Time travelling with T*riticum*

An Ecotron experiment to study the wheat of the future

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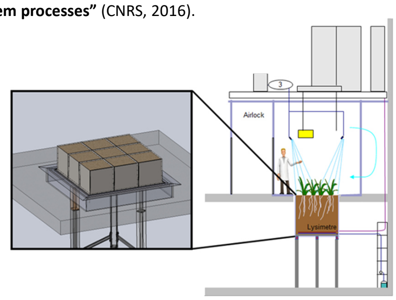
BIOFAIR holistically determines **soil biodiversity** under different farming practices and environmental stressors to **anticipate negative impacts** of climate change on belowground processes and **provide adaptation strategies**. On the crop site, a specific focus is given to grain quality parameters such as **vitamin and mineral nutrient contents** and to technological bread making properties such as flour viscosity, to ensure the crops of the future have a **high nutritious value** and are **suitable for food production.**

What is an Ecotron?

"An Ecotron is a set of **replicated experimental units** where <u>**ecosystems**</u> are confined in enclosures allowing simultaneously the **control of environmental conditions** and the **online measurement of ecosystem processes"** (CNRS, 2016).

The **Ecotron at TERRA Gembloux Agro-Bio Tech**

Controlled variable	Range	Regulation precision
Air relative humidity (%)	7 - 95	5
Air renewal (m^3/h)	0 - 200	10
Air temperature (°C)	4 - 40	1
Biosafety	L2	-
Calm air speed (m/s)	0.1 – 0.3	0.1
Carbon dioxide (CO_2 ppm)	[ext.] - 800	10
Chamber air pressure (Pa)	Ext. P – 15	5
Irradiation (PAR m^{-2} s^{-1})	0, 60 - 1200	20
Number of rain event per day (-)	0 - 13	-
Ozone (O_3 ppb)	10 - 300	10
Rain event volume (l)	0.2 - 7	0,02
Soil basal temperature (°C)	5 - 20	1
Soil basal water potential (kPa)	-100 - 30	1
Turbulent air speed (>0.5m/s)	on/off	-

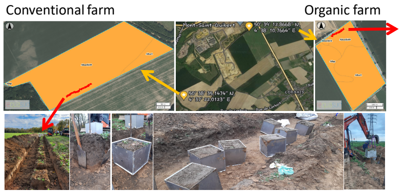


By studying the **physiological performance of wheat plants** together with the **activity of the associated rhizosphere micro- and mesofauna populations** in multiple climate scenarios, we disentangle **biodiversity-ecosystem functioning** relationships and gain mechanistic insights to major **biogeochemical cycles.**

Conventional vs. organically managed soils: Which impact on crop resilience to climate change and plant nutrient uptake?

Two related soils (both classified Aba(b)0) with **contrasting long-term farming history** were sampled as **intact soil monolith** (125 liter / 200kg each) and moved to the Ecotron. The cubes were planted with winter wheat (*Triticum aestivum* (L.) var. Asory) at a density of 308 seeds m^{-2} (77 seeds per cube).

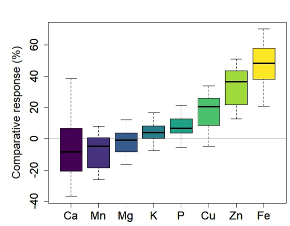
Conventional farm — Organic farm



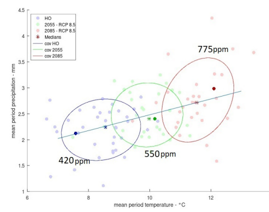
2 x 27 cubes (50x50x50cm)
→ moved to the Ecotron,
→ planted with winter wheat
→ exposed to the **meteorological conditions of the present and the future**

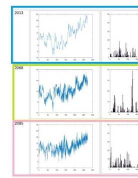
Wheat grain quality : Will wheat grains in the future provide us with sufficient protein, nutrients and vitamins?

Winter wheat grains contain **all of the eight essential B-vitamins**: thiamin (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B7), folic acid (B9) and cobalamin (B12). Wheat is an important source of **protein** and contains several **micronutrients** such as iron (Fe), magnesium (Mg), calcium (Ca) and zinc (Zn).



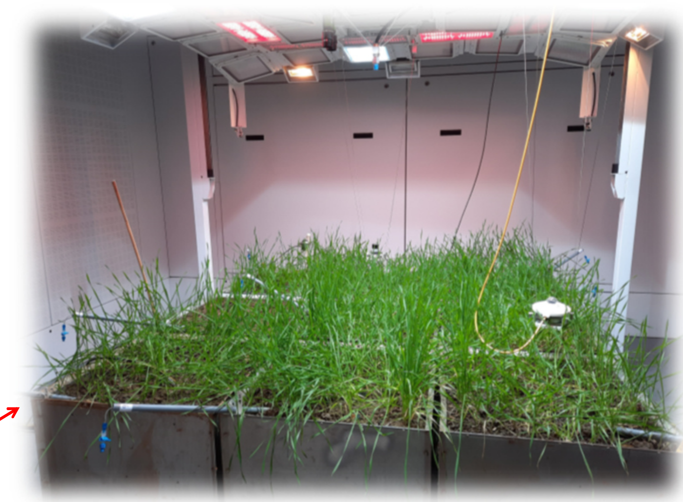
Climate change : How will winter wheat (*Triticum aestivum* L.) cope with the weather in 2013, 2068 and 2085?





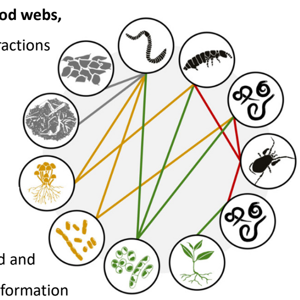
Harvest year	Mean temperature (°C)	Mean precipitation (mm)	Hydrothermal index
2013	7.59	2.12	3.99
2068	10.17	2.40	4.49
2085	12.10	2.98	4.74

Ecotrons can **materialize any meteorological condition** for which sufficient data is available. Here, we used **historical data of continuous climate observations** from the Ernage meteorological station (Gembloux, Belgium, since 1980) and predicted **future meteorological conditions using the Alaro-0 model** (Giot et al., 2016). The model ran for the Representative Concentration Pathway (RCP) scenario 8.5 Wm^{-2} (IPCC, 2014) and the two time periods 2040-2070 and 2070-2100. We chose **three years along a continuous gradient** of increasing temperature, precipitation, hydrothermal index (HI= R / 0.1 ∑t , Meshcherskaya & Blezhevich 1997) and atmospheric CO_2-concentrations.



Soil biodiversity: Which organisms maintain soil functions and how is soil life affected by climate change?

To understand the **trophic multifunctionality of soil food webs,** soil communities and belowground–aboveground interactions are described comprehensively. For this purpose, soil organisms are classified by their size, mobility, feeding preferences and prey-protection traits. **Energy transfer** between trophic guilds is calculated using food web reconstruction and assimilation efficiencies. By these means, **indicators of system stability** and top-down control can be identified and related to soil biogeochemical cycles, notably the transformation of organic matter (Potapov, 2022).



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