This brief summarizes both the harvesting systems currently used in Minnesota and those that are potentially available. Information in the GEIS Harvesting Systems Background Paper was obtained from field trips to harvesting operations, discussions with people engaged in timber harvesting and forest management, and a questionnaire to which 70 Minnesota logging contractors with 457 employees responded.

Factors to Consider

Harvesting renews or rejuvenates the forest, and makes wood available for use by society. There are a considerable number of methods, systems, and equipment available for harvesting in all silvicultural systems and conditions present in Minnesota. The GEIS Harvesting Systems Background Paper recommends that the following factors be considered when choosing a harvesting system: stand location; sensitivity class; land-use designation; species of trees being cut; tree size; volume per acre; branchiness; logging area size; average and maximum off-road transport distance; distance to point of utilization; brush/undergrowth conditions; ground conditions; slope and position on slope; obstacles; snow depth; weather conditions; and visual and wildlife management requirements.

All these factors will influence logging costs and impacts on the site and residual trees. Each logging system fits specific conditions. For example, the full tree mechanized systems are most suited to large, concentrated harvesting operations. The small tree length or cut-to-length systems are better for small, widely dispersed logging operations. The choice of the logging method will also influence the amount of access roads required in the area.

Systems and Methods

Figure 1 shows that the most common silvicultural systems employed in Minnesota are clear-cutting and clear-cutting...
with residuals. These systems account for 80 percent of the total wood volume harvested.

- Most logging (43%) occurred during the winter (December-February) while the least (9%) occurred during the spring (March-May).

- Most of the tree cutting in Minnesota (nearly 73%) was accomplished using a feller-buncher. Some operators use a chain saw and a small percentage use a harvester.

- Chain saws are mostly used to delimb deciduous (hardwood) trees at the logging site. Mechanical delimming is used more with conifers (softwoods) and occurs primarily at the roadside away from the logging site.

- Off-road transport of wood is mainly by grapple skidder (69 percent of the volume harvested) and cable skidder (30 percent of the volume harvested). Forwarders are used to transport less than 1 percent of the total wood volume harvested.

- Transport of wood from roadside to mill is by truck. Most of the wood volume (82 percent) is moved in pulpwood or log lengths, some (17 percent) as tree lengths (full trees delimbed and topped), and a little (1 percent) in chip form.

Logging Today

Results from the questionnaire used in preparing the GEIS Harvesting Systems Background Paper were compared to a similar profile of Minnesota loggers conducted in 1980. This comparison shows that there has been a major shift from manual felling (cutting) and processing to mechanized equipment.

The survey identifies two reasons for this mechanization: 1) the need to increase productivity and 2) the desire to control further increases in the excessively high workers’ compensation cost.

However, the survey also identifies several costs and hazards associated with this increase in mechanization. The average age of logging equipment in Minnesota is high. The majority (64 percent) of the machines are more than six years old. In most situations, excessive maintenance requirements and breakdown costs on a machine older than five years makes its use as the main equipment in a harvesting system uneconomical. Older machines also have more oil leaks and hydraulic hose failures than newer equipment, thus representing a greater potential risk of environmental impact through soil and groundwater contamination.

Harvesting System Alternatives

- The most recent major development has been the one-grip harvester. Small in size, this machine can work in thinnings and clear-cuts with minimum impact on the site since it can extend its “gripper” attachment up to 27 feet. This harvester can delimb and top the trees in front of it to form a brushmat on which it can travel, thus minimizing soil compaction, rutting, and puddling (changes in soil structure that restrict water infiltration).

- To minimize the impact on forest soils and reduce damage to trees left on-site, small-size, multi-axle, low-ground pressure forwarders (tractors that carry wood entirely off the ground) have been developed. The use of this type of forwarder, as well as good operator training, has resulted in less than 2 percent of the trees left on-site being damaged during the thinning process.

- To minimize detrimental ground disturbance on low strength soils (bogs and wet clays and silts), the easiest solution is to harvest only during the winter when the ground is frozen. This is not always possible or feasible. Skidding wood from these areas with conventional logging tires (i.e., tires 18 to 24 inches in width) will most often result in unacceptable levels of ground disturbance. To reduce this negative impact, special high flotation tires ranging in width from 42 to 50 inches have been developed.

High flotation tires have been shown to reduce site disturbance and damage to advanced regeneration. On slopes, the wide tires increase stability and mobility, and the reduced site disturbance results in less soil erosion. However, the tires are expensive, cause increased stress on the equipment, are subject to puncture and sidewall wear, and severely limit the maneuverability and mobility of the equipment. Also, the increased width of the equipment limits their applicability to logging activities where narrow machine trails are required (thinning operations, selective logging, shelterwood logging, etc.).
A recent logging development has been the chain flail-delimber-debarker-chipper that processes harvested trees into debarked chips at roadside or forest landings. The benefit of this technology is that the bark is now left in the forest. Research is currently being done on how to most economically redistribute the limb/top/bark mulch evenly over the cutover site so nutrient removal through logging can be minimized.

Conclusion

The GEIS Harvesting Systems Background Paper concludes that harvesting mechanization has had a very positive impact on improving the working environment and safety of forest workers. Proper choice and use of equipment will not result in increased site impacts when compared to the old manual logging systems. In fact, many of the new machines available will have less impact on the site than the narrow-tired skidders used in the 1960s and 1970s. So, planning logging operations, properly using equipment, following Best Management Practices (or BMPs, a set of guidelines that have been developed to reduce the impact of timber harvesting and forest management activities on water quality and aquatic ecosystems), and training workers will minimize the negative environmental impacts of harvesting operations, while still meeting economic objectives.

Productivity and costs of logging vary extensively. The main factors are tree size, off-road transport distance, merchantable volume per acre, total merchantable volume, and whether the operation is clear-cutting or thinning.

Definitions

- **Cable skidder** - a skidder that employs a mainline and chokers to gather (pick up) and fasten a load.

- **Clear-cutting** - removing all trees from a designated forested area.

- **Clear-cutting with residuals** - leaving selected trees standing in a clear-cut area for a specific purpose such as providing cover and/or nesting sites for wildlife.

- **Feller-buncher** - a machine used to fell (cut) trees and move them into bunches or windrows.

- **Forwarder** - a forest tractor, usually self-loading, that carries wood entirely free of the ground.

- **Grapple skidder** - a skidder using a large suspended grapple (a freely moveable component of a boom or arch for grasping wood) that opens downward for gathering (picking up) and fastening a load.

- **Harvester** - a self-propelled machine that fells (cuts) trees and performs at least two processing functions such as delimbing and cutting trees to predetermined lengths.

- **Patch and strip cutting** - removing trees in patches or strips to avoid large continuous areas of logged-off land, encourage natural regeneration, and reduce the amount of accumulated slash.

- **Seed tree and shelterwood cutting** - leaving selected trees during a logging operation to provide protection for younger trees and to ensure a viable seed source for natural regeneration.

- **Selective cutting** - removing only certain trees based on a criterion like specific species, age, value, etc.

- **Silviculture system** - a process following accepted silvicultural principles, whereby stands of trees are tended, harvested, and...
replaced, resulting in a forest of distinctive form.

- **Skidding** - transporting trees or tree parts by dragging them partly or fully in contact with the ground.
- **Thinning** - removing selected trees to reduce stand density so the remaining trees can increase in size and improve in form.