Benefits of varying cable yarding technologies with respect to specific timber harvesting and extraction needs in Southern China

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Keywords: Cable Yarding, Harvesting, China,

Introduction

Along with China's booming economy, the country's wood processing industry went through a rapid development over the last decades. This progress caused a huge demand for timber resources which the Chinese forestry sector is currently unable to supply, creating a high dependency on timber imports (Zhang & Gan 2007). Currently, China's annual timber imports reach values of US$ 10 billion from various countries, with Russia as the biggest contributor (Hui & Jintao 2011). In order to be less dependent on timber imports, China's Central Government initiated various programs to increase the timber supply capacities of domestic forests. Besides conservation initiatives for the recovery and rehabilitation of overexploited natural forests, various activities have been carried out for the development of a plantation based commercial forest management with a special focus on the Southern provinces (Zhang 2008). Though harvesting rates could be increased, the current management of these plantations has failed to lead China into independence of timber imports. Apart of silvicultural and governance shortfalls, the low degree of mechanization in harvesting operations hamper efficient management of the mainly on steep slopes located plantations. Furthermore, increasing wages and the governmental endorsement for the development of a professional forestry sector in Southern China demand the introduction of modern operation technologies. Cable yarding systems seem to be promising to fulfill these new management targets.

This study aims to analyze two recently introduced cable yarding systems in the Southern province Guangxi with respect to productivity and environmental soundness.

Material and Methods

Two different cable yarding systems, with crews of six months working experience have been surveyed through time and motion studies in the two main plantation management schemes representative for Southern China. Within the first scheme, Chinese plantation managers aim at the production of dimensional timber with targeted DBH up to 50 cm through periodic thinnings. A late thinning operation with 60% reduction in stem numbers and expected harvest volume of 180 m³ ha^{-1} within a 26 years old pine stand (*Pinus massoniana*) of a state owned forest farm has been conducted with the trailer based standing skyline system KOLLER K303H. This very popular small scale European all-terrain (3-drums) yarder has been operated during this study in the optional 2-drum gravity mode for uphill yarding on two corridors with an average slope of 42%. The yarding crew consisted of five workers including the operator of a knuckle boom loader unit which completed the system. The second surveyed logging operation has been conducted in a private concession of a seven year old short rotation eucalyptus (*Eucalyptus* *grandis x urophylla*) plantation. The operation is based on a clear-cut managed production system to supply the local wood based panel and wood fiber industries, presenting the second popular plantation management type. In this stand a merchantable volume of 110.71 $m^3 ha^{-1}$ has been extracted by the tractor PTO driven Igland Hauler 4000/2, a 2-drum running skyline system for all-terrain operations, which has been very popular on the British Isles and New Zealand in the 1980's. The surveyed operation with the Igland Hauler consisted of three corridors in moderate terrain (17%) with a yarding crew of eight people and manual decking operation at the landing.

Table 1: Technical specifications of the surveyed cable yarders

	KOLLER K303H	**Igland Hauler 4000/2**
System:	3-drum all-terrain standing skyline (optional 2-drum gravity mode)	2-drum all-terrain running skyline
Drive:	Diesel engine (trailer-based) with 64 KW, hydrostatically	Tractor PTO of 45 KW, mechanically
Tower:	Hinged lattice tower, 7.2 m heigh	Hinged lattice tower, 6.0 m heigh
Guylines:	4 x 30, Ø 16 mm, on manual drums	2 x 30 m, Ø 10 mm, endfastend through shackle
Skyline:	420 m, Ø 16 mm, line-pull 44 kN	*See haulbackline*
Mainline:	400 m, Ø 9.5 mm, line-pull 18 kN	180 m, Ø 8 mm, line-pull 16.8 kN
Haulbackline:	800 m, Ø 10 mm, line-pull 18 kN (optional use for all-terrain mode)	300 m, Ø 10 mm, line-pull 16.8 kN (serves also as the running Skyline
Carriage:	Slack-pulling carriage with hydraulic clamps, payload of 1.5 t	Simple highlead carriage, payload of 0.5 t
Chokersystem:	Bardon chokers, 4 tags	Choker chains, 3 tags

In both operations, tree felling was conducted prior to the yarding activities and initial processing has been done in the stand to yard full tree lengths which have been further processed at landing within a hot deck operation. With short corridor lengths up to 100 m, both operations are very representative for typical harvesting conditions in Guangxi.

Based on the surveyed cycles, delay free cycle time equations have been developed using stepwise regression techniques in order to model net productivity based on the prior scaled timber of the operations. Further, all delay events have been recorded and classified in operational, mechanical, personal and disturbance delay times in order to estimate gross productivity of the system at the current stage and to identify operational shortfalls at the six months crew experience level. Based on the modeled productivity, an initial cost calculation with different scenarios in respect of annual SMH has been conducted following the FAO (1992) methodology.

Preliminary Results

The crews of both yarding systems showed inefficient machine utilization rates below 50%, whereas the Igland crew in the short rotation clear-cut system had reached a higher rate compared to the KOLLER crew in the thinning operation. Unproductive times are mainly related to rigging and installation times, which have been much shorter for the Igland running skyline with smaller reach compared to the standing skyline of the KOLLER system. Looking into additional delay times of both crews and yarding systems, avoidable delay times related to the direct operation dominated compared to unavoidable, mechanical and personal delay times. The percentage of the KOLLER crew's avoidable operational delay time was twice the one of the Igland crew. With respect to the high share of non-productive times, also the gross and net cycle times differed and respected productivity values have been affected.

In general, the cycle times for the Igland crew with 3.54 minutes net (excluding delays) and 5.35 minutes gross (including delays), have been much shorter compared to 5.70 minutes net and 9.52 minutes gross for the KOLLER crew. But due to the bigger piece size in the thinning stand compared to the clear-cut operation, the actual productivity differed not much between the two systems, with the KOLLER crew achieving a slightly higher output of 5.80 m^3 h^{-1} net and 3.47 m^3 h^{-1} gross, compared to 5.14 m^3 h^{-1} net and 3.41 m^3 h^{-1} gross of the Igland crew. However, both systems could proof to have a much higher daily extraction performance compared to the conventional manual extraction through laborers. From a first approximated cost calculation, both yarding systems seem to be economic competitive with the manual extraction, considering daily outputs and technical feasibility with respect to piece size.

Conclusion

According to the preliminary results, small scale cable yarders as presented in this survey offer potential for being more efficient than manual extraction systems, which are predominantly applied in China. Regardless of the technical efficiency, operation costs in consideration of a changing labor market in China have to be analyzed by further research and also other harvesting systems need to be included in the feasibility assessment. The current stage of the study also exposes the need for integrated training programs for a successful system introduction in order to make use of the full technological benefits offered by a modern harvesting system. As prevailed in this study, six months of operation is a rather short time for new technology users to develop a routine and well organized work flow in order to make full use of a harvesting systems potential. Therefore, the presented productivity and cost indicators shall be seen as intermediate performance and need to be revised at a later stage of the systems application in China.

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