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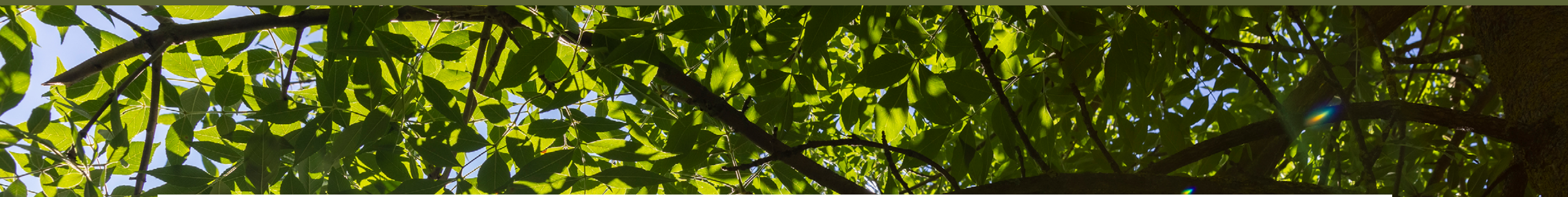


Don't give up on the ash trees!

New hope for the Nordic-Baltic ash forests

European ash *(Fraxinus excelsior)* trees are suffering across Europe. An Asian fungus *(Hymenoscyphus fraxineus)* is causing severe crown damage, increasing susceptibility to secondary infections and root rot and causing early mortality. Old ash trees are dying, and young ash trees are rarely planted. The problems are most severe in forests, but trees in the open landscape are also affected.

The decline of the ash constitutes a huge loss for the stakeholders who grew ash trees for valuable furniture or various other purposes. It also affects people who treasure the presence of ash trees in their vicinity and the historical trees of national importance, as well as the many associated species that benefit from ash trees in their native habitat.

Recommendations:

1 PROTECT NATURALLY TOLERANT ASH TREES IN EXISTING FORESTS
Healthy mature ash trees showing natural tolerance to ash dieback should be retained to support natural regeneration and strengthen the spread of tolerance in future forest generations.

2 SUPPORT DEPLOYMENT OF IMPROVED SEED SOURCES
Newly developed seed orchards should be expanded to provide planting material with increased tolerance, helping restore ash populations while enriching local genetic diversity through gene flow with surviving trees.

3 INVEST IN LONG-TERM BREEDING AND TESTING PROGRAMMES
Continued selection and breeding based on the Breeding Seed Orchard (BSO) concept is essential to progressively increase tolerance and enable future large-scale restoration and productive use of ash.

4 MAINTAIN LONG-TERM RESEARCH AND CONSERVATION EFFORTS
Governments and stakeholders should continue funding research and ex situ conservation programmes, as current evidence from over 20 years of Nordic research shows strong potential for securing the future of ash in resilient broadleaf forestry systems.

Nordic-Baltic partners were early to address the problem

Fortunately, not all ash trees are equally susceptible to the new disease. The presence of unaffected trees amid heavily infected ash stands was already observed and documented in parallel by Lithuanian[1], Swedish[2] and Danish[3] tree breeders and scientists early in the epidemic. They teamed up with the Nordic-Baltic forest pathologists who investigated the cause of the disease, which was still cryptic at the time.

Nordic forest geneticists and pathologists soon formed a joint SNS supported network and initiated establishment of the very successful EU supported FRAXBACK COST network, taking the cooperation to the European level. The Ash catastrophe is at European level, and the early establishment of cooperation across Europe was very important for the present scientific achievements.

CURRENT STATUS: REASONS FOR OPTIMISM

Ash trees in the forests are still dying, but findings from two decades of research offer hope for the next generations of ash trees.

1. **Systematic surveys of ash forests since 2012 have shown that a small fraction (1-5%) of ash trees have a high natural tolerance toward the disease.** Some ash trees remain healthy today, even after many years under heavy infection pressure.[4]
2. **Natural tolerance is passed down from parents to offspring** with fair heritability. Offspring from healthy trees have higher tolerance to the new disease.[5]
3. **Healthy trees in the ash forests tend to generate more offspring** than unhealthy trees.This leads to an overrepresentation of genes from healthy trees in the next generation.[6,7]
4. **Healthy trees can spread their seeds 100 m and pollinate other ash trees much further away.** A few healthy, vital trees per ha are therefore sufficient to disperse seeds across much of a forest, and they can mate with other ash trees even if they have become rare in the previous ash dominated forests.[7]
5. **The fungus *Hymenoscyphus fraxineus*** can be spread by sexual spores on dead leaves from both tolerant and susceptible ash trees. Replacement of susceptible ash trees with tolerant ones may not trigger selection for increased pathogen aggressiveness over time if the fungus maintains its life cycle on the tolerant trees. Rather, the fungus may remain as a benign endophyte or weak pathogen causing limited damage[8]. This dynamic must be monitored, but fungal isolates with low or no pathogenicity have already been documented from Denmark.[9]
6. **The natural variation in tolerance seems** to be of a polygenic nature. This suggests that testing and selection can continue, to increase the level of tolerance over time.[10]

New seed sources with improved tolerance

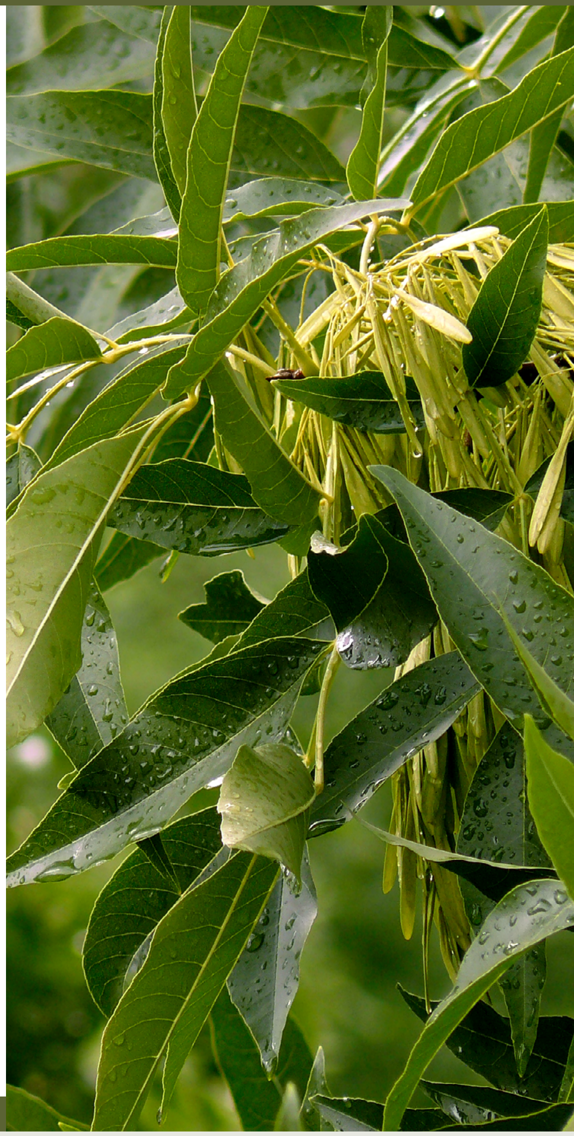
Many questions remain, but the above results suggest that selection and breeding can be an effective way to create new ash trees with improved tolerance to ash dieback.

There is a long tradition of tree breeding in the Nordic countries, and important experience on breeding for improved tolerance to ash dieback has been gained in the past 20 years.

Based on this experience, an approach based on planting, observing and selecting in breeding seed orchards (BSO) is being developed and tested in a Nordic-Baltic cooperation between Skogforsk (SE), the Swedish University of Agricultural Sciences (SE), the Lithuanian Research Centre for Agriculture and Forestry, Institute of Forestry (LT), the Norwegian Institute of Bioeconomy Research (N), the University of Copenhagen (DK), and The Nature Agency (DK).

The strategy behind the BSO approach is to increase tolerance without reducing the general level of genetic diversity in future ash forests. The strategy utilises the fact that susceptible trees can be identified by observing symptoms at an early age. Only tolerant trees are then left for seed collection (Figure 1, page 4). The level of genetic diversity can be controlled based on the known pedigrees and using genetic markers. The use of simple forward selection allows the testing of thousands of trees simultaneously, is a practical and cost-effective method with expected gains not being at the cost of genetic diversity.

New progeny trials and seed orchards have already been established based on the developed concepts. The orchards include genetic material that has already been through one generation of selection, and that will form the foundation for future seed sources (Figure 2, page 4).



Take home message: Don’t give up on the ash trees!

Most forests are likely to contain healthy trees with a high degree of natural tolerance to ash dieback. These trees should retained to promote natural regeneration with increased tolerance, although some damage due to ash dieback must be expected.

New seed sources are being developed, and seeds can be produced for future plantings of more tolerant ash trees. Not all ash seedlings from these early-generation seed orchards will be highly tolerant, but the healthier trees can form viable ash populations that can be, e.g. included in multi-species plantings. Later, the introduced tolerant ash trees can enrich local gene pools of ash trees by mating with surviving ash trees. The new seed sources will also serve as an important ex situ gene conservation resource for Nordic-Baltic ash genetic diversity and ash dieback tolerance.

With continued testing and selection based on the BSO concept, progress in tolerance can continue. This points towards a situation within the next 15-30 years, where ash trees again can be planted and grown for high-quality wood products as part of robust and resilient broadleaved forestry in the Nordic and Baltic countries.

The research is still ongoing, and many important questions still need to be addressed. Continued funding for long-term Nordic-Baltic research, monitoring, conservation, and breeding efforts is essential to maintain the progress already achieved and to support further testing and selection of tolerant genotypes for resilient ash reproductive material for future forests. However, the results from more than two decades of Nordic research provide good reasons for ***not giving up on the ash trees.***

SNS supports the Nordic cooperation on sustainable use and conservation of ash trees by co-funding networks and research projects.

TRIALS & BREEDING SEED ORCHARDS

Figure 1 (above). Breeding Seed Orchard FP291 (Denmark) with ash 5, 8 and 13 years after planting. The difference between tolerant and susceptible trees could easily be identified. Seeds from healthy trees were collected in 2018 and are now part of the Danish second generation seed orchard (see Figure 2). Photos: Erik Dahl Kjær and Lene Rostgaard Nielsen

Figure 2 (below). Development of European ash *(Fraxinus excelsior)* breeding material selected for tolerance to ash dieback across Nordic breeding programs. Upper left (Panel 1): Second-generation breeding seed orchard established with progenies derived from trees originally selected within the FP291 network. Photo: Erik Dahl Kjær. Upper middle and upper right (Panels 2–3): Vigorous progenies originating from the Trolleholm seed orchard growing in Swedish field trials, demonstrating strong growth performance. Photo: Mateusz Liziniewicz. Bottom panel: Progeny trial at Kråkolten, Trøndelag, Norway (photo taken 03 June 2026), showing vigorous growth and promising field performance under Norwegian conditions. Photo: Rannveig Kristiansen.

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