



Harvesting / Transportation No. 18

© COFORD 2009

ForestEnergy Programme 2006-08

The COFORD ForestEnergy programme has the objective of securing marketable wood fuel of acceptable moisture content for sale as wood chip, firewood and other wood fuels, to support the development of the renewable wood energy sector in Ireland. The programme achieved this through commercial scale demonstrations of forest harvesting supply chains for wood energy on 15 forest sites (Figure 1). At each site the supply chain productivity, fuel quality and delivered energy cost of each system was assessed. Different storage options and seasoning schedules over one and two summer seasons were investigated. Public demonstrations of machinery and methods were held each year of the programme.



- | | |
|-----------------------------|-------------------------------------|
| Conifer sites | Broadleaf sites |
| 1. Abbeyfeale, Co Limerick | 10. Dovea, Co Tipperary |
| 2. Ballybofey, Co Donegal | 11. Manseragh, Co Tipperary |
| 3. Bweeng, Co Cork | 12. Mullinavat, Co Kilkenny |
| 4. Croaghrimcarra, Co Mayo | 13. Portlaw, Co Waterford |
| 5. Foilaghig, Co Cork | 14. Stradbally, Co Laois |
| 6. Frenchpark, Co Roscommon | |
| 7. Kilbrin, Co Cork | Cutaway peat site |
| 8. Swan, Co Laois | 15. Boora, Co Offaly |
| 9. Woodberry, Co Galway | |
| | Long-term storage trial site |
| | 16. Rochfortbridge, Co Westmeath |

Figure 1: Location of the ForestEnergy programme trial sites.

COFORD
 Arena House, Arena Road,
 Sandyford, Dublin 18, Ireland
 Telephone: +353 1 2130725
 Email: info@coford.ie
 http://www.coford.ie

FORESTENERGY PROGRAMME

Forest storage and seasoning of conifer and broadleaf whole trees

Pieter D. Kofman¹ and Tom Kent²

Harvesting wood fuel from forest thinnings differs from other assortments in that the whole tree is suitable as a fuel. Branches and tree tops will produce suitable material for chipping; only the leaves or needles are not suitable fuel. Any wood that is to be used for energy should be seasoned before it is chipped, as the energy content of wood chips is directly related to the moisture content. Seasoning the whole trees in the stand before chipping utilises the ambient climate to remove moisture and does not require investment in dedicated storage. As the tree dries, the leaves will desiccate, and fall off. This has the added advantage that the nutrients, which are mainly found in the needles, stay in the forest. Forest sites vary greatly in local climate, exposure and humidity, so the time required to season timber before chipping will vary.

Chipping of whole trees in the forest has been shown to be the cheapest method of harvesting wood for energy. This partly due to the fact that up to 75% more biomass is harvested when chipping whole trees compared to roundwood. Further savings are due to simpler and more integrated operations.

The purpose of this trial was to determine how whole trees season in the stand under Irish conditions. A number of treatments was investigated. Whole Sitka spruce trees were felled by chainsaw or feller-buncher and left to season at the stump. Sitka spruce was also chemically killed, left to season while standing, and then felled and chipped in one operation. Whole-tree broadleaf thinning trials were carried out in ash and sycamore. In the broadleaves, only chainsaw and feller-buncher methods were employed.

The conifer trials were carried out at eight first thinning sites. Three stands were thinned in February-March 2006: Frenchpark, Kilbrin and Swan. Plots for whole-tree thinning by chainsaw, by feller-buncher and chemical thinning were laid down at all three sites. These were for one summer season only, except for the chemical thinning, which was harvested in autumn 2006 and autumn 2007. Unfortunately, the chemically thinned plot at Frenchpark could not be chipped due to lack of time and problems with ground conditions.

¹ Danish Forestry Extension, Senior Consultant Wood for Energy. Email: woodenergy@gmail.com.
² Waterford Institute of Technology. Email: tkent@wit.ie.

Whole-tree thinning by chainsaw was examined at five more sites over the period April – June 2007. At three sites - Abbeyfeale, Ballybofey and Woodberry - half the felled trees were chipped in September 2007, with the remainder left to season for a second year, until chipping in August 2008. The whole-tree plots at the Bweeng site were all chipped in September 2007, while those at Toormakeady were chipped in August 2008.

At Woodberry and Bweeng another small experimental trial was carried out in spring 2007. In a narrow strip along the road, small trees were cut free from the stump and left standing. In September 2007, after one summer's seasoning, the trees were winched to the roadside and chipped for energy using a small tractor-mounted chipper with a winch attachment over the infeed.

Broadleaf whole-tree thinning trials were carried out at four sites: Portlaw, Dovea, Manseragh Estate and Mullinavat. A non-intimate mixture of ash and sycamore was thinned at Portlaw in 2006 by a feller-buncher and by chainsaw. Whole



Whole trees previously felled by a feller-buncher after a summer seasoning.

trees were left to season at the stump. For comparison, a plot was felled with the feller-buncher and stacked for seasoning at the roadside by forwarder. All material was chipped in September 2006. Whole-tree thinning plots were laid down at Dovea in July 2007, at Manseragh Estate in February 2008 and at Mullinavat in April 2008. The whole-tree plots at the Dovea and Mullinavat trials were chipped in September 2008. Ground conditions were not suitable for terrain chipping at the Manseragh Estate.

The results of trials with clearfelling small diameter trees on cutaway peat at Boora Bog, Co Offaly, are also reported here. A planted and a naturally regenerated stand of birch, a Sitka spruce plantation with a heavy encroachment of birch and a lodgepole pine stand were clearfelled and left *in situ* to dry. Most of the birch area was felled in March 2006, as was part of the lodgepole pine area. The remainder of the lodgepole pine area was felled in June 2006. All wood was chipped in September 2006.

In all eight conifer stands, trials were also conducted on the roadside storage of roundwood, both as 3 m pulpwood and 4.3 m energy wood, using covered and uncovered stacks. This work is described in the COFORD Connects note: *Storage and seasoning of conifer roundwood in the forest.*

Further trials were carried out to investigate the difference between seasoning in the forest and at a dedicated storage yard. Again, both roundwood and energy wood, covered and uncovered, were studied. This work is described in the COFORD Connects note *Long term storage and seasoning trial of conifer energy wood.*

Results

Results from the storage trials for 2006, 2007 and 2008 are presented by assortment and tree species (Table 1).

It was not possible to obtain chips from conifer whole-tree thinnings for use as fuel in boilers that require a moisture content less than 30%. Of the whole-tree thinning experiments, only the chemical thinning at Kilbrin had a moisture content below 40%. In those cases where the wood was on the ground for two summers, the moisture content fell a few percent more. It should be noted that 2008 was a particularly wet summer.

The chemical treatment applied in 2006 did not result in total mortality, so a second treatment was applied in early

Table 1: Moisture content (MC) in conifer and broadleaf stands over one and two summer seasons.

Assortment	Location	Year harvested	Starting MC	MC 2006	MC 2007	MC 2008
			%			
Conifer whole trees	Frenchpark	2006	56.8	53.0		
	Swan	2006	62.7	57.2		
	Kilbrin	2006	56.8	40.8		
	Abbeyfeale	2007	56.3		52.7	43.1
	Ballybofey	2007	61.5		53.9	49.8
	Bweeng	2007	52.4		45.2	
	Toormakeady	2007	54.6			48.5
	Woodberry	2007	54.6		50.1	47.2
Conifer, chemical thinning	Frenchpark	2006	56.8	Not harvested		
	Swan	2006	60.5	54.4	45.6	
	Kilbrin	2006	56.8	49.5	32.3	20
Conifer felled, and left standing	Bweeng	2007	52.4		42.3	
	Woodberry	2007	54.6		45.1	
Broadleaf thinning	Portlaw, sycamore	2006	46.2	35.3		
	Portlaw, ash	2006	35.9	35.7		
	Dovea, ash	2007	45.2			38.4
	Manseragh Estate, ash	2008	36.5	Not harvested		
	Mullinavat	2008	40.7			36.5
Boora clearfell	Boora, planted birch	2006	50.8	32.6		
	Boora, natural regeneration birch	2006	48.3	36.7		
	Boora, mixture of spruce and birch	2006	52.3	34.9		
Conifer, premature clearfelling lodgepole pine	Boora fell March	2006	54.6	27.4		
	Boora, fell June	2006	54.6	36.0		

2007. At Swan the largest trees still remained alive, even after two treatments. Drying rates obtained with the chemical treatment were similar to those where whole trees were felled and left on the ground.

The results also show that broadleaves in general have a lower starting moisture content than conifers, and that their moisture content can be reduced by summer drying. In both 2006 and 2008 good drying rates were obtained in broadleaves with one summer seasoning. The ash at Portlaw did not dry much, but did not need to as the initial moisture content was very low. No broadleaf whole trees were left on the ground for two full summers, but at Dovea the trees were felled in July 2007 and chipped in September 2008 and thus had more than one summer of seasoning.

The best drying rates came from the clearfells at Boora, especially in the premature clearfell of lodgepole pine. In general, clearfelled trees lost far more moisture than thinnings. This indicates the benefits of exposure to wind. Trees that were felled in April 2006 had lost 27% moisture, while trees in the same block that were felled in June lost only 19%. This shows that drying should start in April.

It is also very important that trees are cut completely free from the stump, especially in Sitka spruce, where only minimal attachment is sufficient for the tree to live on and take up moisture. Where trees were fully cut free from the stump, they had dried and shed most of their needles; and after two summers drying, all the needles were gone. This was not the case for lodgepole pine which retained its needles after a summer's drying; for this species a 2-year drying period is needed for needles to fall off.

Conclusion

It is unlikely that the whole-tree method will be able to dry trees sufficiently for chips to be suitable for boilers needing fuel at less than 30% moisture content. Even broadleaves, which have lower initial moisture content than conifers, did not dry sufficiently to provide suitable fuel for such boilers. However, for larger boilers (particularly for co-firing) the material dried sufficiently. Also, drier chips lower the cost of transportation.

A second summer period did result in some small additional drying; it is likely that the effect would have been greater but for the very wet summer of 2008.

The only exception was the premature clearfell of birch and lodgepole pine, which dried very fast over the summer. However, lodgepole pine still largely retained its needles after a summer's drying, and would not, therefore, produce

acceptable fuel for most applications. A further summer's drying would be required.

Chemical thinning, where it was effective in killing off suppressed trees, promoted good drying. Unless, however, it leads to most trees dying off, the overall chip moisture content is unlikely to be suitable for small-scale boiler use.



Chipping whole broadleaf trees after summer drying in a covered stack at the roadside.

For information and a free on-line advisory service on the wood energy supply chain, the quality of wood fuels and internal handling visit www.woodenergy.ie

Note: The use of trade, firm or corporation names in this publication is for the information of the reader. Such use does not constitute an official endorsement, or approval by COFORD of any product or service to the exclusion of others that may be suitable. Every effort is made to provide accurate and useful information. However, COFORD assumes no legal liability for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed herein or for any loss or damage howsoever arising as a result of use, or reliance, on this information.