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Fuel efficiency produces big payback

High fuel prices drive need for better fuel efficiency and changes in farming practices

With increasing fuel costs squeezing producer margins in already tight times, many farmers are wondering what they can do. It turns out there is plenty they can do, say agencies that have been testing tractor efficiency.

One answer is tractors that are more fuel-efficient. Tractor manufacturers are paying attention to fuel economy, with engines on new models becoming more fuel-efficient each year. While not everyone can afford to invest in a brand-new tractor, engineers at the forefront of the farm equipment industry say there are several simple, common-sense alternatives that can help any producer get the most efficiency from their resources.

"Whether a tractor is 20 years old or rolling off the dealership lot for the first time, farmers can implement a number of fuel-saving measures that will not only reduce fuel consumption but also prolong the life of the tractor," says Reed Turner, project manager with the AgTech Centre in Lethbridge, a part of Alberta Agriculture, Food and Rural Development's Technical Services Division.

Although there are many things that can be done to increase fuel economy on the farm, optimum fuel efficiency generally narrows down to three broad categories: tires, ballast and fuel. ✦

In this Issue

• Tires, ballast and fuel – three major factors within any producer's control
• Tire tips • Changing the way we farm
• Tips for working in GUTB mode

Tires, ballast and fuel

Three major fuel use reducing factors within any farmer's control

Fuel efficiency varies depending on the type of equipment, travel speed, working load and a number of tractor settings. One of the pivotal tractor settings affecting fuel efficiency is tire inflation pressure.

Tire pressure key

On a good day, about 70 percent of the power delivered by the engine translates into power at the drawbar, says Reed Turner, project manager with the AgTech Centre in Lethbridge. Tires are the conduits through which that power is delivered to the ground. How efficient that delivery is depends on the condition and inflation pressure of the tires (see chart).

"Set tire inflation pressure too high and you decrease that power delivery even further," he says. "Tires should be inflated to the lowest pressure allowed by the manufacturer for the load the tires are carrying."

Tire tips

- A properly inflated radial is six to eight percent more efficient than a bias-ply tire. Radial tires need more management than bias-ply tires. Matching inflation pressures to loads is critical to optimizing the performance of radial tires.
- Don't exceed the maximum permissible operating weight/load for the tractor tires. Consult the owner's manual or tire manufacturer's guidebook for recommended pressures for given loads.
- Check all tire pressures regularly.
- Use an accurate pressure gauge for measuring low pressures. Being off by 2 psi (14 kPa) won't have a big effect on performance with tires at 30 psi (207 kPa) inflation pressure, but at 10 psi (69 kPa) pressure, a 2 psi (14 kPa) error means you are off by 20%.
- Never exceed 35 psi (241kPa) inflation pressure, as severe damage or personal injury can occur should the tire separate from the rim.
- The pressure recommendations molded into the side of tires are maximum pressures for maximum loads. Using these pressures at less than maximum load can adversely affect tire and tractor performance.
- Always inflate and ballast all tires on the same axle to the same level.
- Remember that changing tire size will change travel speed – a factor to consider when adjusting ballast to match travel speed.

Over-inflated tires will rut soft soils more easily, decrease traction, wear the tread unevenly and strain the tire material itself. Under-inflated tires increase sidewall wear and raise the risk of side buckling and rim slip. "By keeping tire pressure at the correct level, you get a little more tire on the ground and are a bit more efficient with the power delivery," Turner says.

Old tires, big savings

Although shiny, black new tires can look mighty impressive, those same tires can actually increase fuel consumption, says Turner. "New tires usually have longer lugs and unless you're in mud, long lugs are not a good thing."

Long lugs can mean lost energy. Every time a lug bends, the tractor is using energy that does not add to the operation at hand. "So brand new tires can be less efficient, unless you're in wet conditions where the lugs squeeze more mud out the sides, helping the tractor not get stuck so easily."

Outside of wet conditions, older tires with worn down lugs are more efficient at providing power to the ground, which translates into better fuel efficiency, says Turner.

Fuel efficiency is also affected by other tire factors, including overloading, type of tire and number of tires used. Overloading causes premature tire wear, excessive soil compaction and increased fuel consumption due to the increased rolling resistance.

It's important to choose the correct type of tire, says Turner, who recommends using radial tires over bias-ply tires. A North Dakota State University study found that properly inflated radials improve fuel efficiency by six percent over bias-ply tires. Similar results were found in an AgTech Centre study.

Using duals can decrease a tractor's fuel efficiency. Duals increase flotation but may be unnecessary in good traction conditions. "Typically, when fields are dry and traction is good, the more tires you add, the less efficient your tractor is," he says. "Duals are worse than singles and triples are worse than duals."

Farmers should stay away from triples, advises Turner. "If that much flotation is needed, larger radials as duals are more efficient than smaller ones as triples. When the soil gets too wet, farmers shouldn't be out there anyway."

Ballasting for efficiency

Most farmers reach the upper limits of their tractor's power only 15 to 20 percent of the time. With this in mind, weighting the tractor for typical conditions rather than maximum needs will reduce fuel costs.

Farmers usually look at ballasting from a worst-case scenario, says Turner. "If they need to pull 20,000-pound loads for two weeks of the year, they ballast their tractors for that load 52 weeks a year. They might be better off to ballast their tractors for 15,000-pound loads. While that means they could struggle a bit for those two weeks a year, it's more efficient than carrying the weight for the other 50 weeks," he says.

Ideally, farmers could change the ballast on their tractors for specific loads, but that can be a hassle, says Turner. "The key to ballasting is to decide the speed necessary for an operation and the amount of the load. Then set the tractor weight just heavy enough

to pull that load at that speed and at an acceptable slip level. The total tractor weight should wind up being 2.5 to 3 times the load being pulled."

When a tractor is over-ballasted, excessive torque can be transmitted through the drivetrain and tires to the ground, he says. That can cause overloads, wear and drivetrain failures. As well, fuel costs are increased from carrying the extra weight and from the inefficient power transfer.

"Over-ballasting is the most common farmer error," says Turner. "An over-ballasted tractor will feel sluggish and, on top of burning more fuel than it should, may experience premature drivetrain problems."

An under-ballasted tractor wears tire tread at a faster pace because of excessive slip while never delivering full horsepower to the drawbar, he says. Fuel is wasted because of the extra wheel revolutions to travel the same distance.

When fine-tuning ballast distribution, it's important to consider wheel slip, horsepower and speed. The total ballasted weight for drawn implements should balance as follows:

Type	Front	Back
2WD	**25%**	**75%**
MFWD	**40%**	**60%**
4WD	**55%**	**45%**

For further information, see Research Update 725 from the AgTech Centre.

Use the right fuel

Another way to cut down on fuel consumption is to use the right fuel for the season, says Turner. "It's not a good idea to use winter fuel in the summer or vice versa."

The density of most diesel fuels is normally 0.80 to 0.874 kg/l for optimum engine performance. Winter fuels are typically at the bottom of that range, with summer fuels near the top.

"All an engine does is convert the energy in fuel into usable power. Since winter fuel is blended lighter to improve its viscosity in the cold, it winds up with less energy per gallon. Winter diesel has around 154,000 BTUs per gallon while summer diesel has around 159,000 BTUs per gallon. This means that the same amount of winter fuel gives about three percent less power than summer fuel. That can be acceptable in the winter in order to keep the engine running, but carrying winter diesel over and using it in the summer is not such a good idea."

Running a tractor during the heat of the day also heats the fuel, and this can affect tractor performance. Generally speaking, cooler fuel in the summer enhances performance. Some manufacturers now install fuel coolers on tractors.

Correct tire pressure makes a difference

Effect of Changing Tire Pressure from Overinflated 20 psi to Correct 10 psi (J.D. 8760 Tractor with 20.8R42 Duals)

THE COST OF USING INCORRECT TIRE PRESSURES		
Implement	32 ft (9.75 m) Chisel Plow	
Tractor	John Deere 8760 4WD	
Tire	Radial 20.8R42 Duals	
Tractor weight	36500 lb (16600 kg)	
Desired work speed	5 mph (8 km/h)	
Required horsepower	190 hp (141 kW)	
Fuel cost	$2.59/gal ($0.70/L)	
Tractor cost	$70.00/hour	
Implement cost	$30.00/hour	
Labor cost	$12.50/hour	
TOTAL FIXED COST/HOUR	$112.50/hour	
	10 psi Inflation	20 psi Inflation
Operating slip	6%	11%
Actual work speed	4.7 mph (7.5 km/h)	4.4 mph (7.2 km/h)
Actual work rate	18.23 ac/hr (7.38 ha/hr)	17.07 ac/hr (6.91 ha/hr)
Actual fuel rate	14.1 gal/hr (53.3 L/hr)	14.4 gal/hr (54.4 L/hr)
Fuel cost per hour	$37.31	$38.08
Fuel cost per acre	$2.04	$2.23
Fixed cost per acre	$6.17	$6.59
TOTAL COST PER ACRE	$8.21	$8.82

For a 640 acre field, this is a savings of $390 plus 2 hours and 20 minutes for one farm operation just by using correct tire inflation pressures!

Time Saved = Total Farm Acres x (1/17.07 - 1/18.23)
= Total Farm Acres/268.2

Money Saved = Total Farm Acres x ($8.82 - $8.21)
= Total Farm Acres x ($0.61)

Avoid diesel idling

Perhaps the simplest factor in fuel savings is this: when you're not using your tractor, shut it off.

"Some people let their tractors, especially diesel ones, idle for long periods of time because it's easier than restarting, but that isn't the best for fuel efficiency," says Turner. "If well-maintained, today's turbocharged diesel engines start easily in all but the most extreme weather conditions; they simply do not need to idle as much as many people think," says Turner.

The fuel costs of idling quickly add up to significant dollars. "Research suggests heavy truck engines idle between 25 and 45 percent of their total engine hours," says Turner. "With today's fuel costs, that can easily add up to hundreds of dollars over a short period of time, and that's in addition to the non-productivity expense of time spent idling the engine."

Turner says there are alternatives to idling, even in cold conditions. "Block heaters are just one example of a cold starting aid for weather below -7 C and oil heaters and fuel tank heaters can help if the engine is operated below -18 C."

Finally, there's regular maintenance. It's important for the life of a tractor and for the safety of the operator. Though some people overstate the effect of regular maintenance on fuel

efficiency, says Turner, keeping air filters relatively clean and keeping regular maintenance up-to-date are still sensible guidelines.

However, major mechanical problems can significantly affect fuel efficiency. "For instance, if an injector is plugged, you're running on five cylinders instead of six, and that means a big loss in power and efficiency."

Changing the way we farm

The simplest solution to fuel savings is not to start the tractor

The most effective way to reduce fuel costs associated with tillage is to till less, says Lawrence Papworth, a long-time Farm Machinery Engineer with the AgTech Centre in Lethbridge.

"Fuel consumption is affected by a number of factors, including equipment type, speed, depth, soil type, crop residues, soil moisture content, field shape and the number of tillage operations," he says.

But studies have shown that fuel cost savings are substantial when a direct seeding system is adopted over a conventional till system, says Papworth. "The fuel cost per acre pegs direct seeding at $2 per acre and $5 per acre for conventional till. But a $4 to $5 difference is quite common." When these studies were done, farm diesel fuel was $0.30 per litre. Today's fuel prices are at least double that.

This can mean thousands of dollars in savings, says Papworth. Those savings aren't as clear when comparing a strictly no till system to direct seeding where optional procedures meant to maximize return, such as harrowing, spreading pre-emergent herbicide and so forth, are added into the mix.

A producer must weigh all the costs and benefits of adopting such a system, but there is no doubt reducing tillage will reduce fuel consumption, says Papworth. "Changes in input costs, planting rotations and timing as well as new equipment are examples of costs that might be factored in. A farmer isn't going to adopt a direct seeding system because of fuel savings alone, but when added to the benefits of increased yield (depending on the soil zone and weather), soil conservation and reduced time in the field, it is an option worth considering."

In the Dark Brown Soil Zone of Alberta, crop yields are similar or higher in direct till or no till systems than in conventional till systems. Crops perform better in dry conditions because direct seeding and no till systems preserve moisture in the soil.

Reducing the overall depth that double-shoot openers must go will also save on fuel and often improve crop emergence, says Papworth. But farmers shouldn't plant too shallow, he cautions.

"The best way to save on fuel is keep the tractor parked. No till and reduced till operations are a good way to do just that," adds Papworth.

Gear up, throttle back

For ideal tractor efficiency, match the tractor power to the load, says AgTech project manager Reed Turner. "If you have a 200-horsepower tractor and 100-horsepower load, it's not as efficient as a 100-horsepower tractor and 100-horsepower load."

While nobody would ever buy a 100-horsepower tractor to pull a 200-horsepower load, a lot of people will buy a 200-horsepower tractor to pull a 100-horsepower load, "because you never know when you might need that extra power," Turner humorously observes. "That's just human nature, to buy bigger than you need, whether it's a house or tractor."

When a load requires less than 70 percent of the tractor's power, a farmer can save fuel by shifting to a higher gear and slowing engine rpm to maintain the desired speed. This practice is sometimes referred to as GUTB (Gear Up, Throttle Back). "So the speed is the same, but the gear is higher and the engine is running slower. That loads the engine again and brings it back into that 'sweet spot' where fuel is being used most efficiently." Recently introduced IVT and CVT equipped tractors are automatic high precision versions of this technique. ✦

Tips for working in GUTB mode

- Use GUTB when the load pulled requires less than 70 percent of the tractor's power.
- Engine speed can usually be reduced by 20 or 30 percent below rated engine speed.
- Don't overload or lug the engine. Visible black smoke is often an indicator of an overloaded diesel engine.
- Make periodic checks for optimum GUTB settings. Work for a short time at desired speed and throttle setting. Then quickly open the throttle. If the engine easily speeds up, the setting is suitable. If the engine does not respond, shift down a gear or increase the engine speed. Perform the check again and adjust as required.
- Remember that GUTB also reduces PTO speed and reaction time for tractor hydraulics.

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