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. Foilagohig, 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.

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

FORESTENERGY PROGRAMME

Production of wood chip from premature clearfelling of lodgepole pine on cutaway peat

Pieter D. Kofman[1] *and Tom Kent* [2]

Introduction

Occasionally forest plantations may fail to grow productively, due to incorrect species choice, poor site conditions or damage from pests. Such areas can be felled prematurely and reforested, but the harvest may not yield sawlog or pallet wood due to the poor quality of the trees. Similar considerations apply to over-aged and over-sized Christmas tree plantations. Felling such areas for a wood fuel assortment could provide a viable end use for the trees removed.

Trials were conducted in a lodgepole pine plantation on cutaway Midland bog, which, shortly after planting, had been attacked by pine shoot moth, which resulted in trees with multiple stems, of poor form, with heavy branching. A decision was taken to remove the stand after 8 years of growth, and to find out if the resulting material could be used for energy.

One part of the stand was clearfelled in April 2006 with a feller-buncher, which placed the trees in windrows for summer drying. The machine had to return to Denmark on a specified date, so the area was not completely harvested. The remainder of the stand was felled by chainsaw in May-June 2006. The trees were all chipped in September 2006 by a Silvatec terrain chipper.

Machines

As stated, in one part of the stand, all trees were felled by a Silvatec feller-buncher, and were placed in lines, all facing the same direction. A three-axled base machine was used, equipped with a parallelogram crane and a Silvatec felling head. The head has a stabilising cylinder that enables it to handle trees in a standing position. It also has a set of accumulating arms, instead of feed rollers and delimbing knives, so that more than one tree in a cycle could be felled and lifted out to the rack. The trees were so heavily branched that it was necessary to

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

Silvatec chipper offloading into the chip forwarder.

remove the lower branches by chainsaw so the felling head could reach in and grip the stem.

The second part of the stand was felled by chainsaw in a more random fashion, because it was difficult to place the trees, by hand, in the one direction.

Chipping was done using a Silvatec chipper, a self-propelled machine, developed for chipping trees in confined spaces in stands. In Denmark, 500 mm wide tyres are normally used, but these were replaced by 600 mm tyres to increase flotation under Irish conditions. The machine would have benefited from having band tracks on the wheels, but these were not available at the time. The front-mounted chipper can handle trees up to 35 cm in diameter. Chips are blown to the rear of the machine into a 15-17 m^3 storage tank, which can be lifted high in the air to unload the chips into the chip forwarder. The forwarder was also equipped with wider tyres than is usual in Denmark. The machine transported the chip from the stand to roadside, where it tipped off for reloading into walking-floor trailers.

Results

Averages for one stand in the study are presented here. Further details are available in the ForestEnergy 2006 programme report.

The trees felled in April dried much better than those felled in May/June. The drying time for the latter was too short. The trees from the April felling had a moisture content on chipping of 27%, while those felled in May/June were at 36%. Since pine does not shed its needles readily, one summer's drying was not enough to shed the needles, so the chips were full of brown needles. Another year would have been needed for most of the needles to shed. Had it been Norway or Sitka spruce, all the needles would have been gone after one summer.

Table 1 lists results of the operations in 2006 for whole trees felled by feller-buncher or by chainsaw and chipped by Silvatec terrain chipper.

The average total production cost of wood chip to roadside ranged from €17.58/$m^{3\ sb}$ to €18.23/$^{m3\ sb}$. When the moisture content was factored in, the production cost per unit of wood energy ranged from €2.04/GJ to €2.28/GJ.

An estimate of the delivered-in cost of wood energy to the end user includes some assumptions on the whole chain costs. If the forest owner gets €5 per m^3 (stumpage), then the total cost at the roadside delivered in containers would be in the order of €2.75 to €3 per GJ. The cost of road transportation should be added to this amount: depending on the distance to be covered this would add another €1.50/GJ to the cost, giving a total cost delivered at the plant of €4.66 to €4.92 per GJ. An allowance of a 10% management fee for the wood fuel trader is included in the calculation.

Stumpage (€5/$m^{3\ sb}$) €/GJ..................€ 0.70

Chipping operation €/GJ...................€ 2.04 - € 2.28

Road transportation 50 km €/GJ........€ 1.50

Traders allowance 10% €/GJ............€ 0.42 - € 0.45

Total delivered-in cost €/GJ..............€ 4.66 - € 4.92

System productivity

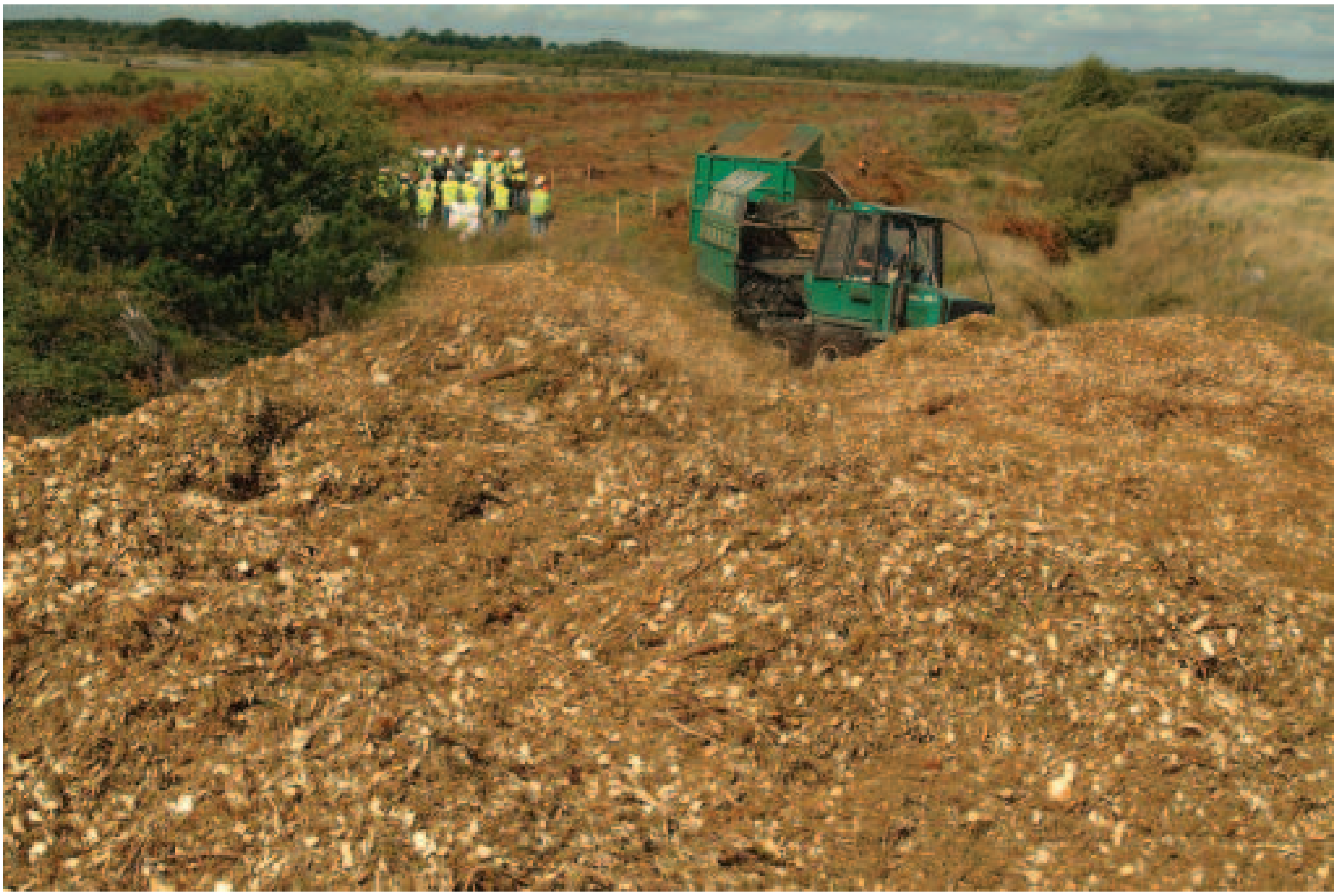
All operations were time studied, and the net productive time was recorded. Net productive time excludes all interruptions and, in order to reflect a normal working day, allowances were added to obtain work place time. Allowances include rest breaks, small repairs and other normal interruptions, but exclude events such as major breakdowns and bogging. as these are unpredicatable By adding 30% allowances for machine work, and 70% for chainsaw work, productive machine hours (pmh) was obtained.

Units

In all cases the volume of loose chips ($m^{3\ lv}$) from the chippers was converted to m^3 solid biomass ($m^{3\ sb}$) by using a conservative ratio: 1 $m^{3\ lv}$= 0.33 $m^{3\ sb}$. All production figures and costs are expressed in $m^{3\ sb}$/pmh or €/$m^{3\ sb}$. With the measured moisture content of the chips at the time of chipping, the energy content of the chips is expressed in GJ/$m^{3\ sb}$ and the final cost is expressed in €/GJ.

Table 1: Overview of productivity and costs of the whole-tree method with terrain chipping in premature clearfell of lodgepole pine.

Year	2006	2006
Number of sites	1	1
Site type	Lodgepole pine	Lodgepole pine
Harvesting type	Clearfell	Clearfell
Felling method	Feller-buncher	Chainsaw
Felling productivity (m^3/pmh)	13.56	3.76
Chipping machine	Silvatec	Silvatec
Chipping productivity (m^3/pmh)	27.7	27.7
Felling cost @ feller-buncher €100/pmh, chainsaw €25/pmh (€/$m^{3\ sb}$)	7.31	6.66
Silvatec chipper cost @ €300/pmh (€/$m^{3\ sb}$)	10.92	10.92
Total cost (€/$m^{3\ sb}$)	18.23	17.58
Average energy content (GJ/m^3) at harvested MC	8.9	7.7
Average energy cost to roadside (€/GJ)	2.04	2.28



Pile of chips from the lodgepole pine site.

Conclusions

If stands have to be clearfelled prematurely, and the mean tree size is insufficient to produce stake, pallet or sawlog, wood for energy is a potentially profitable use of the material.

For lodgepole pine, the trees should be left on the ground for two summers, because it takes a long time for their needles to fall off. The same is true for noble and Nordmann fir, while Norway and Sitka spruce need only one summer to lose their needles.

Drying of felled trees following clearfelling can be rapid, as removing all trees creates an open, exposed site with good air flow. In order to maximise the benefit of this drying potential, the trees should be felled in spring and seasoned over the entire summer period. In the case of the lodgepole pine, trees dried very well over the five months before chipping: the moisture content fell from 55% to 27%. The other half of the stand, felled by chainsaw in June, had only three months drying time and so they had a higher moisture content at chipping of 37%.

Chainsaw felling may be the best solution, as the production cost per m^3 was lower than the feller-buncher operation. The total costs were lower per GJ for the feller-buncher operation, but this was simply because the trees had a longer drying period, and therefore had a higher energy net 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***