Adapting planted forests genetic to future climate and other risks

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The components of a successful planted forest project

Genetic resources

Environment

climate + soil + biotic component

Genetic diversity (intra and inter specific) = The fuel of evolution (adaptation)

Silviculture

FRM

Project strategy objectives, accepted risks

Planted forest
A positive perception of adaptive tree breeding from the European forest 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**

Adaptation

Resilience to abiotic and biotic risks

Growth = / +  

Wood quality = / +
Adaptation to future climate and other risks is dealing with

1- the **uncertainty** about climatic scenarios

2- increased **inter-annual variability**

3- Cumulative **risks** and risk cascades

WP1: Combine decision theory, thresholds and scenarios with selected climatic indices
The Tree Breeder Tool box

Genetic Resources → Evaluation → Selection → Recombination → Deployment

Knowledge
Available

Adaptation and growth potential to past and present climate to a limited range of environments

Perfomances (Adaptation, Growth, Quality) in a wider range of environments

Local adaptation Genetic diversity

EU « local » Breeding
EU/international « range » Breeding
Natural Genetic Resources In & ex situ
The Tree Breeder Tool box

Genetic Resources

Evaluation → Selection → Recombination → Deployment

Knowledge

Available

To be acquired

EU « local » Breeding

EU/international « range » Breeding

Natural Genetic Resources

In & ex situ

Adaptation and growth potential to present and past climate to a limited range of environments

Local adaptation

Genetic diversity

intensify the sharing of information, expertises, experiences and genetic resources

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The Tree Breeder Tool box

Breeding targets

1950-2000

- Survival
- Growth
- Susceptibility to main pests and diseases
- Wood density

2000-2050

- Phenotypic plasticity
- Resilience
- Efficiency (Water, Nutrient)

Experimentation costs

- More sites
- More climatic years
- Artificial environments
The Tree Breeder Tool box

Breeding targets

1950-2000

2000-2050

Survival
Growth
Susceptibility to main pests and diseases
Wood density

Phenotypic plasticity
Resilience
Efficiency (Water, Nutrient)

Experimentation costs
- More sites
- More climatic years

Coordination of efforts at EU scale
+ Use new technologies (sensing)
+ Develop prediction models

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A multitrait selection which manages trade-offs

Genomic selection to accelerate breeding cycles

Genomic selection to compromise genetic gain and genetic diversity

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A multitrait selection which manages trade-offs

Genetic selection to accelerate breeding cycles

Genomic selection to compromise genetic gain and genetic diversity

Share information about trade-offs and DNA-based tools

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The Tree Breeder Tool box

**Genetic Resources** ➔ **Evaluation** ➔ **Selection** ➔ **Recombination** ➔ **Deployment**

**Longer term options** ➔ **Explore new genetic diversity**

*Controlled crosses between complementary genotypes*  
*« Orchards for future generations »*  
*Ex-situ collections with high genetic diversity in multiple environments*

*Increase frequency of « adapted » alleles and genotypes*  
*Infusion of genetic diversity*
The Tree Breeder Tool box

Genetic Resources ➔ Evaluation ➔ Selection ➔ Recombination ➔ Deployment

Transfer rules

PLANTER’S GUIDE - Scots pine - Skogforsk & Luke

Conditions for recommendations

Performance index

Map of the suitable deployment area for each seed orchard

Comparison of deployment maps for different seed orchards

2019 Survey

Difficulty to access information on FRM

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Genetic Resources → Evaluation → Selection → Recombination → Deployment Transfer rules

2019 Survey

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Map of the suitable deployment area for each seed orchard

Comparison of deployment maps for different seed orchards

PLANTER’S GUIDE - Scots pine - Skogforsk & Luke

Conditions for recommendations

- Altitude (m.a.s.l.): 320 m
- Temperature sum: 890 degree days

Climate scenario

Adjustments

Share reference FRMs and information from evaluation tests

Performance index

100 = unimproved local seed stand

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Take home messages

• Forest reproductive materials need human help to **adapt quickly** to future climate and increased biotic and abiotic risks

• **Maintain genetic diversity** in selected FRM will ensure higher adaptive potential for an uncertain future

• **High phenotypic plasticity** has been observed in selected FRM and in natural genetic resources

• Evaluation of performances in **wider range of environments** is needed: how to share resources, evaluation efforts, expertises on different risks and performance information?

• **User-friendly decision support tools** are needed to promote updated deployment guidelines of a more diverse portfolio of improved FRM.
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