Ballasting tractors for fuel efficiency

Most tractor operators know proper ballasting is important to transfer as much engine power as possible to the drawbar. Exactly how to accomplish this ballasting, however, frequently remains a mystery. Too little weight or ballast results in excessive drive wheel slippage and an obvious waste of fuel. Conversely, carrying too much ballast on a tractor dramatically lowers wheel slip but results in greater rolling resistance as the tractor sinks too far into the soil, causing wheels to be constantly climbing out of a deep rut.

Many larger modern tractors have an option to display wheel slippage to the operator. To maximize transfer of power from drive axles to the drawbar, optimum amounts of wheel slippage depend on the soil surface. On firm, untilled soil, wheel slip should be in a range of about 6–13%. More slippage is allowed on a tilled surface, 8–16%, with slightly more yet on a non-cohesive sandy soil. Conversely, optimal wheel slip is about 4–8% on concrete. Checking wheel slippage on tractors equipped to display this information provides an easy check to determine if the tractor is optimally applying fuel and horsepower to the drawbar.

If tractor wheel slip is outside these suggested ranges for operation with drawbar loads, check the operator's manual for ballasting suggestions or consult the following procedure. Total gross tractor weight required for optimal ballasting is a function of tractor type (two-wheel drive, mechanical front wheel assist/drive, four-wheel drive) and travel speed in the field (Table 1).

Table 1. Gross tractor weight, lb/Hp

Speed, miles / hr	< 4.5	5	> 5.5
Tractor type			
2WD & MFD (lb/Hp)	130	120	110
4WD (lb/Hp)	110	100	90

Since only wheels on powered axles supply traction, it's also important to distribute ballast properly between front and rear axles. Optimal weight split between axles is affected by tractor style and whether the attached implement is pulled or mounted (Table 2). Equipment such as manure tank wagons and grain carts have significant tongue weight and can be considered "fully mounted" drawbar loads when calculating the proper weight split between front and rear axles because they add weight to the tractor's rear axle similar to fully mounted implements.

Table 2. Front-to-rear axle weight ratio as percentage of total weight

Tractor type	Towed / drawbar % Front / % Rear	Semi-mounted % Front / % Rear	Fully-mounted % Front / % Rear
2WD	25/75	30/70	35/65
MFD	35/65	35/65	40/60
4WD	55/45	55/45	60/40

An important exception to the ballasting procedure described above occurs when lighter drawbar loads are used that require less than half of the available tractor power. Examples include a pull-behind sprayer, a small planter, or a field cultivator that does not require much horsepower. Ballast previously added for primary tillage or heavy drawbar loads simply adds to tractor weight, increases rolling resistance and can increase fuel use. Although adding and

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removing cast iron ballast can be daunting, with proper equipment to support weights, a semiannual weight management strategy may be appropriate. Ballast is removed in late spring for lighter drawbar work such as planting and spraying, and also summer PTO operations such as mowing or baling with light drawbar loads. Ballast is then added to the tractor prior to fall tillage operations which require more of the tractor's engine power to be transferred to the drawbar.

Total tractor weights and percentage weight splits between front and rear axles shown in Tables 1 and 2 are only a guide. Because tractor fuel and power efficiency are optimized over a range of wheel slippages, fuel use is not likely to increase substantially with a 5% deviation from these values, but increased fuel use may become evident if weights differ by 10% or more. **NOTE:** if slippage cannot be easily checked and tractor axle weights are not known, they should be measured to gain confidence that fuel is not being wasted. Total tractor weight as well as the weight being carried on each axle can be conveniently checked on commercial scales at a grain elevator or co-op (Figure 1).

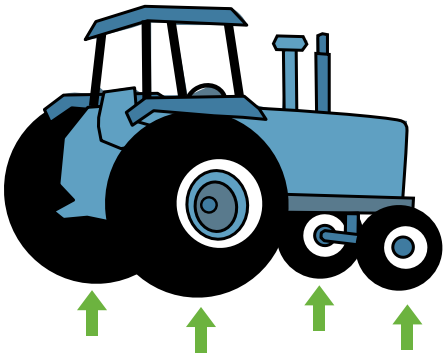

Figure 1. Tractor weight should be checked on both front and rear axles.

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Tire inflation

Besides proper ballasting, it's important to know axle weight in order to calculate the load each tire carries. Correct tire inflation pressure for the load carried can be found from load and inflation tables available on the tire manufacturer's web site or in the equipment operator's manual. Correct inflation pressure for a given weight depends on tire size, whether the tire is used as a single or dual, and if the tire will be used at high speed (e.g. greater than 25 miles/h).

Because underinflated tires wear sidewalls quickly, a natural tendency is to overinflate tires for a given load. Unfortunately, over-inflation reduces contact of the tire's lugs with the soil and results in excessive slippage and increased fuel use. Figure 2 shows fuel used for primary fall tillage operations with five different tractors when tires were inflated at a relatively high 24 psi inflation pressure and also with tires inflated at 14 psi pressure, which was more appropriate for the load these tires were carrying.

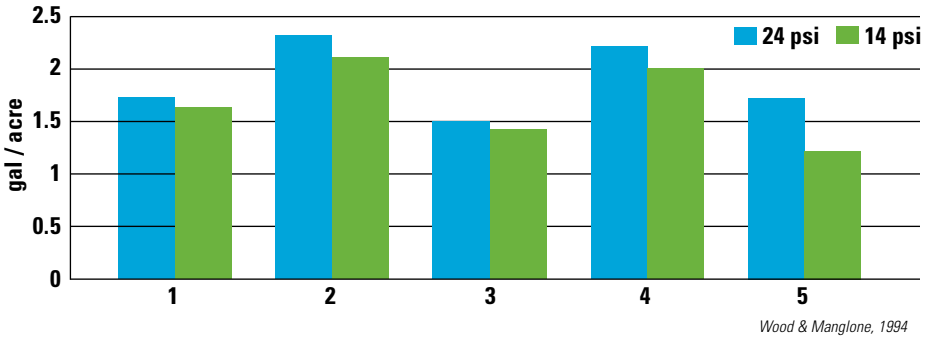

Figure 2. Fuel used during fall tillage by five tractors with tires inflated at either 24 psi or 14 psi.

Summary

Tractor fuel efficiency, time spent in the field, and tractor engine hours used can be adversely affected by either using too much ballast, causing excessive rolling resistance, or too little ballast, causing excessive tractor wheel slip. As an example, wheel slippage is usually not noticeable to the operator's naked eye until it's above 20%. Correct wheel slip in soil generally produces visible lug marks, but with distinct crumbling of the soil near the tire centerline indicating some slippage of lugs in the soil. If lug marks are distinct across the tread width without evidence of some soil crumbling, excess ballast is being used.

Checklist

- **Know the proper weight that should be carried on the front and rear axles of the tractor in order to efficiently transfer engine horsepower to drive wheels. Ensure weight being carried by the tractor is in this range by checking these weights on a scale.**
- **Check tractor slippage and consider reducing tractor ballast during periods when the tractor will be used with lighter drawbar loads.**
- **Use a good tire inflation gauge capable of readings within 1 – 2 psi and manage inflation pressure according to tire load and tractor use conditions.**