
INRA
Céréales Vallée
UNIVERSITÉ BLAISE PASCAL CLERMONT-FERRAND
UBP
BREEDWHEAT
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'AGRICULTURE DE L'ALIMENTATION DE LA PÊCHE DE LA RURALITÉ ET DE L'AMÉNAGEMENT DU TERRITOIRE
INVESTISSEMENTS D'AVENIR
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE
UNIVERSITÉ PARIS-SUD 11
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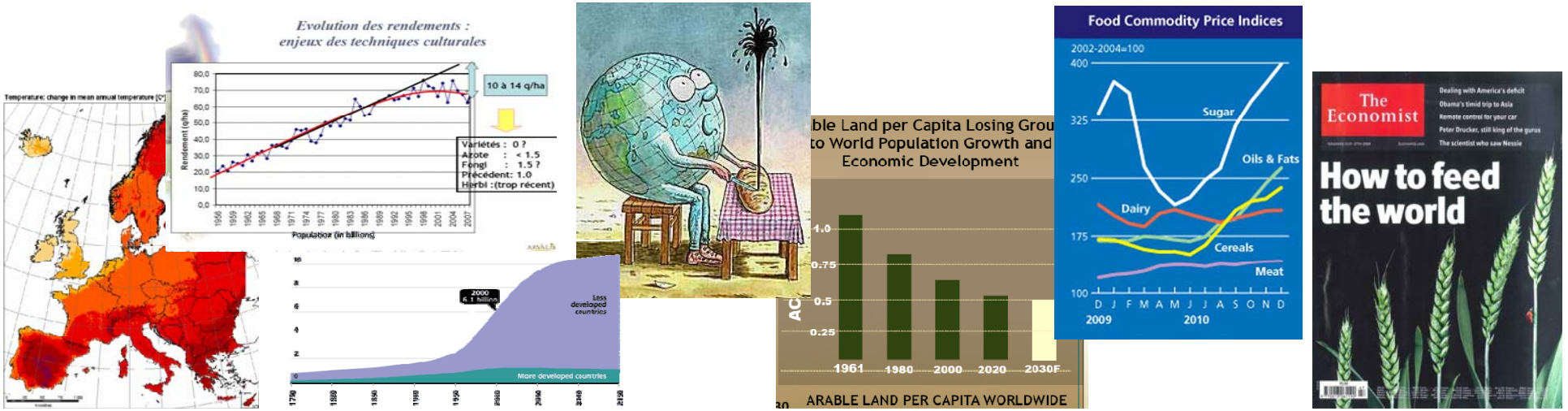
UNIVERSITÉ DE BORDEAUX
AgroParisTech
UNIVERSITÉ D'AVIGNON ET DES PAYS DE VAUCLUSE
ARVALIS Institut du végétal
biogemma
Limagrain de la terre à la vie
agri obtentions Filiale INRA
RAGT
bioplante
Bayer CropScience
SECOBRA recherches
CAUSSADE semences
syngenta
Momont LA FORCE FERTILE
UMR 1095 GDEC INRA

Wheat production is facing great challenges

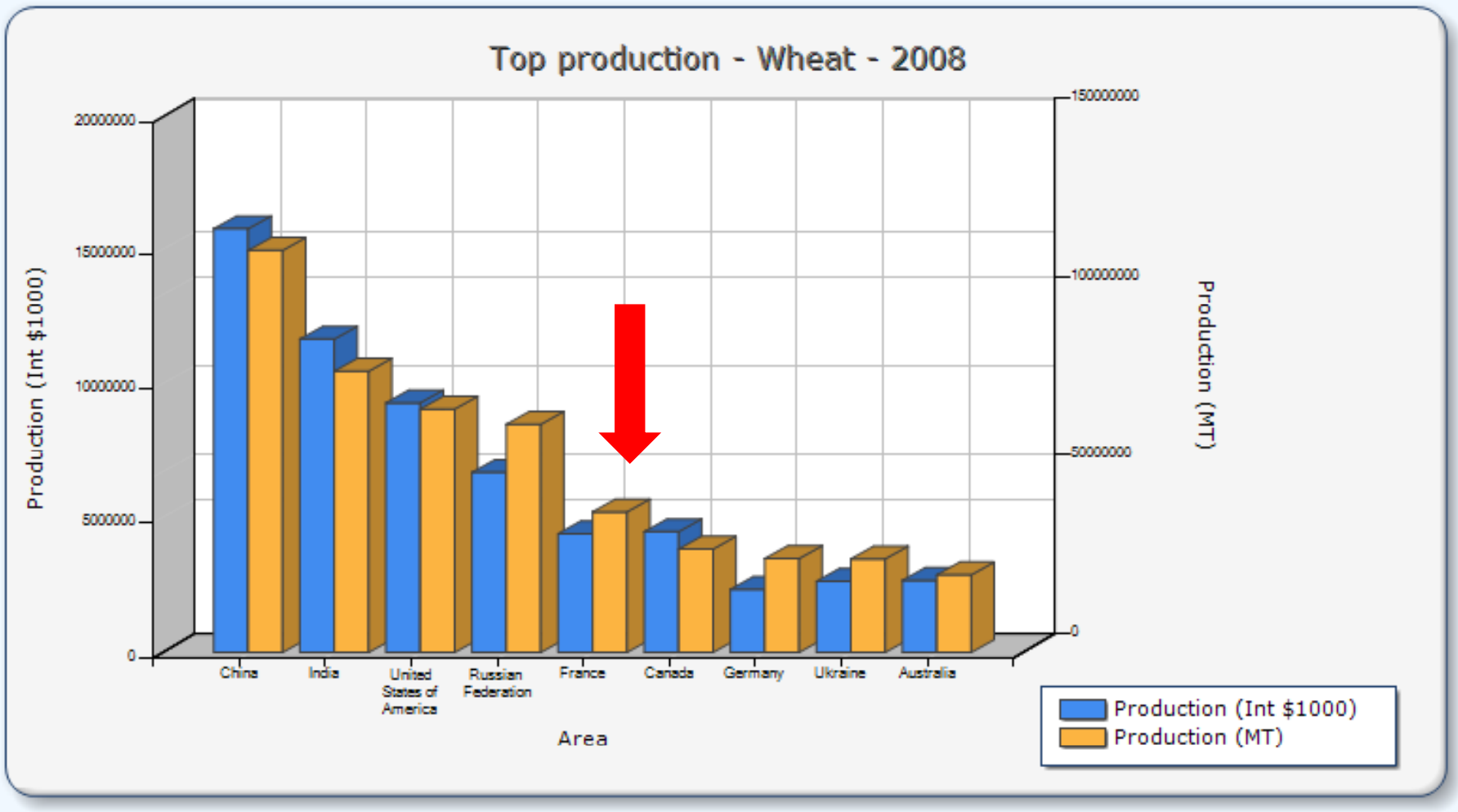
- **Provide consistently sufficient, high quality food and feed products as well as non food products through a sustainable agricultural system**

while

- **Increasing demand** (population, urbanization) = need to **increase production by 2%/year until 2050** (FAO)
- **Yield stagnation** in the past 10 years in main producing areas
- **Climate change**, reduced and unevenly distributed **water resources**, limited expansion of **arable lands**
- Need to **reduce environmental impact** of agricultural production (e.g. ECOPHYTO 2018)
- **Increasing competition** between food and non food uses (products and areas)
- **Agricultural policies** difficult to coordinate, agricultural research is not a priority



Wheat is essential for the French economy



- **France ranks 1st in the EU/5th in the world for both production and export**
- **A positive balance of 6.6 billion € (2007)**
- **~58% of the production is exported (mostly for milling)**

BREEDWHEAT

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

Objective

Develop a sequence-based tool box for the wheat genome, exploit and develop new phenotyping capabilities and combine those to:

- decipher the genetic and ecophysiological basis of key traits for wheat improvement e.g. abiotic and biotic stress tolerance, yield components and quality,
- expand and facilitate the use of genetic resources to increase allelic variability in the elite gene pool and ,
- develop and deploy new breeding methods

to select improved bread wheat varieties that meet the breeders, growers and consumers needs thereby enabling a competitive and sustainable wheat production in France.

The future is an integrated toolbox

Genetic material

Mapping populations (RILs, NAM, MAGIC, RH….)

Association panels

Exotic germplasm

Mutant populations

Genetic and genomics resources

Genetic maps

Genome sequences (Ref and others)

HT DNA markers/platforms

HT gene expression platforms

all"omics"

Phenotyping

HT in controlled conditions

HT in the fields

Imaging technologies

Methodologies

Modeling/prediction

GM approaches

Breeding methods

Gene and QTL mapping

Map-based cloning

Candidate genes

Perfect markers

Allele mining

Improved Triticeae germplasm

BREEDWHEAT

WP1: Sequencing and marker development for high throughput genotyping and candidate genes isolation

WP2: Genetics and ecophysiology of wheat adaptation to biotic and abiotic stress

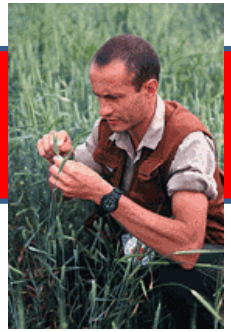
WP3: Characterization and exploitation of natural and induced genetic variability

WP4: Design, implementation and evaluation of novel breeding strategies

WP5: Bioinformatics for gene discovery, data integration and dissemination

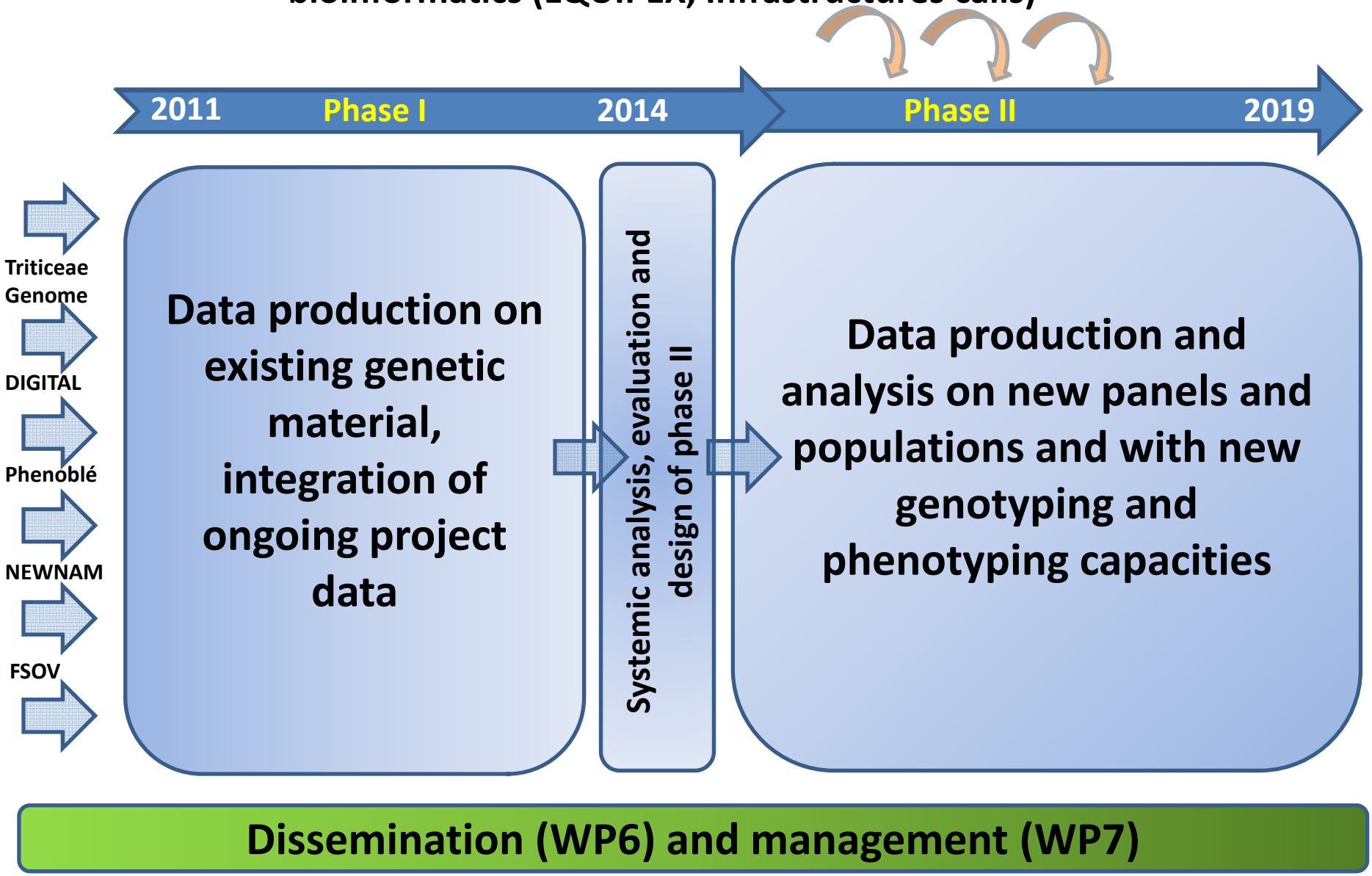
WP6: Outreach

WP7: Management



BREEDWHEAT: timeline

High throughput technological developments: genotyping, phenotyping, bioinformatics (EQUIPEX, Infrastructures calls)



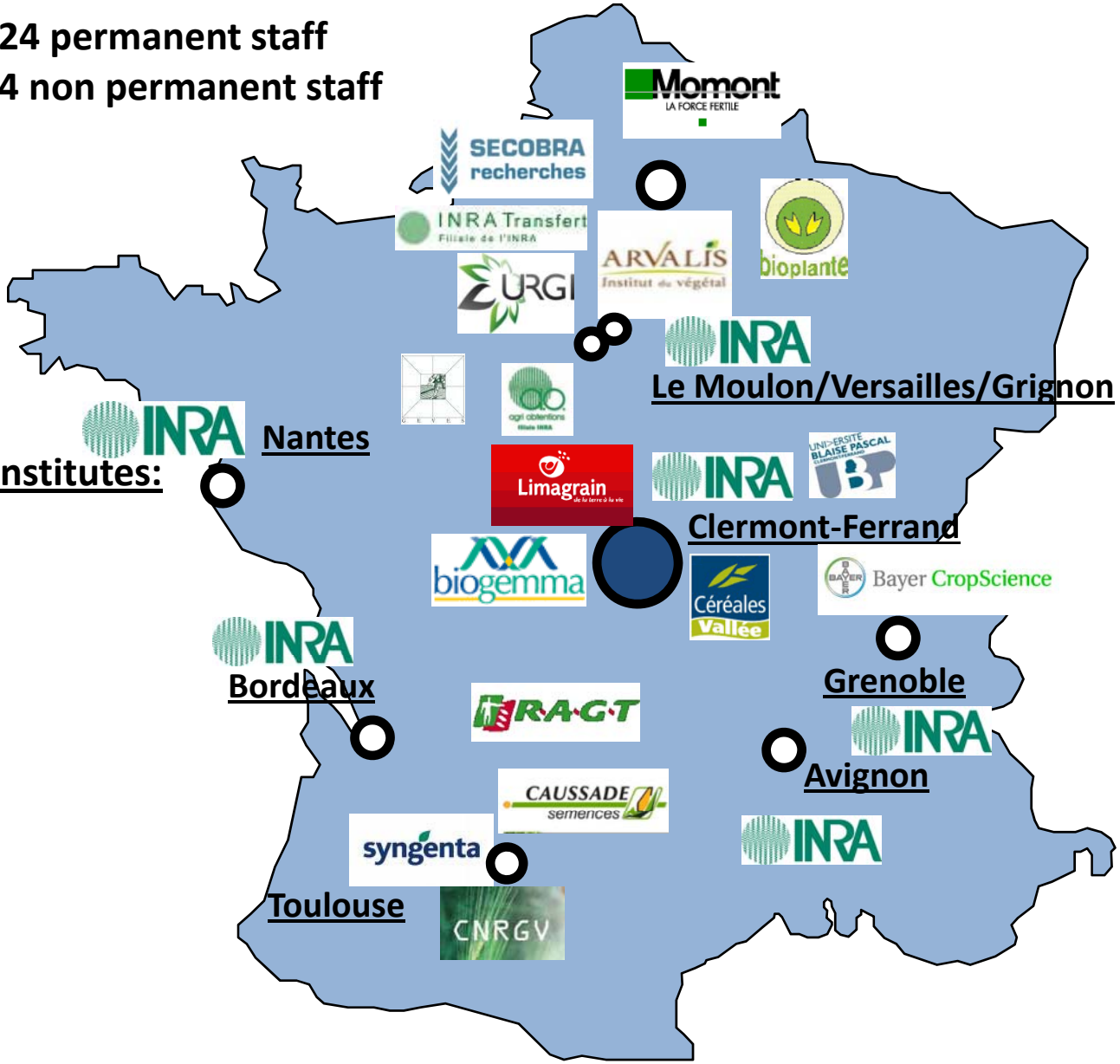
BREEDWHEAT - Partnership (26)

Public partners:
- INRA (12 centres)
- ISIMA
- INRA Transfert

Competitivness Cluster
- Cereales Vallées

Private partners / Technical institutes:
- Agri Obtention
- Arvalis
- Bayer
- Biogemma
- Bioplante
- Caussade semences
- GEVES
- Limagrain
- Momont
- RAGT
- Secobra
- Syngenta

- **124 permanent staff**
- **54 non permanent staff**



	Partners	Total cost	Total Request	Permanent Staff (PM)	Non permanent staff (PM)
Partner 1 (C)	GDEC	15 934 196	4 589 031	1 031	346
Partner 2	BIA	764 915	177 910	42	48
Partner 3	EPGV	690 787	71 525	72	21
Partner 4	CNRGV	362 263	151 620	24	-
Partner 5	GV	189 490	41 600	9	12
Partner 6	URGI	1 102 926	289 882	72	72
Partner 7	CPP	1 251 317	99 999	97	24
Partner 8	GAEL	491 321	150 176	18	36
Partner 9	BF	171 369	40 000	11	-
Partner 10	EGC	1 398 467	310 009	82	93
Partner 11	LIMOS	291 627	88 583	24	24
Partner 12	EMMAH	143 396	46 800	6	12
Partner 13	Agronomie	831 658	229 195	60	36
Partner 14	ARVALIS	1 159 557	579 779	97	54
Partner 15	GEVES	62 982	34 953	4	8
Partner 16	RAGT2n	686 850	206 055	62	46
Partner 17	BIOPLANTE	686 710	206 013	14	-
Partner 18	BGA	3 132 433	939 730	281	-
Partner 19	LIMAGRAIN	1 020 000	306 000	94	9
Partner 20	SYNGENTA	688 719	206 616	6	60
Partner 21	AO	946 317	320 991	49	25
Partner 22	MOMONT	667 410	200 223	45	65
Partner 23	CAUSSADE	677 120	203 136	57	46
Partner 24	BAYER	846 300	199 590	41	51
Partner 25	SECOBRA	666 930	200 079	47	64
Partner 26	Céréales Vallée	4 248 500	128 500	324	12
TOTAL		39 113 561	10 017 995	2 667	1 163

WP1	WP2	WP3	WP4	WP5	WP6	WP7
2 999 919	3 000 000	1 305 000	1 300 000	648 030	299 800	450 000

Total cost: 39 M€

Grant: 9 M€

➢Complete with France Agrimer and private partners

WP1: Sequencing and marker development for high throughput genotyping and candidate genes isolation

INRA biogemma

WP2: Genetics and ecophysiology of wheat adaptation to biotic and abiotic stress

INRA biogemma RAGT SECOBRA recherches Momont LA FORCE FERTILE CAUSSADE semences

WP3: Characterization and exploitation of natural and induced genetic variability

Limagrain ARVALIS Institut du végétal Bayer CropScience

WP4: Design, implementation and evaluation of novel breeding strategies

INRA syngenta bioplante GEVES agri obtentions

WP5: Bioinformatics for gene discovery, data integration and dissemination

biogemma URGI INRA

WP6: Outreach

Céréales Vallée ARVALIS Institut du végétal

WP7: Management

INRA INRA Transfert Filiale de l'INRA

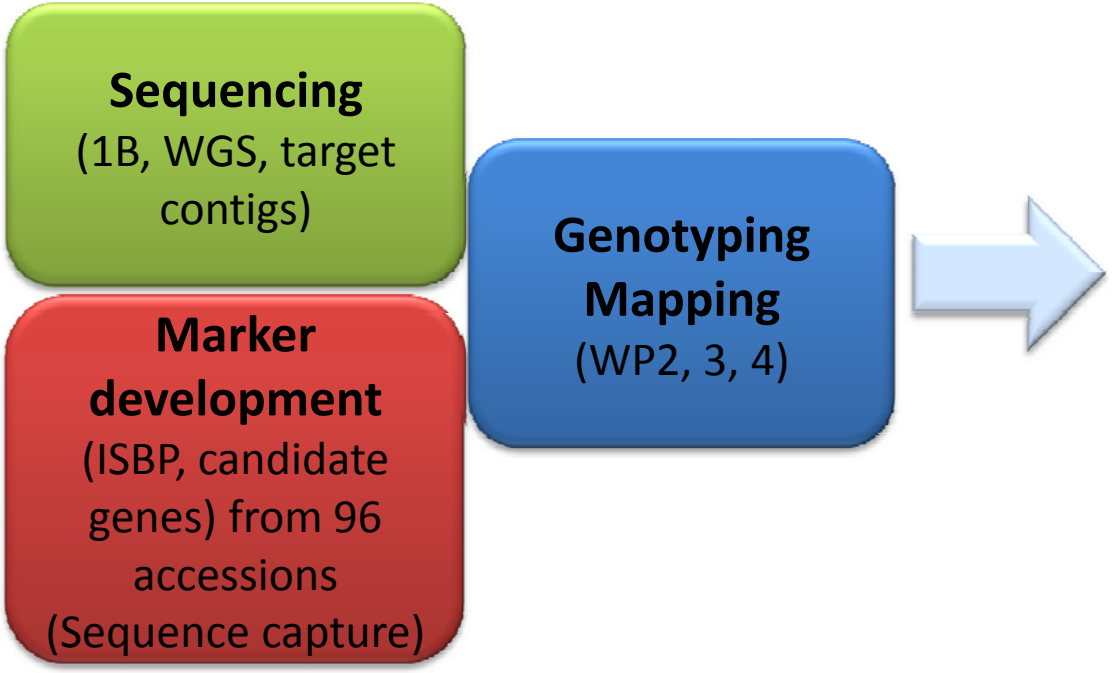
WP1: Sequencing and marker development for high throughput detection of polymorphisms and target trait candidate genes isolation (E. Paux, INRA GDEC)

Objectives:

- Develop **high throughput and innovative molecular resources** to support efficiently the genetics studies undertaken in the BREEDWHEAT project and
- Contribute to **maintain France leadership** in the international wheat genomics projects.

Budget: 3 M€

4 tasks



- **Chromosome 1B** sequence
- **15'000 SNPs** (5500 genetically and physically mapped)
- Genotyping of 7500 SNPs on 19 900 lines (**33 million SNP data points**)
- **Sequencing/annotation of 300 BAC contigs** for positional cloning of 5 target traits

WP2: Genetics and ecophysiology of wheat adaptation to biotic and abiotic stress (J. Le Gouis, INRA GDEC)

Objectives:

• Develop integrative approaches to decipher the **ecophysiological, genetic and molecular basis** of key factors impacting important agronomic traits such **as yield and quality in the context of sustainable systems and climate changes**

Budget: 3 M€

5 tasks

Modeling (plant architecture, development)

Association Genetics = Genotyping + Phenotyping (48'000 plots)

- **Yield**
- **Water use efficiency**
- **Heat stress**
- **Disease resistance**

Data integration

- A **structure-function model** to assess ideotypes maximizing grain yield and quality
- A list of **2000 candidate genes** for target traits
- **New marker-trait associations** for yield and quality traits under major biotic and abiotic stresses
- **fine mapping and positional cloning of 5 loci**

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

Objectives:

Broaden the genetic diversity present in modern French cultivars through the introduction of novel sources of diversity that contains favourable alleles for abiotic and biotic stresses

Budget: 1.3 M€

2 tasks

- **Genotyping** of 5000 wheat lines from INRA collection with 1000 SNPs
- **Phenotyping** of selected panels (2 x 250)

- **Identification of new sources** (adapted material from other programs, synthetics) of abiotic and biotic stress tolerance
- **Introduction into French germplasm**

- **Detailed description and on line database access** of the INRA collection
- **Adapted panels (250)** for abiotic and biotic stress
- **Novel European Elite Germplasm** with improved stress tolerance **(2 x 9 Advanced Back crossed populations)**

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

Objectives:

Budget: 1.3 M€

- Develop **innovative tools and methodologies** to better **exploit natural and induced variability** in breeding programmes and **accelerate genetic progress**.
- **Test the effectiveness of newly developed ideotypes** to increase sustainability and profitability

4 tasks

New statistical tools **for molecular breeding**

Development of **real size breeding programs (AO)**

Evaluation of new ideotypes in innovative, sustainable and profitable cropping systems

Economic impact of new molecular breeding models

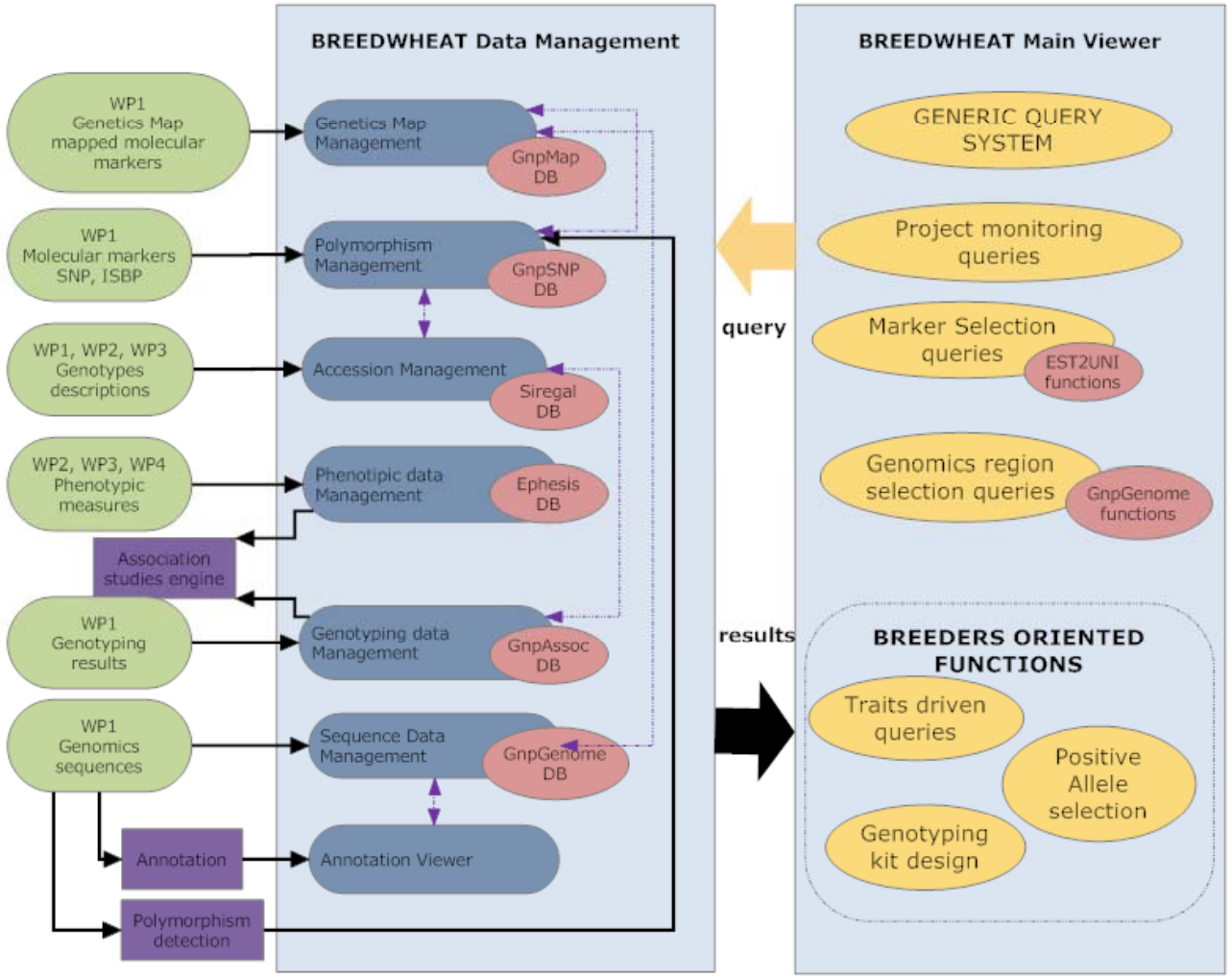
- An **integrated pipeline** of softwares to **estimate marker-based breeding values**, and **maximize genetic progress**
- **Comparisons between classical,** genomic or marker-assisted selection schemes
- Identity cards and agro-climatic atlas of adaptation **of new ideotypes**
- **Evaluation of economic impact** of new breeding methods

WP5: Bioinformatics (O. Dugas, BGA)

Objectives:

Budget: 0.65 M€

- **Integrate data** from others WPs, as well as publicly available information (**BIS**)
- Develop **new tools to integrate new polymorphisms** and **automate association studies**
- Establish a **Breeder's oriented portal**



3 tasks

Genetic resources

Elite lines, synthetics (EU/world)

Polymorphisms (SNP, CNVs…)

Statisticals tools and Methods

Phenotyping
> 60 field assays (1000 parcels each) on N, Drought, fusarium and septoria in > 15 locations over 9 years

X

Genotyping
➢33 million SNP assays (Gene and ISBP based) on ~20 000 lines

X

Ecophysiology
Modeling (N economy, Phyllocron /T°, leaf optical properties, radiative transfer Septoria and fusarium)

Bioinformatics tools and database

Socio economic impact of innovative breeding methods and agricultural practices

Characterization of genetic resources and new alleles

Physical and genetic mapping

Association genetics studies

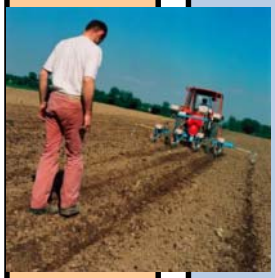
Pre competitive breeding program

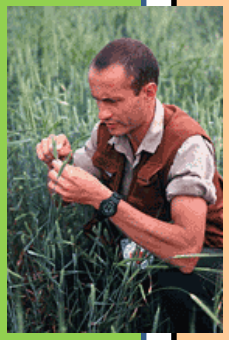
- New core collections
- New AB QTL lines
- Chromosomal regions underlying agronomically important traits
- Candidate genes
- Markers for MAS and genomics selection
- New breeding methods evaluated

BREEDERS

GROWERS

CONSUMERS



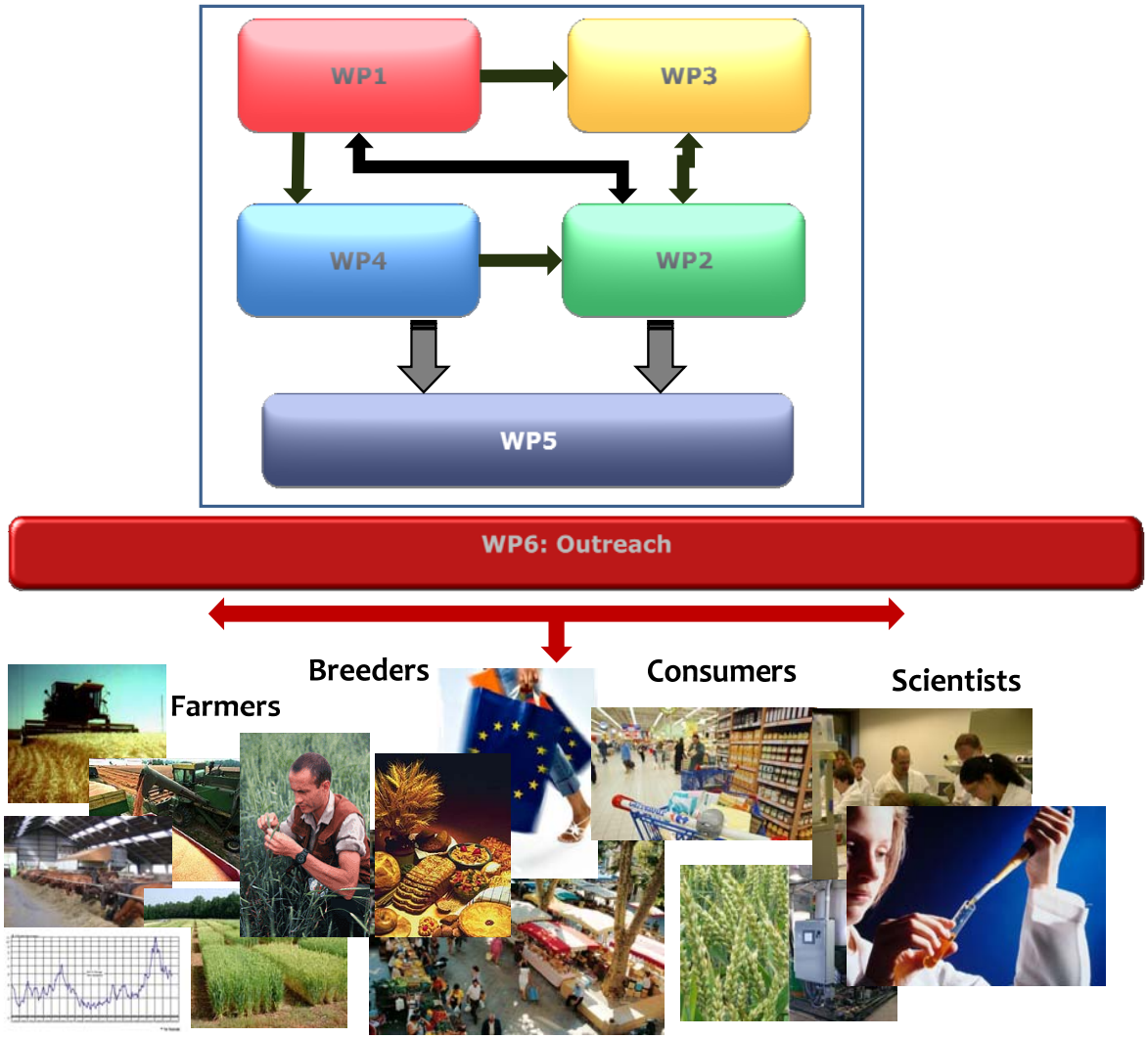


BREEDWHEAT

WP6- Dissemination, and Technology transfer

(G. Berthe, Cereales Vallées)

Objectives: **Disseminate the results of the BRREDWHEAT** to scientists, breeders, farmers and consumers and develop interactions with international initiatives



Budget: 300 K€

4 tasks

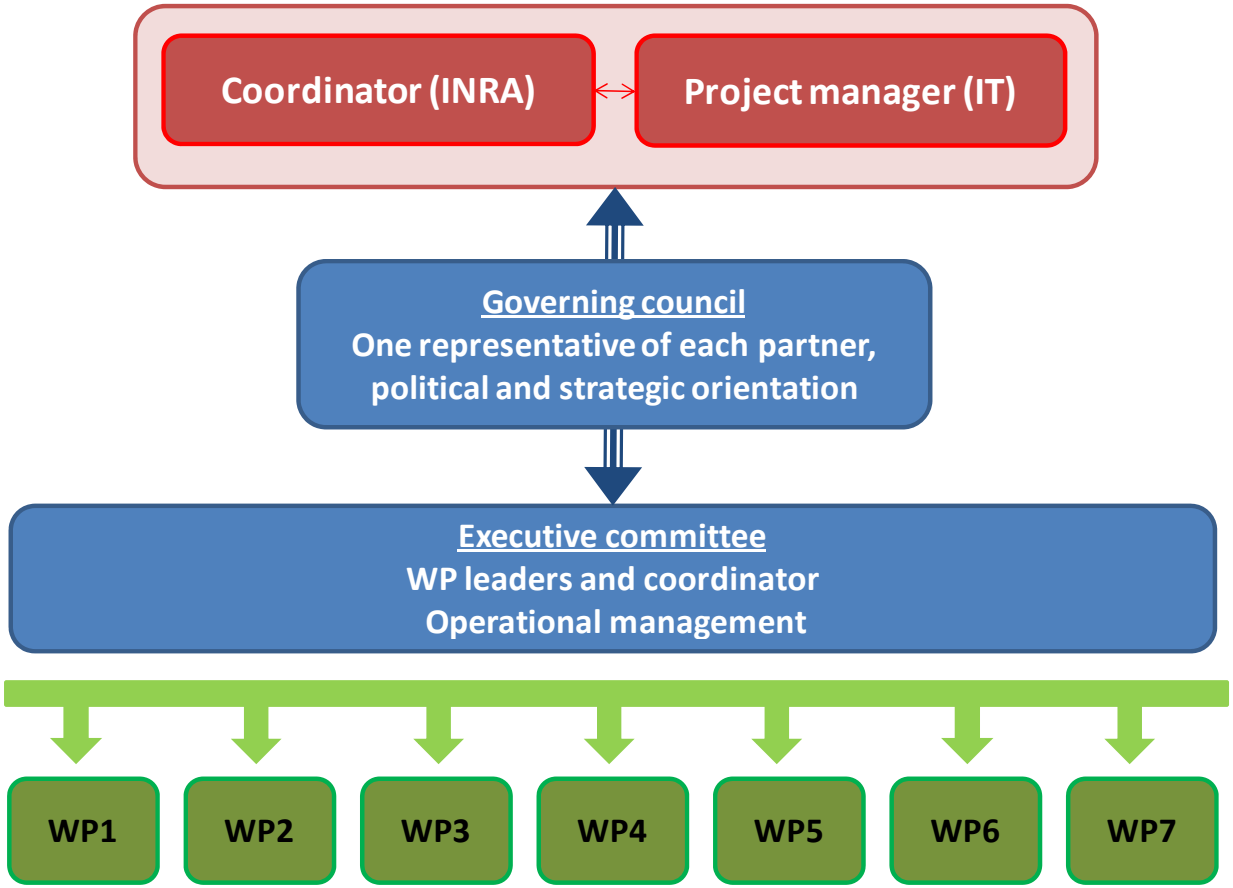
- **Website**
- **Leaflets and newsletters**
- 6 **Booklets**
- 5 **Training courses**
- **BREEDWHEAT conferences**

WP7: Management (C. Feuillet/E. Lagendijk, INRA GDEC)

Objectives:

Ensure a **timely development of the project**, **reaching the goals and achieving the deliverables** on time, ensure **good practice** in resources management, **guarantees financial good practice** at the managerial level

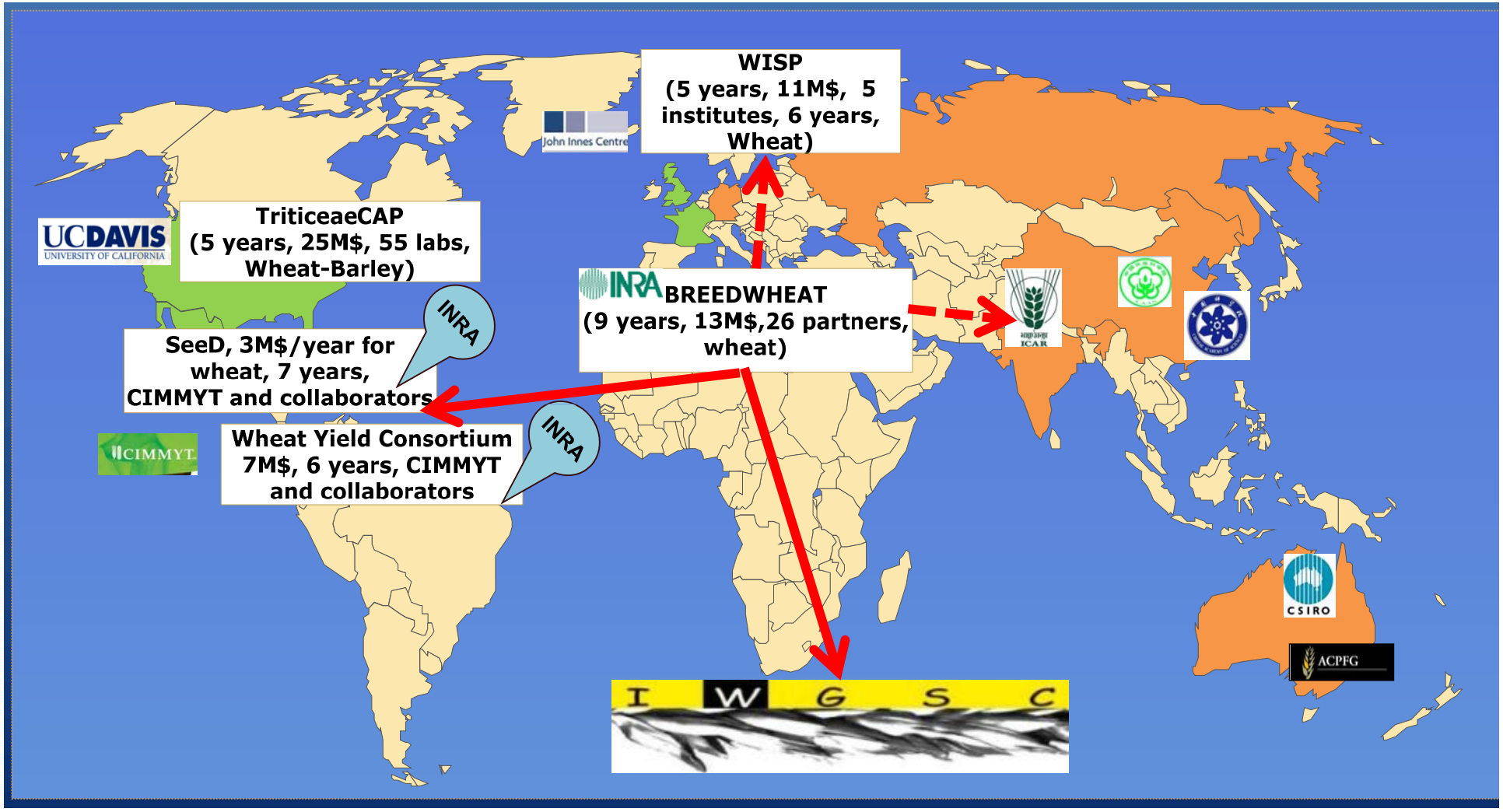
Budget: 450K€



6 tasks

- **Project management**
- **Project reporting** (scientific and financial)
- **Meetings**
- **Intellectual Property**
- **Interactions** with international initiatives and stakeholders

BREEDWHEAT: partnership with international initiatives



INNOVATION ■ Un programme ambitieux piloté depuis l'INRA lauréat d'un appel à projets du Grand emprunt

Les blés du futur en germe à Clermont