Expanding Ground-based Harvesting onto Steep Terrain

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Expanding Ground-based Harvesting onto Steep Terrain
Presentation Overview

- Issues with harvesting on steep terrain.
- Ground-based equipment with extended operating range.
- Cable assist – a step change?
  - System options / differences
  - Defining operating range and safety
  - Cost and safety
Steep Terrain: Forests

- Many managed natural and plantation forests.

- Great resource – also many eco-system services.

- A focus area for forest engineering.
Steep Terrain: Issue?

- Cable logging systems well developed:
  - Relatively expensive
    - 20 → 50+ €/m³
  - Relatively unsafe
    - 3 → 10 fatalities/10mil.m³
Steep Terrain: Mechanisation?

- Many developments over time...
  - Self-levelling (operator!)
  - Centre of gravity
  - Independent suspension
  - Tracks, belts, chains
Machine Slope Limits?

- UN-FAO/ILO (1971) capability based
  - 50% wheeled and 60% tracked

- Based on erosion risk (mid-80’s);
  - 30% wheeled and 40% tracked
    - ‘Limit’ in many texts, guidelines

- Safety Rules → manufacturer specification
  - None specify a limit!

- New rules? i.e. BC exceed 50% with ‘plan’.
Machine Slope ‘Limits’?

- Safety → Machine roll-over

- Actual roll-over accidents caused by loss of traction – not slope!
Basic Eng: Slope ➔ Gravity Force
Effect of Traction Efficiency

Technical operating range 40% to 100%!
Slope + Trafficability?

(after Heinimann 1995)
Effect of Cable!

A LOT of forest land > 40%, not much over 80%!
Effect of Cable!

- With cable 100% (45deg) is easily achievable.
Cable-Assist: Step-change for steep terrain?

- Forestry: late 80’s on Forwarders to match Harvester capability on slope.

- 00’s expanded to harvesters...

Europe:

- No ‘rules’ but concept is “only operate where machine is stable without cable”

- Manufacturer: wire rope approx. ‘design’ 50% breaking load
Cable-Assist: New Zealand

NZ Rules (2012):
- Tension never >33% of breaking load.
- Weight of machine < breaking load rope.

22 - 28mm rope!

now 35+ systems in operation!
Cable Assist: Cost and Safety?

**Cost:**
- Significant capital investment
- *Potential* benefit of €5/m³ compared to yarding

**Safety:**
- Machine roll-over and wire rope breakage not uncommon.

HOWEVER...

- ROPS and operator restrain systems appear very effective → no fatalities!
Step-change: Safety
Key Considerations for Progress

- Incremental Improvements
  - Chain section
  - Tension monitoring & control

- Wire-rope Factor-of-Safety?
  - None = assume machine is stable?
  - 3 = same as forestry cable yarding
  - 5 = ISO mechanical eng. standard
  - ...11? – ‘people supported by rope’ standard

- Operators?
  - Professional training / certified operators
  - Fatigue management
Key Considerations for Progress

- Felling + shovelling = replacing cable yarder

- Environmental Standard?
  - Safer but greater soil disturbance!
Summary: GB on Steep Terrain

- Steep terrain harvesting must innovate to remain viable
- Clear safety benefits of expanding ground-based operations
- Cable-assist true step-change:
  - for expanding operating range
  - replacing cable yarding?
  - highly suited to remote control...