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Science For A Better Life

The wheat genome sequence: a key enabler to boost wheat research

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September 13, 2016





Outline

- Wheat strategy @ Bayer
- Why do we need a reference sequence?
- How to get there? The IWGSC
- How do we leverage the genome sequence in our programs?

WHAT THE WORLD EATS: WHEAT



 **CIMMYT**

INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

Food Security • Hunger & Malnutrition • Economic Development • Climate Change

The Wheat ID card

Name : Triticum aestivum L.

Surname: Bread wheat

Birth place: Fertile Crescent

Family: Grasses (rice, maize, sorghum, sugar cane, millet..)

Parents: T. urartu (A), unknown (B), Ae. tauschii (D)

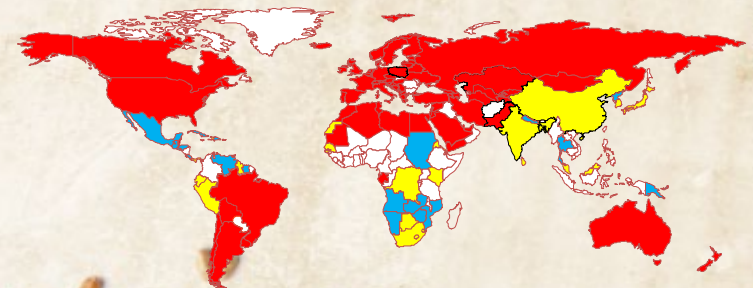
Address: More than 160 countries (China, India, USA, Russia France, Canada, Australia, Germany, Pakistan, Turkey, Ukraine, Argentina, UK...)

Weight: >600 Million tons/year

Size: 16 billion bp

Features:

- Globally most important food crop
- Staple food for 30% of world population
- Provides up to 20% of calories and proteins



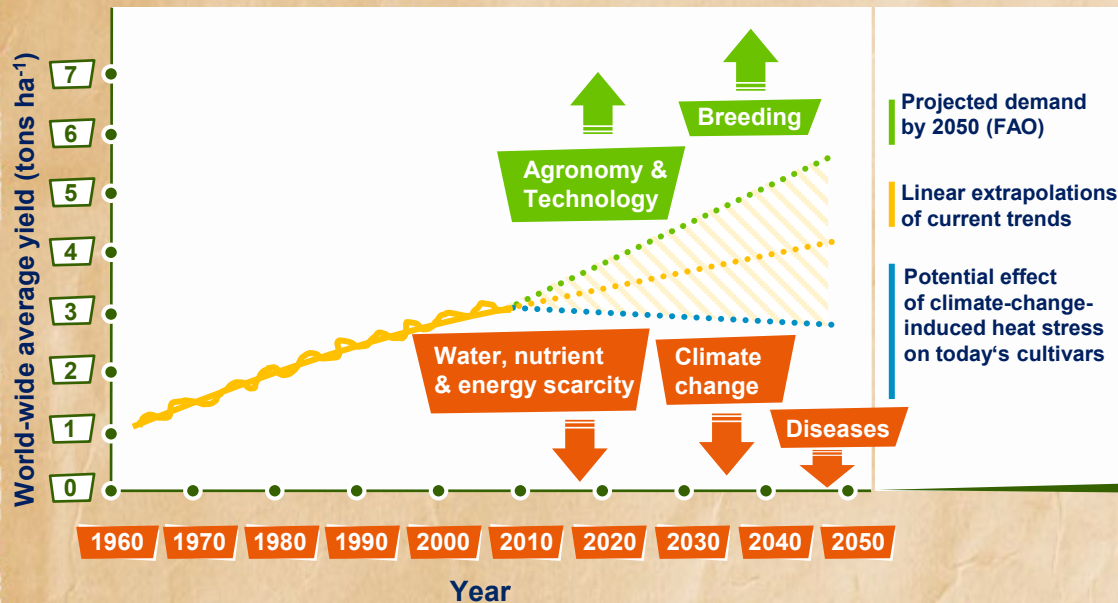
Rank 1
Rank 2
Rank 3



Future demand projections suggest growing productivity gap in wheat



Projected demand and wheat yield trends under several scenarios



Source: CIMMYT 2014

Challenges

- Yield growth rate lower than rate of population growth
- Area competition between crops
- At maturity position with “today’s” technology?
- Impacts from climate, resistance and water/nutrient scarcity

Way forward

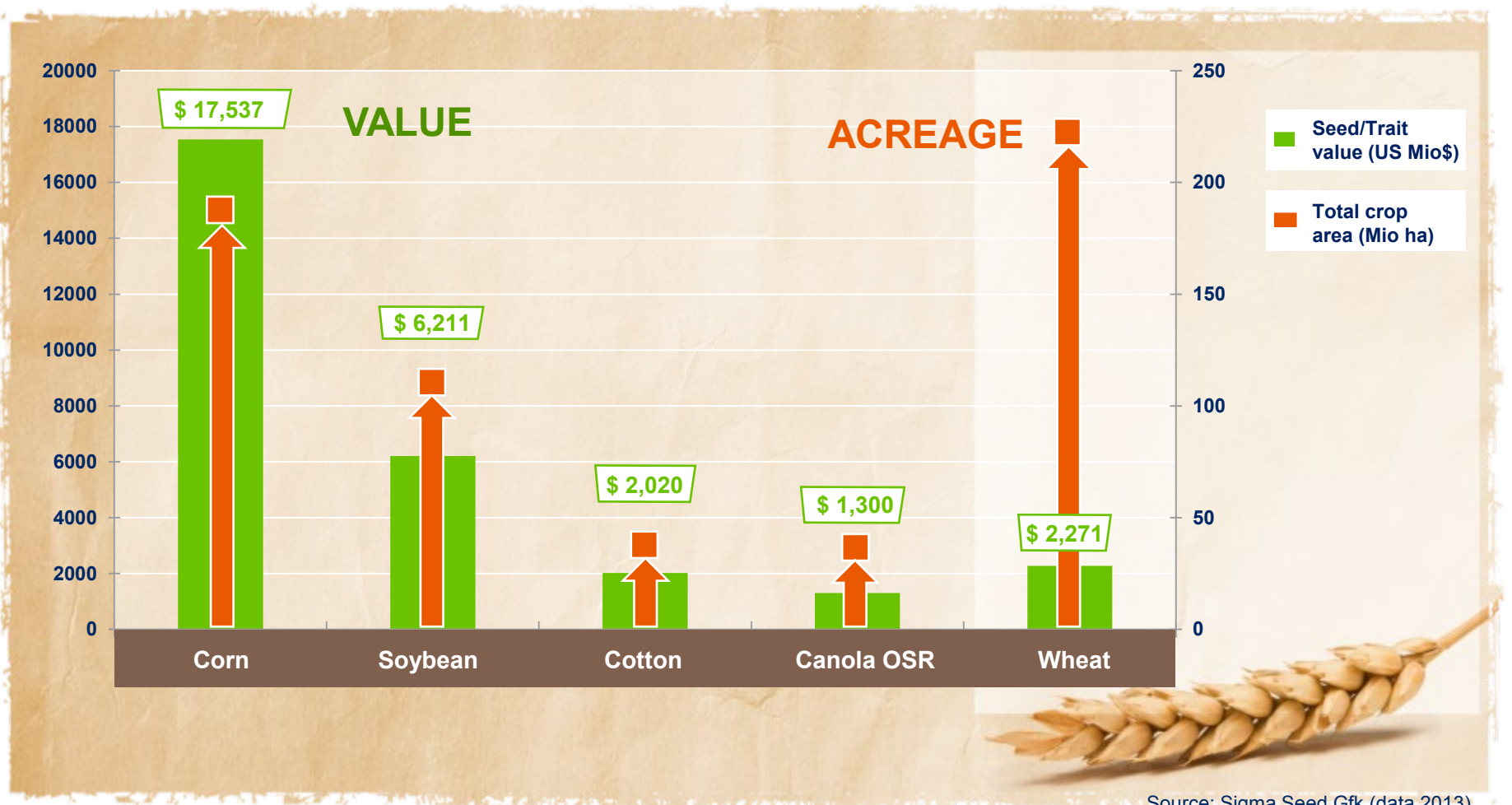
Sustainable intensification through investment in yield and yield stability:

- locally adapted, stress-tolerant, high-yielding varieties
- improved agronomic practices and storage





Potential of Wheat Seed/Trait market



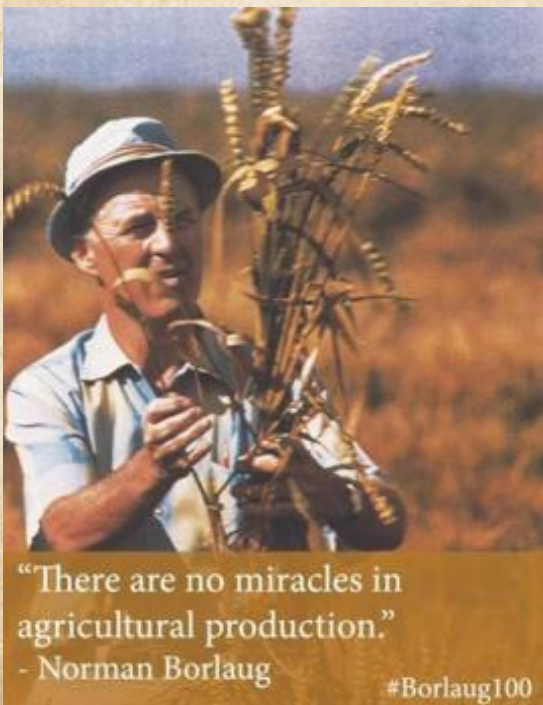
Source: Sigma Seed Gfk (data 2013)

Bayer CropScience is committed to advancing wheat R&D



“We have mapped out a comprehensive 10-year plan to invest EUR 1.5 billion in the research and development of new solutions for wheat through 2020 – encompassing both seeds and crop protection products.”


- Liam Condon, CEO Bayer CropScience-Sept 2014



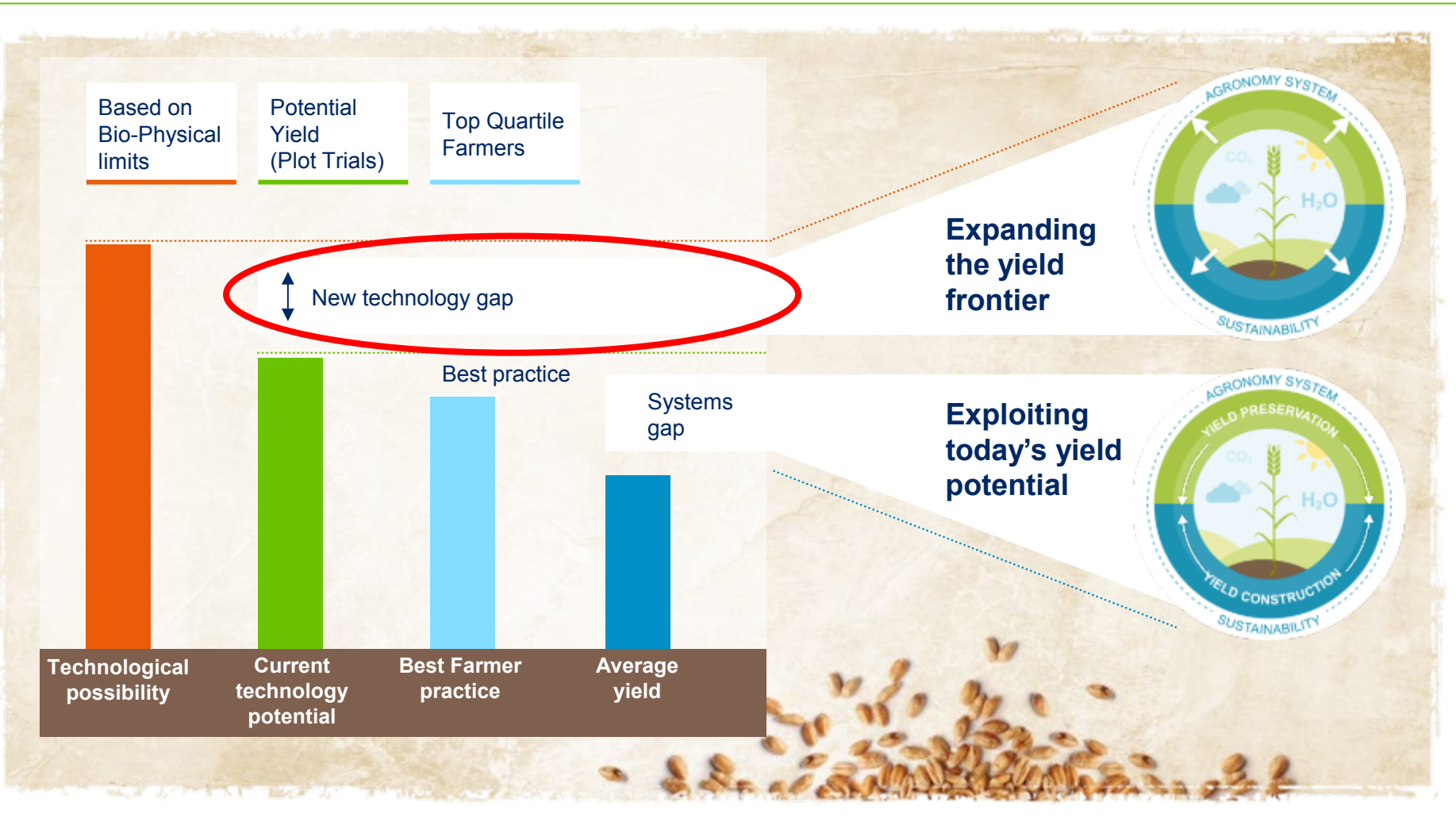
Future solutions will work across disciplines: Selected examples for wheat



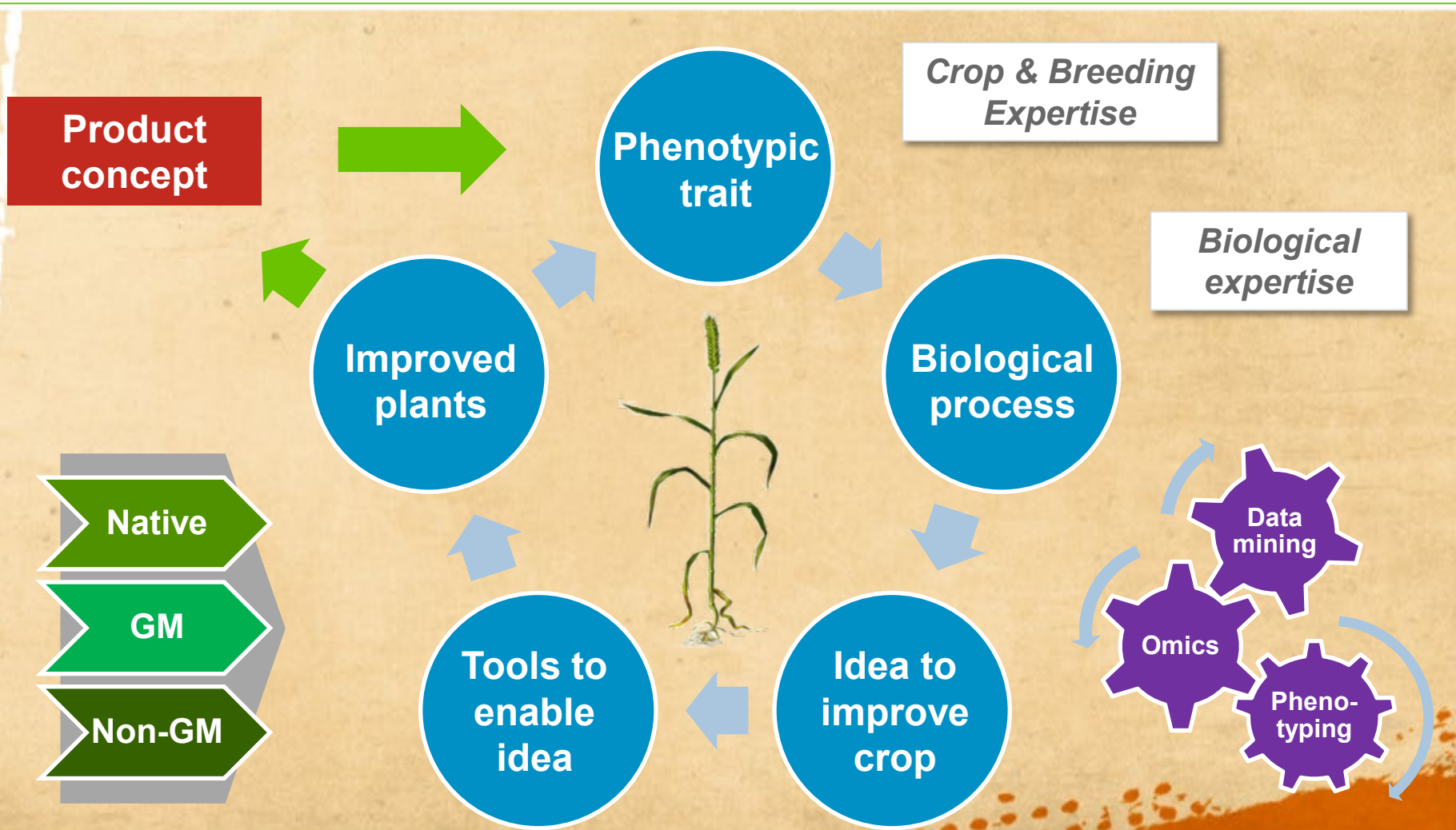
	Chemicals	Biologicals	Traits	Seeds
1. Weed Management Systems for grass & broad-leaved weeds	✓		✓	
2. Disease management which meets increasing regulatory demands, provides excellent disease control, & yield benefits beyond disease control	✓	✓		
3. Deliver Yield gains			✓	✓



Wheat yield frontiers

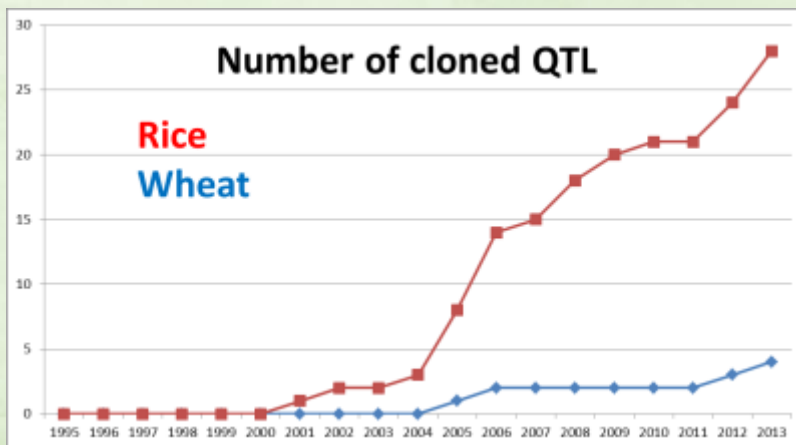
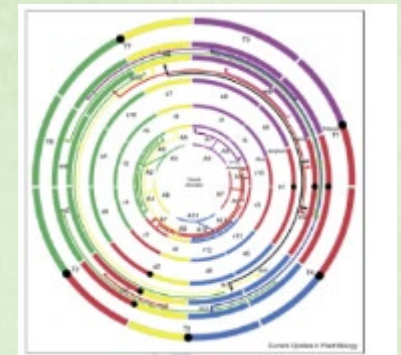
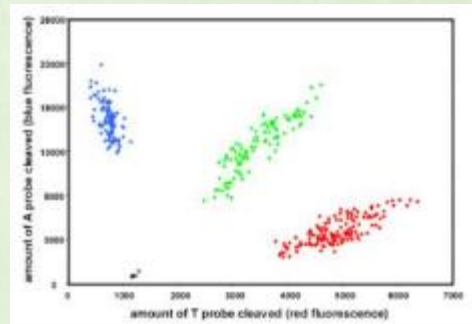


Crop Efficiency Research Strategy: focus on yield components



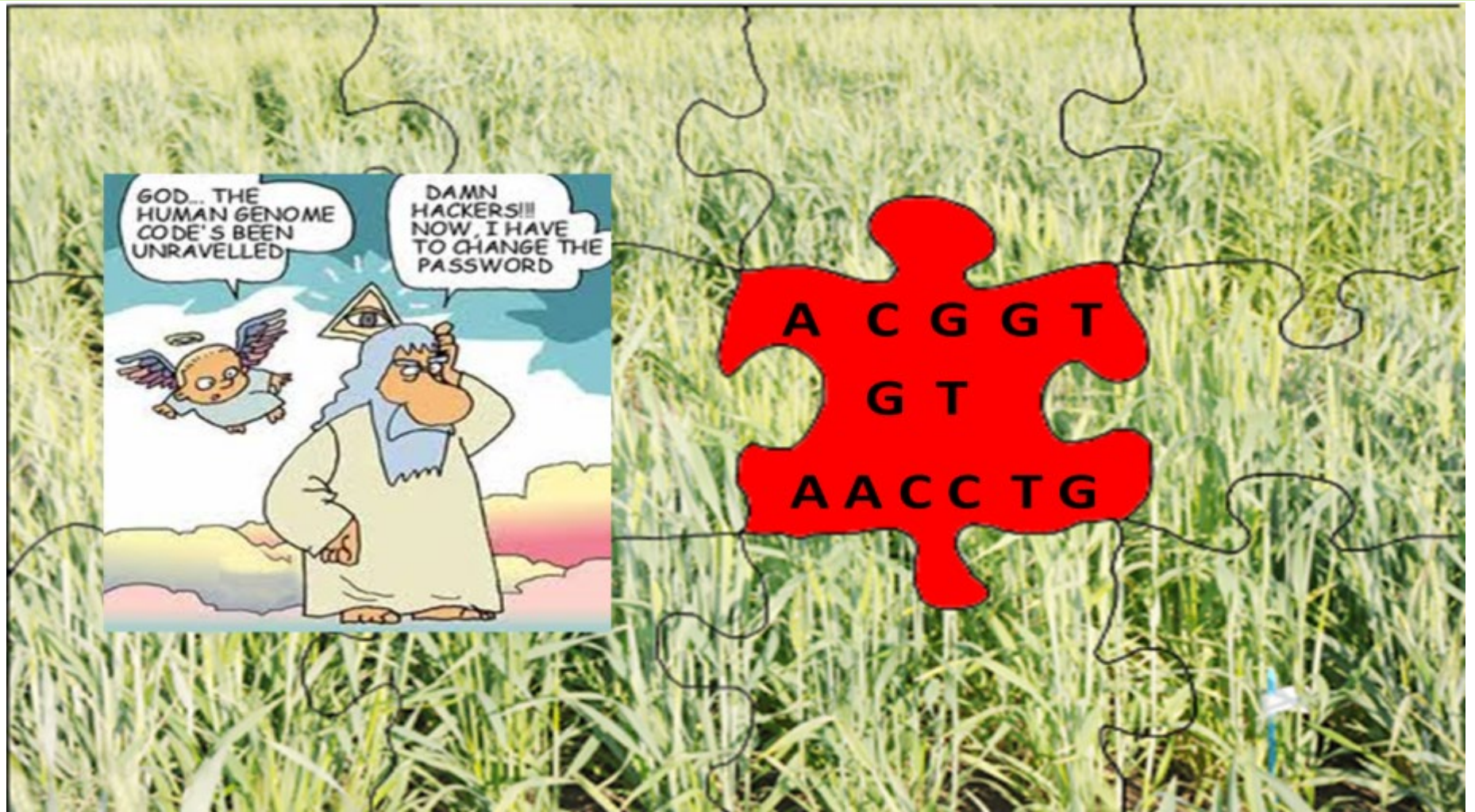
Gene discovery in wheat.....10 years ago

- Molecular markers
- ESTs and microarrays
- BAC libraries
- Genetic resources
- Gene validation
- Grass comparative genomics

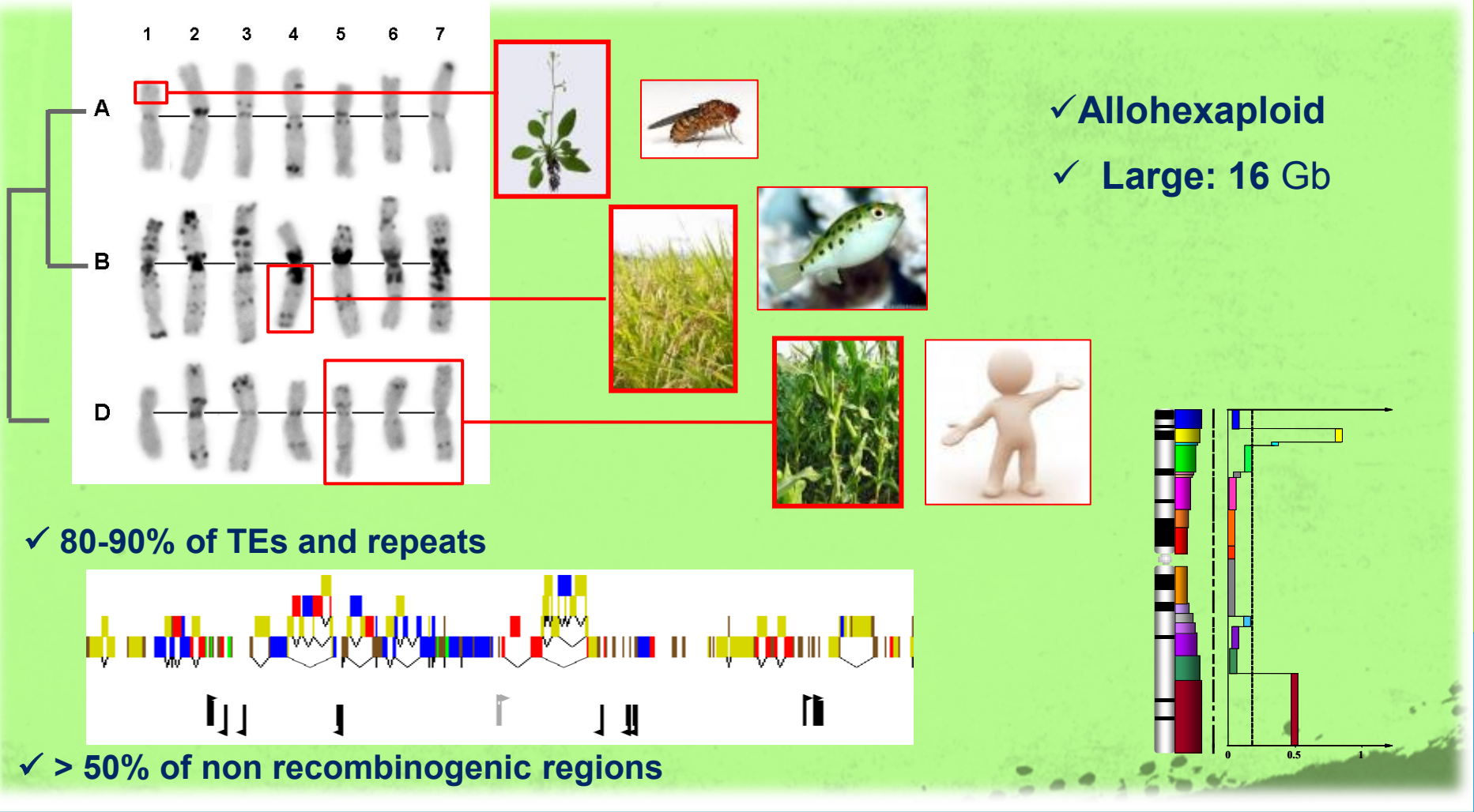


~ 10 years for map based cloning single trait genes...

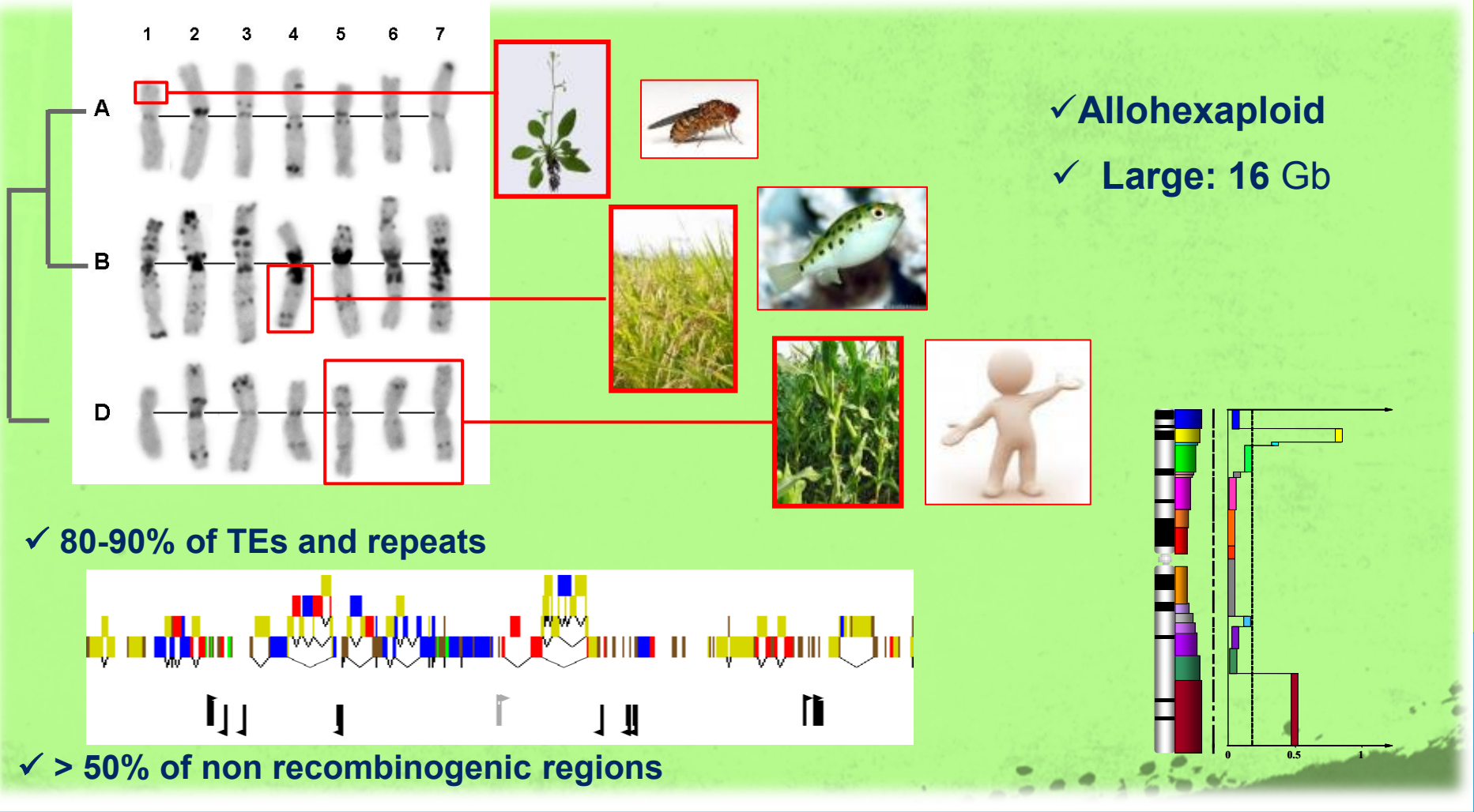
Gene discovery in wheat.....10 years ago



THE Challenge....



THE Challenge....



International Wheat Genome Sequencing Consortium



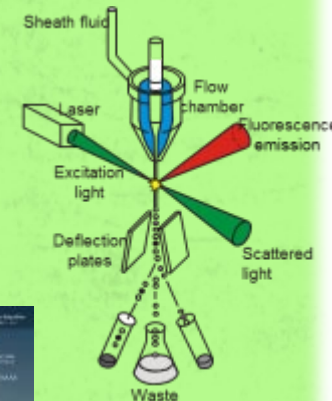
- ✓ 2005: **Launch** (Kansas Wheat)
- ✓ 2006: 1st **Strategic road map**
 - Involve industry
 - Hexaploid wheat
 - Chromosome-based approach (BAC by BAC)
 - Regular revisions (2008/2010/2015)



✓ Country based funded projects

✓ Key achievements

- 2008: 1st physical map of chr. 3B (1Gb)
- 2012: first reference sequence chr. 3B
- 2014: 21 chromosomes survey sequences



✓ 2015: NRGene de NovoMAGIC assembly from **whole genome sequence**

Highlights



www.wheatgenome.org

A chromosome-based draft sequence of the hexaploid bread wheat genome

The International Wheat Genome Sequencing Consortium

- ✓ **10.2 Gb** assembled sequences
- ✓ **128Mb (1DS) – 639Mb (3B)** assembled sequence per chromosome
- ✓ **N50 contig* = 5.9 kb** (1.7kb-8.9kb)
- ✓ **99,386** annotated genes assigned to chromosomes for the first time
- ✓ **50% gene ordered**- In silico mapping
- ✓ Homoeologous gene **expression studies**
- ✓ Ancestral **genome evolution** studies

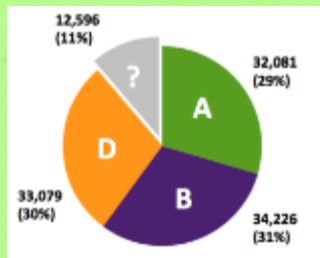
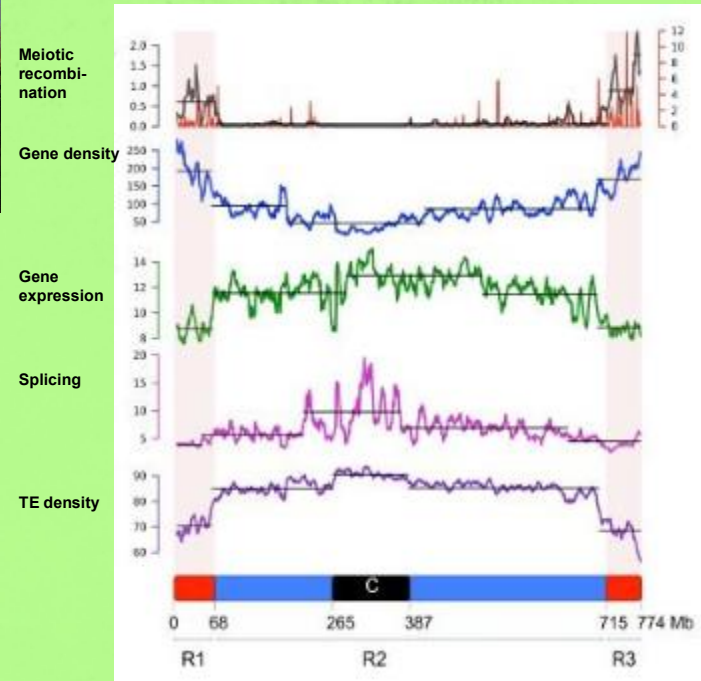


Special issue
Science, 345 (2014)

Structural and functional partitioning of bread wheat chromosome 3B

Choulet et al.

Structural and functional variation along a wheat chromosome

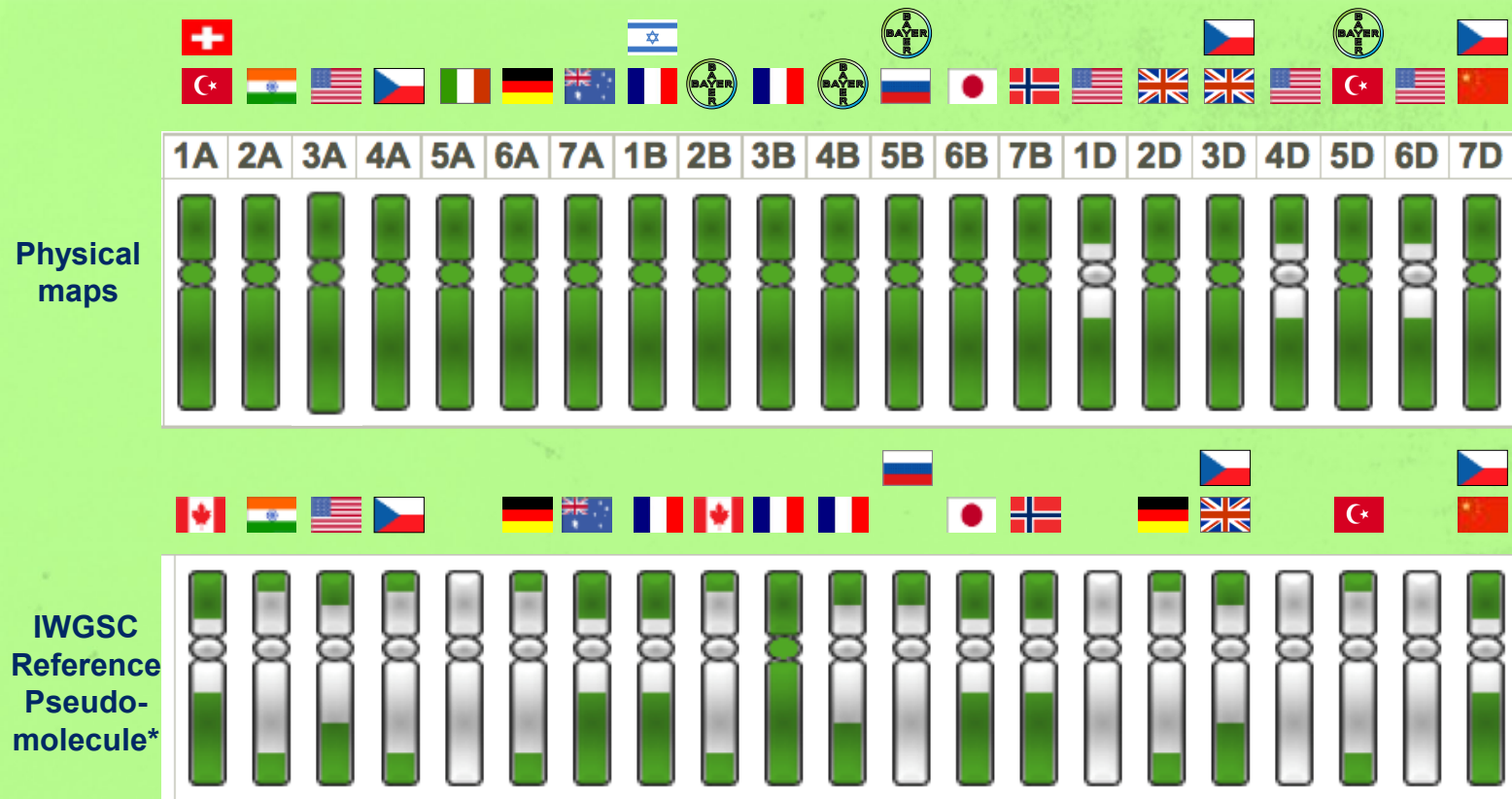


*After repeat masking



Download & BLAST search available at the IWGSC repository:
<http://wheat-urgi.versailles.inra.fr/>

Progress towards completion of a bread Wheat reference genome sequence: Status 2016



*Flags represent countries where work is underway with funding, as of January 2016

Completion expected for 2018-19

The IWGSC WGA project



IWGSC coordinated - Led by Nils Stein, Curtis Pozniak, Jesse Poland with NRGene and Illumina

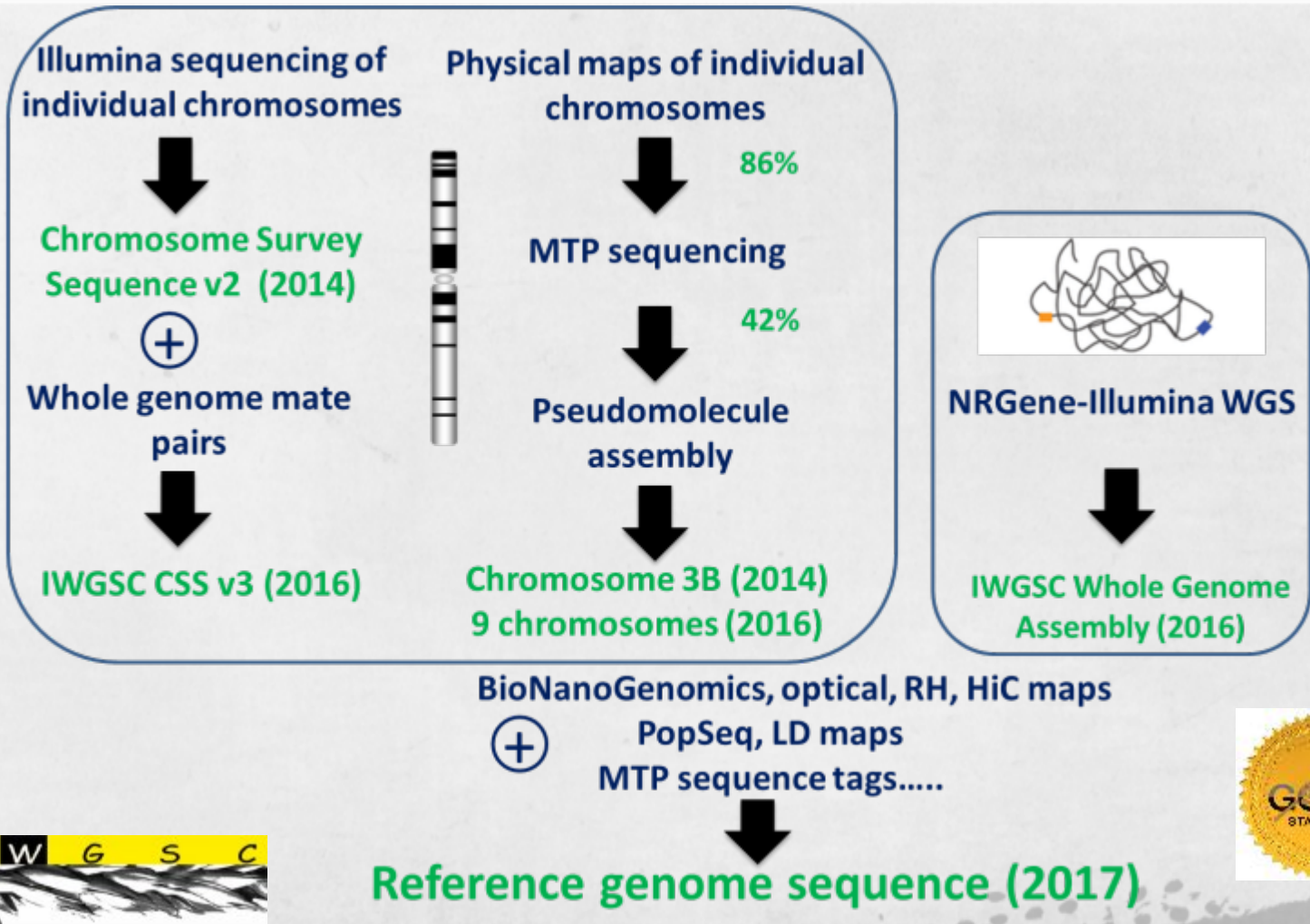
De novo assembly:

- **NRGene's DeNovoMagic-2** platform, total run time < 3 weeks, 1Tb RAM computer
- **Illumina short-read** sequence data only (200x coverage, paired ends + mate pairs)
- Sequence contigs / scaffolds assigned to chromosomes using **IWGSC CSS + POPSeq data**

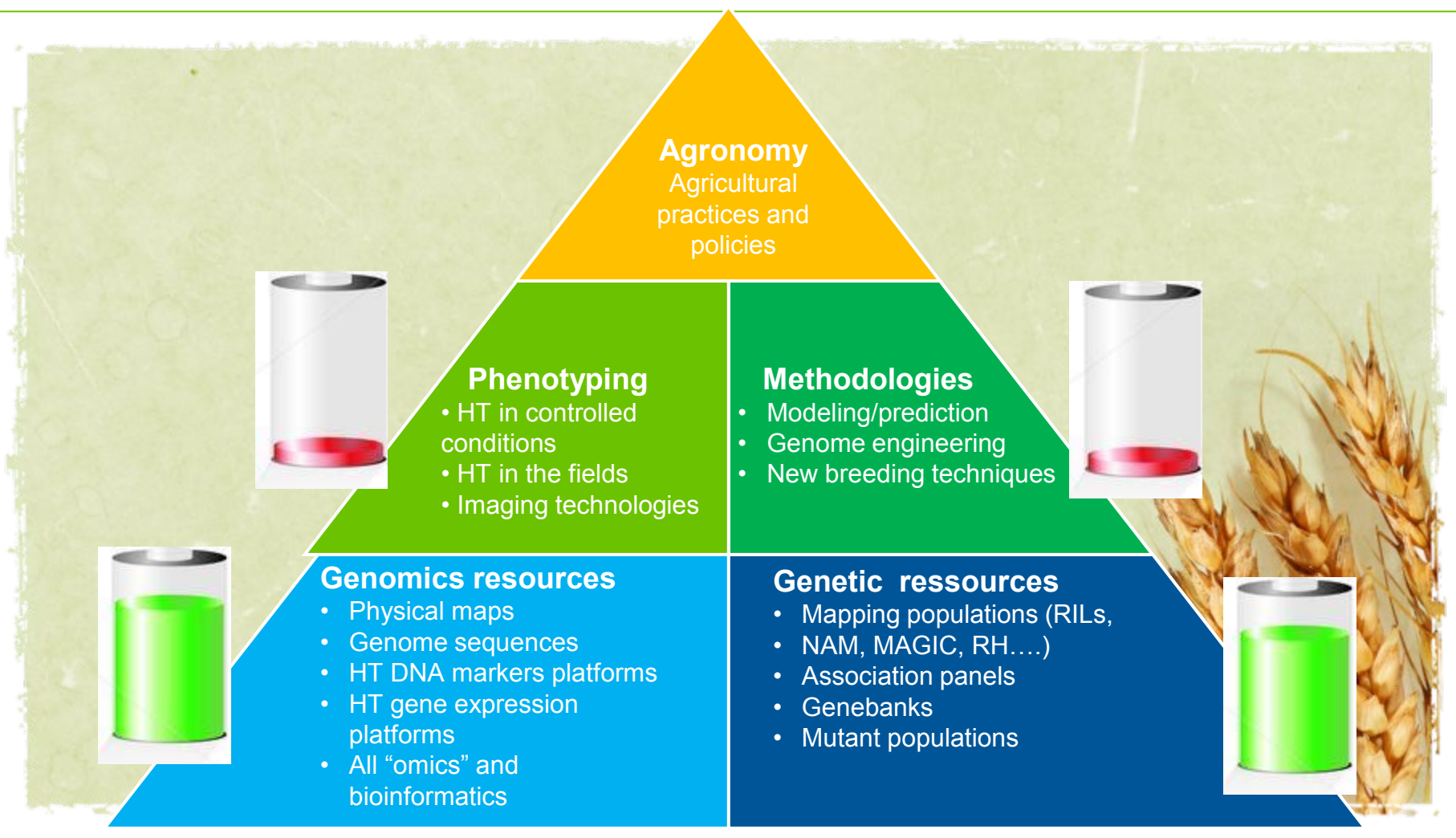
Assembly size:	14.5 Gbp
Gaps size:	262 Mbp (1.8%)
N50 (scaffolds):	7.1Mbp
Coverage in scaffolds > 100kb	14.2 Gb (4,442)
Scaffolds ordered by HiC map	3,975 (14.1 Gb)

- Assembly contains **95 to 99%** of the genes and TE based markers
- **Chromosome data** (physical maps, WGP tags, Bionano maps, HiC) used to correct chimeras, orient scaffolds and generate super-scaffolds
- Super-scaffolding extends linkage by ~ 3-fold - **N50 superscaffolds 23.8Mbp.**

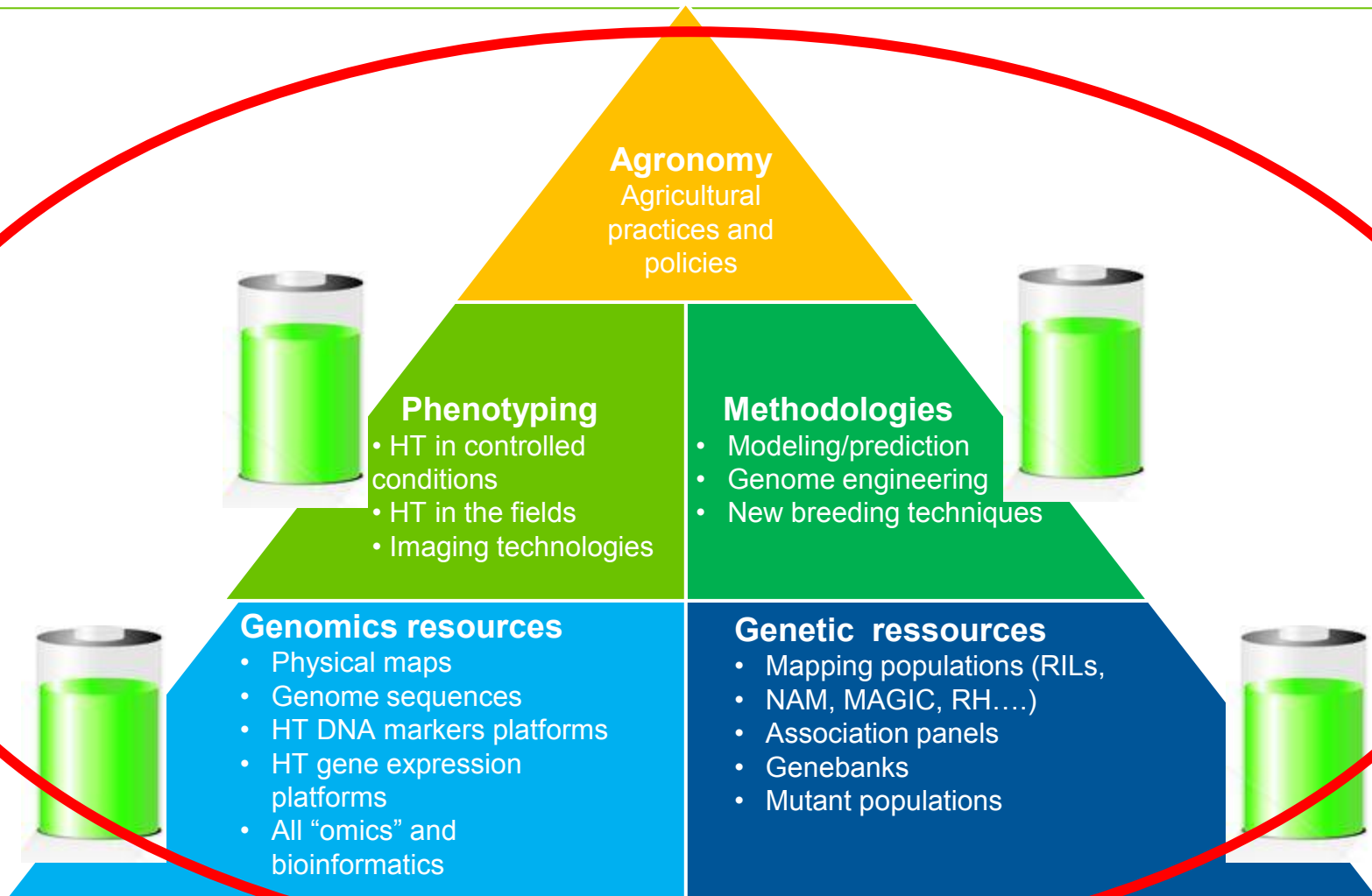
Roadmap to the Wheat Genome Gold standard Reference Sequence



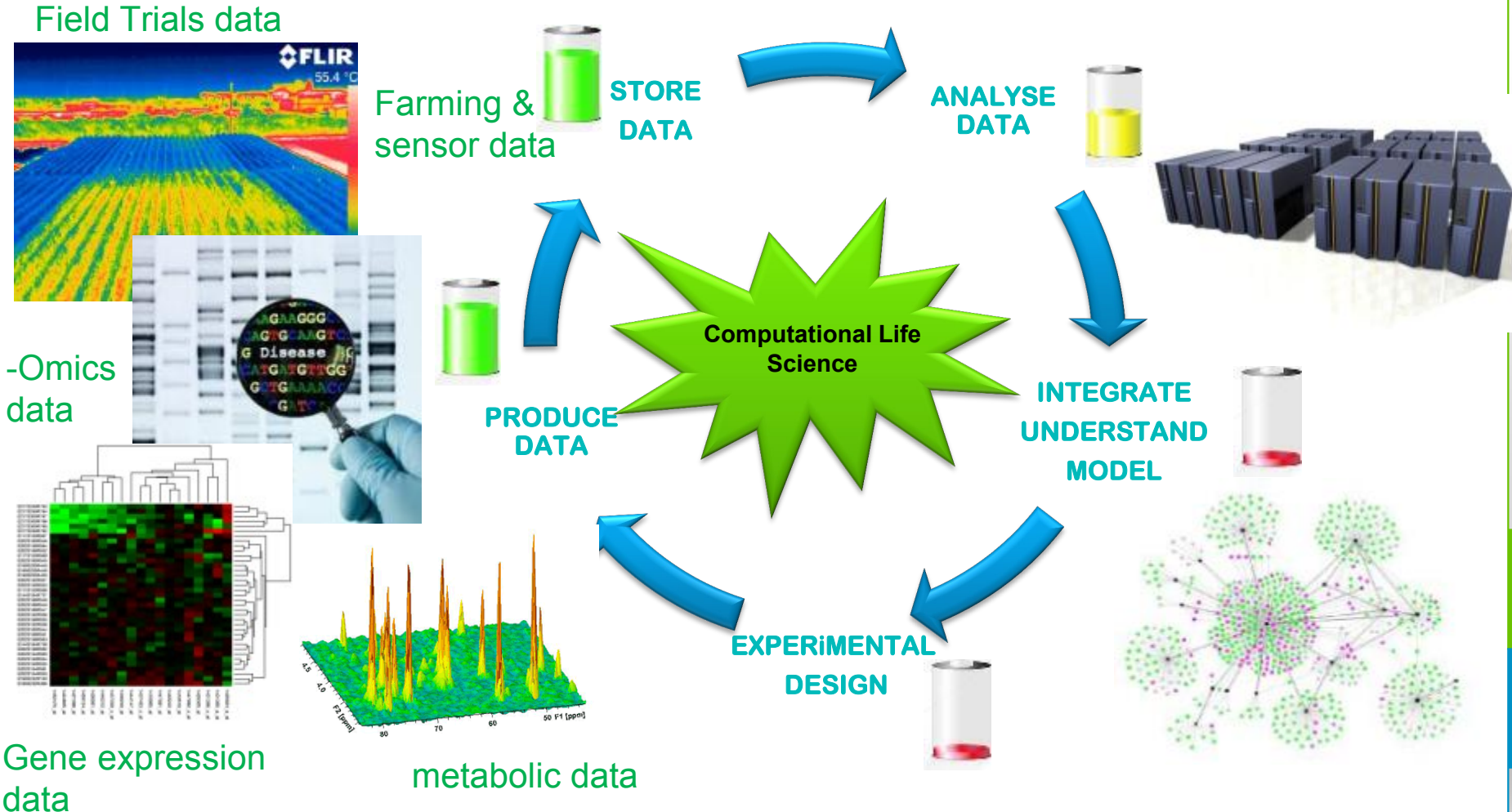
Wheat Research gets a boost! But ...



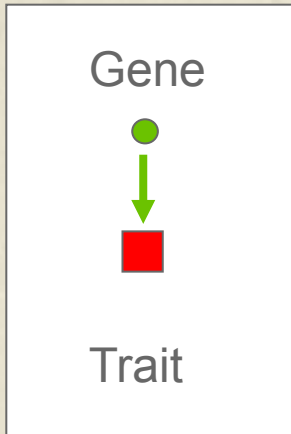
Success will depend on our ability to translate data into knowledge and use technologies



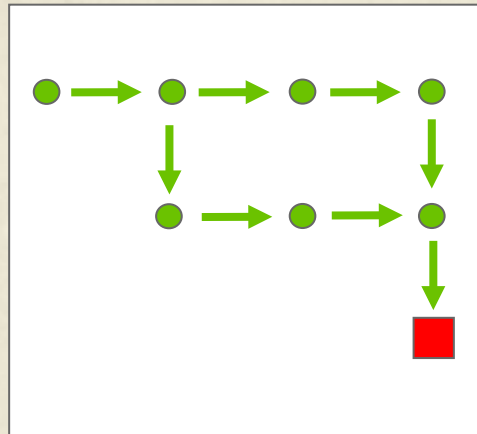
Computational biology is key to ensure integration and translate data into knowledge



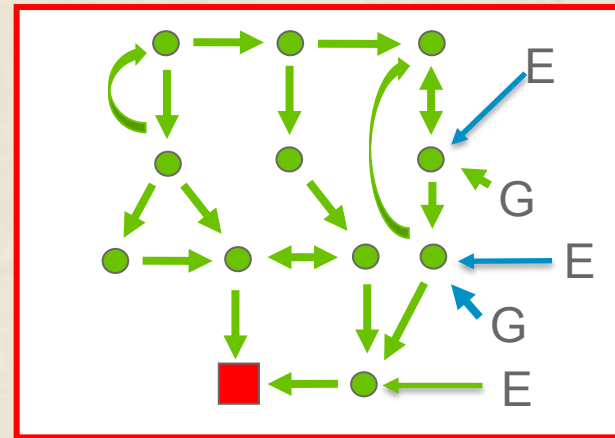
Translating knowledge into products for a next generation of (complex) traits



Herbicide,
Insect, Disease
resistance..



Oil composition,
Pod shatter
reduction..



Crop Efficiency,
water use
efficiency...



Bayer CropScience allocates grants for the exploration of attractive, novel solutions to increase crop productivity



Grants4Traits™

Novel solutions to increase crop productivity



At Bayer, we have a successful history of collaborating with external parties to deliver safe and innovative seed products to markets. We are interested in learning from you and partnering with you to sustain this innovation.

Apply now for a grant and develop further some of your ideas towards products that will increase sustainable crop output to meet the demands of an ever growing population and changing environment.

Next submission deadline is October 31st 2016

[SUBMIT PROPOSAL](#)

<https://innovate.bayer.com/>



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