Plant Biotechnology at BASF

Plant Genomics and Gene Editing Congress,
Rotterdam 15th May 2018

BASF
We create chemistry

BASF – We create chemistry

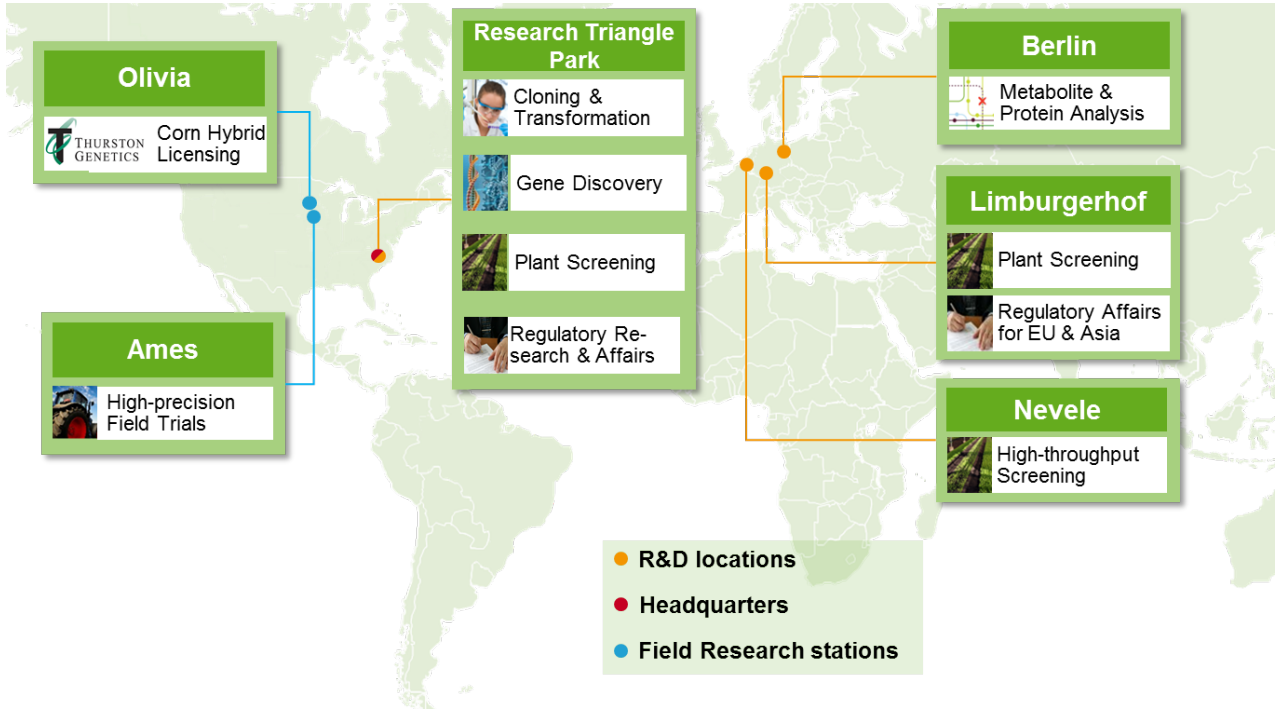
- Our chemistry is used in almost all industries
- We combine economic success, social responsibility and environmental protection
- Sales 2017: €64,457 million
- EBIT 2017: €8,522 million
- Employees (as of December 31, 2017): 115,490
- 6 Verbund sites and 347 other production sites

BASF Plant Science Strategy

Our Mission and Vision

Our Mission and Vision

- We strive to provide a better quality of life and improved environment through Plant Science Technologies
- We drive innovative solutions for agriculture, nutrition, and industrial applications, creating value for BASF and customers
- We base our strategy on supporting farmers:
  - Yield Increase & Stress Tolerance
  - Herbicide Tolerance
  - Fungal Resistance
  - Quality traits (EPA+DHA canola oil)



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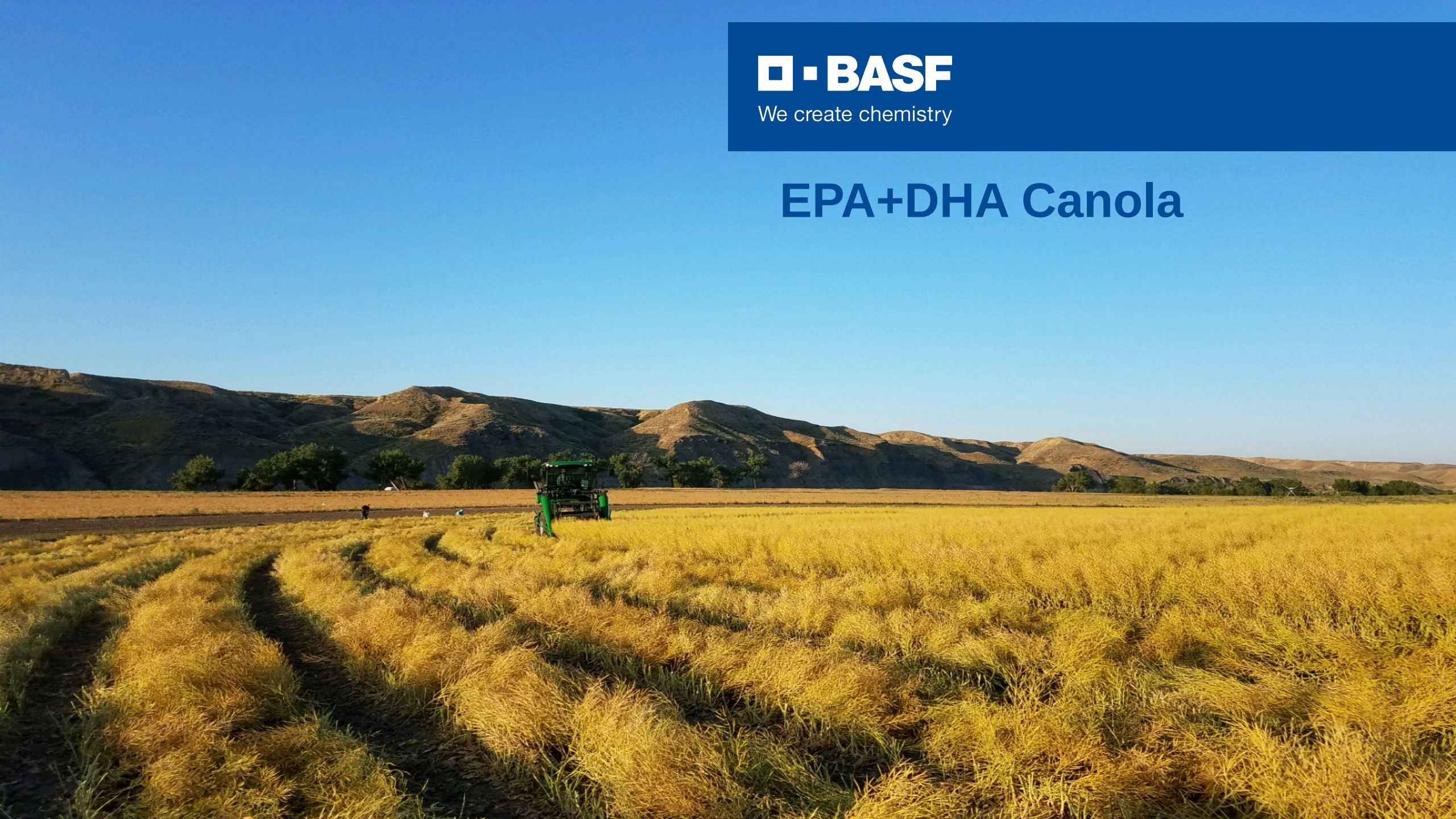
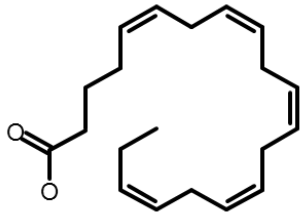
EPA+DHA Canola



EPA and DHA Omega-3 fatty acid intake is linked to human health benefits

Eicosapentaenoic acid (EPA)



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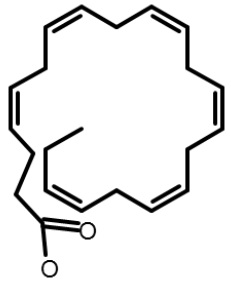
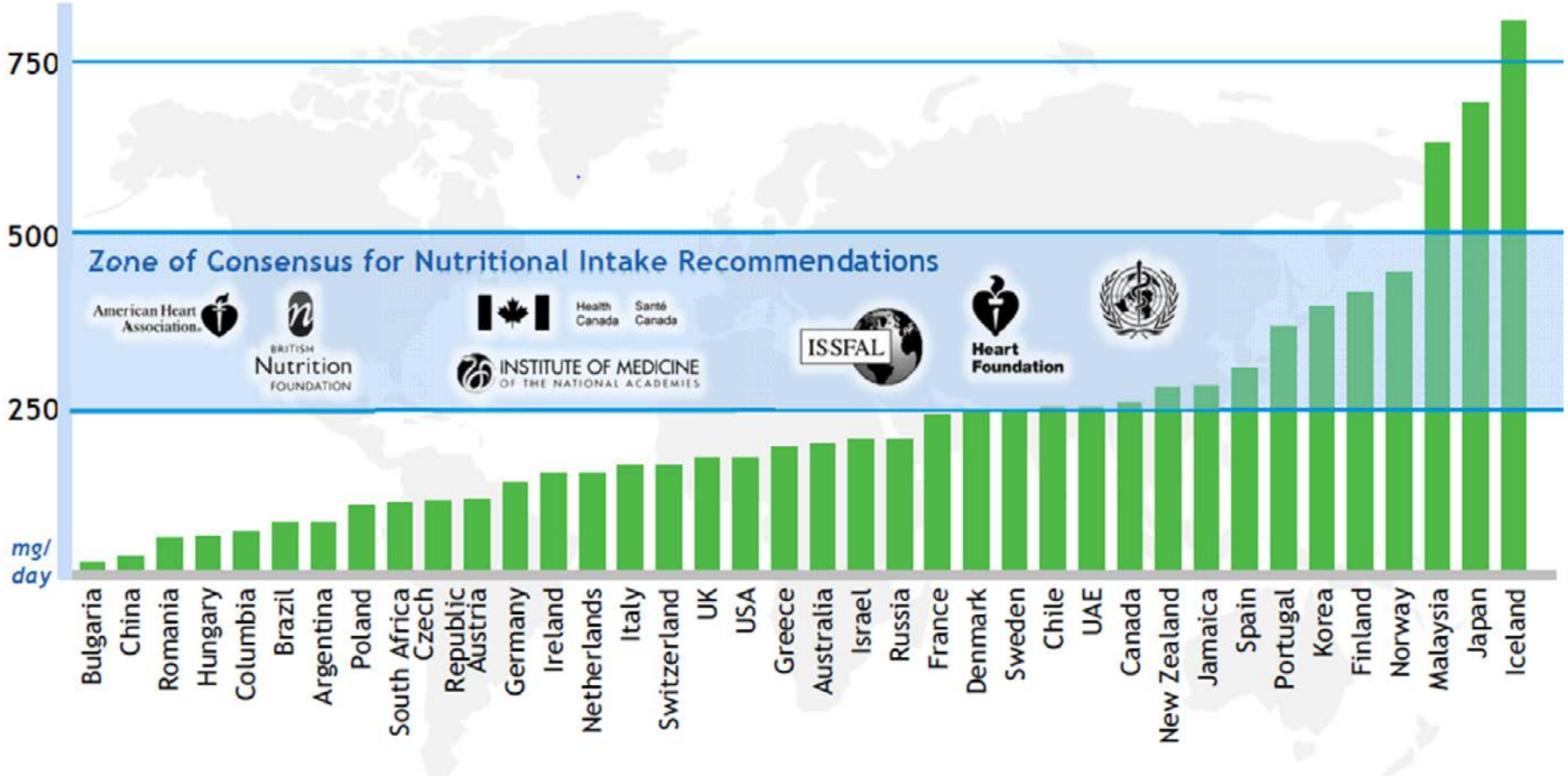


Docosahexaenoic acid (DHA)

Most people consume less than the recommended intake



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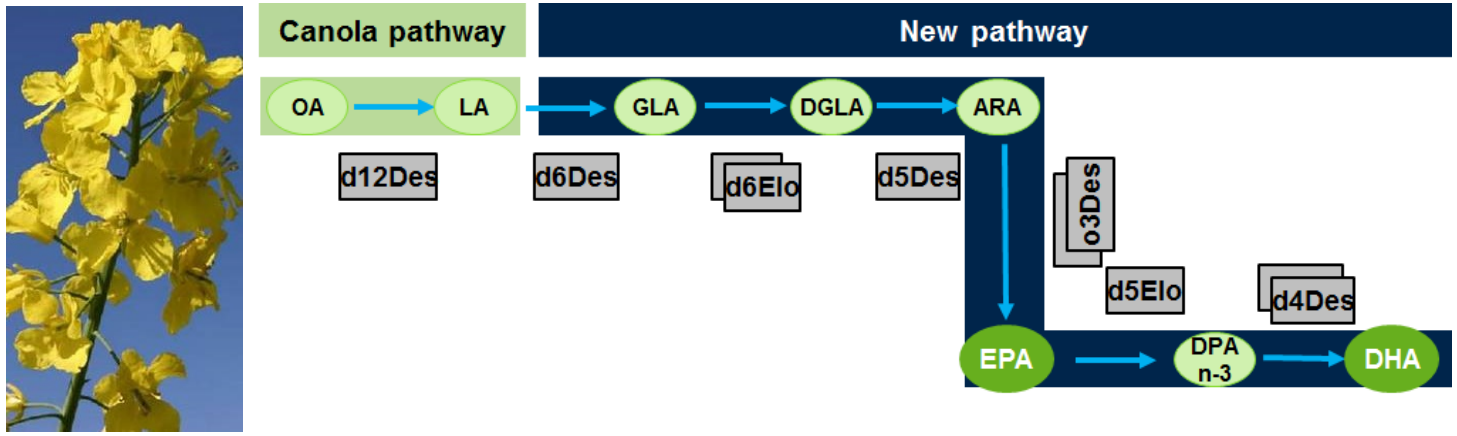
EPA+DHA Canola using Biotechnology:

A Renewable Alternative Source of Omega-3's

Marine algae are primary producers of EPA and DHA

Transfer of genes

Introduction of new biosynthetic pathway into canola to produce EPA and DHA



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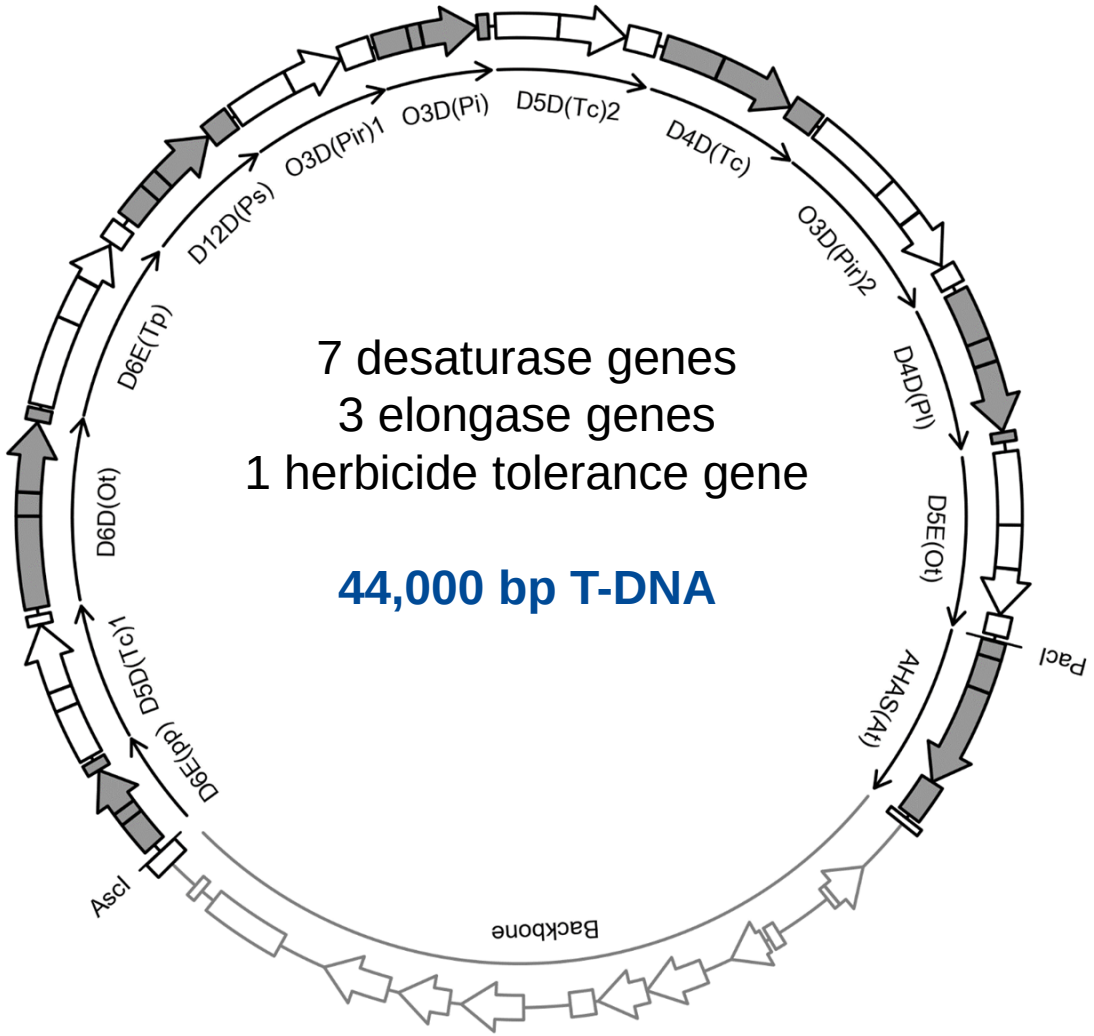
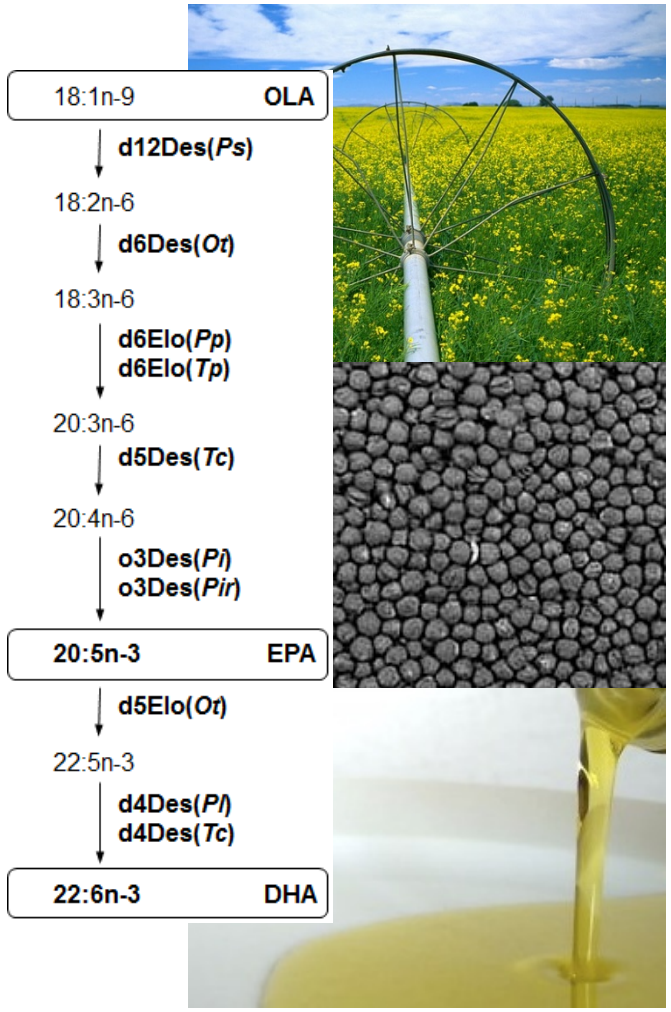
We transferred our pathway into canola to make a crop capable of producing EPA and DHA





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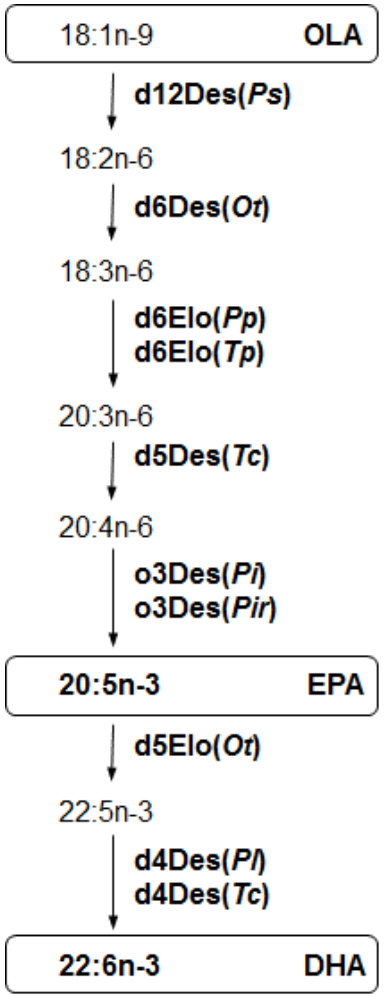
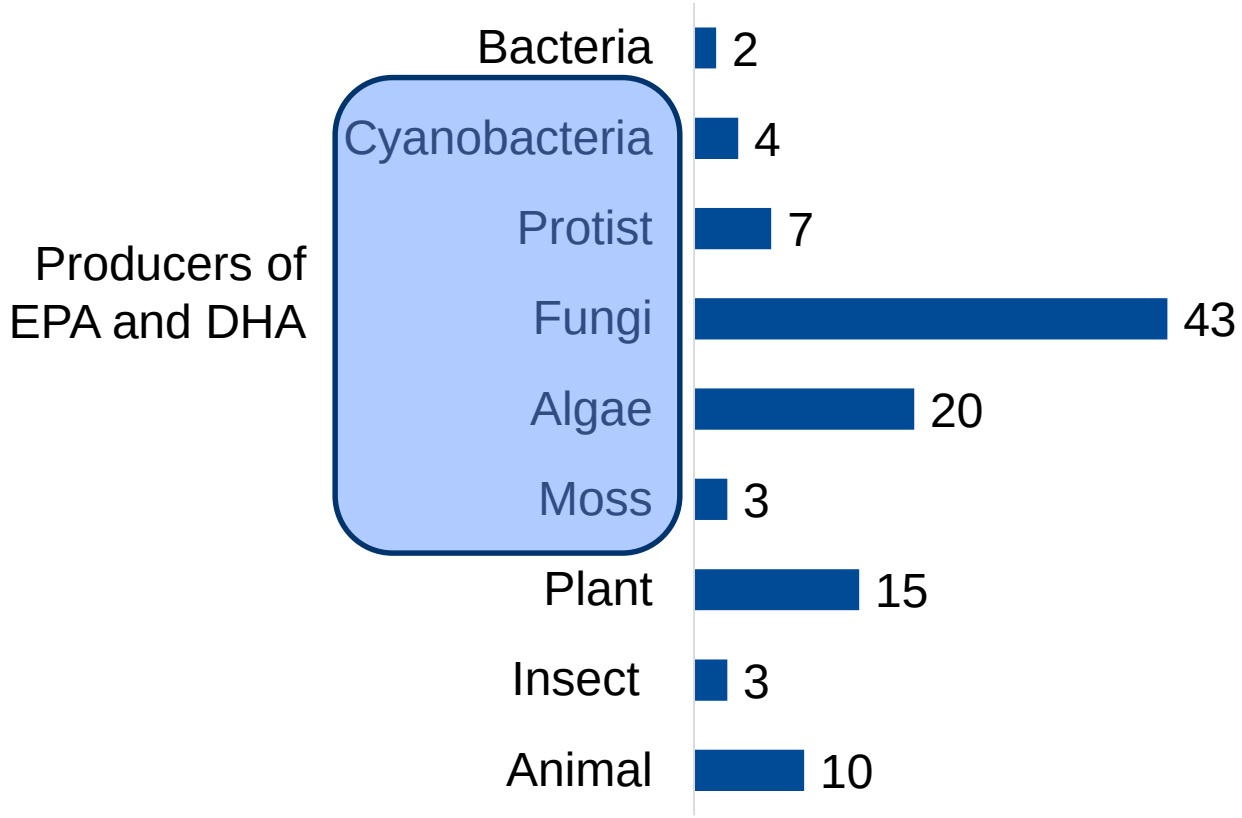
EPA+DHA Canola

Introduced 10 enzymes to convert oleic acid into EPA



Built an enzyme portfolio from >100 different organisms



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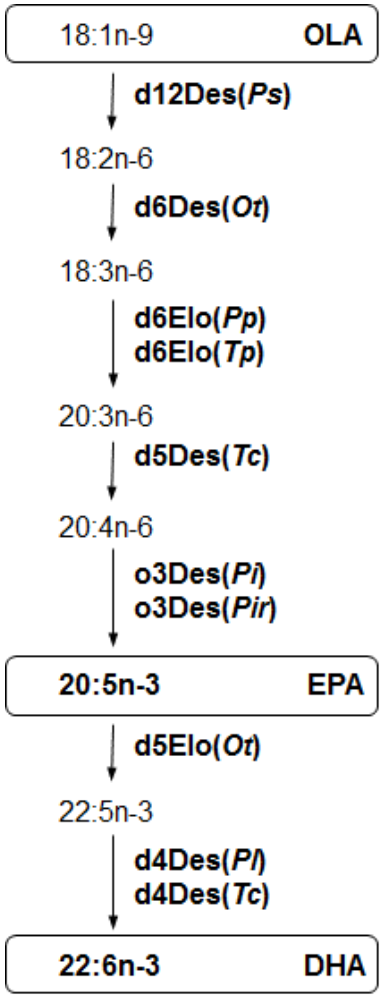
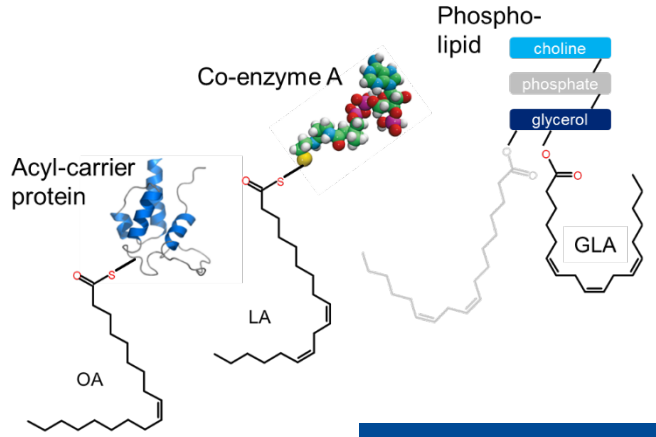


Fatty Acid Desaturase and Elongase Proteins

- 10 Integral membrane proteins
  - Desaturases (Des) and Elongases (Elo)
  - Proteins require endogenous partners
- Substrate specificity of each enzyme influences pathway output
  - Fatty acid specificity
  - Backbone specificity
    - Coenzyme A
    - Acyl Carrier Protein
    - Phospholipid



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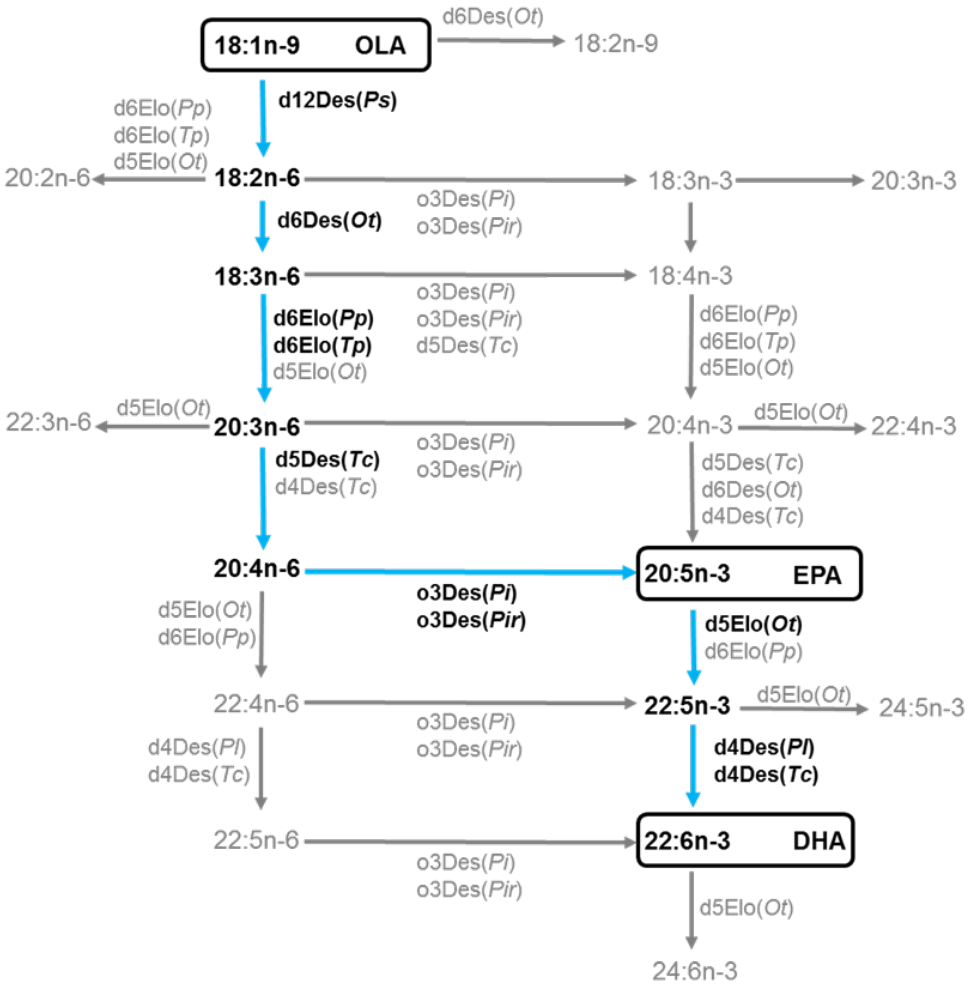
EPA+DHA Canola

The introduced pathway is a 3D network



Specificity for the Fatty Acyl Chain

EPA+DHA Canola

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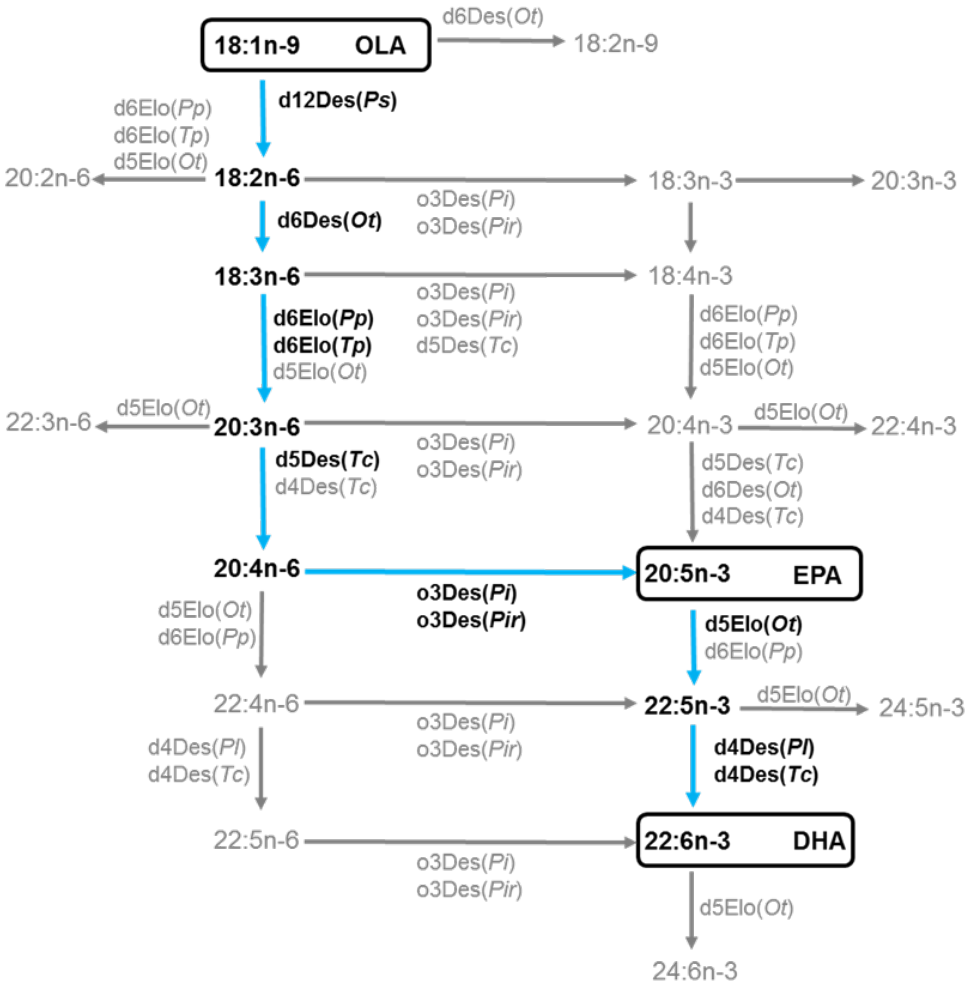
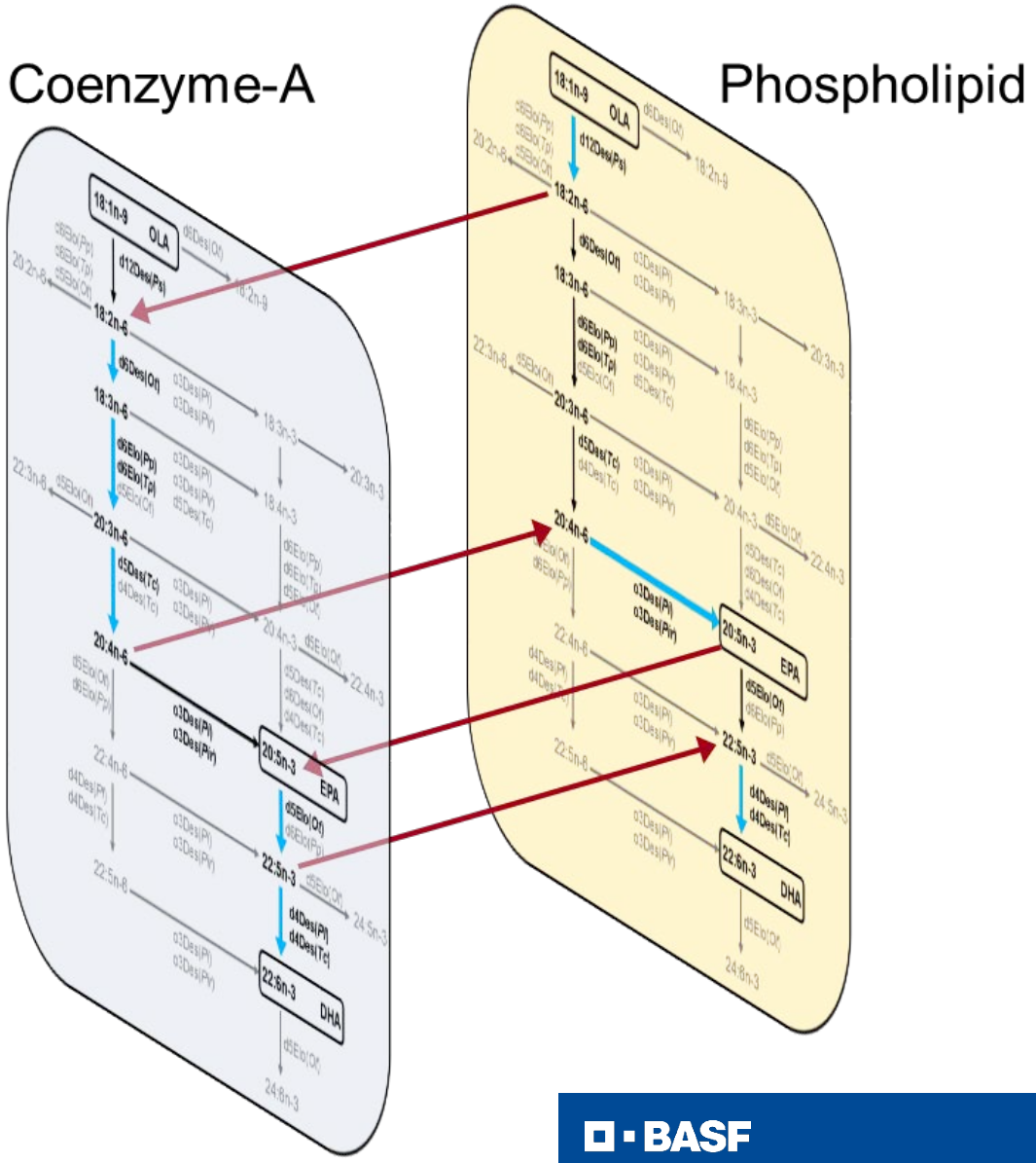


Back-bone Data



Specificity for the Fatty Acyl Chain

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We generated safety data packages (Dossiers) to show that our biotech plant is as safe as a conventionally bred plant

Molecular Characterization + **Food and Feed Safety** + **Environmental Safety** ▶ **Submission**

- Inserted DNA
- Proteins
- Genetic stability
- Detection methods

- Protein expression/safety
- Compositional equivalence
- Bioinformatics
- Exposure/intake
- Other safety studies

- Agronomic and phenotypic equivalence
- Disease and pest susceptibility
- Interaction with the environment

Regulatory Authorities Globally

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Fungal Resistant Soybean Project

Soybean rust resistant soybean

Solving a huge problem in soybean production

Non-infected Soybeans

Asian Soybean Rust

Project overview

- Soybeans provide oil and protein; worldwide >250 million tons are produced
- Soybeans are highly sensitive to Asian Soybean Rust (ASR), which can cause yield losses of up to 90%
  - Treatment plus loss valued at >$1 bn/yr in Brazil
- New tools to manage ASR are required urgently
  - Key fungicides are quickly losing efficacy as the ASR fungus develops resistance
  - Breeding efforts for strong and durable resistance have not yet been successful
- A durable solution for ASR requires the combination of two (or more) technologies
  - Combining fungicides with genetic solutions will extend the life of both tools while providing growers with a stronger, more durable solution to ASR

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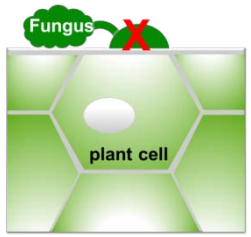
Soybean rust resistant soybean

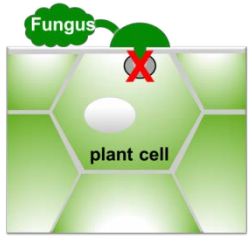
Innovation inspired by nature

Arabidopsis
Medicago
clover
tobacco

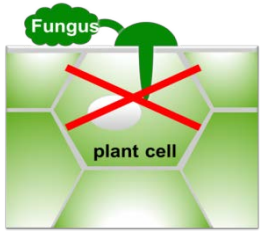
transfer of defense mechanisms



Structural barriers & antimicrobial molecules



Recognition of pathogen induces plant defense signaling



Recognition of fungal effector proteins induces local cell death

Non-Host Resistance

- Soybeans are highly susceptible to Soybean Rust
- There are plants with a natural immunity against soybean rust, like chickpeas, certain clovers, tobacco, Arabidopsis, etc.
- Non-Host Resistance strategy relies on introducing the responsible genes into soybean
- Strong and durable resistance is achieved by combining genes with different mechanisms
- Broad gene discovery to identify multiple lead genes with different mode of actions

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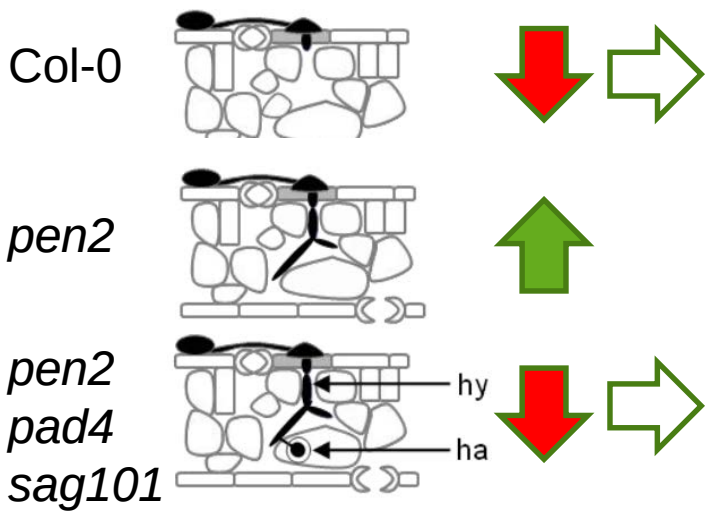
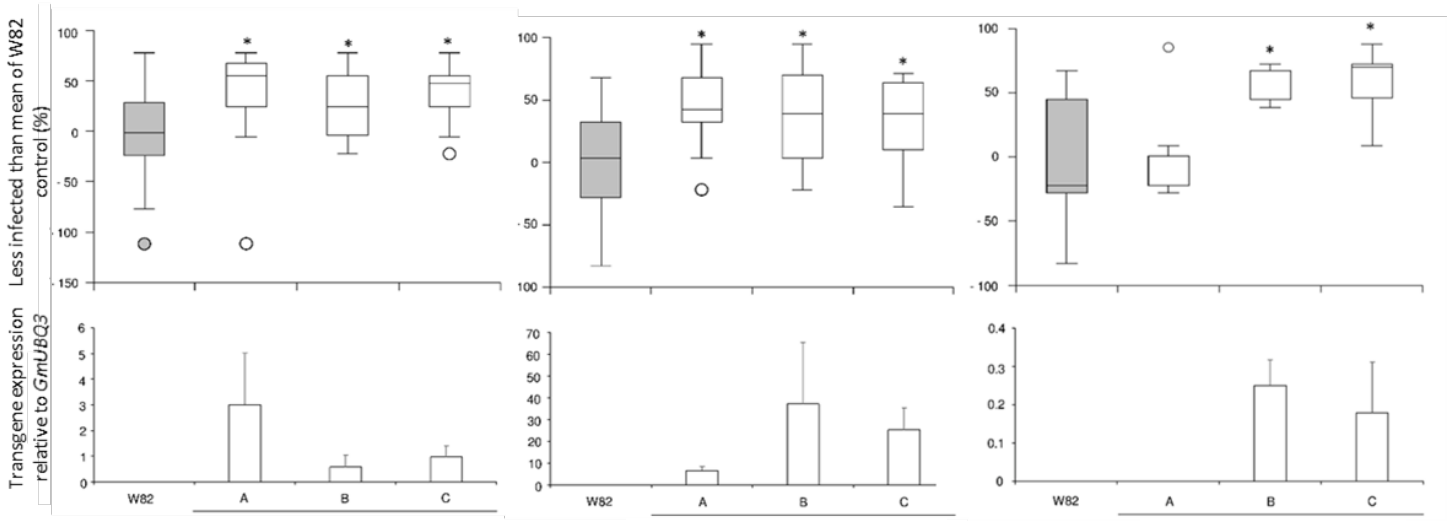
Soybean rust resistant soybean

Example: Finding the right genes

Transcriptomic analysis of Arabidopsis mutants after soybean rust infection

- Analysis of gene expression to elucidate molecular basis of mesophyll resistance of Arabidopsis pen2 plants against soybean rust fungus
- Selection of genes upregulated in pen2, but not in wild-type (Col-0) or pen2 pad4 sag101 triple mutant
- Interspecies transfer of these genes to soybean leads to increased resistance against soybean rust





Phospholipase-like protein (EARLI4-like) | GDSL lipase/hydrolase | Germin-like protein

Langenbach et al. Plant Biotechnology Journal 2016

Soybean rust resistant soybean

Best results are achieved by gene combinations

Susceptible infected soybean

Field trials, 80 days after planting
no fungicide treatment

Transgenic resistant soybean

- Discovery of multiple ASR resistance enhancing lead genes with different mode of actions (transcription factors, regulatory proteins, resistance genes, enzymes).
- Strong disease resistance and yield preservation achieved by combination of lead genes.
- Results were confirmed in 4 consecutive seasons (2016A, 2016D, 2017A, 2017D).
- Further development ongoing, aiming market introduction in next decade.

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Thanks

…to all contributors

…to all collaborators

…to you for your attention

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