

Project number: 6874
Funding source: DAFM

Date: May, 2019
Project dates: Mar 2017 – Apr 2019

EARTH

Exploitation And Realisation of Thinnings from Hardwoods



Key external stakeholders:

Farmers. Landowners. Forestry industry and sector. Forest Service, Department of Agriculture, Food and Marine.

Practical implications for stakeholders:

This research project aimed to preliminarily identify potential added value products from Irish hardwood first and second thinnings. If the identified potential end uses are further verified and developed, they may provide an enhanced income stream to hardwood forest owners, support rural employment, and substitute imports.

Main results:

- Classification of thinnings in the forest in terms of suitability for structural uses should be based on 3 parameters: stem straightness; stem diameter; stem mechanical properties.
- Ash thinnings present higher mechanical properties than the other 3 species. Properties of first and second thinnings were similar for both ash and birch and can be used for structural purposes.
- Due to its' mechanical properties and treatability with preservative, ash is the most suited species for structural purposes as small recreational constructions, playgrounds and fencing.

Opportunity / Benefit:

- If ash dieback has the impact on Irish ash similar to that seen in continental Europe, there is likely to be a much increased supply of small diameter ash in the coming years. This may have potential to substitute imports used in small recreational constructions and playground equipment.
- Small diameter thinnings of alder, ash, birch and sycamore have the potential for conversion to inside-out beams for internal construction uses, such as window and door lintels.

Collaborating Institutions:

NUI Galway (Project coordinator), ECC Teoranta sawmill, Lonza Wood Protection

Teagasc project team: Dr Ian Short (PI), Derek Gibson
External collaborators: NIUG: Prof. Annette Harte (Coordinator), Dr Daniel Llana

1. Project background:

The Irish stocked forest area is 673,000 ha (Government of Ireland, 2018); 480,000 ha and 194,000 ha of conifer and broadleaf forest respectively. Approximately 45% of the estate (302,000 ha) is \leq 20 years old – 218,000 ha are coniferous and the remaining 85,000 ha are broadleaf. In total, 308,000 ha of forest are classified as juvenile and have not reached the development stage for first thinning, whilst 111,000 ha of the forest estate have been thinned. According to the National Forest Inventory 2017 (Government of Ireland, 2018), the proportion of standing volume consisting of potential straight logs 3m or longer is low (Table 1).

Table 1. Percentage of standing volume by broadleaf species consisting of a minimum of 3m potential straight log (Government of Ireland 2018)

oak spp.	beech	ash	sycamore	birch spp.	alder
26.3	18.3	6.0	10.6	2.5	17.1

Thinning is an important part of good broadleaf forest management. It involves the removal of competitors of selected high quality trees, diseased trees and trees removed for extraction racks, all to favour the growth of the selected trees, maintain stand health and vigour, and to provide access for future management. Many felled trees are small-diameter or of lower quality. In Ireland, hardwood thinnings are mainly used for energy production. Other uses are in chipped form for use in the manufacture of wood-based panels or in the pulp/paper industry.

The challenges of commercialisation have identified the need to get maximum value out of all the forestry output including what has often been considered a secondary by-product – forest thinnings. There is commercial value in seeking to use it in higher value-added end uses as principal structural components within the construction industry and to develop its volume use in local rural industry. In an Australian study (Yeates, 1999), it was found that if even a small percentage of thinnings material can be utilised as roundwood for construction, the return to the investors in plantation hardwoods is large when compared with sale into woodchip markets only.

Very little is known about the properties of Irish hardwood thinnings, which needs to be quantified in order to identify potential new uses. Quality, in terms of strength and straightness, is essential. The EARTH project investigated alder (*Alnus glutinosa*), ash (*Fraxinus excelsior*), birch (*Betula pubescens* and *B. pendula*) and sycamore (*Acer pseudoplatanus*).

2. Questions addressed by the project:

- Determine the availability and quality of the Irish alder, ash, birch and sycamore hardwood resource
- Carry out a preliminary evaluation of the physical and structural properties of alder, ash, birch and sycamore.
- Examine the issues related to drying and durability of alder, ash, birch and sycamore hardwood thinnings
- Identify end-use applications for first and second thinnings of alder, ash, birch and sycamore.

3. The experimental studies:

The availability of the hardwood resource was assessed by interrogating DAFM datasets. The Afforestation Grant and Woodland Improvement Grant (Tending and Thinning) shapefiles were used to identify sites with potential suitability for fieldwork sampling.

Fieldwork consisted of installing plots approximately 20 x 20m. Potential Crop Trees (PCTs) were identified and marked. Competitors were identified and marked. Where required, an extraction rack was installed 1 line in 7. The following data was collected:

- No. planting positions;
- No. standing trees;
- DBH of each tree;
- Height of 4 largest DBH trees;



Figure 1. Non-destructive testing of standing ash thinnings using TreeSonic equipment.

Top Height calculated;
 No. PCTs;
 No. competitors;
 No. trees on rack (if applicable).
 From the competitors, five trees were randomly selected for non-destructive testing (NDT) measurements and harvesting of log samples for testing in NUIG of timber properties, drying and durability. Non-destructive testing (NDT) was carried out on standing trees using TreeSonic (Fakopp, Sopron, Hungary) (Figure 1) and on green logs from these trees directly after harvesting and in the lab after drying using a mechanical timber grader (MTG; Brookhuis, Enschede, The Netherlands). Destructive testing was carried out in the NUIG lab.

A sample of 2m length debarked logs was treated with Tanalith E 8000 (Lonza Wood Protection) preservative in an industry-standard high pressure chamber. The preservative and protocol used are commonly used in the Irish timber industry. Disks were subsequently sampled from the centre of each log to evaluate preservative penetration.

Inside-out (ISO) beams, a form of engineered wood product, were produced from dried logs of alder, ash, birch and sycamore with minimum diameter 10cm and tested both non-destructively and destructively.

4. Main results:

- The total stocked area of alder, ash, birch and sycamore is 76,000 ha. For each species, ≥ 45% of the stocked area is ≤ 20 years old.
- Alder, ash, birch and sycamore represent the four broadleaf species with the greatest growing stock volume in the 7-19.9 cm DBH cohort, totalling 5.067 million m³. For each of the species, >50% of the growing stock volume had no straight log >2m length.
- Classification of thinnings in the forest in terms of suitability for structural uses should be based on 3 parameters:
 - Straightness – visually classify in the same way as assessed for classification as a PCT
 - Diameter – thinnings of < 10cm diameter should be discarded for structural uses
 - Mechanical properties – can be estimated by NDT on standing trees or green logs with relatively good accuracy without requiring timber density measurements.
- Ash thinnings present higher mechanical properties than the other 3 species. Properties of first and second thinnings were similar for both ash and birch and can be used for structural purposes.
- Ash was the only species that exhibited evidence of sapwood and uniform penetration of the preservative (Figure 2).
- Due to its' mechanical properties and treatability with preservative, ash is the most suited species for structural purposes as small recreational constructions, playgrounds and fencing. With the potential impact of ash dieback (*Hymenoscyphus fraxineus*) over the next decade, there may be large volumes of small diameter material becoming available in the coming years.
- Approximately 25% of the logs studied were considered suitable for ISO beams. Straightness, log diameter and presence of cracks are the criteria used. Mechanical properties of the ISO beams are slightly reduced compared with that of the roundwood. The main use of the ISO beams could be as door or window lintels.

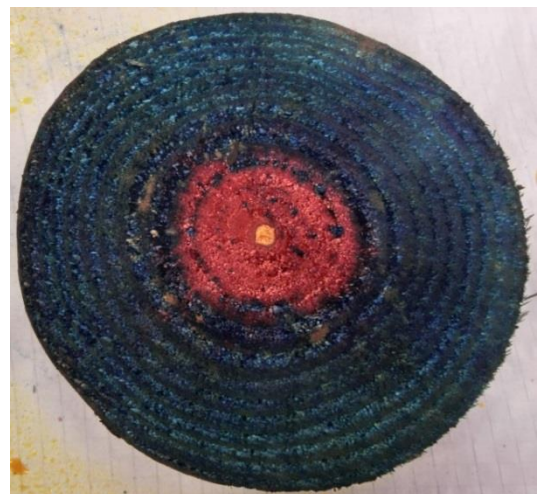


Figure 2. Preservative penetration, indicated by blue stain, in small diameter thinning of ash.

5. Opportunity/Benefit:

- This was only a preliminary investigation and further research should be conducted to verify results. However, results indicate that, of the four species tested, ash is the only one suitable for outdoor structural purposes using the industry-standard preservative protocol tested. If ash dieback has the impact on Irish ash similar to that seen in continental Europe, there is likely to be a much increased supply of small diameter ash in the coming years. This may have potential to substitute imports used in small recreational constructions and playground equipment.
- Small diameter thinnings of alder, ash, birch and sycamore have the potential for conversion to inside-out beams for internal construction uses, such as window and door lintels.

6. Dissemination:

- Project websites – Hosted on NUI Galway and Teagasc Forestry websites.
- Project overviews presented at:
 - DAFM visit to NUI Galway, 29-08-2018
 - Ryan Institute Research Day, NUI Galway
 - 2017 National Forestry Conference
 - 2017 Teagasc Researcher's Conference
 - Ministerial announcement: funding for Wood Properties for Ireland – NUI Galway
 - 2017 Forestry Show
 - 2017 and 2018 Tullamore Show
 - 2017 and 2018 Ploughing Championships
 - Talking Timber, Ballyhaise College, Co. Cavan – 31-08-2017

Main publications:

Llana, D.F., Short, I., Harte, A.M. (2019) Acoustic measurement differences on trees and logs from hardwoods in wet and dry condition. Proceedings of the 21st International Nondestructive Testing and Evaluation of Wood Symposium. September 24-27. Freiburg im Breisgau, BW, Germany. Pp. 561-568.

Llana D. F., Short I, O'Ceallaigh C, Harte A.M. (2018) Mechanical Properties Estimation by Non-destructive testing of Irish Hardwood Round Timber from Thinnings for Construction Purposes. In: Proceedings of the 8th Hardwood Conference, Sopron, Hungary, October 25-26 2018. Oral Presentation

Short, I. (2018) Productive Woodlands – A Researcher's Perspective. Productive Woodlands Conference, Co. Antrim.

Popular publications:

Short, I. and Llana, D.F. 2018. Invited lecture at UCD to Master of Architecture students, 13th February 2018.

7. Compiled by: Dr Ian Short