Forest Research
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TECHNICAL DEVELOPMENT

TECHNICAL NOTE 6/94

GLENFINNAN LOG CHUTE

A log chute developed by an estate forester has potential for extracting timber from first thinnings in environmentally sensitive areas. Initial indications are that, at around £7/m^3, cost compares favourably with cable crane working for the conditions studied. Further work on construction and use is required.

FOREST RESEARCH
TECHNICAL DEVELOPMENT BRANCH
TECHNICAL NOTE 6/94

GLENFINNAN LOG CHUTE

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GLENFINNAN LOG CHUTE

Summary

1. A log chute developed by an estate forester can be used effectively for extracting timber from first thinnings in environmentally sensitive areas. The system causes minimal ground disturbance and, as a rack system is not needed, windthrow risk may be reduced.

2. Particular care must be taken over layout and practice to ensure safe operation: the chute is not suitable for amateur use and instruction is required.

3. Outputs were assessed at 2.59 m^3/Standard Hour (m^3/shr) or £7.14 m^3 over a 56 m chute length, on a 28% slope. Initial indications are that cost compares favourably with cable crane working for the conditions studied.

4. More work is required to refine the system.

Introduction

5. The main benefits of log chute extraction are:

- There is minimal ground disturbance during the extraction process (Plate 1) and virtually no risk of contamination of watercourses through erosion.

- No extraction racks are required (Plate 2).

6. Potential disadvantages are restrictions imposed by cost, slope, terrain, crop, produce size and the high proportion of manual handling.

7. The Glenfinnan Log Chute has been developed by the Glenfinnan Estate forester, Alistair Gibson. This method of extraction meets the needs of the estate first thinning programme on sensitive sites. Conventional cableway or tractor systems involve the creation of racks, which increase the risk of windthrow. The appearance of the woodlands is also important. This method of extraction is not dependant on a rack system and will ensure minimal ground disturbance.

8. Recently, there has been a revival of interest in the use of log chutes. In the Welsh borders an area is being considered for extraction primarily by horse, with subsequent extraction to roadside by log chute. Scottish Natural Heritage has shown interest in the Glenfinnan log chute for use in very sensitive areas.

9. Small awkward corners of steep woodlands, where the cost of importing machinery becomes prohibitive, are likely to lend themselves to chute extraction. Water courses can be crossed without any ground damage occurring.

10. The first Glenfinnan design used plastic barrels, which were cut in half and pop riveted together. Although this prototype indicated that the plastic chute system had potential, the sections were not sufficiently rigid or ideally shaped. Plans were then made to produce purpose built sections. After requesting funding from Lochaber Enterprise, it was agreed that Technical Development Branch should assess the suitability of the new system under working conditions. This report was prepared after the log chute had been used by Glenfinnan Estate over a three month period.

Log Chute Description

11. The chute (Cover Plate) can be made to any length by joining the 2 m long sections together with wing nuts and 8 mm bolts (Plate 1). The sections are rotary moulded from medium density polyethylene and are designed to overlap to avoid timber fouling during its descent (Plate 2). Effective chute length is then 1.86 m.

12. The plastic is flexible enough for the top sections to be pulled together to form a continuous tube. This is advantageous in steep undulating ground or at corners where pulpwood may otherwise escape from the chute. The sections weigh 9.5 kg and are easily lifted by one person and carried into the wood.

13. Each 2 m section (1.86 m effective length) costs £28 to produce, excluding the initial mould tooling cost. The chute is not currently available on a commercial basis.

<u>Site</u>

14. Glenfinnan Estate, which has *c.* 700 ha of woodland, is situated in Lochaber, near Fort William in north west Scotland. The log chute was used and studied in Yield Class 12 first thinning stage Sitka spruce planted in 1970. Soils were peaty mineral of glacial origin and extraction distances ranged form 50 m to 200 m. Slopes varied from undulating to 45%.

<u>Chute Layout and Working Method</u>

15. The chute was designed originally for use in **first thinnings** only particularly where it was considered economically beneficial to Gelnfinnan Estate. In practice it has been found suitable for use with produce up to 3.2 m long and *c*. 0.06m^3 volume. If pieces are too long they will jam at corners and will not descend freely. If pieces are too bulky and heavy they will tend to escape from the chute or cause blockages. To prevent pieces escaping from the chute, the open top can be tied closed; two pairs of holes are available for this.

16. It is always advisable to have the chute in place before felling commences because the chute is more stable if it is not resting on brash. For the **initial set-up**, the first section is dragged (using a rope passed through the chute fixing holes) to a suitable 'tail spar'. The top section is secured by passing a rope through the bolt holes and around the tree. Further sections are dragged and bolted to those which are in place, until the chute reaches the bottom of the slope. During initial use after set-up the chute has a tendency to 'stretch' as slack is taken up.

17. During the period of the appraisal, chute sections were dragged manually uphill, although a portable winch might be used to haul sections. Where a site is bounded on the upper side by a raod, sections could be hauled downhill. Depending on terrain and physique, up to 2 sections bolted together can be dragged at one time. If more than 2 sections are dragged it is difficult to position them for joining to the chute sections already in place.

18. A **slope** of at least 15–20% is required for the chute to be successful. If the chute is wet, the speed of descent is increased, even on slopes of below 20%. The chute has performed safely on slopes up to 45%. Timber tends to slide more freely if the chute is a little damp. In dry conditions it may be helpful to throw a bucket-full of water into the top of the chute.

19. Once the angle of descent rises above *c*. 30% a **braking mechanism** is required to slow the descent of the produce. The method used has been to suspend a 3.70 m log from the standing crop with the butt end hanging in the centre of the chute. As produce comes up against the log its speed is reduced. On steeper slopes produce should be slowed before it reaches the bottom. Turning the lower end of the chute slightly uphill is not an acceptable alternative, as timber may become momentarily airborne.

20. The chute should be positioned so that very severe **drops** are avoided. Small depressions are best filled with brash or logs to support the chute. If severe drops cannot be avoided then the chute may be suspended from standing trees over a short length. This has two main disadvantages:

- Joints between the sections become vulnerable.
- Loading of the chute becomes more difficult because the pulpwood has to be lifted higher.

21. When the chute is **moved** it is dismantled into two 2 m sections which are dragged across the hillside to the next extraction route and reassembled. During studies the distance between set-ups was *c*. 40 m.

22. Timber should be **felled** towards the chute but the current chutes are susceptible to damage and timber should not be felled on top of them. Where possible, brash should be kept clear of paths used to transport timber to the chute.

23. Produce may be loaded immediately after snedding and conversion or stacked beside the chute for **extraction** as a separate process. In either case a stacker should be present at the lower end of the chute to clear the landing and prevent access by passers by.

24. It is possible for **2** and in theory **more** chutes to be in position at once, in which case they could be spaced across the hillside to minimise the need to carry timber any great distance. In one set-up 2 chutes were in use, with 2 cutters extracting using both chutes with a stacker clearing the produce from both. Ideally, cutters would fell and extract on a tree by tree basis to avoid double handling in the stand. The use of multiple chutes may improve the efficiency of the stacking operation but there must be sufficient space for the stacker to work in safety.

25. To ensure safe working only one part of the thinning operation (chute assembly/felling/loading) should be carried out at any time in the same area. If a number of cutters are working at any one time **safe felling distances** between cutters (at least 2 tree lengths) must be observed at all times[1].

26. The planning of **roadside landing** is as important as the position of the chute in the wood.

27. At roadside the produce has to be **stacked** and this may involve sorting into separate piles. This is usually done manually so the end of the chute should be as close to the stack as possible. The largest product should be moved the shortest distance. The cost of using a mechanical loader to pick up and sort individual pieces is prohibitive.

28. To reduce the distance that the stacker needs to move timber, the chute should normally be **laid out** so that the timber is discharged along the road rather than across it. If a mixture of products is being sent down the chute, the smaller ones have a tendency to travel further along the landing area. This could be used to reduce the distance that billets need to be moved to place them in the correct stacks.

29. The layout of the chute at the landing area in relation to roadside banks and ditches and the road itself is important. Steep final descents may cause the timber to leave the chute and are to be avoided. The mouth of the chute should be positioned so that produce slides smoothly out. The billets are thereby quickly slowed by friction and allowed to accumulate away from the chute in a controlled manner. To keep road damage to a minimum a 1 m – 2 m piece of 'conveyor belt' should be placed under the mouth of the chute extending along the road (Plate 5).

30. The chute will quickly block with accumulated billets if pieces cannot easily slide out and away from the chute. The stacker must have space in which to work and should not need to retrieve timber from confined locations, such as drains, into which further produce is being directed.

31. Where pieces may continue into the area below the road they should be stopped by a barrier of larger billets or the chute should be directed towards a suitable terrain feature.

32. All landing sites must be carefully **taped off** to ensure that no one accidentally strays into the path of the descending timber.

Safety

33. The system is a simple and efficient method of extracting timber to roadside but should only be used by operators who have received instruction in safe practices. To ensure safe working only one part of the operation (chute assembly/felling/loading) should take place at any time in the same area.

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[1] Forestry Safety Council (FASTCo) Guide 11, Felling by Chain Saw

34. The main potential danger area is the landing. During studies the average speed of descent for a 0.01 m^3 billet was 16 mph but speeds of up to 40 mph can be achieved. However, if care is taken over chute and landing layout, produce can be discharged in a controlled and predictable manner. The stacker must not stand in or near the path of produce whether within or emerging from the chute.

35. Landing areas should be taped off to exclude casual access to the work site. Produce should only be extracted when there is someone present at the landing to ensure that no one enters the risk zone. This person will normally be a stacker.

36. Stackers employed at the chute end must be aware of timber descending. Although it is normally possible to hear billets approaching, the use of a bell to warn of timber nearing the chute end has been proposed. This would help to doubly ensure that the stacker does not enter the danger zone as timber arrives. Under no circumstances should the stacker attempt to stop or slow down the descent of timber before it is finally at rest.

37. Manual lifting is part of the system. Safe pulling, lifting and carrying techniques should be adopted at all times and lifting aids used to best advantage.

38. The layout of the chute should avoid sharp corners and steep drops as these can cause timber to leave the chute. Timber can be prevented from leaving the chute by tying it shut but this is not practicable for more than a short distance. If there is any possibility that timber may escape from the chute then exclusion zones should be marked out.

Outputs

39. Extraction of a quantity of timber (Table 1) was studied so that outputs could be calculated.

Table 1

Volume Extracted by Product Type

Product Type	Average Piece Size (m^3)	Number of Pieces	Total Volume Extracted (m^3)
2.6 m Rustics	0.014	25	0.35
3.2 m Logs	0.057	2	0.11
2.0 m Pulp	0.023	51	1.17
1.7 m Posts	0.011	40	0.44
1.7 m Posts	0.024	42	1.01
Firewood	0.015	26	0.39
Totals	0.019	186	3.47

40. The chute was loaded by hand with produce that had previously been felled and stacked. At the other end of the chute the roadside stacker was studied to assess the output of the system from loading through to final stacking. Finally, the time taken to move between set-ups was obtained.

41. From this data it is possible to calculate the output from the set-up, which was laid on a 28% slope. With a total chute length of 56 m, and 40 m between set-ups, the total area was 0.224 ha. At 35 m^3/ha, the volume removed from the area covered by the set-up was 7.84 m^3.

42. The time taken to move the chute was 57.44 Standard Minutes, or 7.33 Standard Minutes per m^3 extracted from the area covered.

43. An overall output of 2.59 m^3/shr is indicated (Table 2).

Table 2

Study Outputs

Operation	Standard Minutes	m^3 Extracted	Standard Minutes /m^3	Output m^3/shr
Extraction	54.95	3.47	15.84	3.79
Move chute	57.44	–	7.33	-
Totals	**-**	**–**	**23.17**	**2.59**

Standard output includes an allowance of 10% for other work and 23% for rest

Costs

44. When overlapped, the 2 m sections give a working length of 1.86 m. Assuming a chute length of 200 m is used, this will require 108 sections. At £28 per section, this gives a capital cost of £3 024.

45. The hourly capital cost of the chute will depend upon its life, which is not known at present. Hourly cost estimates, assuming 800 hours use per year, range from £1.58 for a 5 year life to £3.50 if the chute only lasts 1 year (Appendix I). A cost of £2.50/hr is assumed (equivalent to a 2-3 year lifespan) to calculate total extraction cost.

46. With 2 man working and a labour cost of £8 per hour, the total extraction and stacking cost based on studies over 56 m would be as follows:

Labour	= £16.00
Chute	= £ 2.50
	£18.50/hour
Output	= 2.59 m^3/hr
Cost	= **£7.14/m^3**

47. On the site visited overall costs were £15/m^3. Extraction distances ranged from 50 m to 200 m. Contract labour was employed for felling, crosscutting, extracting and stacking at roadside.

48. Even with an additional cost of £1.0/m^3 for the chute (based on £3.50 per hour or 1 year lifespan) the total cost is still only £16/m^3. This compares favourably with a cost of £18/m^3 quoted for cable crane working on the same site.

Future Developments

49. Problems have arisen with the original mouldings breaking after a period of use (Plate 6). Consultation with the manufacturers has indicated that a new type of plastic could be used to overcome this problem. This plastic is less fragile than the original and is more likely to stand the wear and tear of forestry use.

50. The use of wing nuts and bolts to join the sections together can be slow and awkward especially if conditions are cold. Alternative fastenings could be designed.

51. To reduce the chances of timber leaving the chute due to excessive speed, alternative methods of braking should be investigated. For example, the use of flexible conveyor belting should be considered.

52. Glenfinnan Estate hopes to have a marketable log chute in 1995.

Conclusions

53. The Glenfinnan Log Chute is an effective means of extracting first conifer thinnings on slopes over 15–20%, particularly where ground disturbance is to be completely avoided.

54. This method of extraction, which avoids the need for racks, may reduce the likelihood of windthrow following first thinnings in areas of high windthrow risk. However, the effect of racking at second thinning on stability may then become a constraint.

55. The system allows a range of products to be cut without the provision of crosscutting space at roadside. This would normally be required for a wide product range from cableway or skidder extracting whole poles.

56. Care must be taken over site selection, chute layout and working methods, particularly at the discharge end of the chute.

57. An extraction and stacking cost of £7.14/m^3 was indicated from a chute length of 56 m. Initial indications are that costs compare favourably with cable crane working.

Recommendations

58. The Glenfinnan Log Chute is suitable for extracting first conifer thinnings, providing that operators have the necessary expertise and care is taken over site selection and chute layout. The chute is not suitable for amateur use and should only be used by operators who have received instruction in safe practices.

59. An operator/stacker should be present at the landing area when extraction is taking place, to ensure that no one else enters the discharge zone.

60. Further information and work is required on:

a) The plastic used in section manufacture, details of chute design and section lifespan.
b) Chute initial layout by portable winch or other non manual means.
c) A section connecting system that is cheap and quick to use.
d) Produce slowing systems.
e) Audible systems to indicate that produce is approaching the landing area.
f) The layout of landing areas to maximise safety and minimise the carrying of timber.
g) Use of the chute in variations of crop, terrain and work-site organisation, including the set-ups involving more than one chute.

Acknowledgements

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Appendix 1

Cost Assumptions

		5 Year Life	1 Year Life
Capital Cost (£)	C	3024	3024
Residual Value	RV	150	600
Life in Hours	L	4000	800
Productive Hours/year	PH	800	800
Life Years	n	5	1
Discount Rate (%)	R	6	6
Discount Factor	$Dn = \frac{1}{(1+r^*)^n}$	0.7473	0.9434
Equivalent Annual Cost	$An = \frac{(r)}{1 - Dn}$	0.2374	1.0600
Capital Cost (£/hr)	$\frac{C - (RV \times Dn)\,An}{PH}$	0.86	3.25
Replacement of Broken Sections (£/hour)[2]		0.72	0.25
Total Cost (£/hour)		1.58	3.50

$*r = \frac{R}{100}$

Capital cost assumes a chute length of 200 m which divided by 1.86 m working length per section requires 108 sections x £28 = £3 024.

[2] Based on an estimate of the number of sections that would need to be replaced over the life of the bulk of the chute, in order to maintain its effective length.

Plate 1 Minimal Ground Damage

Plate 2 Rackless Set Up

Plate 3 Wing Nut and Bolt Fixings

Plate 4 Overlapping Sections

Plate 5 Chute End at Roadside

Plate 6 Damaged Section at the Road