

# ***BEAN\_ADAPT***

**Evolution in a changing environment: the genetic architecture of adaptation outside centers of domestication of *Phaseolus vulgaris* and *P. coccineus***



**ERA-CAPS**

ERA-NET for Coordinating  
Action in Plant Sciences



# *Phaseolus vulgaris* L.

Family: Leguminosae - Genus: *Phaseolus*

Diploid species ( $2n = 2x = 22$ )

Annual and predominantly self-pollinating (autogamous) species



*P. vulgaris*  
(common bean)



*P. dumosus*



*P. coccineus*  
(runner bean)



*P. acutifolius*  
(tepany bean)



*P. lunatus*  
(lima bean)





Annibale Carracci, *Mangiafagioli*, 1584-1585



Vincent Van Gogh, *I Mangiatori di patate*, 1885

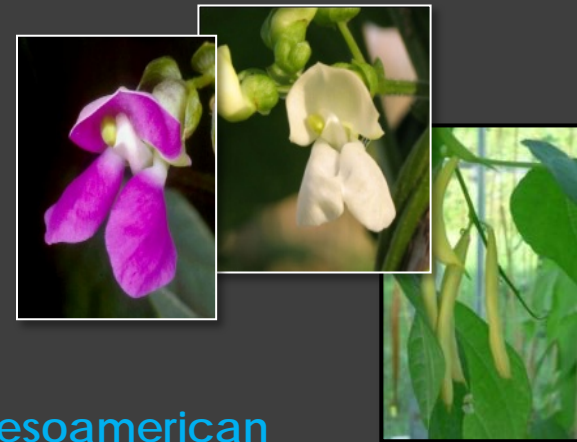


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## Mesoamerican origin of the common bean (*Phaseolus vulgaris* L.) is revealed by sequence data

Elena Bitocchi<sup>a</sup>, Laura Nanni<sup>a</sup>, Elisa Bellucci<sup>a</sup>, Monica Rossi<sup>a</sup>, Alessandro Giardini<sup>a</sup>, Pierluigi Spagnoletti Zeuli<sup>b</sup>, Giuseppina Logozzo<sup>a</sup>, Jens Stougaard<sup>c</sup>, Phillip McClean<sup>d</sup>, Giovanna Attene<sup>e</sup>, and Roberto Papa<sup>a,i,1</sup>

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PNAS

Independent  
domestications

Mesoamerican  
gene pool

Northern Peru  
and Ecuador

Andean  
gene pool



New  
Phytologist

Volume 197, Issue 1, pages  
300–313, January 2013

Research

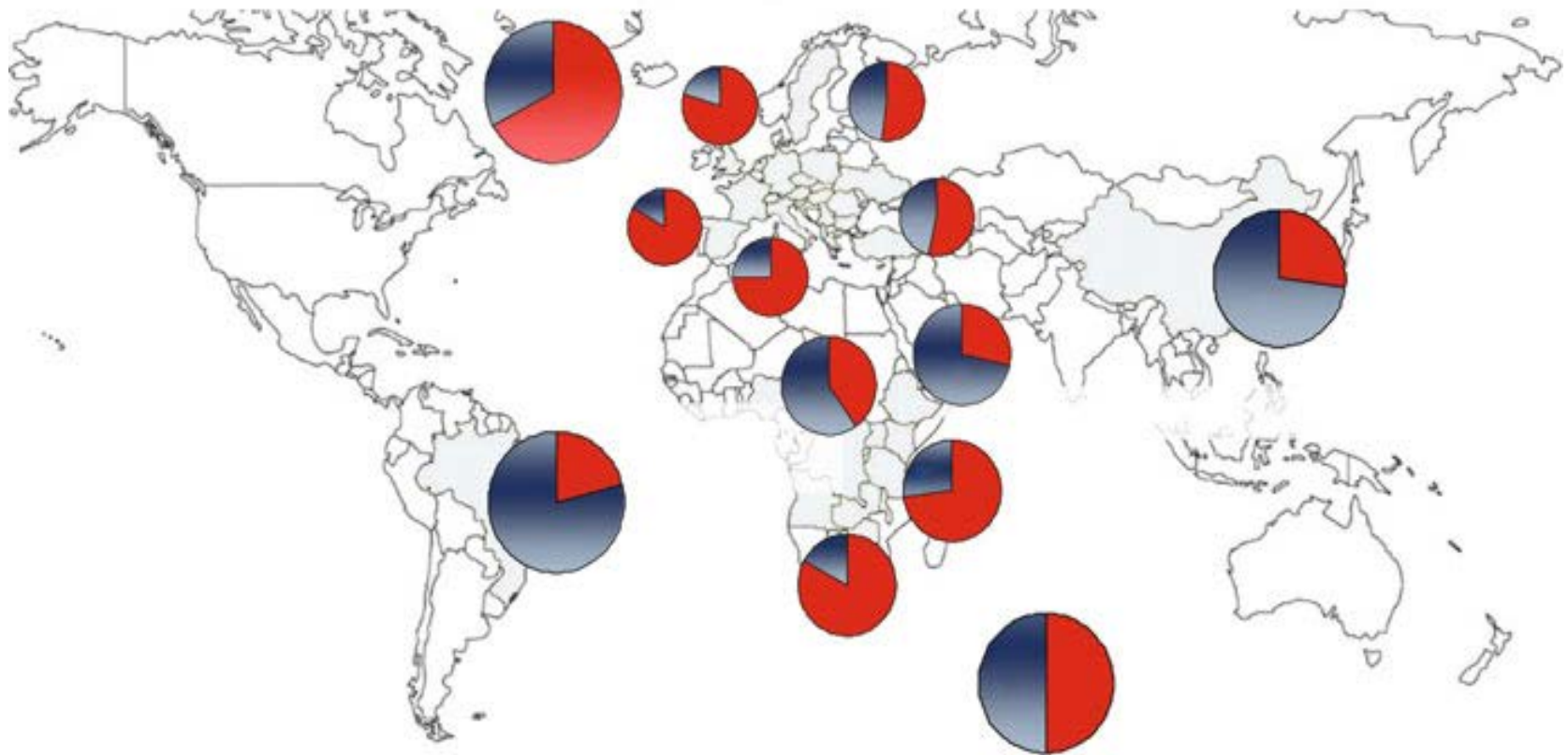
## Molecular analysis of the parallel domestication of the common bean (*Phaseolus vulgaris*) in Mesoamerica and the Andes

Elena Bitocchi<sup>1</sup>, Elisa Bellucci<sup>1</sup>, Alessandro Giardini<sup>1</sup>, Domenico Rau<sup>2</sup>, Monica Rodriguez<sup>2</sup>, Eleonora Biagetti<sup>1</sup>, Rodolfo Santilocchi<sup>1</sup>, Pierluigi Spagnoletti Zeuli<sup>3</sup>, Tania Gioia<sup>3</sup>, Giuseppina Logozzo<sup>3</sup>, Giovanna Attene<sup>2</sup>, Laura Nanni<sup>1</sup> and Roberto Papa<sup>1,4</sup>

Gepts et al. 1986; Gepts & Bliss 1988; Koenig & Gepts 1989; Singh et al. 1991; Rossi et al. 2009; Becerra Velasquez & Gepts 1994; Freyre et al. 1996; Tohme et al. 1996; Papa & Gepts 2003; Blair et al. 2006; Diaz & Blair 2006; Kwak et al. 2009; Kwak & Gepts 2009; Schmutz et al. 2014



# Beans in Europe



# Beans in Europe

The main aim of this project is to **dissect out the genetic basis and phenotypic consequences of the adaptation to new environments** of the common bean and its sister species, the runner bean, through the study of their introduction, from their respective centers of domestication in the Americas, and expansion through Europe, as a **recent and historically well-defined event of rapid adaptation.**



# BEAN\_ADAPT Consortium

## *backgrounds and facilities*



### Project leader:

Prof. Roberto PAPA

UNIVERSITA' POLITECNICA delle MARCHE, D3A - Department of Agricultural, Food and Environmental Science  
Ancona, ITALY

Project Manager Dr. Elisa Bellucci

Research Scientists from UNIVPM (Dr. Elena Bitocchi, Dr. Laura Nanni) and one PhD student (Debora Santo),  
Associated group from Sassari University: Research scientist (Dr. Domenico Rau) and one PhD student (Maria Murgia)

- **Population genetics,**
- **Genomics,**
- **Plant breeding**
- **Evolution,**
- **Adaptation,**
- **Genetic resources and conservation**





# BEAN\_ADAPT Consortium

## *backgrounds and facilities*



The University of Georgia

Project partner PI:

Dr. Scott A. Jackson

University of Georgia

Scott Jackson, Professor and Georgia Research Alliance Eminent Scholar  
University of Georgia, Center for Applied Genetic Technologies

Bioinformatics: Brian Abernathy. GBS: Jennifer Leverett  
Facilities



Center for Applied Genetic Technologies

- Genetic resources
- Computational biology
- Genomics
- Evolution/Domestication
- Chromosome biology

# BEAN\_ADAPT Consortium

## *backgrounds and facilities*



### Project partner PI:

Dr. Alisdair Fernie

Central Metabolism

MPI-Molecular Plant Physiology

Germany

The Central Metabolism group comprises of a group leader (**Alisdair Fernie**), a project leader (**Takayuki Tohge**) nine Post-Docs, five PhD students and four technicians, with expertises in:

- **Primary Metabolism,**
- **Secondary Metabolism,**
- **Genetics**
- **Metabolomics,**
- **Metabolic Regulation,**







# BEAN\_ADAPT Consortium *backgrounds and facilities*

**UC DAVIS**  
UNIVERSITY OF CALIFORNIA

Project partner PI:

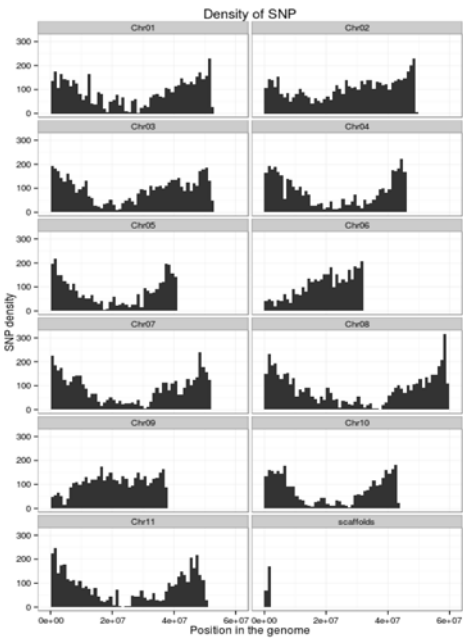
Dr. Paul Gepts, Professor of Plant Sciences

Personnel Involved

Andrea Ariani, Postdoc

Antonia Palkovic, Asst. Specialist

Jorge Berny, Graduate Student



- Crop Evolution and Domestication
- Botanical Explorations
- Genetic Resources and Conservation
- Legume Breeding
- Adaptation to drought, heat, daylength
- Genomics





# BEAN\_ADAPT Consortium

## *backgrounds and facilities*



Project partner PI:

Prof. Andreas Graner

Genebank Department

Leibniz Institute of Plant Genetics & Crop Plant Research (IPK)  
Germany

The Department maintains the Federal *ex situ* Genebank for agricultural and horticultural crop plants. Totalling 150.000 accessions it represents one of the largest Genebanks world-wide.

Major research areas in the department include.

- Conservation management
- Crop genomics
- Genome evolution
- Trait mapping and gene discovery
- Biodiversity informatics



# *Germplasm (*P. vulgaris*)*

5000 landraces from the Centres of Origin (Mesoamerica and Andes)

5000 landraces from Europe



10,000 accessions



Pv\_ALL 10,000 SSD purified accessions (1 cycle)



GbS (about 10000 SNPs) and seed stocks



# ***Germplasm (*P. vulgaris*)***

**Pv\_ALL 10,000 single seed purified accessions**



**PV\_Core1 (500 lines)**



**Field Trials (phenology)  
(Colombia, Germany and Italy)  
Additional from associated  
partners**



**WGS (low coverage)**

# ***Germplasm (*P. vulgaris*)***

**PV\_Core1 (500 lines)**



**PV\_Core2 (500 lines)**



**Growth Chamber**  
(two contrasting conditions of light  
and temperature, to simulate a  
tropical short-day vs a temperate  
long-day environment)



**Molecular phenotyping:**  
Transcriptomics  
Metabolomics



# ***Germplasm (*P. coccineus*)***

**750 landraces from the Centre of Origin (Mesoamerica)**  
**750 landraces from Europe**



**Pc\_ALL 1,500 accessions**



**GbS (about 10000 SNPs) and seed stocks**

# *Germplasm (*P. coccineus*)*

**Pc\_All (1500 accessions)**



**Pc\_Core1 (60 lines)**

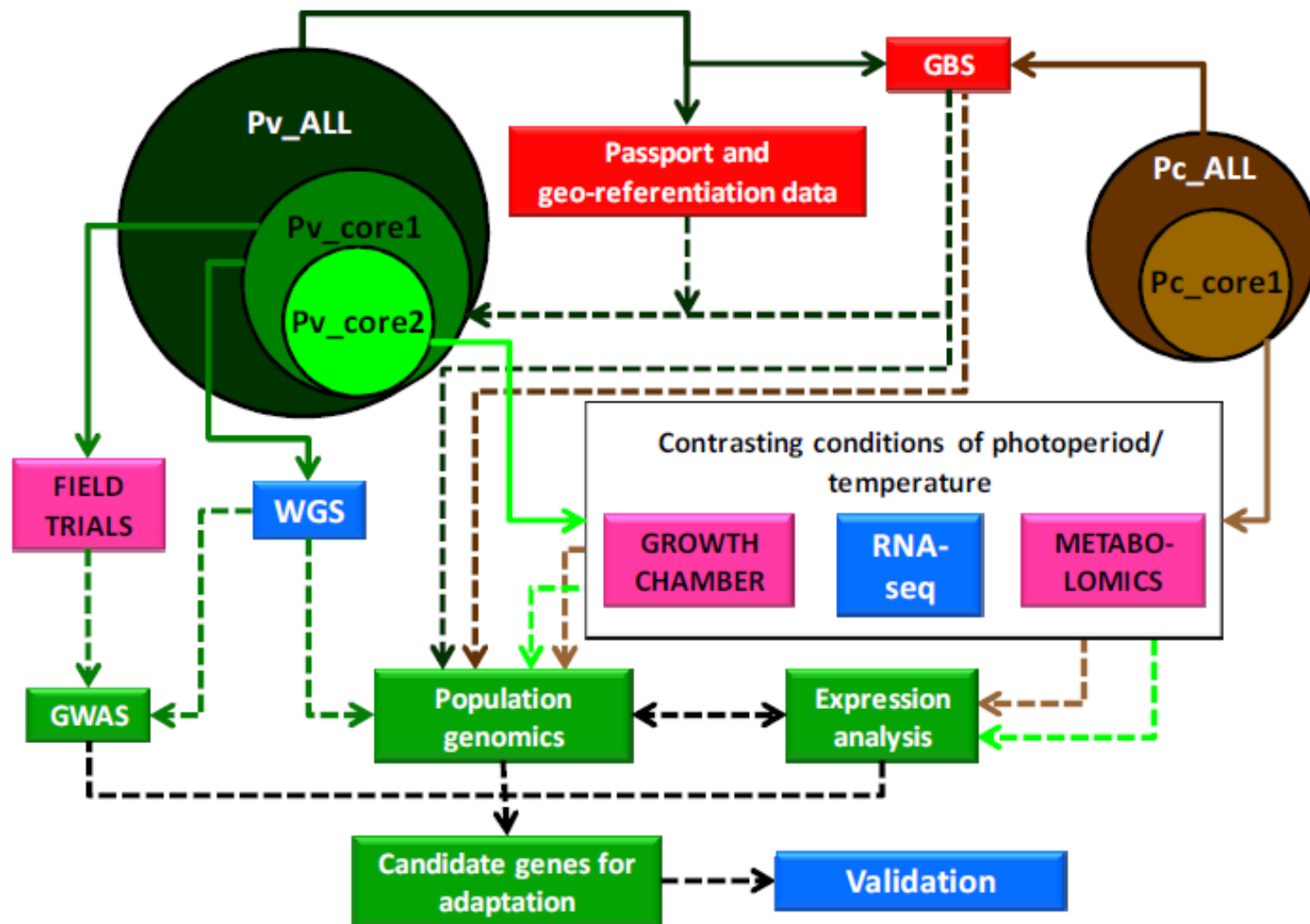


**Growth Chamber**  
(two contrasting conditions of light  
and temperature, to simulate a  
tropical short-day vs a temperate  
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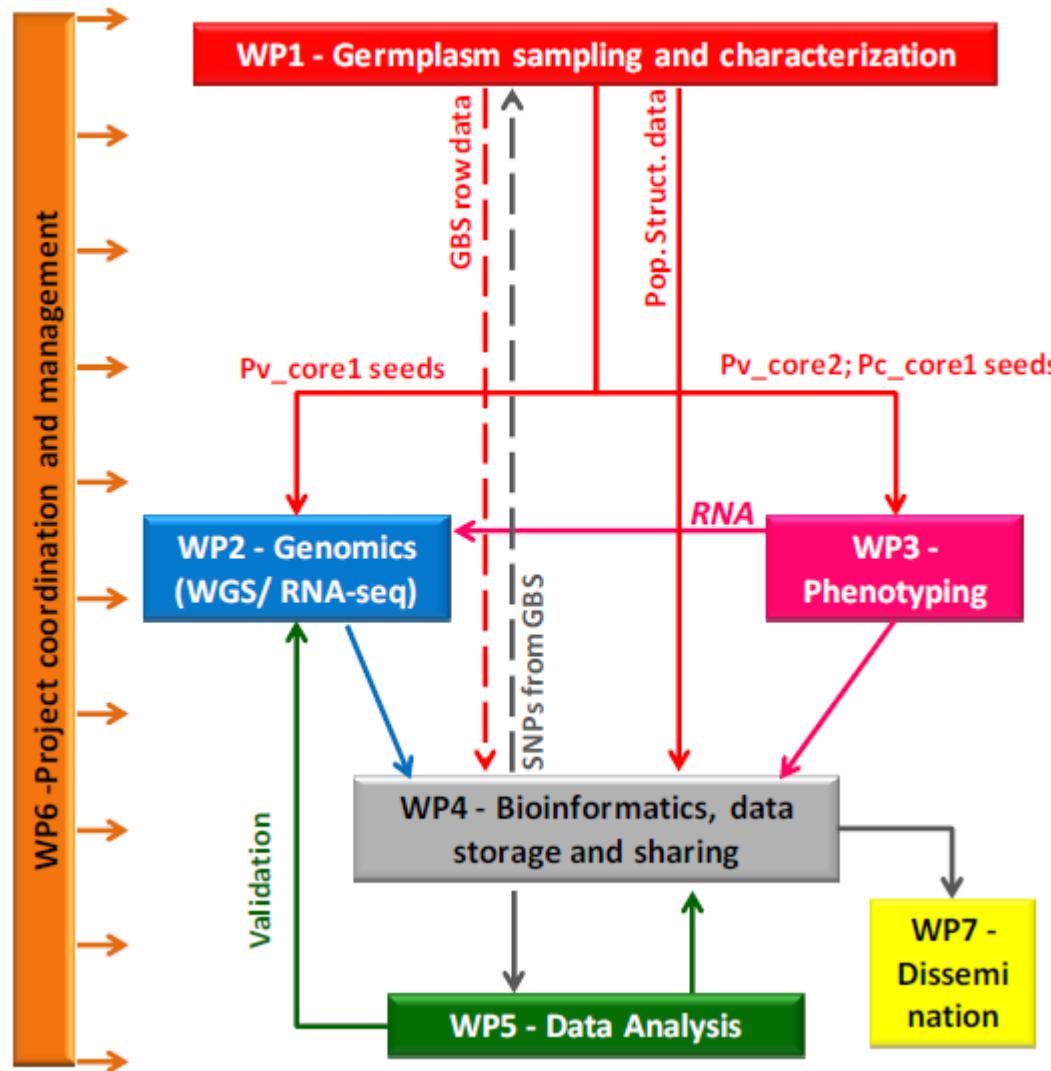


**Molecular phenotyping:**  
Transcriptomics  
Metabolomics

# Workflow



# WPs





# ***Main Deliverables***

## **Deliverables**

D4.3 Computed haplotypes from 500 Pv\_core1 accessions, and haplotypes for PV\_ALL

D5.1 List of genes and phenotypes showing signature of selection.

D5.2 List of loci significantly associated with traits and environmental variables.

D5.3 Improved expression associated genome annotation.

D5.4 List of strong candidates for validation.

D5.5 List of validated candidates.

# kickoff meeting

<b>Papa Roberto</b>	Università Politecnica delle Marche ( <b>UNIVPM</b> )
<b>Jackson Scott A.</b>	University of Georgia ( <b>UGA</b> )
<b>Gepts Paul</b>	University of California ( <b>UC Davis</b> )
<b>Fernie Alisdair R.</b>	Max-Planck-Institute of Molecular Plant Physiology ( <b>MPI-MP</b> )
<b>Graner Andreas</b>	Leibniz Institute of Plant Genetics and Crop Plant Research ( <b>IPK</b> )

**Kickoff Meeting, 11-12 August Bonn (Global Diversity Trust)**

**Advisory Board: Kirstin E. Bett College of Agriculture and Bioresources- University of Saskatchewan, Canada**

**2) Valerie Geffroy, INRA, France**

**3) Massimo Delledonne, University of Verona, Italy**

**Associated partners (e.g. CIAT)**

Thanks for  
your attention

# Evolution of Human bean

