
UNIVERSITÉ DE LORRAINE
UMR Silva
INRAE
Wood yield in two agroforestry systems including nitrogen-fixing species after nine growing seasons
Agro-TCR
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AnaEE
Analysis and Experimentation on Ecosystems
France
EURAF
2024

# Context

Increasing demand:

- for renewable energy sources, including **wood biomass**
- for more **sustainable production systems**

➔ **Agroforestry combining fast growing tree species and nitrogen fixing species**

What are the effects of the association of species on tree performances in temperate agroforestry systems?

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# Context

**Objective:**

To compare growth performances of fast-growing trees (poplar, alder) in agroforestry and in monoculture

**Hypotheses:**

Trees with better growth performances in agroforestry than in monoculture due to:

(1) a *reduced competition* between species

(2) a *facilitation* effect due to the presence of $N_2$-fixing species

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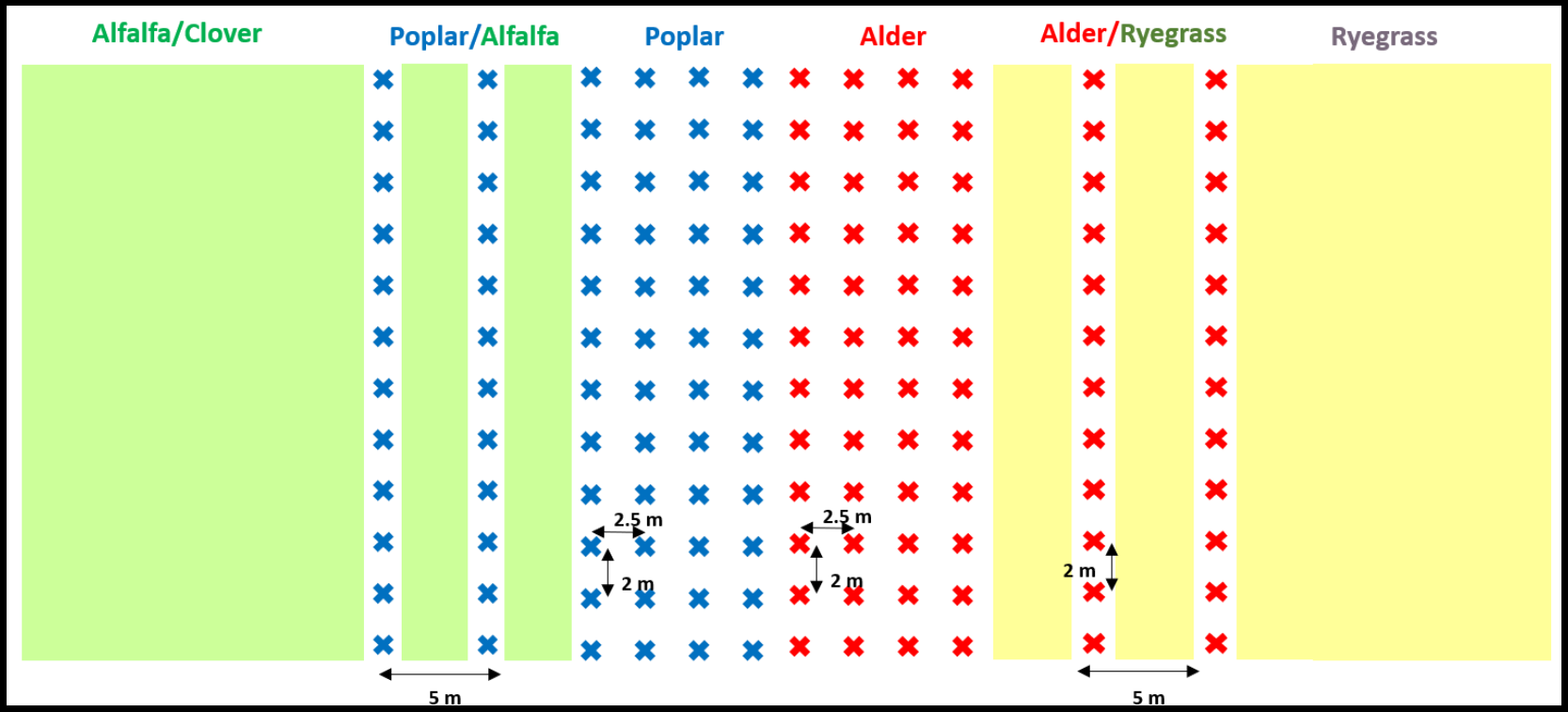
# Trial

## Two tree species and two crops in association or in monoculture

- Poplar (*Populus deltoides* × *Populus nigra*)
- Alder (*Alnus glutinosa*)
- Alfalfa (*Medicago sativa*, 2014-2018), clover (*Trifolium pratense*, 2018-2022)
- Temporary grassland (ryegrass, fescue)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August 2014


August 2015
EURAF
2024


August 2016
EURAF
2024


August 2017
EURAF
2024


July 2018
EURAF
2024


August 2019
EURAF
2024


August 2020
EURAF
2024


August 2021
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2024


July 2022

February 2023

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# Protocol

Fresh weight (and then dry weight) of each stem section and branches

1 m


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# Protocol

## Biomass production expressed at different scales

**Individual tree**

Aboveground tree biomass (kg, n=60 trees)
➔ Extrapolated to all trees (~3600 trees)

**Tree population**

Wood yield ($Mg.ha^{-1}.year^{-1}$, n=3 blocks)
taking into account planting density and tree mortality

**Agroforestry system**

Land Equivalent Ratio, LER (n=3 blocks)
taking into account crop and tree yields

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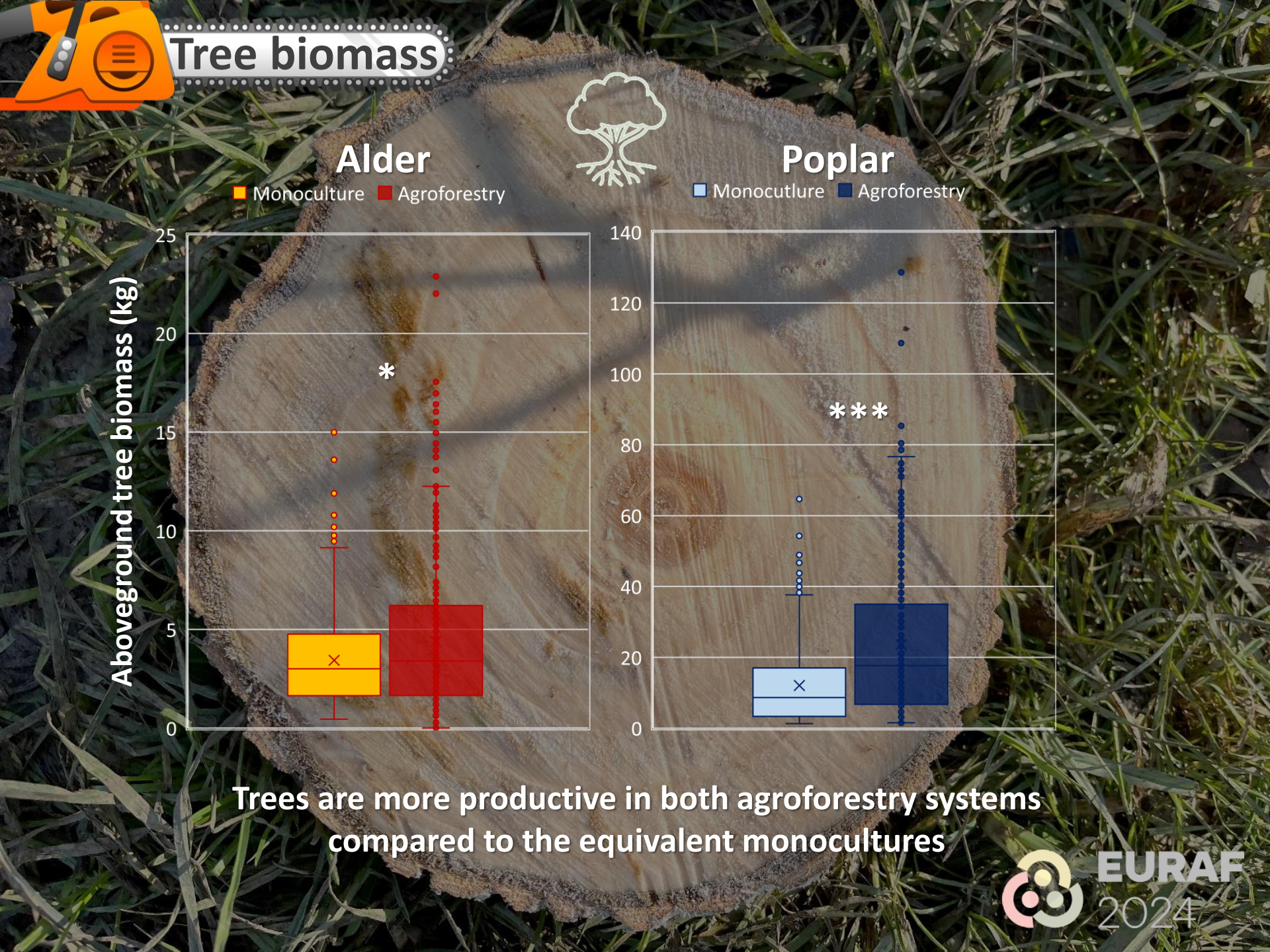
# Tree biomass




**Trees are more productive in both agroforestry systems compared to the equivalent monocultures**

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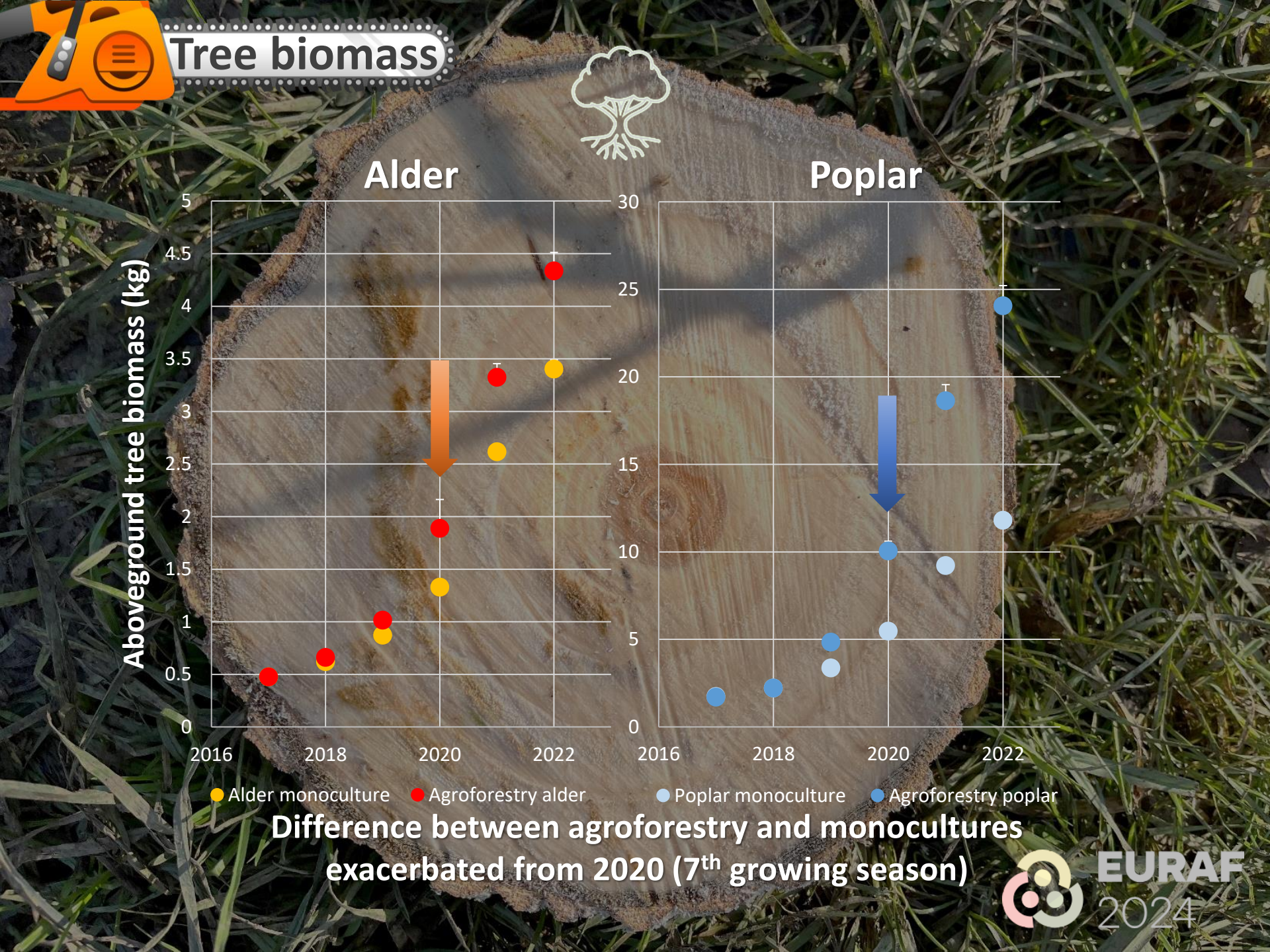
# Tree biomass




**Difference between agroforestry and monocultures exacerbated from 2020 (7th growing season)**

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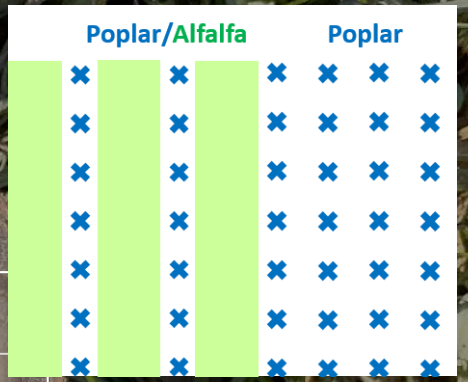
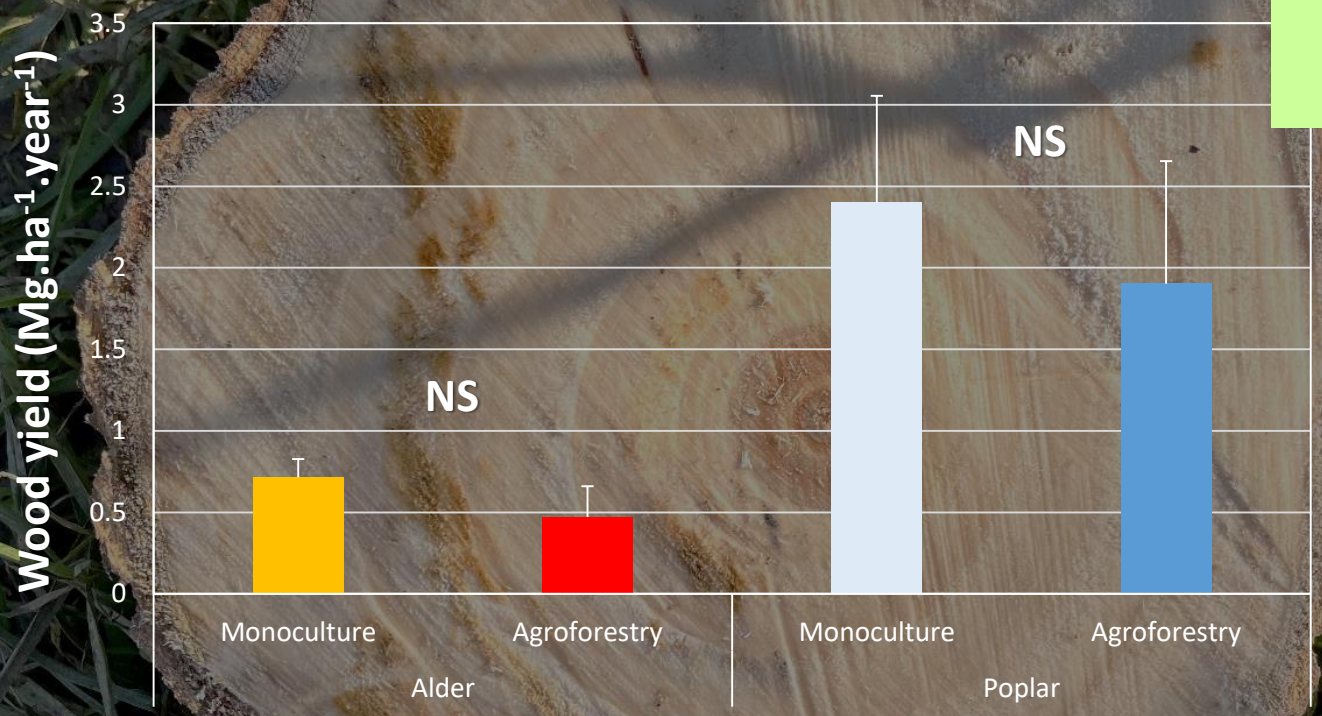
# Wood yield




**Wood yield per ha is not significantly different between agroforestry and monocultures**

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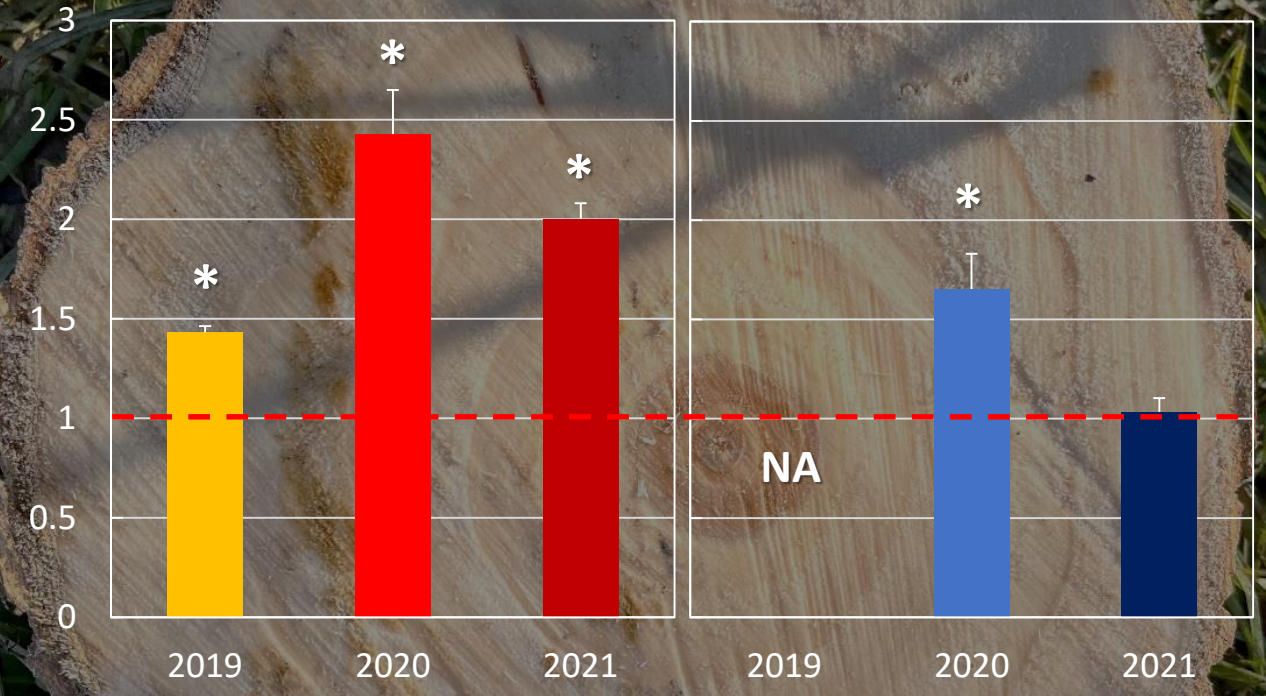
# LER




**Land Equivalent Ratio much superior to 1**
**(but before 2021 for the poplar agroforestry system)**

➔ **The two agroforestry systems are much more productive than the same area of crop and tree monocultures**

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# Take-home

## Can we recommend these agroforestry systems?

It depends on the scale (and on what you want to produce)

Yes, trees are bigger than in monocultures!

But no, wood yield per ha is not higher than in monoculture…

But yes, the agroforestry system produces a lot more than pure plots of crops and trees!

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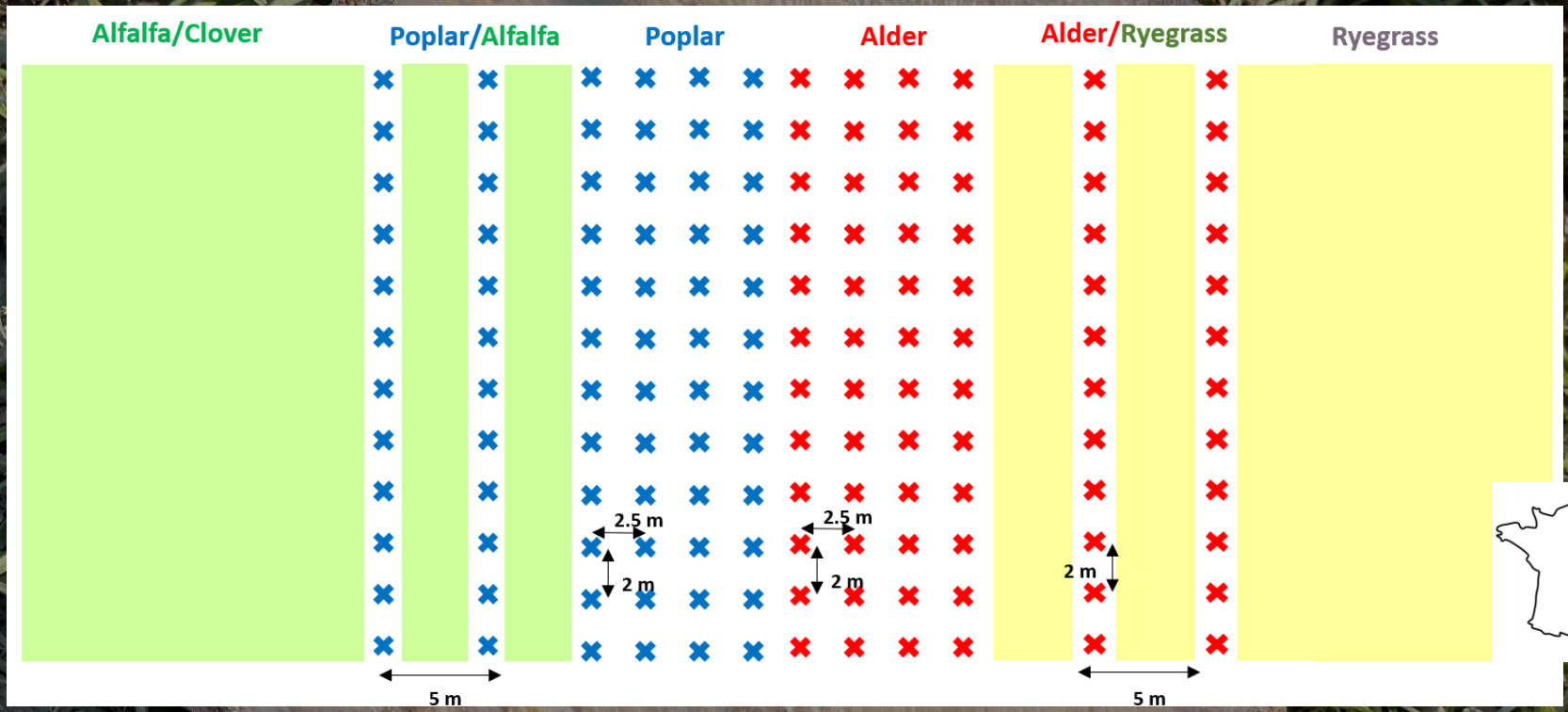
Thank you!
(to you and to all the participants to the tree harvest)

# Trial

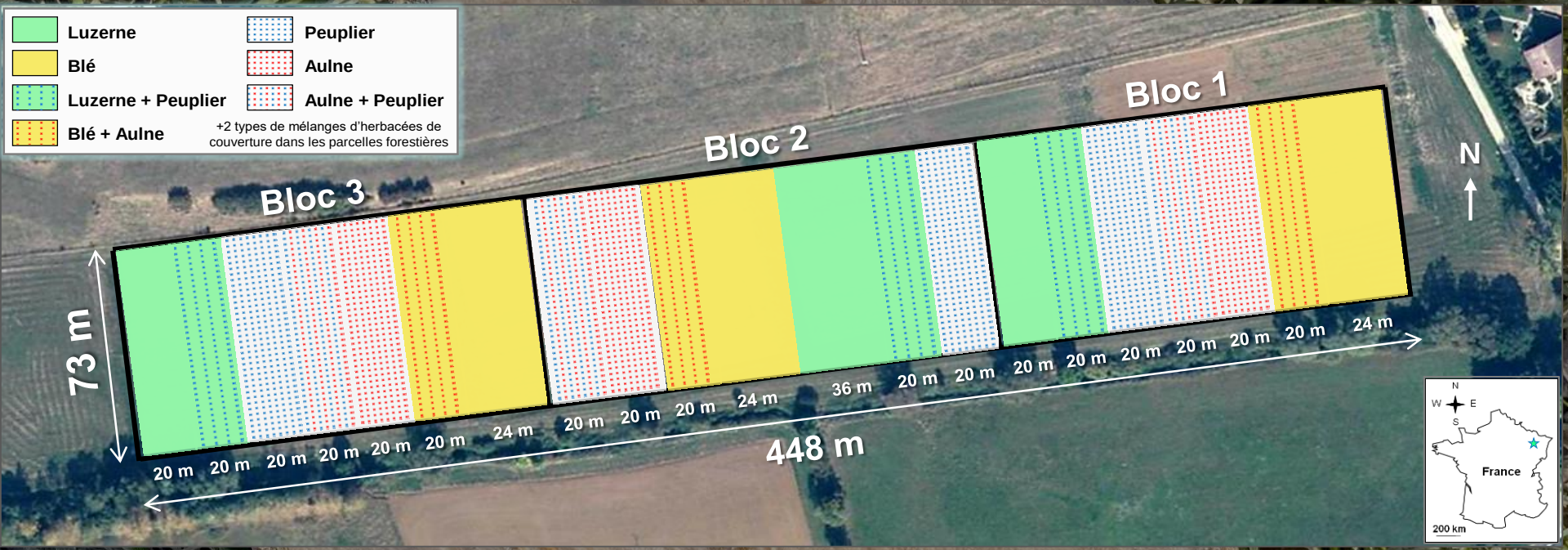
- Poplar (*Populus deltoides* × *Populus nigra*)
- Alder (*Alnus glutinosa*)
- Alfalfa (*Medicago sativa*, 2014-2018), clover (*Trifolium pratense*, 2018-2022)
- Succession wheat (*Triticum aestivum*), Triticale and temporary grassland (ryegrass, fescue)







# Trial


Luzerne
Blé
Luzerne + Peuplier
Blé + Aulne
Peuplier
Aulne
Aulne + Peuplier
+2 types de mélanges d'herbacées de couverture dans les parcelles forestières
Bloc 3
Bloc 2
Bloc 1
N
73 m
20 m 20 m 20 m 20 m 20 m 20 m 24 m 20 m 20 m 20 m 24 m 36 m 20 m 20 m 20 m 20 m 20 m 20 m 20 m 20 m 24 m
448 m
N
W
E
S
France
200 km

# Chronology

## Trees

Plantation → 1st rotation (9 years) → Harvest

Thinning

| 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|

## Crops

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wheat | | Triticale | | Grassland (ryegrass / fescue) | | | | | |
| Alfalfa | | | | Clover | | | Alfalfa | | |