

SCIENCE MEETS LIFE

Rainbow Crops

Hilde Nelissen

Maize plants are extremely suited for genetics



► ... and there is a lot of knowledge on genetic variation

Plants grow continuously



► ... and that is what interests our research team, Plant Growth Dynamics

Maize growth processes: yield and architecture: multigenic traits



Transgenic Non-transgenic



Ectopic expression of *PLASTOCHRON₁*
(GA2OX::PLA1): increased leaf and stem
biomass and seed yield

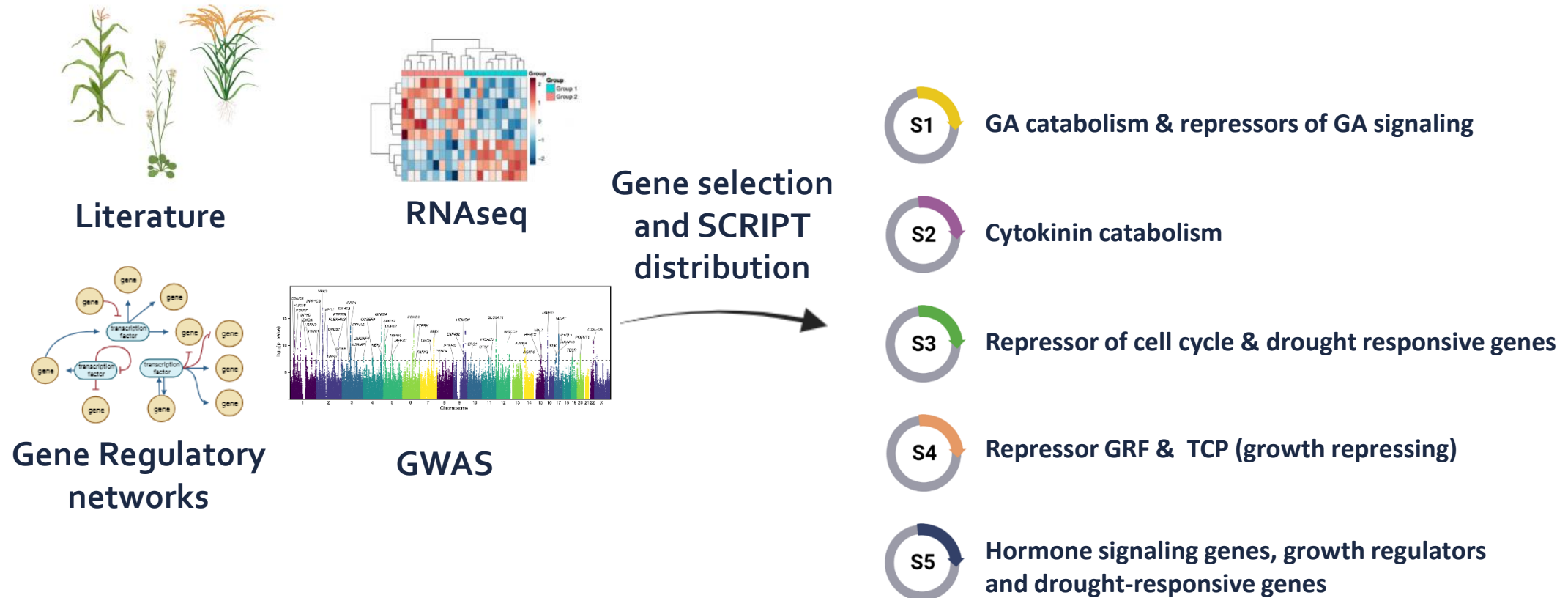


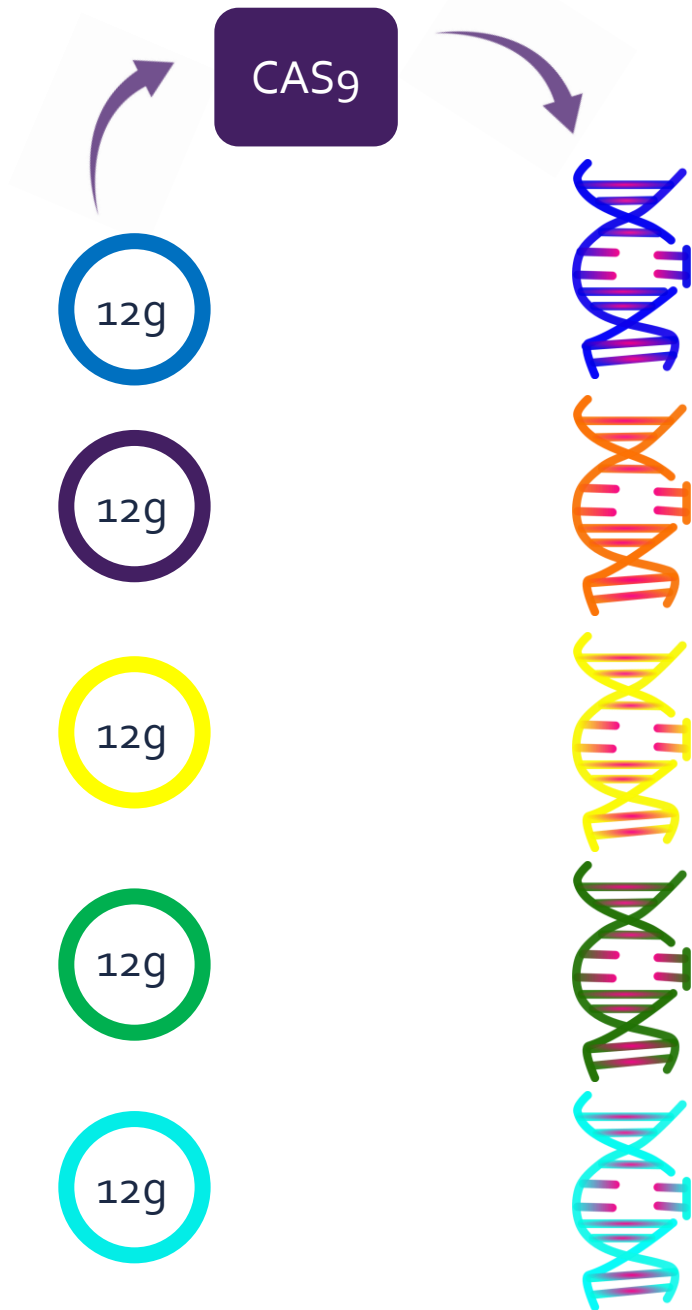
GA20- control GA
OXIDASE biosynthesis
OE mutant

BREEDIT = Breeding + editing

- ▶ Most traits (including growth) are multigenic traits: thus variations at different locations are needed
 - ▶ Redundancy
 - ▶ Gene regulatory networks
 - ▶ Linked loci
-
- ▶ Growth as an example for multiplex genome editing

Data driven gene selection of negative growth regulators





BREEDIT = Breeding + edit



S1



S2



S3



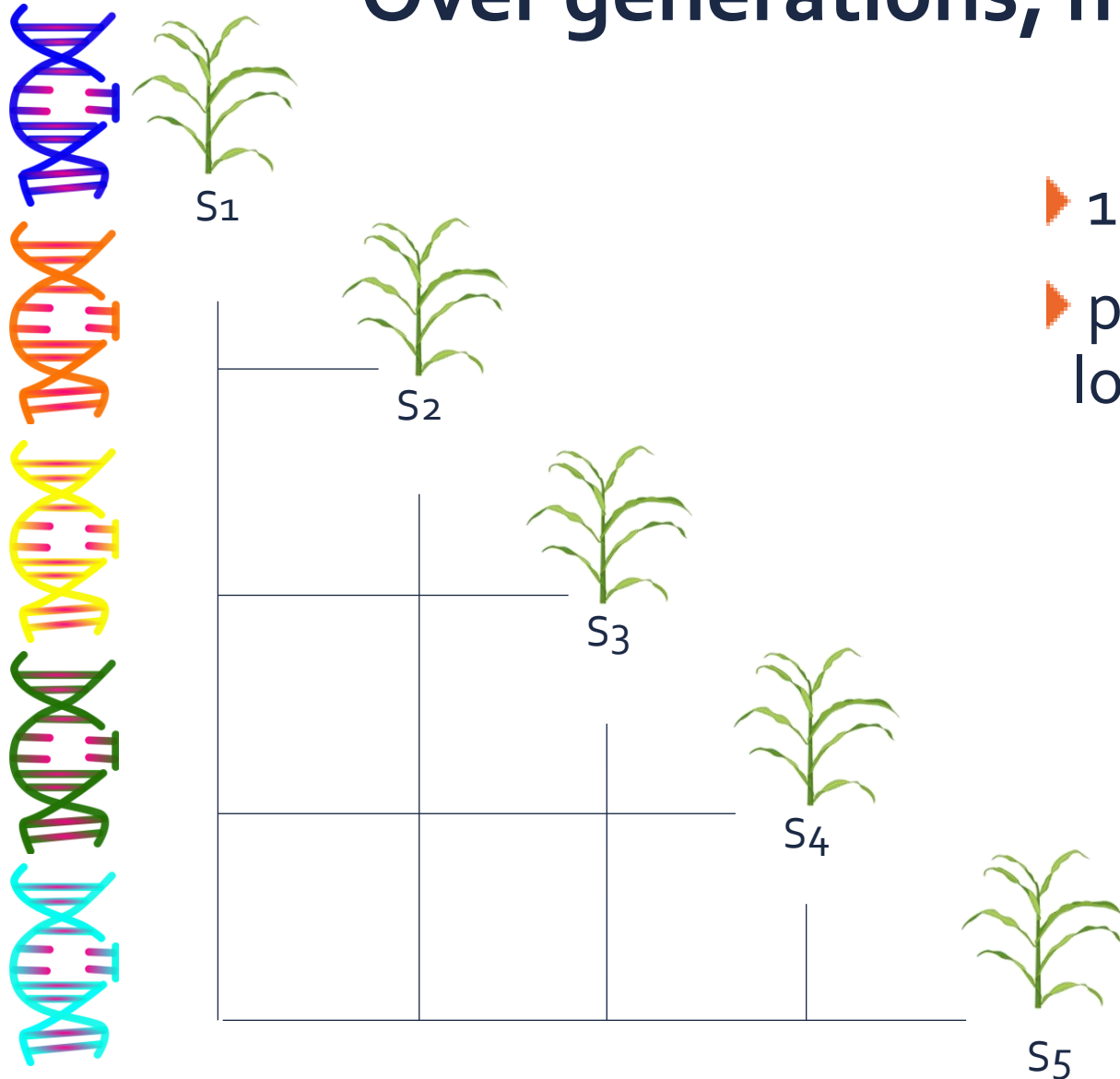
S4



S5

▶ Generation of populations in which different alleles of 12 loci segregate

Over generations, more variation



- ▶ 12, 24, 36, etc...
- ▶ populations of different alleles of 60 loci segregating

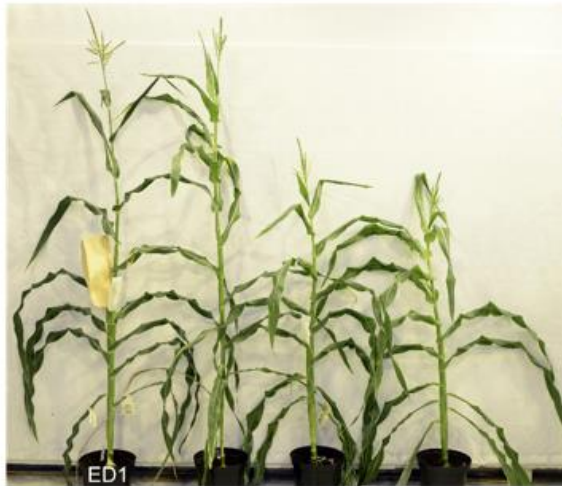


Up to 60 gene edits segregating

Expected, unexpected but interesting and undesired outcome



Increased growth



Compact plants

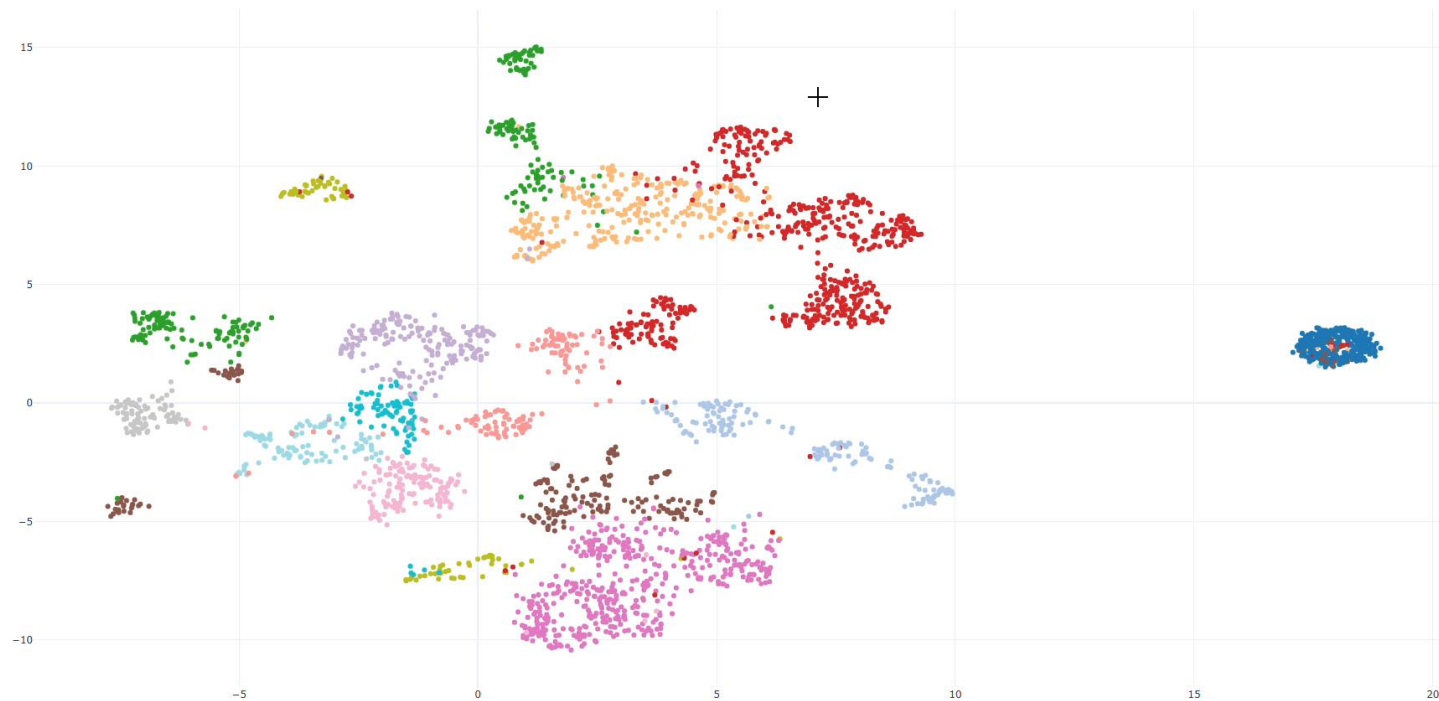


Albino plants

- ▶ The BREEDIT strategy shows which edits to combine, or which combinations are detrimental
- ▶ but how to identify the underlying edits?

Populations of individuals that are genetically unique

- ▶ All plants are phenotyped and genotyped by multiplex amplicon sequencing



A photograph of a person's silhouette in the foreground, looking up at a vast, starry night sky. The sky is filled with numerous stars of varying brightness. The person is positioned on the left side of the frame, and their head is tilted upwards. The background shows a dark, silhouetted landscape with some trees and a distant horizon line.

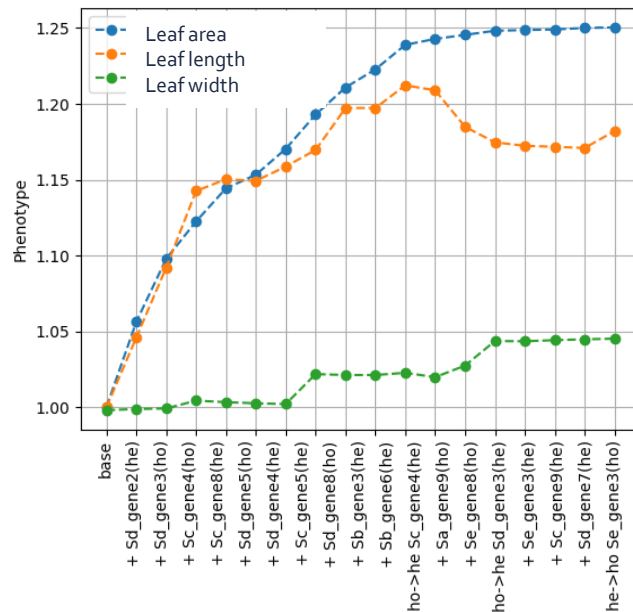
Stars in the universe

42.391.158.275.216.200.000.000.000.000 combinations

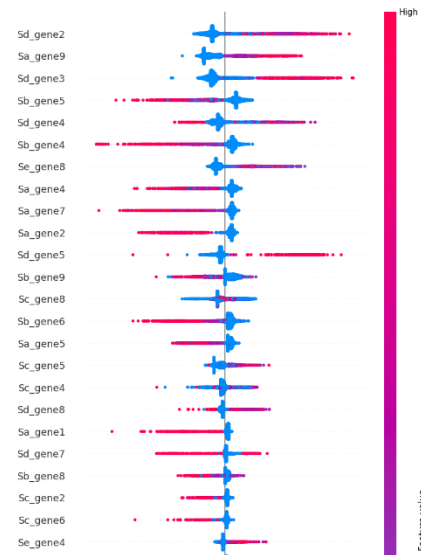
Number of people in the world

Train a model on genotype – phenotype data

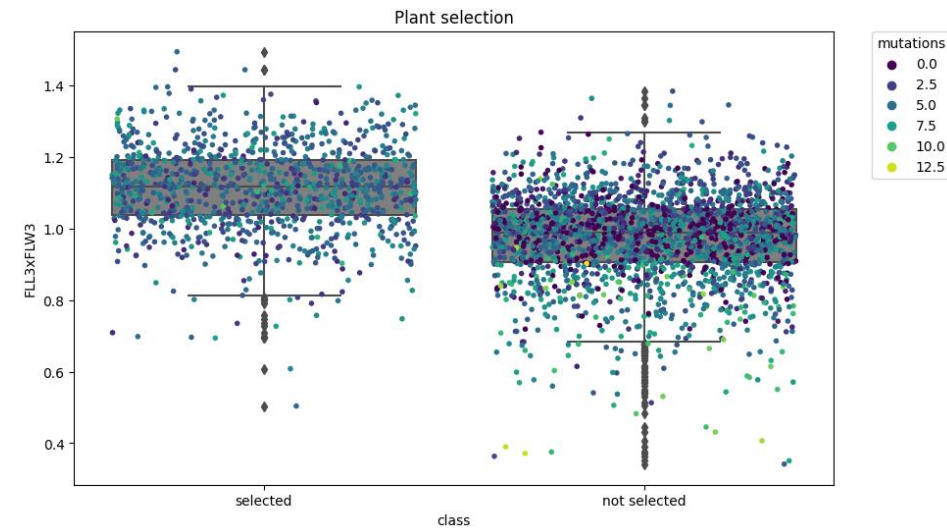
In silico trait design



AI-based **gene** selection



AI-based **plant** selection

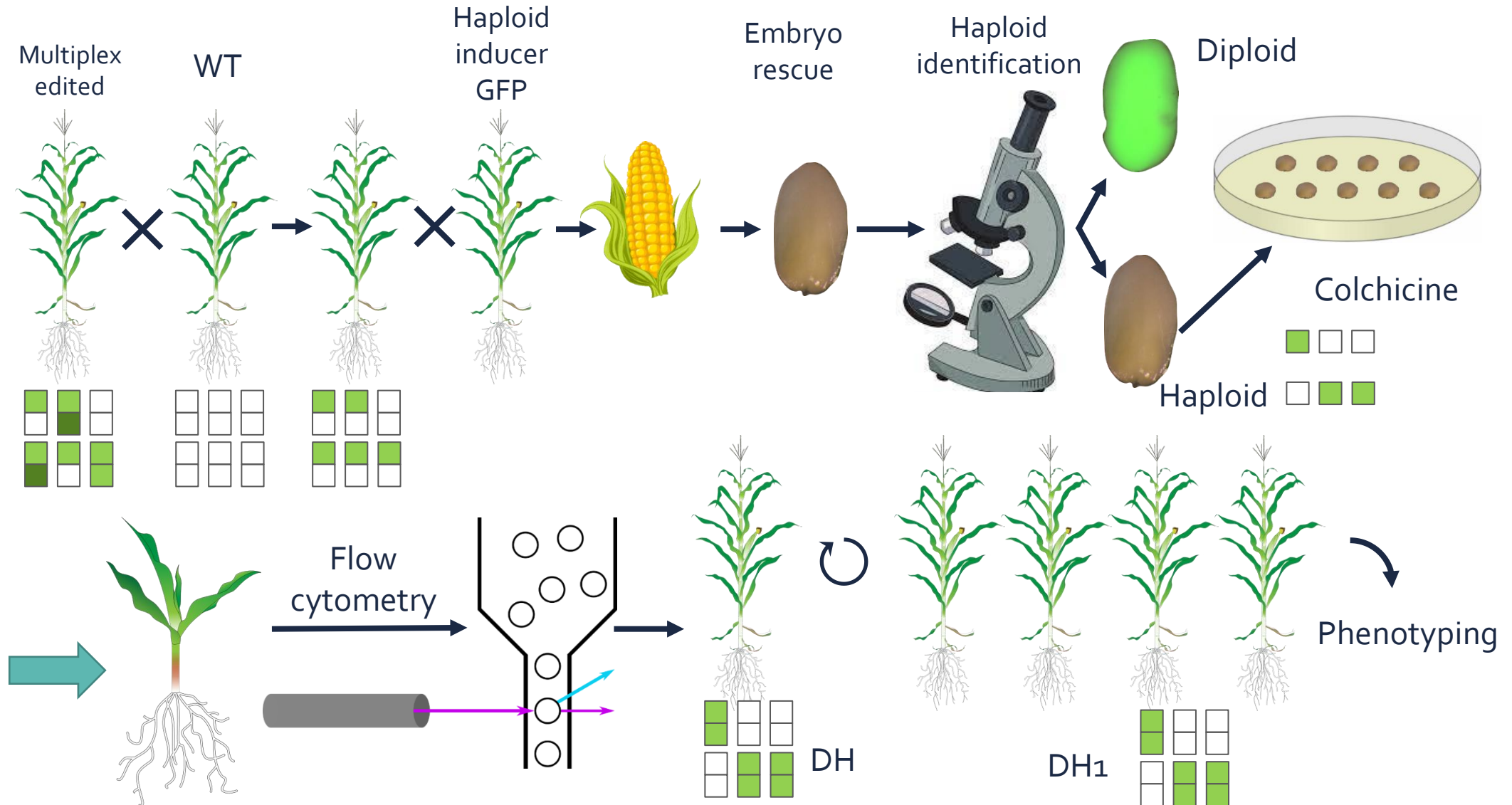


AI-based modeling predicts gene pairs

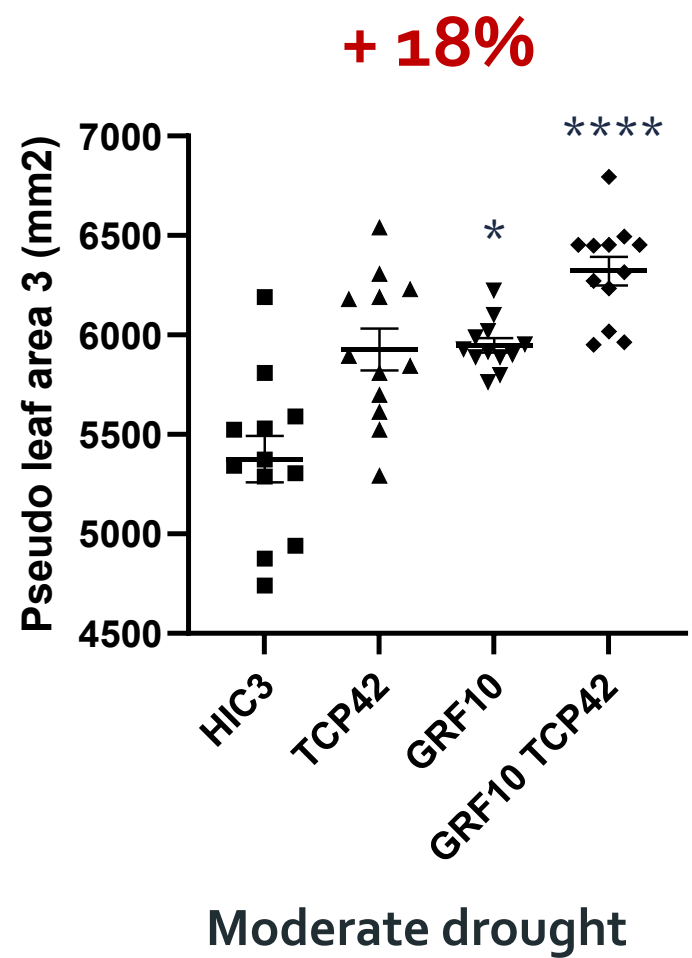
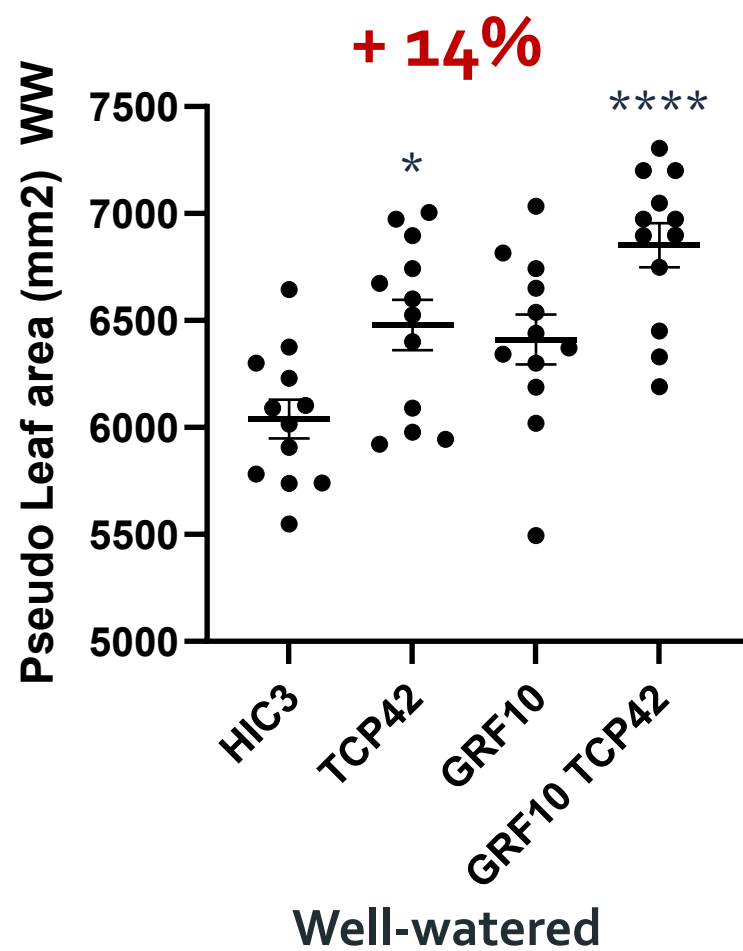


Gene pairs that are major contributors to leaf size, for example **GRF10-TCP42**

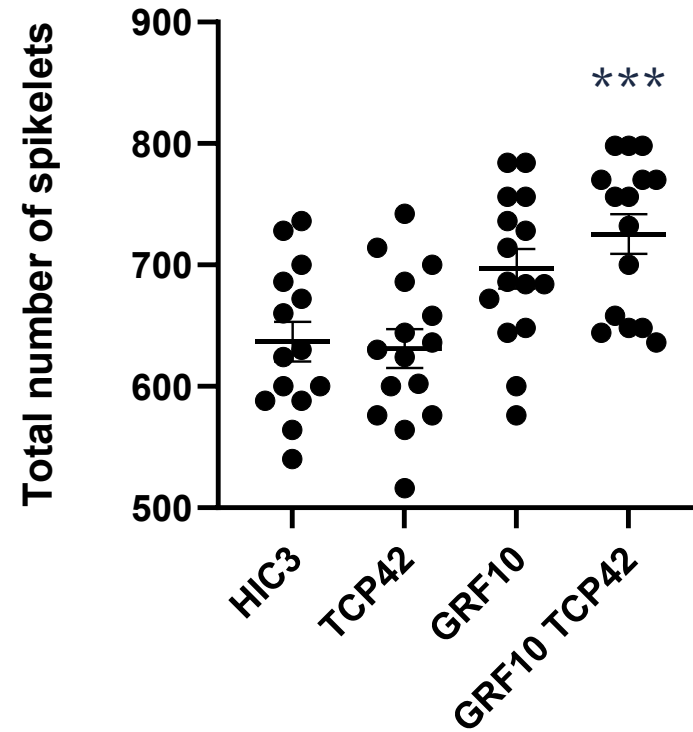
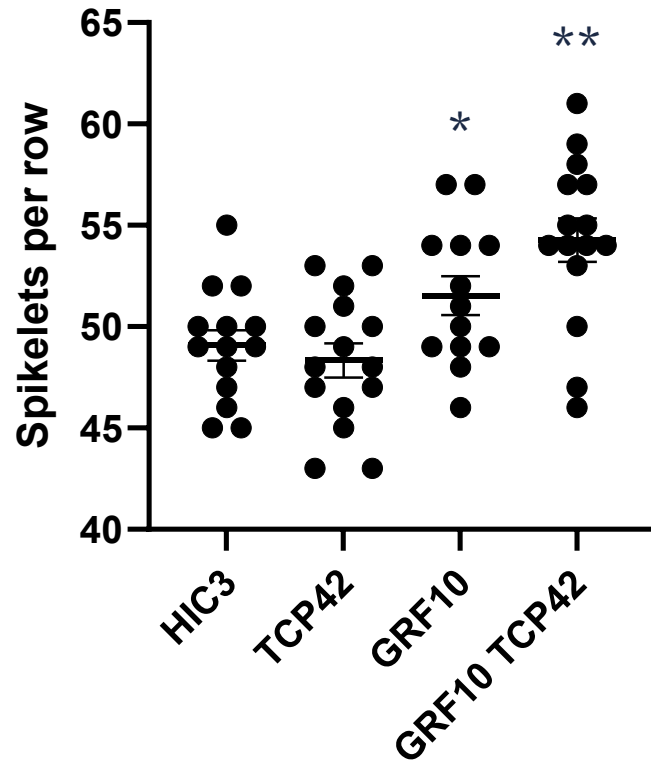
Stabilize mutations for statistical analysis



Haploid induction to fix the mutations



Mature plants with increased seed yield potential



HIC₃

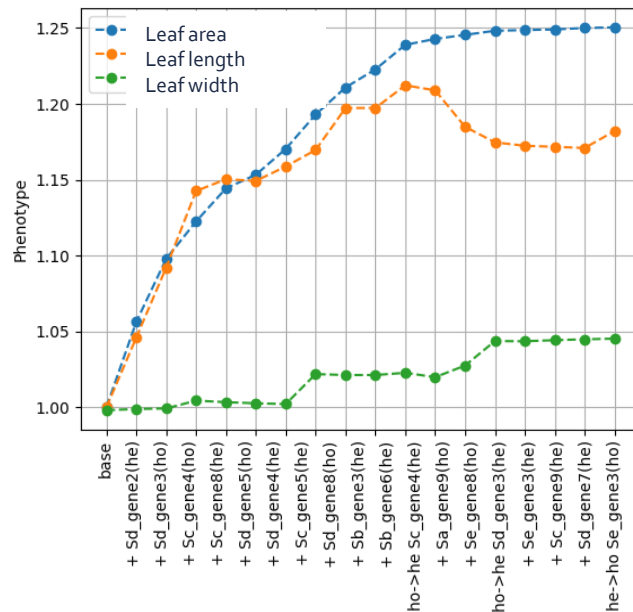
TCP₄₂

GRF₁₀

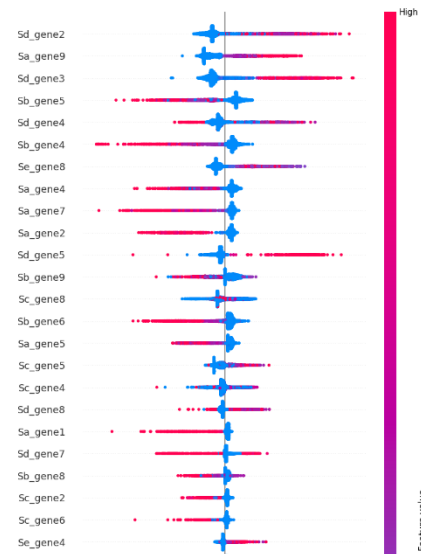
GRF₁₀
TCP₄₂

Train a model on genotype – phenotype data

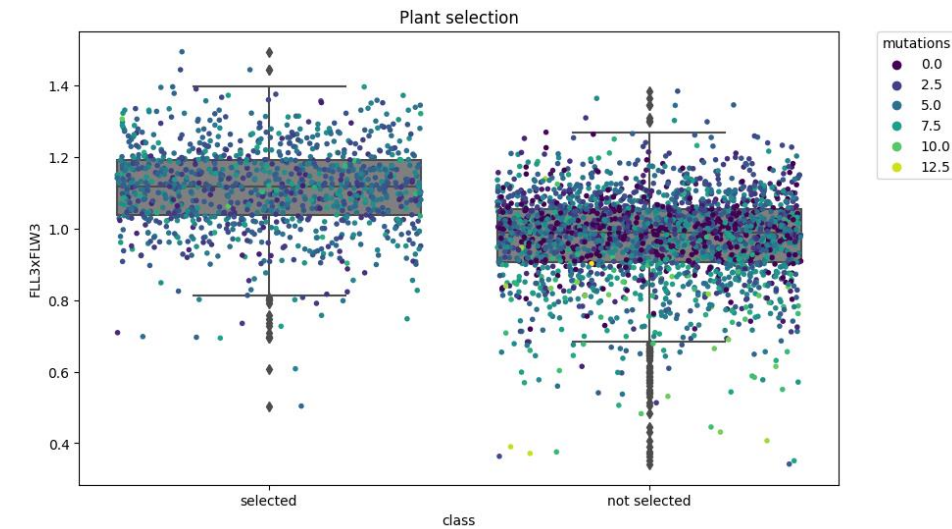
In silico trait design



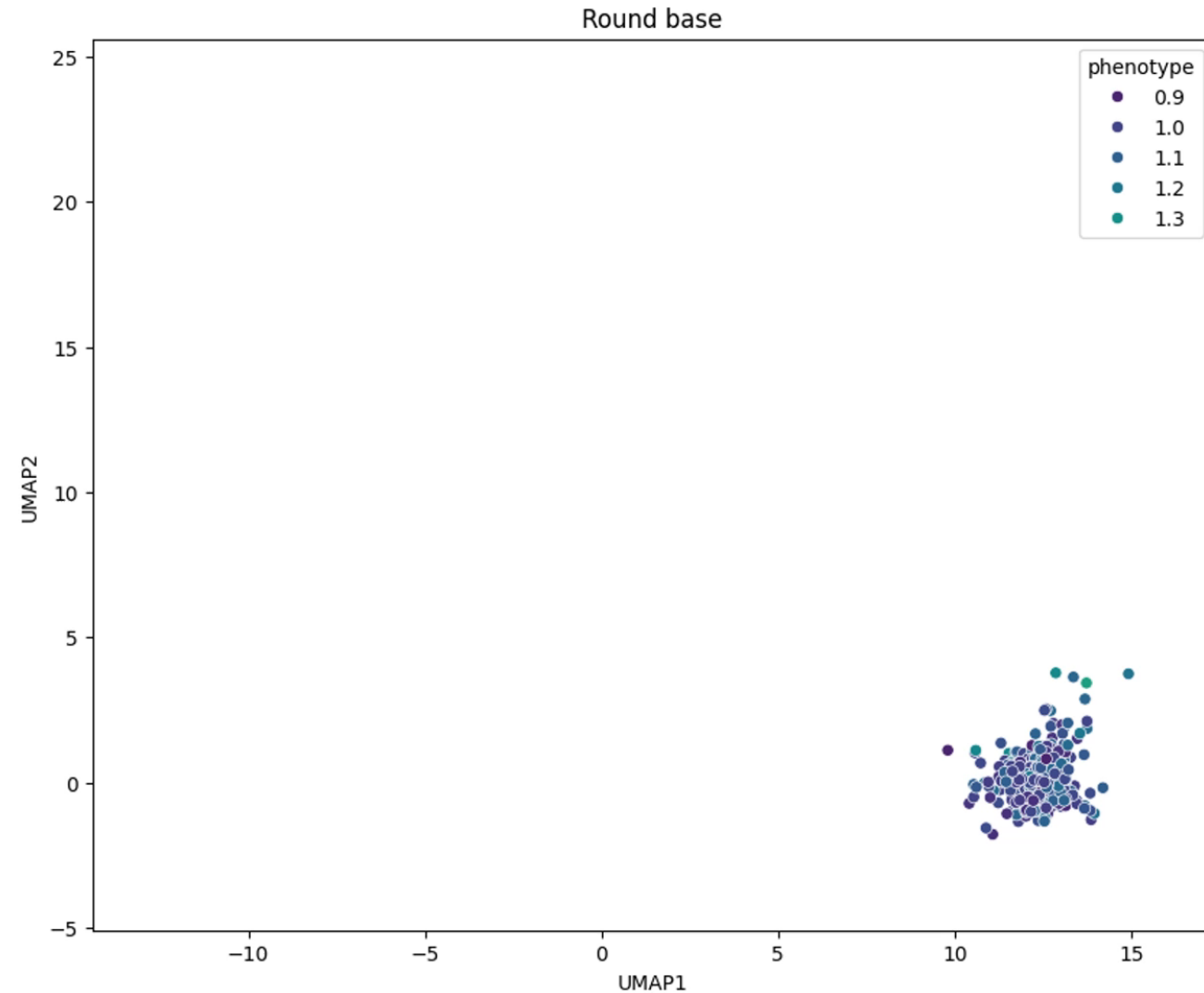
AI-based **gene** selection



AI-based **plant** selection

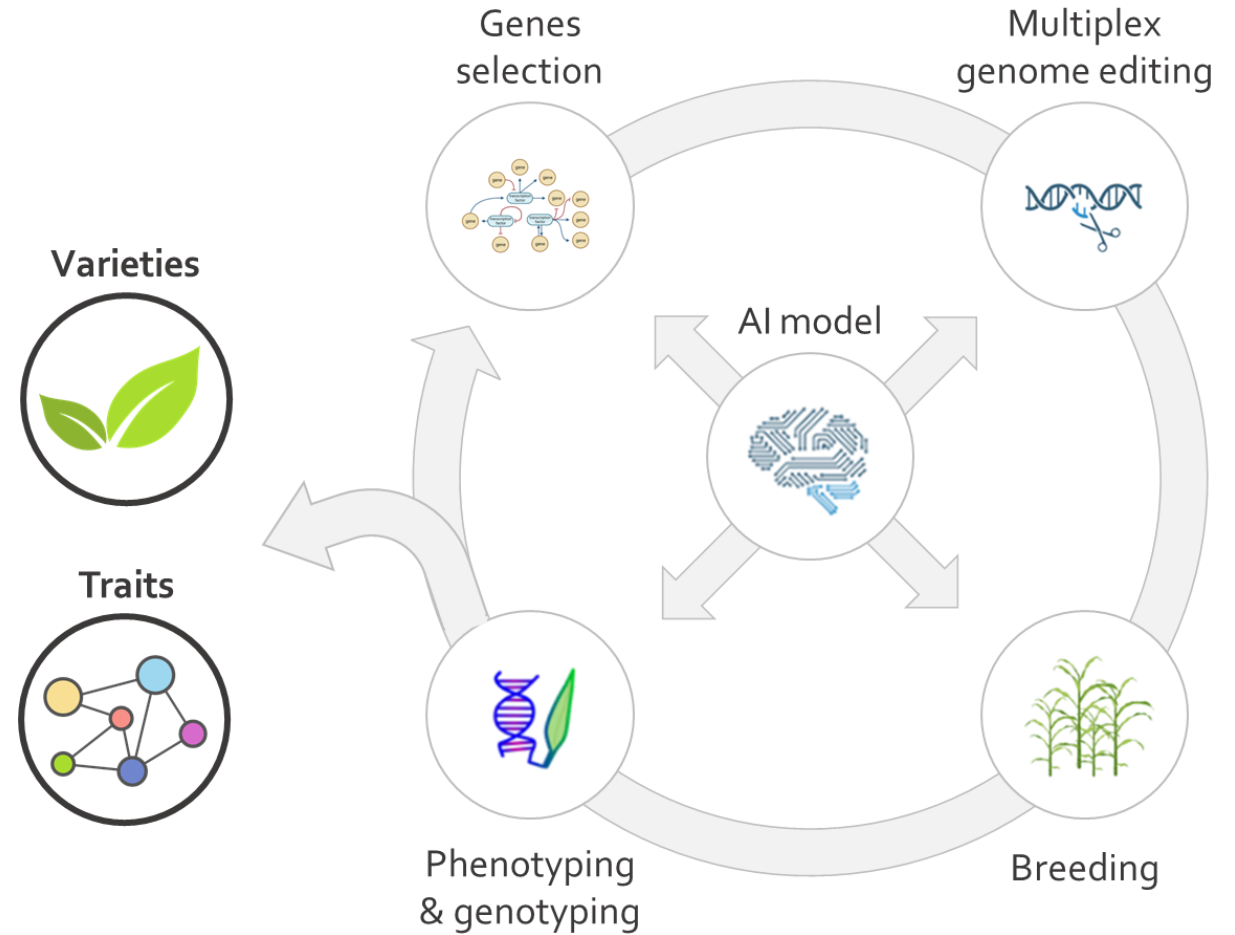


From exploratory to exploitation: AI-guided breeding



From fundamental research to spin-off

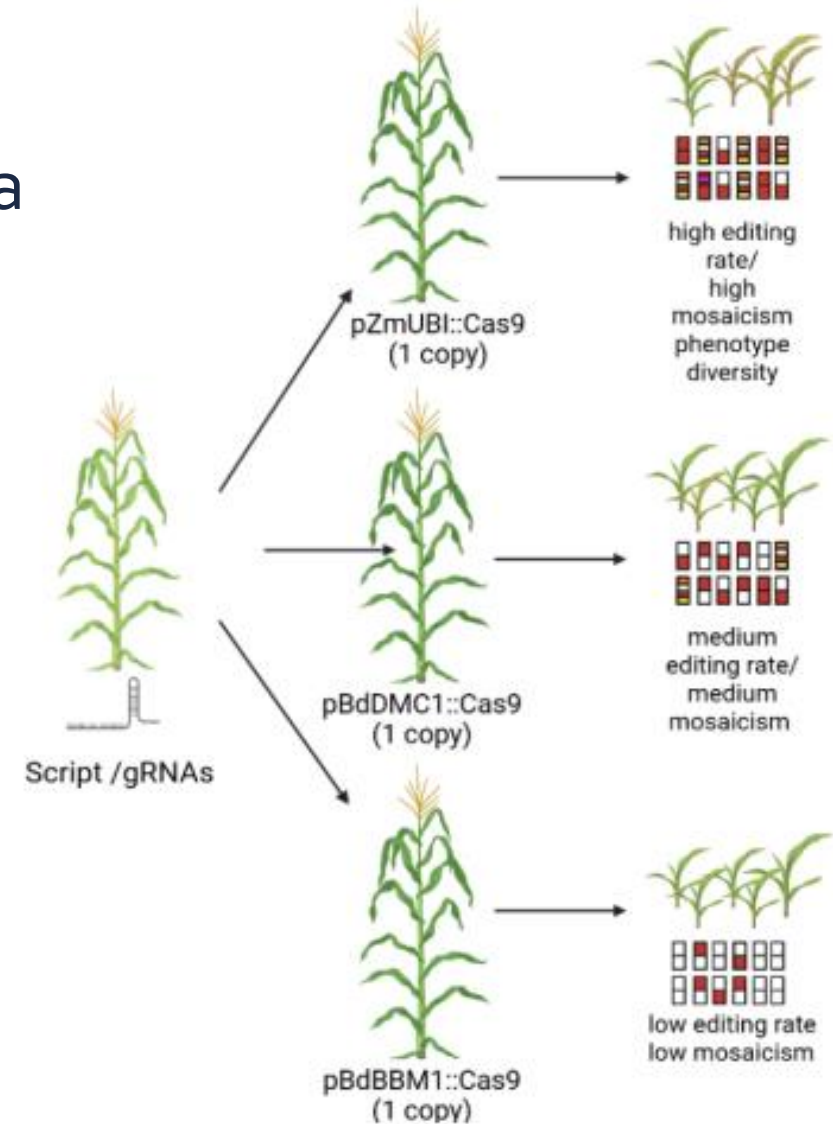
- ▶ Strong support from VIB Innovation&Business and New Venture teams
- ▶ Initial round of funding: launch in April 2025
- ▶ CEO: Giacomo Bastianelli
- ▶ “Engineering complex traits to develop resilient crops”



RAINBOW CROPS

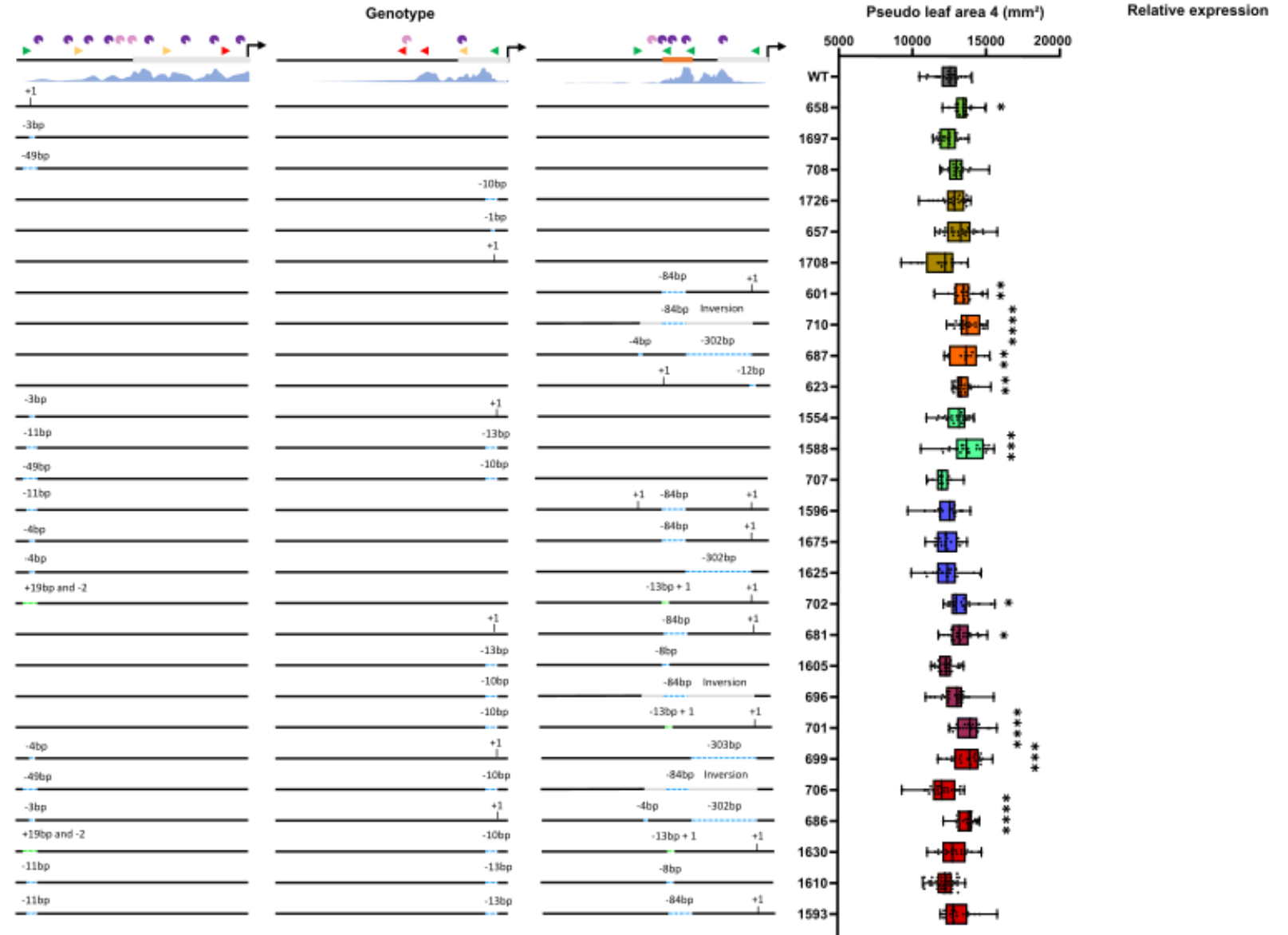
Continued developments

- ▶ Select different nucleases: Cas9 and Cas12a
- ▶ Drive expression of the nucleases by different promoters
- ▶ Target regulatory sequences



Continued developments

- ▶ Editing of regulatory sequences
- ▶ Finetuned expression instead of constitutive knock-out
- ▶ (semi-)dominant



Acknowledgements



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Tom
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Agro-Incubator



Plant growth dynamics group



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