



# Forestry Commission Project Report 042 - Extended summary Woodfuel Processors for the Small and Medium Scale

### Summary

This study aimed to provide information on working practices and outputs for the processing of woodfuel likely to be produced from undermanaged woodlands. A study of a Hakki Pilke 2X processor was made, covering 8 different specifications in terms of species and form (good/poor). The mean piece volume had the greatest effect on outputs; explaining around 61% of the variation, and poor form leading to difficulties in processing and handling caused a drop in output of around 25%. Very poor form, such as presented by the oak, led to a drop in output of around 60% and was virtually unworkable. Processing costs were found to be as low as £33/m³, for good and larger volume material, around £41/m³ for average material, and in excess of £100/m³ for very small and poor quality material. Processing rates were found to be lower than generally quoted by manufacturers, ranging from 0.29 to 0.96 m³/shr.

#### **Review of Machinery Options**

There is a great variety of firewood processors on offer ranging from low output domestic machines to high output units intended for dedicated firewood producers. They can be characterised by:

- power requirements: from c. 7.5 kW to in excess of 30 kW
- power source: stand-alone processors either have their own petrol or diesel engine or have an electrically driven hydraulic pump; the other power option is to utilise the PTO from a tractor
- mobility: smaller stand-alone processors are often mounted on their own trailer, whereas larger processors can require machinery to move them. Processors attached via 3-point linkage can be transported and moved by a tractor.
- splitting force: varies with size and power consumption, ranging from 3.5 t to over 50 t pressure; greater force will increase work rate and allow larger and more knotty logs to be split.
- cutting system: affecting the diameter capacity and speed of the processor; can be circular saw, chainsaw or guillotine based system.
- splitting type: where it is achieved though a ram, splitting blades are required. Larger logs will need to be split into more fractions and require more complex blades.
- conveyors: normally a set length but adjustable for height to facilitate filling of different containers. Higher-end processors have the ability to move the conveyors laterally, primarily so that they can be swung between containers without interrupting processing.
- sawdust collection: processor upgrade that funnels sawdust away from the machine and collects it. It keeps the processing areas tidy, removes the need to shovel sawdust manually, and keeps the sawdust clean, making it suitable for use as a co-product such as briquetting feedstock.
- loading tables: raised bed of feed rollers loaded with a stack of logs which are then individually fed to the loading conveyor. It removes the need for the operator to manually handle logs, so enabling the processing of larger material.

## Machinery description and study method



Hakki Pilke 2X Firewood Processor

Date of publication: December 2011

The firewood processor used was a Hakke Pilke 2X mounted on the 3-point linkage of a New Holland TN55 tractor. Machine output is stated as 10-11 m³/hour by the manufacturer, although this is not specified as being either loose log or solid wood volume. The processor was in good working order and had the log cut length set to 25 cm to produce 'open grate' specification firewood for the typical British markets. Eight types of product were studied; good and poor form conifer, birch and chestnut, very poor form oak, mixed hardwood of variable form.







Chestnut - poor form

Birch – good from

Oak - very poor form

## Observations of firewood processor and working method

- As loading was manual, piece size was limited by what could be lifted and handled by the operator. The feed conveyor was above waist height and lifting some of the largest pieces onto it proved strenuous even though tongs were used. Ergonomics were improved when the track was lower than the ground the timber was stacked on, allowing the pieces to be dragged across onto the conveyor rather than having to be lifted onto it.
- Poor form caused a number of problems;
- very bent pieces tended to slip off the conveyor and required adjusting to feed into the saw housing, and when they fed into it the end was often found to feed over or under the length set stop. This was exacerbated by the support roller, exerting downward pressure to control pieces being feeding onto the conveyor, in this case forcing the piece mid-section to lay flat, lifting or dropping the tip over or under the stop. This demanded repeated forceful and direct adjusting of the piece during feeding and processing.
- when processed, crooked pieces were often cut at an angle, rather than perpendicular to the grain, slowing the processing rate and often required pressure to be released and several cuts being required rather than a single one.
- The length set stop of 25 cm log, targeting British open grate markets, led to the logs frequently spinning and landing cross-ways in the channel in front of the splitting rams, causing jams and requiring frequent stops from processing to lift the guard and place the logs square in front of the rams. This was more frequent with particularly bad defects such as bends, prominent knots and branch stubs.

Poor logs also tended not to clear the splitting blades as easily as straight logs, and did not feed onto the discharge conveyor as easily.

#### Results

Sample	Conifer good form	Conifer poor form	Chestnut good form	Chestnut poor form	Birch good form	Birch poor form	Oak poor form	Hardwood mixed form
Output in m <sup>3</sup> /shr <sup>1</sup>	0.96	0.58	0.93	0.58	0.51	0.40	0.29	0.78
Cost in	32.78	54 46	33.83	54.07	61 60	78 94	107 58	<i>4</i> 0 37

• Outputs of split wood solid volume from the firewood processor varied between 0.29 and 0.96 m³/shr¹. The manufacturer's typical outputs of 10-11 m³/bhr does not state whether this refers to solid or loose volume, and higher outputs would be likely if longer pieces of better form were processed to a longer specification. Previous Technical Development studies of similar sized machines recorded outputs such as 3.53 m³/bhr (TD, 2008), 1.22 m³/shr (McAllister & Jones, 2007) and 0.70 m³/shr (Jones, 1997), and this indicates that outputs for a specific given operation should be established empirically rather than being derived from typical outputs.

<sup>&</sup>lt;sup>1</sup> Standard hours (shr) include an allowance for non cyclic work (e.g. maintenance) and operator rest requirements

- The three comparison studies carried out all show a drop in output with poor form, ranging from 40% in conifer to 22% in birch. Part of these differences is due to the difference in piece size between good and bad samples, but observations during the study clearly showed that a proportion is due to the greater processing difficulty. Whilst this proportion is likely to vary with volume, based on this study an indicative 25% drop in output due to poor form seems a reasonable estimate.
- The lowest processing costs calculated were around £33/m³, for good form conifer and chestnut. The mixed hardwood selection represented a good average for the firewood generally processed in the area, with a processing cost of £40.37/m³ comparable to the average for chestnut (£43.55). High processing costs in birch are likely to be due to the small mean piece volume, and this is another consideration for some undermanaged woodland types where smaller stem volumes will produce smaller volume products with lower outputs, leading to higher costs. Very small unit volume produce, particularly if of poor quality as was the case for birch and oak, can be completely uneconomic to process.
- It is generally likely that material from undermanaged stands will be of poor shape and small piece volume, and contribute to the high costs of firewood.

#### Recommendations

- Careful layout of firewood stacks and processing areas can improve ergonomics, reducing the need for lifting by using bearers and considerably reducing the physical strain on the operator
- Difficulties inherent to processing material of very poor form can lead to tiredness and frustration for the operator, translating into lower outputs and potentially leading to risk taking with poor working practices. This should be considered as part of the risk assessment process.
- Studies on the effect of log form on loading tables would be useful to assess if they are capable of handling material of poor form.
- All day studies of firewood processors would improve the accuracy of rest and other work allowances, including effect of product size and form on these allowances.
- Further comparative studies should use standardised products if possible to eliminate differences in outputs caused by piece volume.

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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Date of publication: December 2011