

Seed Sourcing and Tree Improvement of Minor Species

– a call for Plus Trees of Beech and Hornbeam

Joe Beesley, Ollie Stock and Jo Clark describe a new project to select plus trees of beech and hornbeam and establish a grafted seed orchard of beech producing *Qualified* seed.

The Future Trees Trust has launched a project to select plus trees of beech and hornbeam and establish a grafted seed orchard of beech producing *Qualified* seed. They would like to hear from managers and landowners across England and Wales who can recommend excellent stands of these two species for plus tree selection. By making this improved material available to foresters, they hope to enable the creation of diverse and productive woodlands as part of increased tree planting across the UK.

Tree planting is increasing across the UK

The England Trees Action Plan 2021-2024 sets out steps to achieve the government's long-term ambitions for the trees and woodlands of England. The plan aims to treble tree planting rates in England as part of the wider effort to plant 30,000ha of woodland across the UK every year by the end of this Parliament (UK Government, 2021). This equates to around 90-120 million trees each year by 2025, and, in England particularly, there is a strong focus on broadleaved woodland.

Such an acceleration in the rate of tree planting presents challenges across the forestry sector from sourcing a greater quantity and diversity of seed to producing and establishing more planting stock. Coupled with these increases in demand are the risks of maladaptation, and novel pest and pathogen introduction if seed from abroad is imported and used. Expanding and diversifying the sources of homegrown seed, as well as providing support to seed suppliers and nurseries to expand production capacity, is



Figure 1. Beech plus tree.
A dominant individual with high amounts of recoverable timber.

therefore essential if new tree planting targets are to be reached.

To support the sector in this effort, the Forestry Commission has launched a series of grants with funding through Defra and the Nature for Climate Fund. These sit alongside woodland creation grants and include the Tree Production Innovation Fund, the Tree Production Capital Grant and the Seed Sourcing Grant. The latter grant provides support for activities that enhance the quality, quantity and diversity of tree seed sources in England such as the registration and maintenance of seed stands and the establishment of seed orchards. By boosting the sector's capacity to source and handle a greater quantity and variety of tree seed, the grant aims to introduce diversity and resilience into the new woodlands that are being planted.

The Seed Sourcing Grant, and the guidance behind it, is built on many years of research into the benefits of mixed woodlands for both biodiversity and production. Diversity in species composition, as well as in stand structure and species genetics, is crucial in providing woodlands with the resilience to threats from emerging pests and disease, and from those caused by climate change, such as drought, stronger winds and more serious storm events (Messier et al., 2022). Plenty of important work is in progress at Forest Research such as trialling lesser-known species for their suitability to British forestry and providing silvicultural advice on mixed stand establishment (Kerr et al., 2020; Reynolds et al., 2021).

The increased rates of tree planting and species diversification in the UK present a fantastic opportunity. With such large amounts of new planting, the trees that are established in the coming years will form a significant portion of the nation's future forests. By using seed that is more likely to produce higher quality productive trees, we could ensure that these new woodlands are able to provide excellent quality timber which can be used in net-zero construction whilst reducing our reliance on imports.

Tree improvement is the use of traditional selective breeding to improve desired characteristics in a breeding population. For timber production, the key traits selected for are commonly form, vigour and disease resistance (Pâques, 2013). Forest Research has managed a long-running and successful programme of tree improvement on Sitka spruce (*Picea sitchensis*), but broadleaves have been historically understudied (Savill et al., 2005; Samuel et al., 2007).



Figure 2. Hornbeam plus tree.
The individual in the centre has exceptional stem form.

Tree improvement at Future Trees Trust

Future Trees Trust is a research charity that uses tree improvement to enhance the form and growth rate of the main productive broadleaved species in the UK: oak (both *Quercus petraea* and *Q. robur*), silver and downy birch (*Betula pendula* and *B. pubescens*), sycamore (*Acer pseudoplatanus*), wild cherry (*Prunus avium*) and sweet chestnut (*Castanea sativa*). We select superior individuals from woodlands across the UK (known as plus trees), replicate these trees through grafting to establish clonal seed orchards and investigate the genetics of the selected plus trees through large experimental plots called progeny trials (Beesley and Clark, 2020).

The foundation of our work is our collection of plus trees for each species. For timber production, plus trees are dominant and healthy individuals within a stand that show exceptional form: straight and circular stems, excellent apical dominance, light horizontal branching and absence of heavy forking in the crown (Clark and Wilson, 2005) (Figures 1 & 2). These are the trees that will produce the greatest amount of high-grade recoverable timber and therefore those highly sought after by the sawmills.

Once a significant number of plus trees have been selected for a particular species, we collect scion material from their crowns and graft this onto rootstocks to genetically copy each plus tree. Multiple copies of many plus trees are then planted at a wide spacing as clonal

seed orchards (Figure 3). By bringing plus trees together in an orchard to cross-pollinate, the seed produced is considered *Qualified* by the Forest Reproductive Material (FRM) regulations (Forestry Commission, 2019). We recently produced a guidance document on where planting stock arising from each of our seed orchards can be established to reduce the risk of maladaptation and increase the likelihood of outperforming local material collected from *Source identified* or *Selected* seed stands (Clark et al., 2022).

To improve the quality of the seed produced at these orchards further still, we establish progeny trials to investigate whether the excellent form and growth of our plus trees is due to its genetics or its environment. In these large trials, plants raised from seed collected from our plus trees (therefore the progeny of each plus tree) are assessed for growth and form traits over many years. If a plus tree has consistently excellent progeny, then we can infer that these superior traits are more due to the genetics of that tree rather than its original environment.

Ultimately, Future Trees Trust is focused on the production and championing of improved broadleaved seed (*Qualified* and *Tested* FRM) for the forestry sector. We work with landowners across the country whose woodlands contain our selected plus trees and who host the trials, orchards and genetic archives that constitute our breeding programmes.

Starting work on minor species

Future Trees Trust has a long history working on the major broadleaved species, but for several years we have been aiming to begin tree improvement programmes with a number of minor species to make these species more attractive to foresters when establishing mixed and resilient productive woodlands. The Seed Sourcing Grant described above lists 23 Priority Species for which there are current and/or forecasted shortages in seed sourcing and an advised strategy on how to best bolster seed production for each species.

Beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) are two of these Priority Species. They are seen as important components of mixed broadleaved woodlands in lowland England, and as our climate warms over the coming decades their distributions may extend further across southern Britain. As they are productive species, the recommended strategy of seed sourcing for both is the selection of plus trees and replication of these plus trees to establish seed orchards producing *Qualified* seed. Our

successfully funded project will take this approach and build upon the expertise developed with our core species.

The first stage of our project involves the selection of 100 plus trees of both beech and hornbeam from across England and Wales. As described above, these are exceptional individuals for timber production that will form the basis of our tree improvement programmes. It is important to select these plus trees from across the entire natural range of the two species to ensure we retain high levels of genetic diversity in our breeding populations.

The second stage is to return to 50 of the beech plus trees with an arborist team to collect graftwood from their crowns. The collected material will be grafted onto rootstocks by a specialist team at NIAB East Malling and the successful plants used to establish a large and genetically diverse seed orchard. This will be the first beech clonal seed orchard in the country and the only source of *Qualified* seed for the species.

A third element of this project involves the creation of a blackthorn (*Prunus spinosa*) seed stand. Blackthorn is one of the most widely planted shrub species in the country and adds structure and biodiversity to woodlands. However, sufficient seed is sometimes in short supply and blackthorn was defined as a Priority Species by the Seed Sourcing Grant. We are partnering with the Millennium Seed Bank at Wakehurst Place to utilise seed from their Native Tree Seed Project. This project collected seed from at least two native populations of blackthorn in every Native Seed Zone in the



Figure 3. Silver birch clonal seed orchard at Maelor Forest Nurseries. Grafted copies of plus trees managed to produce *Qualified* seed. We will establish a similar orchard from our beech plus trees.

UK. We will raise seed from populations containing greater than ten individuals to establish a genetically diverse native seed stand of blackthorn.

Beyond the timeframe of this project, we will revisit 50 of the hornbeam plus trees to collect graftwood and use this material to establish a large and diverse clonal seed orchard. As with beech, this orchard will be the first of its kind providing *Qualified* hornbeam seed for use across southern England and an important resource for this resilient species.

This is a really exciting new project for Future Trees Trust and will allow us to improve seed supply to the forestry sector for these three Priority Species. Through the grant we have been able to employ a Forestry Technician to join our research team. We are delighted to welcome Ollie Stock to Future Trees Trust who will primarily be working on this project.

Selecting plus trees of beech and hornbeam

Searching for 200 plus trees across England and Wales requires focused field visits to high quality stands. We are locating such stands in several ways. Firstly, we have turned to the National Register of Approved Basic Materials which records all the seed stands and seed orchards currently registered with the Forestry Commission. This lists 26 seed stands of beech (23 are *Selected* and three are *Source identified*) with a majority in south west England, but no stands of hornbeam. Our second source is from a previous project called the Sustainable Seed Sourcing Project which focused on potential stands of hornbeam in south east England. A total of 31 stands were visited and any potential plus trees recorded. Revisiting the higher quality stands and the potential plus trees will be an excellent starting point for this species.

Our third and most important and effective way is to reach out to the wider forestry community. We would love to hear from landowners and forest managers who know of or manage excellent stands of beech or hornbeam in England and Wales that we could survey for plus trees. This would involve a first visit to select trees of interest, potentially



Ollie Stock. Forestry Technician at Future Trees Trust.

followed by a second visit during the winter months to collect graftwood.

But it's not just beech and hornbeam we are interested in. Future Trees Trust are always on the lookout for plus trees of our core species and other minor species that may be of future interest. These include both species of oak, small-leaved lime (*Tilia cordata*), wild service tree (*Sorbus torminalis*), wild cherry (*Prunus avium*) in Region of Provenance 30 and silver birch in Wales and southern England. If you would like to learn more about the project or recommend stands or trees of beech, hornbeam or any other species, please contact Ollie Stock by email at oliver.stock@futuretrees.org.

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Joe Beesley is a Researcher at Future Trees Trust. He has a doctorate in Biochemistry and brings his experience in genetics and disease to forestry research.

Ollie Stock has recently joined Future Trees Trust as a Forestry Technician. He has a BSc and a MSc in Forestry, as well as research experience on forest monitoring in the European context.

Jo Clark is Head of Research at Future Trees Trust. She has over 30 years in forestry research and leads the Living Ash Project.