

Using Farm Tractors in Small-Scale Forest Harvesting Operations

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Abstract: Farm tractor logging systems have been used in small-scale forest operations due to relatively lower capital investment and operating costs comparing with mechanized harvesting systems. They can operate more effectively and reduce the residual stand damage or soil compaction in thinning of stands with high timber density. Besides, a farm tractor equipped with appropriate forestry attachments can be used in various types of operations without any major investment. The logging systems should be well planned to retain the advantages of using farm tractors in small-scale forestry. This study discusses the ways of using farm tractors efficiently in various forest harvesting operations including skidding and forwarding.

Key words: Farm tractor, forest harvesting, small-scale forestry

INTRODUCTION

In many regions of the world, farm tractors have been used in forestry where the terrain conditions and the size of the forest operation are not limiting. In developing countries, mechanized harvesting machines are generally not favorable due to high capital investment and energy consumption, which is highly correlated with high fuel prices^[7]. Farm tractors, on the other hand, have very low initial costs and relatively low operating cost comparing with harvesting machines. In developed countries, farm tractor logging systems have been also used in forest operations in cases where they provide efficient operation and reduce environmental damages. Farm tractors equipped with specialized logging attachments are often used by farmers to perform timber harvest during the winter in Scandinavian countries^[9]. In North America, farm tractors have been used by the farmers to provide extra income. Using a farm tractor in various forest operations (skidding, forwarding, processing and yarding) can be very functional when the harvesting system is planned properly and directional felling is applied^[2].

Farm tractors are mostly used to perform skidding and forwarding operations in small-scale forestry. They can be also used to fell and buck trees by using a harvesting head mounted on them^[3]. Besides, a farm tractor equipped with a cable logging tower can be used for yarding operations in a steep terrain^[10]. In this study, using farm tractors in skidding and forwarding operations will be discussed.

Skidding with farm tractors: The productivity of the skidding operation with farm tractors is often limited by the type of soil, terrain conditions, and the size of trees and their accessibility. To improve the productivity and efficiency of the skidding operation, directional felling techniques should be applied^[9]. Directional felling may also reduce labor cost, residual stand damage, and soil compaction. According to^[1], the percentages of the damaged trees were from 0.5% to 1.5% during a thinning operation by a farm tractor. Skid trails should be well planned and located in the harvesting unit before directional felling takes place. The average skid trail distance mostly used in farm tractor skidding operations varies from 30 to 70 m [1]. The winch-attached tractors are used for uphill extraction of logs for distance of 30 m to 50 m^[4].

There are two common methods to perform skidding with farm tractors; winch and grapple. The grapples are used to skid logs only on level grounds since the farm tractor has to drive to each log^[3]. The farm tractors attached with a winch system can skid logs downhill, up to 25 % ground slope^[4]. The winch-attached farm tractor logging is the least cost farm tractor logging system because it requires least amount of additional investment^[9]. In this section, skidding with winch-attached farm tractors will be presented.

In order to use farm tractors in a skidding operation, they have to be modified and following equipment should be attached^[2,9,1]

• Three-point hitch is used to anchor the winch on the

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ground and to raise the ends up.

- C A special logging winch is required to skid logs.
- C Chain chokers are to be used to skid multiple logs per turn.
- C The pulley has to be installed to pull the timber from stump to the trail in a straight line.
- C The farm tractors must be equipped with a protective cab or roll bars for operator's safety.
- C To provide stable skidding operation, extra weight should be located on the front end of the tractor.
- C To improve traction on soft ground or snow, tire chains should be installed on the rear wheels.

Farm tractors should be located on level ground and in line with the pulling direction with less than 30 degrees sideways (Figure 1)^[1]. Pulley can be used to prevent winching sideways, as well as to overcome various difficulties such as limited space on the skid road, obstacles, or inaccessible areas^[2]. Before winching the logs, tractor brakes should be applied and three-point hitch should be lowered down on the ground^[1]. Then, logs are attached butt first to the main cable by using chain chokers. Winching should be performed by applying the power gradually and it should be stopped when the logs approach to the tractor within 2-3 m^[1]. Then, three-point has to be raised to skid logs to the landing area. The logs can be loaded into the logging trucks by using grapple loader mounted on a modified farm tractor.

Forwarding with farm tractors: The tractor may pull a trolley, a small trailer with two wheels, which can be used for winching or skidding on the forest floor, and for hauling on the skid road^[2]

- C In the case where only one end of the logs drag on the ground and the other end is carried, the tractor-attached trolley can haul the logs up to 200 m.
- C When the logs are raised completely off the ground and ends of the logs are placed on the trolley, hauling distance can be increased up to 500 m.
- C For long distances (up to 1000 m.), the hauling of logs should be done by forwarding with a forestry trailer.

Forwarding operation requires a well planned network and forwarding roads to perform efficient transportation. Trailers are usually equipped with a hydraulic grapple loader to load logs from the roadsides and to unload them onto the landing, or to load directly onto the logging trucks (Figure 2). The loader can be also mounted on the three-point hitch. The tires on the trailer

should have tire chains installed.

A forwarding operation with farm tractor requires more initial investment than a skidding operation with farm tractor. However, forwarding operation has advantages over skidding operation such as larger payload, less soil disturbance, and transporting the logs from stump to the logging truck off-ground.

RESULTS AND DISCUSSIONS

McCormack *et al*^[6] provided a report on harvesting operations in small-scale forestry being mostly applied by contractors from the forest industry. In this report, they presented several harvesting methods and provided extensive literature review that covers the operations performed in Scandinavian countries, Southern USA, New Zealand, and Australia. In a study conducted in Australia, six small-scale harvesting operations were evaluated; (1) chainsaw for felling, farm tractor for skidding, farm tractor with trail for forwarding, and logging truck for hauling, (2) chainsaw for felling, skidder for skidding, forwarder for forwarding, and logging truck for hauling, (3) harvester for felling, forwarder for forwarding, and logging truck for hauling, (4) harvesting was done by contractors, (5) chainsaw for felling, dozer for skidding, logging truck for hauling, and (6) chainsaw for felling, skidder for skidding, loader, and logging truck for hauling. The summary of these case studies are shown in Table 1. The income listed in the table is based on mill-delivery prices. The results indicated that Case 2 had the lowest cost of felling plus skidding or forwarding, followed by Case 3, 1, 4, and 6.

In another study^[8], 1127 small-scale foresters were surveyed considering the usage of farm tractors and type of equipment used with farm tractors. The number and percentage of foresters who used the various equipment of farm tractors in 1985 is indicated in Table 2. According to this table, skidding winch was mostly used during the farm tractor logging operations, followed by trailers, loaders, and grapples.

Koistinen^[5] conducted a study regarding small-scale forestry in Finland. In this study, surveys were sent to people in private forestry and interviews were made with forestry specialists. Table 3 indicates the forest transportation methods and their associated percentages of logging volumes during three logging seasons. The results collected from 182 different small-scale operations in Table 3 indicated that farm tractors were used in 82 % and 77% of the total number of harvesting operations during the logging seasons of 1982-1983 and 1989-1990, respectively.

Table 1: Summary of six mall-scale harvesting studies^[6]

Case Studies	Felling+Skidding/Forwarding (\$/m ³)	Hauling (\$/m ³)	Yield (m ³ /ha)	Income (\$/m ³)
Case 1	27.00	8.00	500	50.00
Case 2	13.45	7.70	470	36.15
Case 3	19.77	8.36	160	43.00
Case 4	38.00	14.35	91	50.00
Case 5	-	-	200	50.00
Case 6	18.23	10.12	250	35.58

Table 2: The number and the percentages of small-scaled foresters who used various equipments of farm tractors in 1985^[8].

Equipment Types	Number of Foresters	Percentages of Foresters
Farm Tractor Winch	36800	23
Farm Tractor Skidding Grapple	3600	2
Boom Loader	15300	10
Hydraulic Loader	16500	10
Farm Tractor Trailer	33700	21

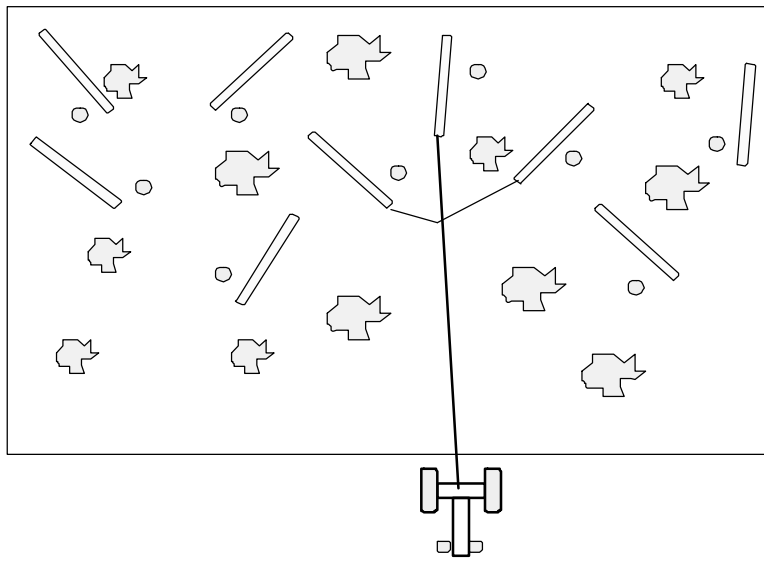


Fig. 1: Skidding operation with a farm tractor.

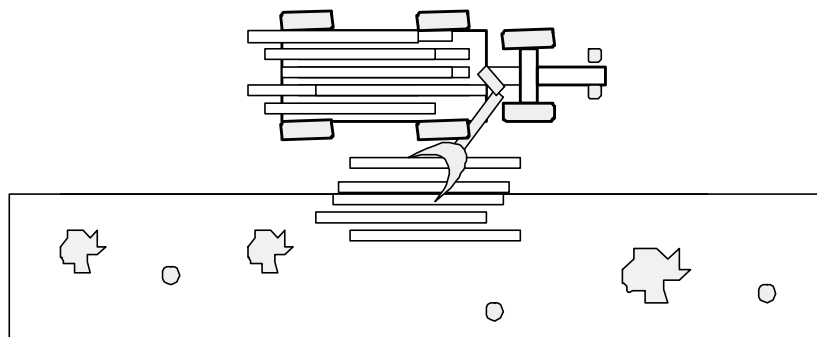


Fig. 2: Forwarding operation with a farm tractor.

Table 3: Forest transportation methods and their associated logging volumes in percentages for the logging seasons of 1982-1983 and 1989-1990^[5].

Forest Transportation Method	Logging Volume in Percentage	
	1982-1983	1989-1990
FT* with winch/skidding block	33	16
FT with trailer and manual loading	28	8
FT with trailer, winch, and loader	11	4
FT with trailer and hydraulic loader	10	41
FT with grapple skidding	1	8
Skidder	13	17
Horse	4	1
Other	1	5
Total	100	100

*FT: Farm Tractor

Conclusions: This study presented a discussion on applying farm tractors in skidding and forwarding operations. It should be pointed out that using farm tractor in small-scale forestry has several key advantages such as relatively low initial investment and operating cost, versatility, and less damage on residual trees and forest soil. However, farm tractor logging can be limited by some factors including the terrain conditions, ground slope, and timber size. In order to maintain the advantages and not to be constrained by the limitations, the logging managers should develop an effective logging plan that ensures physically feasible and economically viable operations. They should also well understand the capabilities of the farm tractors and functionalities of their equipment to perform an effective farm tractor logging operation.

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