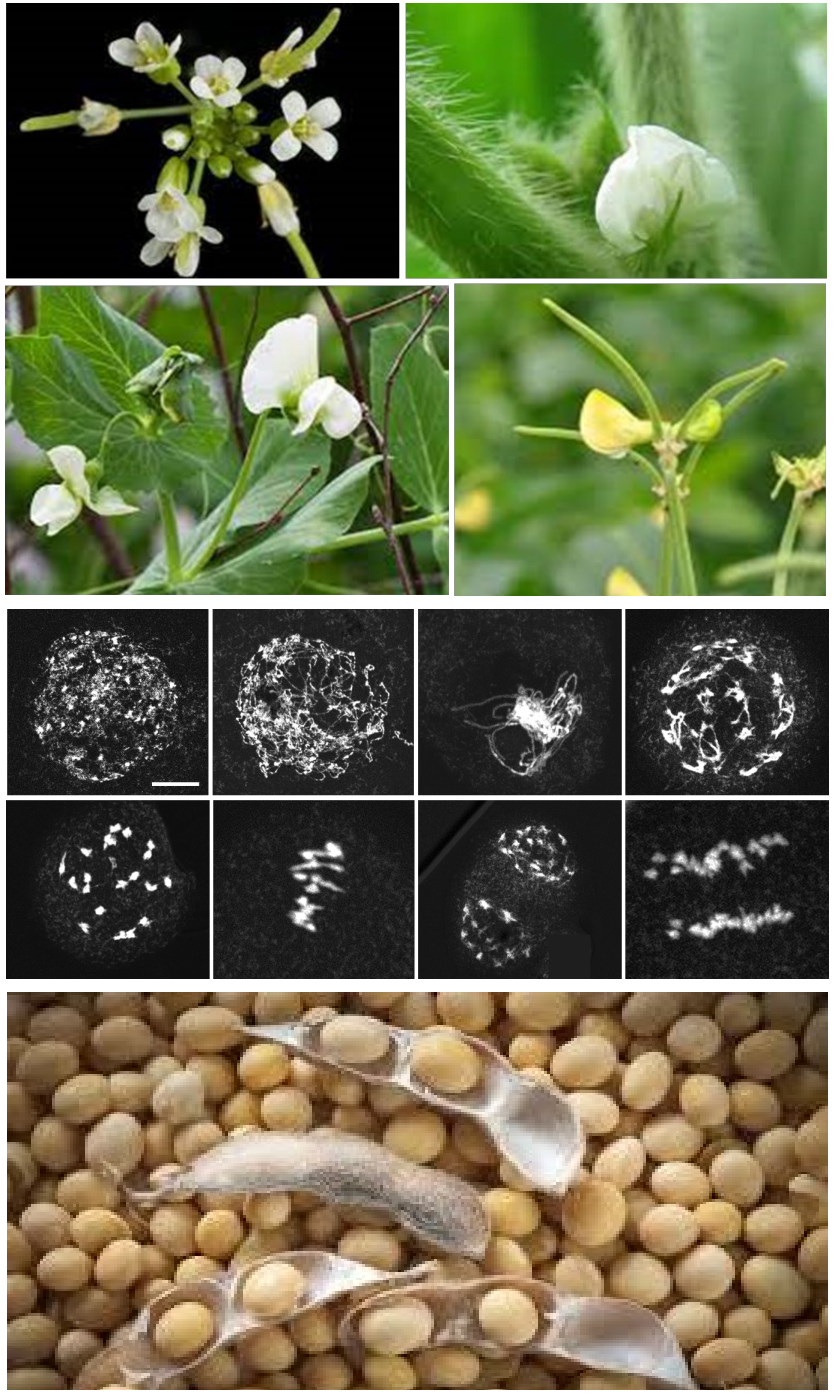


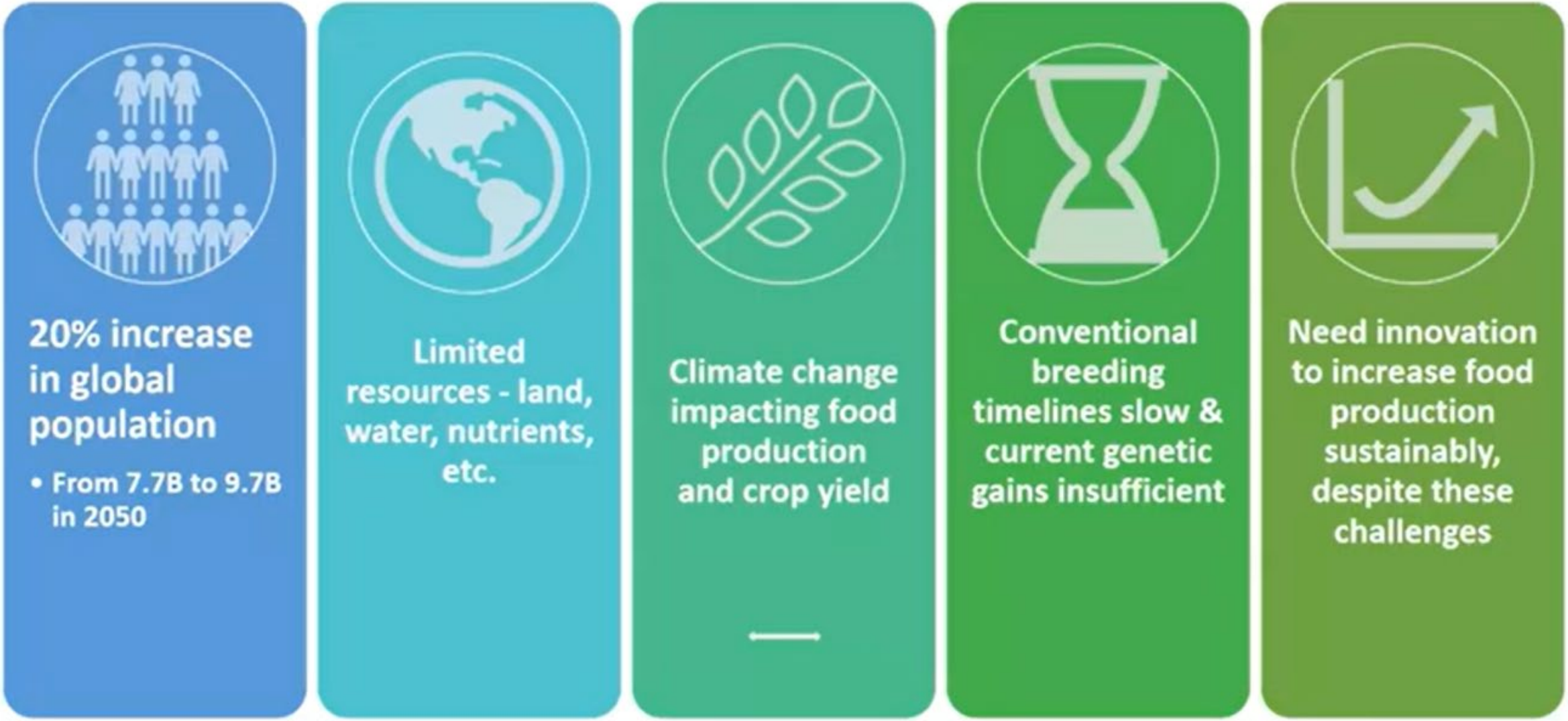
Crop Breeding Technologies: Advances and Challenges

Natasha Yelina

September 26th, 2024
AFCP Webinar: Novel Crop Breeding Technologies

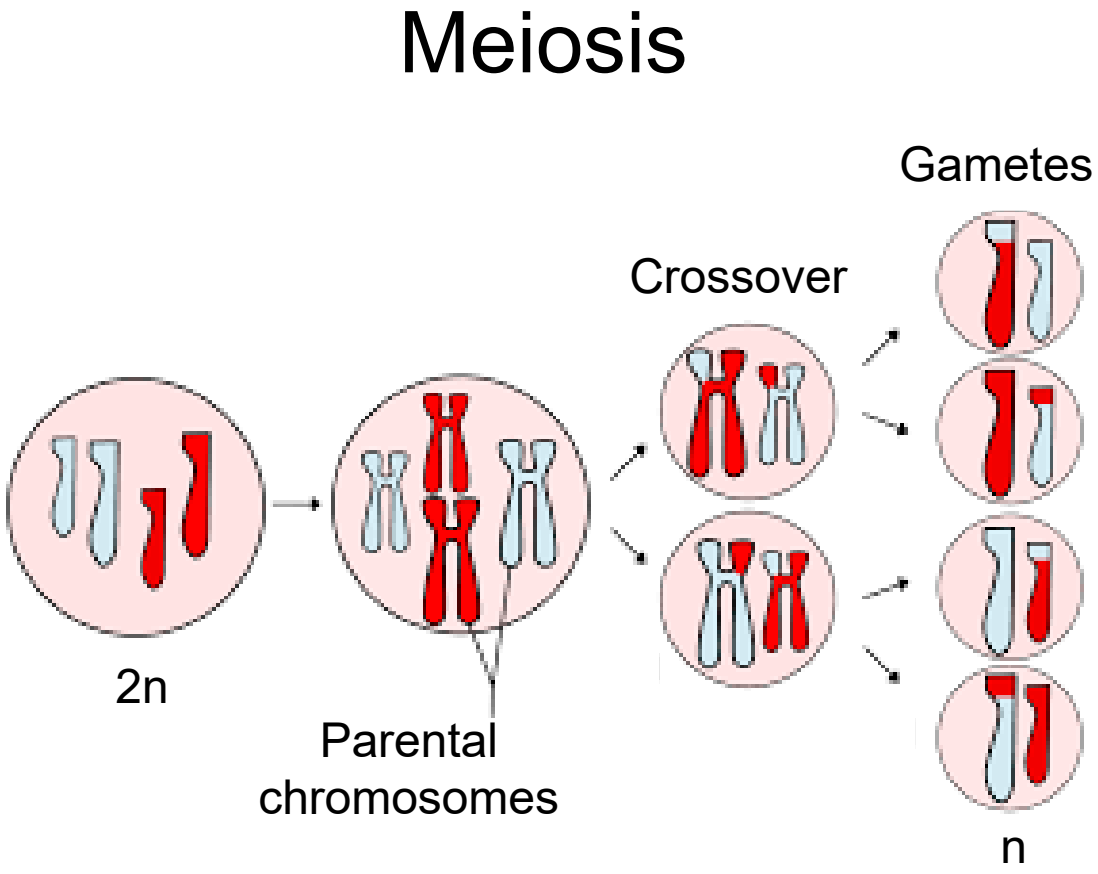
UNIVERSITY OF CAMBRIDGE
CROP SCIENCE CENTRE

Challenges to Feeding the World

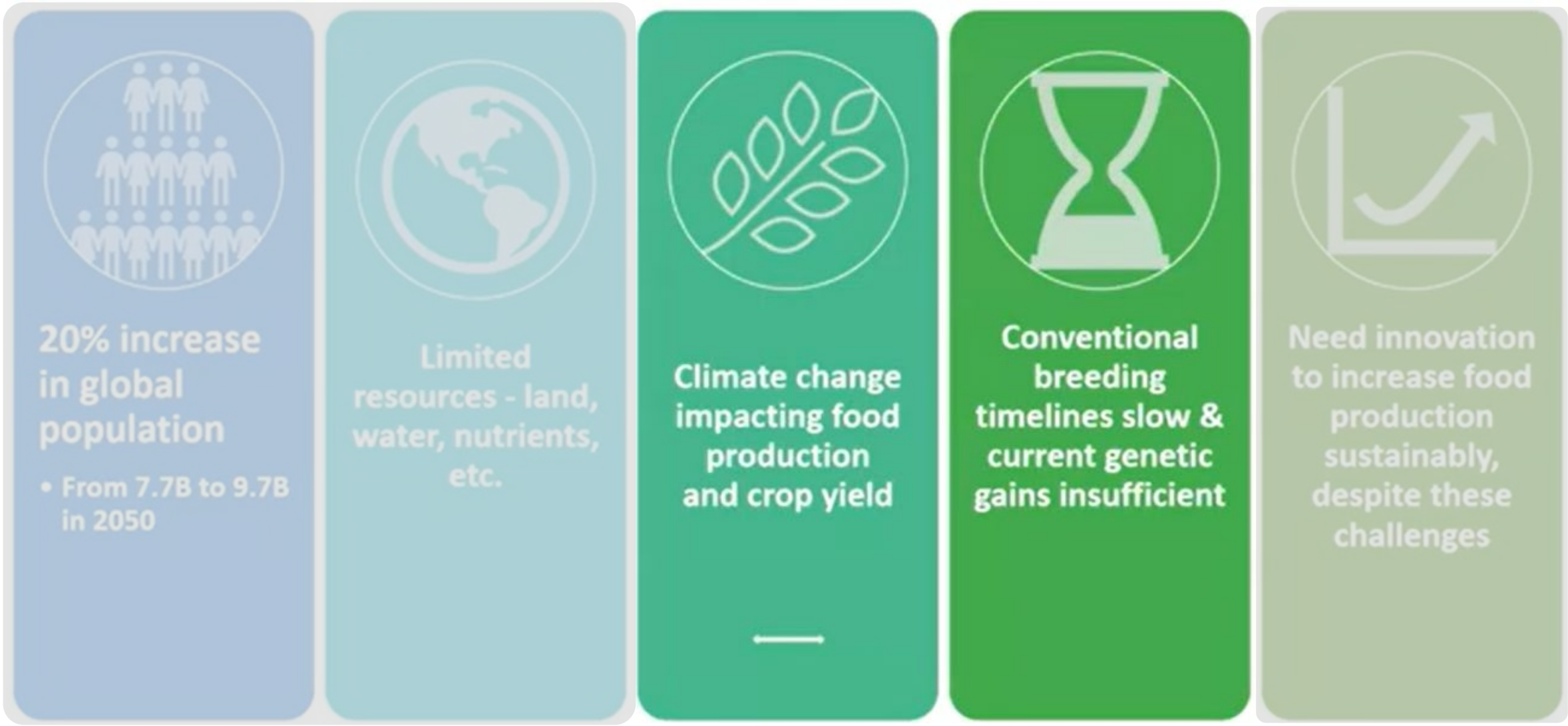


Source: Global Institute of Food Security

Meiosis Underpins Reproduction and Breeding

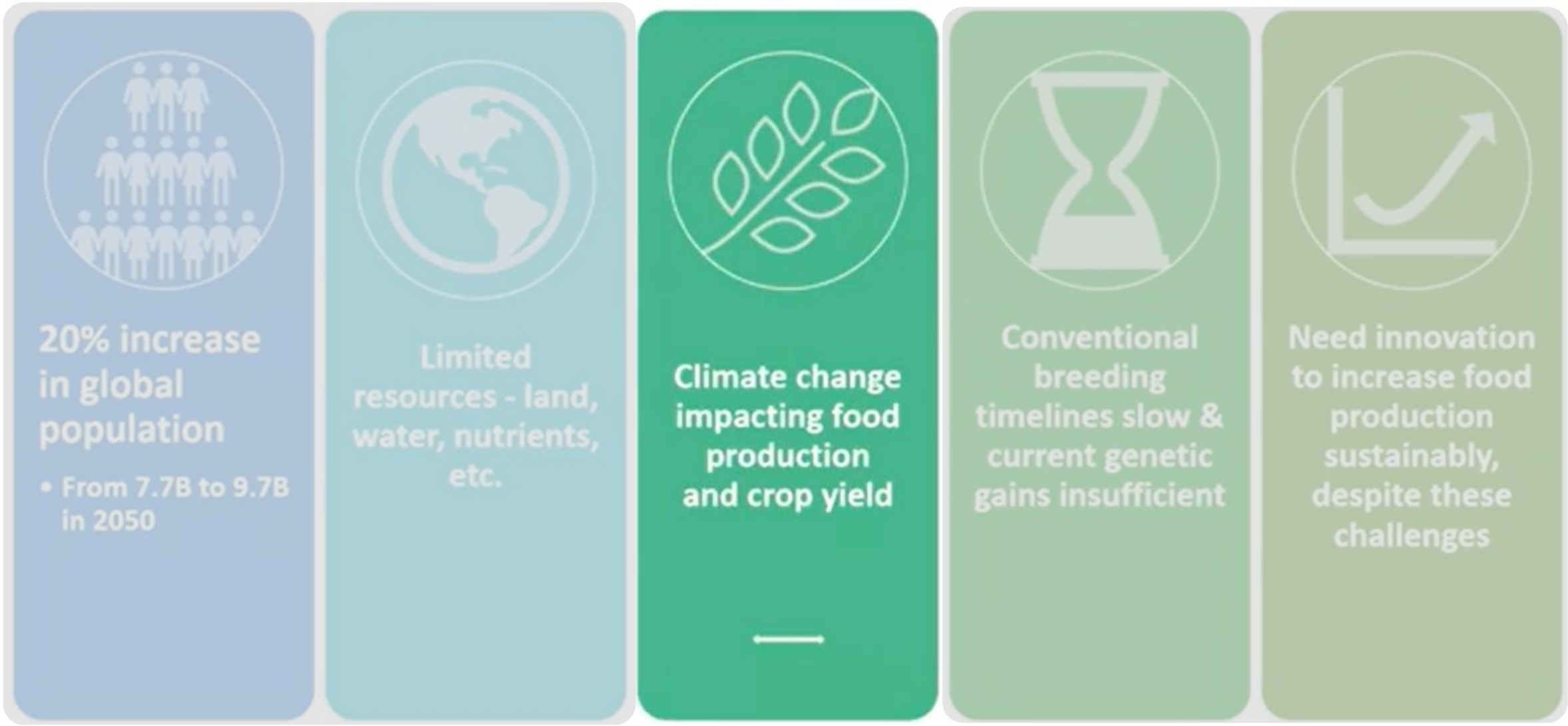


Challenges to Feeding the World



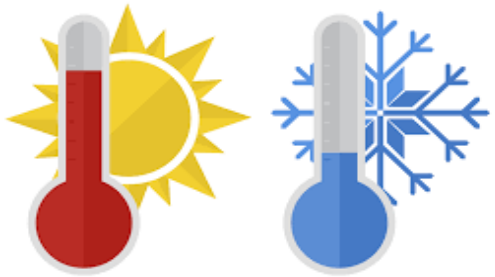
Source: Global Institute of Food Security

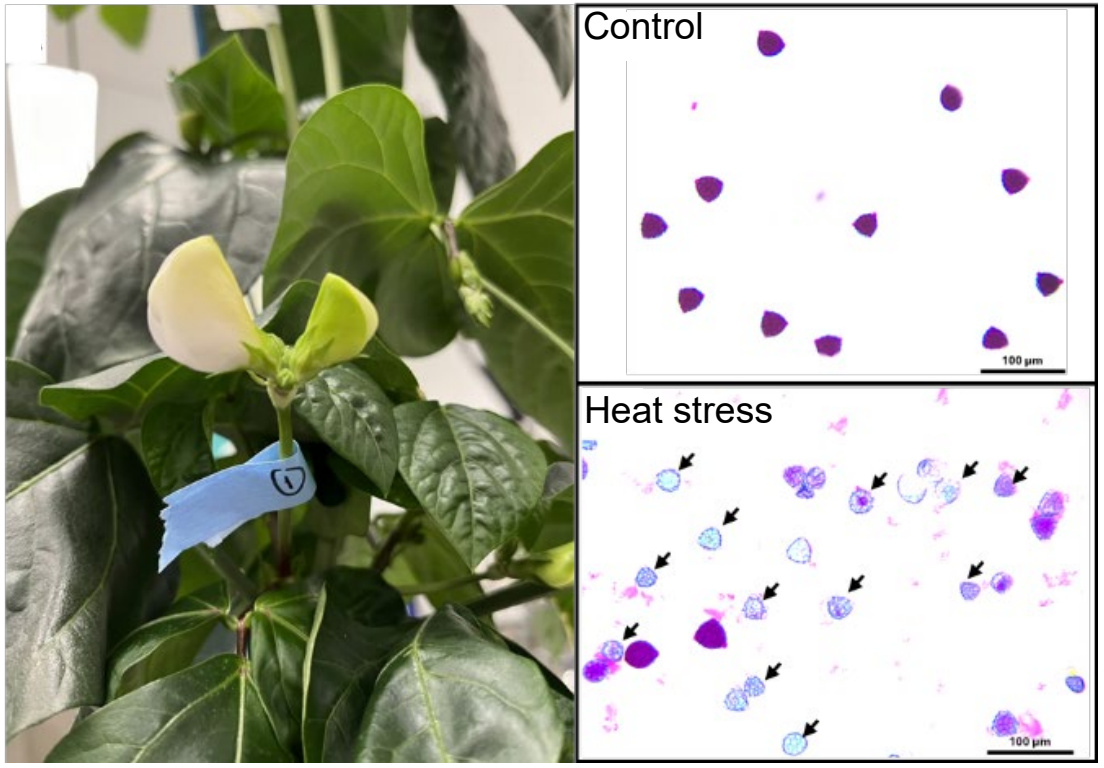
Challenges to Feeding the World



Source: Global Institute of Food Security

Aim I: Resilience to Reproductive Temperature Stress





Credit: Dr Lovely Lawas, Yelina lab

Chickpea

Pea

Cowpea

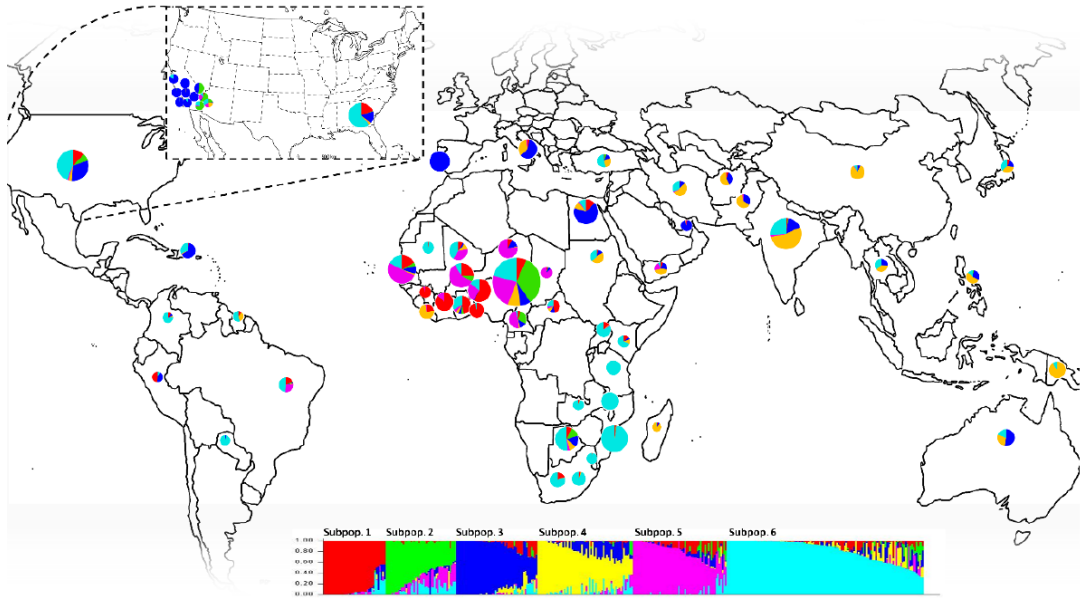
Rice

Barley

Wheat

Tomato

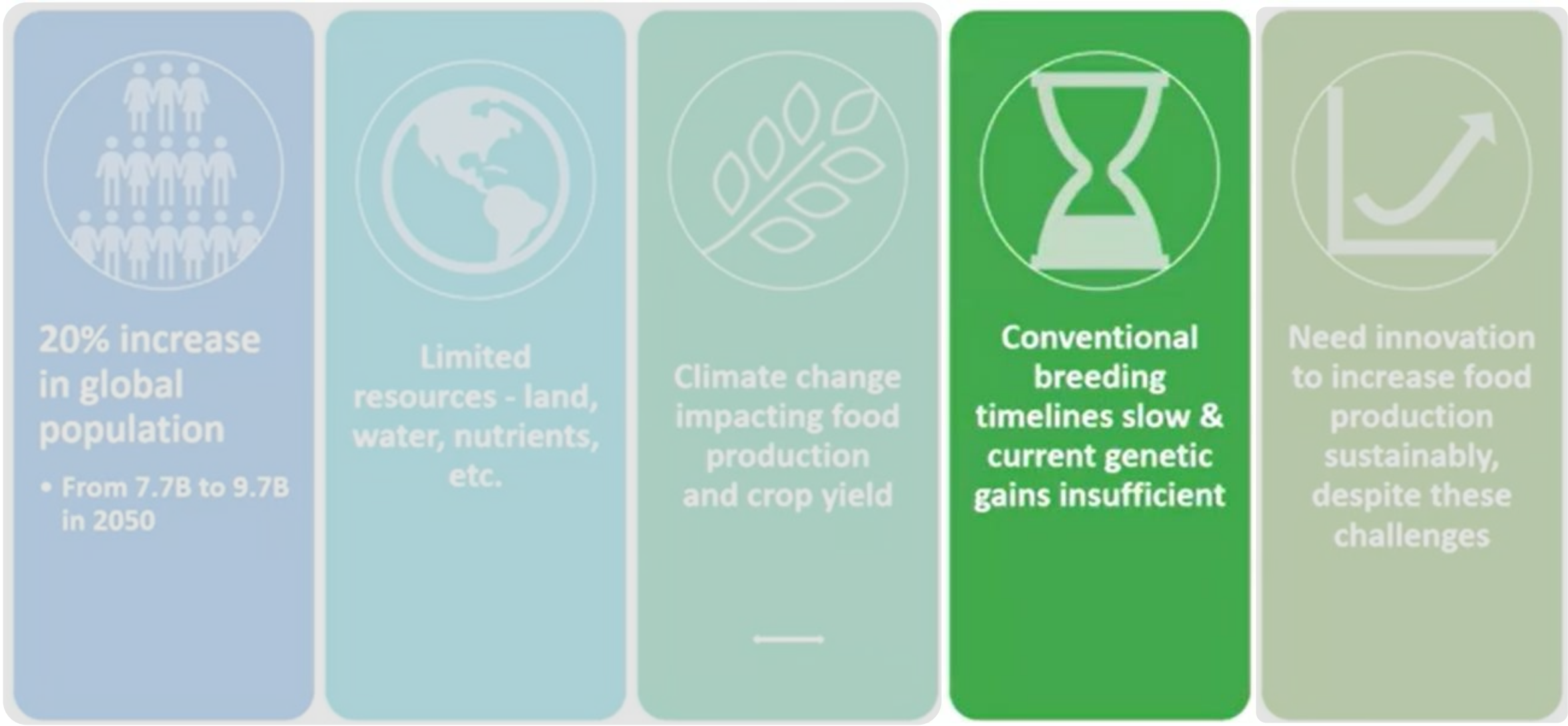
Aim I: Resilience to Reproductive Heat Stress



Fatokun et al. *Scientific Reports* 2018;
Muñoz-Amatriaín et al. *Legume Science* 2021

Approach: Understanding and harnessing naturally occurring adaptation to reproductive heat stress

Challenges to Feeding the World



Source: Global Institute of Food Security

Thank you to our funders!

Dr Steve Rawsthorne

AFCP
The AgriFood Charities Partnership

FELIX COBBOLD TRUST

THE MORLEY AGRICULTURAL FOUNDATION

Chadacre Agricultural Trust

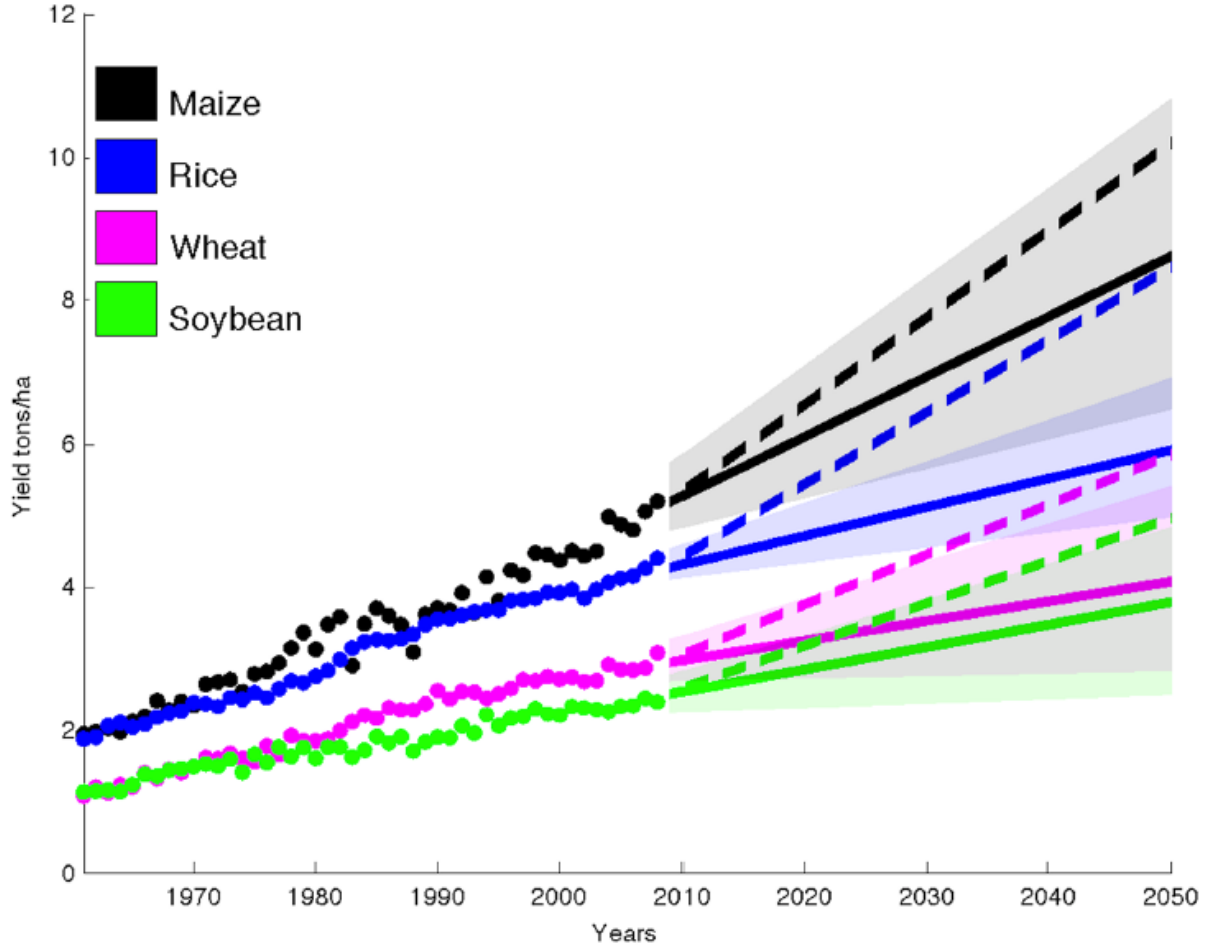
Perry FOUNDATION

4-year PhD studentship

Elena Bidash

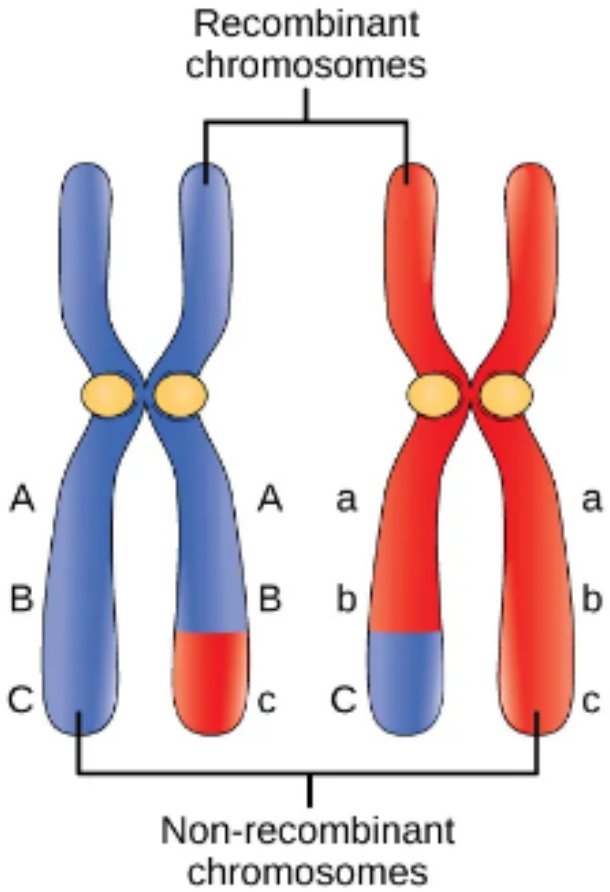
The Need to Expedite Conventional Breeding

Projected Crop Yields by 2050

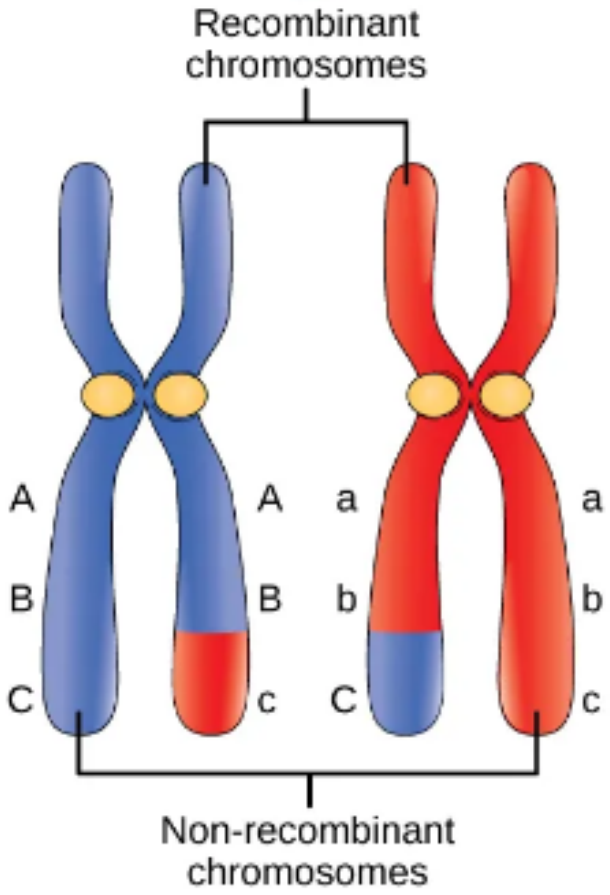


Ray et al. *PLoS One* 2013

Aim II: To Enhance Trait Reassortment



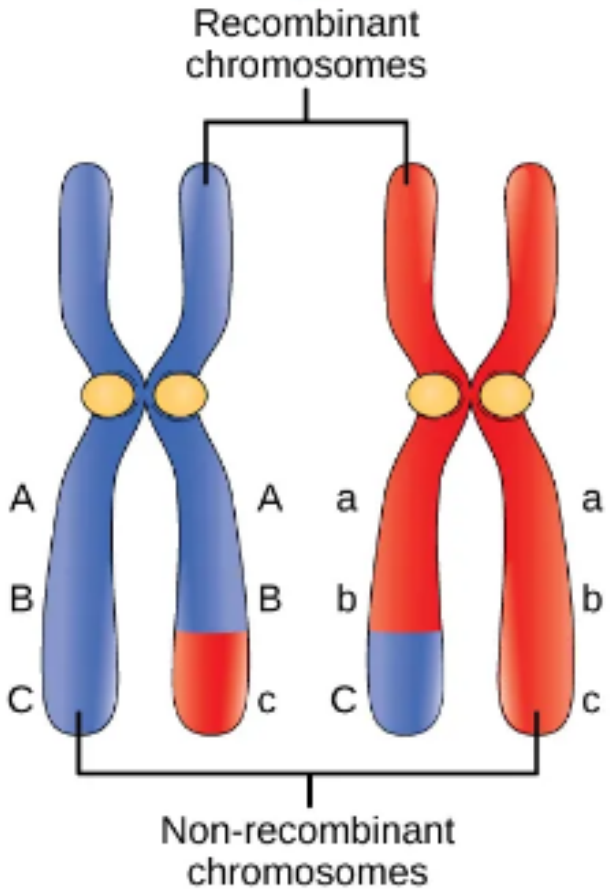
Crossovers Enable Breeding

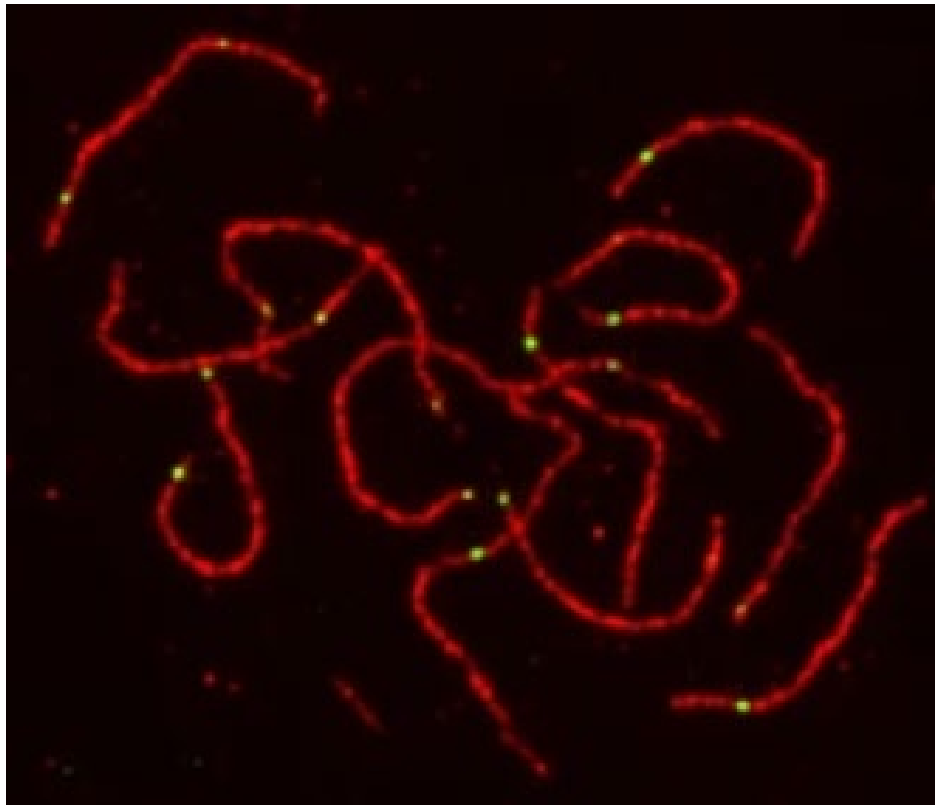


Greaves et al. *Plant Physiol* 2015

Crossovers Limit Breeding

1-3 crossovers per chromosome



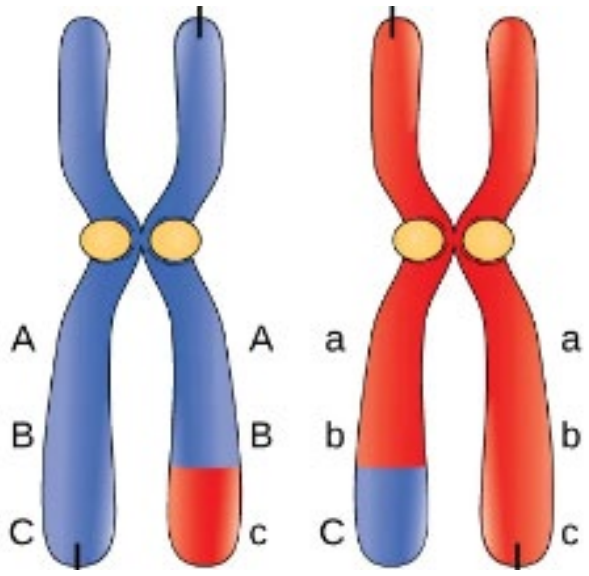


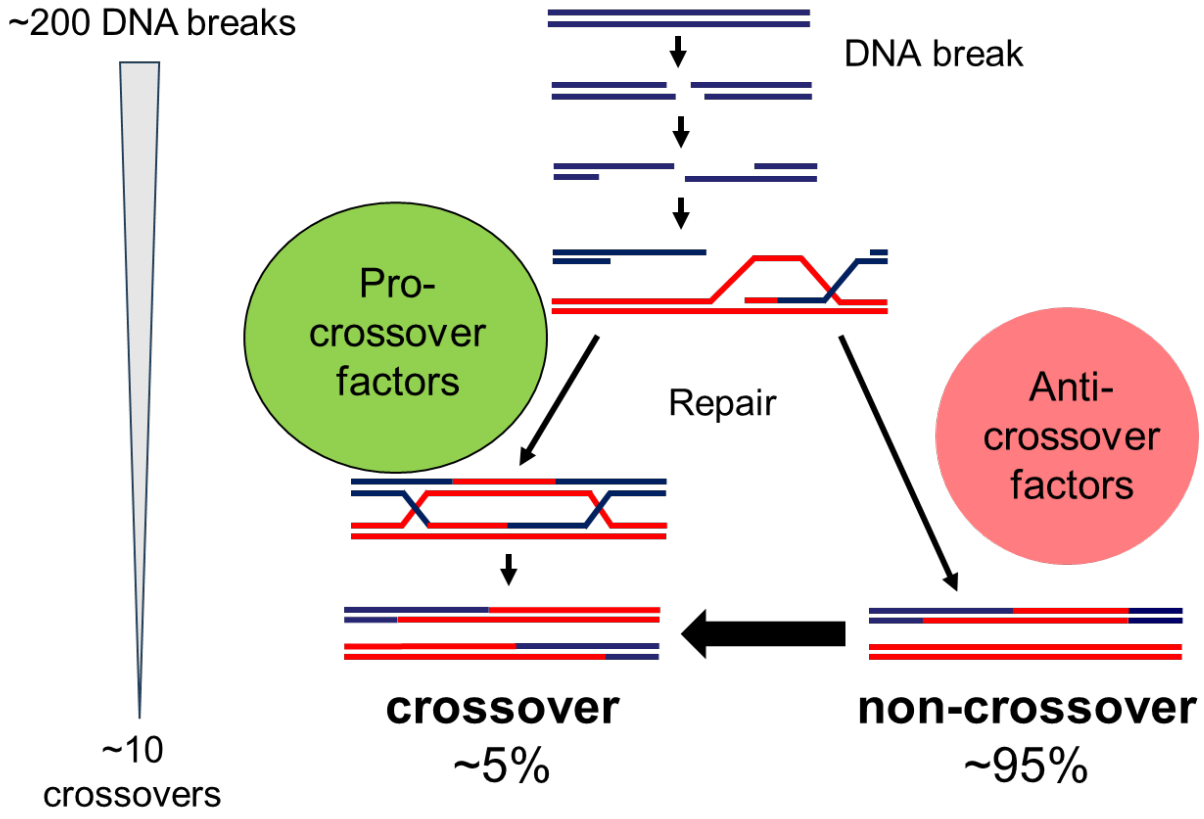
Qiao et al. 2012

Recombination point = crossover

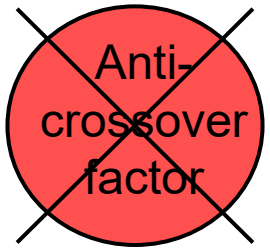
Chromosome

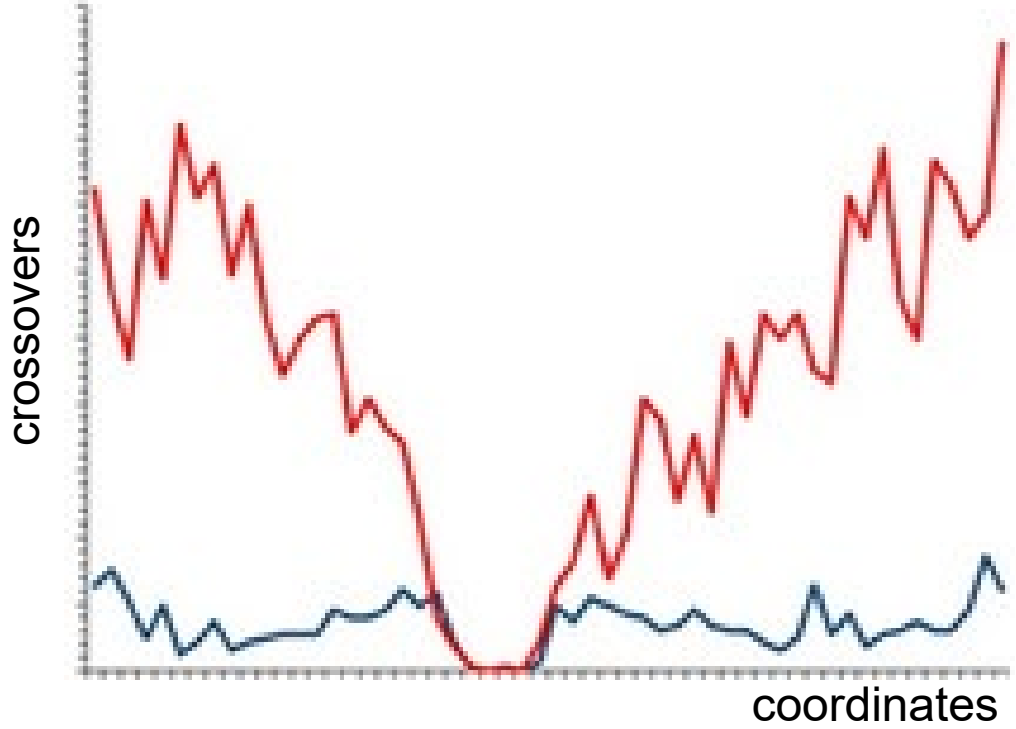
Crossover Pathway





Solution: Enhanced Trait Reassortment





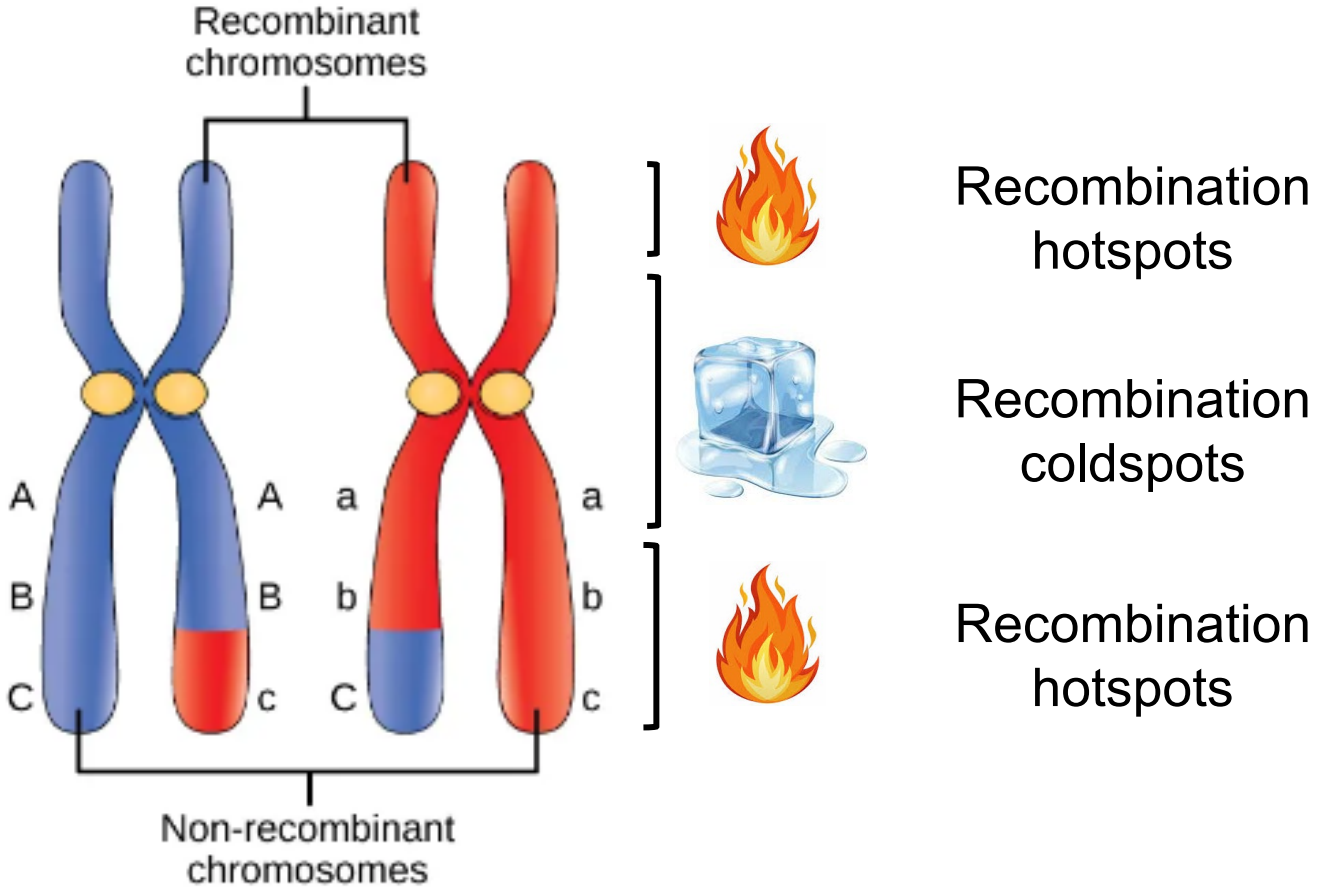
Wild type

Capilla-Pérez et al. 2024
and other studies from the Mercier lab

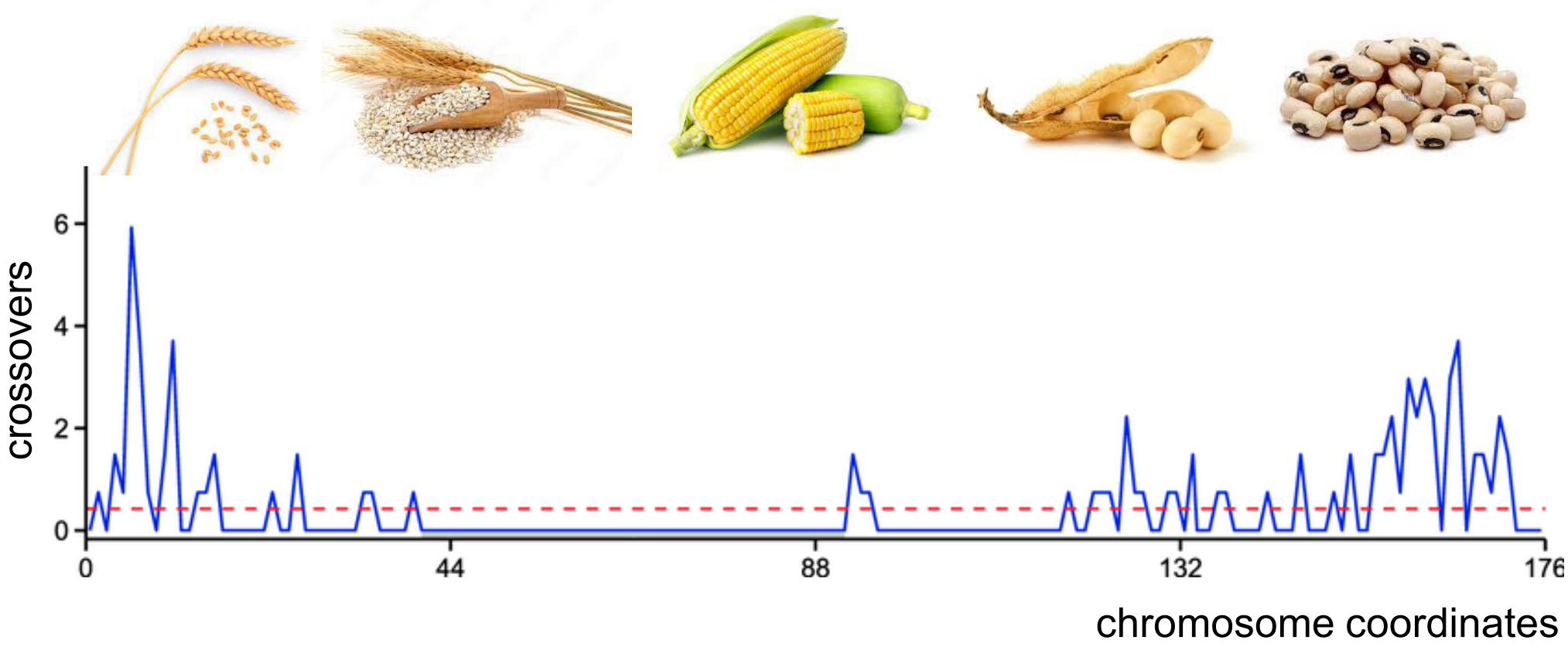
Approach: Mutating anti-crossover factors

Crossovers Limit Breeding

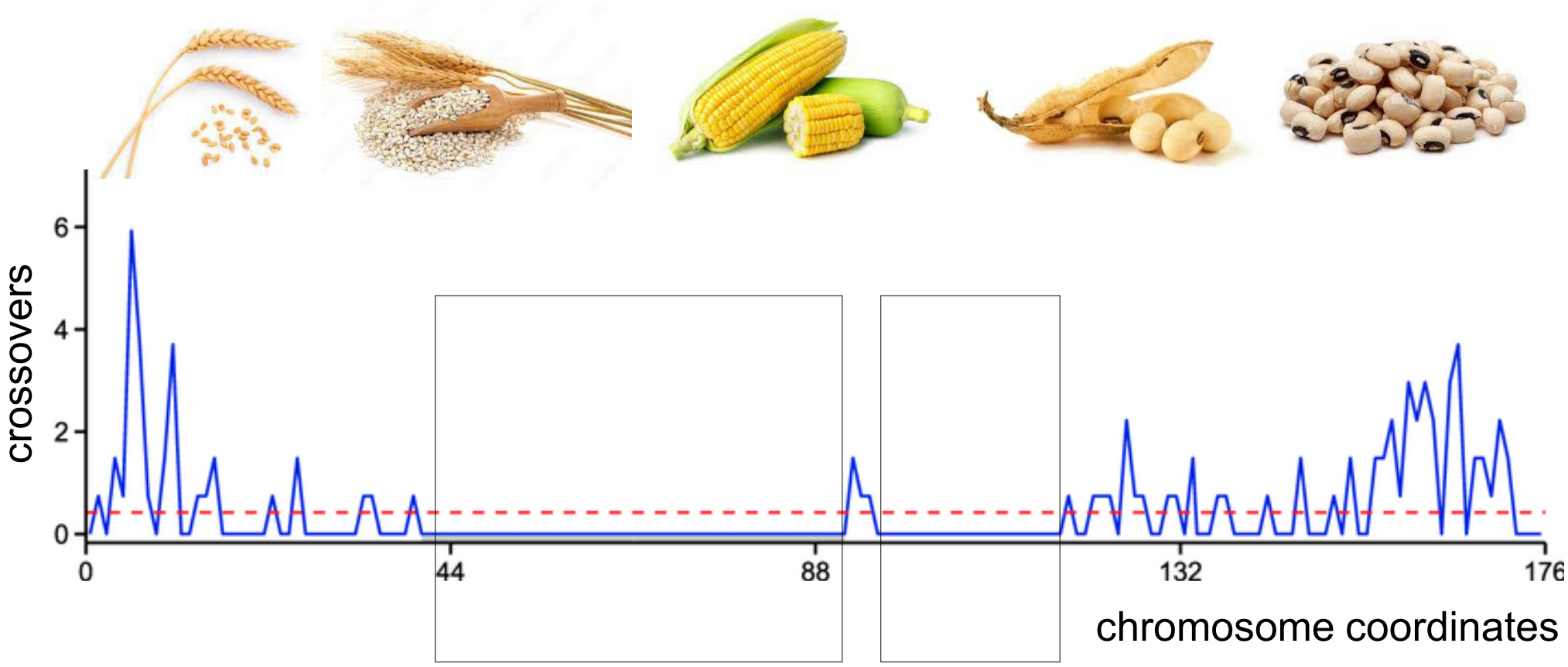
1-3 crossovers per chromosome



Crossovers Enable and Limit Breeding

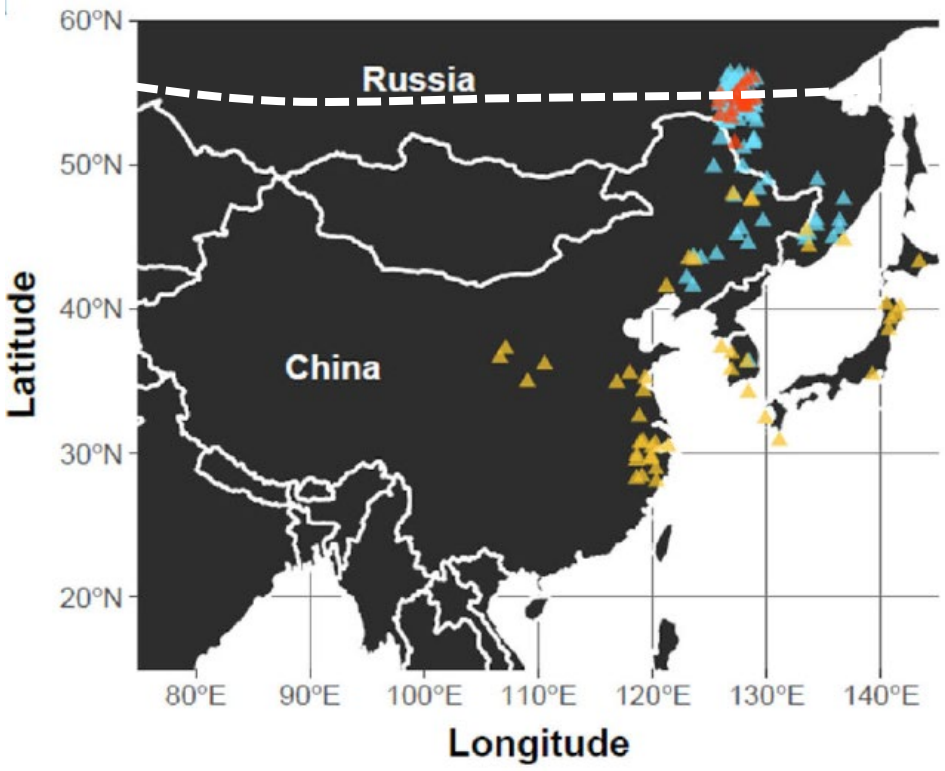


Limitation: ~25% Genes Crossover-Suppressed



Breeders' interest

Crossover Coldspots Have Useful Traits!



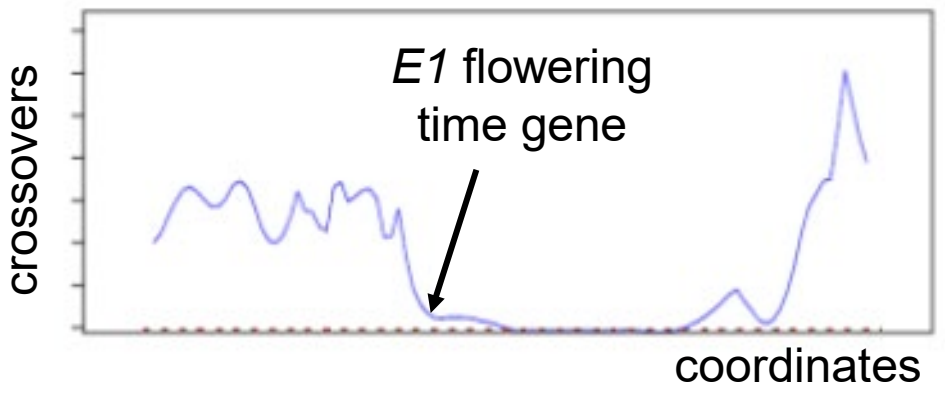
Dietz et al. 2021

~UK

E1 variants

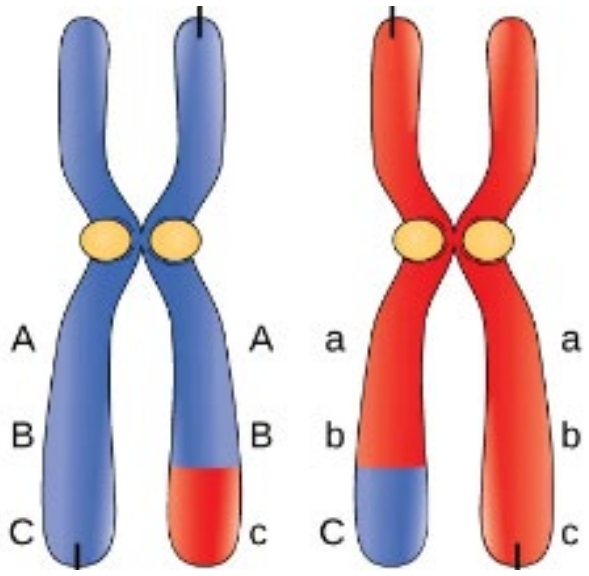
Days to flowering:
35 – early
60 - late

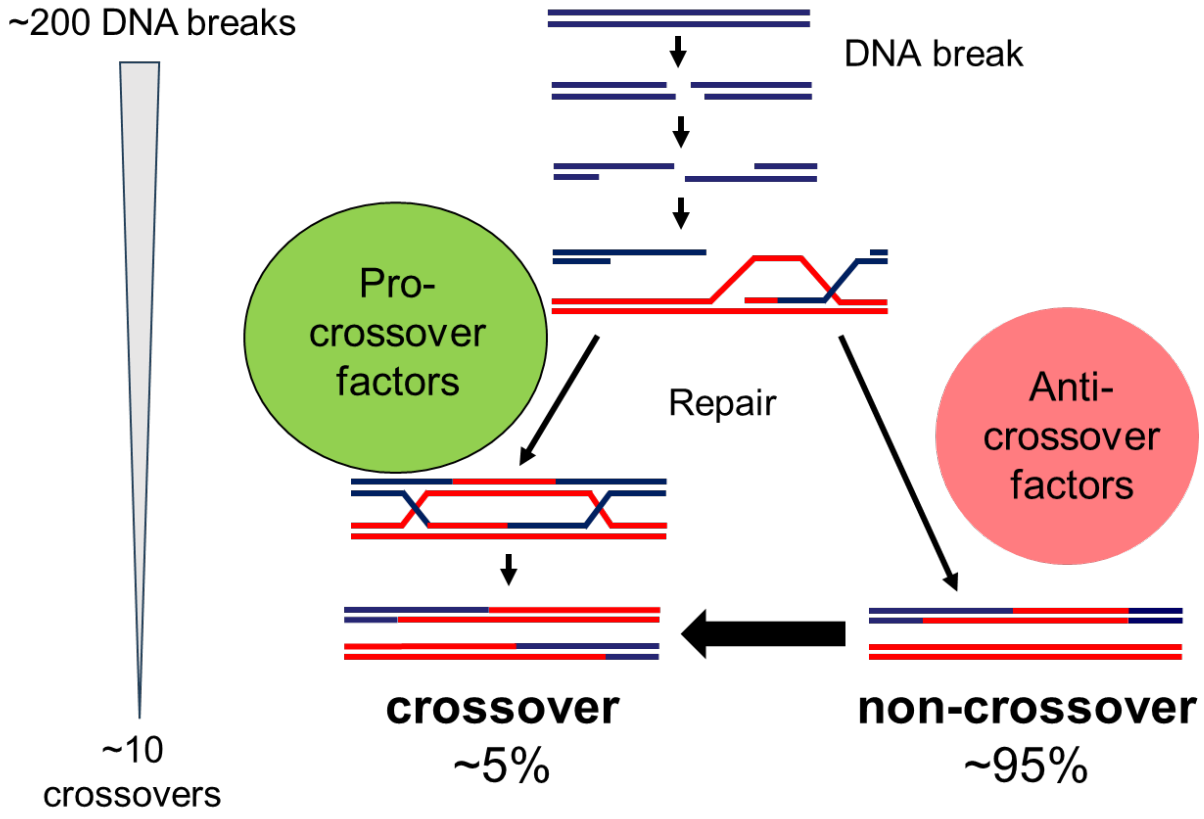
Crossover Profile In Soybean Chromosome 6



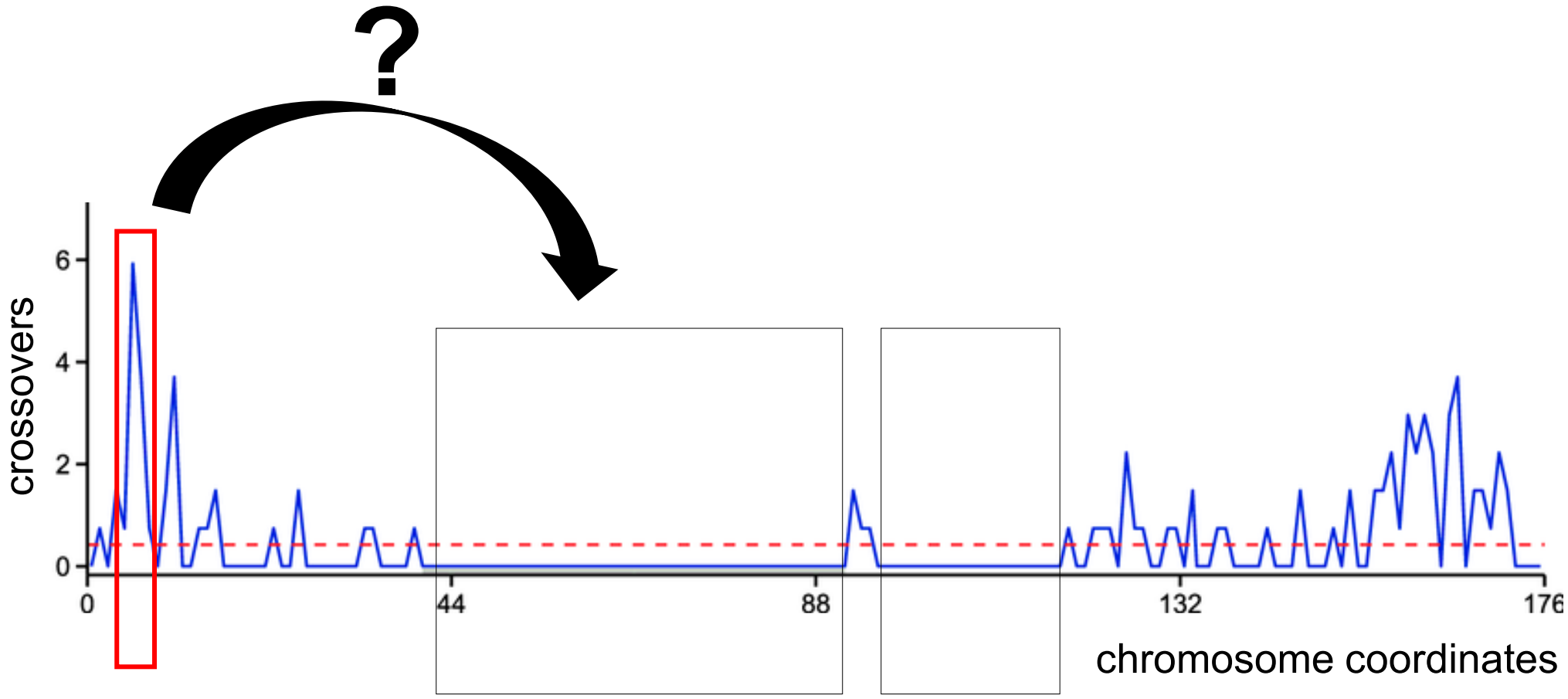
Du et al. 2012; Xia et al. 2012

Crossover Pathway





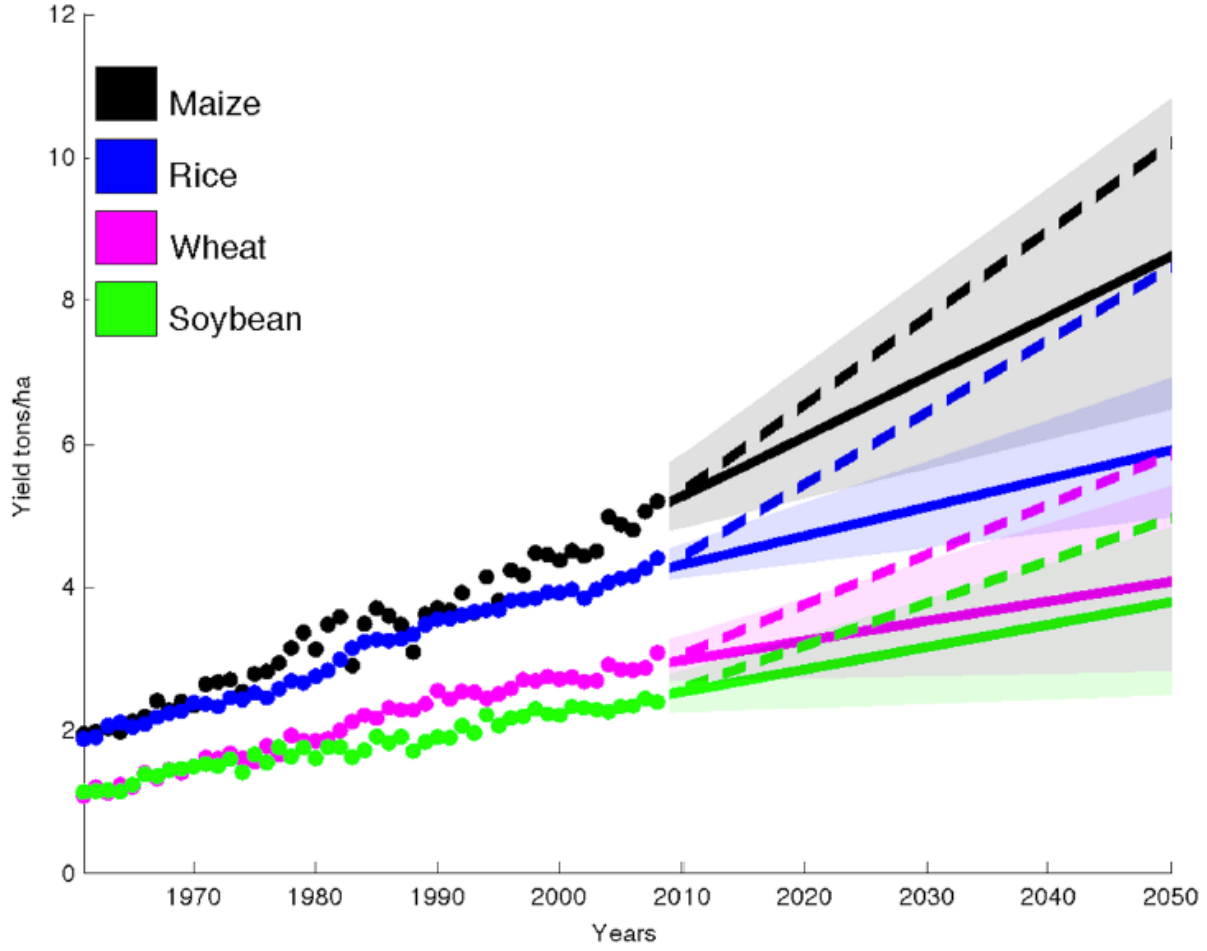
Solution: New Technologies Needed



Approach: Engineering crossover hotspots?

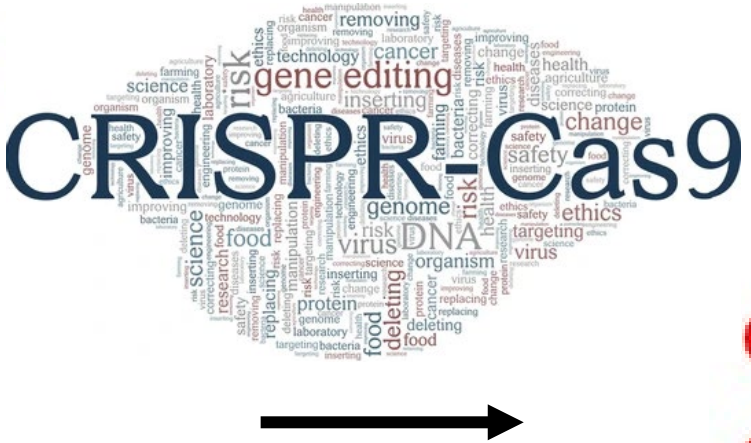
The Need to Expedite Conventional Breeding

Projected Crop Yields by 2050



Ray et al. *PLoS One* 2013

Aim III: Expedite Precision Breeding



Conventional breeding timelines slow & current genetic gains insufficient

Summary

Routes to Address Food Security:

- Crops tolerant to reproductive temperature stress = yield stability
- Accelerated breeding technologies = improved cultivars faster
- Rapid gene editing = improved cultivars via precision breeding

Acknowledgements

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The Crop Science Centre
Department of Plant Sciences