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Climate Change – Innovative Adaption Strategies

Fdir. D.I. Dr. Kurt Ramskogler
in collaboration with Dr. Silvio Schüler, BFW

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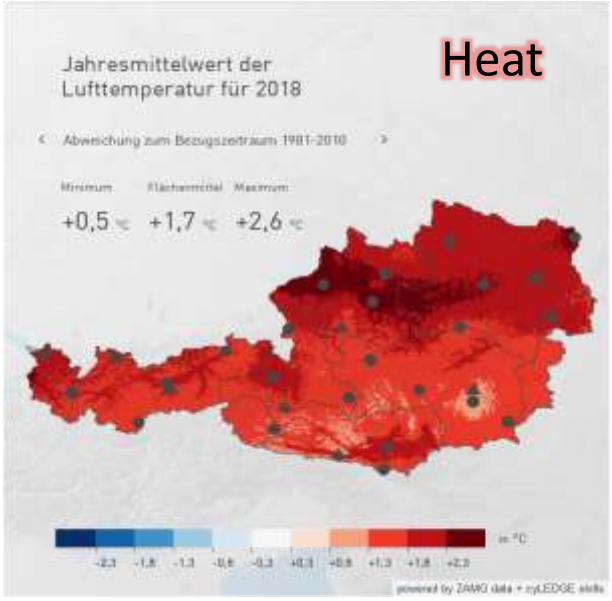
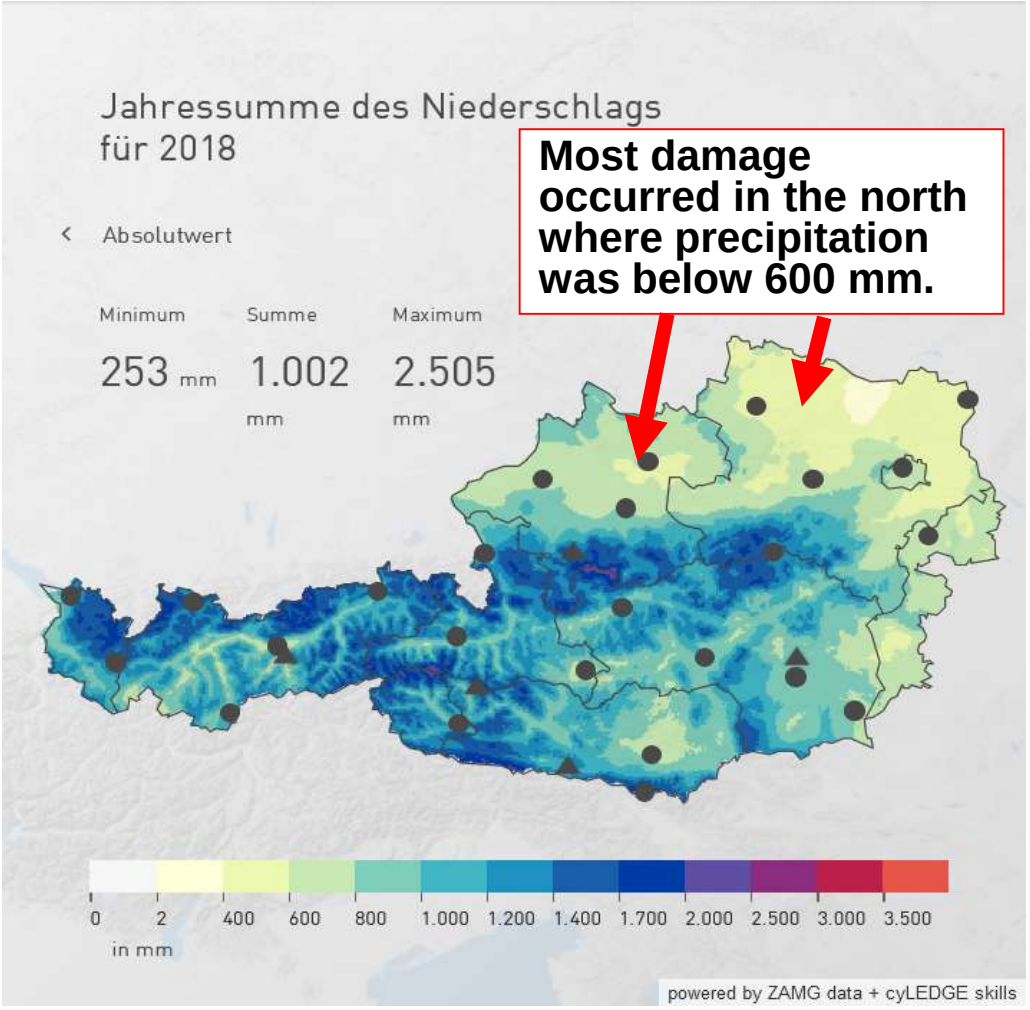
BFW

Drought, heat, precipitation in Austria

Drought

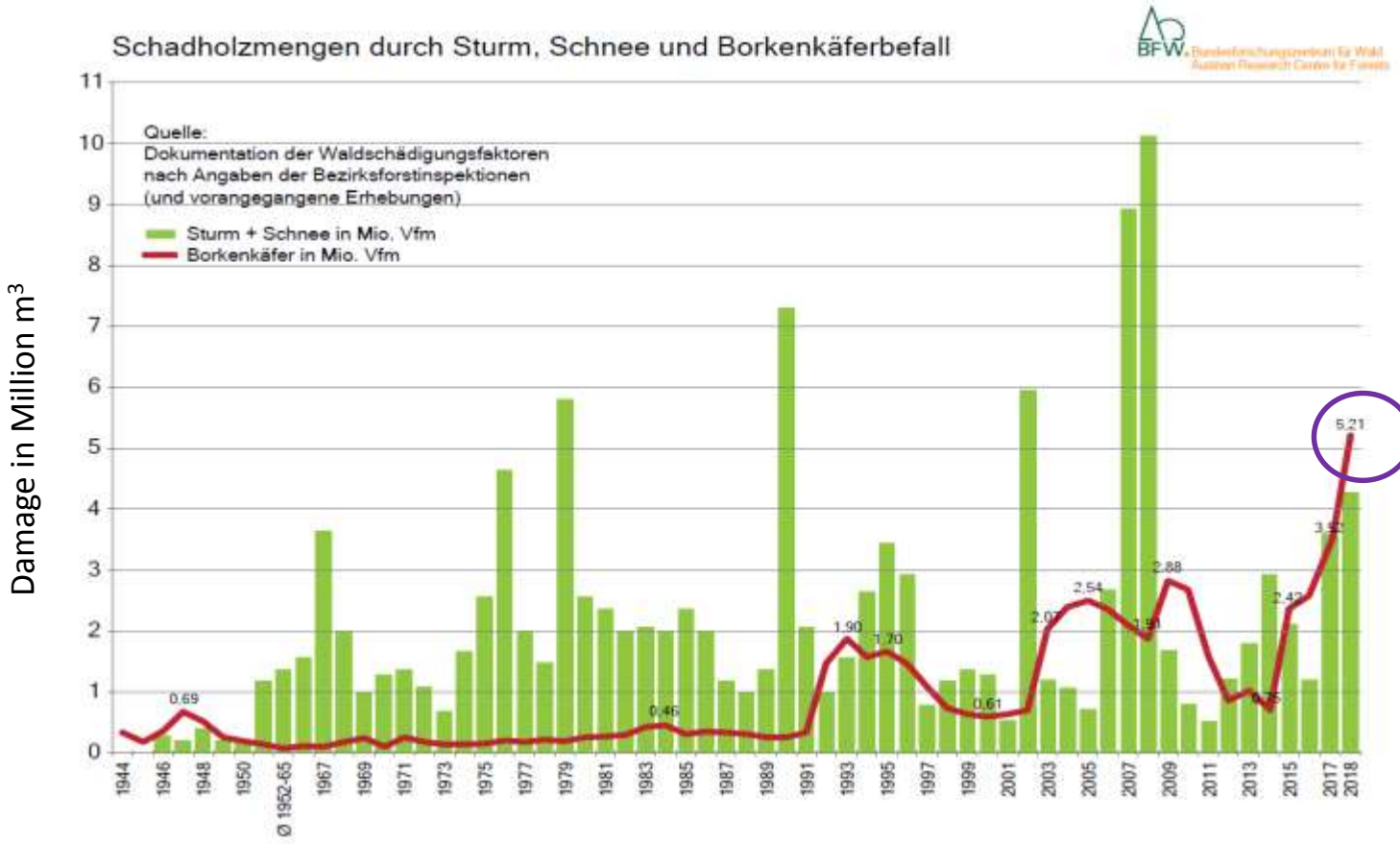




Zentralanstalt für Meteorologie und Geodynamik

www.zamg.ac.at

Bark beetle, storm/snow damage in Austria



90 % ***Ips typographus***

Annual damage by bark beetles and storm/snow in Austria
(Documentation of forest damaging factors, DWF)

Situation in Austria

Major storm events providing abundant breeding material led to previous outbreaks of *Ips typographus* in AT (e.g. 1992, 2003, 2009).

No such major events occurred in the year(s) before 2015

(only regional damage by ice breakage).

Situation in Austria

Cleared outbreak site in Lower Austria in July 2018, near CZ border

Situation in Austria

Waidhofen/Thaya, 27.4.2019

Photo: Hoch, BFW

Situation in Austria

Loads of infested timber awaiting further action...

Photo: Hoch, BFW

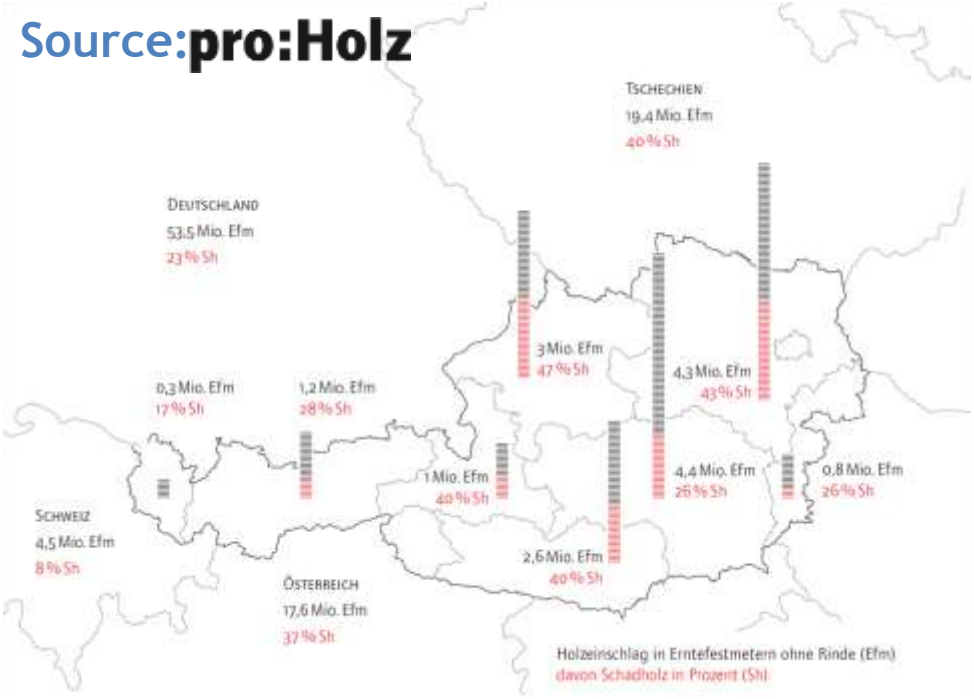
Situation in Austria

Bez. Urfahr-Umgebung (near Linz, north of the Danube), 18.7.2018 (Photo: Hoch, BFW)

Also individual trees attacked in mixed forests.

In the outbreak situation, species mixture did not prevent the attack. However, the photo shows the „insurance effect“ – the area is not deforested.

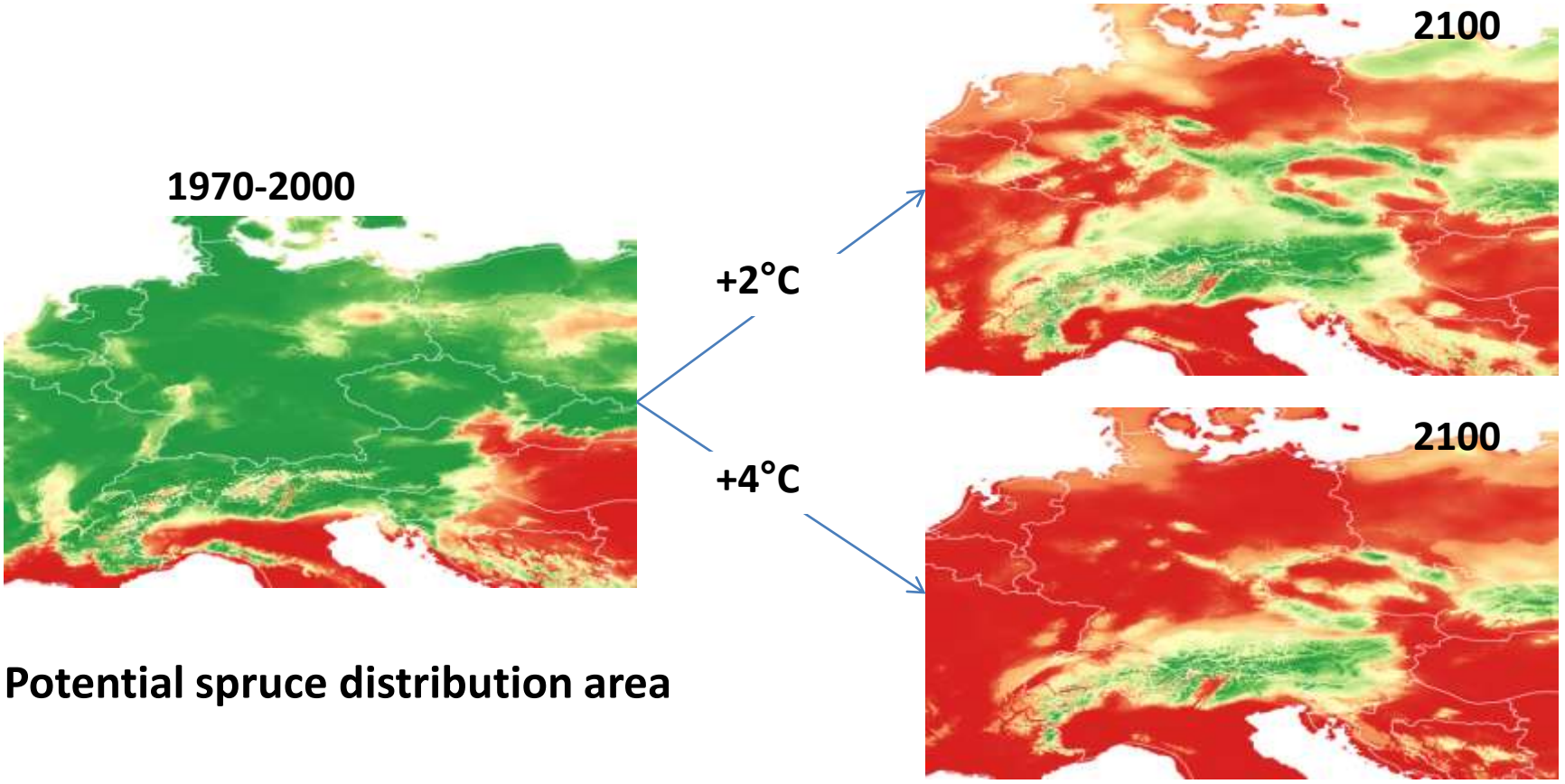
Situation in Austria and neighbouring countries



- **Neigbouring countries equally/stronger affected**
- **Bark beetle not only attacks spruce, but also larch and pine**
- **Besides bark beetles, drought itself is a problem**

Bark beetle as signs of climate change

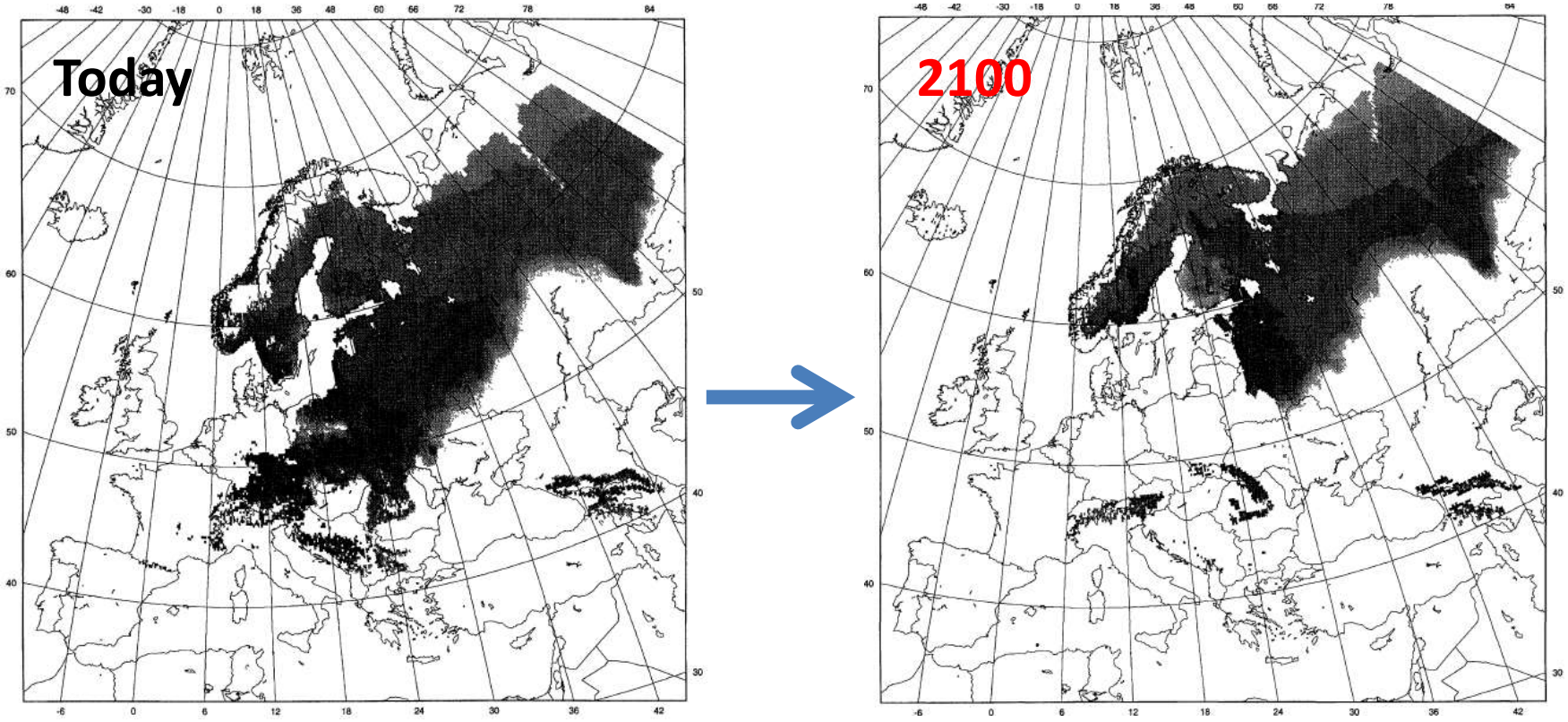
➔ **Decrease of cultivation areas for European conifers**



Potential spruce distribution area

Climate change : negative consequences

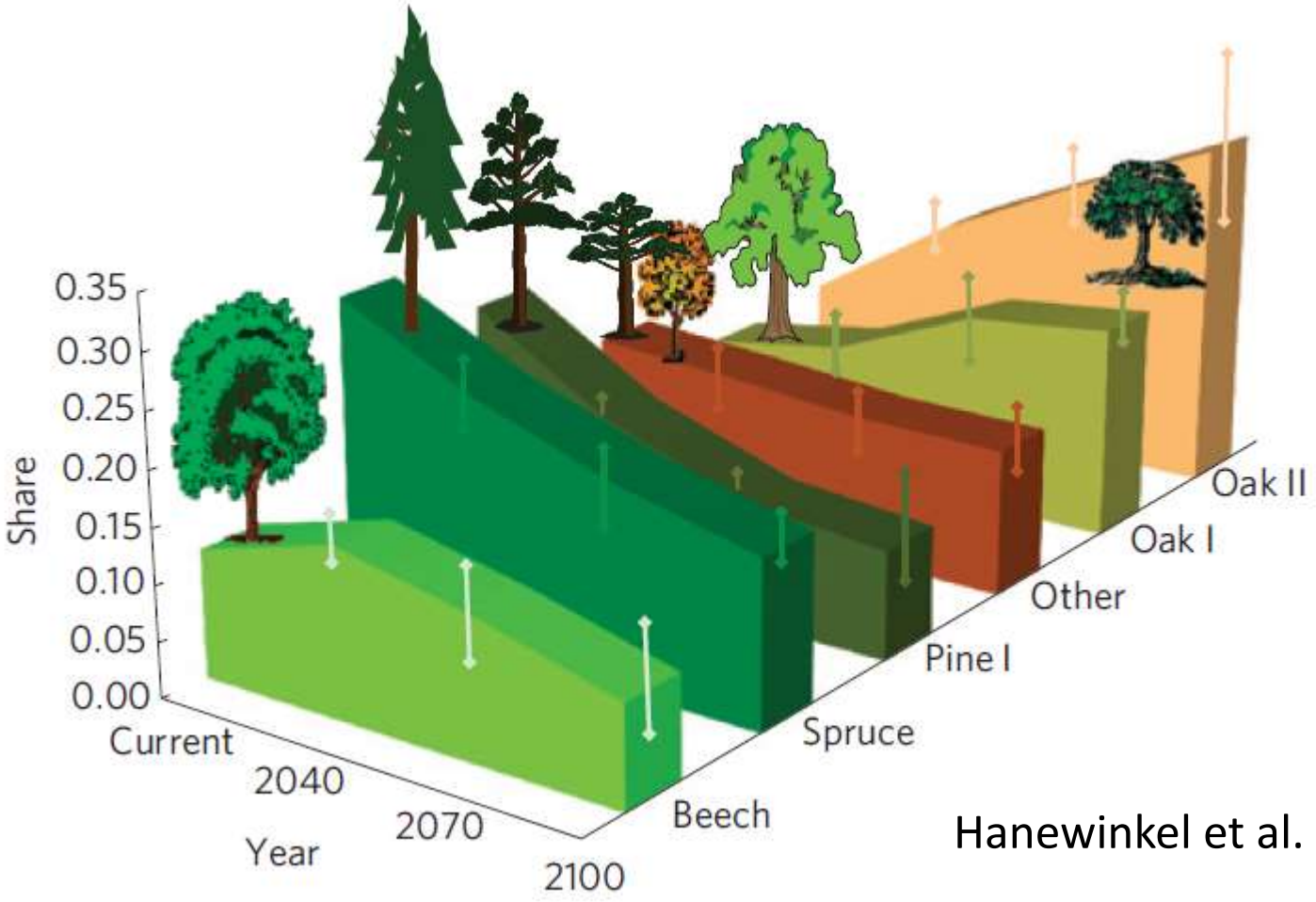
➔ **Decrease of cultivation areas for European conifers**



Potential spruce distribution area

Not new: Knowledge more than 25 years old.. e.g. Sykes et al. 1996

Climate change : negative consequences



Hanewinkel et al. 2012

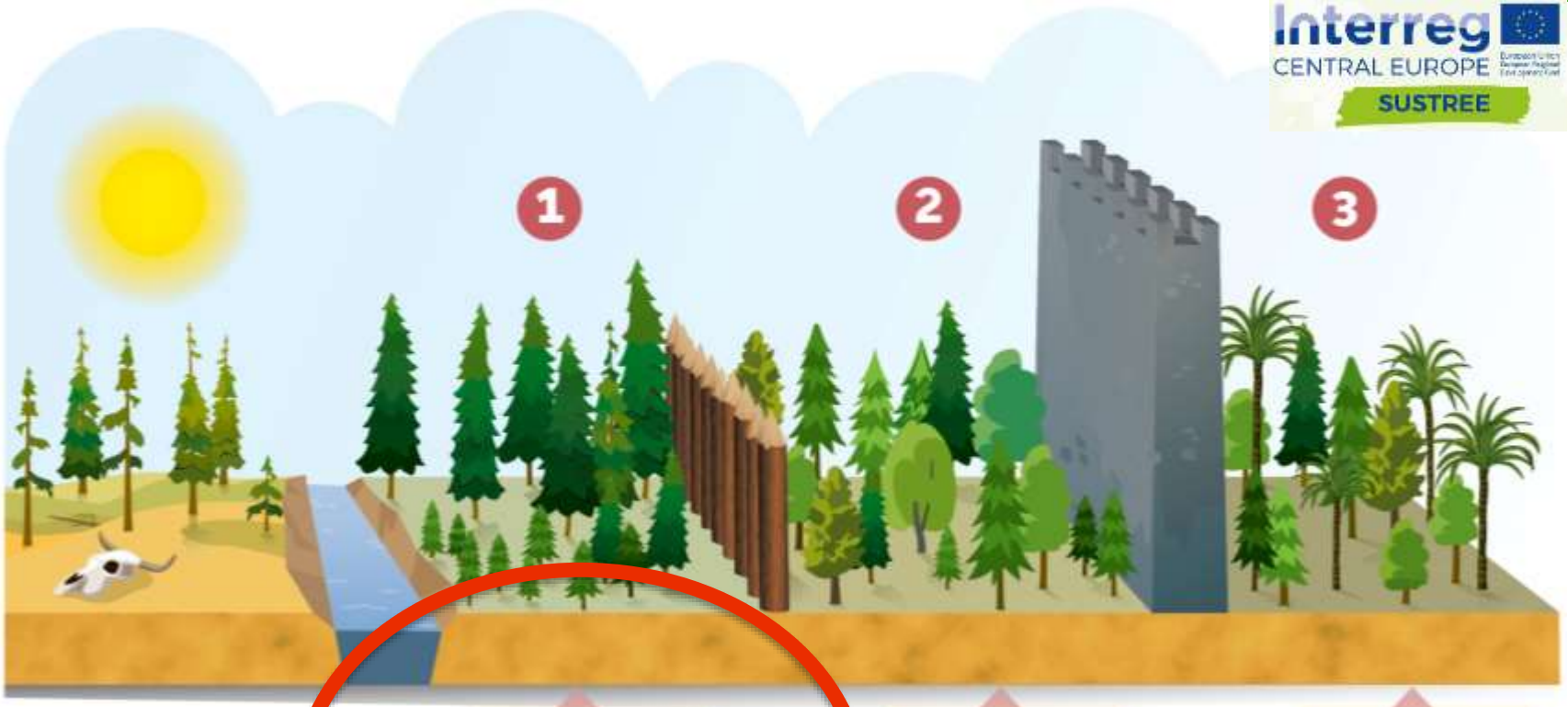
Three lines to defend forest ecosystem services in climate change

Assisted Migration, climate resilient genotypes, stronger thinning measures

Planting other native species and species mixtures

Planting non-native tree species

Three lines to defend forest ecosystem services in climate change

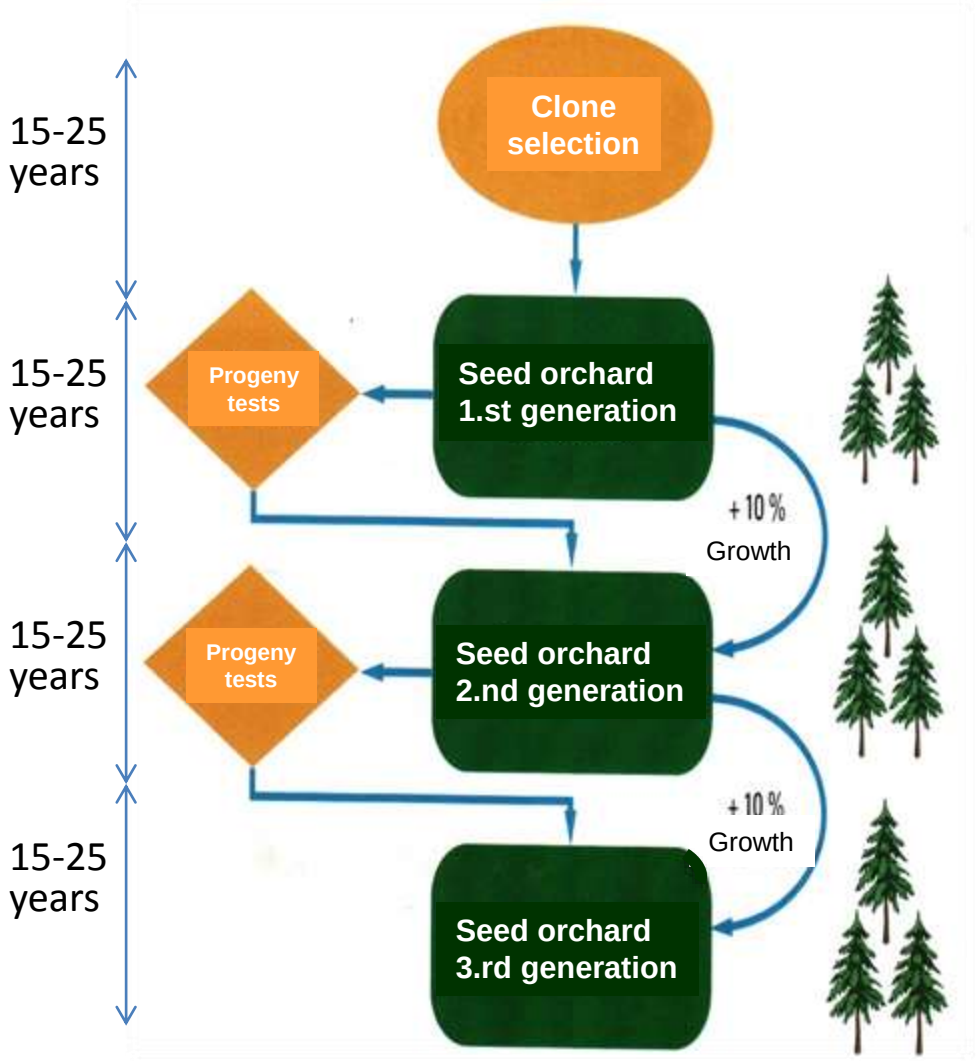


Assisted Migration, climate resilient genotypes, stronger thinning measures

Planting other native species and species mixtures

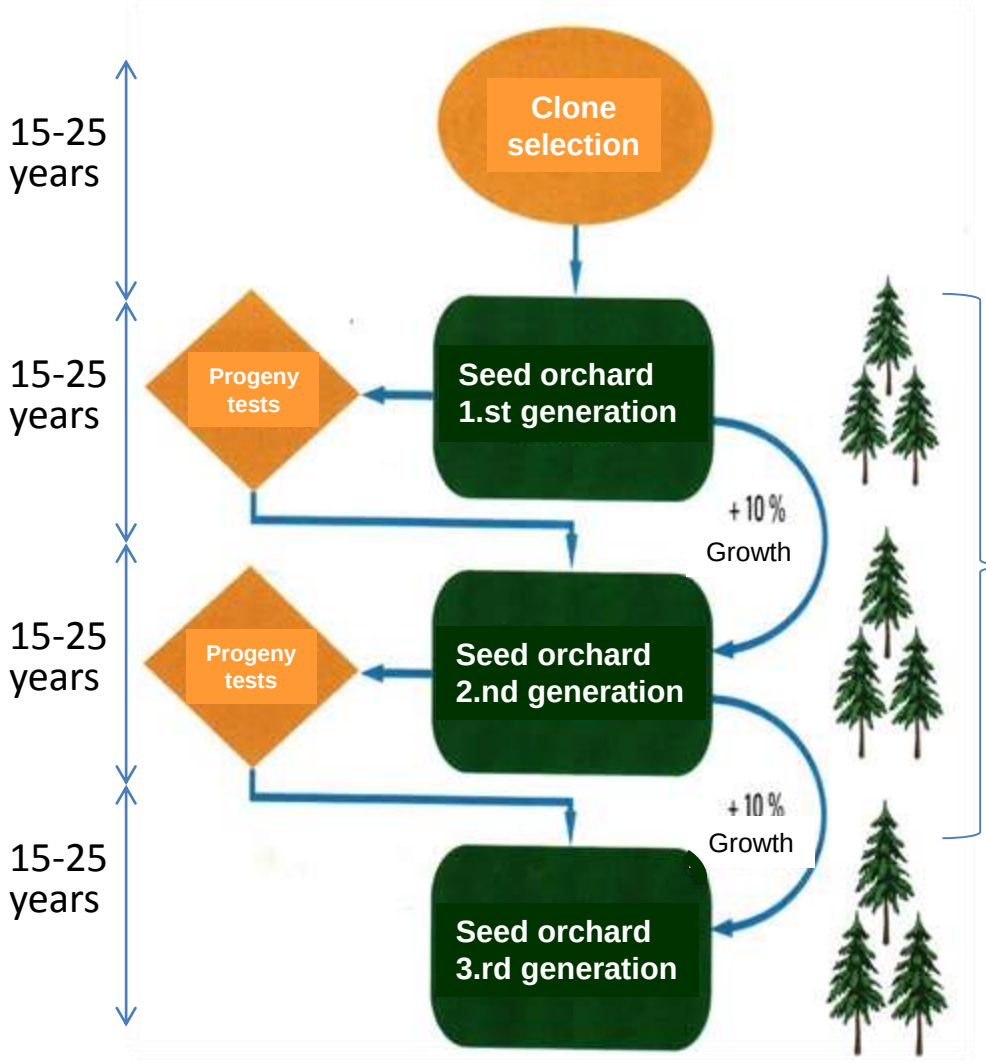
Planting non-native tree species

Forest plant breeding



Traditional forest plant breeding

Forest plant breeding

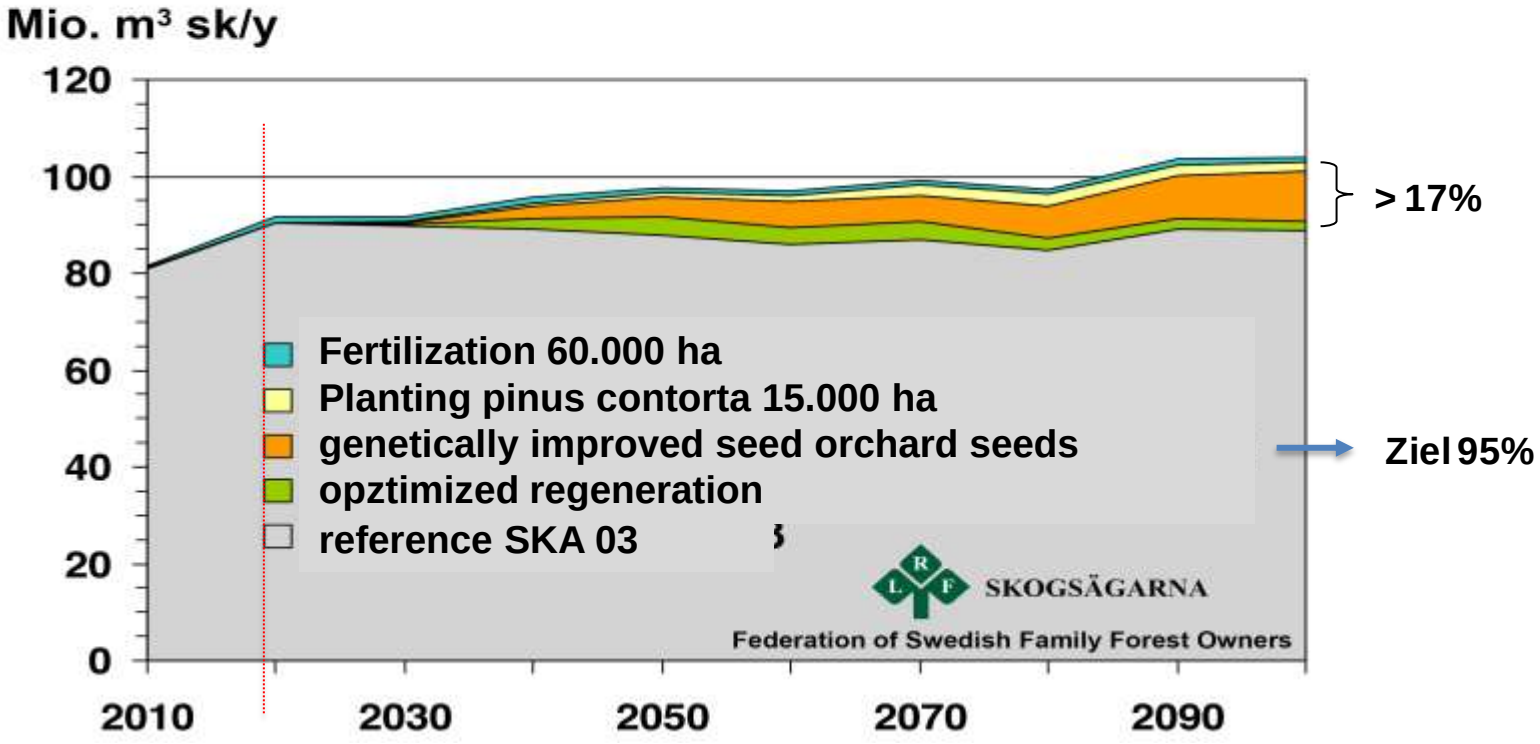


Sweden: Spruce and pine

Traditional forest plant breeding

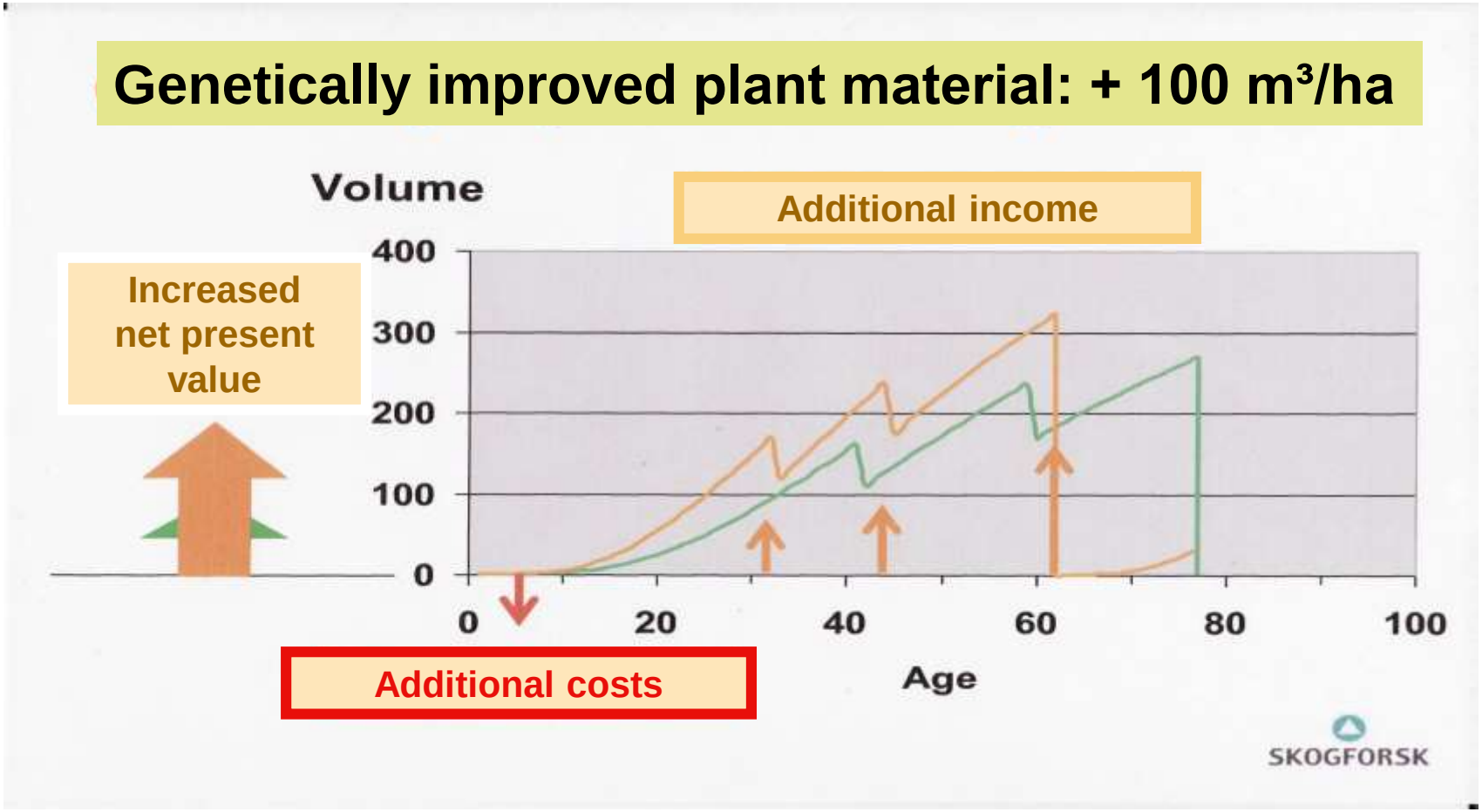
Forest plant breeding in Sweden

Incrased logging in Sweden: A future scenario

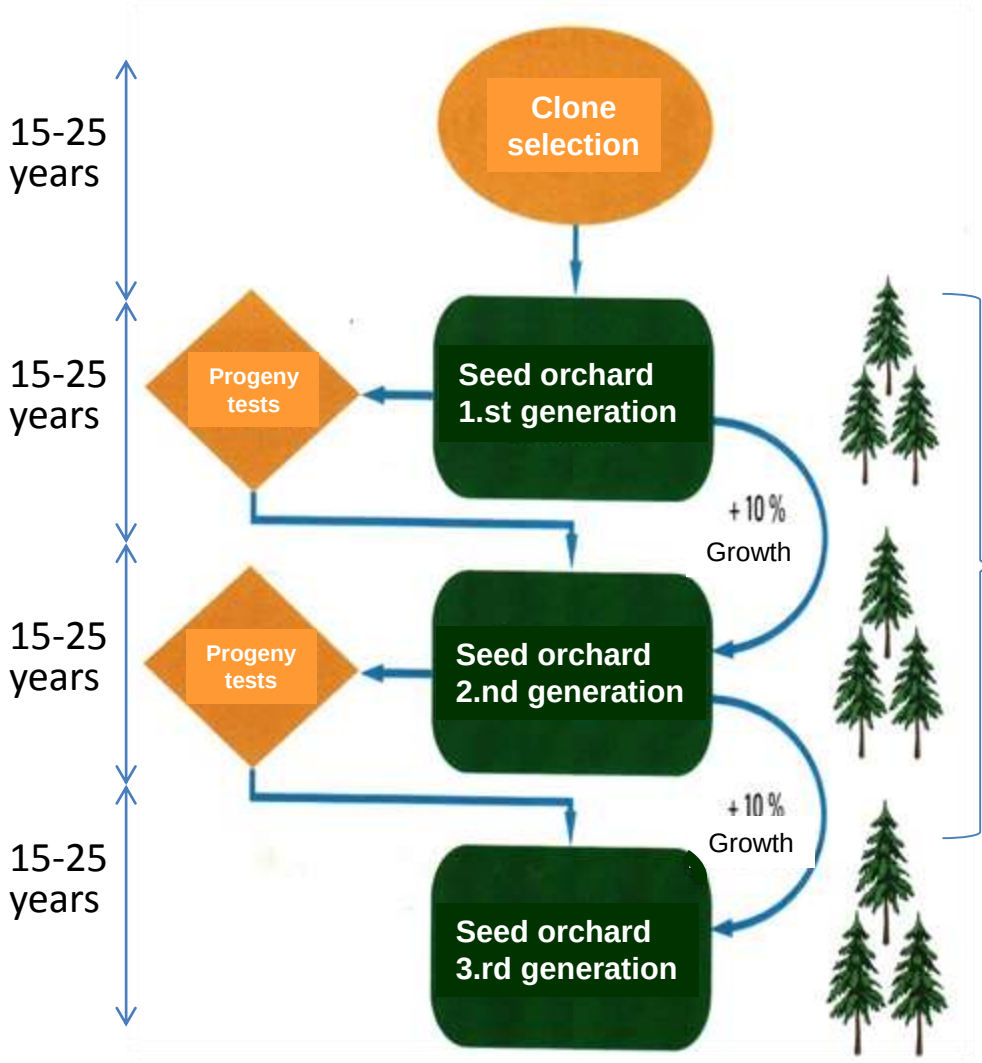


Forest plant breeding in Sweden

Genetically improved plant material: + 100 m³/ha



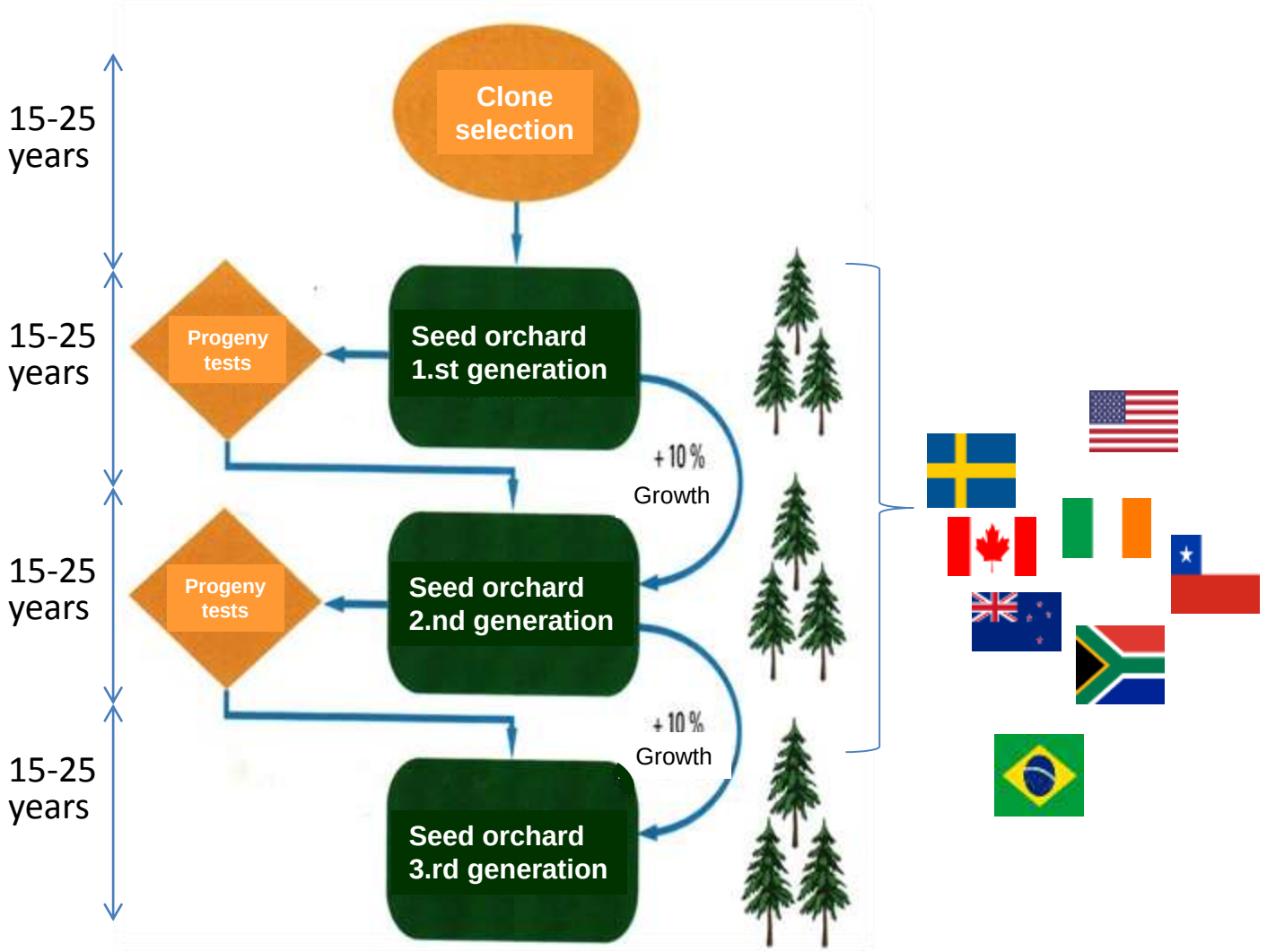
Forest plant breeding



Canada: Douglas fir, spruce!, lodgepole pine, …

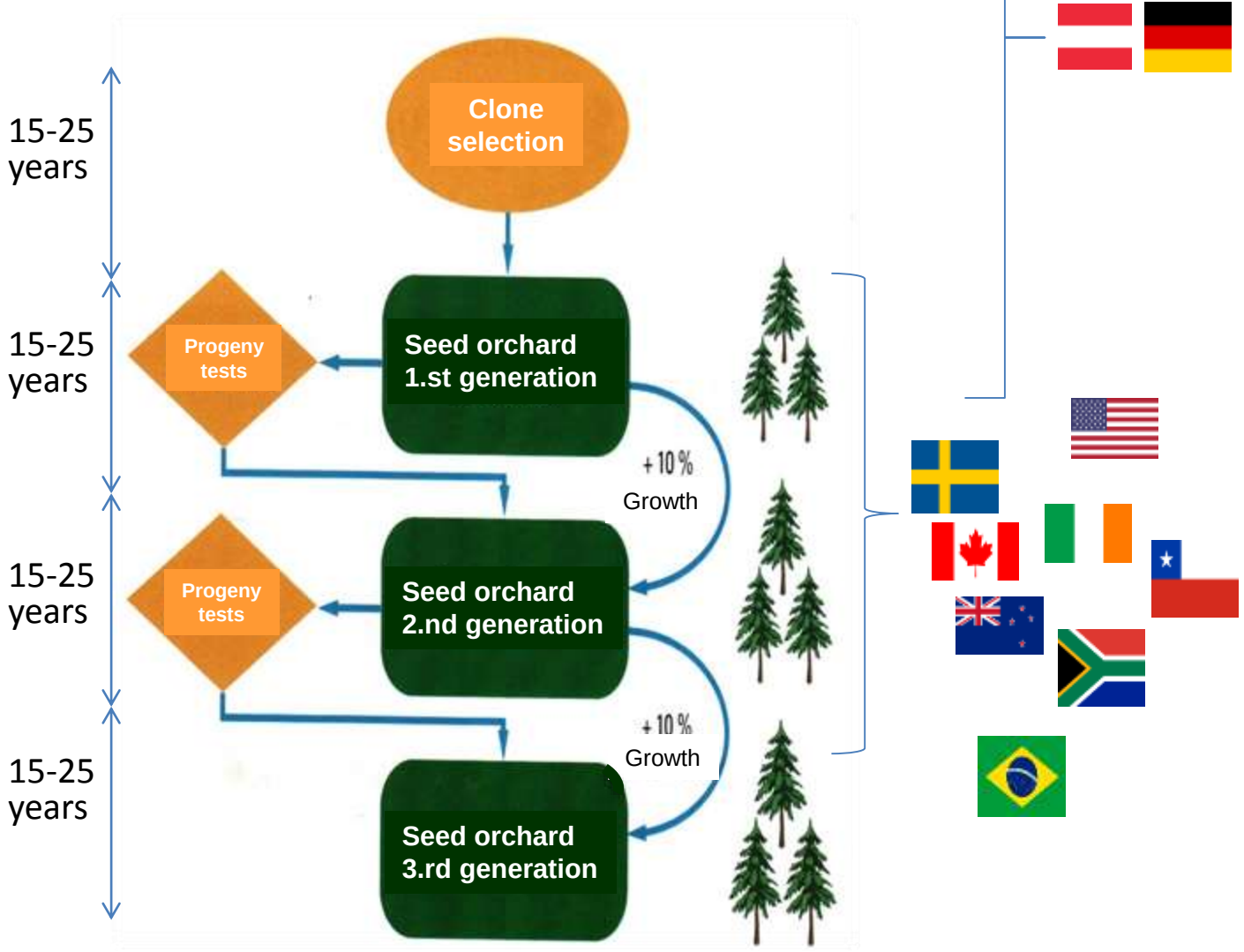
Traditional forest plant breeding

Forest plant breeding



Traditional forest plant breeding

Forest plant breeding



Traditional forest plant breeding

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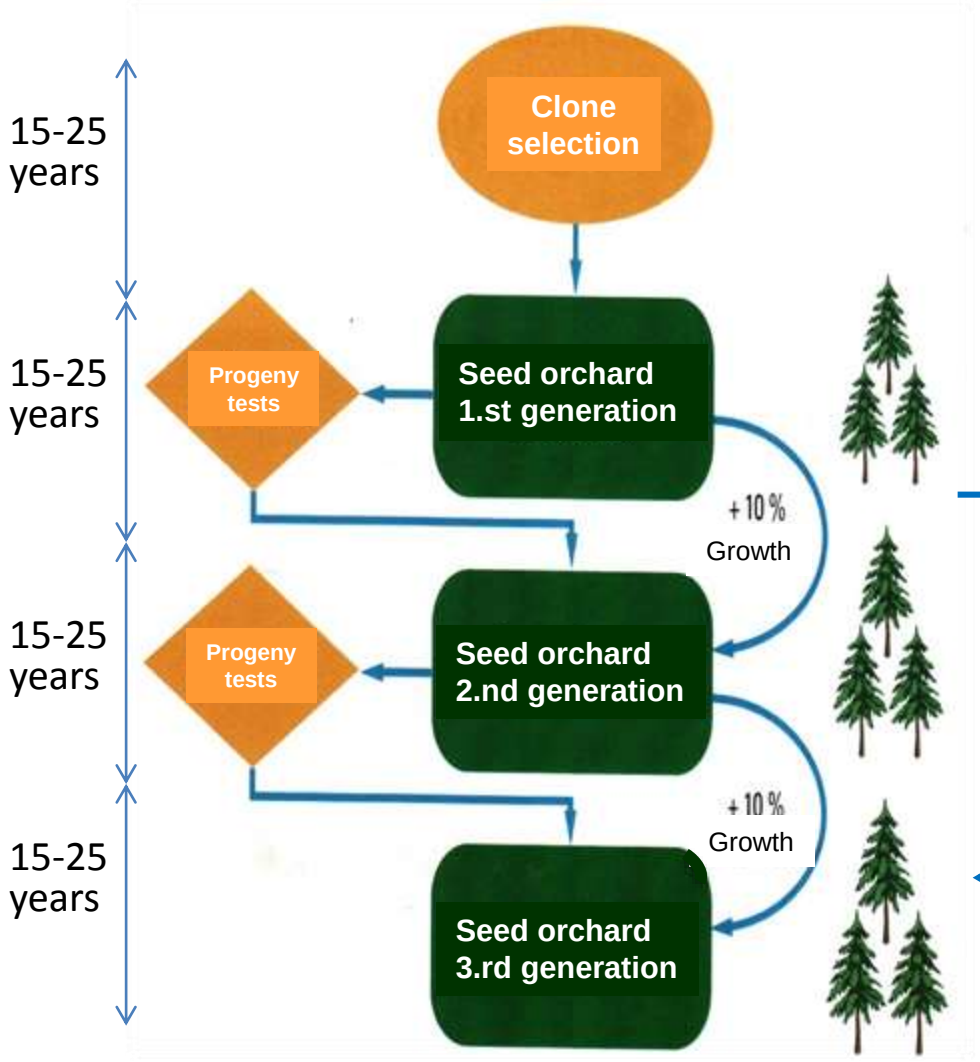


Biotech,

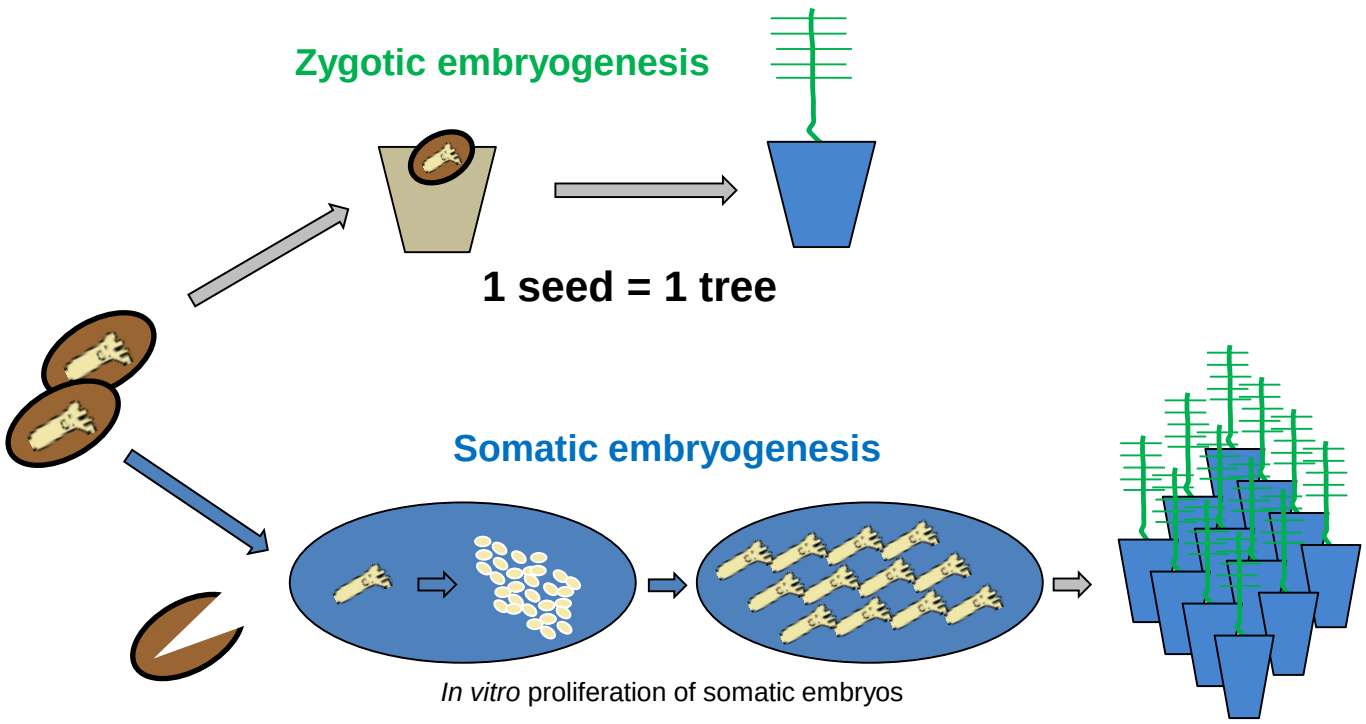
Somatic embriogenesis

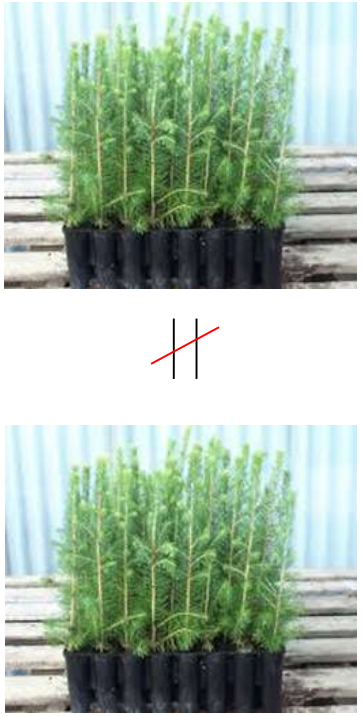
„Reduces breeding cycles around 10-15 years“

Traditional forest plant breeding

Somatic embryogenesis (SE)

Breeding result 15-20 years earlier into effect





Forest plant breeding

Advanced breeding programme:

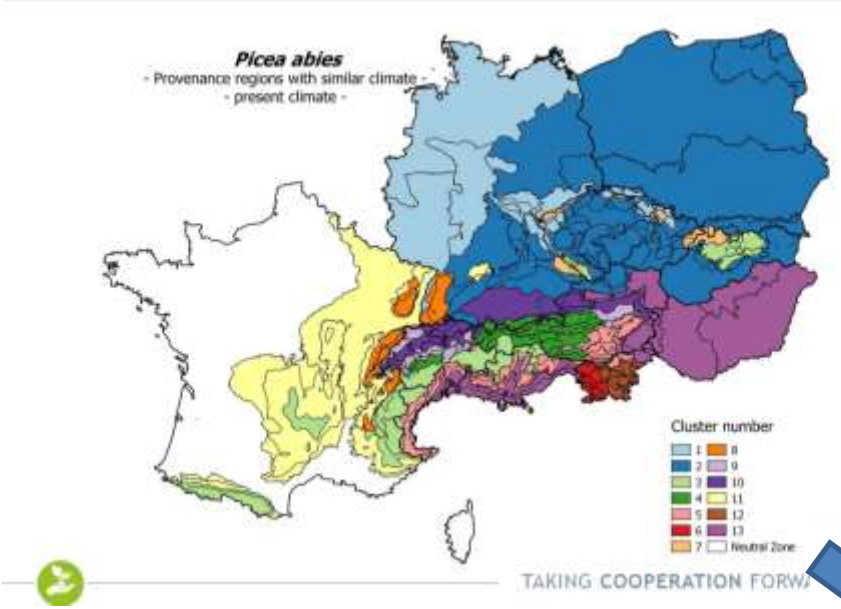
Not only requirement for higher productivity, but especially for a better understanding of the interaction between genotype and environment!!

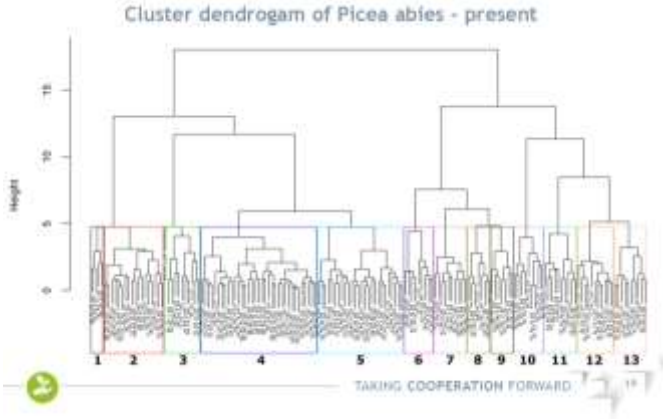
➔Choice of genotypes for new climatic conditions

➔Pest resistance

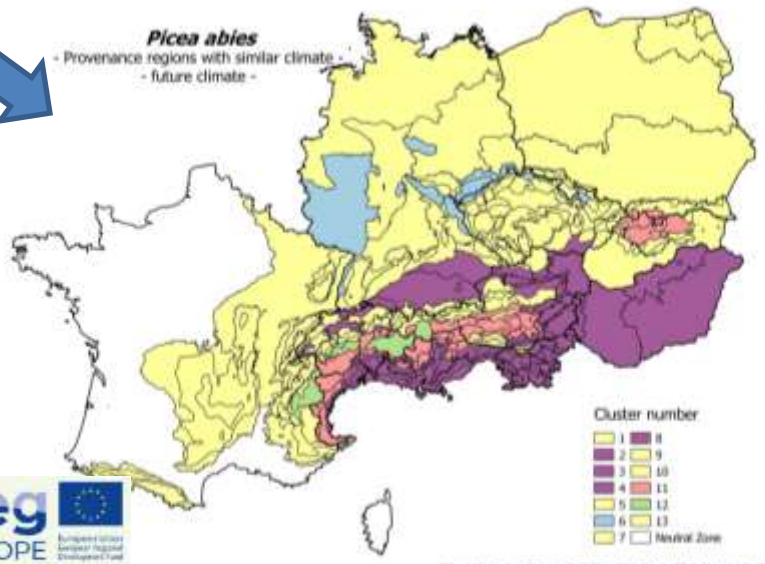
➔Specific timber traits

Cross-border provenance- and breeding zones

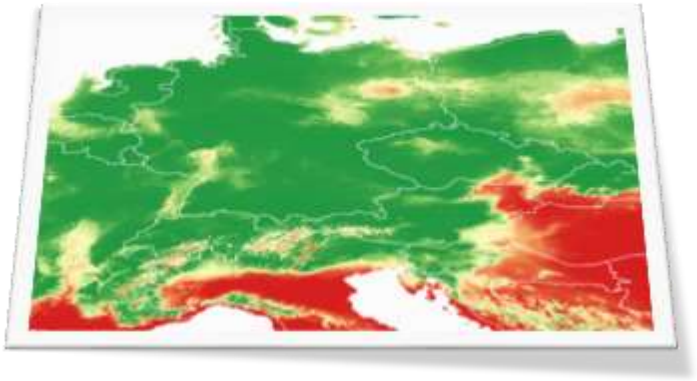




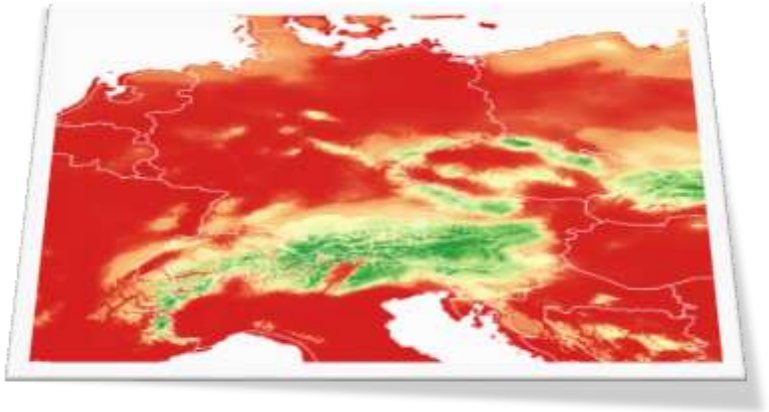
- **Climatic similarity of European spruce provenance regions**
- **E.g. Germany needs only 3-5 regions (current 17!)**



Assisted Migration



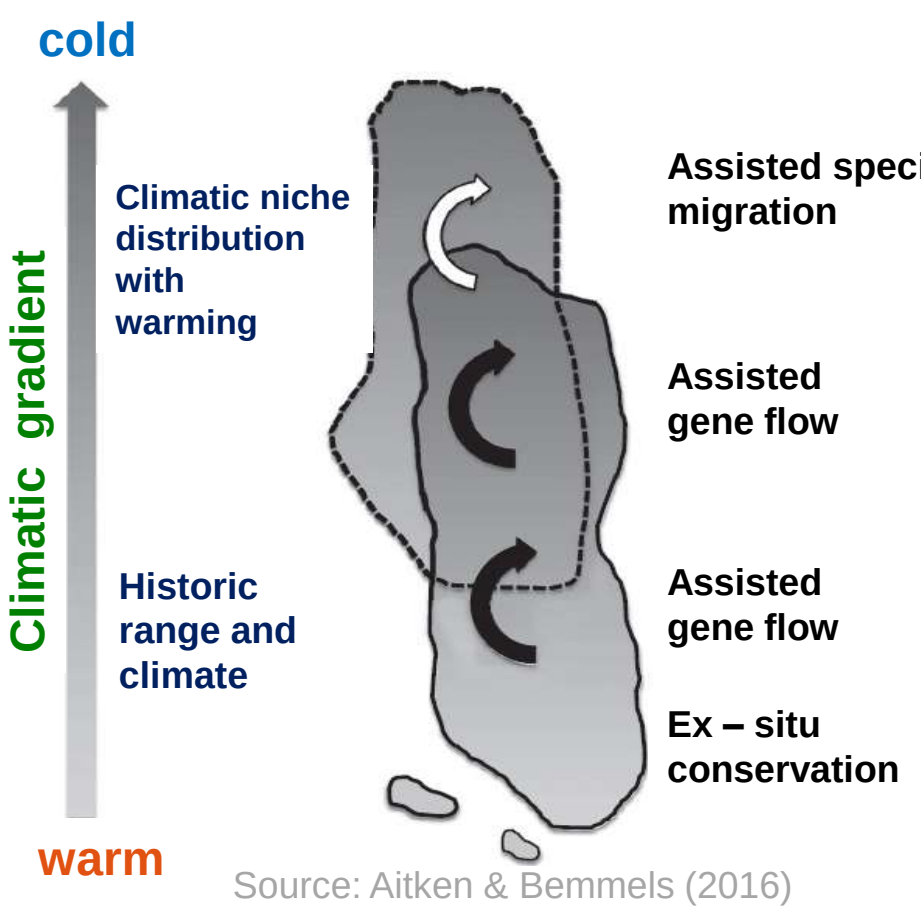
Spruce until now



Spruce 2100 (+4°C)

1. Climate change modifies tree species distribution!
2. Natural processes are not fast enough
   - Genetic adaption
   - Migration
   - Gene flow

Assisted Migration

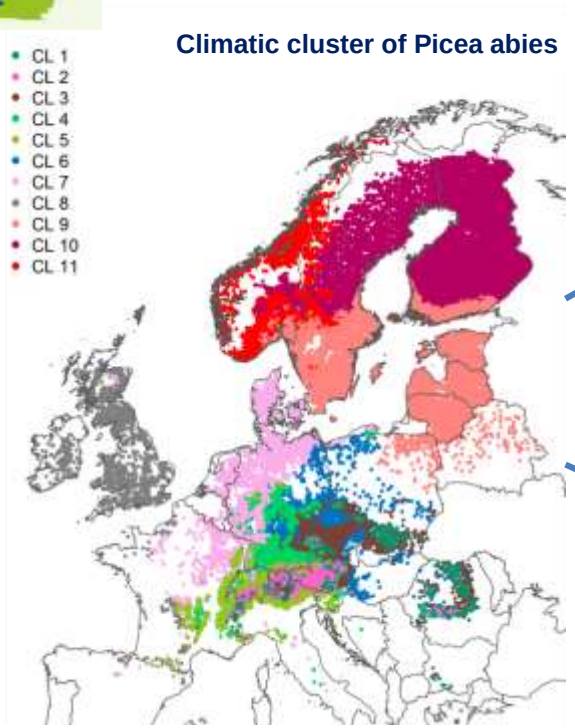


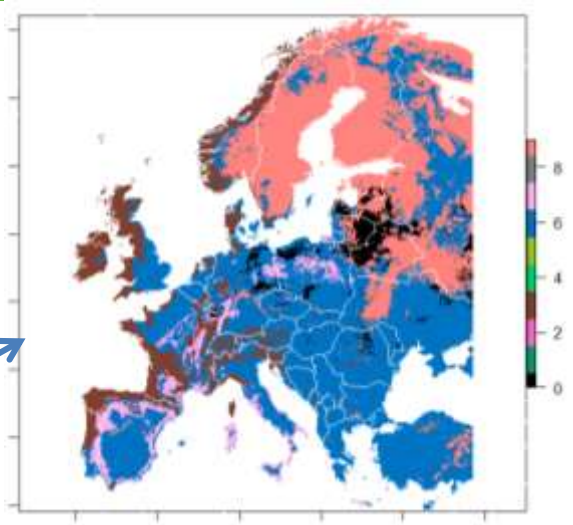
Source: Aitken & Bemmels (2016)

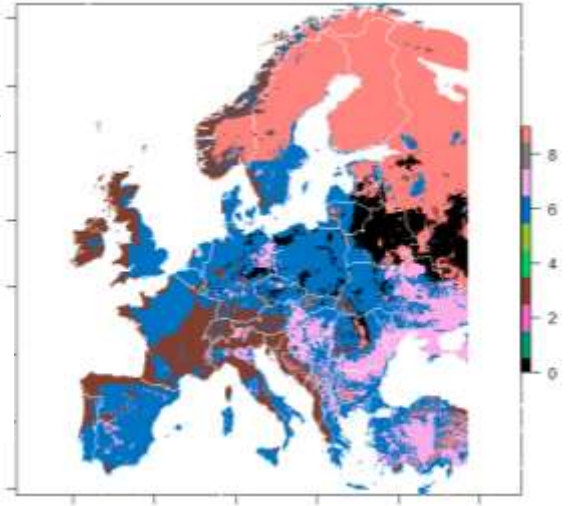
→ In various contries already in implementation: „S“, „CA“, „USA“, …

→ In parts of „CA“ and „USA“ is implementation statutary

Assisted migration: Solution for Europe



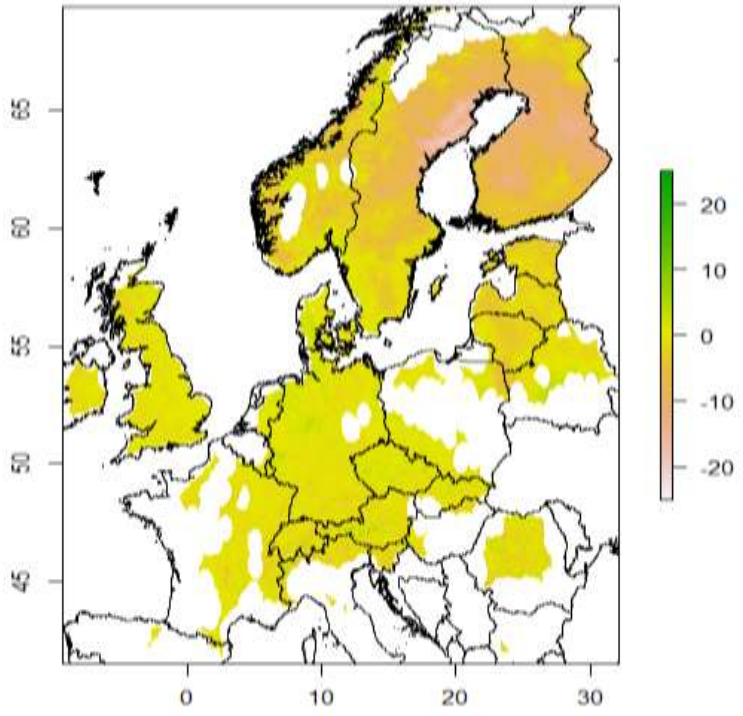




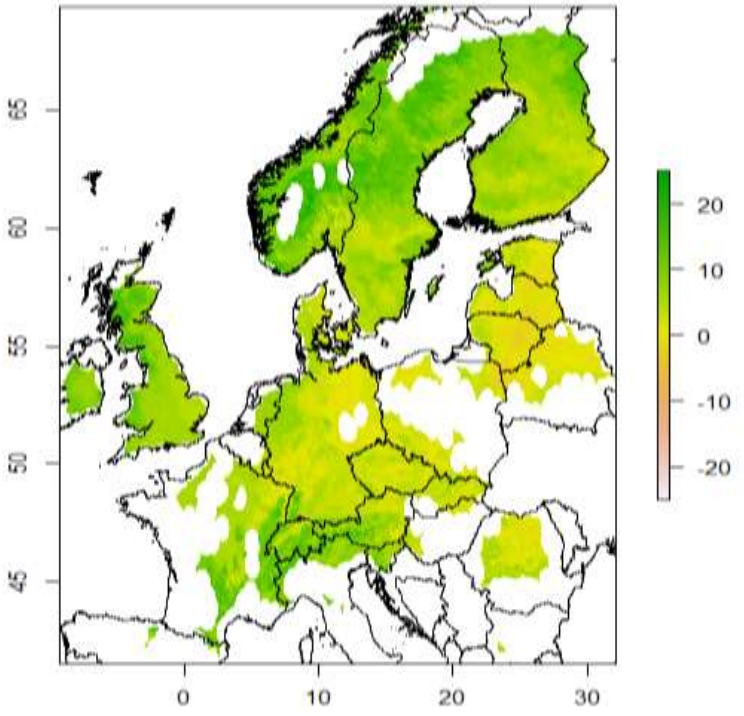
Seed provenance transfer based on Europe-wide provenance trial data

Assisted migration

helps to reduce forest vulnerability



Decreasing productivity with local provenances in CC

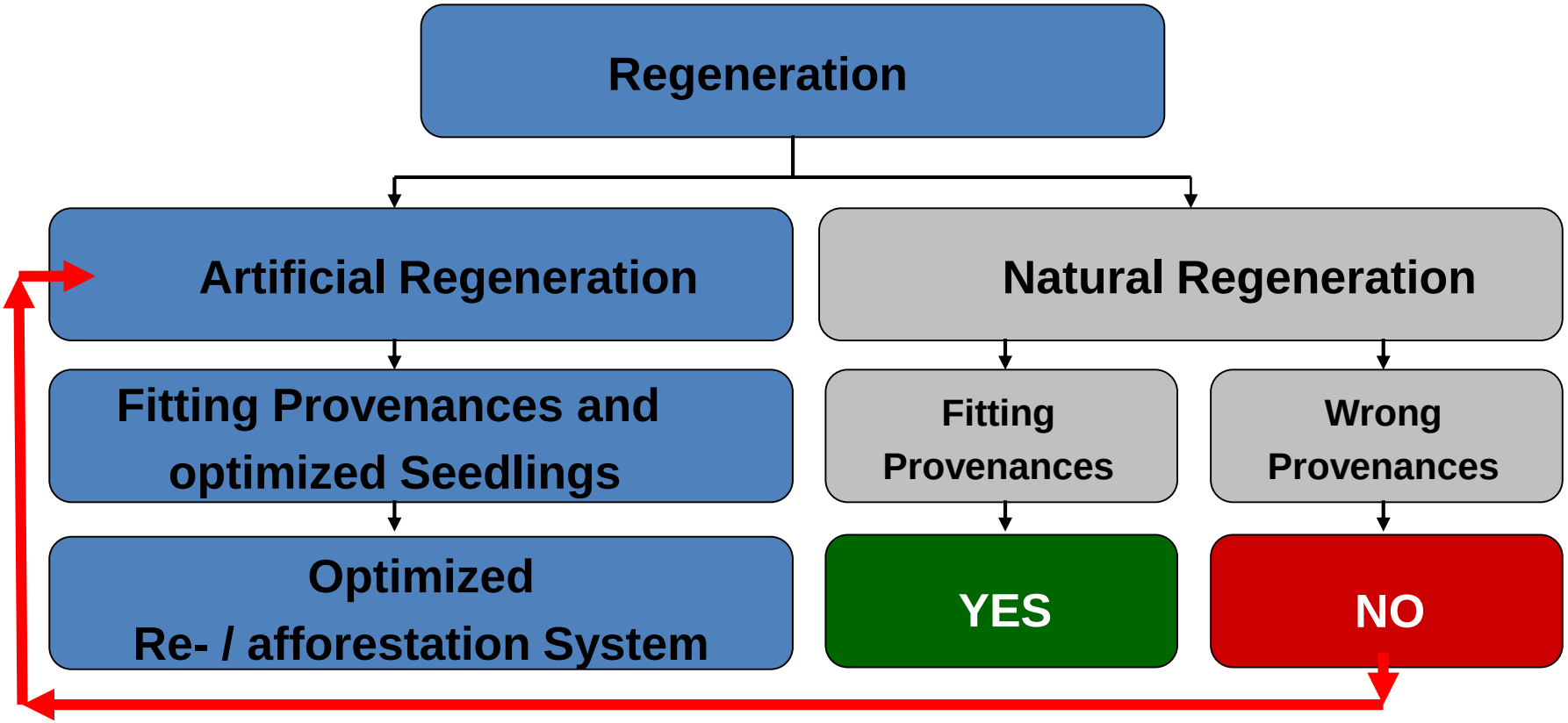


Increasing productivity with optimal provenances in CC

Assisted Migration

- **Needs the best data**
- **First recommendations for seven important tree species are available**
- **Statutory requirements within EU and many countries are not available yet**
- **Strong economic cooperation especially with the seed supply sector in Eastern Europe is essential**
- **Needs the best af-/reforestation system and an increasing amount of high quality forest seedlings**

Af-/reforestation system



„genetic repair / yield increase / better resistance and traits?“

Example: wrong spruce provenance

1.500 m altitude

Assisted Migration

- **Needs new silviculture treatments to utilize the genetic potential of forest stands properly**

  ➔ To reach shorter rotation times, more stability, yield increase „trees need space“

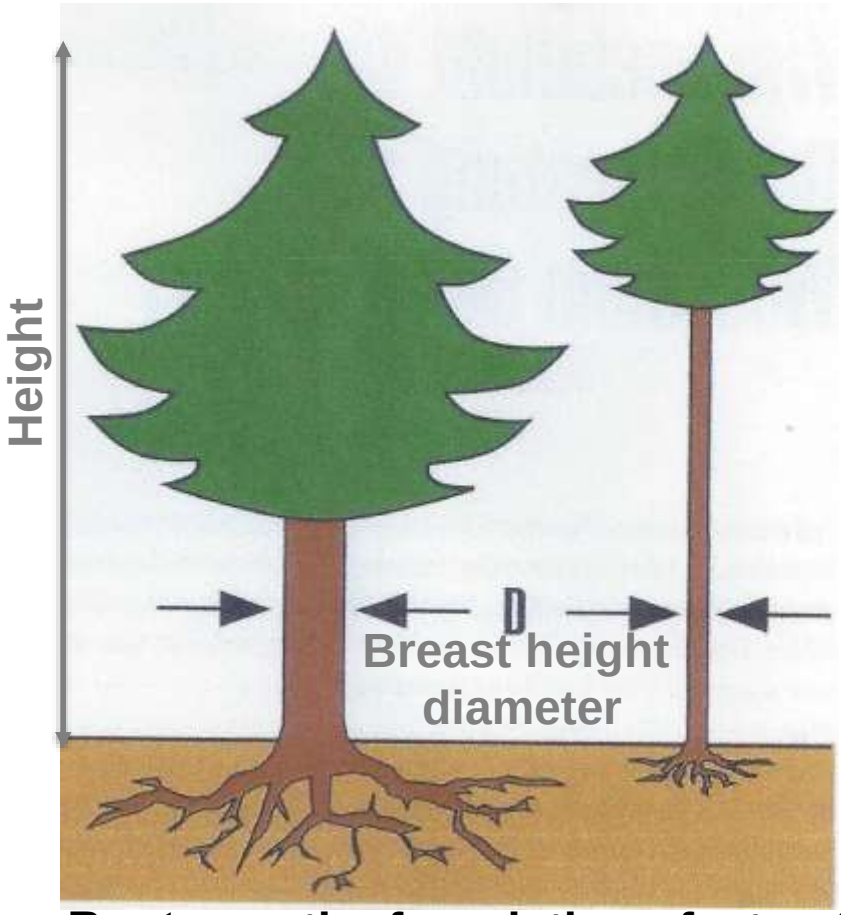
Instead of

„Early-moderate-frequent“ today

„Early-strong-rarely“

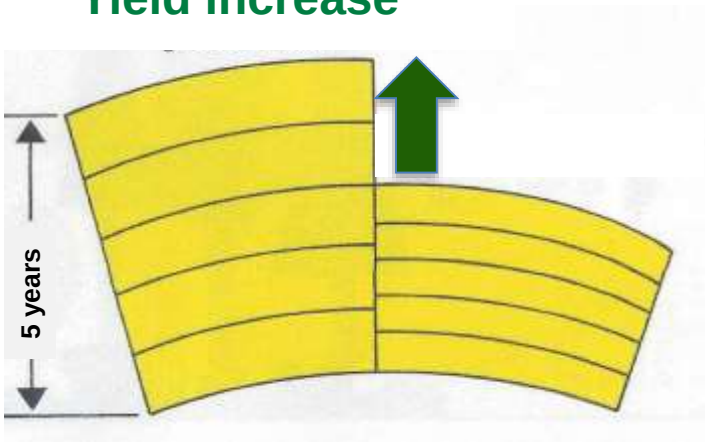
Consequent spacing

„Trees need space“



„Roots are the foundation of a tree“

Lower risk (pest, storm, snow)
Higher stability
Water ability increases
Viatlity increases (crown, root)
Yield increase

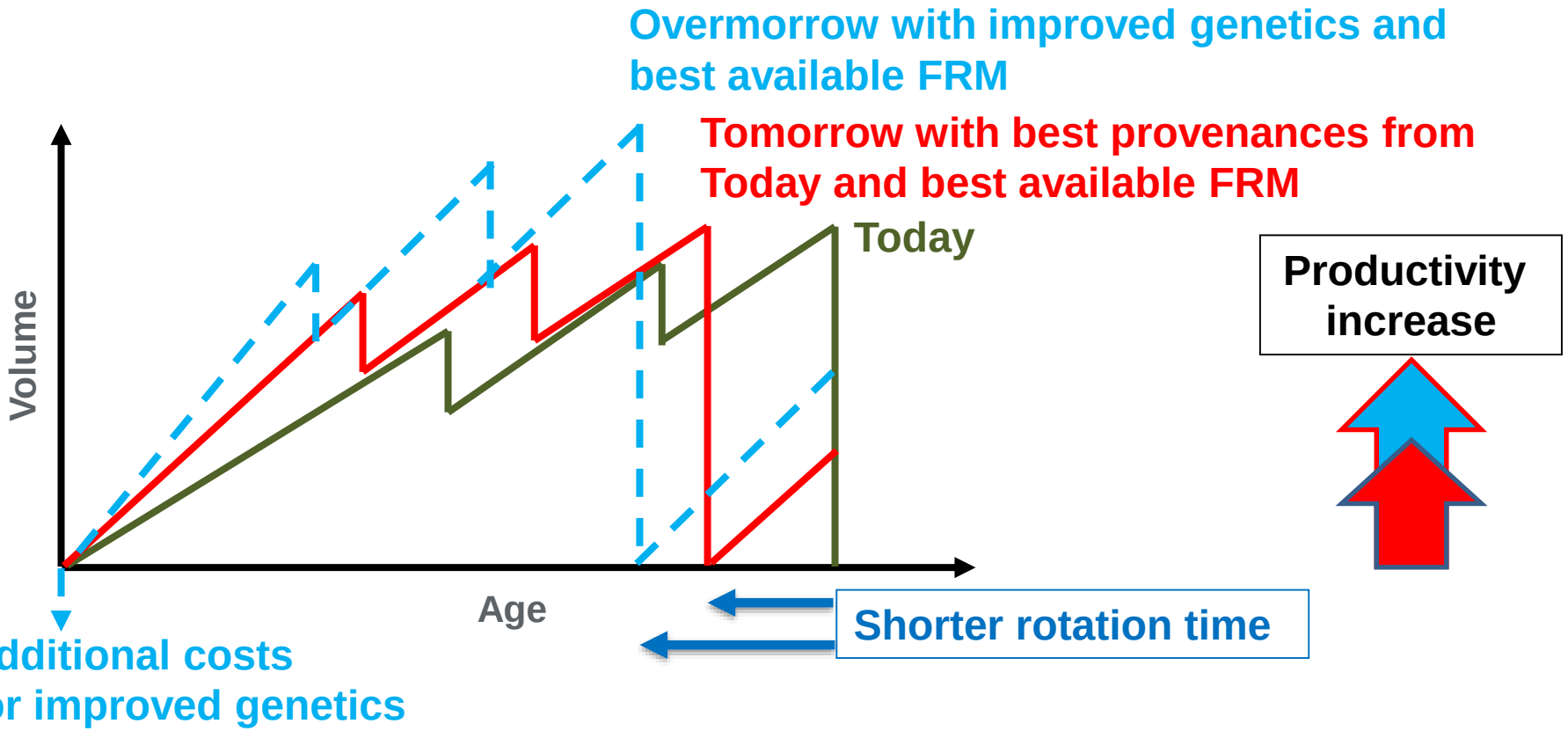


Higher yield in less time / less land, more wood

Various sources: BFW, LKÖ, …

Silviculture treatments

- **Use of best available „Forest reproductive material (FRM)“ and „Genetics“**



„LESS LAND, MORE WOOD IN SHORTER TIME“

Requirements

Interaction of wood and product traits

Source: HWG – A. Teischinger, 2010; adapted from Kellomäki 2002

Institut für Holzforschung

GENETICS

- Provenance / Seeds and Seedlings (FRM)

ENVIRONMENTAL FACTORS

- Light
- Temperature
- Water
- Nutrient

SILVICULTURE

- Afforestation, Regeneration and Spacing
- Thinning
- Rotation
- Pruning
- Fertilizaation

WOOD TRAITS

Stem-traits:

- Knottiness
- Taper

Wood-traits:

- Wood Density
- Tree Ring Widths
- Sap- and Hart-Wood Relation
- Branches (healthy / dead)
- Fibre
- Early- and Late-Wood Relation
- Wood Stability and – Bending Strength
- Wood- and Cell-Structure
- Colour, Texture
- Microfibril Orientation (Cell Wall) Chemical Structure

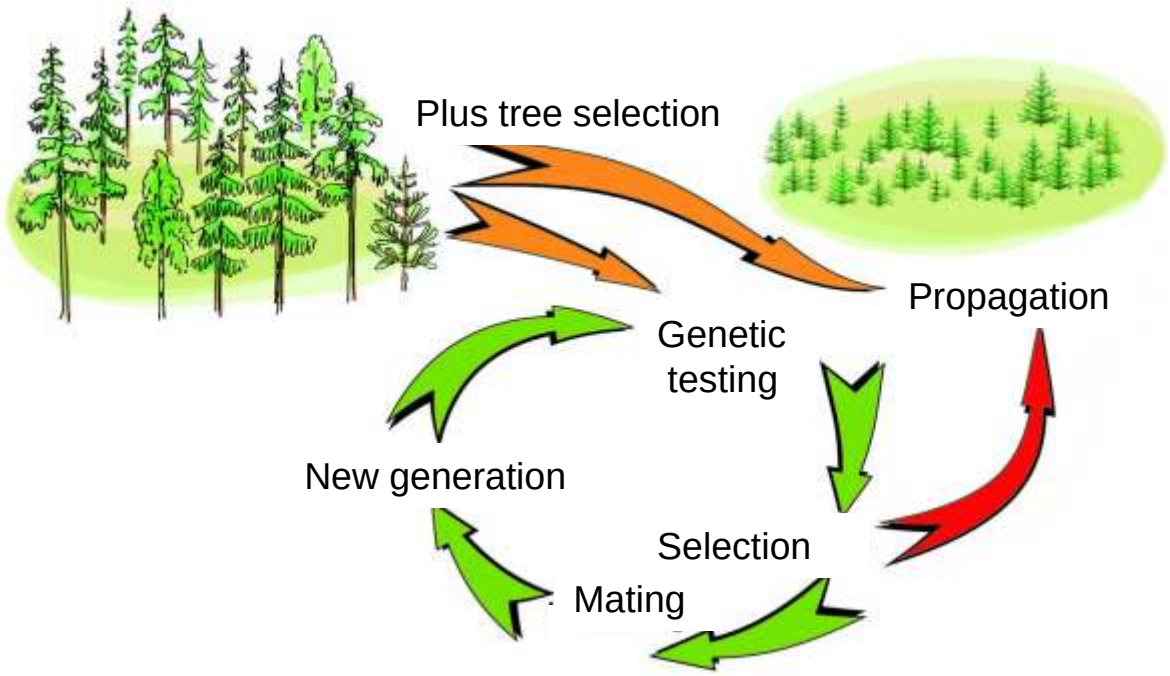
PROCESS-PARAMETERS

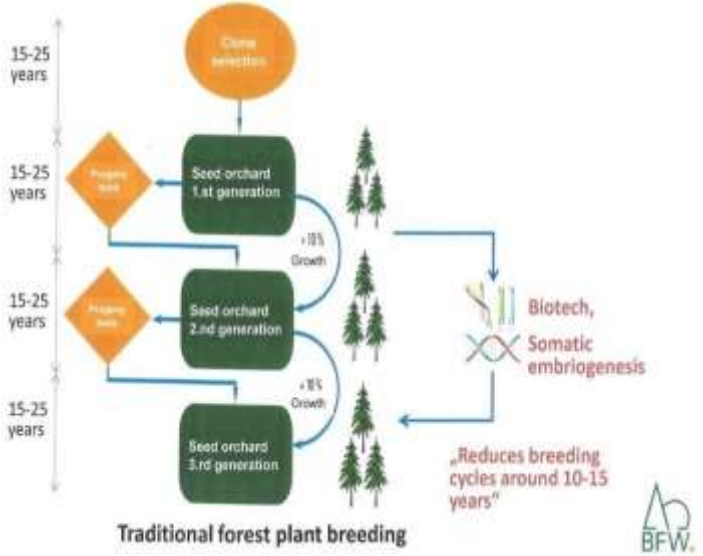
- Storage Conditions
- Cutting Model
- Drying
- Mechanical Processing and Finishing
- Shaping
- Cemical Transformation and Processing

MATERIAL TRAITS OF THE FINAL PRODUCT

Consequences

- **On national level best genetics must be made available – „targeted breeding for the main tree species under consideration of important traits like drought- and frost-resistance, …“**





Conclusions

- **Conifers in Central Europe are seriously endangered by climate change, but spruce and conifers will not be at an end**
- **Future production area will be much smaller than today**
- **Tree breeding, improved genetics and new silviculture treatments offer unutilized options in adapting to climate change**
- **However, due to climate change and better silviculture site production already increased and could further be facilitated**

Conclusions

- **Other countries and continents already have a huge advantage through improved FRM from advanced tree breeding, using site adapted forestry well matched with climate change demands**
- **Availabilty of high quality forest seedlings with best genetics have to be increased** ➔ Af-/ Reforestation is a key fighting CC (Carbon sequestration)

Conclusions

- **Forest tree breeding, advanced biotech solutions like SE, assisted migration and genome analyses have to be introduced / used as fast as possible**
- **Stronger transnational cooperation needed to foster breeding, implement assisted migration and statutory revisions**

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Thanks for attention

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