

## TYPE OF EQUIPMENT

Wheeled single-grip harvester



Tracked single-grip harvester

Tracked feller-buncher



Forwarder

Grapple skidder



Cable skidder

Clambunk skidder



Delimber

The Forest Innovation Partnership is the result of a joint initiative between the Forest Engineering Research Institute of Canada (FERIC), Forintek Canada Corp. (Canada's Wood Products Research Institute), and the Canadian Forest Service (CFS). Its mission is to promote the adoption of innovative approaches to forest management by means of improved transfer of knowledge between researchers and the users of research results.



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IN FORESTRY OPERATIONS,  
**FUEL ECONOMY COUNTS!**

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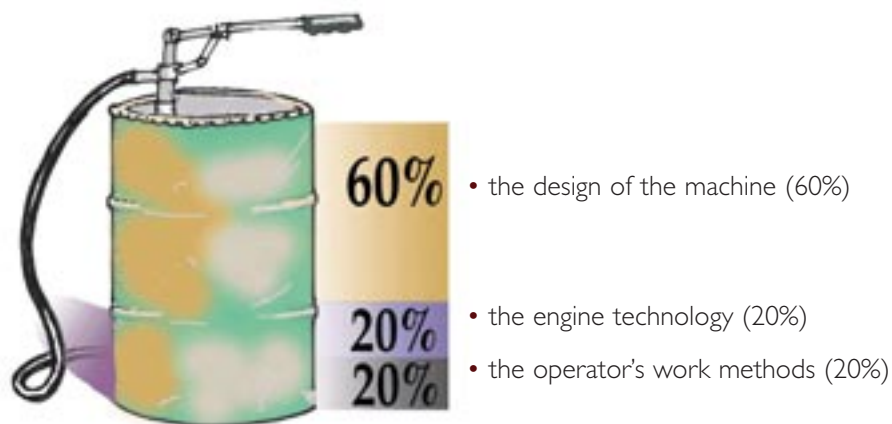
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# WHAT FACTORS INFLUENCE FUEL CONSUMPTION ?

Even though the continuing increases in fuel prices are raising operating costs for forestry equipment, the equipment's design, maintenance practices, and operating conditions, as well as how the machines are used, also influence fuel consumption.

As the owner of forestry machines, you can reduce the impact of increased operating costs by purchasing new equipment that is proven to have low fuel consumption. In contrast, if you already own or operate forestry equipment, you need be well informed on how to adequately maintain and correctly operate your equipment so as to reduce fuel consumption.

According to various experts, fuel consumption differs among the different types of equipment. These differences can be explained by three main factors: the design of the machine, the engine technology, and the operator's work methods



Purchasing the wrong machine for the job can clearly have a considerable impact on fuel consumption.

# IMPROVING FORESTRY EQUIPMENT FUEL EFFICIENCY

Choosing accessories wisely and using them appropriately can have a strong impact on fuel consumption.

## Engine power

Diesel engines provide a wide range of power outputs, but operate at different degrees of efficiency for each power level. In general, these engines are most efficient when they operate at the speed (rpm) where they develop their maximum torque and use 75% of this torque. An engine operated in this manner will consume less fuel. Therefore, when the machine requires less power, operators should reduce engine speed so as to maintain a high output torque. Remember that the combination of high engine speed with low output torque increases fuel consumption.

Operators of forestry equipment should avoid traveling in the woods at excessive engine speed. The use of a moderate engine speed can save fuel and reduce maintenance and repair costs without decreasing productivity.

The introduction of electronic controls and other engine design features have clearly improved fuel consumption by improving the match between engine speed and the machine's power requirements at any given time.



AVOID TRAVELING AT FULL THROTTLE



### The fan

Thermostatic fans and hydraulically driven variable-speed fans improve fuel consumption only if the machine's cooling system is up to the job. In general, the fan should not be required to work at full speed under all working conditions. A fan that operates continuously at full speed consumes 1 to 2 litres of fuel per hour (L/h).

### The power train

The power train must be matched to the engine capacity to operate efficiently. Mechanical transmissions should provide a range of gear speeds so the operator can reduce engine speed to the lowest speed needed.

Hydrostatic transmissions are often equipped with an electronic control. The acceleration pedal then signals the desired travel speed to the computer, which adjusts the engine speed and fuel flow in response. This approach minimizes fuel consumption.



LOAD-SENSING HYDRAULIC SYSTEMS WORK BEST  
IN OPERATIONS WITH VARIABLE LOADS

### Differential lock

Automatic differential locks sometimes lock at inappropriate times, and the resulting slippage of one or more wheels increases fuel consumption. A manual differential lock, used when needed, is more efficient. However, operators must pay careful attention to wheel behavior to obtain good results. The use of manual differential locks at appropriate times can reduce fuel consumption.

Hydrostatic transmissions, when paired with direct-drive wheels, can be designed to provide very precise control of wheel rotation. As a result, each wheel can turn at the most appropriate speed, thereby minimizing wheel slippage, soil disturbance, and fuel consumption.

### Hydraulic systems

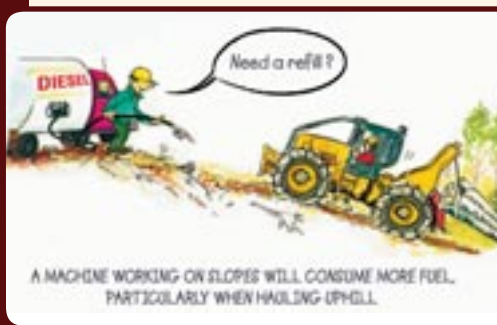
The effectiveness of a hydraulic system depends on several factors that are difficult for a buyer to determine. It's possible to lose considerable efficiency through a poor choice of the mechanical and hydraulic components of a forestry machine. Load-sensing hydraulic control systems are generally the best choice for forestry machines, followed by constant-pressure systems. Load-sensing systems regulate the hydraulic pump's pressure and flow to meet the demands of the machine's hydraulic functions. An increase in pressure from 1.5 to 2.5 MPa can provide better flow control even though this leads to a slight loss of power. Load-sensing systems are particularly appropriate for situations in which the load varies.

Operators should use as many hydraulic functions as possible simultaneously, since this increases the load on the engine and thus, the work is performed more rapidly. It's preferable to install flexible hydraulic oil hoses of appropriate diameter and to be particularly careful to avoid elbow fittings or tight bends in the lines.

In constant-pressure and constant-flow systems, the output of the hydraulic pump is not adjustable. The operator sets the engine speed in order to vary the hydraulic flow to meet the needs and to improve the system's efficiency.

### Hydraulic oil cooler

Hydraulic oil coolers should be equipped with a thermostat that lets the oil warm more rapidly and maintain its optimal temperature longer. The initial temperature of the thermostat should be adjustable by the operator so as to maintain the oil at its optimal viscosity. Oil viscosity varies depending on the type of oil used (summer vs. winter). Too-thick oil slightly increases fuel consumption, whereas too-thin oil increases component wear. Increasing the diameter of the hydraulic line does not significantly reduce fuel consumption and does not solve problems related to overheating of the oil.



Operating conditions have a significant influence fuel consumption. Hauling loads uphill, as well as sinking or slippage of wheels, increase fuel consumption significantly for skidders and forwarders. Similarly, the size of the trees being handled and their resistance to cutting affect the fuel consumption of single-grip harvesters, feller-bunchers, and delimiters.

### Before purchasing a forestry machine

As it is difficult for a potential buyer to evaluate all the technical aspects of a forestry machine, they should arrange to see the prospective machine while it's working in a real operation and to ask the owner about fuel consumption.

As a general rule, larger and heavier machines consume more fuel than lighter machines.



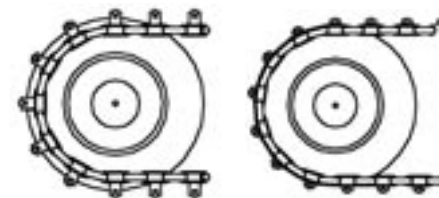
# WHAT IMPROVES FUEL ECONOMY?

Optimal use of a machine and good preventive maintenance of forestry equipment are effective means of saving fuel. Here are some other simple, practical tips that can help:

- **Use the work lights only when required.** Their use can increase fuel consumption by up to 0.5 L/h.
- **Choose tires of adequate dimensions so as to minimize sinking and loss of traction.** According to studies conducted by FERIC, skidders equipped with high-flotation tires have lower fuel consumption than skidders with narrow tires on soils prone to rutting. However, the narrow tires provide greater mobility in deep snow. Thus, it would be best to use different tires in each season.

- **Add tire chains or tracks to wheeled forestry machines only when required.** They provide better mobility, but also increase the rolling resistance and the weight of the machine. As a result, they increase fuel consumption.
- **If you use wheel tracks, choose tracks whose connecting links lie close to the tire periphery.** The further these links are from the tire periphery, the greater the distance the treads must travel and thus, the greater the fuel consumption (see figure).

At left, the links lie relatively far from the tire periphery; at right, they are closer. The tracks at the right thus help reduce fuel consumption.



- **Keep the fuel-supply system components in good shape, since leaks and spills increase your fuel costs.**



**FUEL LEAKS ARE COSTLY. KEEP YOUR EQUIPMENT IN GOOD SHAPE !**



**AVOID SPINNING YOUR WHEELS AND YOU'LL SAVE GAS... AND THE SOIL !**

# FUEL CONSUMPTION BY DIFFERENT TYPES OF FORESTRY MACHINES

- **Minimize engine idling.** A typical feller-buncher engine can consume up to 2.5 L/h while idling.



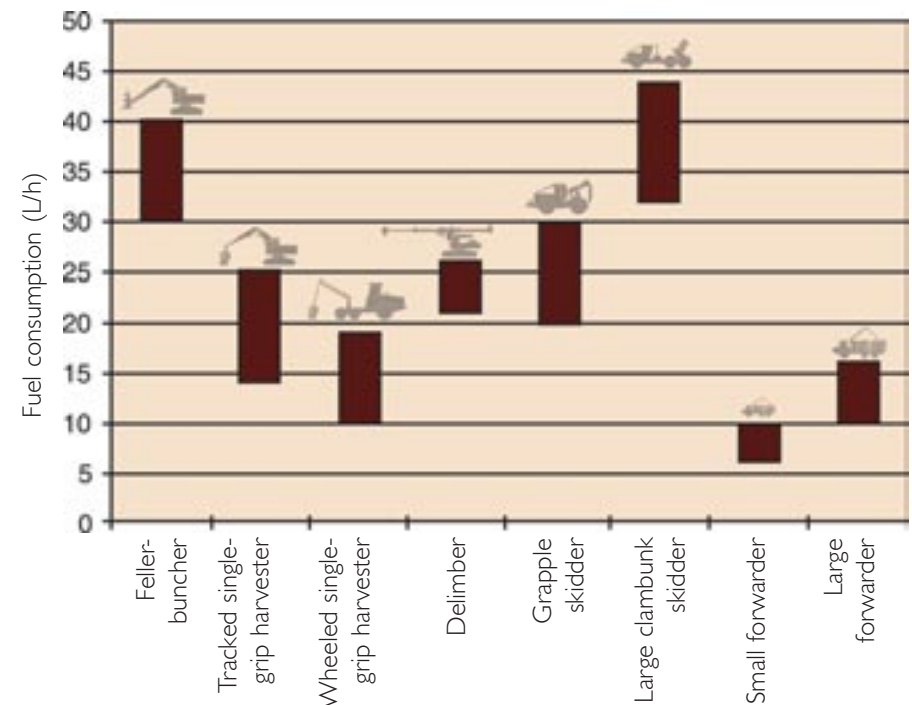
- **Follow the cold weather start-up procedures specified for your machine so as to shorten the warm-up period.** Depending on the temperature, let the engine idle for 5 to 10 minutes. Next, use the hydraulic functions slowly, keeping the engine speed at around 1100 rpm. If you hear noise from the pumps, reduce the speed.



- **Keep the radiator and oil cooler clean.** This helps keep the oil at the right temperature, thereby reducing fan operation for thermostat-controlled fans.

The range in fuel consumption depends on the type of forestry machine used. As mentioned previously, the engine design is responsible for 60% of the fuel consumption. The figure below shows the fuel consumption for common forestry machines.

**Variation in fuel consumption by various forestry machines during typical operations.**



# TIPS FOR REDUCING FUEL CONSUMPTION WITH DIFFERENT FORESTRY MACHINES

**The following table presents various fuel-saving solutions for the different types of forestry machine you may be using:**

- Tracked feller-buncher



- Wheeled single-grip harvester



- Tracked single-grip harvester



- On firm ground with few obstacles, try to work using the middle range of the boom's reach (4 to 6 m) in front of the harvester; this reduces the energy required to move the boom.
- On soft or stony ground, or when travel becomes more difficult, try to harvest the maximum number of trees while staying at the same position.
- Telescoping booms permit faster movement of the felling head towards the tree that will be cut, require less power, and reduce fuel consumption.

- Wheeled single-grip harvester



- Tracked single-grip harvester



- Exert as little pressure as possible on the delimbing knives and feed rollers while still maintaining high delimbing quality.
- Use the energy of the falling tree to help you move forward or to delimb the stem; this move requires considerable skill. However, the energy provided is free.
- Keep the saw chain and delimbing knives sharp; cutting and processing of logs requires more power, and thus more fuel, when the cutting surfaces grow dull.



# IN FORESTRY OPERATIONS,

## FUEL ECONOMY COUNTS!

Steadily increasing fuel prices have emphasized the importance of controlling fuel consumption. This guide discusses the various means of controlling fuel costs, and provides specific tips for forest machines including harvesters, feller-bunchers, forwarders, skidders, and delimbers.

The information contained in this guide has been extracted from a report that is restricted to FERIC members:

Makkonen, I. 2004. *Saving fuel in mechanized forestry operations*. Forest Engineering Institute of Canada, Pointe-Claire, QC. Internal Report IR-2004-08. 10 p. (aussi disponible en français)



### • Tracked single-grip harvester



### • Tracked feller-buncher



- Avoid sharp changes in direction during travel; gradual turns produce less skidding and consume less fuel than sharp turns.
- For machines equipped with a cab-leveling system, use the hydraulic cylinders provided for this purpose to keep the cab level; pivoting a tilted cab requires more power; thus consumes more fuel.

### • Tracked feller-buncher



- Immediately replace damaged or worn saw teeth; this will require less power, thereby increasing productivity and improving the cut quality.
- Stop the saw motor during prolonged travel on the cutover.

### • Grapple skidder



### • Cable skidder



### • Forwarder



### • Clambunk skidder



- Minimize turns while traveling with a load; it's preferable to turn gradually, since this consumes less fuel than sharp turns.
- Install landings and extraction trails at the most appropriate locations; this approach both decreases fuel consumption and increases productivity.
- Try to travel on soils with a good bearing capacity; traveling in soils with poor bearing capacity requires more power; thus consumes more fuel.
- Use tire chains or tracks only when required to provide better mobility or flotation; these accessories require more power; thus more fuel.

### • Grapple skidder



### • Cable skidder



### • Clambunk skidder



- Transfer as much of the load as possible onto the skidder; by raising the load higher and closer to the cab, you reduce the friction of the tops on the ground and thus decrease fuel consumption.
- Balance the pressure between the front and the rear tires; the rear tires deflect more, increasing the amount of friction against the ground, when the rear of these machines is under a load.

### • Forwarder



- For loaders with a telescopic extension, pull the logs as close as possible to the machine using the telescoping feature before lifting the logs onto the forwarder; lifting the logs at full extension requires more power and thus more fuel.
- Avoid raising the logs high above the load bunk's pickets; position the forwarder as close as possible to the log piles and try to pass the logs between the pickets rather than above them, since fuel consumption increases the higher you raise the logs.

### • Clambunk skidder



- During loading, position the skidder as close as possible to the piled logs; fuel consumption increases when stems must be raised at full boom extension.
- During loading, place the butts of the stems as close as possible to the cab; this will increase the proportion of the load's weight on the rear of the skidder and reduce friction between the stems or crowns and the ground.

### • Cable skidder



- Use a remote control during winching to reduce fuel consumption; the engine speed is lower with a winch that is remotely controlled than it is when the winch is operated by the operator from the cab.

### • Delimber



- Keep the bearings of sliding or telescoping booms well lubricated and in good condition so as to reduce friction.
- Exert the minimum possible pressure on the delimbing knives while maintaining delimbing quality.
- Keep the delimbing knives and the topping saw sharp; these operations require more power with dull knives, and thus more fuel.