



Together towards bioeconomy

Sirkku Pöykkö

LUKE Natural Resources Institute Finland

1898 MTT Agrifood Research Finland is founded

1917 Finnish Forest Research Institute (Metla)

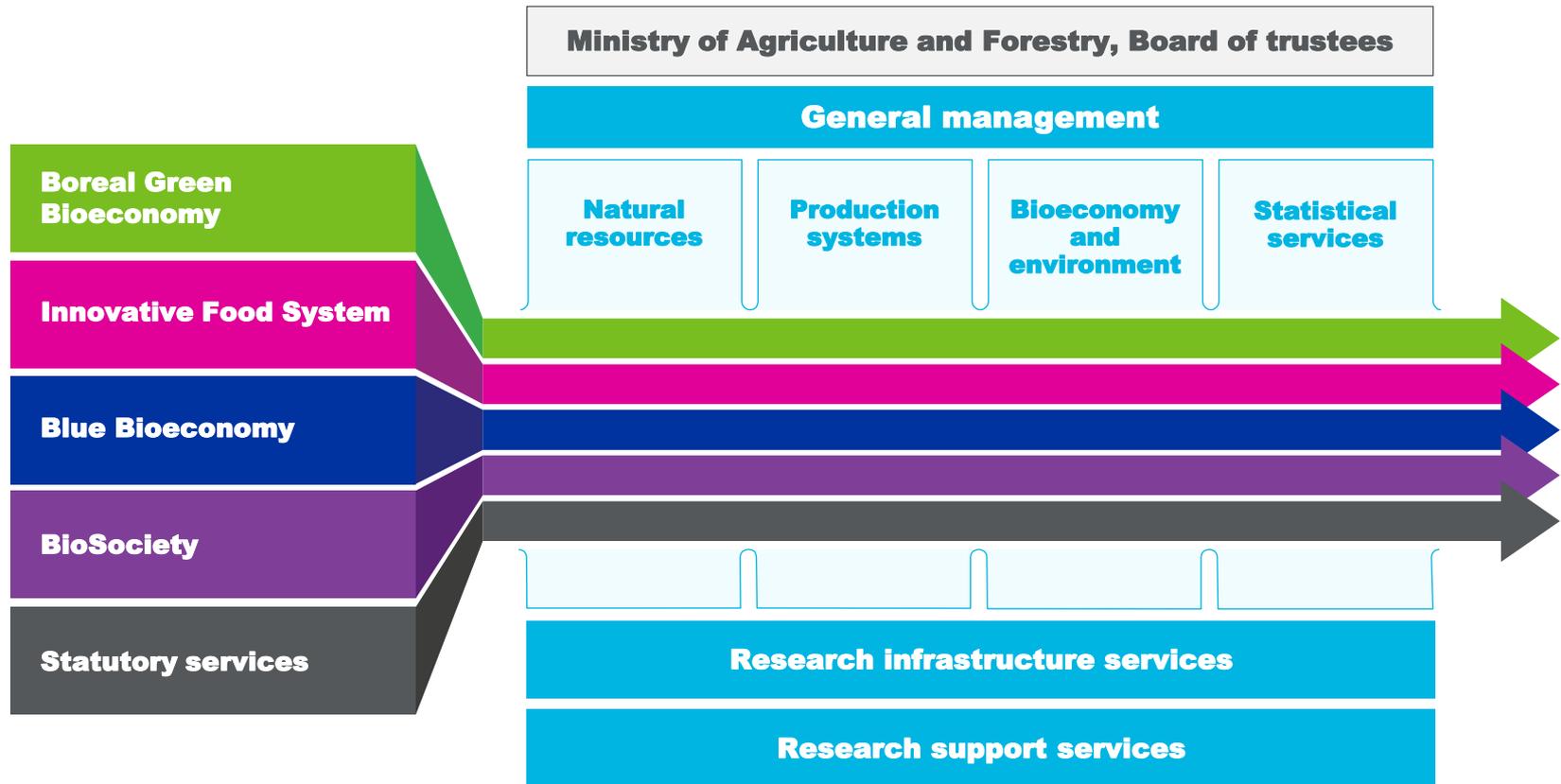
1971 Finnish Game and Fisheries
Research Institute (RKTL)

1993 Information Centre of the Ministry
of Agriculture and Forestry (Tike)

2015

MTT, Metla, RKTL and Tike's statistic services are merged. Natural Resources Institute Finland (Luke) is formed.

LUKE Natural Resources Institute Finland



120 M€

Turnover

90 M€

Research & customer portfolio

30 M€

Statutory services

25

Locations in Finland

HQ in Helsinki

Present in 12 campuses with universities, research institutes and polytechnics

1300

Employees

50 research professors
650 researchers

We are one of the four Statistical Authorities in Finland.

Luke is located throughout Finland

Locations

Helsinki ja Espoo, Jokioinen, Joensuu, Oulu, Turku, Jyväskylä, Seinäjoki, Kokkola, Maaninka (Kuopio), Paltamo, Rovaniemi

Experimental stations

Piikkiö, Haapastensyrjä, Ypäjä, Parkano, Savonlinna, Suonenjoki, Paljakka, Siikajoki, Utsjoki

Aquaculture infrastructure

Enonkoski, Laukaa, Taivalkoski, Keminmaa, Inari

Research co-operation sites

Tampere, Mikkeli, Kajaani, Kuopio campus

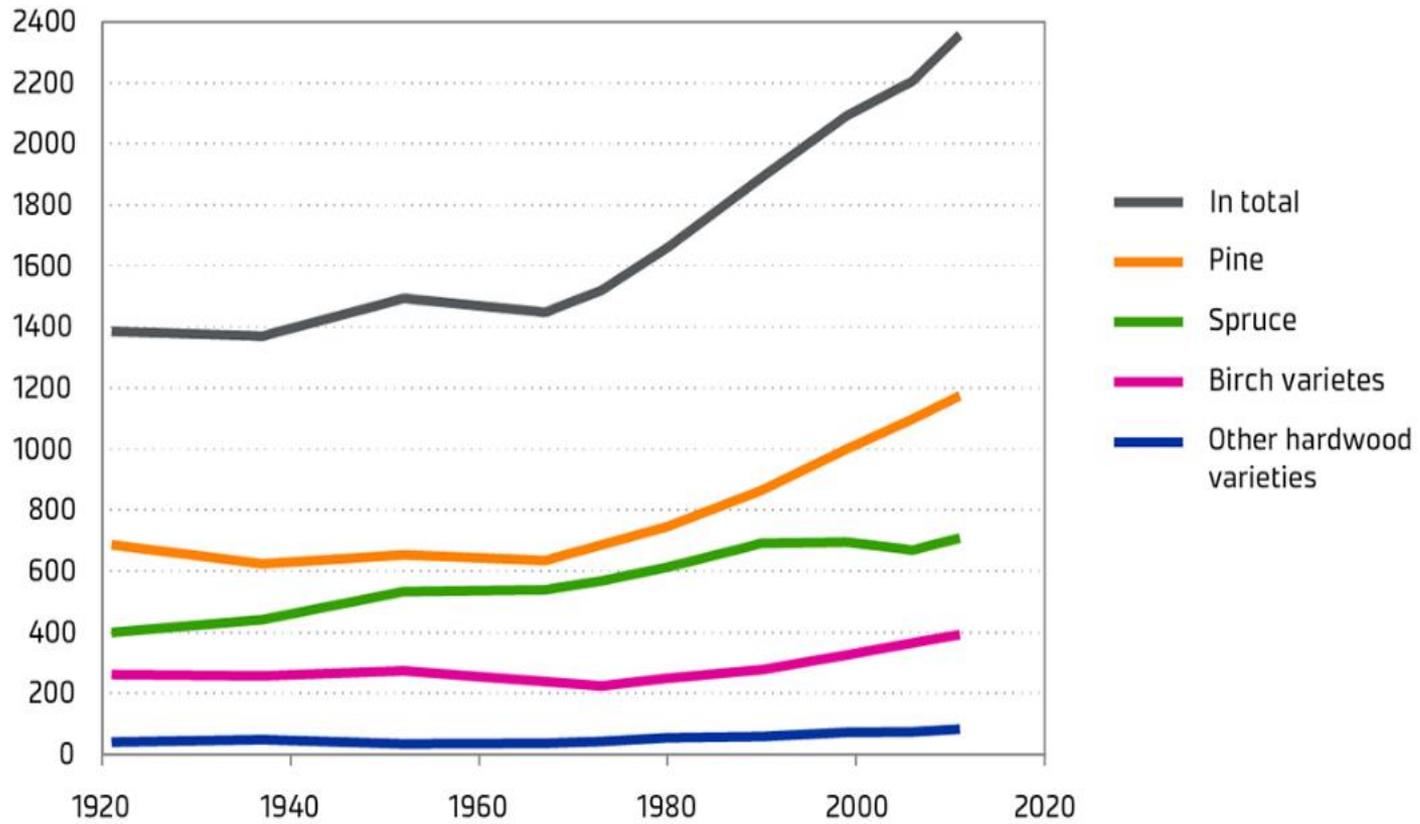


Birch breeding in Finland



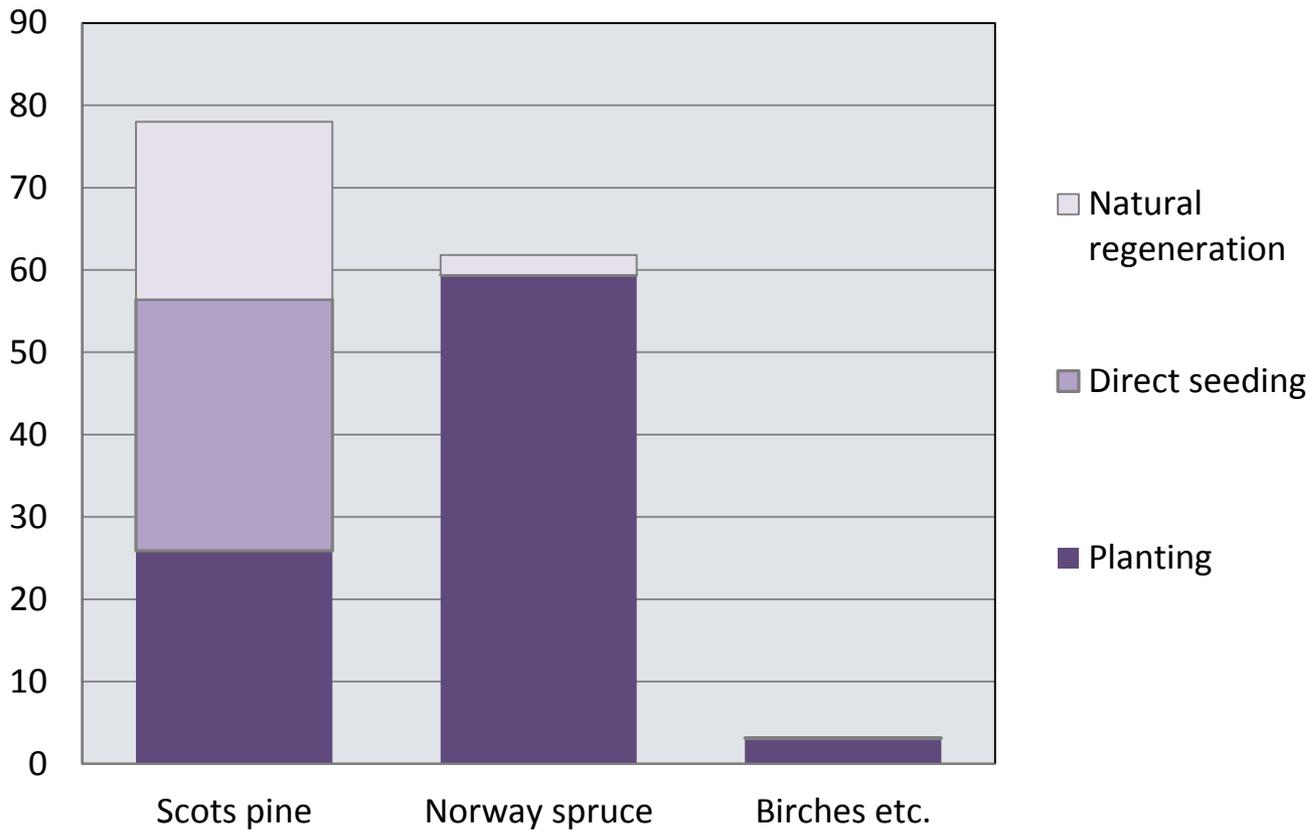
Volume of forest resources

million m³

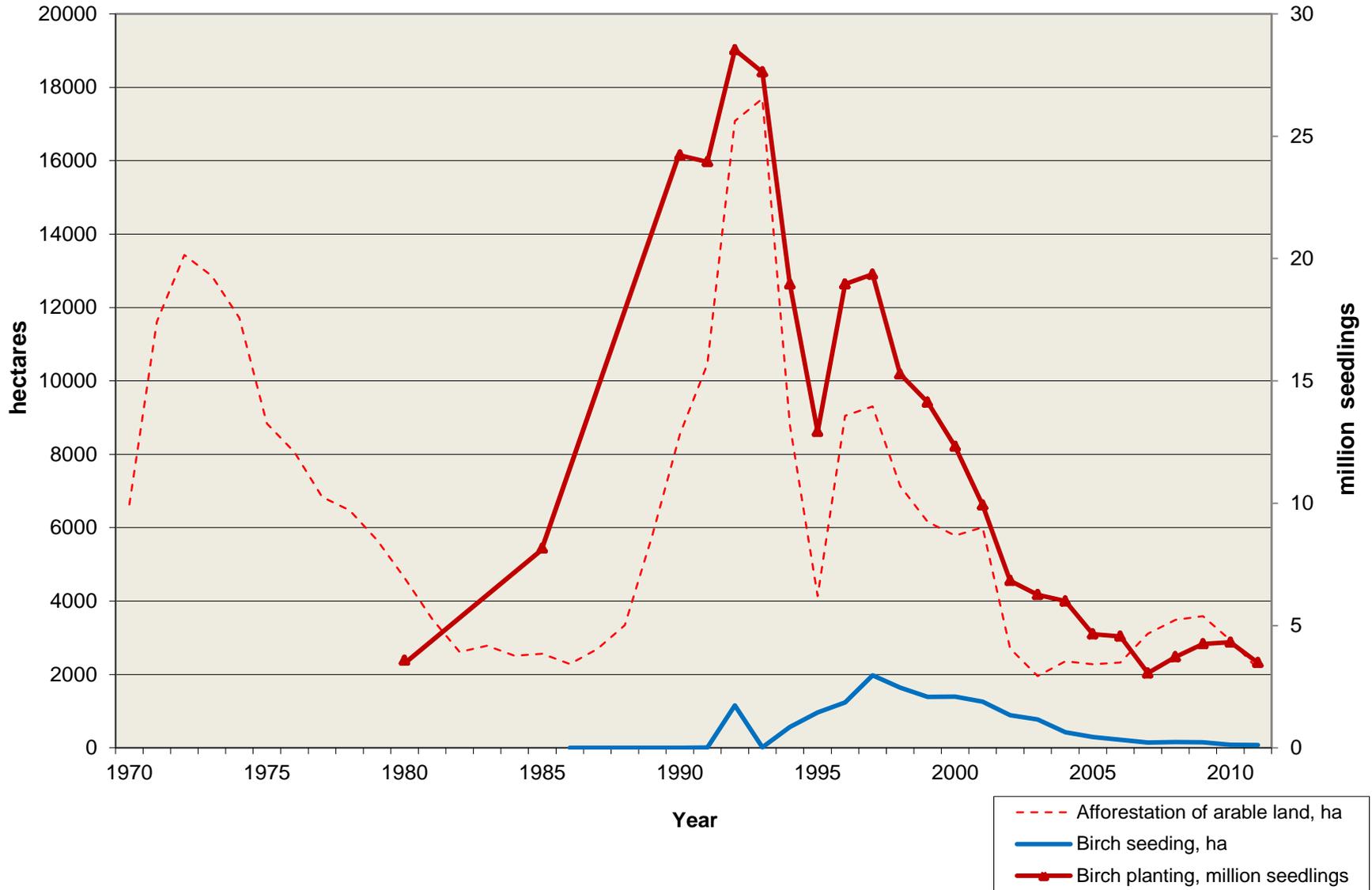


Annual forest regeneration

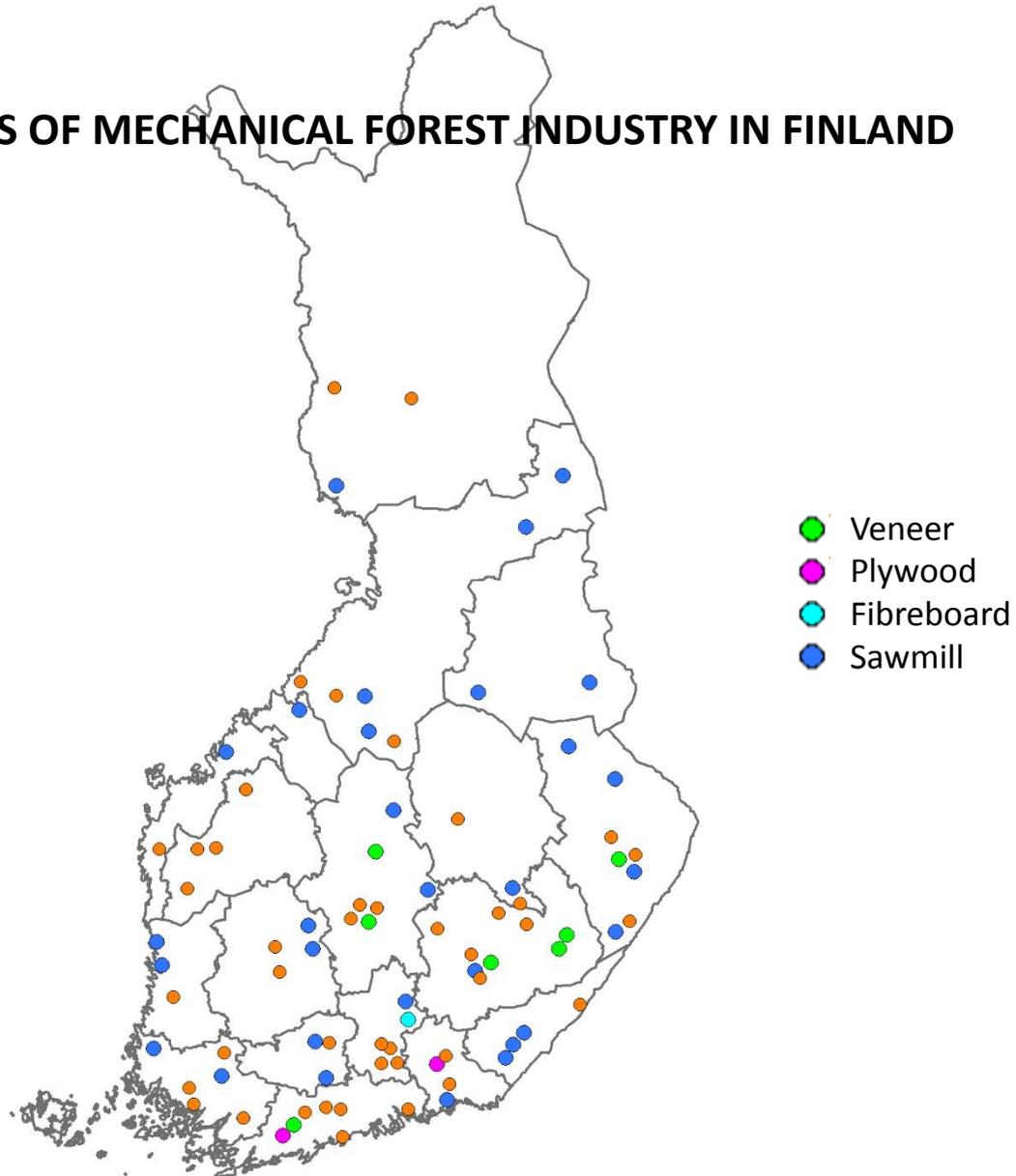
1000 hectares



ARTIFICIAL REGENERATION OF SILVER BIRCH



PLACES OF MECHANICAL FOREST INDUSTRY IN FINLAND





Pinus sylvestris

Photo: Matti Haapanen



Picea abies

Photo: Matti Haapanen



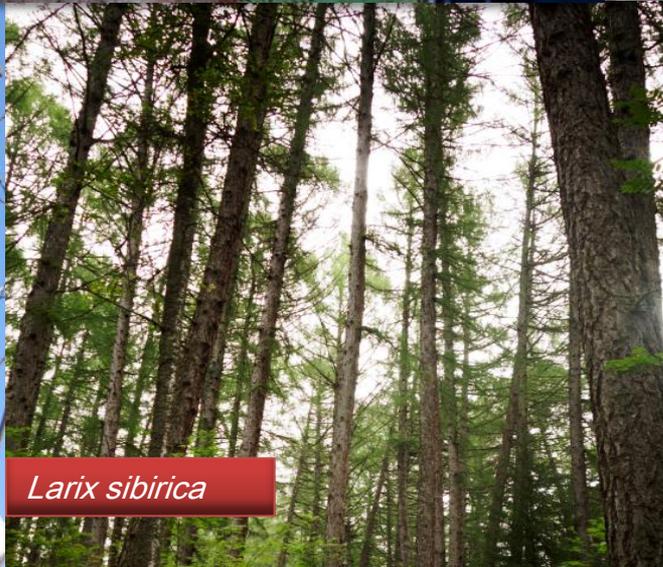
Betula pendula

Photo: Marja-Leena Annala



Alnus glutinosa

Photo: Sirkku Pöykko



Larix sibirica

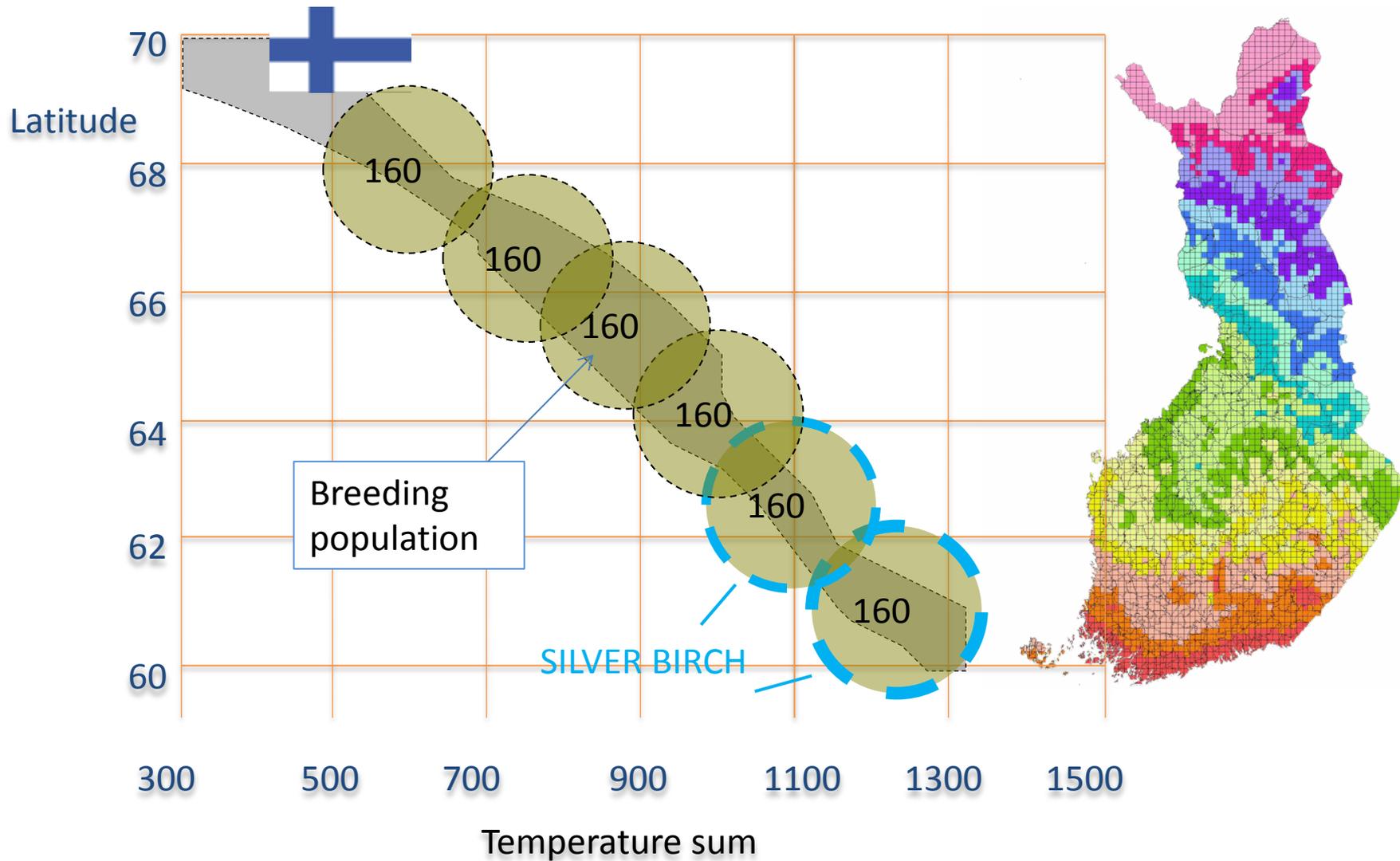


Populus x wettsteinii

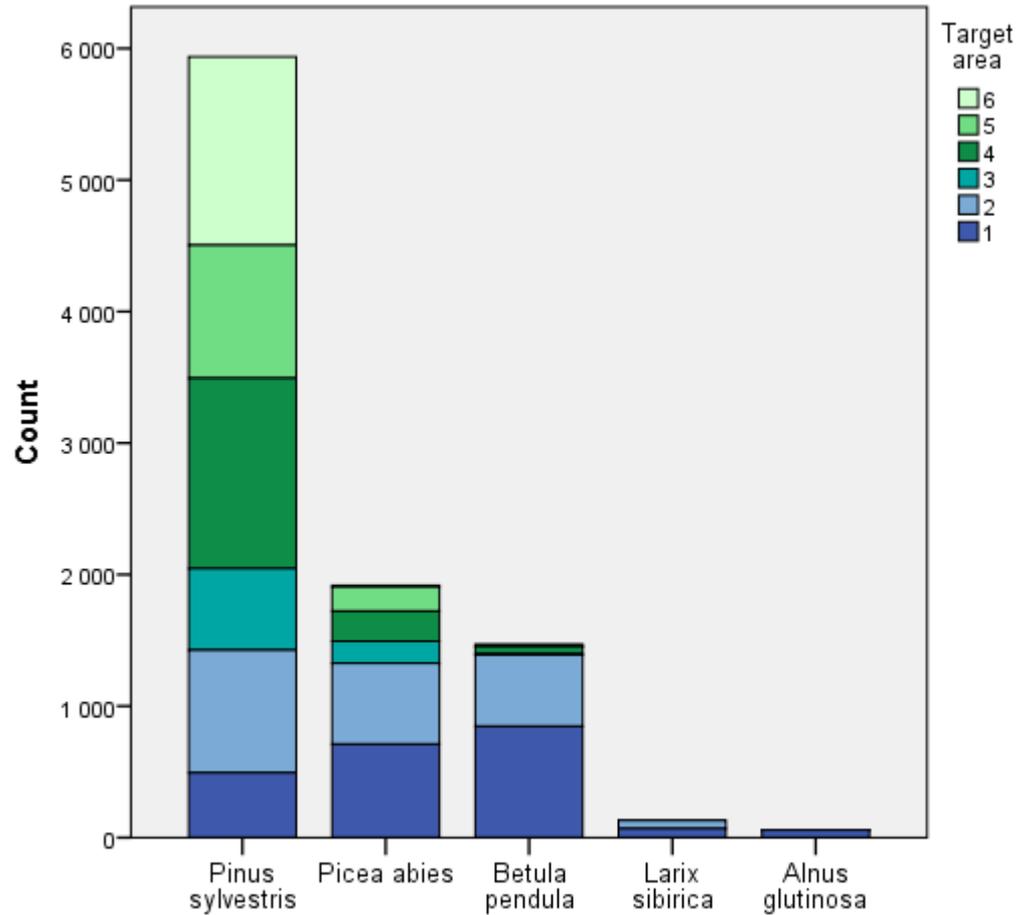
The birch species

- **Silver birch** (*B. pendula*)
 - In breeding programs since the 1960's
- **Curly birch** (*B. pendula* var. *carelica*)
 - Planted ~ 200 hectares per year
 - Seed orchards when necessary
 - Clonal plants produced by one company
 - Low intensity breeding (assessment of old trials etc.)
- **Downy birch** (*B. pubescens*)
 - Finland's third most common tree species
 - Majority of the standing volume on peatlands
 - Very little planting, no breeding / seed orchards (old plus trees and orchard seedlots can still be found)

Multiple population breeding strategy



Plus trees in progeny trials



3. generation in a demo plot at Hauho



Photo: Risto Hagqvist



Breeding strategy

- Two breeding populations for Southern and Central Finland, comprising 1st to 3rd generation selections
- Controlled matings
 - Assortative (mating partners have similar breeding values)
 - Unbalanced (double-pair matings, except for the best trees which are allowed to mate with more partners)
- Full-sib families produced by mating are planted in forward selection trials

Breeding goals

- Major aim is to increase the production of high-quality timber (suitable for plywood/veneer) per unit area
- Selection for a combination of height and diameter growth, branch quality, defects (ramicorns, freezing damages). No attention on internal wood quality traits.
- Selection in genetic trials at age ~10-13 years
- Breeding cycle could be ~15 years, longer in practice



Supplementary selections

- Birch breeding earlier focused on a fairly small number of most promising trees
- To expand the genetic base of breeding, several dozens of new trees have been selected from mature field trials and natural stands
- The first batch of the new selections is to be controlled-crossed this spring



”Line breeding”

Special project

- In the 1980’s, crosses of inbred lines were found to express significant heterosis (~50-100% gains in growth rate observed at a young age)
- A new breeding plan was devised in the late 2000’s to exploit the inbred material in clone banks
- Repeated inbreeding followed by outbreeding
- The most advanced inbred birch lines are now in the 4th generation
- Used for genome mapping by University of Helsinki scientists
- Highly inbred clones flower poorly and only a fairly small number of between-line crosses have been completed so far

A photograph of a vineyard with a red tractor in the aisle. The vines are lush green and trained on a metal trellis system. The tractor is positioned in the center aisle, facing away from the camera. The text "Production of improved seed" is overlaid in a white box with blue text.

Production of improved seed

Photo: Sirkku Pöykkö

Traditional birch seed orchards

30-50 clones

1-2 grafts/clone



GENETIC GAINS

(*Betula pendula*)

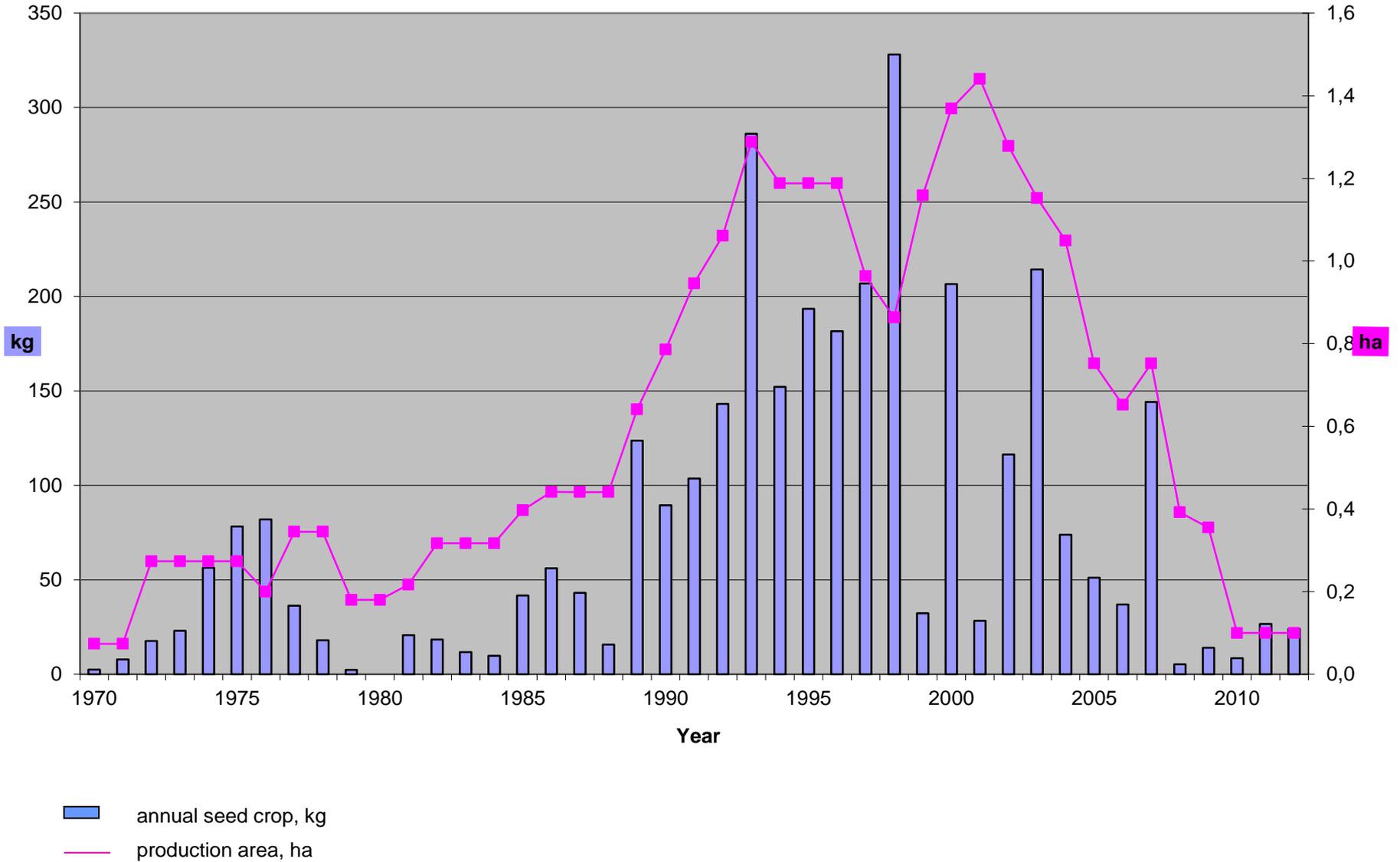
Volume +29%

Relative tapering -13%

Relative branch diameter -10%



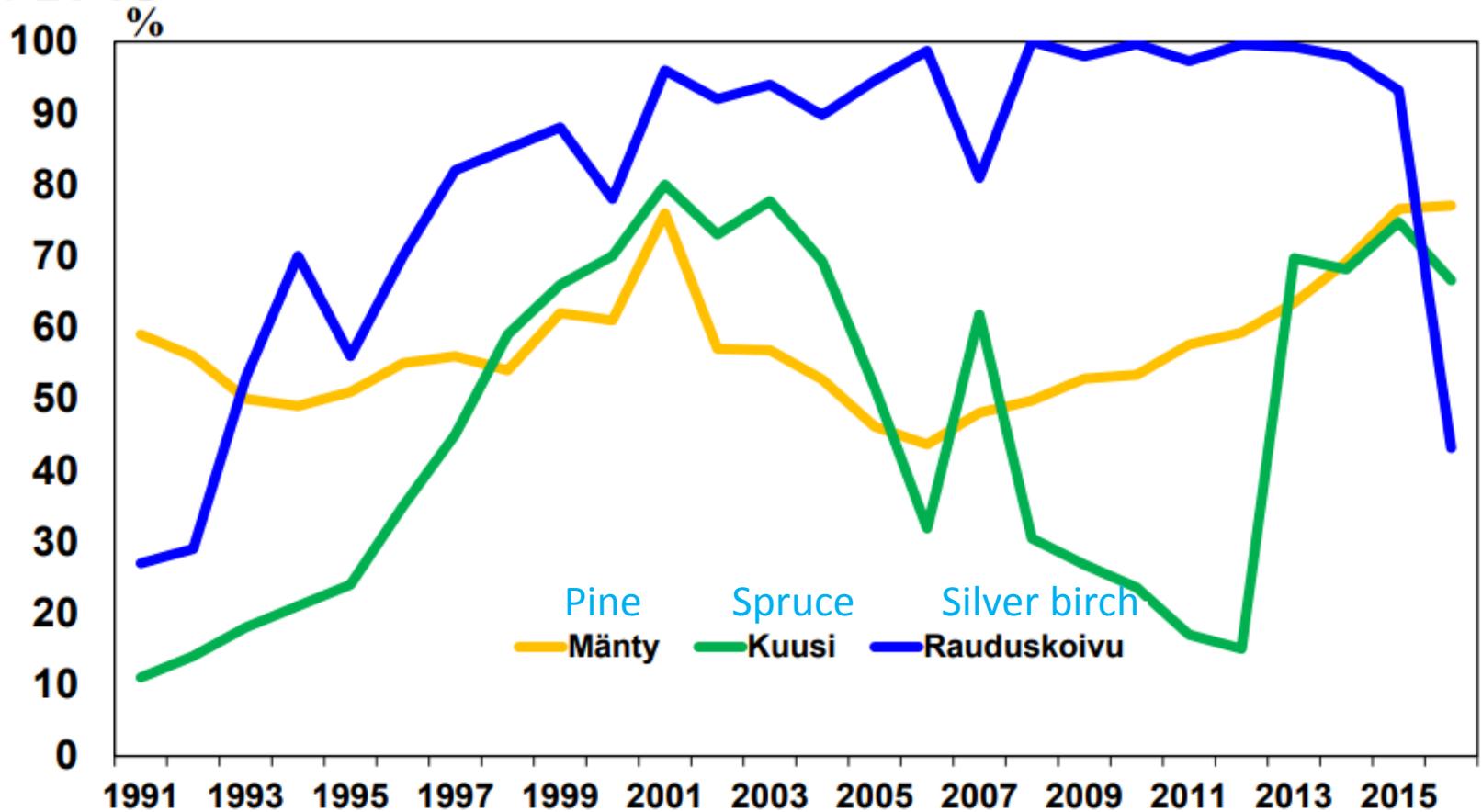
The Finnish Birch Seed Orchards ANNUAL SEED CROP





Proportion of seed orchard seed in tree nurseries 1991-2016

Siemenviljelyssiemenen osuus taimitarhakylvöissä 1991-2016



Full-sib family orchards

- Designed to reproduce some of the best full-sib families and extract higher genetic gains than normally (e.g. by exploiting part of the non-additive genetic variance and higher selection intensity)
 - Selection was based on 9 progeny trials comprising 149 full-sib families
 - Measured at ages 13...21
 - Breeding values predicted for the **families**
 - Parents represent 1.-3. generation elite birches
 - Used for seed production only, not for forward selections for breeding
- An orchard has 2-3 bi-clonal blocks separated by plastic walls
- Full-sib seedlots from different blocks are mixed up
 - Genetic gains in stem volume ~+30%
 - Most of the genetic variation still retained

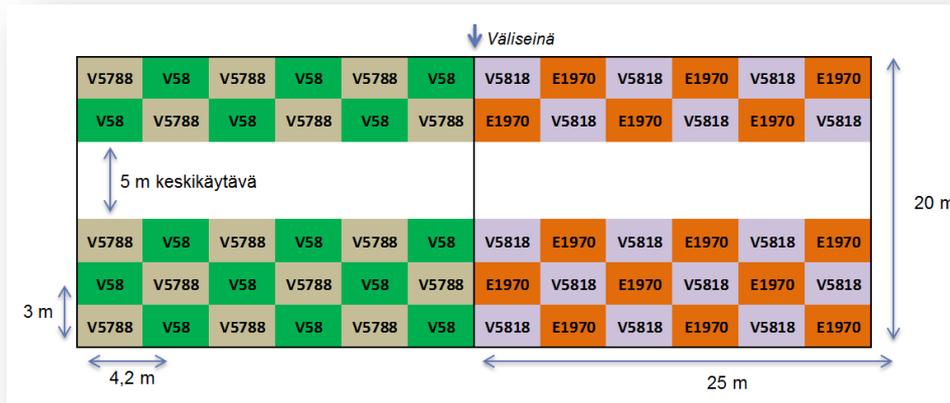


Photo: Leo Holopainen

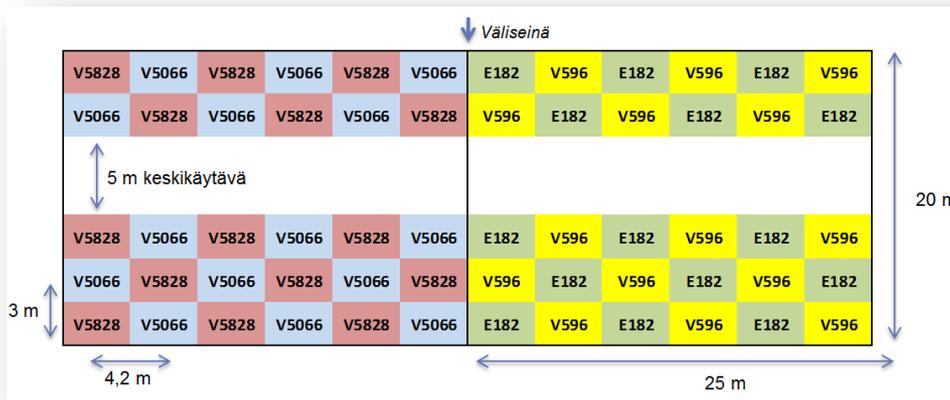
Earlier we have had 6 biclonal seed orchards in Finland

These have mainly produced "JR-1" the famous cross of birch breeder Jyrki Raulo (E1970 x E1980)

Sv466 & Sv468, Oitti (Tapio Silva)



- 2 x 500 m²
- Two tested full-sib families
- 4 clones, 60 grafts
- 1150...1350 d.d.



- 2 x 500 m²
- Two tested full-sib families
- 4 clones, 60 grafts
- 1100...1350 d.d.





V5788 x V58

V5788 = 3rd generation
plustree

V58 = 2nd generation
plustree

Superior in growth (rank=2)

Average branch quality

V5818 x E1970

V5818 = 3rd generation plustree
E1970 = 1st generation plustree

Superior growth (rank=1)

Branch quality in the top 1/3

10% less ramicornes than in check-
lots





Assessed traits

- Height growth
- Stem diameter
- Branch quality (visual score)
- Total worth (visual score)
- Ramicorns
- Forks



Compliments to

Senior Scientist Matti Haapanen
Specialist Risto Hagqvist

Thank you!