

# Mechanized Logging and Its Operational Efficiency in Japan

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Logging mechanization in Japan has progressed, depending on technology development such as the advent of chain saw, improvement of yarder to small and light one, and improved performance of tractor and truck, and it has been widely adopted. However, since we don't have any logging machine which can be applied to every case, work studies on selection of the type of machine to be used or rational methods of the operation adapted to each case, etc. have been taken up as an important subject.<sup>1-5)</sup>

As the final objective of the work studies is to improve operational efficiency, it is needed to measure or estimate operational efficiency in the course of work studies.

The operational efficiency is an important index for practicing actual logging. It also serves as useful data to find out the most suitable operational method at the stage of work plan. Furthermore, it gives a basis for planning a time schedule of logging, and is used as a guideline to improve logging works.

Present status of mechanized logging in Japan, and survey results on the operational efficiency are presented in this paper.

## Logging methods

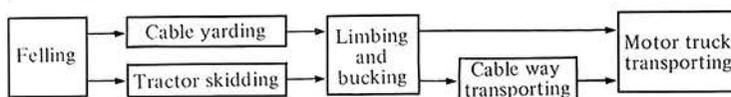
Working processes of logging, now in practice in Japan, are classified into tree-length logging (full-tree logging), and short length logging. Each of them is further divided whether yarder or tractor is used (Fig. 1).

The tree-length logging is to harvest cut trees after branching without any other treatment. The tractor skidding is mostly employed for the tree-length logging. The tree-length logging including tractor skidding and cable yarding accounts for about 70% of the total logging works. On the other hand, the short-length logging is to harvest cut trees after cross-cutting at a given interval, and is practiced mainly for man-made forests of small scale logging.

Merit and demerit of the tree-length logging are as follows:

- (a) As the working process can be simplified, the improvement of labor productivity is expected.
- (b) Yield percentage of material logs is increased because slash is also harvested.
- (c) Cost of reforestation in cut areas can

(Tree length logging - full tree logging)



(Short length logging)

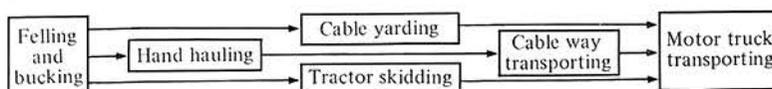


Fig. 1. Working process used in logging

- be saved.
- (d) Since the work on steep slopes with bad scaffold is avoided, a labor accident decreases.
  - (e) In cable yarding, large scale yarder and wire rope of large diameter have to be used, so the machinery cost is increased.
  - (f) As the place of conversion is used as a log deck, the area of the log deck has to be widened.

- (g) Treatment of slash arises a problem.
- (h) In case of tractor skidding, it sometimes damages remaining stands.

### Cable yarding operation

Cable yarding is a method of aerial hauling of logs by using wire ropes. There are many different cable systems (Fig. 2).

The wire ropes used for cable yarding are

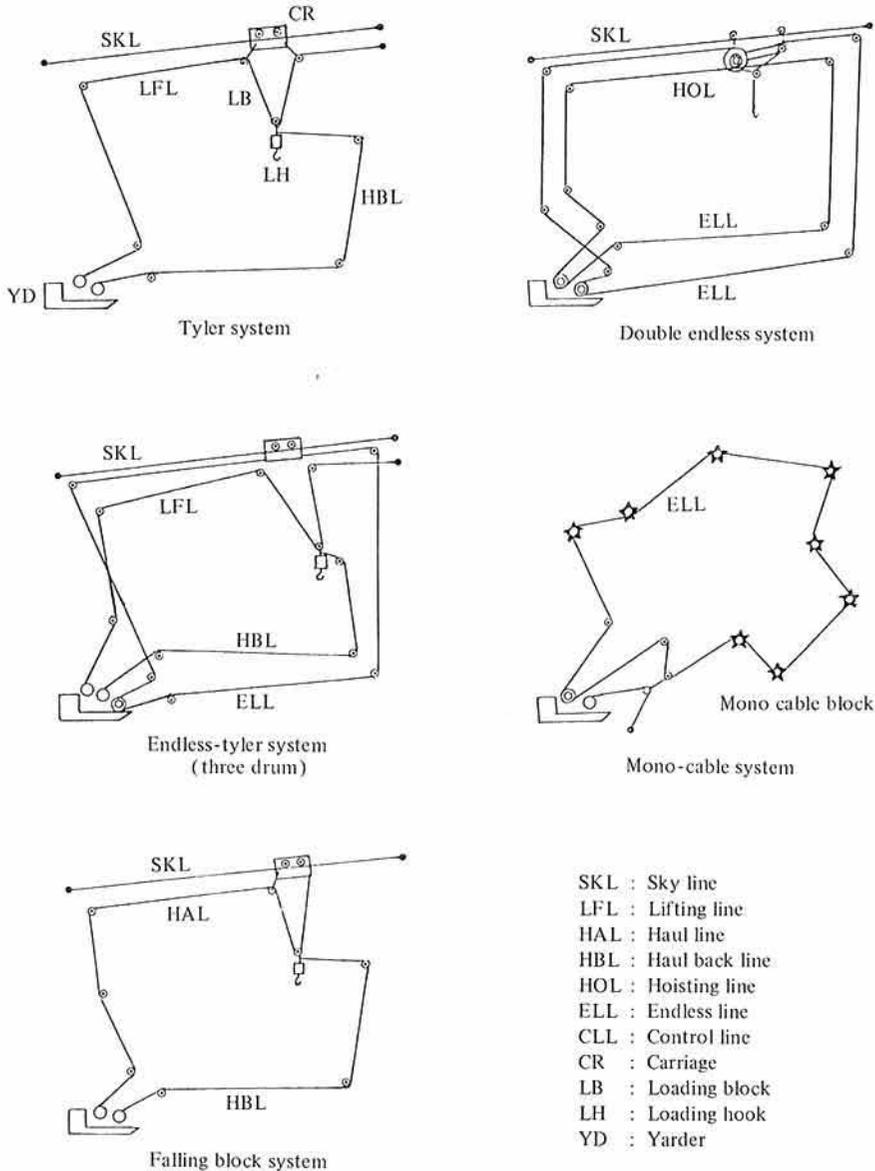


Fig. 2. Cable yarding system

usually divided into skyline and operating line. The former conducts aerial hauling, and the latter hauls logs from a snatching point to a landing point. The major cable systems are as follows:

- (a) Tyler system, composed of lifting line and fallback line, is suited to down hill yarding which takes advantage of the weight of log itself. The gradient more than  $15^\circ$  is needed for sky line. This system is characterized by simple rigging and easy handling.
- (b) Endless Tyler system is composed of three operating lines, i.e., lifting line, fallback line, and endless line, and it enables easy hauling of logs even in plain areas without gradient. In hauling of long logs such as obtained by tree-length logging, the landing is easy, but the endless line is worn badly.
- (c) Falling block system, composed of fallback line and haul line, is adapted to the hauling work on moderate slopes, but it is difficult to perform long distance yarding. Lateral yarding can be done easily by the fallback line.
- (d) Double endless system utilizes the carriage equipped with a hoisting drum. The hoist line, sent out from the carriage, hoists logs, which are then hauled by two endless lines. A narrow yarding road is good enough to this system, resulting in less damage of forest land and young trees.
- (e) Mono-cable system is able to haul logs hanging from an endless cable along a zigzag route in forests, by the use of special mono-cable blocks. This system is often used for yarding of thinned logs.

### Operational efficiency of cable yarding

The cable yarding system is designed to enable the yarding to cover an area as wide as possible in both sides of the sky line. In general, the operational efficiency is influenced by many factors such as cable systems, types of yarder, yarding distance, lateral yarding

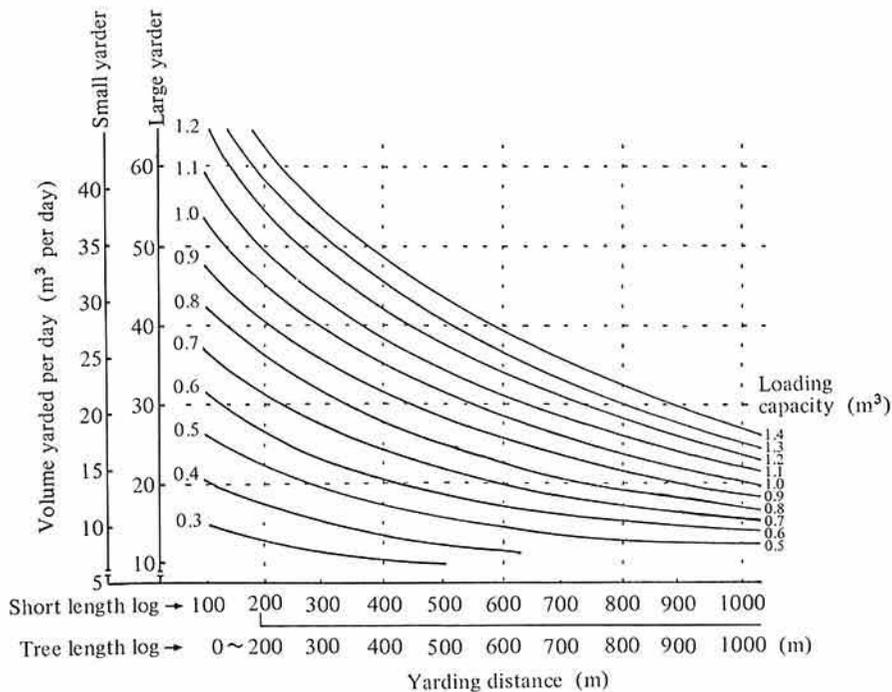


Fig. 3. Operational efficiency of cable yarding

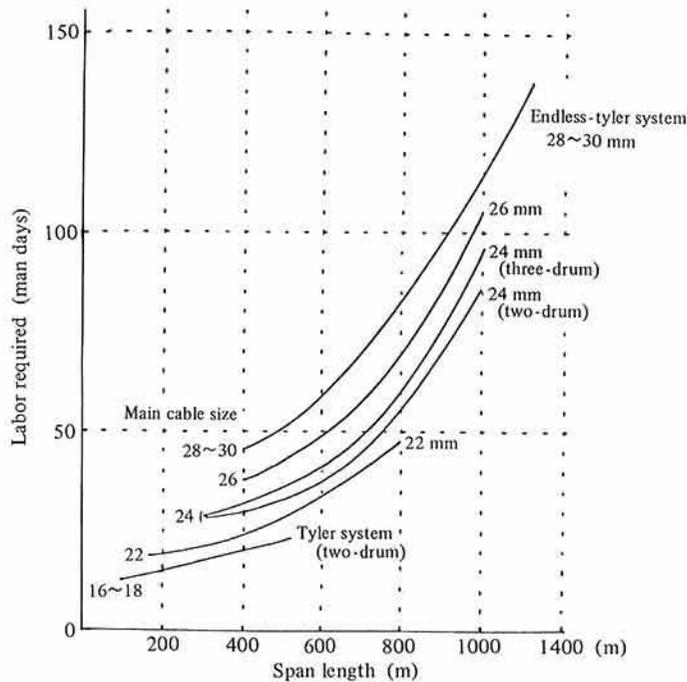


Fig. 4. Labor required for rigging and that for dismantling

distance, volume of a log, terrain condition, etc. Among them, the yarding distance gives a large effect, i.e., the greater the yarding distance, the lower the operational efficiency.

Results of the survey on operational efficiency of cable yarding and on labor required for rigging and dismantling of cable yarding system are shown in Fig. 3 and Fig. 4, respectively.

### Tractor skidding operation

Tractor skidding, which doesn't need any fixed facilities, unlike the case of cable yarding, has high mobility, and requires less number of workers. Furthermore, by equipping with dozer, three-point linkage, and power take off, the tractor can drive various attachments, and hence multipurpose utilization can be made.

Tractors used for skidding are of crawler type and wheel type. In Japan, the number of wheel type tractor is increasing as a result of improvement of forest road nets. The crawler tractor is less influenced by soil prop-

erties, and shows a great tractive force by adhesion. Therefore, it is suitable for yarding a large volume of logs. In addition, its hill-climbing ability on steep slopes is excellent. However the crawler tractor is characterized by slow running speed, low mobility, and more cost required for the maintenance of under-carriages. On the other hand, the wheel tractor is characterized by high running speed, high mobility, and less maintenance cost. However, it shows a small tractive force by adhesion and high ground contact pressure, so that it is not adapted to the work on the soft ground.

Methods of skidding by tractors are given as follows:

- (a) Ground skidding: Logs to which springs are attached, are gathered by using winch (pre-skidding), and then yarded by traction. The advantage of this method is that the operation is quite simple and no other machine is needed. But, due to great tractive resistance, logs and forest land are often damaged.

- (b) Integral arch skidding: Yarding is made by heaving the top of logs by an arch mounted on a tractor. As a yarding method, it is excellent because of small tractive resistance. No other working machine is needed and driving is easy.
- (c) Pan skidding: A log, a part of which is placed on a skidding pan, is yarded. This method is employed on the soft ground where sulky skidding can not be used, or on steep downhill where breaking resistance is needed.
- (d) Sulky skidding: A log, hanging at one end from the sulky towed by a tractor is yarded. Unlike the integral arch skidding, it has an advantage that the tractor becomes stable because the load of the log is placed on the sulky.
- (e) Traller skidding: Logs are placed on the traller which is towed by the tractor. This method is advantageous for long distance transport of logs, but this method causes increased logging cost, because the strip roads must be constructed.

## Operational efficiency of tractor skidding

The tractor skidding constitutes continuously repeated works in which the tractor, starting from a landing point, goes to a pre-skidding point, and picks up a log and carries it back to the landing point. The operational efficiency of the tractor skidding is influenced by various factors such as skidding distance, condition (good or bad) of a skidding road, size of logs, terrain condition, etc. Particularly, skidding distance exerts a marked effect.

The result of the survey on the operational efficiency is given in Fig. 5.

## Conclusion

The cable yarding in Japan has developed various types of cable systems well adapted to different configurations of the land. It still involves a problem how to reduce suboperation such as rigging and dismantling of cables.

On the other hand, the tractor skidding has expanded its working period from summer season logging to the year round operation including winter season logging.

In recent years, development of various

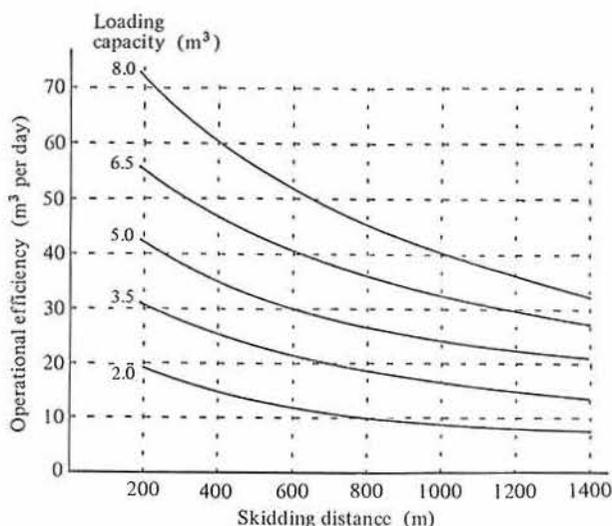


Fig. 5. Operational efficiency of tractor skidding

types of machines, such as remote-controlled yarder, remote-controlled winch, mobile bucking machine, self-powered carriage, etc., has progressed. On the other hand, helicopter yarding has come to be practiced. In such a situation, the study of operational efficiency, which can serve as a basis for setting a target of improvement of the current logging system, is an important subject.

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