

Small and Medium Harvesting and Extraction Machinery: A Guide to Site Suitability

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Summary

This report describes the suitability of medium, small and mini scale forestry harvesting machinery for a range of site and crop conditions. Site factors which limit machine suitability are listed, then appropriate harvesting systems recommended and finally appropriate machinery options are described. Indicative output and cost information is also given along with job costing guidance.

Matching the scale of machinery to site and crop conditions has benefits for the economics of harvesting and minimises the impact of harvesting operations, preventing ground disturbance and potential for damage to the remaining crop trees. The purpose of this report is to identify appropriate machinery options for forest harvesting for a range of site types and scales.



Figure 1 Medium Farm Forwarder 8 tonne un-laden weight



Figure 2 Vimek 606 Forwarder 3 tonne un-laden weight



Figure 3 Alstor 831 Forwarder 2 tonne un-laden weight



Figure 4 Mini OxTrac Skidder 2 tonne un-laden weight

Introduction

This report is aimed at those who are selecting equipment for harvesting small woodlands, with the aim of choosing the most appropriate scale and type for the site. The scope of this report includes small to medium sized purpose-built harvesting and extraction equipment for

forest harvesting and adapted agricultural machinery. Primary processing equipment is not included.

The machine size classifications used in this report are based on un-laden machine weight:

- Medium 6 -12 tonne
- Small 3-6 tonne
- Mini <2.5 tonne

In addition to the information in this report a complementary Technical Development report¹ gives small scale machinery specifications and safety requirements. A series of supporting technical notes (in press) further describe operating systems applicable to the main site types described in this report and their productivity in more detail, to assist with job planning and costing.

How to Use this Report

1. Identify your **site type** and **system** of working from the examples given in Table 1 which shows the most suitable machine options for common site types and operations.
2. From each cell in Table 1 further information is referenced in sections 2-6 on operational limits and outputs and costs to allow machinery selection to be further refined.

Section 1. Limiting Site Factors on Harvesting and Extraction







The suitability of forestry machinery is limited by site and crop constraints; either because conditions are beyond the operational limits of the machine, or because using the machine would be inefficient, uneconomic, damaging to the environment or dangerous. Factors which limit the use of forestry harvesting machinery include:

- Slope
- Ground Roughness
- Ground Condition
- Access Network and Distance
- Tree Size and Produce Size

Machinery suitability for a variety of example site types is shown in Table 1.

¹ Saunders, J. (2015). Small & Mini Harvesting and Extraction Machinery – a guide to their selection for safety. FC Technical Development Report TDJR131

Table 1 Examples of Small Scale Machinery Suitability Linked to Site Type

Site Type →	Firm / Level	Soft / Level	Firm / Rough	Soft / Rough	Firm / Steep	Soft / Steep
Operational System ↓						
Option 1 Shortwood Extraction < 150m Suitable machinery:	Purpose built harvester Pedestrian controlled / ATC / Mini / Small forwarder or Tractor forwarder ↳ See section 5 for access / distance limits	Purpose built harvester Motor manual felling Pedestrian controlled / Mini / Small forwarder Tracked forwarder ↳ See section 4 for details	Purpose built harvester Motor manual felling Pedestrian controlled / Mini / Small forwarder ATC forwarder ↳ See section 3 for details	Motor manual felling Mini / Small forwarder Small tracked forwarder ↳ See sections 3 and 4	Motor manual felling Self powered Winch Small tracked forwarder Log chute ↳ See section 2 for details	Motor manual felling Self powered Winch Small tracked forwarder Log chute ↳ See section 2 for details
Option 2 Shortwood Extraction > 150m Suitable machinery:	Purpose built harvester Mini / Small forwarder Tractor forwarder ↳ See section 5 for access / distance limits	Purpose built harvester Motor manual felling Mini / Small forwarder Tracked forwarder ↳ See section 4 for details	Purpose built harvester Motor manual felling Mini / Small forwarder ↳ See section 3 for details	Motor manual felling Mini / Small forwarder Small tracked forwarder ↳ See sections 3 and 4	Motor manual felling Small tracked forwarder (limited by degree of slope) Tractor skidder ↳ See section 2 for details	Motor manual felling Tractor skidder ↳ See section 2 for details
Option 3 Pole length / Part pole Extraction < 150m Suitable machinery:	Purpose built harvester Motor manual felling Pedestrian controlled / Small tracked skidder Tractor skidder ↳ See section 5 for access / distance limits	Purpose built harvester Motor manual felling Pedestrian controlled / Small tracked skidder Cable crane / High lead ↳ See section 4 for details	Purpose built harvester Motor manual felling Small tracked skidder Cable crane / High lead ↳ See section 3 for details	Motor manual felling Small tracked skidder Cable crane / High lead ↳ See sections 3 and 4	Motor manual felling Self powered Winch Small purpose built skidder Tractor-based skidder ↳ See section 2 for details	Motor manual felling Self powered Winch Small purpose built skidder Tractor-based skidder ↳ See section 2 for details
Option 4 Pole length / Part pole Extraction > 150m Suitable machinery:	Purpose built harvester Small tracked skidder Tractor skidder ↳ See section 5 for access / distance limits	Purpose built harvester Motor manual felling Small tracked skidder Cable crane / High lead ↳ See section 4 for details	Purpose built harvester Motor manual felling Small tracked skidder Cable crane / High lead ↳ See section 3 for details	Motor manual felling Small tracked skidder Cable crane / High lead ↳ See sections 3 and 4	Motor manual felling Cable crane / High lead ↳ See section 2 for details	Motor manual felling Cable crane / High lead ↳ See section 2 for details

Machinery and method limits for each site type and harvesting option in Table 1 are described in further detail in the following sections.

Section 2. Slope

Table 2 Influence of Slope on Small Scale Forestry Equipment

Slope	Operational System	Machine Suitability	Indicative Output and Cost
>20%	Unrestricted	<p>Limiting to most pedestrian controlled machinery, however when used for skidding – can winch over short distances of steep terrain, but limited by winch rope (20-30m)</p> <p>Some systems need slope to operate efficiently, i.e. log chute requires a minimum 20% to operate</p>	<p>Pedestrian controlled machinery: Output: (Iron Horse 0.93m³/shr for skidding – 1.67m³/shr forwarding) Cost: £17 for skidding and £10 for forwarding</p> <p>Log chute: Output: 1.8 - 2.0m³/shr* Cost: £13 - £14/m³</p>
>30%	Unrestricted	<p>ATC use with forwarding trailer is limited – with increased slope the load volume needs to be reduced to maintain traction and stability and with slope > 30% is inefficient.</p> <p>Skidding limit for purpose built tracked skidder, however can winch to the machine, over steeper slopes (typical winch rope length 30m)</p>	<p>ATC forwarding: Output: 1.10m³/shr Cost: £16/m³</p> <p>Purpose built skidder: Output: 2.5 – 3.0m³/shr Cost: £10 - £12/m³</p>
>35%	Unrestricted	<p>Purpose built mini forwarders (2 – 4 tonne load capacity) and machines based on modified agricultural tractors are suited to slopes up to 30 - 35%.</p>	<p>Mini forwarder / Small tracked forwarder: Output: 2 – 3.0m³/shr Cost: £6 - £8/m³</p> <p>Compact Agricultural Tractor: Output: 2 – 3.0m³/shr Cost: £6 - £8/m³</p>
>40%	Unrestricted	<p>Purpose built small harvester (4 – 6 tonne weight) operational slope limit</p>	<p>Purpose built harvester: Output: 5 – 6.0m³/shr Cost: £6 – 8.0m³</p>
>50%	Unrestricted	<p>Purpose built small forwarder (4 – 6 tonne load capacity) are suited up to slopes of 50%.</p>	<p>Small forwarder: Output: 6 - 6.5m³/shr Cost: £5 - £6/m³</p>

>60%	Shortwood is less suitable due to economics of accumulating produce for skidding and cable extraction; whole tree, whole pole, or part pole systems are more suited	<p>Motor manual felling is essentially unrestricted by slope, provided fellers can safely access the site.</p> <p>Limiting to most wheeled machinery. With careful planning static skidding can overcome short sections of steep terrain. Therefore suited to: Static Skidder, Portable winch, Cable Crane or High Lead.</p> <p>All winches are limited by the length of wire rope on the winch drum, restricting their range from a static position.</p>	<p>Motor Manual: Output: 1.0 – 1.2m³/shr Cost: £20 - £24/m³</p> <p>Purpose built / Tractor-based skidder: Output: 2.5 – 3.0m³/shr Cost: £10 - £12/m³</p> <p>Portable winch: Output: 2.5m³/shr Cost: £6.00/m³</p> <p>Cable Crane / High Lead Output: 5.00m³/shr Cost: £12.00/m³</p>
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*shr: Standard hour: Standard time includes allowances for rest and other work.

Slope recommendations in Table 2 are obtained from machinery manufactures literature, however the risk assessment for each machine needs to determine safe working practice on steep terrain on a site specific basis, taking into account variables such as site conditions, crop type, operator experience, machine configuration and operational best practice.

Section 3. Ground Roughness

Machine ground clearance will limit use where terrain becomes uneven or rough. See Appendix 1 for definitions of terrain classification. Ground roughness machine limits are shown in Table 3.

Table 3 Influence of Ground Roughness on Small Scale Forestry Equipment

Limiting Ground Roughness	Operational System	Comments	Indicative Output and Cost
Uneven ~ Obstacles of 40cm at 1.5 – 5m spacing	Skidding efficiency is reduced due to obstacles: shortwood extraction can be more efficient provided obstacles can be negotiated	<p>Likely to be the operational limit for ATC extraction due to low ground clearance and limited crane reach</p> <p>Purpose built small harvester (4 – 6 tonne weight) limited by ground clearance, but can function if manoeuvrability and crane reach are used to avoid obstacles.</p> <p>Barrier to skidding machinery due to obstacles making skidding inefficient Obstacles such as rocks and boulders require</p>	<p>ATC: Output: 1.1m³/shr Cost: £23/m³</p> <p>Purpose built harvester: Output: 5 – 6.0m³/shr Cost: £6 – £8.0m³</p> <p>Purpose built / Tractor-based skidder: Output: 2.5 –</p>

		guarding of wheeled machinery to prevent damage and downtime.	3.0m ³ /shr Cost: £10 - £12/m ³
		Purpose built mini forwarder extraction possible if machine ground clearance and manoeuvrability allow obstacles to be avoided and shortwood presentation for extraction is well organised	Mini forwarder / Small tracked forwarder: Output: 2 - 3.0 Cost: £6 - £8.0/m ³
		Small tractor based forwarder extraction, rack-based, with manoeuvring to avoid obstacles and well organised shortwood presentation	Tractor-based forwarder: Output: 2 - 3.0m ³ /shr Cost: £8 - £9/m ³
		Obstacles are a barrier to log chute set up, and increase layout time affecting economics	
Very rough ~ Obstacles of 60cm or more at 1.5 - 5m spacing	Whole tree, whole pole, or part pole systems are more suited than shortwood for cable extraction	Motor manual harvesting is unrestricted by roughness Obstacles are likely to form a barrier to wheeled and tracked small-scale machinery Cable crane / High lead extraction not restricted by ground roughness if produce is extracted with chokered ends elevated well off the ground	Motor Manual: Output: 0.8 - 1.0m ³ /shr Cost: £24 - 30/m ³ Cable Crane / High Lead Output: 5m ³ /shr Cost: £13/m ³

Section 4. Ground Condition

Machinery with low ground pressure is optimal where terrain becomes low load bearing. See Appendix 1 for definitions of terrain classification. Ground condition machine limits are shown in Table 4.

Table 4 Influence of Ground Condition on Small Scale Forestry Equipment

Limiting Ground Condition	Operational System	Comments	Indicative Output and Cost
Average ~ Soft mineral or	Unrestricted	Limit for wheeled skidding / horse skidding owing to potential for ground damage	Tractor-based skidder: Output: 2 -

ironpan soils in drier areas			3.0m ³ /shr Cost: £10 - £12/m ³
Poor ~ Peaty gleys in drier areas; soft mineral soils in wetter areas	Shortwood preferable due to potential for ground disturbance from skidding	Pedestrian controlled forwarding suitable Tracked skidder limit owing to potential for ground damage Traction aids will extend the operating ability of wheeled machinery when forwarding	Pedestrian controlled machinery: Output: 0.8 – 1.0m ³ /shr Cost: £12 - £19/m ³ Purpose built tracked skidder: Output: 2 – 3.0m ³ /shr Cost: £12 - £14/m ³
Very Poor ~ Peaty gleys in wetter areas; deep peats	Shortwood or possibly cable extraction of pole-length products if cost is justified	Motor manual harvesting is unrestricted by ground conditions Purpose built tracked forwarder is suitable - low weight and high floatation are a benefit for low load bearing terrain Cable Crane / High Lead are suited where suitable support and anchor points exist and where produce is extracted with chokered ends elevated off the ground	Motor Manual: Output: 0.8 – 1.0m ³ /shr Cost: £24 – 30/m ³ Purpose built tracked forwarder: Output: 5- 6.0m ³ /shr Cost: £5 - £7/m ³ Cable Crane / High Lead: Output: 5.0m ³ /shr Cost: £13/m ³

Where ground conditions are low-loadbearing small low ground pressure machinery like the tracked forwarder shown in Figures 5 and 6 can prevent ground damage. Preventing ground damage not only has environmental benefits but also safeguards the site for future access.



Figure 5 OxTrac tracked forwarder loading



Figure 6 OxTrac forwarder in farm woodlands

Section 5. Access Network and Distance

Some systems need road access in specific locations i.e. log chute systems require a road for onward transport on the downhill side of the site. Forwarding requires a greater density of racks than skidding. However skidding requires a greater density of forest roads than forwarding for timber lorry access.

Access network limits for small scale machinery are described in Table 5.

Table 5 Extraction Distance and Access Road Limits on Small Scale Forestry Equipment

Distance to road	Operational System	Comments	Indicative Output and Cost
>40m	Unrestricted	Portable winches cannot reach over 40m and log chutes become impractical beyond this range due to the time required to uplift and relocate the multiple chute sections across a site	Portable Self powered Winch: Output: 2.5m ³ /shr Cost: £6.0/m ³ Log Chute: Output: 2.5m ³ /shr Cost: £13.00/m ³
>150m	Unrestricted	Limiting to pedestrian controlled machinery as walking time and small load size impacts on economics	Pedestrian Controlled: Output: 0.90 – 1.60m ³ /shr Cost: £10 – 17/m ³
> 200m	Unrestricted	Limit for ATC extraction, due to small load size impacting economics and method (skid or forward)	ATC: Output: 1.1 – 1.90m ³ /shr Cost: £16 - £23/m ³
>250m	Unrestricted	Recommended limit for small scale cable crane systems to operate efficiently	Cable Crane / High Lead: Output: 5.0m ³ /shr Cost: £13/m ³
> 450m	Limiting for both shortwood and Pole-length systems. Inefficient to extract over long distances – however, improving access	Distance limit for small tractors, Mini/small forwarders, small harvesters, and skidders	Small Tractor: Output: 2 – 3.0m ³ /shr Cost: £6 - £8/m ³ Mini Forwarder / Small tracked forwarder: Output: 2.5 – 3.0m ³ /shr Cost: £6 - £8/m ³

	infrastructure will increase efficiency.		<p>Small Forwarder Output: 6 – 6.5m³/shr Cost: £4 - £6/m³</p> <p>Small Harvester Output: 5 – 6.0m³/shr Cost: £6 - £8/m³</p> <p>Small Skidder Output: 2.5 – 3.0m³/shr Cost: £10 - £12/m³</p>
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Tree size and produce size (dictated by market requirements and harvesting system) limit machinery selection due to the handling capacity of the machine. The effect of tree and produce size on machine suitability are described in Table 6.

Section 6. Tree size and produce size

Table 6 Influence of Tree size and Produce Size on Small Scale Forestry Equipment

Tree size and produce size	Operational System	Comments	Indicative Output and Cost
< 0.10m ³ first thin	Shortwood and part pole	<p>Unrestricted, however some machine options that bulk handle will improve economics such as accumulating felling heads.</p> <p>This scale is well suited to pedestrian controlled machines and ATC Extraction</p>	<p>Pedestrian Controlled: Output: 0.9 – 1.60m³/shr Cost: £10 - £17/m³</p> <p>ATC forwarder: Output: 1.9m³/shr Cost: £16/m³</p>
> 0.10m ³ first and second thin	Unrestricted	Unsuitable for pedestrian controlled machines, ATC extraction, small tractors	<p>Small tractor Output: 2 – 30m³/shr Cost: £6 - £8/m³</p>
> 0.10 m ³ second thin, logs up to 3.70m	Unrestricted	Limiting to mini and small forwarders due to produce dimensions	<p>Mini forwarder / Small tracked forwarder: Output: 2 - 3.0m³/shr Cost: £6 - £8/m³</p> <p>Small forwarder: Output: 6 – 6.5m³/shr Cost: £5 - £6/m³</p>

> 0.30 m ³	Unrestricted	<p>Generally limiting to small harvesters, and small skidders</p> <p>Motor Manual Felling is not limited by tree size, but consider limits for extraction</p>	<p>Small Harvester: Output: 5 – 6m³/shr Cost: £6 - £8/m³</p> <p>Small Skidder: Output: 2.5 – 3.0m³/shr Cost: £10 - £12/m³</p> <p>Motor Manual: Output: 1.0 – 1.5m³/shr Cost: £16 - £24/m³</p>
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Section 7. Silviculture

In some circumstances specific silvicultural systems can influence form and stocking density of the standing trees to the extent that they influence machine suitability. Examples include mature coppice and naturally regenerated crops where tree spacing is too close to allow mechanised harvester head access to the stems to be felled.



Figure 7 Valtra T160 with Keto 51 felling head harvester Configuration in Sweet Chestnut coppice felling

Figure 8 Valtra harvester in Sweet Chestnut coppice felling

Buttressing, stem sweep and branch coarseness can all limit the suitability of machines for harvesting, and in some cases motor manual felling may be the only option.

In cases of disease outbreak small volumes of large over-mature trees may be required to be felled for tree health purposes. Where the volume to be harvested and access network are limited it may not be economic to bring in large scale machinery for harvesting. Therefore working methods may be adapted to use smaller scale machinery; the increased cost of doing so being justified by the forest health benefits.



Figure 9 motor manual felling



Figure 10 motor manual sneding and cross-cutting

Section 8. Health and Safety

In addition to the points identified in Tables 2-6 health and safety requirements for forest machinery also have an influence on machine suitability. The design and operational practice of some small scale equipment is significantly different to similar larger machines, and therefore care must be taken to identify risks to operator health and safety and to safeguard against these through the risk assessment process.

Technical Development Job Report 131 gives detailed information on health and safety requirements for small scale forest machinery. The most important health and safety considerations from TDJR 131 are summarised as follows:

- CE marking 'Declaration of Conformity' indicates that the equipment is fit to sell and market in the UK, however it should be noted that it does not necessarily indicate that it is fit for use in a given manner, condition or task.
- The manufacturers' manual describes the parameters under which the machine should be operated, and under no circumstances should machines be operated outside those parameters. A good example of this is the operation of an ATC or Mini tractor where the tongue and towing weight of the 'Prime Mover' is compromised by the attachment and load.
- Before determining the machine type or operating method a critical review of the operation is required considering:
 - Site
 - Ground conditions
 - Terrain classification²
 - Proposed working method

Only then can a proper judgement be made on the machine/system selection that does not compromise the health, safety and wellbeing of any individual.

² Forestry Commission, Technical Development Branch (2005). Terrain Classification. Technical Note 16/95

The risk assessment process for the use of the machine will determine restrictions on safe use:

- Appropriate slope limits for an operation on-site need to be determined as part of the Risk Assessment procedure and agreed with the operator.

This should apply to all machine types identified in this report. The main controlling factor of identifying a slope limit is the risk of machine roll over as well as the operational confidence and competency of the operator.

- The working position of the operator when using either an ATC or small tractor and a forwarder trailer has to be assessed to ensure that their safety is not compromised during all stages of the operation.

Section 9. Adaptation of agricultural machinery for forestry

Choosing the appropriate scale of machinery for forest operations is a significant factor in achieving management objectives. While large scale purpose built machinery usually gives the highest outputs and ergonomic benefits to the operator, there are still benefits of Agri-Forest tractors. Agri-Forest tractors are machines modified or purpose built for forestry with high versatility for a wide range of jobs.



Figure 11 Modified agricultural tractor skidding pole length produce on steep terrain Figure 12 Farm forwarder based shortwood extraction

Adapted agricultural machinery can be well suited to managing small woodlands as well as being economically attractive. However, care must be taken to safeguard operator ergonomics and safety and consider the durability of equipment which is adapted for forestry use.

All tractors used in forestry must have safety features appropriate to the work undertaken. Examples of this are: Roll Over Protection Structures (ROPS) to protect the operator from roll over, Falling Object Protection Structures (FOPS) to protect them from falling and penetrating objects and Operator Protection Structures (OPS) from events such as chain-shot. Additional

guarding will be required around the engine compartment, belly plate and radiator, deflector bars around the cab and mesh or other window protection will be required.

A number of ergonomic factors need to be considered, access and egress from the cab, environment of the cab as well as noise and vibration levels that the operator will be subjected to. The layout of the controls for the tractor and ancillary-attached equipment (loader) should be reviewed and any modifications identified, seat/lap belt fitted as well as adequate lighting around the machine for working in winter conditions and under the tree canopy.

Modifications to machinery should only be carried out with the approval of the manufacturer.

Section 10. Job costing

To establish the cost of an operation certain factors need to be identified before this can be calculated. One major factor is for time study data to be gathered on the task, indicating the output for the operation. An example of the factors used to determine costs of felling and extraction using medium scale machinery is shown in Table 7.

Table 7 Example Job Costing

Machine Costings*		Harvester - Forestry tractor based harvester	Forwarder - Forestry tractor and forwarding trailer	Chainsaw - Motor Manual Chainsaw
Description	Unit	New	Used tractor – New trailer	New
Capital cost	£	132,000	50,000	900
Residual value	£	80,000	25,000	0
Productive hrs/ yr	hrs	1,500	1,000	1,500
Life in hrs	hrs	7,500	5,000	3,000
Life in years	yrs	5	5	2
Interest rate	%	5	5	5
Equivalent annual cost	£	16,010.69	7,024.37	484.02
Capital cost/hr	£/hr	10.67	7.02	0.32
Operating Costs				
Repair & Maintenance	£/hr	10.00	2.00	1.00
Fuel		(10.0 l/hr @ £0.55/l)	(10.0 l/hr @ £0.55/l)	(1.5 l/hr @ £1.20/l)
	£/hr	5.50	5.50	1.80
Insurance	£/hr	0.75	0.75	0.75
Total Machine Costs	£/hr	16.25	8.25	3.55
Operator	£/hr	20.00	20.00	20.00
Total cost	£/hr	46.92	35.27	23.87

*Costs in Table 7 are for illustrative purposes only, actual costs and rates should be checked for specific conditions

Initial placement cost (i.e. the cost of transporting machinery to site) has a considerable effect on overall economics. Small scale machinery may be transported to site on a trailer, without the need for low loader transport required for larger scale machinery. Where medium scale machinery is chosen for use, if operations are carefully planned it is possible to spread the placement cost by scheduling several small scale forest operations to coincide with each other while the machine is on site.

Conclusions

Small and medium scale machinery does offer benefits for UK forestry, however their scale can limit their use based on the site and crop conditions. Careful consideration is required to match machinery scale to the operation.

Carefully selecting the scale of machinery to suit the forest site and crop conditions has benefits for reducing the impact of harvesting on the site and residual crop, as well as optimising harvesting economics and operator ergonomics.

The running costs of all scales of machinery have to be related to work programmes, expected outputs and anticipated unit costs. Acceptable operational costs are also influenced by management objectives. Harvesting economics is a complex issue and all costs including haulage, access and site amelioration have to be considered.

Adapted agricultural machinery can be well suited to managing small woodlands as well as being economically attractive. However, care must be taken to safeguard operator ergonomics and safety and consider the durability of equipment which is adapted for forestry use. Modifications to machinery should only be carried out with the approval of the manufacturer.

Safe use of small scale machinery and appropriate training is essential. Some small scale machinery requires additional skills and physical effort from the operator e.g. chokering winch systems and assisting with loading produce. Careful use of manual handling techniques and tools is important to safeguard ergonomics and operator health.

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Appendix: Terrain Classification

Class				
1	2	3	4	5
• Ground Condition				
Very Good	Good	Average	Poor	Very Poor
Dry sands and gravels	Firm mineral soils	Soft mineral or ironpan soils in drier areas	Peaty gleys in drier areas; soft mineral soils in wetter areas	Peaty gleys in wetter areas; deep peats
• Ground Roughness				
Very even	Slightly even	Uneven	Rough	Very Rough
Obstacles (boulders, plough furrows etc) small or widely spaced	Intermediate	Obstacles of 40cm at 1.5 - 5m spacing	Intermediate	Obstacles of 60 cm or more at 1.5 - 5m spacing
• Slope				
Level	Gentle	Moderate	Steep	Very Steep
0-10% 0.6°	10-20% 6-11°	2-33% 11-18°	33-50% 18-27°	50%+ 27°+

Example: sites described by the class 4.3.2. means:

4. Poor ground conditions.
3. Uneven.
2. Gentle slope.

The standard order of Ground Conditions, Ground Roughness, Slope, must always be observed. The example of ground conditions and ground roughness given are used to illustrate typical instances and are not intended as precise definitions of the classes.

[Reproduced from Forestry Commission Technical Note 16/95. *Terrain Classification*].