>3</sup>, Issoufou Kapran<sup>4</sup>, Fabrice Sagnard<sup>5</sup>, Monique Deu<sup>5</sup>, Jacques Chantereau<sup>5</sup>, Abdou Ali<sup>6</sup>, Jupiter Ndjeunga<sup>3</sup>, Viviane Luong<sup>1</sup>, Anne-Céline Thuillet<sup>1</sup>, Abdoul-Aziz Saïdou<sup>1,2,7</sup>, Gilles Bezançon<sup>2</sup>

**1** Institut de Recherche pour le Développement, Montpellier, France, **2** Institut de Recherche pour le Développement, Niamey, Niger, **3** International Center of Research for the Semi-Arid Tropics, Niamey, Niger, **4** Institut National de la Recherche Agronomique du Niger, Niamey, Niger, **5** Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France, **6** Centre Régional AGHRYMET, Niamey, Niger, **7** Université Abdou Moumouni, Niamey, Niger



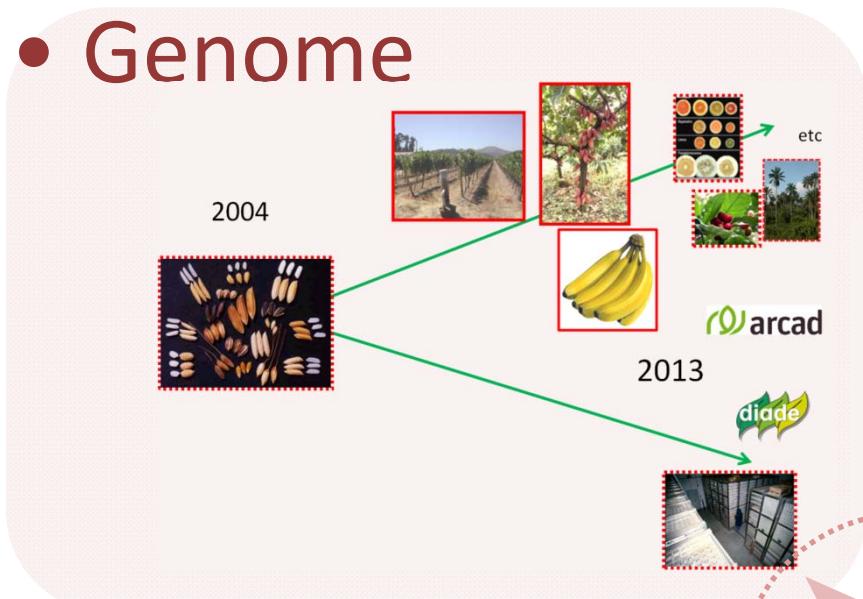
# Agropolis Resource Center for Crop Conservation, Adaptation and Diversity

Jean-Louis PHAM  
*arcad@agropolis.fr*  
*www.arcad-project.org*

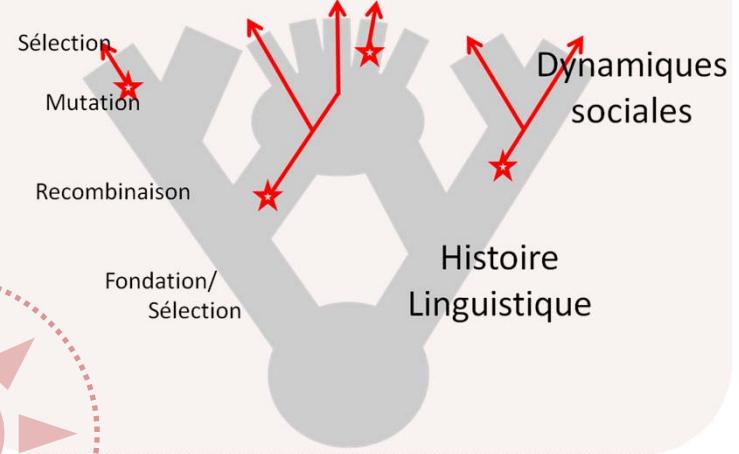


# Confluences!

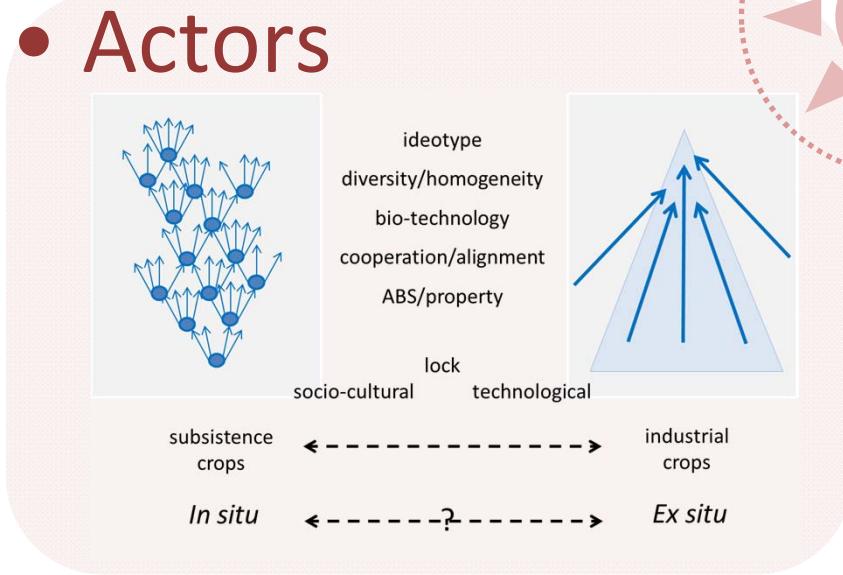
- Genome



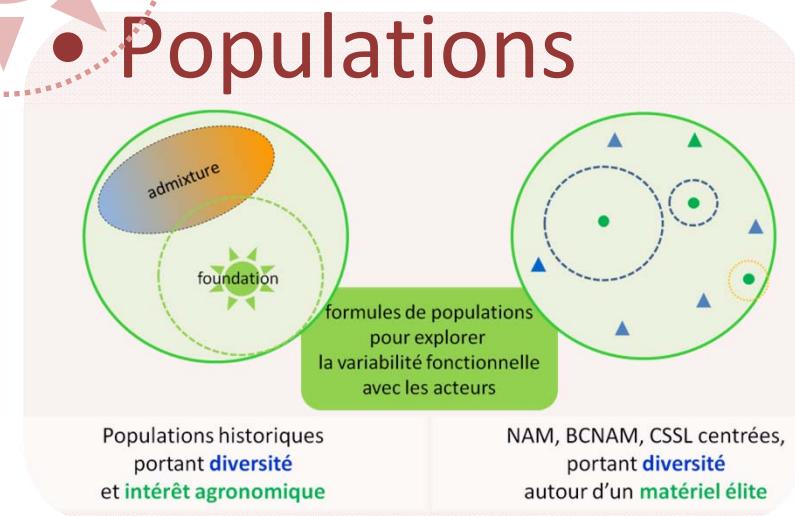
- Diversity



- Actors



- Populations





# International Workshop on the promotion of Public-Private Partnerships for Pre-breeding

## *Montpellier, France 2 – 4 February 2015*

Morten Rasmussen, NordGen  
Robert Domaingue, Cirad



# Mobilization of genetic diversity – *a social science perspective*

*We are interested in the interplay between institutions, structures and behaviors in relation to the nature of the material and information exchanged.*

Welch, E. and **S. Louafi**, 2014, Contested Inputs for Scientific Research: Why Access to Biological Materials Is Blocked, In : [72th Midwest political science association \(MPSA\) Conference](#) Chicago, USA, 3-5 April 2014

**Louafi S.**, Bazile D., Noyer J.L. 2013. Conserving and cultivating agricultural genetic diversity : transcending established divides. In : Hainzelin Etienne (ed.). Cultivating biodiversity to transform agriculture. Heidelberg : Springer , p. 181-230..

# Anchoring in a common past for mobilizing present

For accelerating successful processes

recombination, base-broadening  
progressive populations  
preventive breeding  
more participation  
allelic diversity distribution  
more crop species

(« DAD », Lebot et al, Exp Agric 2005, EDS 2013)



## Plant Breeding for the Home Gardener: How to Create Unique Vegetables and Flowers

By Joseph Tychonievich

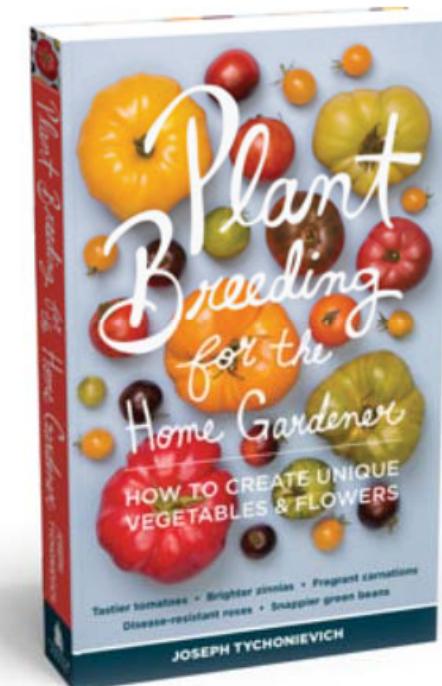
It's the holy grail of gardening: a plant that perfectly matches your tastes and the conditions in your garden. The hitch? You're not likely to find it at your local garden center. You're going to have to create it yourself.

But don't worry — it isn't hard. After all, gardeners have been doing it for centuries, simply by saving seeds of the varieties that tasted or performed best. But you'll get even better results by following the advice in *Plant Breeding for the Home Gardener*. You'll learn how to set achievable goals in your breeding program; the ins and outs of genetics; how to pick the best parent plants; how to cross-pollinate; the best techniques to use for popular vegetables and flowers; and how to harvest and store seeds.

In no time at all, you'll be producing a tomato perfect for your palate, a pepper with just the right amount of heat, or a more fragrant rose!

“It's a gift to be able to break such technical things down and present them in a way that's not only fascinating, but also in language simple enough that you don't need a degree in horticulture to understand it.”

Horticulture





# Acknowledgements

Many AGAP colleagues, including

Claire Lanaud

Xavier Perrier

Claire Billot

Christian Leclerc

Selim Louafi

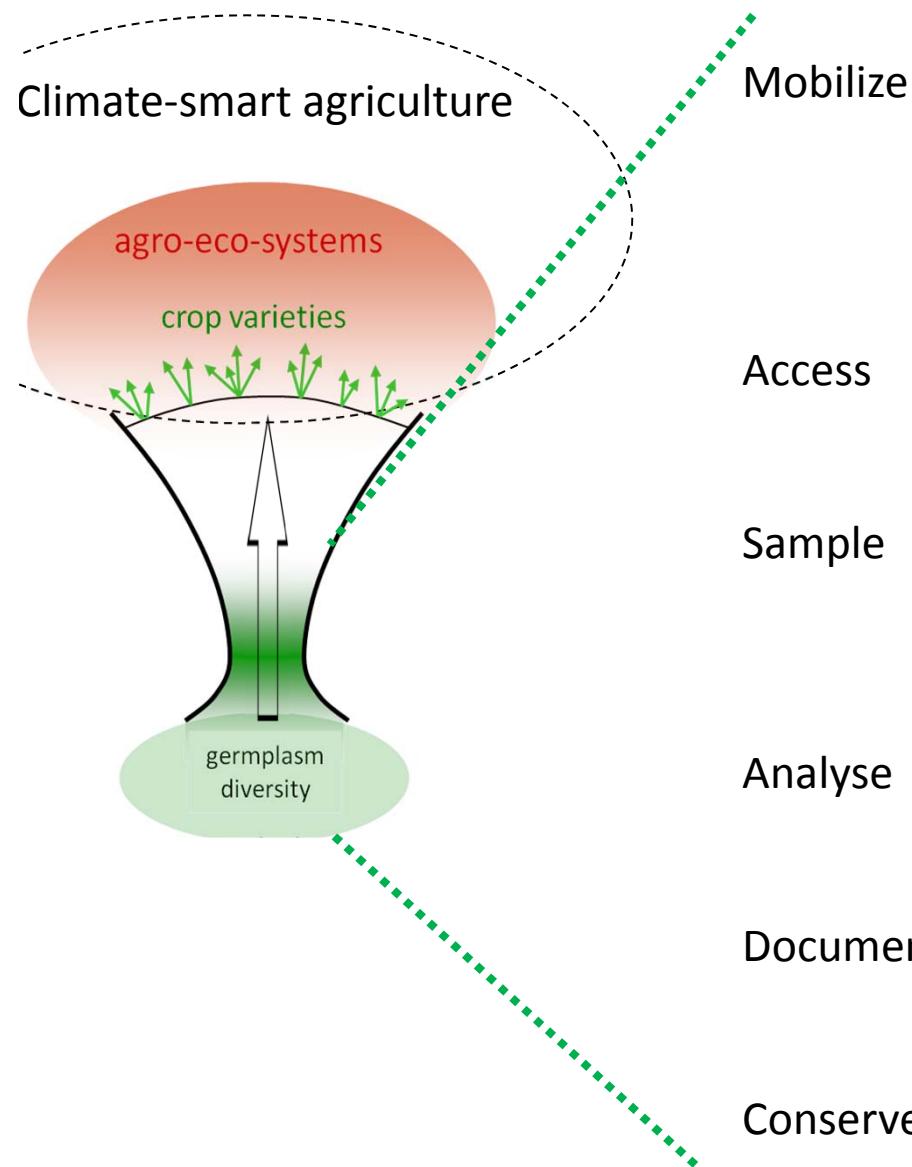
Jean-Louis Pham

Yves Vigouroux

Numerous partners in many projects







- NAM  
BC NAM  
CSSL  
MAGIC  
Wide crosses
  - Rules  
Roles
  - Reference  
Core  
Specialized
  - Historical  
Genomic correlations
  - Environment  
Actors  
Uses
  - CRB  
GCDT
- Integrate breeding work & germplasm science; pre-breeding
- Scientists' roles & responsibilities
- Coordinate, exchange & integrate
- Exchange information (haplotypes)
- Integrate
- Genetic stocks

# Pertinence of the linear model?

