Transformative changes in Tree Breeding to reinforce the contribution of European forest to adaptation and mitigation challenges

Catherine Bastien and all B4EST collaborators

INRAE

B4est

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Forests are moving to the center of political attention

C sequestration

Reservoir of biodiversity

protection

C substitution

Bioeconomy

Forests cover a high but varying % of global land area in European countries

Healthy forests are the foundation to provide goods and services

Mega fires

Forest dieback

(Deforestation)

We need forests more than ever ….. but forests need science and adjusted policies

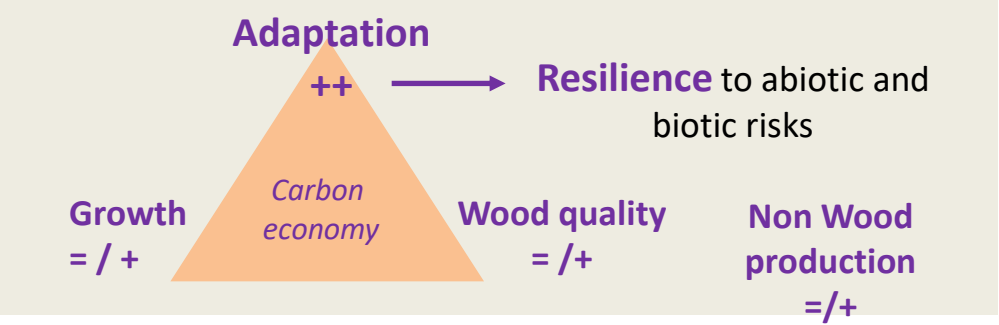
Perception of Tree Breeding in Europe

Forest Based Sector : *2019 survey coordinated by D. Roitsch & G. Winkel (EFI)*

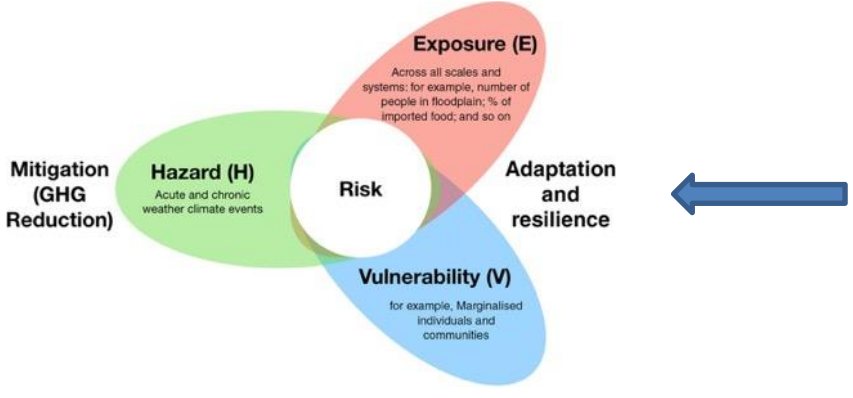
565 responses – 9 EU countries

High expectations on :

- **Diversification** of tree species
- **Plantation with improved FRM** and revision of **guidelines**
- **Enrichment** of natural regeneration with **better adapted FRM**



-> from contribution to **performance** of planted forests to **forest risk management**



Perception of Tree Breeding in Europe

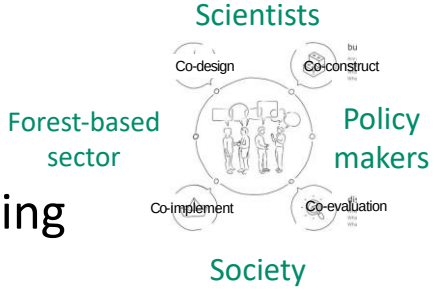
Society : *EU survey for European Forest strategy, national consultations (i.e. F in 2021), associations*

- **Erosion** of biodiversity
- **More intensive** forestry
- **Increased risks**
- **Landscape quality** erosion

-> environmental challenges, natural and heritage protection, OneHealth

A dialogue to strengthen to demonstrate breeding contribution to long term diversity management

- **Differences**/similarities between crop and tree breeding
- **Conventional** / **Genome-Informed**/ NBT breeding
- Continuum – mutual benefits of conservation and tree breeding strategies



Adaptive vs Transformative changes in Tree breeding

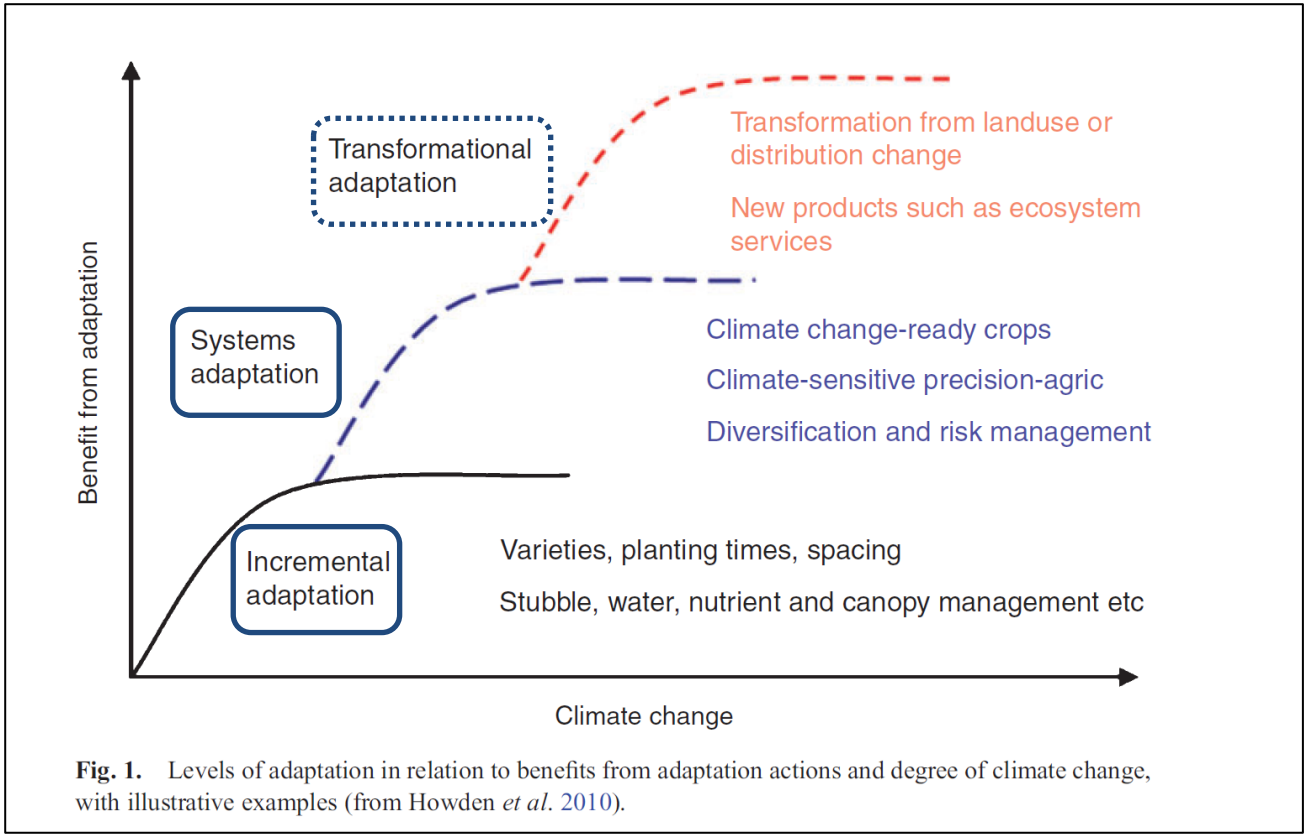


Fig. 1. Levels of adaptation in relation to benefits from adaptation actions and degree of climate change, with illustrative examples (from Howden *et al.* 2010).

Source: Rickards and Howden (2012).

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Tree Breeding is still considered a lever to meet challenges

Forest ownership/Policies

Socio-ecosystem

Knowledge and tools development

Project strategy

objectives, accepted risks, decision

Planted forest

Genetic resources
(species and genetic diversity)

Phenotype ↕ Genotype

Environment

climate + soil + biotic components

Spatial and temporal deployment

Silviculture

Breeding Economy

Genetic Resources

Evaluation

Selection

Recombination

Deployment

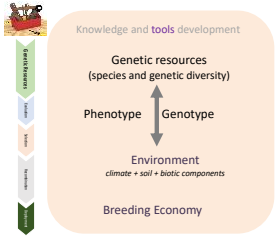
C1 - Adjust methodologies to accelerate processes and consider diversity of expectations

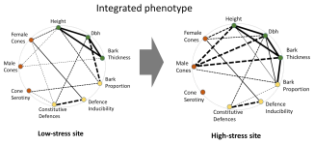
C2 - Share new knowledge on vulnerabilities to risks and adaptive potential

C3 - Better combine breeding with others levers (i.e. silviculture , bioeconomy, …)

Transformative changes in Tree Breeding explored in B4est

New knowledge





- Tree responses to **climatic drivers** (URF)
- Genetic variation for **vulnerabilities** to **known** abiotic and biotic risks -> *more reliable than resistance/resilience*
- Local adaptation -> specific environmental adaptation
- More complete **genetic polymorphism** description at **genome scale**
- A large diversity of **plastic responses**
- **Trade-offs** between breeding targets
- Potential of **group selection**
- Comparison of European Breeding schemes and possible changes

Open new Tools

- Standardized past and projected climatic data (**Climate DT, climate matching tool**)
- SNP arrays (Spruce, Scots pine, 4TREE) for **traceability**, **prediction** and **diversity monitoring**
- **Integrative modelling** (multitrait, Genomic selection) to increase precision

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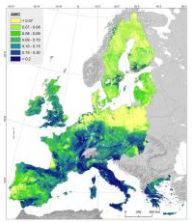
Transformative changes in FRM deployment explored in B4est

New knowledge

- Relevant **new descriptors** of improved FRM to share with users
- Limits of **FRM regulation** to make better use of existing and future FRM
- **Vulnerabilities** to known abiotic and biotic risks -> *more reliable than resistance/resilience*
- FRM responses to **climatic drivers** (URF)
- **Epigenetic effects** and FRM plant stock performances
- **Seed production** risks in South Europe
- Different **uncertainty** levels to integrate in decision-support tool



New Tools - Guides

- Standardized **past** and **projected climatic** data at adapted scales (Climate DT, Climate matching Tool)
- a simulation tool to combine silviculture and genetic composition of FRM scenarios and test innovative uses of improved FRM : Luberon 2
- Planter's guide tool
- Uncertainty descriptors to evaluate
- European regional recommendations (Nordic countries, Scotland, Atlantic regions, Alluvial plains)

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Transformative changes in Tree Breeding and FRM deployment could also benefit from other collaborative efforts :

- High quality **phenotyping at different scales** *(numeric technology)*
- Revision of multi-environment **experiment methodology** (standards, living-labs, participative research and development…)
- **Multi-source information** : Genetic experiments but also information collected thanks to high resolution real-time monitoring of European forests
- **Open Data bases + modelling platforms**

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Transformative changes in Tree Breeding and FRM deployment could also benefit from other collaborative efforts :

- More **interdisciplinary/multi-actor** exchanges and **common projects**
- **Training** ….. We are lacking quantitative geneticists!!!!
- New **skills**, new jobs to integrate technological progress
- Make value of **diversity** of European forests and forest managements
- Do not let South Europe expected help from southern resources and experience

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- All partners of the H2020 project (2018-2022)
- All respondants from forest-based sector to 2019 survey
- Partners from other national or European initiatives involved in a responsible management of forest genetic resources that will secure the future of forests

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