

# An instrumented agroforestry site in Lorraine: optimizing productivity and sustainability of intensive cropping systems through symbiotic nitrogen fixation

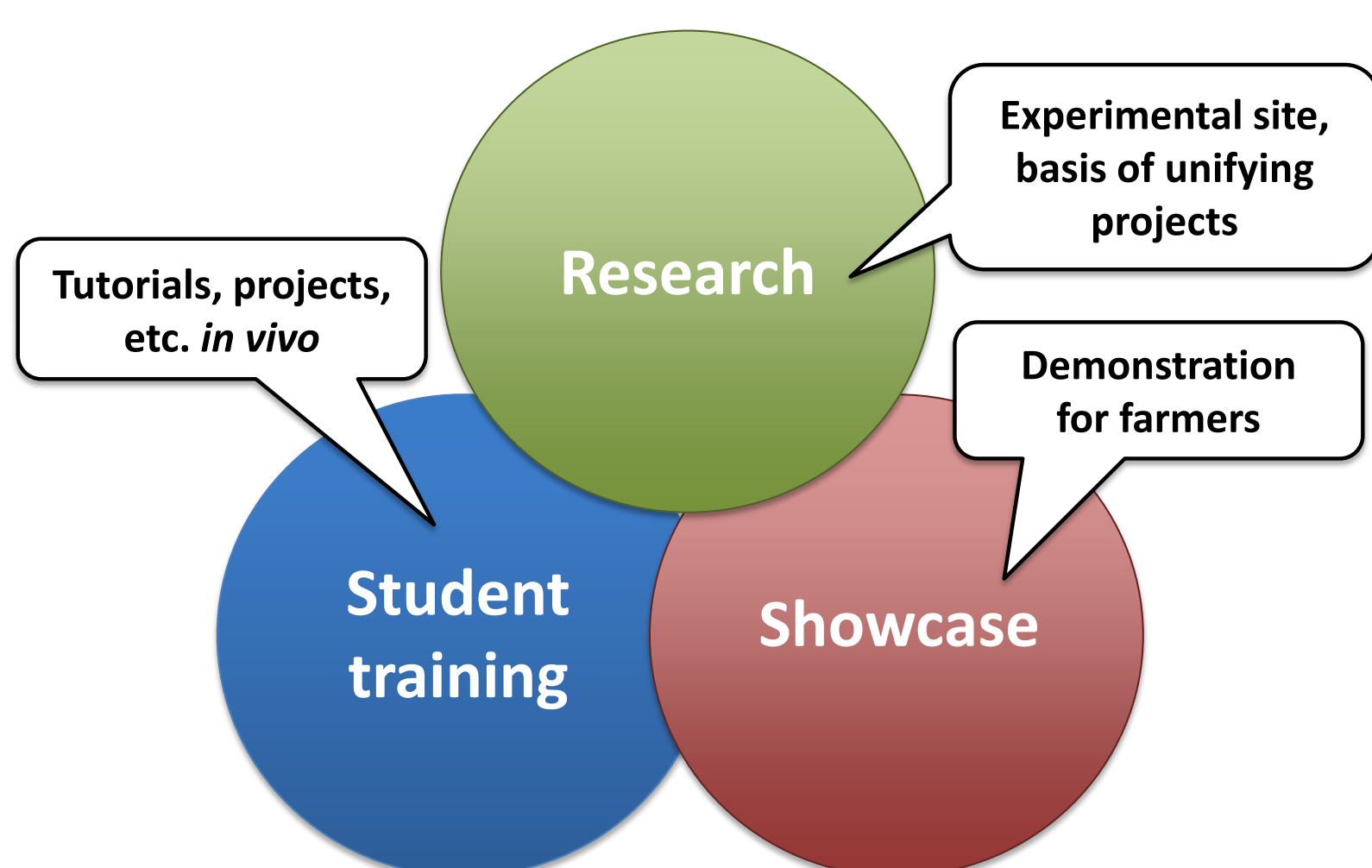
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## Issues

- In temperate areas, intensive timber plantations for energy purposes, such as **short rotation coppice** (SRC), are criticized.
- They are known to deplete the soil in nutrients and to **bring no real profit**.
- The combination of **atmospheric nitrogen fixing species** with fast growing species (i.e. poplar) may be a sustainable alternative.
- The nitrogen fixing species can be woody (alder) or grass (alfalfa).



## Objectives

- Research in agroforestry is lacking behind in France and Europe, unlike North America and Asia.
- The **agroforestry** plantation in Lorraine has the **triple function** of being an experimental research site, an opportunity for students for field courses, and a showcase for farmers.



July 2, 2015: Poplar monoculture



July 15, 2015: Alder row as a border of agroforestry (alder / wheat) and forestry plots (alder monoculture)



August 13, 2015: Poplar monoculture. Behind: Wheat plot



Semi-mechanic weeding around the trees

## Partnership

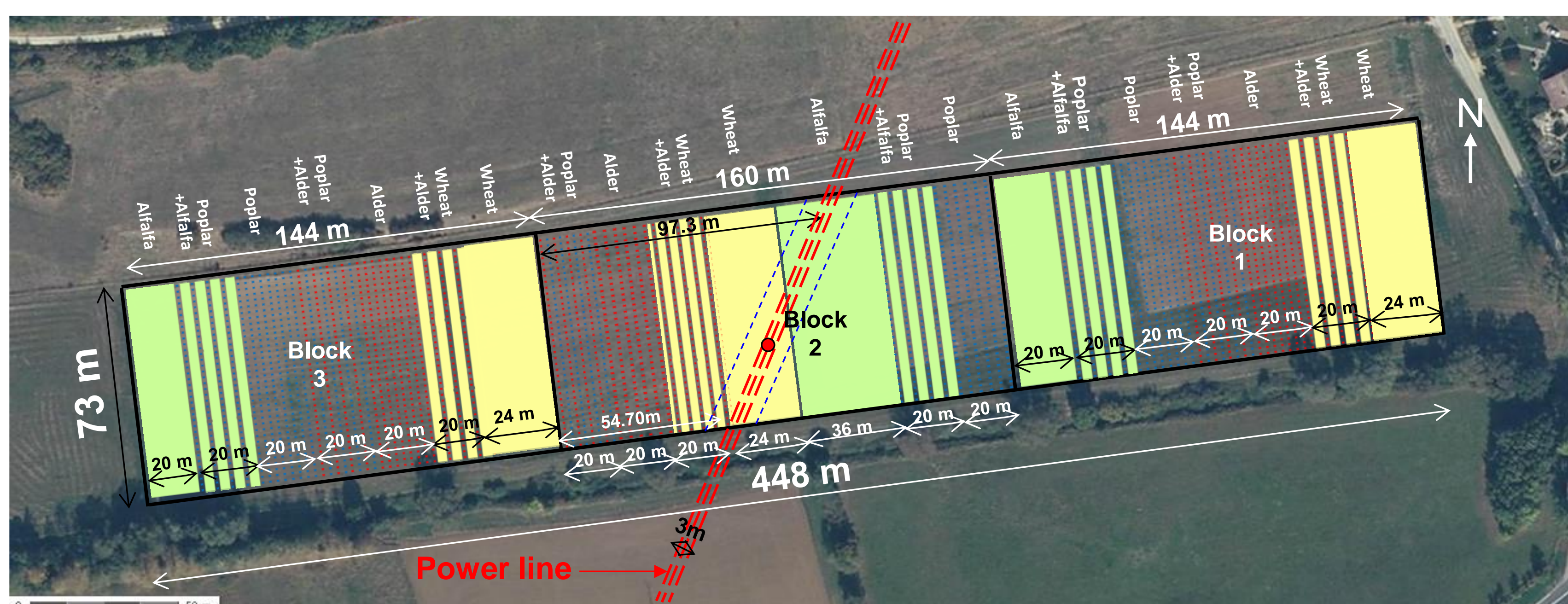
The project is lead by the INRA – Lorraine University Unit, “Forest Ecology and Ecophysiology (UMR 1137 EEF)” in close collaboration with the INRA – Lorraine University Unit “Laboratory Agronomy and Environment (UMR 1121 LAE)”.

The “Trees – Micro-organisms Interactions (UMR 1138 IAM)” and “Biogeochemical cycles in Forest Ecosystems (UR 1138 BEF)” Units also contribute. The establishment of the site was supported by the French National Research Agency through the Laboratory of Excellence ARBRE (ANR-12- LABXARBRE-01).



## Site

The field of 5 hectares belongs to the experimental farm of La Bouzule (Meurthe-et-Moselle, 48° 44'N, 6° 18' E). It presents a slight slope to the south where it is bordered by a river. The annual average rainfall is 823 mm and the mean annual temperature is 9.6°C. The soil is composed of two-thirds of clay and one-third of silt. The plantation has been installed in April 2014, with *Populus deltoides* × *P. nigra* cuttings and *Alnus glutinosa* seedlings (almost 3500 plants). A station for the continuous monitoring of soil and climatic conditions is currently being installed.

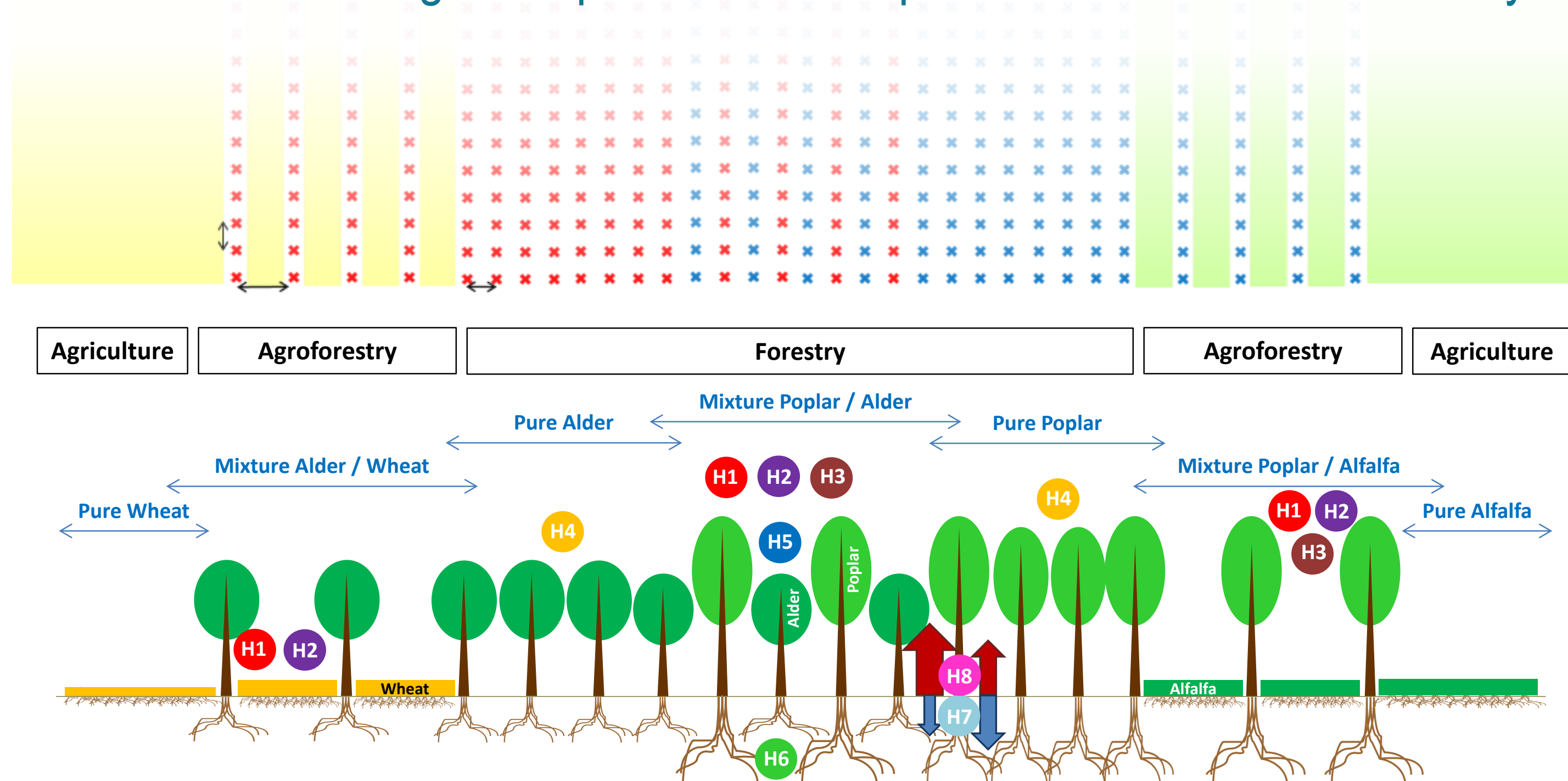


## Layout

The plantation is composed of three types of plots:

- **Agricultural plots** (pure wheat, pure alfalfa),
- **Forest plots** (pure poplar, pure alder, mixture poplar / alder)
- **Agroforestry plots** (mixture poplar / alfalfa, mixture alder / wheat)

In addition, two herbaceous mixtures were planted in the forest plots to estimate the ecological impact of the tree plantations on floristic diversity.



## Scientific hypotheses

**H1:** The **growth** of the non-nitrogen-fixing species is **stimulated** by fixing species in the mixture ...

**H2:** ... **through an increase of the nitrogen stock** in the soil ...

**H3:** ... resulting in **increased leaf area and photosynthetic assimilation** of non-fixing species

**H4:** In forest plots, the **competition** is more intense in monoculture for poplar; inversely for alder

**H5:** **Canopy stratification** in the mixture allows better capture of the light resource

**H6:** A **stratification of root systems** in the mixture allows better capture of water and nutrients

**H7:** The fraction of assimilated carbon allocated to the underground compartment is lower in the mixture

**H8:** The **aboveground production is improved** in the mixture

→ The ratio “Net Primary Production” / “Carbon flux to the underground compartment” increases in the mixture (**H9**)