WISH-ROOTS: Wheat Roots in Soil Health

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SOILS: WHERE FOOD BEGINS

Global Symposium on Soils for Nutrition | 26-29 July 2022

Wheat provides 20% of our daily calories - it is also a source of protein, dietary fibre, mineral micronutrients, B vitamins and beneficial phytochemicals

FW LATEST KNOW HOW MARKETS DISCOVER 11° Sutton

Dry April heightens drought fears for farmers

A dry April has raised concerns the UK could be headed for a drought and left farmers desperate for rain to soak parched crops and grassland.

April has been notably dry, with only around half the normal amount of rainfall in England and Wales.

Climate crisis Wildlife Energy Pollution

UN says up to 40% of world's land now degraded

Rising damage, caused mostly by food production, puts ability to feed planet's growing population at risk

Millions risk undernourishment as wheat prices surge, FAO and OECD warn

in Commodity News 01/07/2022

The war in Ukraine that has stalled its wheat exports will keep global prices high into the 2022/23 season, putting millions more people at risk of undernourishment, the United Nations' food agency and the OECD said on Wednesday.

Russia and Ukraine are the world's first and fifth largest wheat exporters accounting for 20% and 10% of global sales, respectively, but Russia's invasion of Ukraine and the closure of the Sea of Azov and the Black Sea, nearly halted exports.

Grain exports from Ukraine are only 20% of capacity as alternative channels, such as rail and road, are not as efficient as maritime routes, the Food and Agriculture Organization (FAO) and the Organisation for Economic Cooperation and Development (OECD) said.

FAO/OECD projections suggest that 2022/23 wheat prices could be 19% above pre-war levels if Ukraine fully loses its export capacity and 34% higher if in addition Russia's exports are

Food security

Global food prices rise to highest ever levels after Russian invasion

World wheat prices soared by 19.7% in March as war in Ukraine disrupted Black Sea exports, FAO price index reveals

A combine harvester loads wheat into a truck in the Kyiv area, Ukraine. The Black Sea region produced more than a quarter of the world's wheat exports before the war. Photograph: Valentyn

Photo Credit: JIC photography

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EJP Soil - WISH-ROOTS Consortium

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WISH-ROOTS: Wheat Roots in Soil Health

Identification of wheat root traits that improve soil structure and optimize nitrogen cycling.

Concept: making soil health a breeding target

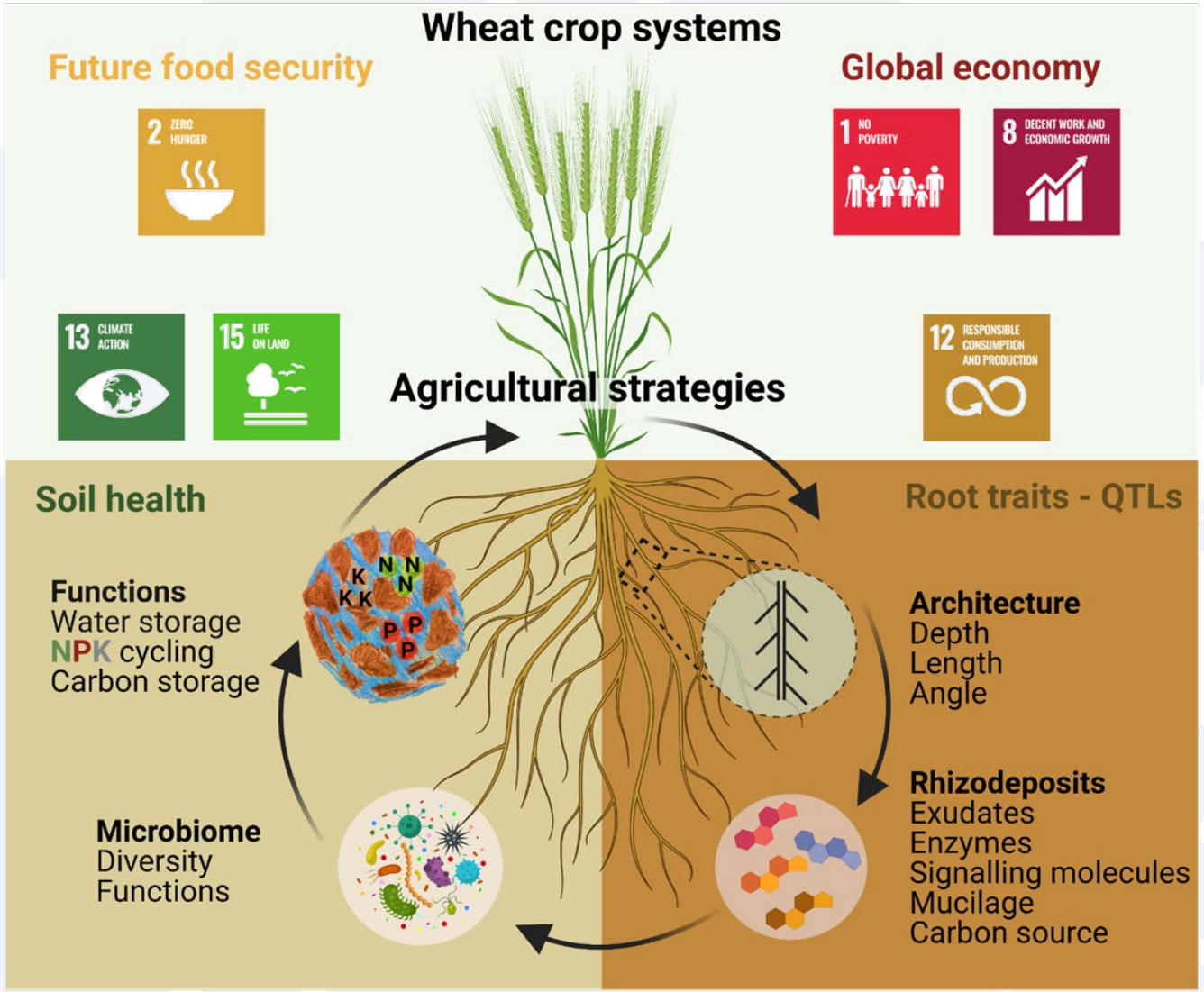


Figure created with BioRender.com

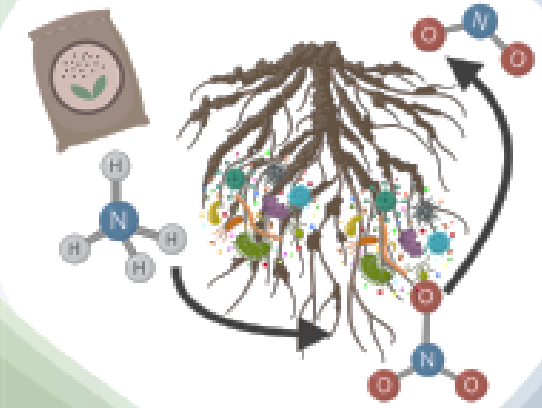
WISH-ROOTS consortium, unpublished

The WISH-ROOTS research targets key UN sustainable development goals: https://sdgs.un.org/goals

Objective

To **enhance the potential beneficial effects of wheat cultivation on soil health** through the identification of **root traits**:

- **soil structure**
- optimize **nitrogen cycling**

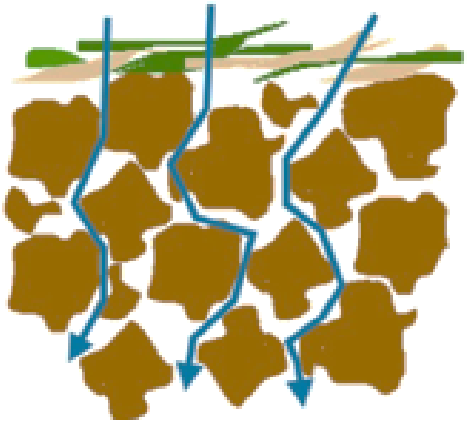


Aims

1) **identify key traits** associated with functionality of **microbial** and fungal **guilds** in the **rhizosphere** and **root system architectural traits**

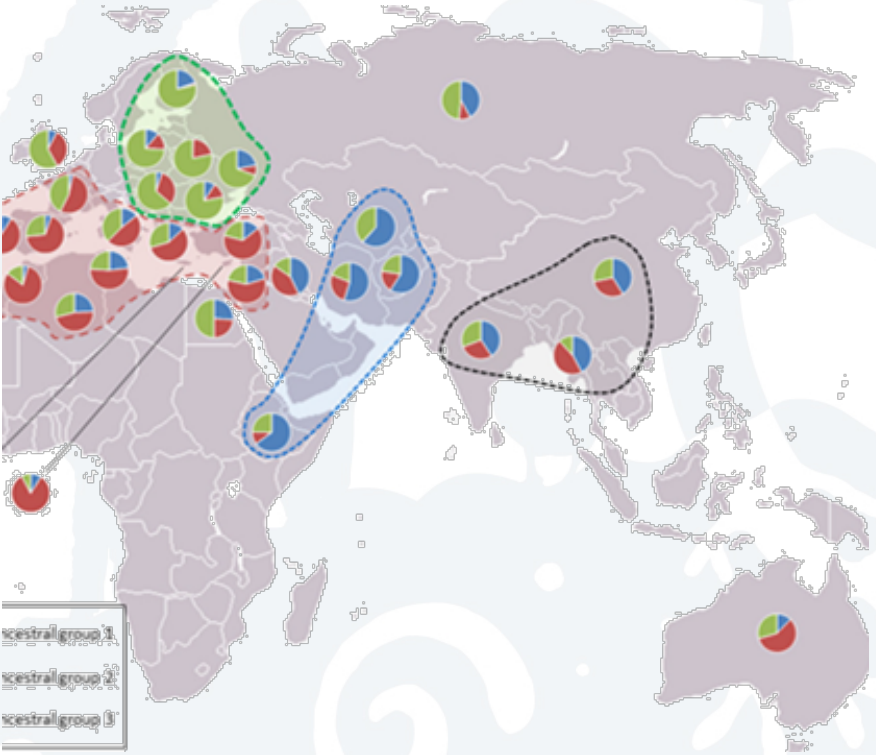
2) **find the genes**, genomic regions or metabolic pathways in wheat that can benefit soil health

3) **develop genetic tools for breeding** to introduce these **beneficial traits** in commercial cultivars.



The **WISH-ROOTS** will explore two **germplasms** resources for **root traits**

A.E. Watkins bread wheat landrace collection



Germplasm Resources Unit, JIC
UK
Designing Future Wheat

SeedStor

DFW

https://www.seedstor.ac.uk/

https://designingfuturewheat.org.uk/

GrainGenes
A Database for Triticeae and Avena

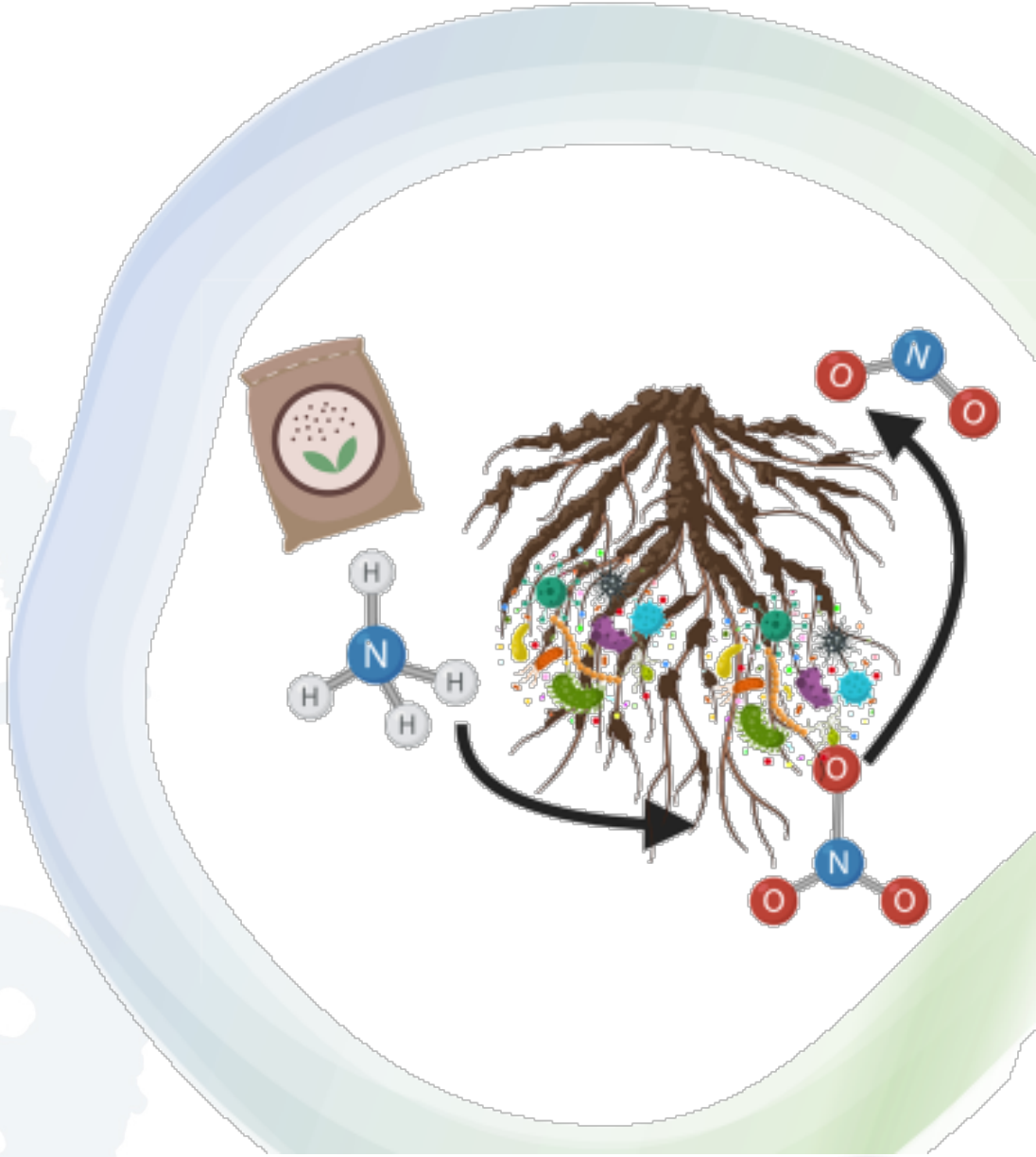
https://wheat.pw.usda.gov/GG3/

Tetraploid global collection

Grain Genes
Global Durum Genomic Resources
Svevo Genome project

Why do we need to optimize nitrogen cycling?

Globally, half of the N-fertilizer applied to crops is lost to the environment



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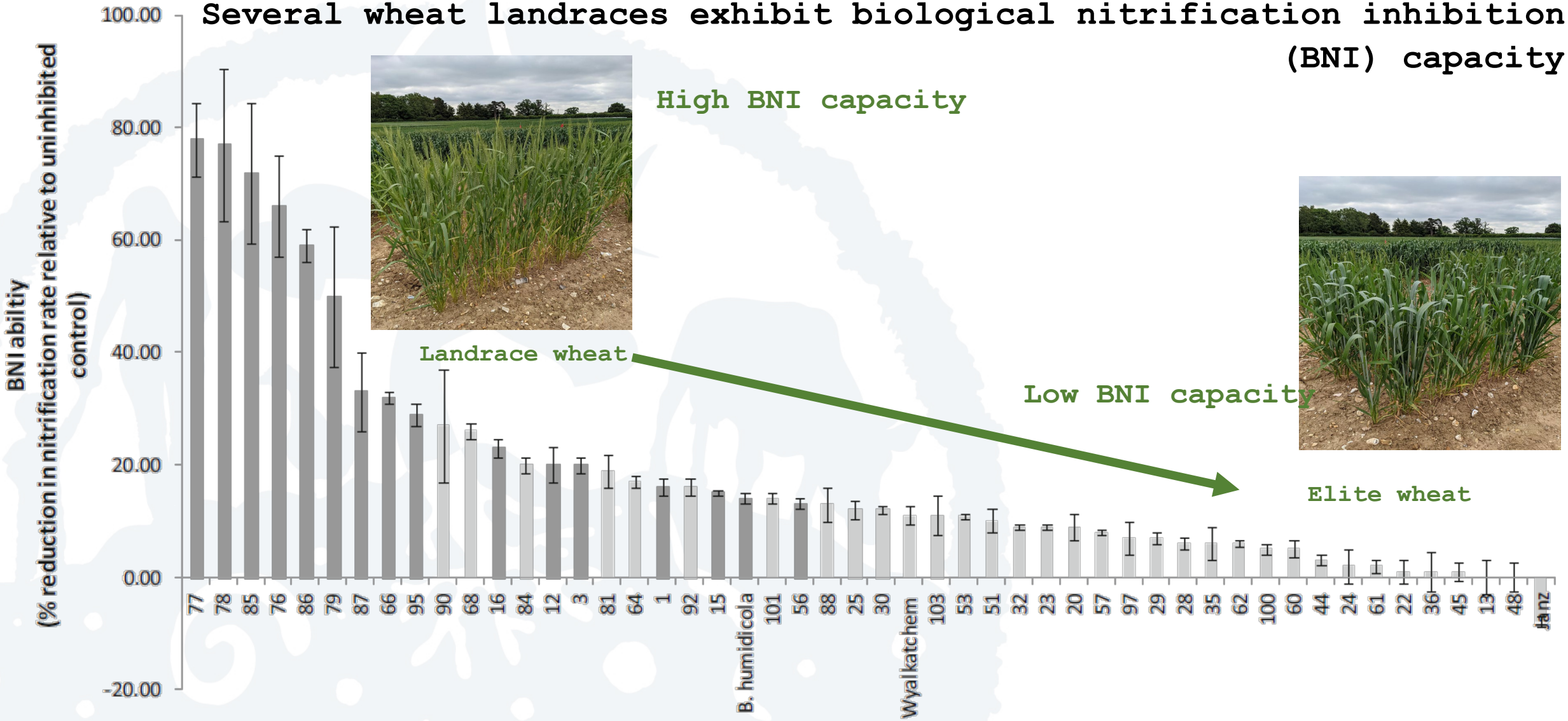
Several wheat landraces exhibit biological nitrification inhibition (BNI) capacity

High BNI capacity

Landrace wheat

Low BNI capacity

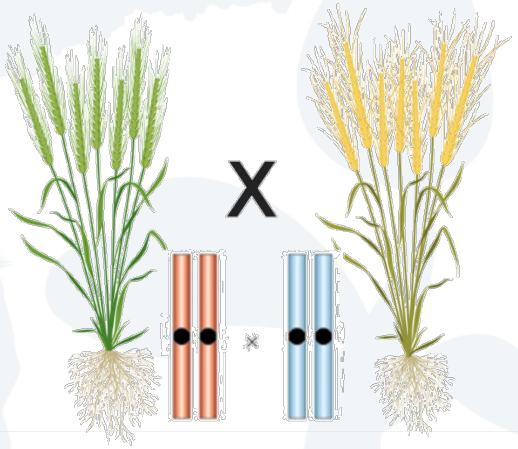
Elite wheat



O'Sullivan CA. et al. Plant and Soil 404.1 (2016): 61-74

Genetic loci for BNI capacity in wheat

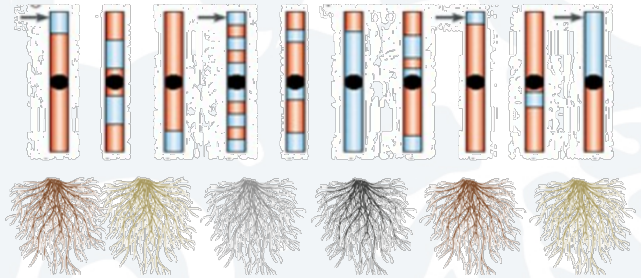
Low BNI
Paragon

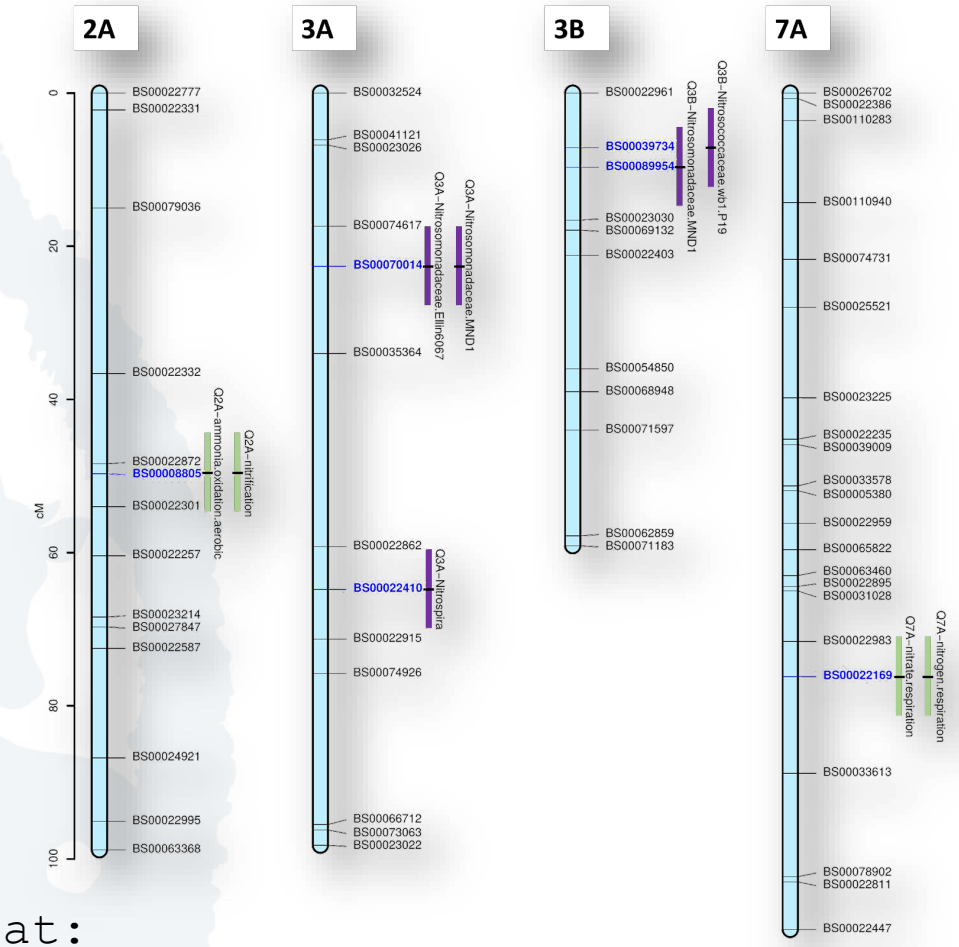


High BNI
Watkins landrace

[a]

Quantitative trait loci (QTL) mapping: linking BNI activity - wheat genes [b]





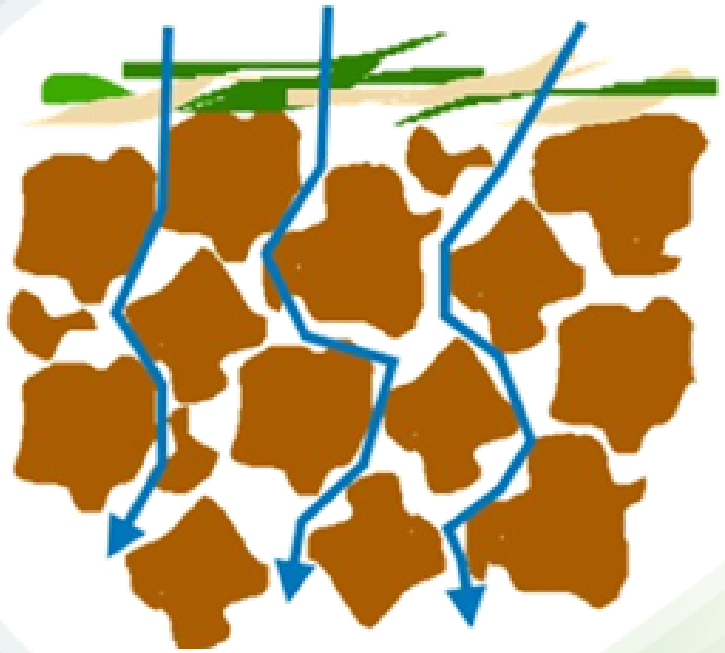
Recombinant inbred lines (RIL) **[b]** of bread wheat: individuals contain different fractions of the genome of each parental line

[a] *O'Sullivan et al. 2016 Plant Soil 404:61-74*

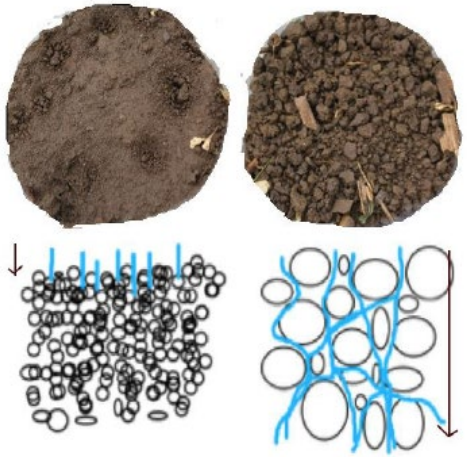
[b] *Wingen et al. 2017 Genetics 205(4):1657-1676*

Root traits to support soil structure?

- Aggregation
- Water retention capacity



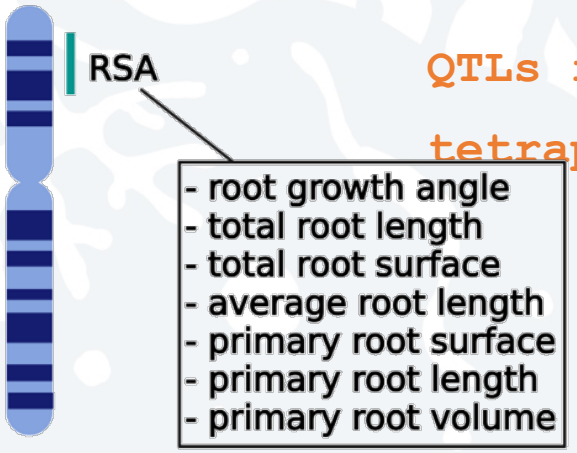
Traits related to root architecture can improve soil structure



wide root angle, shallow roots

narrow root angle, deep roots

Durum wheat: major locus for Root System Architecture (RSA) on chromosome 6A



QTLs for root system architecture in tetraploid wheat

Maccaferri M. et al. 2016 Journal of experimental botany, 67(4): 1161-1178

Kirschner GK. et al. 2021 Proceedings of the National Academy of Sciences 118.35

https://www.wishroots-ejpsoil.net/

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