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for Organic Farming

AVENUE - Breeding organic Avena Sativa L. (Oat) with high nutritional value

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novo nordisk
foundation

AVENUE Project partners

The James Hutton Institute

Nordic Genetic Resource Center

Aarhus University, AU-QGG

The importance of oat in organic agriculture

Denmark has the highest organic market share worldwide and is a large exporter of organic products

Oat is a priority crop for sustainable high-yield agriculture

Traditionally been considered a low-input crop

One of the largest organically produced crops in Denmark

One of the healthiest grains on earth: rich in protein, minerals, antioxidants and β-glucan fibre

Large ex-situ collections are available

New genomics resources: oat reference sequence and pangenome published recently

The challenges and potential solutions

The key issue for oat producers, is the lack of stability in year-to-year supply and quality, largely due to seasonal fluctuations in environmental factors.

Crop varieties grown under organic conditions are more responsive to these interactions than those grown conventionally

Grain quality traits are largely influenced by genotype, environment, and their interactions

The overall aim of AVENUE is to identify nutritionally superior and yield-stable oat accessions through a combination of experimental and on-farm field trials across diverse environments and organic management systems.

Research Plan

200 Nordic oats

WP1: Grain Diversity
Field trials different environments and on farm

AVENUE

WP2: Genetic Diversity
Sequence based captures of grain quality genes

Post harvest phenotyping: grain shape, size and TGW

Identify novel variation across grain related genes

WP3: Prediction Models
Evaluating the relationship between GxExM

Outcomes

Robust oat accessions
Combining grain traits and organic low input

Affordable grain phenotyping
Novel fast and reliable

Simple genetic marker
Marker assisted breeding

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The panel for AVENUE

- 175 NordGen accessions provided

Origin	Count
Sweden	63
Finland	36
Denmark	32
Norway	19
United States	4
UK	2

Level Of Improvement	Count
Cultivar	101
Landrace	62
Breeding/research material	7
Other	5

- 24 cultivars from breeders

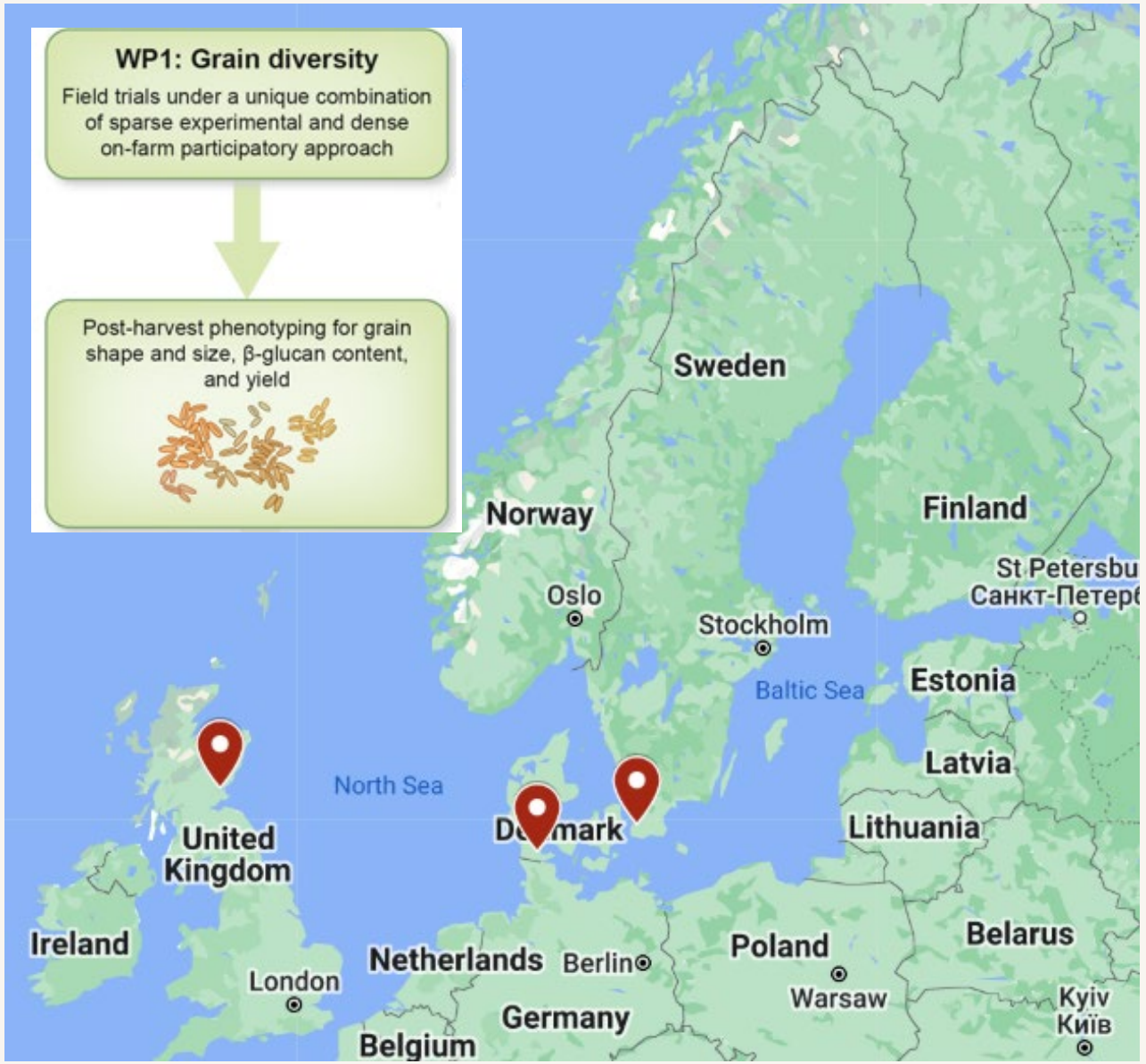
Variety name	Supplier
Peppi	Boreal
Taika	Boreal
Taliko	Darzau Getreidezüchtungsforschung
Hanstad	Graminor
Hurja	Graminor
Odal	Graminor
Vinger	Graminor
Dominik	Hornsyld købmandsgaard, N&S
Conway	IBERS
Oliehavre	Landsorten, DK
Active	Lantmännen
Eos	Lantmännen
Fatima	Lantmännen
Galant	Lantmännen
Nike	Lantmännen
NOS Conrad	Nordic Seed
Symphony	Nordic Seed
Asterion	Nordsaat
Benny	Nordsaat
Caledon	Nordsaat
Canyon	Nordsaat
Isabel	Saaten Union
Lion	Sejet
Scotty	Sejet

WP1: Grain diversity

Experimental trials: 200 oat accessions (2 reps) at 3 different locations (2025, 2026)

Participatory on-farm trials: 3-5 representative accessions at ~20 organic farms (2027)

Descriptors measured in the field:
Plant coverage
Weed coverage
Diseases
Height
Heading date
Yield
<u>Grain analyses:</u>
- Shape and size
- TGW
- β-glucan
- Protein



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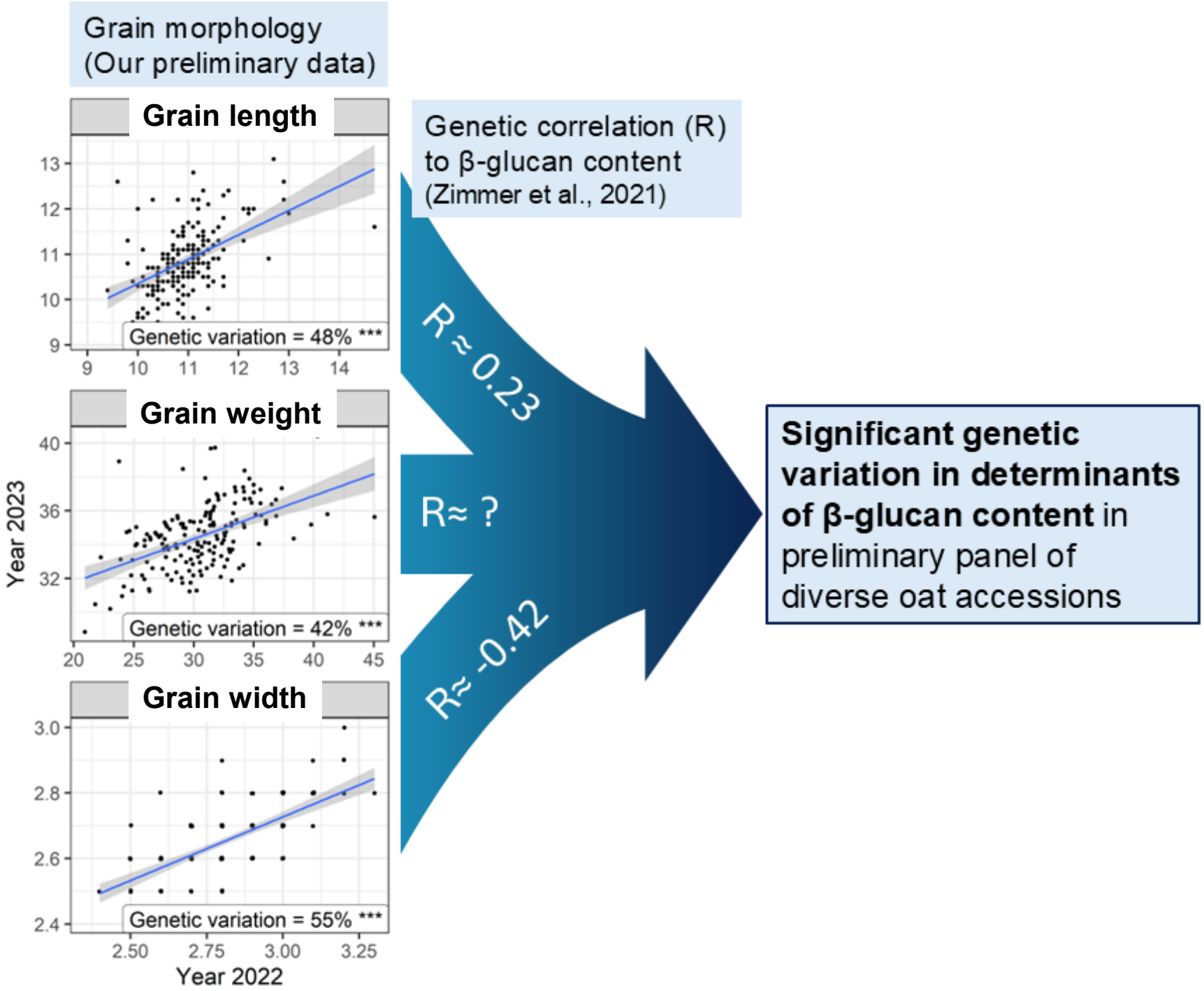
Genetic diversity for grain morphology and β-glucan content



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Organic field trial in Denmark – 24may 2025

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Organic field trial in Sweden

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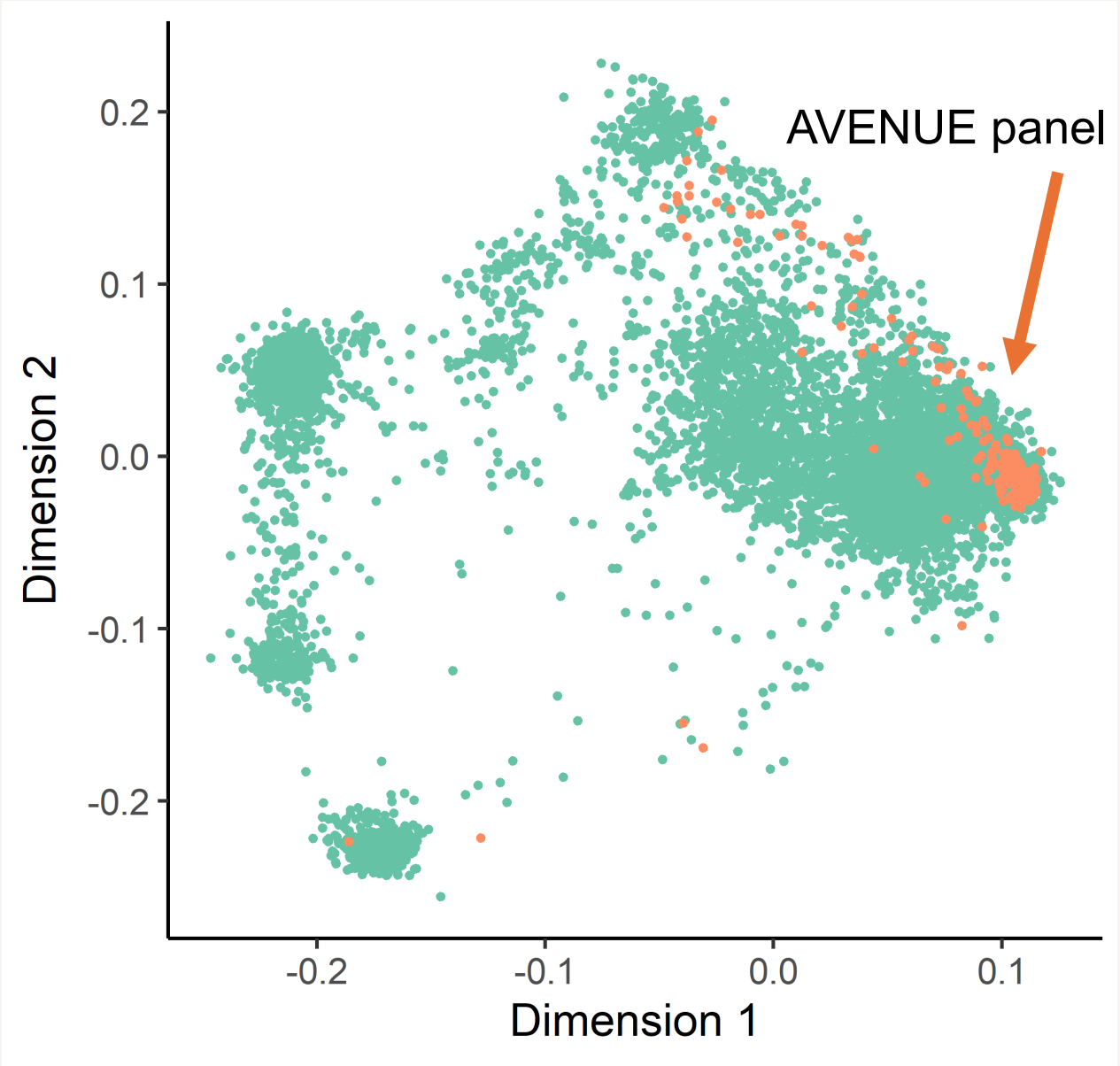
Genetic diversity

- Genotype information for 199 datasets (genotyping by sequencing)

Pre-publication access to GBS data from *Tsardakas Renhuldt et al., Genomic and phenotypic analysis of Nordic oats reveals diversity patterns and breeding opportunities. Manuscript in preparation.*

- Analysing diversity in β-glucan biosynthesis and seed storage protein gene families
  - ~120 genes in total
  - ➢ In the PanOat data
  - ➢ Developing a diversity capture



Data from global panel from:
Bekele, W.A., Avni, R., Birkett, C.L. *et al. Nat Commun* **16**, 9486 (2025).
https://doi.org/10.1038/s41467-025-57895-3

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