Long range Cable Systems in Japan: Succession and Continuous Development to Overcome Terrain and Cost Balance

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  – Role of logging cable systems in Japan
• Overview
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Ara of Japanese forestry

- Recovery -> Mass plantation -> Thinning
- Log price coincides with domestic demand

Cable logging machines

- Conventional yarder: Decreasing
- Swing yarder (Japanese style): Increasing
- Tower yarder: European, imported

Proportion of terrain on forest area

- Gentle (< 20%)
- Medium (20-40%)
- Steep (40-70%)
- Very steep (70% <)

### Area (1000ha)

- Truck: 3,731
- Tractor: 9,852
- Cable system: 10,305
- Long range cable system: 1,140

- Ca. 50% is suitable for cable system.

### Road network status and operation system

Proposed by Gotou (2011, 2016)

<table>
<thead>
<tr>
<th>Road network status</th>
<th>Conventional system</th>
<th>New system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average slope gradient (within a circle of main-road-distance diameter)</td>
<td></td>
</tr>
<tr>
<td>Distance between main roads (m)</td>
<td>Road density (m/ha)</td>
<td>Fine road network</td>
</tr>
<tr>
<td>Truck road 1000 [2.6]</td>
<td>ca. 25</td>
<td>Yes</td>
</tr>
<tr>
<td>Truck road 500 [2.2]</td>
<td>ca. 50</td>
<td>Yes</td>
</tr>
<tr>
<td>Truck road 75 [1.7]</td>
<td>ca. 75</td>
<td>Yes</td>
</tr>
<tr>
<td>Forwarder road 120 [1.4]</td>
<td>ca. 100-150</td>
<td>Yes</td>
</tr>
<tr>
<td>Forwarder road 60 [1.2]</td>
<td>ca. 200</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

- Cable system has its role.

Cable system 1: Endless-Tyler System

- Standard cable logging system in Japan
- **HBL**: Lateral logging to enlarge logging area
  - Mainly for **clear cut**
Practical case: Endless-Tyler

- Clear cut
  - Broad-leaved trees
  - Biomass use: Power generation

- Test operation
  - Efficiency
  - Cost analysis

Endless Tyler:
Damage to residual stands

2: Collector System

- **CB** controls swinging of **HBL**
- Arrangement of Endless-Tyler for **thinning**
Collector system: Lateral logging

- CB controls movement of HBL
- Yarder with 3 axis and 4 drums

Collector system: Loaded logging

- Good for line thinning or fish-bone thinning
- Rearrangement of HBL is required for line change

Practical case: Collector system

• Specifications
  – Span: 500m
  – Skyline: 22mm
  – Payload: 800kgf
  – Full-tree, Processor

• Site
  – Area: 2.25ha
  – Nov. 2009 – Feb. 2010

• Work study
  – P1: 0.34ha (P2: winching)
  – Jan. 7, 8, 14; 2010

CR: Carriage

CB: Collector block

LB: Loading block

Blocks for HBL on mountain side
Felling (Fish borne)

Yarder (SK50-4A)

Loaded main logging

Processor (CAT312C + CM-40Z)

Lateral logging

Processing at the landing
3: H-type system

- Two sets of normal system
- Connected at loading block
- Large area, vertical lifting
- Thinning, single tree selection

Practical case: H-type system

- Average span: 1060m
- Multiple sets / Site
- Ave. 230ha/Site
3.2 Sets/Site
- 14ha/Set
- 98m³/ha

Skyline 1
Skyline 2
Landing

4-Drum yarder; Newly developed
Residue recovery
Productivity and cost: Logging and processing

- Resultant cost: Collector = Endless Tyler
- H-system: High productivity, low resultant cost

Note: Resultant cost \( z \) (JPY/m\(^3\)) = \([\text{Hourly cost} \times (\text{1000 JPY/crew-hour})] / [\text{Productivity} \times (m^3/\text{crew-hour})]\).

Error bars indicate Max. and Min.

1000 JPY = 38 PLN
10 USD
(Aug. 31, 2016)
Cost and income

- **H-system:** Low cost due to low rigging cost
- **Collector income:** Thinning subsidy + Biomass
Conclusions

• Steep terrain, matured forest
  – Need for long range cable system (500m < Span)

• Development
  – Lateral logging: Endless-Tyler + HBL
  – Thinning: Collector
  – Large area, vertical lifting: H-system

• Cost balance
  – Thinning subsidy, Biomass, High efficiency
Acknowledgement and Notification

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• Notice: IUFRO Meeting 2017 Summer
  – Joint Regional Meeting of IUFRO RG3.03.00 and RG3.06.00 in Asia: Productivity and Safety of Final Cutting on Mountain Forests

July 24th-28th, 2017
Ehime & Kochi, Japan

http://www.kochi-u.ac.jp/iufrojrm/
Results: Productivity and cost

[Graph showing productivity vs. hourly cost for different cost values (z = 1000, z = 2,500, z = 5,000, z = 7,500, z = 10,000) with markers for Collector, H-system, and Endless-Tyler (Clear Cut).]
Balance of operational cost and productivity

- $z = \frac{x}{y}$
  - $x =$ hourly cost ($10^3$ JPY/crew-hour)
  - $y =$ Productivity (m$^3$/crew-hour)
  - $z =$ Resultant cost ($10^3$ JPY/m$^3$)

- Resultant cost $z$ is expressed as equivalent lines on the coordinate of hourly cost $x$ and productivity $y$
Balance of operational cost and productivity

If investment on machine ($x$ -> up) results in higher productivity ($y$ -> up), resultant operational cost will be down (a)
  
  - When productivity did not much the investment, resultant cost would be even higher (b)

With less investment ($x$ -> low), not bad productivity would result in lower cost (d)
  
  - If less investment makes productivity too lower ($y$ -> down), resultant cost would be higher (c)

Note: $z = x / y$

Figure source: Setiawan, A.H., Suzuki, Y., and Gotou, J. 2013. Classification of forest operations with regard to hourly cost to productivity balance - A proposal of a framework for analysis of the relationship between hourly cost and productivity using a simple chart -. Journal of the Japan Forest Engineering Society 28:143-148.