Fascination of Plants Day 2024

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# Odd Arne Rognli

## EPSO's president and professor at Norwegian University of Life Sciences (NMBU)

Plants for the Future European Technology Platform with support from epso Euroseeds Embracing Nature copa cogeca european farmers european agri-cooperatives ILVO Flanders Research Institute for Agriculture, Fisheries and Food

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# From fundamental research to crop production

## Laying the groundwork

Odd Arne Rognli | EPSO/Norwegian University of Life Sciences

odd-arne.rognli@nmbu.no

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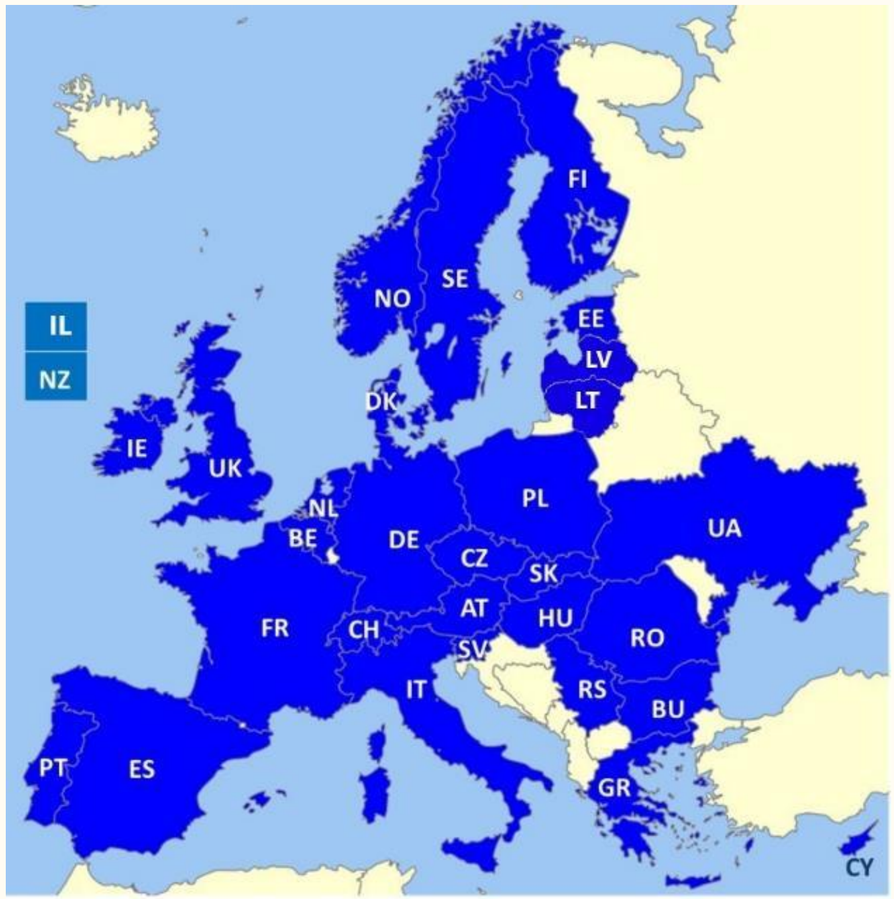
# EPSO represents plant science in Europe

**Independent academic organisation**

([www.epsoweb.org](http://www.epsoweb.org))

- Members: 200 research institutes, universities, departments, representing 31 countries
- >24 000 researchers and staff in plant science, about 2 600 personal members




**What is EPSO doing?**

- Science strategy and policy
- Science support (10 working groups, workshops, white papers, social media, EPSO online seminars)
- Science outreach - FoPD

# Mendel's studies of peas revealed the laws of inheritance

Mendel's work laid the foundation for the sciences of plant genetics and plant breeding

Source: Teaching Tools in Plant Biology, 2009, ASPB

Distinguished plant breeder Norman Borlaug **1914-2009**, Nobel Laureate 1970

# Basic and applied/translational plant research

- Basic biological processes
- Model species
  - *Arabidopsis thaliana* - Genome sequenced in 2000
- Crop species genomes:
  - Rice 2002
  - Barley 2017
  - Wheat 2018
- Genome sequences are the foundation of modern plant research and breeding
- NGS – next generation sequencing technology essential

# Huge natural genetic diversity exists

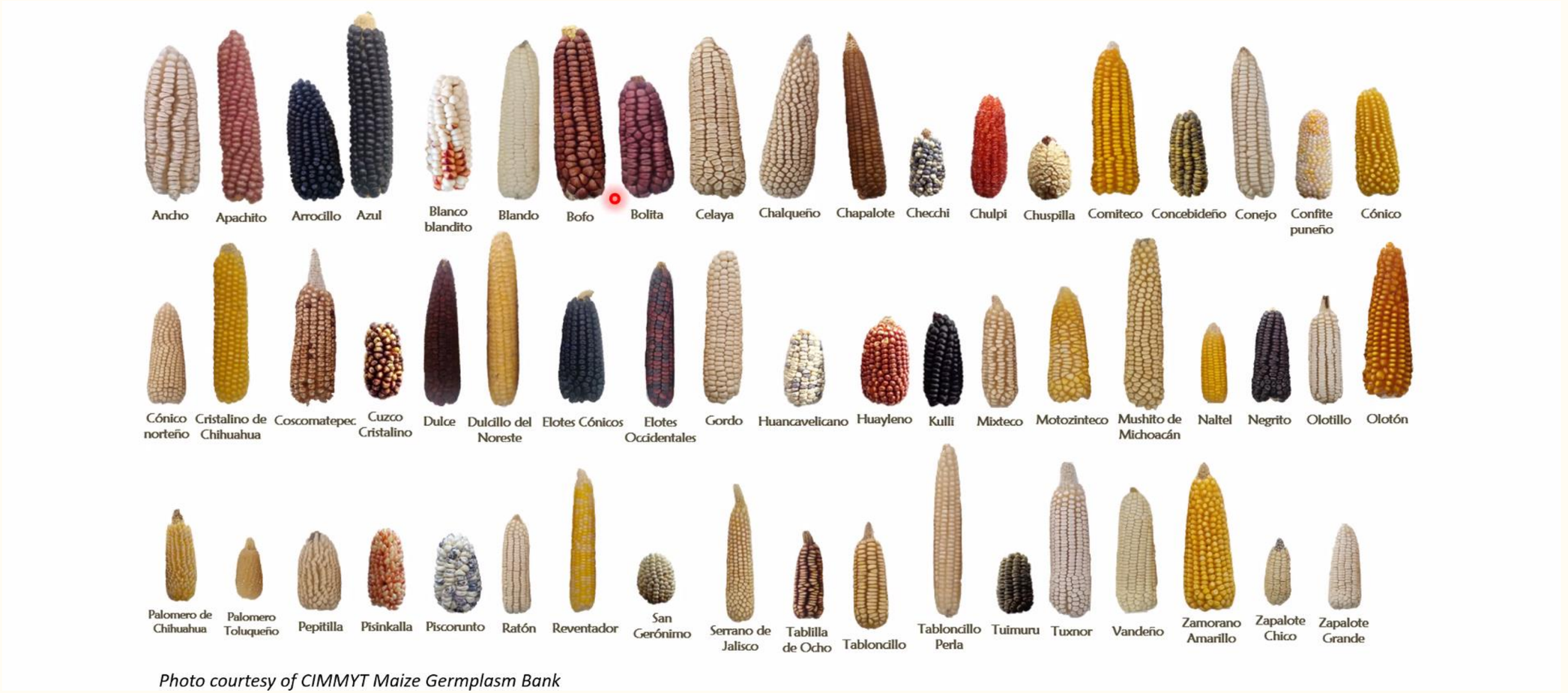
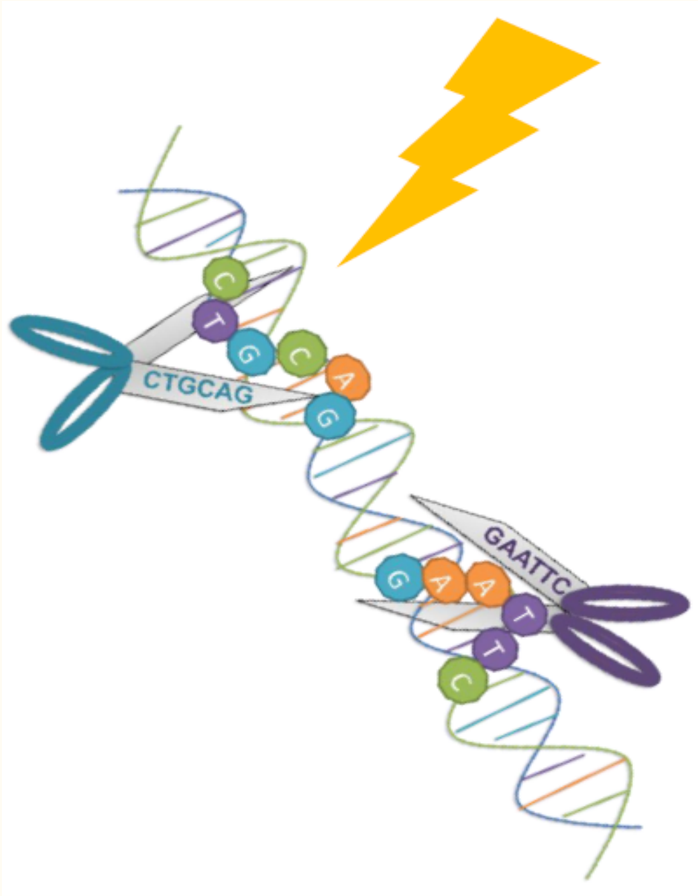



*Photo courtesy of CIMMYT Maize Germplasm Bank*

# When genetic variation is lacking

- **Mutation breeding** (irradiation, chemical)
  - Induce random mutations and search for useful changes in traits
- **TILLING**
  - Induce random mutations and search for changes in known genes
- **Genetic transformation**
  - Transfer genes from non-crossable species
- **Gene editing**
  - Edit specific changes in DNA



# Example: dwarfing genes in wheat, the Green Revolution genes

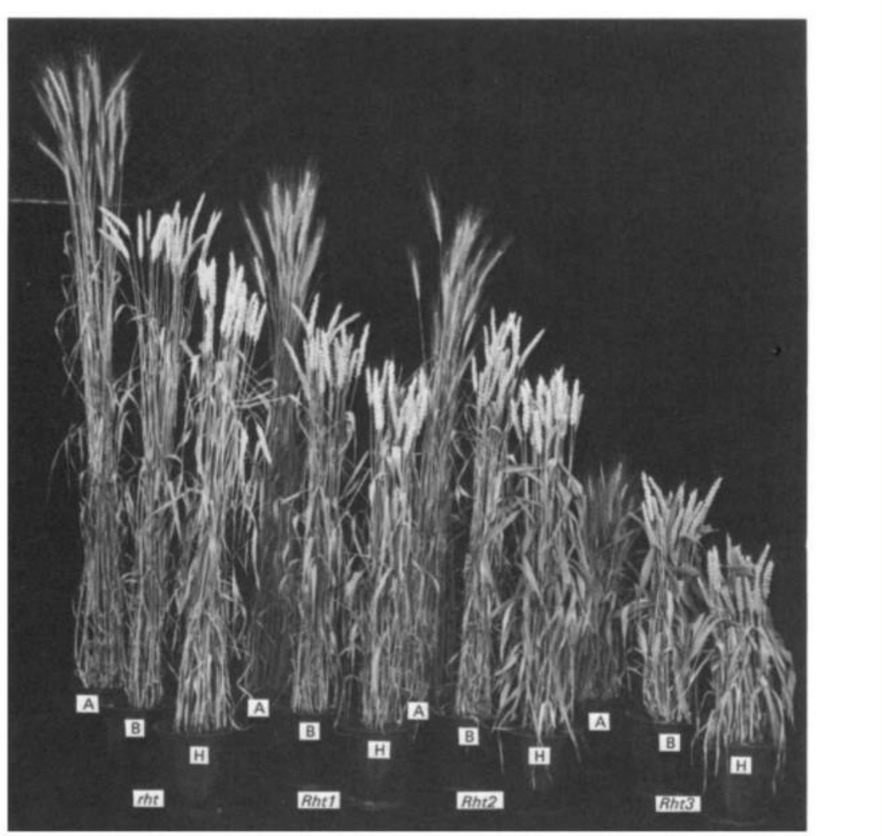
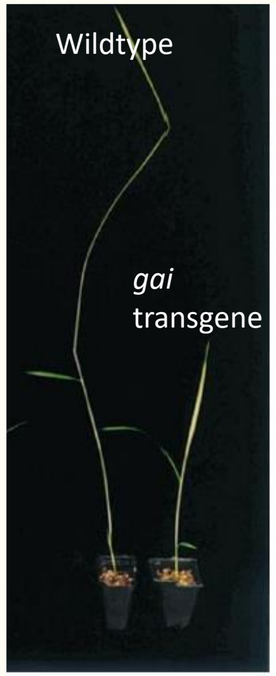



*Figure 1.4* Isogenic lines of *Rht1*, *Rht2* and *Rht3* in April Bearded (A), Bersée (B) and Huntsman (H) genetic backgrounds

Gale MD, Youssefian S (1985) Chapter 1 - Dwarfing genes in wheat.
In: Russell GE (ed) Progress in Plant Breeding–1, pp 1-35

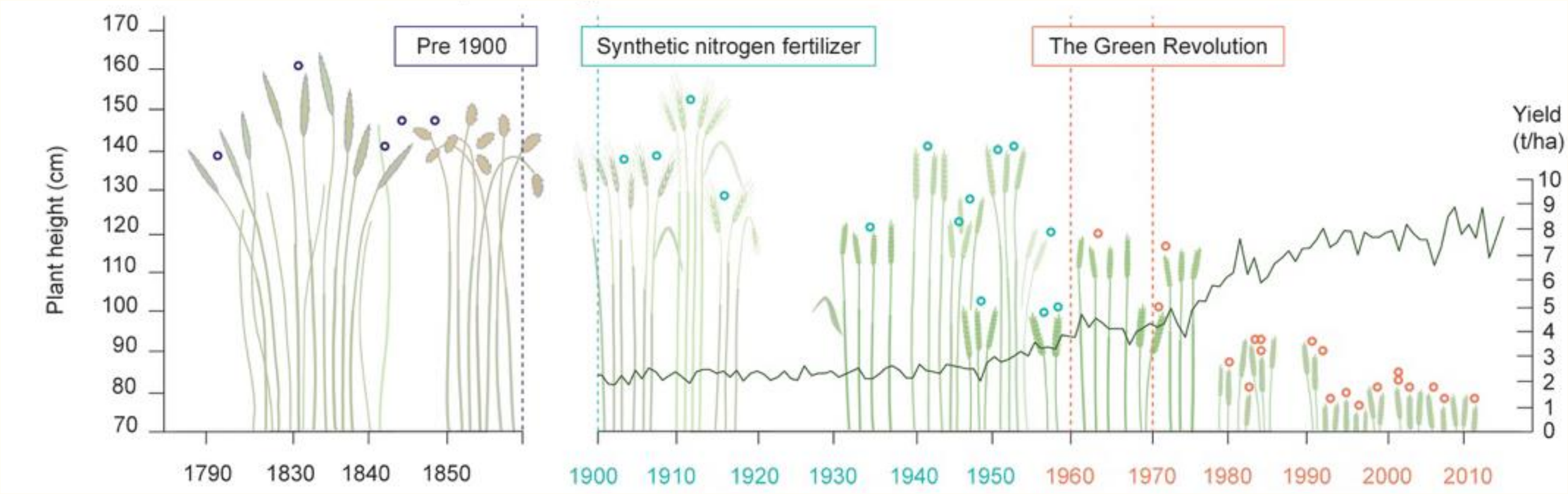




Peng et al. (1999) Nature 400:256-261

Demonstration that the dwarfing genes (*Rht*) are the same as *Gai,* the *Arabidopsis* gibberelin insensitivity gene.
Plants sprayed with gibberelin.

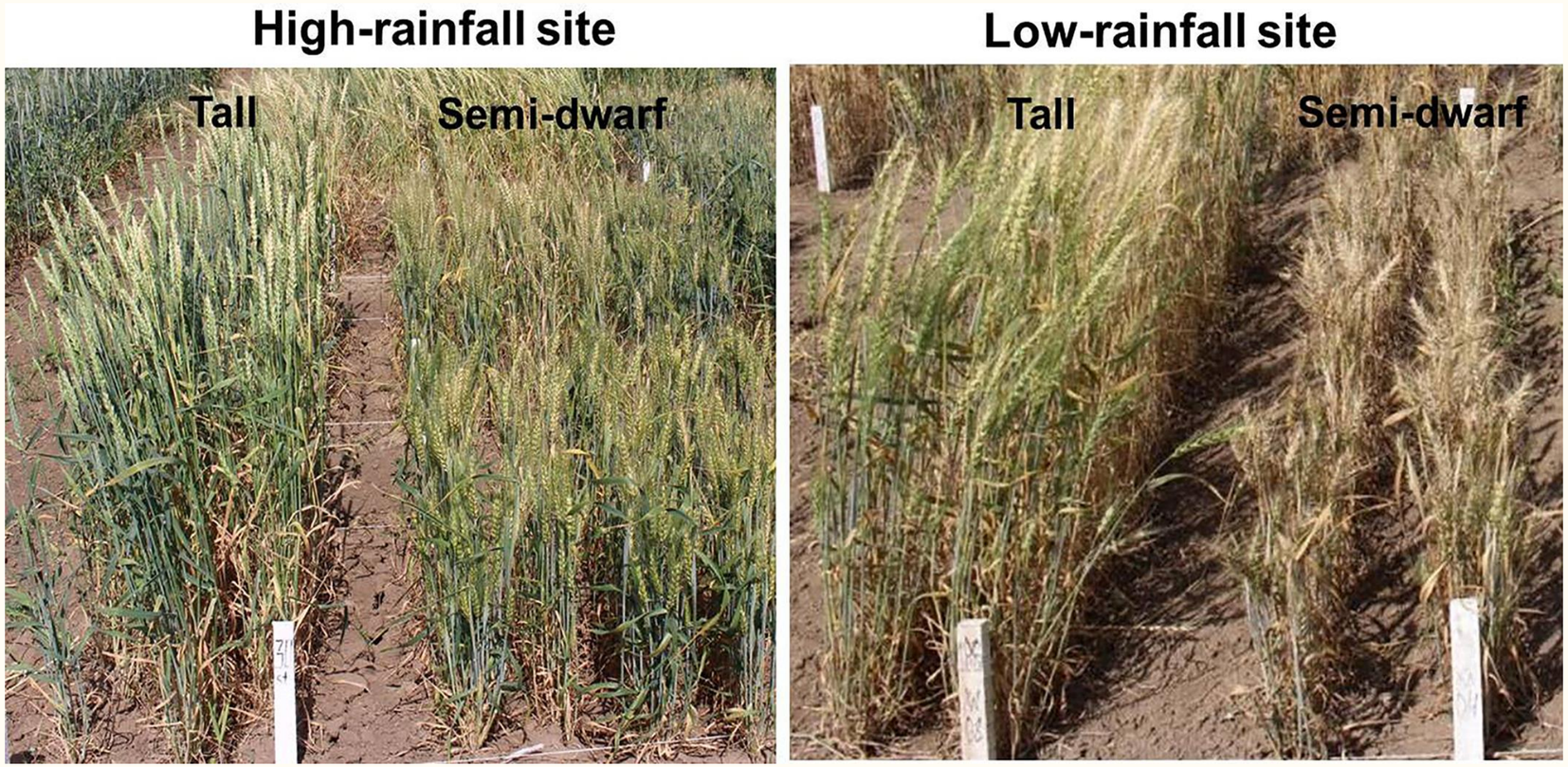
# Historic reduction in plant height of wheat




Cheng et al. (2023) Harnessing Landrace Diversity 1 Empowers Wheat Breeding for Climate Resilience. bioRxiv https://doi.org/10.1101/2023.10.04.560903

- Modern wheat originates from only 2 of 7 ancestral groups of wheat
- A lot of untapped variation to improve modern wheat

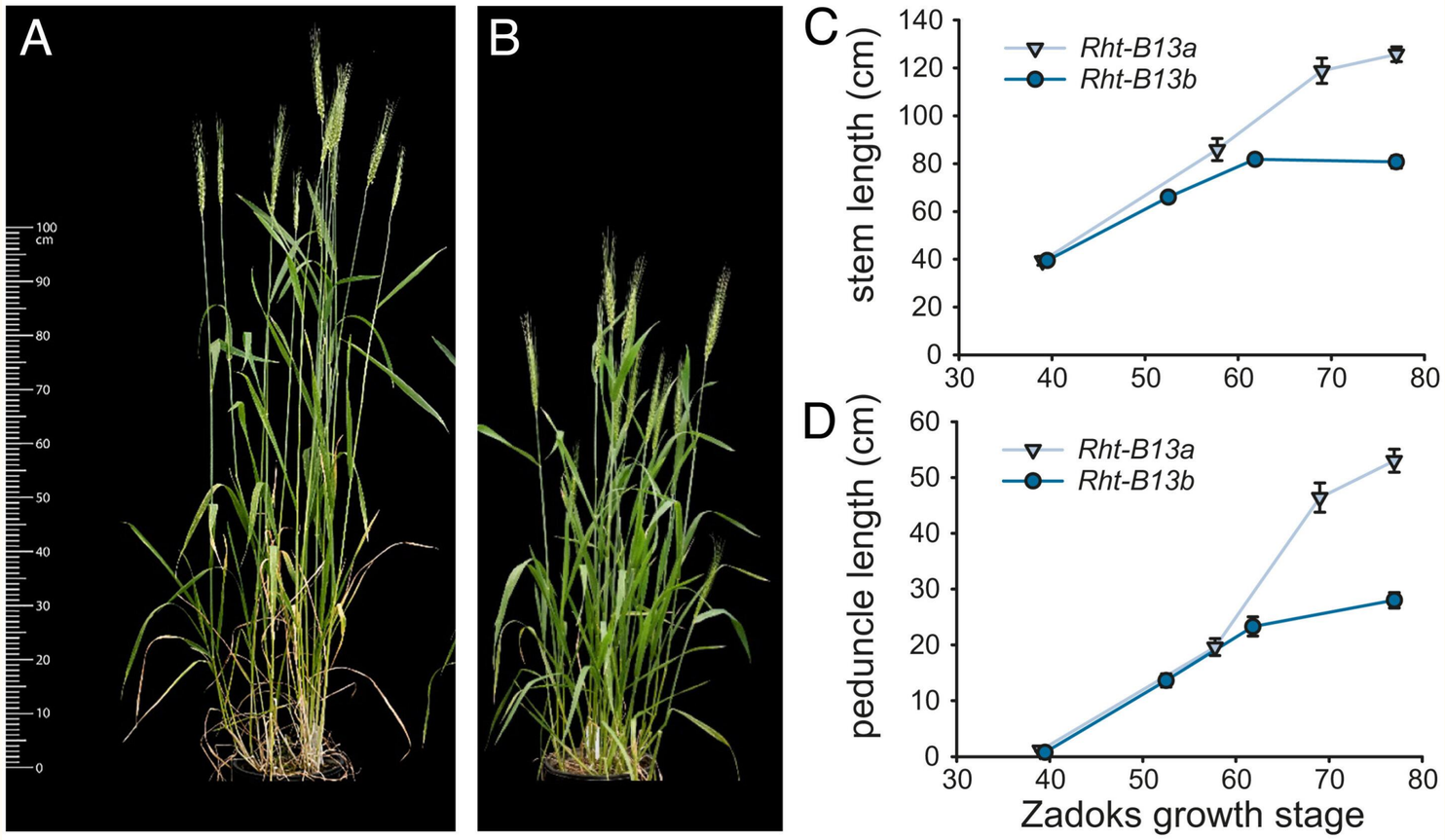
# Dwarf wheat with Rht genes fails to produce higher grain yield than taller plants under drought




Jatayev et al. (2020) Plant, Cell & Environment 43:2355-2364 https://doi.org/10.1111/pce.13819

# New 'Green Revolution' gene discovery sows hope of drought resilient wheat

- Traditional semi-dwarf wheats cannot be planted deeper to avoid drought
- Rht13 dwarf gene acts in tissues higher up in the wheat stem.
- Seeds can be planted deeper




A) Magnif (Rht-B13a) and B) Magnif M (Rht-B13b)

Borrill (2022) PNAS 119:e2209875119

# Flowering time influences biomass accumulation and grain filling

The length of the vegetative phase affects biomass and seed production


Source: Teaching Tools in Plant Biology, 2022, ASPB

## Changing flowering time to adapt to season and climate

- Avoid drought
- Shorten or extend plant life cycle
- Modulate plant size
- Utilize variation in flowering time genes to fine-tune floral transition
- Candidate genes identified in model species
  => conserved function in crops => identify, validate and deploy in breeding

# The Nordic Public-Private-Partnerships for pre-breeding

- **Primary objective:**
  - to support long-term breeding goals for Nordic agriculture and horticulture through collaborative pre-breeding projects in a pre-competitive manner
- **Four principles:**
  - Pooled public funding while allowing some countries to move faster
  - Project based participation from plant breeding companies (12 out of 13 companies)
  - Engagement of the best research environments for the respective projects
  - 50/50-funding between public sources and industry
- **Importance:**
  - Restored collaboration between plant breeding companies and universities
  - Mutual benefits, study and develop genetic resources, access to germplasm and field trials, need >50% public funding for small crops, need added funding (PhD, post doc) from the universities

# PPP projects

- **Period 2012-2020:**
  - NORDFRUIT – Pre-breeding for Future Challenges in **Nordic Fruit and Berries**
  - Pre-breeding in **Perennial Ryegrass** (*Lolium perenne* L.)
  - 6P2 – The Nordic PPP **Plant Phenotyping** Project – Phase 2
  - Combining Knowledge from Field and Laboratory for Pre-Breeding in **Barley**
- **Period 2021-2023:**
  - CResWheat- Pre-breeding for Nordic Climate-Resilient **Spring Wheat**
  - 6P3 – The Nordic PPP **Plant Phenotyping** Project – Phase 3
  - **SustainPotato**
  - NORDFRUIT **Apple** – Pre-breeding for Future Challenges in Nordic Apples
- **2024**- projects on **wheat, potato, berries and oat**

Source: www.norden.org/nordpub

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# Thank you!


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@EPSOEurope

https://epsoweb.org/

odd-arne.rognli@nmbu.no

karin.metzlaff@epsomail.org


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