



Harvesting / Transportation No. 25

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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

1. Abbeyfeale, Co Limerick
2. Ballybofey, Co Donegal
3. Bweeng, Co Cork
4. Croaghrimcarra, Co Mayo
5. Foilaghogig, Co Cork
6. Frenchpark, Co Roscommon
7. Kilbrin, Co Cork
8. Swan, Co Laois
9. Woodberry, Co Galway

Broadleaf sites

10. Dovea, Co Tipperary
11. Manseragh, Co Tipperary
12. Mullinavat, Co Kilkenny
13. Portlaw, Co Waterford
14. Stradbally, Co Laois

Cutaway peat site

15. Boora, Co Offaly

Long-term storage trial site

16. Rochfortbridge, Co Westmeath

Figure 1: Location of the ForestEnergy programme trial sites.

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FORESTENERGY PROGRAMME

Whole-tree harvesting of softwood first thinnings for energy wood chip production, chemical thinning

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Introduction

Harvesting woodfuel from forest thinnings differs from other types of harvested assortments in that the whole tree is suitable as a fuel. The branches and tree tops will produce suitable material for chipping, only the leaves or needles are not suitable. All wood for energy use should be seasoned before it is chipped - the energy content of wood chips is directly related to the moisture content. Seasoning whole trees in the stand, before chipping, utilizes the ambient climate to remove moisture and does not require investment in dedicated storage. As the tree dries, the leaves will desiccate, turn brown 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.

Chemical thinning is a variation on the whole tree method where the trees are felled and left in the stand. Trees are brushed and then treated with Roundup, to kill the trees while standing. When the trees are dead, they are chipped by a terrain chipper that is equipped with a small felling head.

There are some advantages to this method: trees die slowly and thus the transition from a closed stand to a thinned stand is not as sudden as when the trees are felled. The moisture content of standing dead trees can also be lower, since they are not in ground-contact, unlike felled trees.

The method is only suited for initial line thinning, plus some trees in the row immediately beside the row to be removed. If the chipper has to reach into the stand for a selective thinning, too much time is used on felling and the productivity of the chipper would be greatly reduced.

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The particular machines chosen for the work were not available in Ireland at the time of the trials, so they were transported from Denmark, with experienced crews to perform all operations. At the time of writing one terrain going tractor-mounted chipper is now operating in Ireland.

Method and machines

Brushing is carried out by means of a small chainsaw. The stem is also wounded so that the herbicide penetrates more easily into the tree. During the trials several application methods were tested, such as brushing and spraying. Systems are available that inject herbicide into the tree, but these were not tested.

Chemical thinning was tested in the three stands examined in the 2006 trial series: Frenchpark, Kilbrin and Swan. Trees were later harvested in 2006 and/or 2007 by a Silvatec chipper equipped with a small felling head. Chips were removed to roadside by chip forwarders.



- ▲ Treating wounded trees with a pesticide to kill them on the root.
- ▼ The result of the chemical line thinning before felling.





◀ The Silvatec chipper starting on a row of killed trees, felling and chipping in one operation.

Results

Time studies

All operations were followed with time studies and the net productive time recorded. The time excludes all disturbances. In order to come to a more normal working day, allowances are added to the productive time to get work place time. Allowances include rest breaks, small repairs and other normal things, but exclude major events like significant breakdowns, getting stuck etc. By adding 30% allowances for machine work and 70% for chainsaw felling work, productive machine hours (pmh) are obtained.

Production units

In all cases the volume of loose chips (m^3_{lv}) from the chippers is converted to m^3 solid biomass (m^3_{sb}) by using a factor of 0.33. This is a standard ratio for converting loose

biomass to solid and means that $1 m^3_{lv} = 0.33 m^3_{sb}$. All production figures and costs are expressed in m^3_{sb}/hr or $€/m^3_{sb}$. Along with the actually measured moisture content of the chips at the time of chipping, the energy content of the chips is calculated in GJ/m^3_{sb} and the final cost is expressed in $€/GJ$.

In this COFORD Connects note, only the average figures for the two years of study are mentioned. For further details one is referred to the report which will be published at a later date.

Table 1 presents average results for operations in 2006 and 2007 for trees that were chemically killed, and then felled and chipped by the Silvatec terrain chipper.

In 2006 only a few trees were harvested at two sites (Kilbrin and Swan) because the treatment was only partially effective. Early in 2007, the trees were given a second application of Roundup. All the trees at Kilbrin then died,

Table 1: Whole-tree row thinning harvesting chain with chemical thinning, felling and chipping by Silvatec terrain chipper.

Year	2006	2007
Number of sites	2	2
Chainsaw brush, manual apply productivity (m^3_{sb}/pmh)	5.94	5.90
Silvatec chip (m^3_{sb}/pmh)	15.35	8.70
Chainsaw brush and apply cost ($€/pmh$)	5.09	5.09
Silvatec chipper cost ($€300/pmh$)	19.53	34.50
Total cost ($€/m^3_{sb}$)	24.62	39.60
Average energy content (GJ/m^3_{sb}) at harvested MC	7	6.7
Average energy cost to roadside ($€/GJ$)	3.52	5.10

but at Swan some of the biggest trees were still alive even after a second treatment. Only two sites of the three treated sites were harvested. The final one in Frenchpark was situated on very soft terrain, as a result the chipper bogged-down before it could begin harvesting. In 2006 one load of chips was harvested at Kilbrin and at Swan only a few trees. Thus, the 2006 results are based on few observations. Results for 2007 are much more reliable, since several loads were studied.

The average total production cost of woodchip to roadside ranged from €24.62/m³ to €34.50/m³ ^{sb}. When the moisture content was factored in, the production cost per unit of wood energy ranged from €3.52/GJ to €5.91/GJ. If the forest owner gets €5 per m³ solid biomass as payment for the right to harvest the wood (stumpage), then the total cost at the roadside (in containers) would be in the order of €4.25 to €6.60 per GJ. Depending on the haulage distance, transport would add another €1.50 to the cost, giving a total delivered-in cost of €6.29 to €8.92 per GJ. A 10% management fee for the woodfuel trader has been included.

Stumpage (€5/m ³ ^{sb}) €/GJ.....	€0.70
Chipping operation €/GJ.....	€3.52 - €5.91
Road transportation 50 km €/GJ.....	€1.50
Traders allowance 10% €/GJ	€0.57 - €0.81
Total delivered cost €/GJ	€6.29 - €8.92

Conclusions

Chemical thinning might be a solution for stands that have gone beyond the normal thinning age, where a normal thinning might be too harsh an intervention, compromising the stability of the stand. The operation causes trees to die slowly, which allows, to some extent, the crowns of neighboring trees to take over thereby lessening wind exposure. Another advantage is that the trees dry much better standing up than lying down.

The application of the chemical should be investigated further, because the methods used did not kill the trees within one growing season and the chemical was difficult to apply. Some of the chemical was spilled. There are injector appliances available for this kind of work and they should be tried. This might reduce the cost of the thinning operation and increase the drying rate.

The Silvatec chipper is able to fell and chip the standing trees at a slightly higher cost than if the trees had been felled. Also in this method there is no brush mat for machines to operate on, but if band tracks are used machines cause relatively little ground damage.

The total delivered-in cost of this type of wood fuel would be in the order of €6.29 to €8.92 per GJ or roughly €60-85 per tonne at 45 % moisture content.

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