

The Italian contribution to the conservation, characterization and use of plant genetic resources

Giovanni Giuseppe Vendramin

Institute of Biosciences and Bioresources
National Research Council
Italy



Consiglio Nazionale delle Ricerche



6 divisions

182 permanent and 150 non-permanent people

Priority research areas and objectives

IBBR

- ✓ to increase the knowledge on basic biology, mainly focusing on the genetic basis and molecular mechanisms underlying functioning, adaptation, reproduction, evolution and environmental relationships of biological systems.
- ✓ to safeguard and to sustainable manage bioresources in the agricultural, agri-food, environmental fields for human health purposes

IBBR-Firenze-Bari

- ✓ tracing, monitoring, preserving, characterizing and exploiting the biodiversity of forest and crop species with the goal of securing their sustainability
- ✓ enhancing the knowledge on the evolution of bioresources and their distribution and functional role, with the goal of securing their adaptive potential against stress factors generated by the climate change





- **Crea is the national council for research in agriculture**
- **Crea has a strong interest in plant genetic diversity, molecular characterization and breeding of many crop species. In this field Crea has a research strategy based on:**
 - **A main project dedicated to the conservation of Plant Genetic Resources: RGV/FAO**
 - **A number of advanced projects dedicated to the molecular characterization of plant diversity. Three examples: 1-ESPLORA, 2-RISINNOVA, 3-WHEALBI**

- The project is coordinated by Crea and financed by the Ministry of Agriculture to recognize Italy's adhesion to the International Treaty on Plant Genetic Resources for Food and Agriculture.
- Research activities aim at the collection, conservation, characterization, documentation and utilization of more than 70 crops relevant for the Italian agriculture (cereals, vegetables, fruits, olive, grape, fodder and forage crops, forest species, industrial crops, ornamental, medicinal and aromatic plants) 26 of which are currently included in the Multilateral System of the ITPGRFA.



CRA
CONSIGLIO PER LA RICERCA
IN AGRICOLTURA E L'ANALISI
DELL'ECONOMIA AGRARIA

PlantA Res

National Network on Plant Genetic Resources
for Food and Agriculture

MINISTERO DELLE POLITICHE AGRICOLE
ALIMENTARI E FORESTALI

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REGIONI_PROVINCE
STRUTT_PUBB
PRIVATI_

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National Network on Plant Genetic Resources for Food and Agriculture

This network has been realized within the project "Plant Genetic Resources/FAO" (RGV/FAO), approved and financed by the Ministry of Agriculture in order to recognize Italy's adhesion, in 2004, to the International Treaty of the FAO on Plant Genetic Resources for the access to plant genetic material and for the fair and equitable sharing of benefits arising from their utilization. Project partners are 29 Research Centres and Units of the CRA (Council for Research and Experimentation in Agriculture), the "Istituto di Bioscienze e Biorisorse" (IBBR - Mediterranean Germplasm Database) of the CNR

germplasm collections held by participating institutions but is intended to grow over time in order to include also the collections held in other institutions, such as universities, of which some (University of Perugia, University of Potenza) "Nazareno Strampelli" Institute have already included their collections. The documentation of the accessions conserved also allows to notify the inclusion of accessions in the Multilateral System on Access and Benefit Sharing of the Treaty, and to exchange this material under the standard Material Transfer Agreement (sMTA), as foreseen by the Treaty.

1 - ESPLORA project (MIPAAF 2010-2013) biodiversity + molecular characterization

An initiative to organize the genetic and phenotypic characterization of the main crop species with a direct impact on pre-breeding activities.

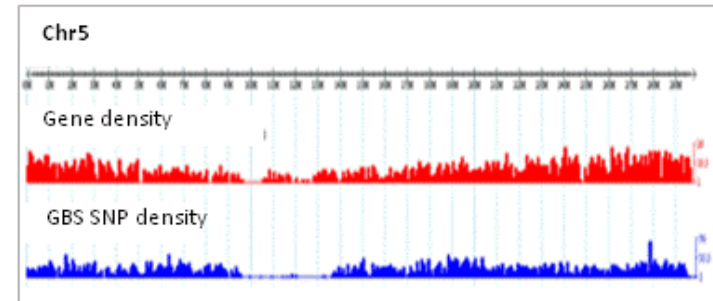
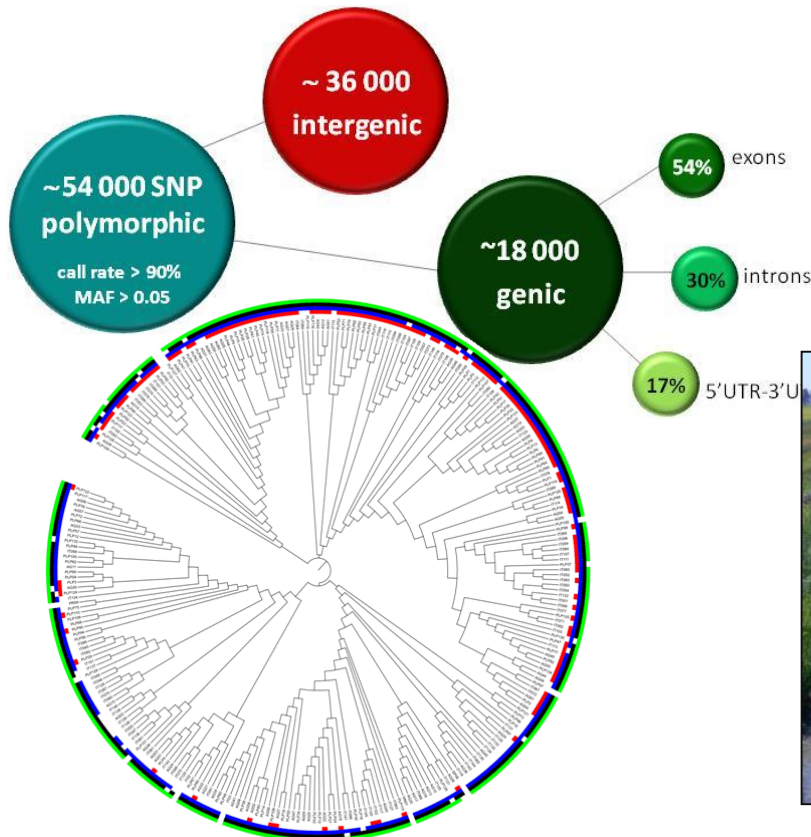
Main species		Collection type	Number of accessions	Genotyping platform
Barley	<i>Hordeum vulgare</i>	Cultivars, landraces and wild relatives	>1000	SNP-Chip, Exome sequencing
Rice	<i>Oryza sativa</i>	Cultivars	300	Genotyping-By-Sequencing
Wheat	<i>Triticum durum</i> + <i>Triticum aestivum</i>	Cultivars, landraces and wild relatives	230 + 500	SNP-Chip, Exome sequencing
Eggplant	<i>Solanum melongena</i>	Wild and domesticated accessions + Mapping populations	240	Genotyping-By-Sequencing
Pea	<i>Pisum sativum</i>	Mapping populations	270	SNP
Poplar	<i>Populus alba</i>	Mapping populations	250	Genotyping-By-Sequencing

Other species considered:

Grapevine, Oat, Peach, Citrus, Tomato, Olive, Strawberry,

2 - RISINNOVA a project for advanced characterization of Italian rice germplasm

Genomic and Phenotypic characterization of a collection of 300 rice italian accessions for the identification of traits and genes useful to improve Italian cultivated genepool .

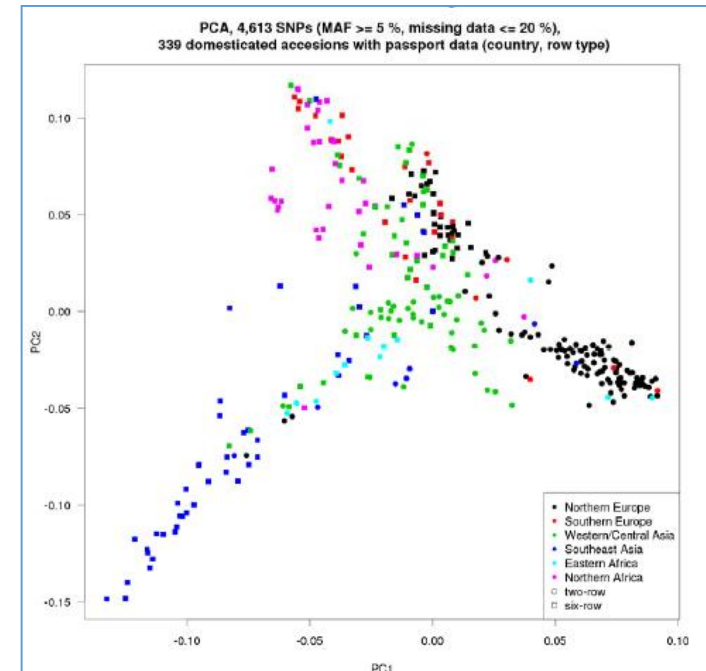


3 - WHEALBI is an EU funded project, participated by Crea, dedicated to innovative methods for the characterization of wild relatives and local varieties of wheat and barley.

- ↳ **512 barley and 512 wheat lines** representing the most relevant genetic diversity for European agriculture: local varieties, wild species representative of geographical and environmental ranges
- ↳ **Extensive phenotypic characterization** for a wide range of traits
- ↳ **Exome capture + NGS** to identify the nature and extent diversity in barley and wheat gene pools and for **allele mining** of key adaptive genes

WHEALBI will produce a legacy in terms of germplasm, molecular and phenotypic data that will represent a milestone for further research and transfer of knowledge into breeding programs.

WHEALBI is indexed as a DivSeek relevant project.





Italian National Agency for New Technologies, Energy and Sustainable Economic Development

- ✓ 2nd largest public research body in Italy
- ✓ Active in high energy physics, nuclear fission and fusion, renewable energies, high performance computing, climate, health, agro-industrial research.
- ✓ approx. 2,700 staff in 14 res. centers



ENEA's research on crop biodiversity rests on three pillars:

- ✓ Breed novel plant varieties (Creso, the most successful Italian durum wheat variety for many decades, has been developed at ENEA in the early '70s)
- ✓ Develop a vigorous crop genomics program in collaboration with international consortia
- ✓ Participate in EU- and national-funded research projects on crop biodiversity

Registered ENEA plant varieties 1995-2014

Nuova Varietà di Triticale (X Triticoseale Witt.) di Tipo Invernale a Portamento Prostrato, denominata "Quirinale".

Varietà di Lupino Azzurro (*Lupinus Angustifolius* L.) Dolce a Semina Autunno-Vernina, denominata "Polo".

Varietà di Frumento Tenero (*Triticum Aestivum* L.) di Tipo Alternativo a Forma di Accrescimento Eretta, denominata "Alburno".

Varietà di Frumento Tenero (*Triticum Aestivum* L.) di Tipo Alternativo a Forma di Accrescimento Eretta, denominata "Treoni".

Varietà di Frumento Tenero (*Triticum Aestivum* L.), denominata "Decontra".

Varietà di Frumento Tenero (*Triticum Aestivum* L.), denominata "Riatello".

Varietà di Cece (*Cicer Arietinum* L.) a Semina Invernale, Portamento a Maturazione Eretto e Seme di Forma Arrotondata, denominata "Emiro".

Varietà di Frumento Tenero (*Triticum Aestivum*) di Tipo Alternativo e Forma di Accrescimento Semieretta, denominata "Collerosso".

Nuova Varietà di Cotone (*Gossypium* L.) a Ciclo Culturale Precoce e Foglia Palmata, denominata "Tornado".

Varietà di Frumento Duro (*Triticum Durum*) a Forma di Accrescimento Eretta e Tipo di Sviluppo Alternativo, denominata "Provenzal".

Varietà di Frumento Tenero (*Triticum Aestivum*) di Tipo Alternativo e Forma di Accrescimento Semieretta, denominata "Sirmione".

Varietà di Frumento Tenero (*Triticum Aestivum*) di Tipo Alternativo e Forma di Accrescimento Intermedio, denominata "Vallerosa".

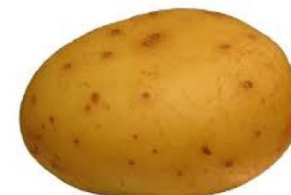
Varietà di Frumento Duro (*Triticum Durum*) di Tipo Alternativo e Forma di Accrescimento Semieretta, denominata "Campodoro".

Varietà di Cece (*Cicer Arietinum* L.) a Semina Invernale, Portamento Eretto a Maturazione e Seme a Superficie Rugosa, denominata "Otello".

Varietà di Cece (*Cicer Arietinum* L.) a Semina Invernale, Portamento Semieretto e Seme Rugoso, denominata "Pascià".

Varietà di Patata (*Solanum Tuberosum* L.) a Pelle del Tubero di Colore Giallo e con Tuberi Privi della Colorazione Antocianica dei Fasci Vascolari, denominata "Tropicana".

Varietà di Frumento Tenero (*Triticum Aestivum*) a Semina Primavera e di Buona Produttività, denominata "Maremma".



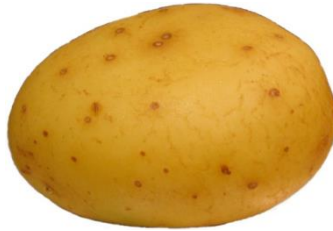
ENEA genomics research for crop biodiversity: a roadmap



Saffron transcriptome



Olive transcriptome



Potato transcriptome



Wheat Chr 5A draft



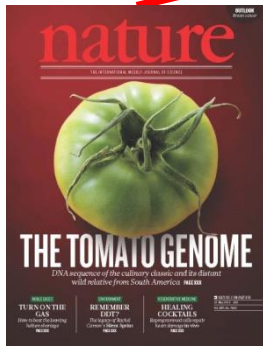
Deep saffron transcriptome*



Saffron genome*



Potato genome



Tomato genome



Robusta coffee genome



Eggplant genome*



Arabica coffee genome*



Pasta wheat genome*

*estimated

Main EU-funded projects on crop biodiversity at ENEA

CYNARES
Selvaggio Cipollato



Genetic Resources of *Cynara Spp.*

SAFENUT



Safeguard of Hazelnut and Almond Genetic Resources: from Traditional Uses to Novel Agro-Industrial Opportunities.

saffron
OM CS



Omics Technologies for Crop Improvement, Traceability, Determination of Authenticity, Adulteration and Origin in Saffron

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

eusol



High Quality Solanaceous Crops for Consumers, Processors and Producers by Exploration of Natural Biodiversity



Traditional tomato varieties and cultural practices: a case for agricultural diversification with impact on food security and health of the European population



The Agricultural Genetic Research Group, lead by Prof. Roberto Papa, has a strong interest in plant genetic resources, crop evolution and adaptation for crop improvement.

Omics technologies are implemented in our research activities in order to characterized crop diversity using population and ecological genomics approaches to identify useful sources of genetic diversity for plant breeding.

Our research focus on the following crops: common bean, barley, maize and wheat.

- **Conservation and Exploitation of Plant Genetic Resources**
- **Plant breeding**
- **Population genetics**
- **Crop evolution**
- **Genomics**
- **Adaptation to climate changes**
- **Food security**



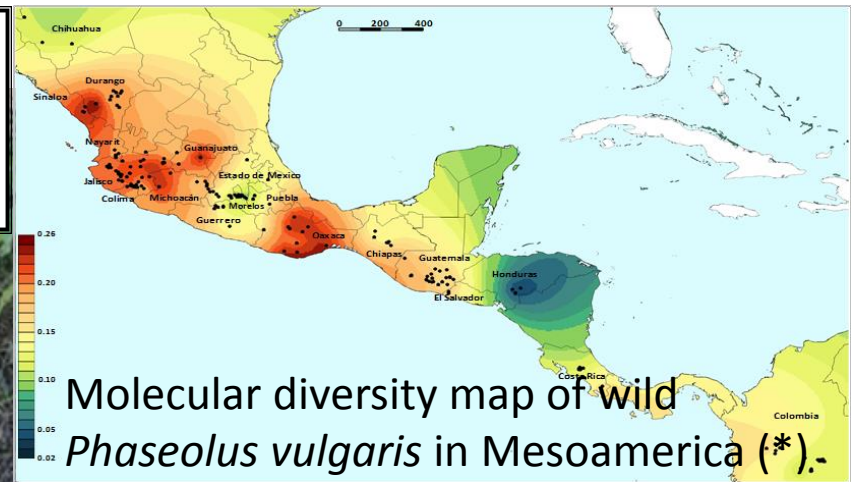
Crop wild relatives (CWR) germplasm for plant breeding

- Origin and diversity of wild *Phaseolus* spp.
- Coll. Sassari University

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

Elena Bitocchi^a, Laura Nanni^b, Elisa Bellucci^c, Monica Rossi^b, Alessandro Giardini^b, Pierluigi Spagnoletti Zeuli^b, Giuseppina Logozzo^b, Jens Stougaard^c, Phillip McClean^d, Giovanna Attene^e, and Roberto Papa^{a,f,1}

^aDipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, 60131 Ancona, Italy; ^bDipartimento di Biologia Difesa e Biotecnologie Agro-Forestali, Università degli Studi della Basilicata, 85100 Potenza, Italy; ^cCentre for Carbohydrate Recognition and Signalling, Department of Molecular Biology, Aarhus University, DK-8000 Aarhus C, Denmark; ^dDepartment of Plant Sciences, North Dakota State University, Fargo, ND 58105; ^eDipartimento di Scienze Agronomiche e Genetica Vegetale Agraria, Università degli Studi di Sassari, 07100 Sassari, Italy; and ^fCereals Research Centre, Agricultural Research Council (CRA-CER), S.S. 16, Km 675, 71122 Foggia, Italy



Molecular diversity map of wild *Phaseolus vulgaris* in Mesoamerica (*).-

Crop Domestication and diversity

- Origin and domestication of common bean
- Domestication traits in *Phaseolus* spp. and *Triticum turgidum*,
 - Domestication traits, transcriptomics and metabolomics, pre-breeding
- Coll. Sassari, Ferrara and Verona Universities, CREA, Cereal Research Centre, Foggia, University of Georgia, Max Planck Institute-Golm, and Forschungszentrum Julich,

Journal of Experimental Botany
doi:10.1093/jxb/erv289

RESEARCH PAPER

Impact of domestication on the phenotypic architecture of durum wheat under contrasting nitrogen fertilization

Tania Gioia^{1,2}, Kerstin A. Nagel², Romina Beleggia¹, Mariagiiovanna Fragasso¹, Donatella Bianca Maria Ficcò¹, Roland Pieruschka², Pasquale De Vita¹, Fabio Fiorani² and Roberto Papa^{1,2,3,*}



LARGE-SCALE BIOLOGY ARTICLE

Decreased Nucleotide and Expression Diversity and Modified Coexpression Patterns Characterize Domestication in the Common Bean^{OPEN}

Elisa Bellucci,^{1,4} Elena Bitocchi,^{1,4} Alberto Ferrarini,⁵ Andrea Benazzo,⁶ Eleonora Biagetti,⁴ Sebastian Klie,⁴ Andrea Minio,⁵ Domenico Rau,⁴ Monica Rodriguez,⁴ Alex Panzera,^{1,7} Luca Venturini,⁸ Giovanna Attene,⁴ Emidio Albertini,⁹ Scott A. Jackson,¹⁰ Laura Nanni,⁴ Alisdair B. Farnie,¹¹ Zoran Nikoloski,¹¹ Giovanni Reberio,⁴ Massimo DelleDonne,² and Roberto Papa^{1,2,*}

The Plant Cell Preview, www.aspb.org © 2014 American Society of Plant Biologists

THE PLANT CELL
AMERICAN SOCIETY OF PLANT BIOLOGISTS



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

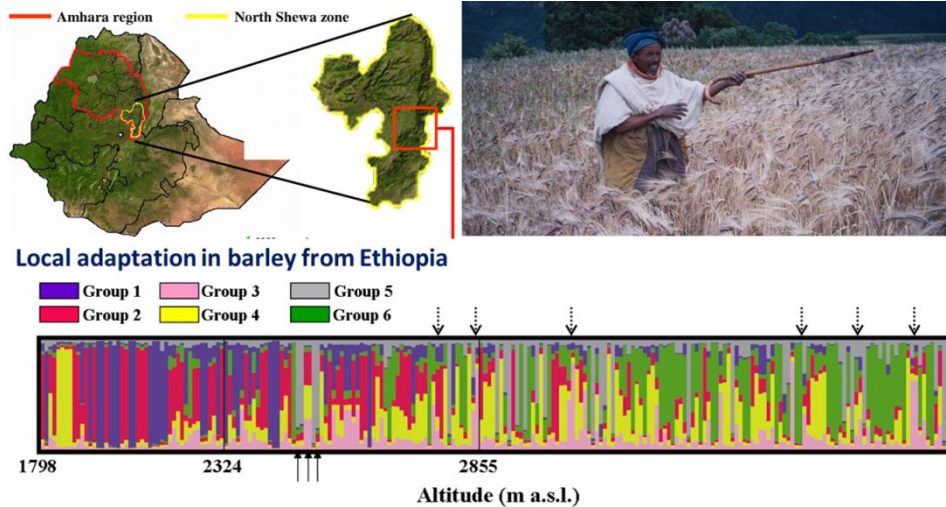


Molecular analysis of the parallel domestication of the common bean (*Phaseolus vulgaris*) in Mesoamerica and the Andes

Elena Bitocchi¹, Elisa Bellucci¹, Alessandro Giardini¹, Domenico Rau², Monica Rodriguez², Eleonora Biagetti¹, Rodolfo Santilocchi¹, Pierluigi Spagnoletti Zeuli³, Tania Gioia⁴, Giuseppina Logozzo⁵, Giovanna Attene⁶, Laura Nanni¹ and Roberto Papa^{1,4}



Landrace populations adaptation and diversity



- Population structure and diversity of landrace populations, grown on farm
- Collection expeditions: Argentina, Mexico, Ethiopia, Italy
- Farmers survey and seed system analysis
- Adaptation and selection (e.g. BEAN_ADAPT project)
- Plant-pathogen coadaptation
- Barley from Sardinia and Ethiopia, Common bean from the Centers of Origin and Europe, European landraces of maize, durum wheat and tomato
- Coll. Sassari University, CREA-Foggia, IPK, CIAT, Bioversity and BEAN_ADPT network
- Publications: <http://publicationslist.org/r.papa>



**NATIONAL RESEARCH COUNCIL
Institute of Biosciences and
BioResources CNR-IBBR**

**VALORIZATION OF GERMPLOSM COLLECTION
AT CNR-IBBR BARI (ITALY)**



PSR (Program of rural development) Apulia Region

Traditional local varieties

Collection
 Conservation (*ex situ* – *on farm*)
 Characterization

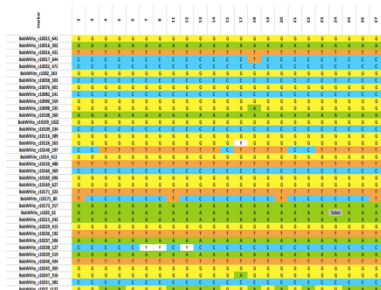
SAVEGRAIN

- Cereals
- Legumes
- Forage crops

BiodiverSO

Vegetable crops
 (Brassicaceae-artichoke-tomato -
 cowpea, etc.)

GBS ANALYSES




BiodiverSO
 Biodiversità delle Specie Orticole della Puglia

UNICA DATI

Cerca nel portale BiodiverSO

Inserisci il termine CERCA

ORA PARTECIPA

COLLABORA
 SEGNA LA UNA
 VARIETA' / SPECIE →

PARTECIPA
 PROPONI UNA RICETTA
 O UNA CURIOSITA' →

SCOPRI
 SCARICA LA APP
 BIODIVERSO →

il verde e il violetto di puglia

Publicato il 17 dicembre 2019 da Francesco Losavio

PGR PROJECTS 2011-2015

Recovery, characterization, safeguard and valorization of pulses, cereals and forage species in Apulia.



GROUP LEADER SCIENTIFIC LEADER	Researcher Technician	AIM	EURO
<p>GROUP LEADER: CNR-IBBR</p> <p>Scientific leader: Dott. Gaetano Laghetti</p> <p>Legume section: Dott. Angela Rosa Piergiovanni</p> <p>Cereal section: Dott. Benedetta Margiotta</p>	<p>Marcella Urbano, Lucia Lioi, Valeria Tomaselli, Mariella Finetti, Maddalena De Virgilio, Venturino Bisignano, Anita Tricarico Giuseppe Colaprico, Salvatore Cifarelli, Lucia Stimolo, Marisa Scarascia, Pasquale Cataldo, Francesco Paolo Losavio, Giovanni Campanella, Nunzia Fornarelli</p>	<p>Cereal, pulses and forage species are characterized and safeguarded, through the application of appropriate, regional and international protocols, and kept both ex situ and in situ.</p> <p>The activities of the project are carried out in collaboration with <u>20 partners working in the region and belonging to public research organizations, universities, regional parks, private companies and associations.</u></p>	<p style="text-align: center;">2.500.000,00</p> <div style="text-align: center;"> <p>Progetti integrati per la biodiversità</p> <p>Regione Puglia</p> <p><small>Reg. C.E. n. 1699/2005 Programma di Sviluppo rurale per la Puglia 2007/2013 Misura 214 - Azione 4 Sub azione a) "progetti integrati per la Biodiversità"</small></p> </div>

Omic technologies for adding value to durum wheat genetic resources**Financial support: Ministry of Education, University and Research (MIUR) DISBA CNR****WP1 – Within the frame of the Consortium of durum wheat sequencing.****Financial support: € 80,000****Principal investigator: Dr Gabriella Sonnante****Aims:**

- Durum wheat sequencing of Cappelli variety
- RNA seq and transcriptome analysis of developing seeds

WP3 - Automated phenotyping in a collection of durum wheat SSD lines.**Financial support: € 50.000****Principal investigator: Dr. Domenico Pignone****Aims:**

- Analyses of SNP variation of the 452 Single seed descent (SSD) genotypes using the ILLUMINA Infinium iSelect 90k wheat chip (81,587 functional molecular markers).
- Selection of 150 genotypes for water use efficiency by automated high-throughput plant phenotyping platform (LemnaTec-Scanalyzer 3D system, Metapontum Agrobios)

Output

- genotypic information and phenotypic data for investigating the genetic basis of the traits



GENE BANK 1970-2015

Germplasm safeguarding is carried out within the frame of the European Cooperative Programme for Plant Genetic Resource (ECP/GR).

The CNR-IBBR gene bank participate to the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

Seed bank activity in Bari

Seed bank

~ 65,000 accessions

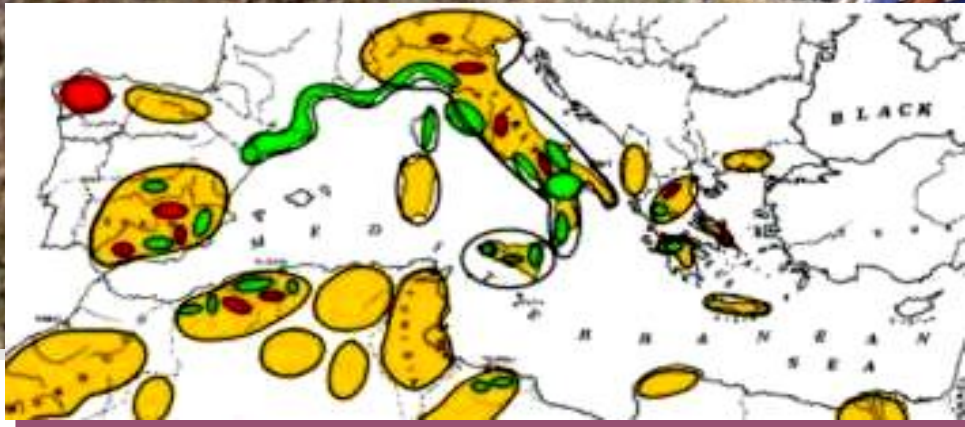
~ 40 genera

~ 600 species

Germplasm collections

> 90 missions

> 13,000 samples



Institute of Biosciences and Bioresources - Bari

Main seed collections

Group	# accessions
<i>Triticum</i>	Ca. 38000 world collection
Grain legumes	Ca. 10000
Forage legumes	Ca. 5000
Horticultural crops	Ca. 3000
Multilateral system of the FAO Treaty for the Plant Genetic Resources	
Durum wheat	5700
<i>Triticum dicoccum</i>	390
<i>Triticum dicoccoides</i>	175



Cultivated material: mainly landraces

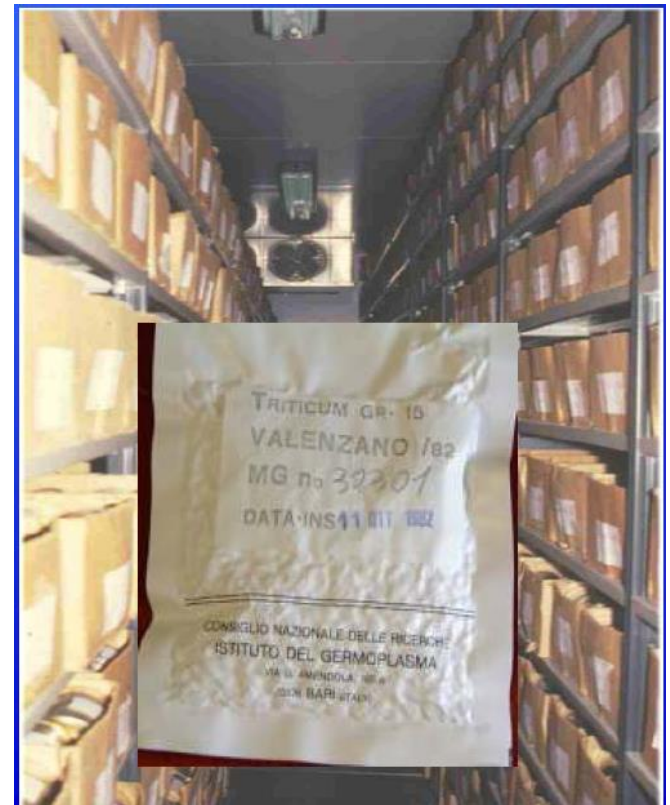


Conservation

Long term: -20 °C



Short/medium term: 0 °C; 35% RH



Italian programme for the conservation, evaluation, and exploitation of durum wheat genetic resources for crop improvement and sustainable development

- Food security can be achieved through crop improvement and yield stability
- Changing environment
- Sustainability

Genetic diversity represents the basis for genetic improvement

Exploitation of genetic diversity can be accelerated by new technologies (genotyping, phenotyping)

Need to share technologies and materials

Involvement of the main Italian institutions (CNR, ENEA, CREA, Universities)



Durum wheat

Major crop in Italy, Northern Africa, and other African countries (e.g. Ethiopia)

Italy plays a leading role in the conservation and evaluation of durum wheat genetic resources.

Besides the Bari germplasm collection, advanced materials have been developed and evaluated from a wide range of tetraploid Triticum germplasm e.g. segregating populations (RILs, IIs, NAM, MAGIC), association and diversity panels, most of which have been characterized also using the 90k Illumina SNP array; MAS (Marker Assisted Selection) tools



Objectives

To promote conservation, evaluation and exploitation of durum wheat genetic resources for crop improvement and sustainable development

Transfer of results (traits, markers, genes, innovative tools and methodologies, new genetic material) to stakeholders, i.e. breeders, food industry, farmers

Dissemination of the importance of plant genetic resources for agriculture

Strengthen Italian international cooperation initiatives

Main activities

CORE activities based on elite material previously evaluated

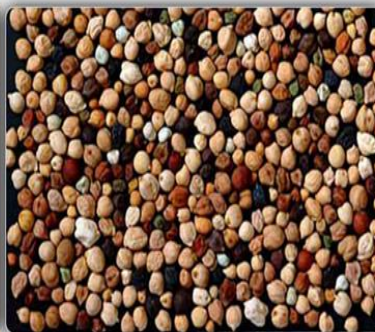
 fast delivery for end-users

- Marker Assisted Selection – quality and disease resistance traits
- Genome wide association study (GWAS) on previously characterized panels
- Development of populations for plant breeding and on farm conservation, based on previously characterized material
- Development of a database to link genotypic to phenotypic data
- Ex situ and on farm conservation of durum wheat genetic resources (including landraces and wild material)
- Deep sequencing of a representative germplasm subset
- Discovery of genes and products related to desired traits (resistance to biotic/abiotic stress)

Expected results

- Characterisation of genetic resources of durum wheat for use in on farm conservation, pre-breeding and breeding programmes.
- Technology transfer and capacity building for analysis and exploitation of genetic resources (MAS programme, GWAS, bioinformatics tools for data management and analysis).
- Development of novel breeding material (lines, mixtures and populations) and evaluation under diverse cropping systems and climatic conditions in the Mediterranean basin and in other selected countries (e.g. Ethiopia).
- Characterisation of genetic resources for a range of characters imposing current key limitations in durum wheat breeding and production in target environments.
- Outputs (traits, markers, genes, innovative tools and methodologies, new plant material) that will become directly applicable to stakeholders, particularly SME, (breeders, farmers)
- Improvements in genetic resource collection, conservation, characterization, and evaluation methods
- Increased efficiency in incorporating valuable genetic traits into commercial durum wheat varieties (e.g. through genetic markers linked to genes and gene segments that govern desired traits).

Mediterranean Germplasm Database



The Mediterranean Germplasm Database is the reference database for the agro-food plant germplasm collection stored at the **Institute of Biosciences and Bioresources (IBBR)** of the Italian National Research Council (CNR) in Bari, Italy.

Description

The collection contains some 56000 accessions belonging to more than 100 genera and over 700 species. Over 13000 samples have been directly collected by exploration teams of the Institute of Biosciences and Bioresources, while others have been acquired from other Institutions through exchange activities. The plant germplasm collection was set up in 1970 when, following a proposal of Prof. G.T. Scarascia Mugnozza, CNR founded the "Germplasm Laboratory", now part of the Institute of Biosciences and Bioresources.

Aims and goals

The main objective of the collection is the safeguard of genetic resources of herbaceous plants interesting for Italian and Mediterranean agriculture. A particular attention is



Accession Number #705

Field	Value	Explanation
accenumb	705	EURISCO: unique identifier as Mediterranean Germplasm Accession
family	Graminaceae	Family term reported in Mediterranean Germoplasm
genus	Triticum	EURISCO: Genus name for the taxon
species	durum	EURISCO: Species name for the taxon
subsp	-	Eurisco Subtaxa descriptor
subtaxa	N.c.	Eurisco Subtaxa descriptor
cropname	Durum h	EURISCO: Common crop name (former cultivar localname)
taxon_id	4567	EURISCO: accession code at the NCBI Taxonomy (Bio-sequence data)
origin	Egypt	Country where the accession was harvested (EXORSTAT)
area	-	EX ORCITREG
origctry	USA	EURISCO: Code of the country where the sample was obtained
date	71	EURISCO: date when the accession was stored in the collection
donor_id	CI 103103	Number assigned to an accession by the donor
donorcode	USA138	EURISCO: Field no. 23 of the main document
name	Beltsville area USDA/Agricultural Research Center	Name of the donor
url	home page	URL of the donor
city	Beltsville md	City of the donor
state	United States	State of the donor
ISO3_state_code	USA	Code of the state of the donor
continent	North America	Continent where the donor is located
sampling_date	-	Date of sampling