ETH zürich

Reducing pesticide use at its base through plant breeding

Public webinar on ‘Pathways for advancing pesticide policies’

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Key messages

- The development of **crop cultivars resistant/tolerant to biotic stress** is at the base of any action to reduce potential risks of plant protection products in Europe




Food security
Population growth
Changing diets

Soil
Erosions
Salinization

Resources
Arable land
Nutrients

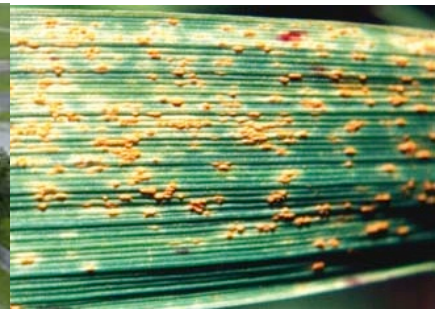
Climate change
Heat and drought
Elevated CO_2

Water
Water deprivation
Flooding

Plant diseases and pests
Occurrence
Pathogen composition



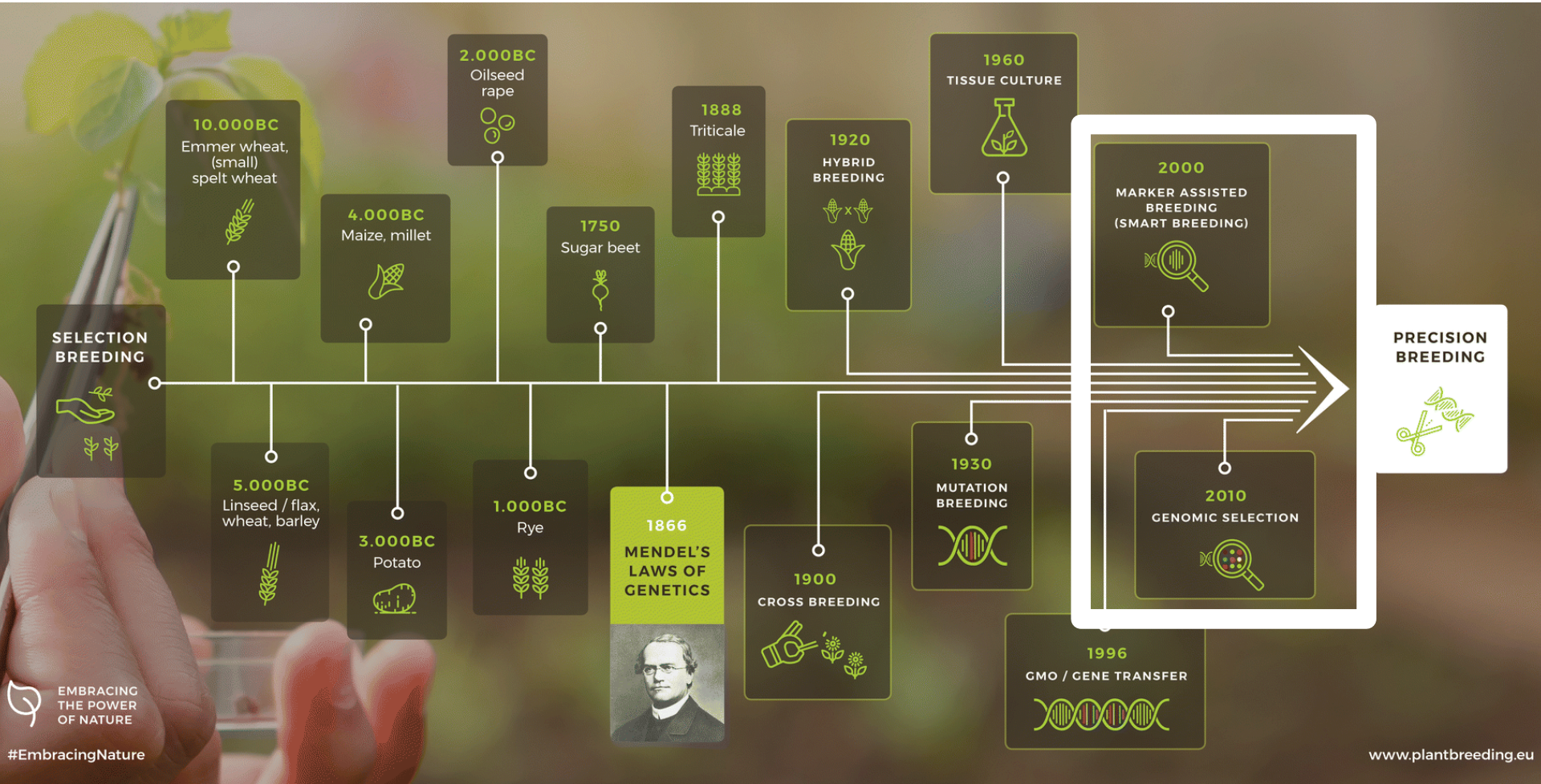




Key messages

- The development of crop cultivars resistant/tolerant to biotic stress is at the base of any action to reduce potential risks of plant protection products in Europe
- Plant breeding is a **long and complex process**, often not able to keep pace with the rapid **evolution and new emergence of pathogens** and **pests**

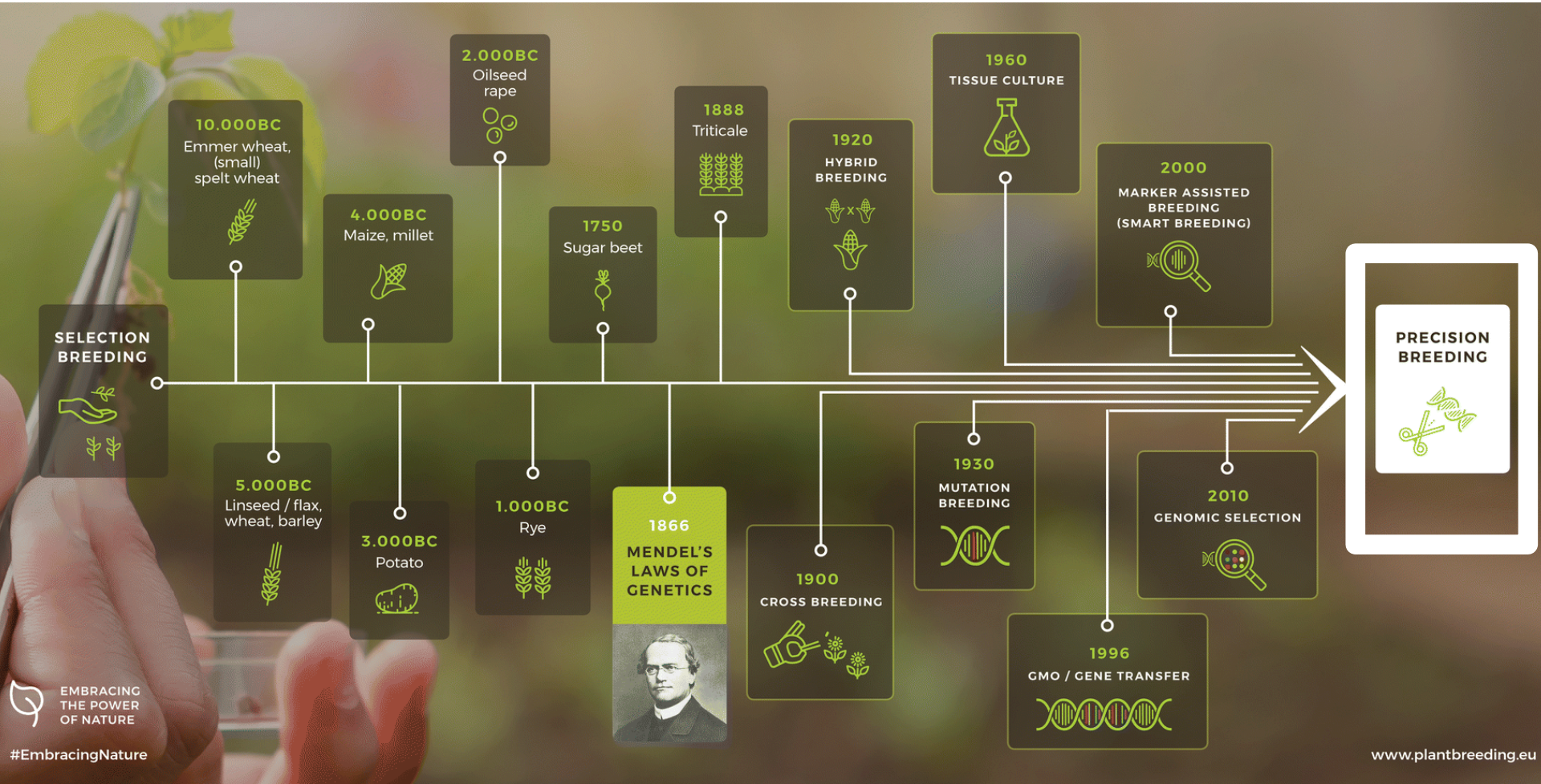
Milestones and tools in plant breeding



Molecular Plant Breeding

- Technological advancements in the area of genetics and genomics offer opportunities
  - to efficiently describe and utilize genetic diversity in plant breeding
  - to find and exploit resistance sources
- Marker- or genomics-assisted breeding strategies enable
  - to tag resistance genes/loci
  - to implement resistance management strategies
    - temporal and spatial variation of disease resistance sources
    - pyramiding of resistance genes or alleles
    - accounting for pathotype-specificity

Milestones and tools in plant breeding



Powdery mildew resistance in wheat

20 minuten

Pilze

04. August 2016 14:58; *Akt: 04.08.2016 14:58*

Weizenernte für Bauern katastrophal

Der nasse Frühling und Krankheiten haben den Bauern das Geschäft vermiest. Besonders gelitten hat der Weizen. Die Ernte ist so schlecht wie seit Jahrzehnten nicht mehr.

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日本語要約

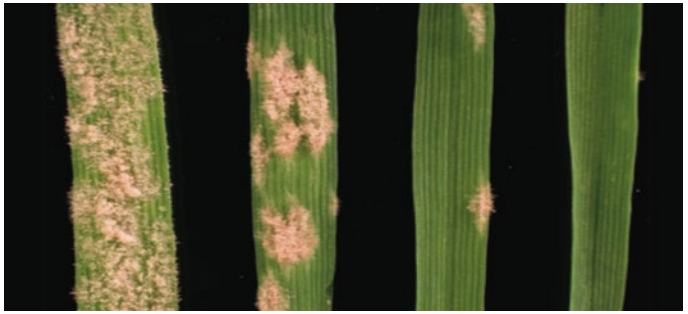
Simultaneous editing of three homoeoalleles in hexaploid bread wheat confers heritable resistance to powdery mildew

Yanpeng Wang, Xi Cheng, Qiwei Shan, Yi Zhang, Jinxing Liu, Caixia Gao & Jin-Long Qiu

Active *MLO* gene is suppressing resistance against powdery mildew

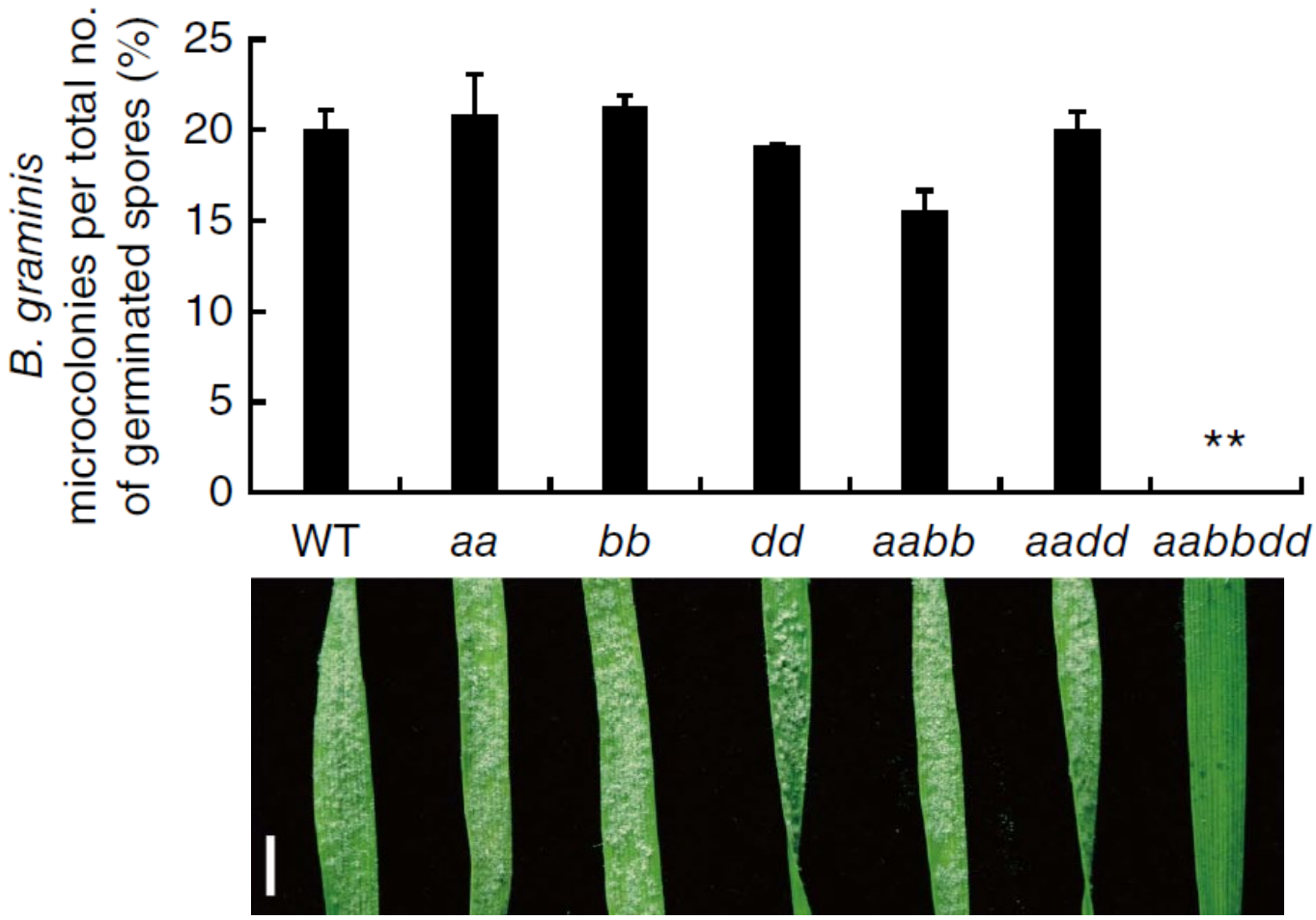
Wheat contains six MLO copies (two each on the A, B and D genome)

Knockout mutants of the six *MLO* genes



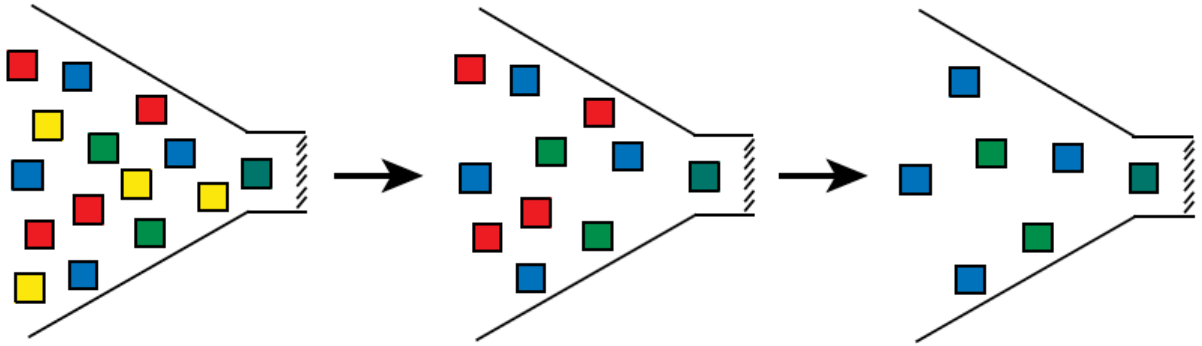
Powdery mildew caused by *Blumeria graminis* f. sp. *Tritici on wheat leaves*

Powdery mildew resistance in wheat



Wang et al. 2014, Nature Biotechnology

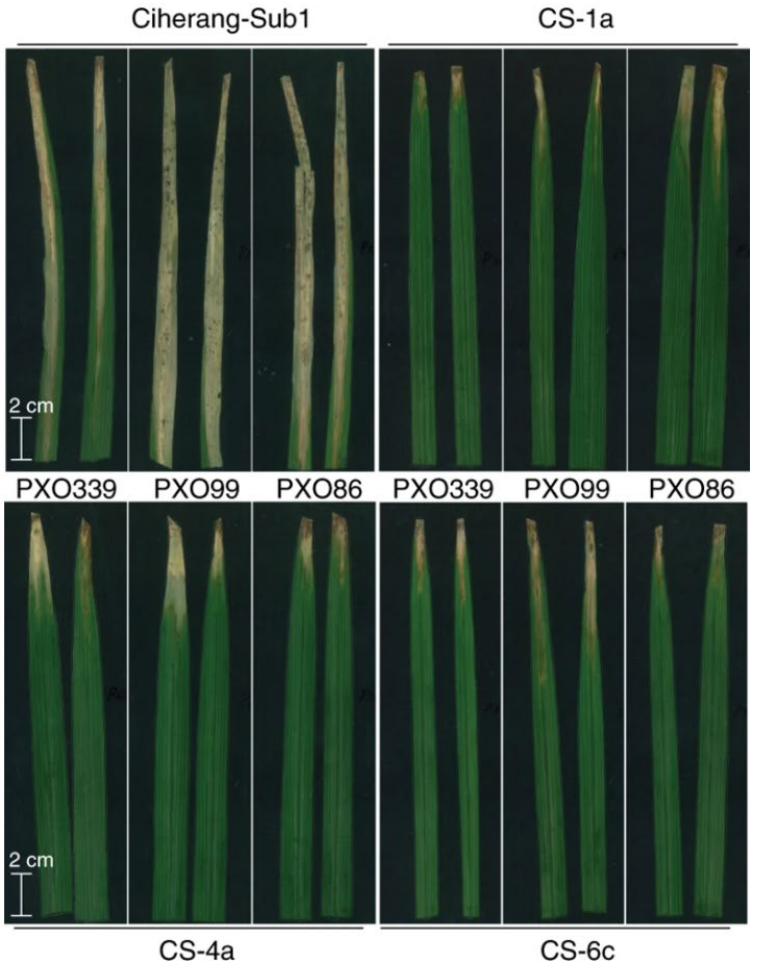
“Rewildering Crops” – tapping the pool of resistance sources lost during domestication



Tanksley and McCouch, Science 1997

Broad-spectrum resistance to bacterial blight in rice using genome editing

- *Xanthomonas oryzae* pv. *oryzae* (Xoo)
- Transcription-activator-like effectors (TALes) in order to induce susceptibility by activating *SWEET* gene promotors
- Modification of the *SWEET* gene promotors by CRISPR–Cas9
- Rice lines with robust, broad-spectrum resistance



Olivia et al., (2019), https://doi.org/10.1038/s41587-019-0267-z

For a more differentiated regulation of genome editing

Key messages

- The development of crop cultivars resistant/tolerant to biotic stress is at the base of any action to reduce potential risks of plant protection products in Europe
- Plant breeding is a **long and complex process**, often not being able to keep pace with the rapid **evolution of pathogens** or the emerge of **new pests**
- **New plant breeding techniques** provide the potential to further **increase efficiency and efficacy** of resistance breeding

Policy-related key conclusions

- Solve the problem at its base – by strengthening **plant breeding**
  - «Strategie Pflanzenzüchtung 2050» in Switzerland
  - Several parliamentary initiatives
- We will need **new approaches and tools** to minimize crop production losses due to diseases and pests
- **Multi-disciplinary** policy approach
  - to realize the full potential of modern plant breeding, thereby helping to reduce agricultural pesticide use and to implement more sustainable agricultural production systems