

Forestry Commission Project Report 027 - Extended summary  
**Woodfuel production from coppice restoration**

### Summary

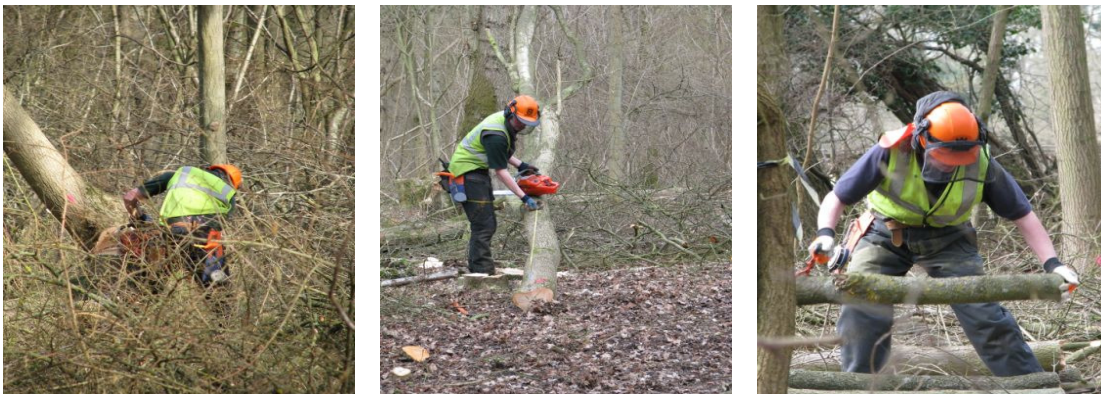
This reports presents the results of a coppice restoration with motor-manual felling and forwarder extraction in an oak (*Quercus robur*) and ash (*Fraxinus excelsior*) stand of c. 75 years of age. The mean diameter at breast height (dbh)<sup>1</sup> and volumes were respectively 20 cm and 0.282 m<sup>3</sup> for the ash and 20 cm and 0.299 m<sup>3</sup> for the oak. The operation consisted of cutting all trees and understorey and only keeping selected standards at a density of approximately 40 stems/ha. A shortwood system was adopted where 2.2 m length firewood products were cut in majority.

The observed outputs were 0.67 m<sup>3</sup>/shr for motor-manual felling corresponding to a £24.28/m<sup>3</sup> felling cost, and 2.22 m<sup>3</sup>/shr/100 m extraction distance with a tractor-based forwarder, corresponding to a cost of £22.28/m<sup>3</sup>/100 m extraction distance. The substantial amount of unmarketable material contributed greatly to the felling costs, and the forwarding costs were affected by the relatively small size of the loads.

A low-impact extraction system, the Iron Horse, was also evaluated as part of this study. It showed a good ability to travel creating a minimal impact, but its full potential could not be evaluated as the forwarding configuration, as well as the products specification, limited the load size.

### Machinery description and study method

Felling was carried out motor-manually by two operators using Husqvarna 357 XPG chainsaws and extraction was carried out by a Massey Ferguson 3095 four-wheel drive tractor, using a Forest Fab timber trailer fitted with a 6 m crane.



Motor-manual felling, products marking and stacking

An Iron Horse was also available during the operations, but because of the lack of experience of the operator, it was decided it would not be relevant to carry out any time study as such of the Iron Horse, however a number of qualitative observations were recorded. The Iron Horse was composed of a 5.5 hp tracking unit fitted with a 1000 kg capacity wheeled timber trailer and a 400 kg capacity loader crane to help with the loading of larger/heavier products.

### Results

Motor-manual felling			Forwarding			Total cost (£/m <sup>3</sup> )
Output (m <sup>3</sup> /shr <sup>2</sup> )	Hourly cost (£/h)	Cost (£/m <sup>3</sup> )	Output (m <sup>3</sup> /shr <sup>3</sup> for 100 m extraction distance)	Hourly cost (£/h) <sup>Error!</sup> <small>Bookmark not defined.</small>	Cost (£/m <sup>3</sup> for 100m extraction distance)	
0.67	16.22	<b>24.28</b>	2.22	49.50	<b>22.28</b>	<b>46.58</b>

<sup>1</sup> dbh (diameter at breast height –1.3 m)

<sup>2</sup> A standard allowance of 25% for rest and 26% for other work has been included

<sup>3</sup> A standard allowance of 15% for rest and 17% for other work has been included

## Felling

- Although time spent cutting/clearing the understorey and unmarketable products might be slightly less at a later stage of the operation (21% in this case), it is expected to remain significant.
- Operator's movement to mark and measure products was often hindered by brash/unmarketable material on the ground and took 14% of the cyclic time observed; stacking products took up 16% of the cyclic time.
- The felling outputs observed are lower than those observed in thinning operations for trees of comparable size (previously measured outputs: c. 1 to 1.5 m<sup>3</sup>/shr). This can be explained by the proportion of unmarketable products cut, when other case studies looked into thinning operations where marketable products mostly were cut. The outputs observed compared well with those in pre-commercial thinning and coppice felling (c. 0.5 to 0.9 m<sup>3</sup>/shr).
- The hourly felling cost used increased noticeably since previous cases studies, which used a cost of £9.50/man hour for a chainsaw operator. Recent anecdotal evidence collected by TD (2010) indicates that these costs are frequently in the £20-£25/hour range.

## Extraction

- The average load size was 3.64 m<sup>3</sup>, far less than the 6 m<sup>3</sup> capacity of the trailer, mostly due to the size and shape of the products. This contributed to decreased outputs, but extraction of 'full' loads would not have been possible as a wet section of the extraction route rapidly degraded despite repeated reinforcement with brash.
- Time spent travelling to load represented 16% of the overall basic time. Although some of it was unavoidable, it is likely that a more systematic organisation of extraction routes would have helped reduce this. This time was also increased by the small size and the number of the stack dictated by the limited manual handling capacity.



Extraction by Massey Ferguson 3095 4wd tractor

- Because of the shape of the products, loads often needed to be adjusted at the loading stage, and similarly stacks required adjustment (with the grapple or by hand) at the unloading stage (18% of basic cyclic time).
- The calculated hourly forwarding cost of £49.50 was much more than the average used in previous studies (£15/hour for a 'large' farm forwarder + operator, £35/hour for a purpose-built forwarder). This is due partly to a general increase in costs, but also to the low annual use of the tractor and trailer leading to a high hourly cost.

## Conclusions and recommendations

- The outputs and costs recorded as part of this study are overall consistent with what could be expected. However it is thought improvements could be made to similar operations in the future by:
  - carefully considering which machinery and harvesting method would be best suited (based on e.g. access, space available, ground vulnerability, products specification) to such operations.
  - better organising the felling and extraction for shortwood systems.
- As with all hand-powered/-driven equipment, the vibration risk when working with the Iron Horse should be assessed and adequate measures taken to reduce exposure.
- The use of the IronHorse
  - with the loading arm operating at a high vertical angle,
  - and using a block fitted on one of the bolster pins to load products from the back of the trailer,should be avoided unless some modifications can be made to the equipment to improve the safety of such operations.

The work summarised here is part of an ongoing programme of research funded by the Forestry Commission aimed at improving the efficiency with which fuel is produced from sustainably managed forests in the UK. For further information on this project and related work:

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