Moving Wheat to the Cutting edge of Innovation

IWGSC and BreedWheat

Grégoire Y BERTHE
ISF Field Crop Section
27 may 2015

Coordinating Global Research for Wheat

Hélène Lucas

An international partnership for Wheat Improvement Research

- A framework to **identify synergies and facilitate collaborations** for **wheat improvement** at the international level
- Created in 2011 following endorsement by **G20 Agriculture Ministries** to improve **food security**



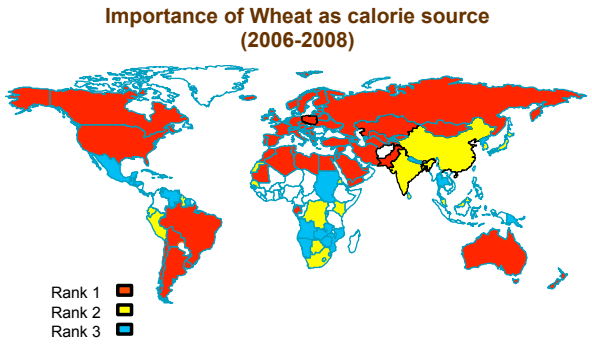
WHEAT INITIATIVE

Why Wheat?

- The world's most important food crop
- Provides 20% of all calories and 20% of all protein in developing and developed countries

but

- Wheat production has not always met demand in previous years
- Demand will increase by 60% in 2050/2010, while yields are stagnating and resources are declining
- Investment in wheat R&D is disproportionally low given the important of the crop



Wheat Initiative Vision and Mission

- **Vision:**

  a vibrant global wheat research **community sharing** resources, capabilities, data and ideas to **improve** wheat land productivity, quality and sustainable **production**

- **Mission:**

  develop a global Strategic **Research Agenda** and support its implementation through **coordinated** actions, knowledge and resource sharing and efficient **investment**

WHEAT INITIATIVE

All countries and companies welcome!

16 countries, 9 private companies, 2 CGIAR Centres

CIMMYT

ICARDA

ARVALIS Institut du végétal

Limagrain MONSANTO RAGT SAATEN UNION syngenta

WHEAT INITIATIVE

Facilitating delivery by leveraging synergies and collaborations

WHEAT INITIATIVE

Expert Working Groups

Established

- Wheat Information System
- Genetics and Genomics of Durum Wheat
- Wheat Breeding Methods and Strategies
- Wheat Phenotyping to Support Wheat Improvement
- Wheat Plant and Crop Modelling

Newly approved

- Control of wheat pathogens and pests
- Adaptation of wheat to abiotic stress
- Genetic resources
- Nutrient use efficiency
- Quality and safety

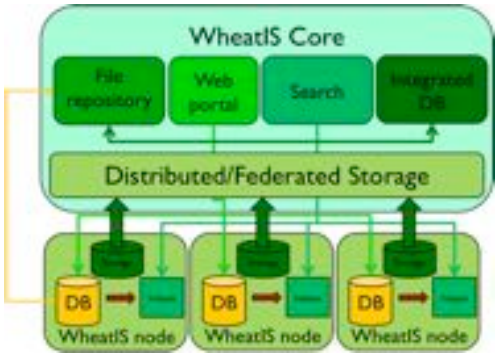
Under development

- Agronomy

WHEAT INITIATIVE

Facilitating access to wheat scientific data

Wheat Information System



Bioinformatics experts from 7 countries & CIMMYT working together to develop the WheatIS

WHEAT INITIATIVE

Supporting the completion of the reference wheat genome sequence

- Creation of an IWGSC-ICC taskforce
- Additional funds raised in several member countries and companies through joint efforts

WHEAT INITIATIVE

2005

KANSAS WHEAT

K-STATE

2 sponsors
3 institutes

5 members
3 countries

INRA

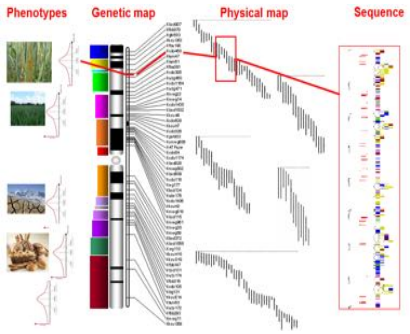
Vision

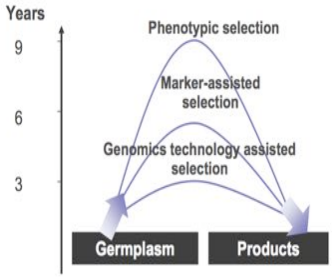
Goal

- Lay a foundation to accelerate wheat improvement
- Increase profitability throughout the industry

Vision

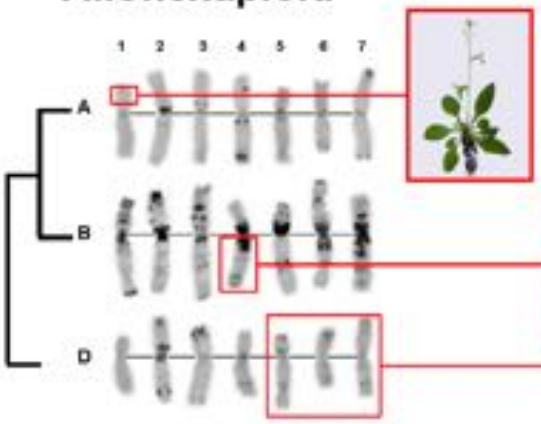
- High quality annotated genome sequence, comparable to rice genome sequence
- Physical map-based, integrated and ordered sequence





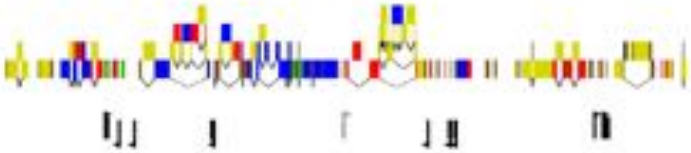
The bread wheat genome is……a challenge

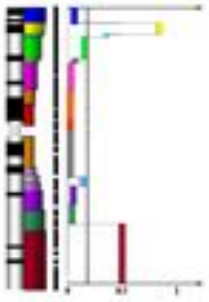
✓Allohexaploid



✓ Large: 17 Gb

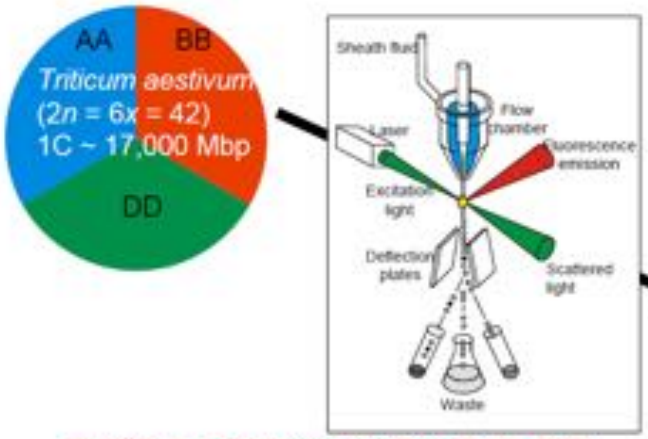
✓ 80-90% of TEs and repeats



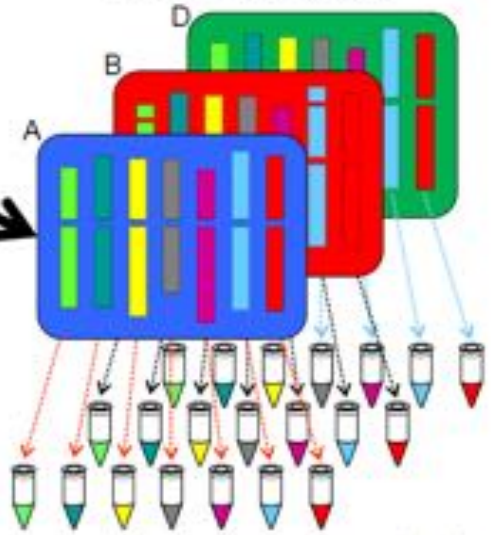


✓ > 50% of non recombinogenic regions

Managing the 17 Gb, Hexaploid Genome



Dissection of the genome into single chromosomes (arms)



Doležel et al., Chromosome Res. 15: 51, 2007

- Chromosomes: 605 - 995 Mbp (3.6 – 5.9% of the genome)
- Chromosome arms: 225 - 585 Mbp (1.3 – 3.4% of the genome)

Chromosome genomics

➢ Chromosome specific BAC libraries and sequencing

IEB

Roadmap to the Wheat Genome Sequence

Physical mapping of individual chromosomes

Survey sequencing of individual chromosomes

Short term
↓
Gene catalog
Virtual order
Markers

MTP sequencing

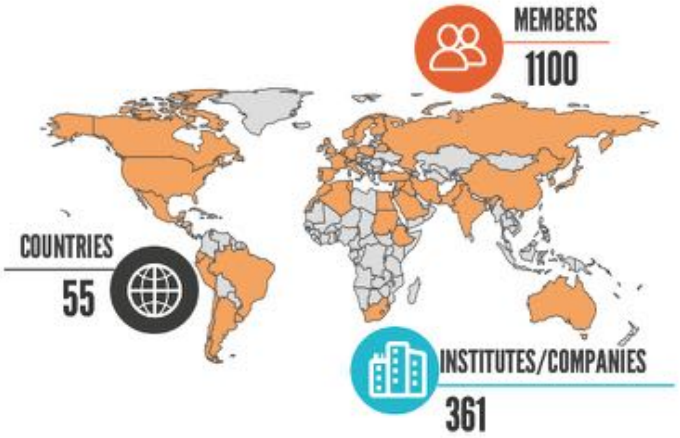
Long term

A reference sequence anchored to the genetic and phenotypic maps

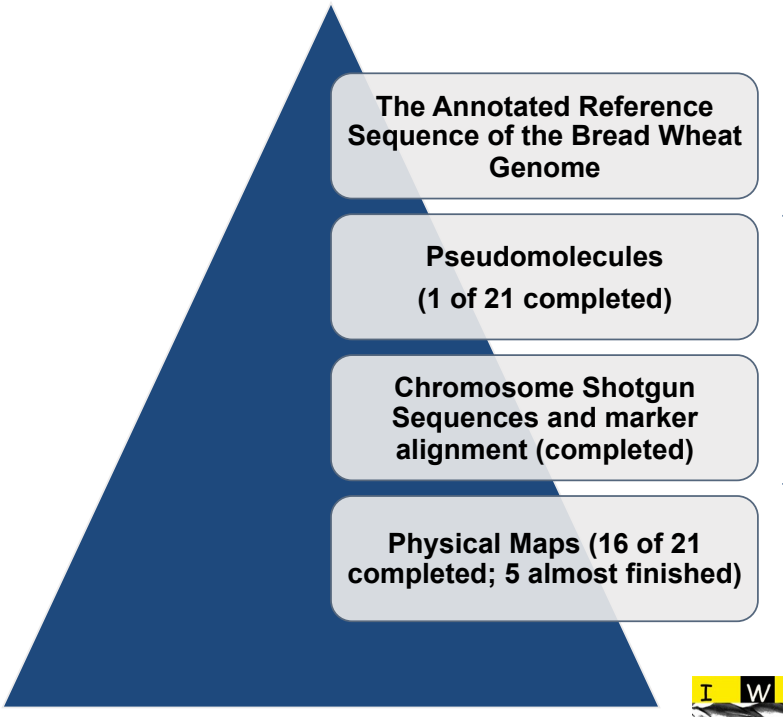
IWGSC

The International Wheat Genome Sequencing Consortium

2015

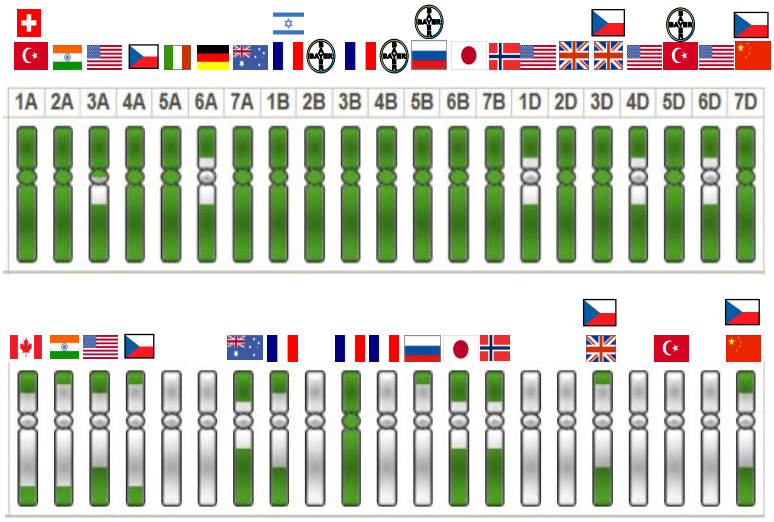


IWGSC Projects



Special issue, *Science* 18 July 2014

Progress towards completion of Bread Wheat Projects



Physical maps

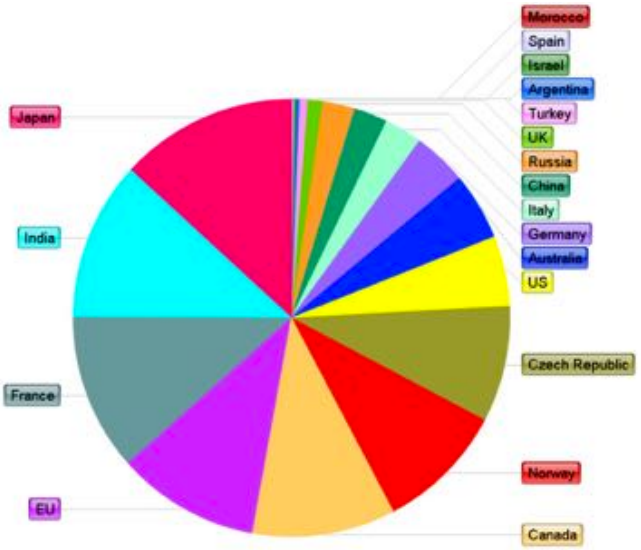
16 chromosomes completed and 5 almost finished

IWGSC Reference*

1 chromosome completed, 13 underway, funding sought for 7

*Flags represent countries where work is underway with funding, as of March 2015.

Funding Sources



Funding provided so far for IWGSC projects to generate physical maps, survey sequences and BAC-based reference sequences for bread wheat

Total: €50 million

Still needed : €11.5 million to complete the entire project

IWGSC Sponsors

For More Information

www.wheatgenome.org

twitter.com/wheatgenome

www.facebook.com/wheat.genome

Contacts

Kellye Eversole
Executive Director
eversole@eversoleassociates.com

Isabelle Caugant
Communications Officer
Communications@wheatgenome.org

Breeding for economically and environmentally sustainable wheat varieties : An integrated approach from genomics to selection

Jacques Le Gouis (INRA)

Emmanuelle Lagendijk (INRA)

Partnership

14 public research laboratories

Centre INRA Auverne-Rhône-Alpes
UMR GDEC (INRA-Univ. Blaise Pascal)
Centre INRA Angers-Nantes
UPR BIA (INRA)
Centre INRA Versailles-Grignon
US EPGV (INRA)
UMR GV (INRA-Univ.Paris Sud-CNRS-AgroParisTech)
URGI (INRA)
UMR BIOGER-CPP (INRA-AgroParisTech)
UMR EGC (INRA-AgroParisTech)
UMR Agronomie (INRA-AgroParisTech)
Centre INRA Bordeaux
UMR BFP (INRA-Univ. Bordeaux I&II)
Centre INRA Toulouse
UPR CNRGV (INRA)
Centre INRA PACA
UMR GAEL (INRA-UPMF)
UMR EMMAH (INRA-Université d'Avignon)
LIMOS (Université Blaise Pascal)

GEVES (Groupe d'Etude et de contrôle des Variétés Et des Semences)

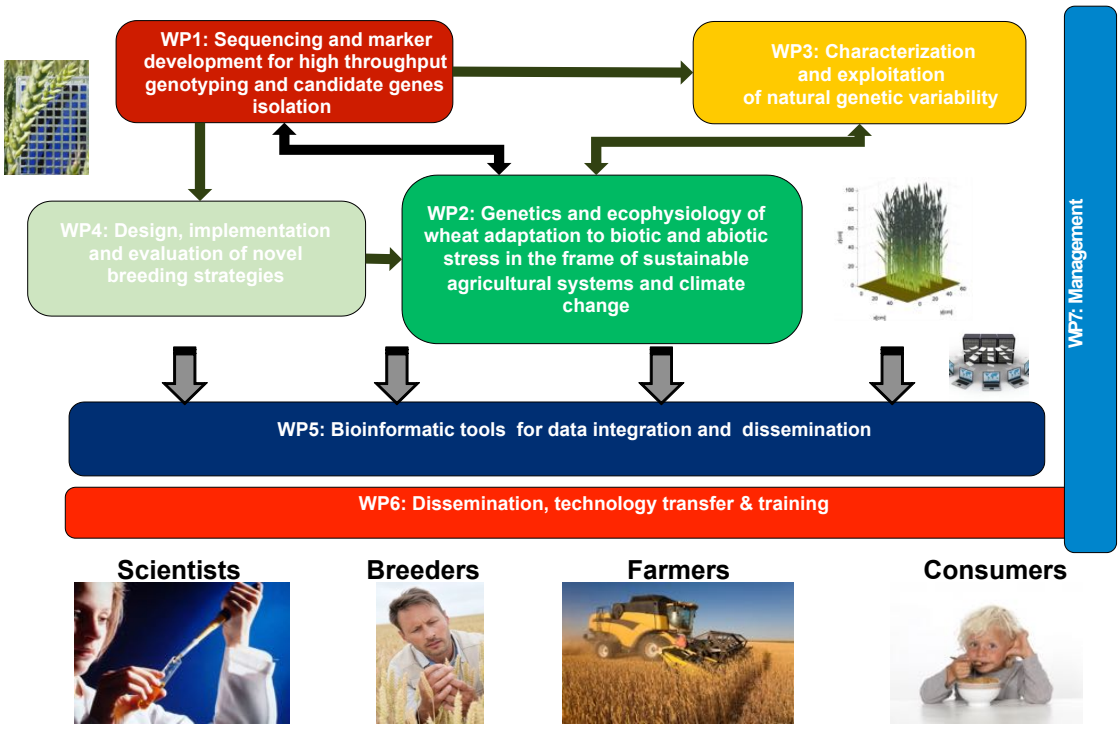
1 technical institute
ARVALIS – Institut du végétal

1 competitiveness cluster
Céréales Vallée

10 private companies

Agri-Obtentions
Bayer CropScience
Biogemma
Caussade Semences
Florimond Desprez
Limagrain Europe
MOMONT
RAGT 2n
SECOBRA Recherches
Syngenta Seeds

BreedWheat Project Structure



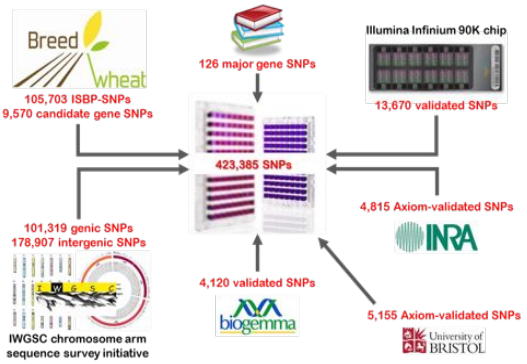
WP1: Sequencing and marker development for high throughput detection of polymorphisms and target trait candidate genes isolation (E. Paux, INRA)

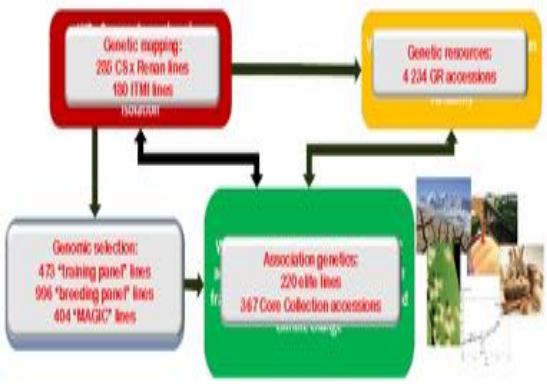
Sequencing (1B, WGS, trait-associated contigs)

Marker development (Genes, intergenic regions, ISBPs)

Genotyping Mapping (WP1, 2, 3, 4)

The BreedWheat TaBW420K SNP array



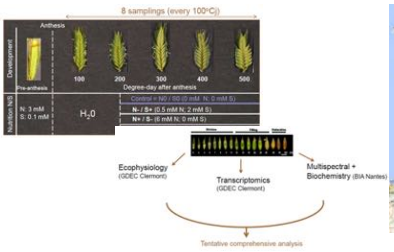


WP2: Genetics and ecophysiology of wheat adaptation to biotic and abiotic stress (S. Lafarge, Biogemma)

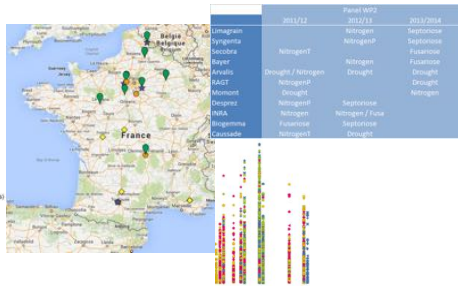
Our Targets:
Nitrogen Use Efficiency
Grain protein composition
Water use efficiency
Heat stress
Diseases resistance

Our Tools:
Modelling/Innovative phenotyping
Candidate genes identification
Field Trials
GWAS

Our Results:
Candidate genes
Markers-associated traits
Materials for breeding



Candidate genes identification in NUE and heat stress tolerance



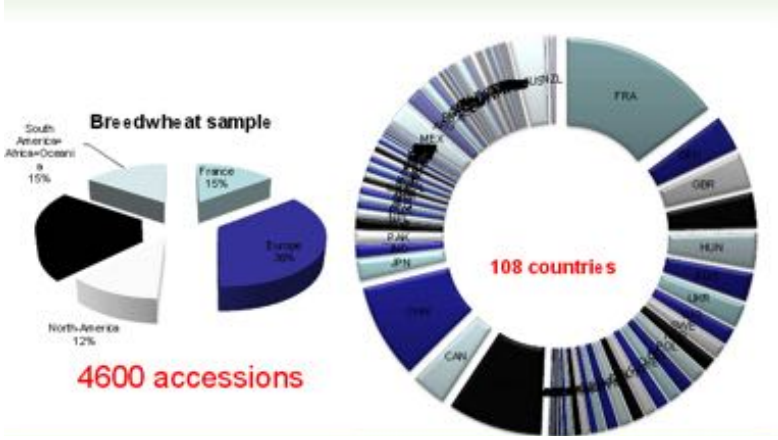
Phenotyping: 3 years – 25 trials
GWAS with 92k SNPs from WP1

Modelling of plant canopy architecture and derived variables (green fraction)

WP3: Characterization and exploitation of natural genetic variability (A. Murigneux, Limagrain)

- **Characterization** of 5'000 wheat lines from INRA collection

- **Identification of new sources for abiotic stress tolerance**
- **Introduction into French germplasm**



Creation of nine advanced-backcross populations using drought/heat tolerant lines

BC1S5 available for field phenotyping in years 7-8

WP4: Design, implementation and evaluation of novel breeding strategies (G. Charmet, INRA)

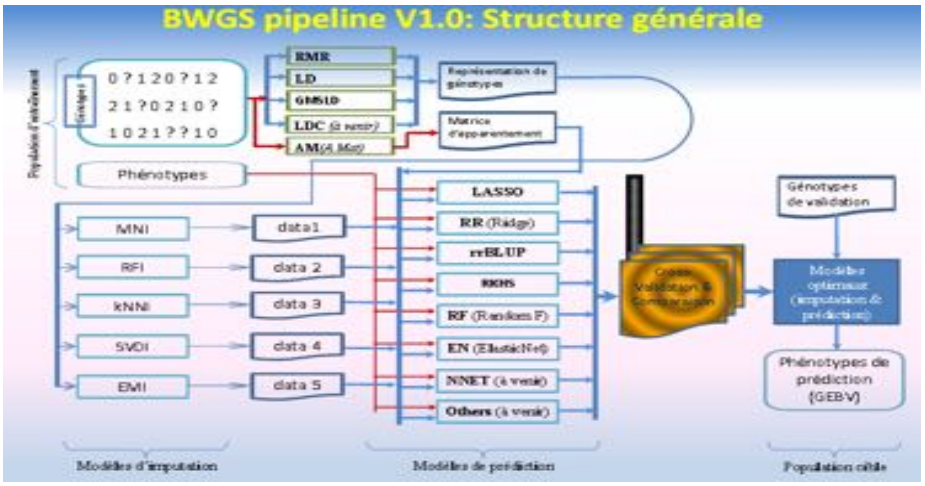
Integrated statistical tools **for molecular breeding**

Development of **real size breeding programs**

Evaluation of new ideotypes in sustainable systems

Economic impact of new breeding models

Sociologic approach of genotyping data production

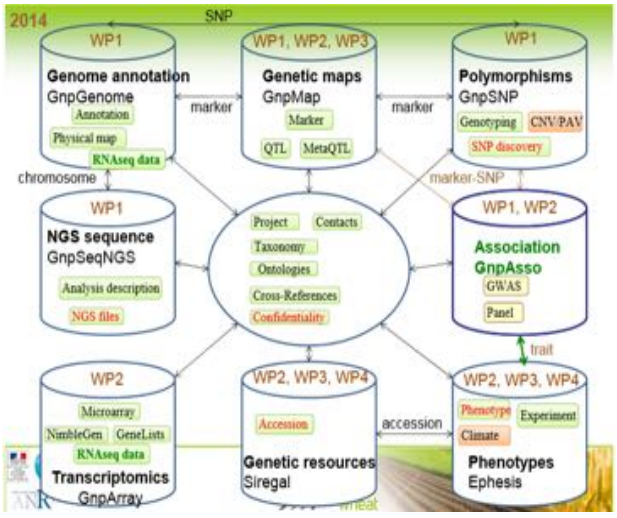


WP5: Bioinformatics (N. Rivière, BioGemma)

BW information system

Specific development

Data integration



First data integrated

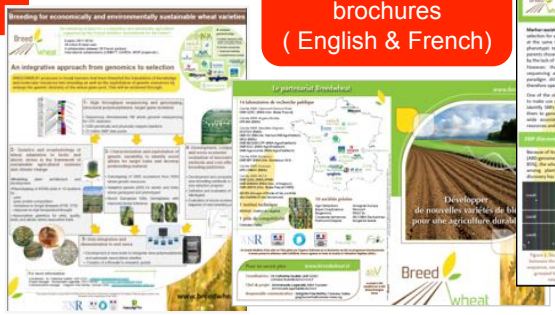
- **471 000 SNP (WP1)**
- **100 000 field datapoints (WP2)**
- **5 000 genetic resources passport data (WP3)**

WP6- Dissemination, and Technology transfer

(G. Berthe, Céréales Vallée)

Public web site:
http ://www.breedwheat.fr/

Posters and brochures
(English & French)



Newsletters

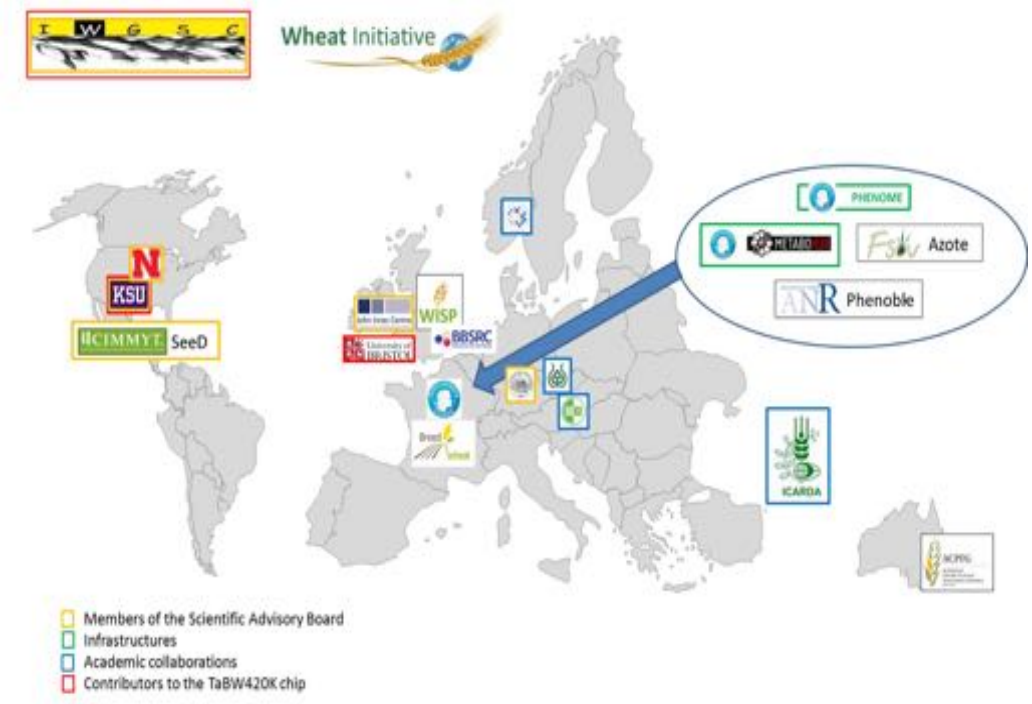
Articles

Training

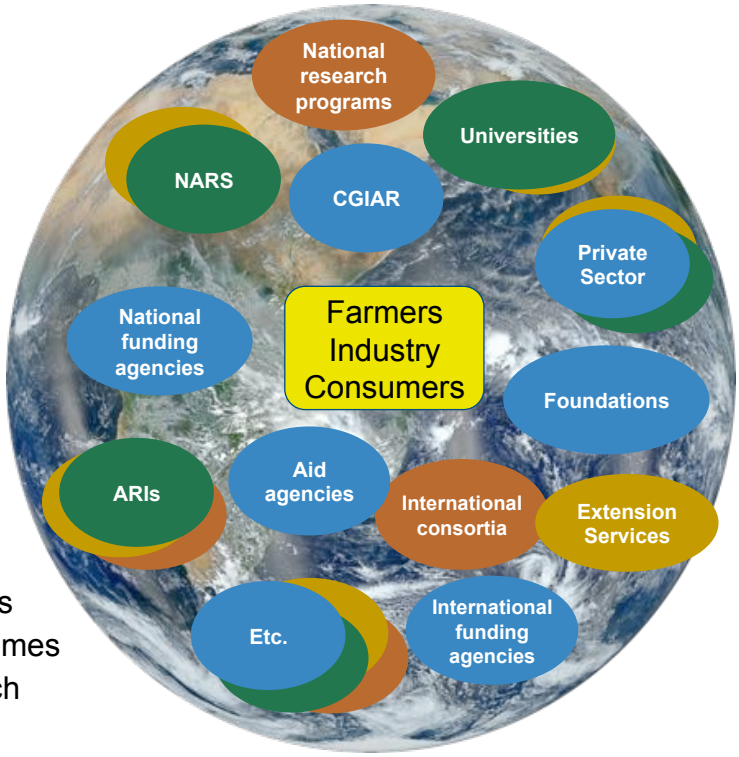
Conferences

International Wheat Innovation Conference

Interaction with other projects/ initiatives



Raising the profile of wheat and working together to add value for all



- Funders
- Research providers
- Research programmes
- Delivery of research outcomes