



# Forest Research

The Research Agency of the Forestry Commission

## **TECHNICAL DEVELOPMENT**

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## **Outdoor Workshops – Review of Small Scale Harvesting Equipment**

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# Outdoor Workshops - Review of Small- Scale Harvesting Equipment

## 1. INTRODUCTION

Using conventional purpose-built harvesting machinery for first and early thinning operations in small woodlands is often inappropriate due to the cost, environmental impact, inappropriate tree size, and insufficient timber volume.

There are a number of key economic factors affecting small-scale harvesting:

- The value of the sawn product has a strong influence on the type of machinery and harvesting system used.
- The declining markets for small diameter wood products from first and early thinning.
- The closure of numerous small estate sawmills over the past 10 – 15 years.
- The reducing number of skilled, experienced chainsaw operators.
- The increasing use of recycled fibre in the paper making industry.

These factors have had a major impact on the economic viability of carrying out small-scale operations. Some woodland owners may be able to find 'niche' markets for their woodland products but for the majority first and early thinning operations provide very little if any income. It is therefore important that the correct harvesting machinery and systems are applied to ensure continued management and silvicultural development of these woodlands.

An additional factor restricting good woodland management at the early thinning stages is the lack of knowledge on the part of woodland owners and managers of the most appropriate harvesting systems and the small-scale harvesting equipment and machinery available. In some instances the harvesting system for the woodland is designed to fit in with the available machinery. However this may compromise the long-term benefits of tree and site development, which should be the primary objective.

Part of Technical Developments' (TD) role is to evaluate new equipment and machinery and to develop work systems with the aim of:

- Reducing environmental impact.
- Reducing operational costs.
- Improving operator safety and ergonomics, efficiency and performance.
- Disseminating this research and development work to practitioners via a regular series of Outdoor Workshops (ODW) throughout the country.

The equipment and machinery chosen for demonstrations at ODWs are those that TD have evaluated and considered appropriate for a particular site and/or crop type. They are most often demonstrated in a woodland environment as part of a harvesting system.

The aims of this report are to:

- Detail the small-scale harvesting machinery and equipment currently demonstrated at ODWs and to investigate any technological developments and modifications in relation to this equipment, which might affect performance.
- To identify new machinery and equipment that is considered to be appropriate for small-scale harvesting.

*Note: For the purposes of this report firewood processors and chippers that do not have an integral hopper or collection bin are considered to be wood-processing machines, which are usually operated at the ride/roadside.*

## 2. SMALL-SCALE HARVESTING MACHINERY AND EQUIPMENT

There is no clear definition of small-scale when making reference to harvesting equipment. However the term is generally accepted as machinery and equipment that is most appropriate for felling and extracting small trees particularly those from first and early thinning operations.

There are four distinct categories of machinery and equipment used in small-scale harvesting ODW demonstrations, the advantages and disadvantages of each are described below.

Type of Machinery and Equipment	Advantages	Disadvantages
<b>Purpose-built Machinery</b>	<ul style="list-style-type: none"> <li>Large proportion tends to originate from Scandinavian countries where forestry is closely integrated with agriculture</li> <li>Often uses the technology developed for the larger harvesting machinery</li> </ul>	<ul style="list-style-type: none"> <li>Relatively high capital cost due to technology used.</li> <li>Dedicated to a specific task and often cannot be easily adapted to perform other management operations.</li> </ul>
<b>ATC</b>	<ul style="list-style-type: none"> <li>Widely used in upland sheep farming industry therefore commonly available</li> <li>Most are 4 wheel drive (4WD) providing good traction</li> <li>Low flotation tyres exert low ground pressure</li> <li>Extensive network of dealers and after sales service</li> </ul>	<ul style="list-style-type: none"> <li>Range of forestry attachments for harvesting is limited to forwarding trailers, skidding frames and winches.</li> <li>Poor low speed power delivery</li> <li>Limited rated pulling power</li> <li>No PTO or 3 point linkage</li> </ul>
<b>Agricultural Tractors</b>	<ul style="list-style-type: none"> <li>Affordable to small woodland owners</li> <li>Not dedicated to a specific task</li> <li>Can be adapted for forestry use at an acceptable cost</li> <li>Fitted with Roll Over Protection System (ROPS)</li> <li>Numerous three point linkage attachments for harvesting operations</li> <li>Most have a hydraulic system which can provide power for loaders and bed processors</li> <li>Conventional PTO</li> </ul>	<ul style="list-style-type: none"> <li>Two wheel drive models have restricted terrain capabilities</li> <li>Additional machine protection required for forestry use</li> </ul>
<b>Mini/Midi Tractors</b>	<ul style="list-style-type: none"> <li>These have all the features of conventional agricultural tractors</li> <li>A wide range of forestry equipment is available</li> <li>Some have articulated steering improving manoeuvring ability</li> <li>Not dedicated to a specific task</li> <li>Narrow wheel base</li> </ul>	<ul style="list-style-type: none"> <li>Limited pulling, lifting and carrying capacity</li> <li>Additional machine protection required for forestry use</li> </ul>



### 3. HARVESTING MACHINERY DEMONSTRATED AT ODWS OVER THE PAST THREE YEARS

The following harvesting equipment has been demonstrated at recent small scale harvesting ODWs particularly Loch Lomond 2002, Llanfyllin 2004, and the South West Wood Fuel Show 2004.

#### Niab Winch-fed Stroke Processor



Attached to the 3 point linkage and hydraulic system of a conventional agricultural tractor. Loading can be by winch or grapple. Can cross cut logs up to 18 cm diameter. Cost c. £15 000.

#### Vimek 606D Mini Forwarder



A 6-wheeled purpose-built machine with a loader reach of 4.2 m, capable of carrying 3000 kg. The low ground impact ability of the machine makes it suitable for woodlands with a weak soil structure. Cost £39 550



### Iron Horse



A pedestrian-controlled tractor with tracks, which can be used as a skidder making use of the integral winch, or a forwarder using a trailer. Versatile and compact with excellent terrain capabilities. Cost £8500 excluding forwarding trailer.

### ATC Forwarder



Comprises a 4WD ATC (>350cc) and a purpose-built trailer. Equipment need not be solely dedicated to timber extraction and is simple to set up and use. Cost ATC c. £6000, forwarding trailer £1800.

### Japa Grapple Skidder



A triple jaw skidder with slewing cylinder coupled to the 3-point linkage of an agricultural tractor. Presentation of produce is important for efficient operation. Relatively inexpensive understated piece of extraction equipment. Cost £1610.

### Terrain Chipper



A trailer mounted NHS 720 chipper with a hopper coupled to a conventional agricultural tractor. Manually fed enabling collection of wood chips and transport out of wood. Cost £16 000.



### Log Chute



A series of connecting semicircular plastic lengths (4.2m) used for extracting small round wood, gravity fed and very useful in woodlands where access is restricted. Cost £50 per section.

### Star Wire Loader



An 'A' frame incorporating a PTO driven winch and loading arm. The winch is controlled by a caddy line held in a cassette on the operator's back. Timber is extracted to the trailer using a skid cone. Cost £2345.



## Scorpion 1205



A purpose-built mini forwarder with 6 or 4 wheel drive. The narrow width of the machine enables working in closely spaced trees. The machine can be easily transported on a trailer towed by a 4WD vehicle. £26 500.

All the machinery and equipment shown above has been evaluated by Technical Development and performed well in trial conditions. It continues to be available for use in small-scale forestry operations. Further evaluation and performance information can be found in the Information Notes produced for the equipment and machinery demonstrated at ODWs. Some of these are available in electronic form on the following web address <http://www.forestresearch.gov.uk/fr/infid-5wwkcq>

## 4. TECHNOLOGICAL DEVELOPMENT AND MODIFICATIONS

### 4.1. Equipment and Machinery

Manufacturers, UK agents, and owners of all the equipment shown in Section 3 were contacted and subsequent discussions suggested that there were no plans for further developments of the machinery demonstrated due to the low demand for purpose-built small-scale harvesting equipment in the UK. The main reason for the low demand cited by the agents was the low value of small round wood in relation to relatively high harvesting costs.

One supplier reported that regional or other financial grant aid supported the majority of sales of small-scale forestry machinery and equipment. This was seen as an indication of the lack of financial sustainability of small-scale harvesting operations for forestry contractors.

Modifications to existing machines were done to comply with new Health and Safety legislation. Under the Provision and Use of Work Equipment Regulations (PUWER) every machine that has ROPS must have a seat belt. The Alstor has been modified to comply with this regulation.

The UK agents for the Vimek forwarder advised that the base machine was to be fitted with a small harvesting head. This was due to be released at the Elmia show in June 2005.

## 4.2 Methods

Method development or modification improves performance and efficiency. They are often implemented when cutting different or additional product specifications, where there are terrain constraints or a different machine or harvesting equipment is being used. Pre-operational planning is essential to ensure efficiency.

A small-scale harvesting system has been adapted to incorporate the production of wood fuel when harvesting to tip. The use of a terrain chipper (as shown on Page 9) to demonstrate integrated wood fuel production at the South West Wood Fuel Show necessitated the need to adapt a conventional short wood harvesting system for merchantable<sup>1</sup> timber.

The position of the in feed chute only allows material to be offered to this terrain chipper from one side. The direction of travel of the chipper and stacking of random lengths of wood fuel has to be carefully planned to ensure minimum handling and machine movement. Stacks should be separate from other felled products.

For all small-scale harvesting systems to perform efficiently the presentation of felled products is highly important. Material is stacked on one bearer with the butt ends raised from the ground and facing the extraction rack. The chipper travels in the racks until the hopper is full. It then delivers the wood chips to a static bin or waiting tractor and trailer at the roadside. The remaining harvested products are extracted by forwarder either before or after the wood fuel. On sites with suitable terrain conditions and appropriate tree sizes, terrain chipping can improve performance by eliminating the need to extract the wood fuel, stack and chip at roadside.

Modifications, adaptations or developments to any recognised small-scale harvesting systems must be within the capabilities of the machine or equipment being used. Operators should be fully aware of machine capabilities and failure to recognise this crucial factor can result in unsafe working practices and machine/equipment damage.

## 5. NEW MACHINERY AND EQUIPMENT

Technological development in small-scale harvesting machinery and equipment tends to be continuous. However if the demand for a particular machine or piece of equipment declines manufacturers often cease research and development, for example the Savall gravity winch.

Small-scale machinery and equipment is manufactured all over the world and is usually developed for a specific purpose. As most if not all of these countries have different operating conditions and statutory health and safety requirements, there is a continual requirement to ensure full compliance with standards and regulations relevant to the UK, before machinery and equipment is imported for use.

A brief description of new equipment follows which merits consideration for small-scale harvesting in the UK. Discussions and advice from TD colleagues and known suppliers of small-scale machinery and equipment were undertaken to identify the industry needs, trends in sales and innovative thoughts on machinery and equipment improvements.

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<sup>1</sup> Top diameter of 7cm over bark or point where no main stem is distinguishable

### **Forcat 2000 Mini Skidder**



A Canadian machine with hydrostatic traction. Fitted with a winch it is capable of skidding tree lengths using a main line and chokers. Weighing 1250 kg and having an overall length of 2.41 m it can be easily transported using a 4WD vehicle and trailer. Cost c £16 500.

### **Feller Buncher**



Cuts and accumulates several stems in the head before laying them for forwarder or grapple skidder uplift. 220° rotational head, cutting capacity 546 mm. Cost of head c. £15 000 – 20 000.



### Lesan 50



A double carriage system allows loads of up to 1 metric tonne to be lifted completely clear of the ground. Built in Eastern Europe the owners of this machine are currently arranging for CE approval. Cost unknown

### Hydro-Ax



Harvester with a 16-tooth single piece cutting disc. Ideal for small diameter thinning. Offset tooth design generates 2 1/4" kerf. Widely used in the USA.

### **TJ Grapple Skidder**



A 4WD single grapple skidder with exceptional manoeuvring capabilities. Potential use in a wood fuel production system with a feller buncher harvester

### **Bell Harvester**



A 3 wheeled machines with excellent manoeuvring capabilities. Widely used in the north eastern states of America

## 6. CONCLUSIONS

It is evident that the small-scale machinery and equipment currently demonstrated remains appropriate for harvesting operations and that there is still value in demonstrating such as far as the industry is concerned.

The capital cost of small-scale purpose-built harvesting machinery and equipment combined with the thinning cycles of most conifer crops, requires the purchaser to work a continuous harvesting programme if a realistic return is going to be achieved on the investment.

An increase in demand and cheaper production costs in Eastern Europe and Asia may result in more affordable purpose-built machinery becoming available in the UK.

An alternative to purchasing purpose built machinery may be to consider the construction of a woodland track. The cost of hiring small track construction equipment and use of stone material from site or delivery of aggregates may be a more economical option. Once constructed, tracks provide access for conventional agricultural tractors. Subject to the standard of construction and subsequent maintenance, woodland tracks can provide machinery access for management for several crop rotations.

Operator training is essential to ensure high productivity and minimal environmental impact. The capabilities of all small-scale machinery and equipment should be recognised by the operator and not exceeded.

Frequency of thinning is largely dependent on the silvicultural system being used. With increased commitment from the Forestry Commission to adopt Continuous Cover Forestry systems (CCF), small-scale harvesting programmes may be organised to ensure more frequent use of machinery.

Additionally horse extraction can be a viable option for small-scale harvesting on sensitive sites.

For the majority of farm woodland owners, agricultural tractors and the equipment available for harvesting small diameter trees will remain the preferred option for small-scale harvesting. They have the greatest potential for use in small woodlands, particularly where the woodlands are part of the agricultural holdings.

Acquisitions of forestland by community trusts such as Abriachan and the development of community woodlands in urban areas on former industrial land are examples where small-scale management and equipment will be the preferred option, particularly where access to these sites is restricted.

Enthusiasts are now purchasing many small woods throughout the UK, these are people who have purchased small woodlands and are managing them for interest and not primarily commercial reasons. These owners are keen to carry out forest management operations themselves and are able to/prepared to consider the purchase of specialised equipment.

It is often the case that whatever machinery is available locally is used, irrespective of suitability, size etc. Investment in machinery rings or co-operatives, and further use of agricultural implements may contribute to the management of small woodlands, using small-scale equipment.

With greater emphasis given to the creation of community woodlands and small farm woodlands, small-scale machinery and equipment may have an important role to play in contributing to effective management.

Small-scale harvesting machinery and equipment operate as part of a harvesting system. The factors affecting the harvesting system are tree size, tree form, and volume per tree, volume per hectare, cutting specification, site conditions and silvicultural practice. With the emerging wood fuel market there is potential to re introduce machinery and techniques which have otherwise become unpopular. One such example is the hydratong. These are most productively used in a pole length system. Trees are felled, bunched together and left in pole length in the wood. A tractor fitted with hydratongs carries out extraction. These consist of a hydraulically operated grab, which can be lowered on the three point linkage arms. Loads are uplifted and skidded to roadside where they can be further processed or transported.



## **7. REFERENCES**

European small-scale forestry and its challenges for the development of wood harvesting technology (Helsinki 2001) ISBN 951-788-327-7.

## **8. ACKNOWLEDGEMENTS**

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Reports generally describe findings of case studies and the findings should be taken as limited to the studied context. The list of products/manufacturers in this report is not comprehensive; other manufacturers may be able to provide products with equivalent characteristics. Reference to a particular manufacturer or product does not imply endorsement or recommendation of that manufacturer or product by Forest Research.
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