Shift up and throttle back to save tractor fuel

Diesel fuel is the largest direct energy purchase for Iowa farmers. Tractor operation accounts for much of this. Higher horsepower tractors that do a large percentage of their work as drawbar pull on tillage and seeding implements must efficiently transfer power from the engine to the drive wheels through a transmission. Speed and torque available from the engine crankshaft is changed to a combination of drive axle speed and torque.

Drawbar tractor operations such as chisel plowing, field cultivating, planting, and spraying require different amounts of drawbar pull or force, depending on the size of the implement and soil conditions. Although a specific amount of power is available from any given tractor, various load requirements of farm operations frequently result in the tractor being only partially loaded for the amount of drawbar power available.

Power and friction

Fortunately, fuel economy of diesel engines is very forgiving for partial drawbar load operation if the transmission is shifted to a higher gear and the fuel supply throttle is adjusted to reduce fuel use. When the engine speed (rpm) is greater than necessary, the excessive friction robs power from the engine. Therefore, a high throttle setting actually decreases the total "useful" power produced by the engine.

The concept of shifting up and reducing throttle setting to reduce engine speed for fuel savings is similar to what occurs with truck or automotive transmissions during highway travel. At slower starting speeds when greater force and higher torque is needed at the drive wheels to overcome inertia and accelerate the vehicle, the transmission transmits greater torque from the engine by reducing axle speed in a lower transmission gear. Once greater force is no longer required to accelerate the vehicle as it comes up to speed, engine power is shifted to higher transmission gears and the throttle (foot accelerator) is reduced.

New technology

Sophisticated transmissions available on some newer large and medium-sized tractors use electronic controls to automatically select gear and throttle setting depending on the drawbar load requirements and the travel speed selected by the operator. Transmissions marketed as "infinitely" or "continuously" variable generally have the ability to automatically operate at the most fuel efficient transmission setting for the selected speed and required load. New features such as this should be considered to improve overall fuel efficiency when deciding if an older tractor is nearing the end of its useful life in the farm operation.

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Fuel savings and technique

Tractor operators with fixed-gear transmissions in either a powershift or standard manual transmission style can still easily take advantage of this fuel economy technique by selecting an appropriate gear for tractor operation in the field. Information from Nebraska/OECD (Organization of Economic Cooperation and Development) tractor tests show potential for fuel savings at reduced drawbar loads.

For example, in tractor tests a CaseIH Magnum 245 produces maximum drawbar power in 7th gear. If the tractor continues to use 7th gear when operating at a reduced load of 75% of maximum available drawbar power fuel consumption is 11.6 gallons/hour at 2090 engine rpm. If the same load is pulled in 9th gear but with a throttle setting reduced to 1580 engine rpm (to maintain the same travel speed and drawbar power output) only 10.5 gallons/hour is consumed – a 10% fuel savings. In a similar fashion, the tractor pulling at 50% of drawbar power uses 10.0 gallons/hour when pulling in 7th gear at 2150 engine rpm but only7.9 gallons/hour when pulling in 9th gear at the reduced engine speed of 1620 rpm, a 20% fuel savings at this reduced load.

Fuel savings examples from several tractors are shown in table 1. Tractor test research data suggests that fuel savings for many existing tractors can be significant. Tractors tested at the Nebraska Tractor Test Laboratory from1979 – 2002 had an average fuel savings of 13% at 75% drawbar load and fuel savings of 21% at 50% drawbar load (Grisso et al., 2004).

Table 1. Percent of fuel saved by switching to a higher gear when tractor is used at 75% or 50% of available power (from Nebraska/OECD tractor tests)

		% fuel saved by switching to higher gear	
Tractor model	**Drive style[a]**	**75% load**	**50% load**
CaseIH 245	Front-wheel assist	10	20
CaseIH 435	Front-wheel assist	11	14
Challenger MT 655	4WD	11	14
Deere 8220	Front-wheel assist	15	18
Deere 9330	4WD	9	11

For partial load applications, how high can the gear be shifted and engine speed subsequently reduced? The key is to not shift up so high or reduce the throttle so low as to overload or lug the engine down. A significant increase in black smoke (particulate matter in the exhaust) or the sound of the engine lugging down to lower speed when pull momentarily increases in harder spots are indicators to shift back down a gear and increase engine speed slightly to give the engine reserve torque capacity in difficult spots.

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When to use

It's important to note that the "shift up, throttle down" technique is not suitable when using power-take-off (PTO) powered implements such as a baler or mower-conditioner. PTO shaft speed is directly related to engine speed. Because the PTO implement requires a standard shaft speed input (1000 or 540 rpm), tractor engine speed can't be reduced. Instead, engine speed is maintained at a level to produce standard PTO speed.

Use of the "shift up, throttle down" technique to save fuel is applicable any time available tractor drawbar power significantly exceeds the power required for implement operation. Common examples include use of a smaller field cultivator or disk for secondary tillage or planter operation, particularly if the implement size is small for the tractor and field conditions and a larger implement could be substituted. Another example is pull-behind sprayer operation if pump speed is not dependent on standard PTO speed.

Summary

- **Larger horsepower tractors are frequently required to do drawbar work at only 50 – 75% load or less.**
- **Shifting to a higher gear and reducing engine speed for partial drawbar loads can save 10 – 20% of fuel depending on tractor and load conditions.**
- **Avoid overloading or lugging the engine when engine speed is reduced.**
- **This technique is not suitable for PTO work when PTO shaft speed must be maintained by engine speed.**