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Ballasting Your Tractor for Performance

A practical guide to proper weighting of your tractor.

PAMI and AFMRC staff frequently handle inquiries about proper tractor ballasting. We've assembled some basic guidelines to help farmers understand its importance.

Controlling Wheel Slip

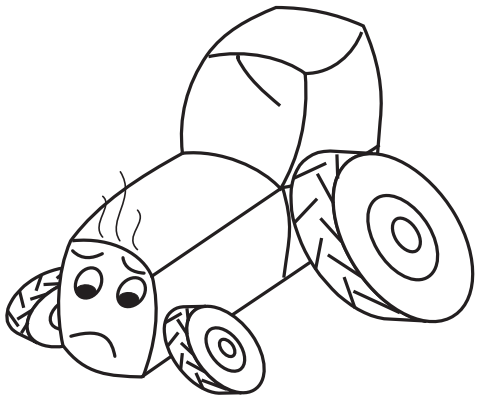
The only reason for ballasting is to control wheel slip. Tractor slip should optimally run at 10 to 15% for two-wheel drive (2WD) tractors and 8 to 12% for four-wheel drive (4WD) or front wheel assist (FWA) equipped units. These measurements apply only when the tractor is delivering full power.

Over ballasting is by far the most common error. If your tractor is over ballasted, you'll probably find that it feels doggy or sluggish, burns more fuel than it should, and will experience premature drivetrain problems.

An over ballasted tractor with about 4,000 hours will have nice square lugs on the original drive tires (no slip means no wear), and visible galling on the faces of the final drive planet pinion teeth. This tractor has been firmly stuck to the ground for many hours, and whenever it was heavily loaded, excessive torque was transmitted through the drivetrain and tires to the ground. In addition, carting around that excess weight (ballast) has consumed hundreds of gallons of extra fuel for nothing.

An under ballasted tractor is really no better. This condition wears tire tread at an accelerated rate due to the excessive slip, while never really delivering full horsepower to the drawbar. Again, fuel is wasted, because of the many extra wheel revolutions made to travel the same distance.

The 8 to 15% guideline is intended to be a minimum cost target where the fuel consumption,



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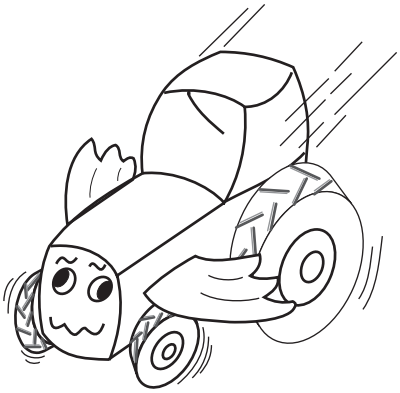

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tire life, productivity, and component durability all combine at the most economical operating point. Mechanically, you can think of wheel slip as a safety valve, which limits your drivetrain loads to a safe level.

Tuning Your Ballast

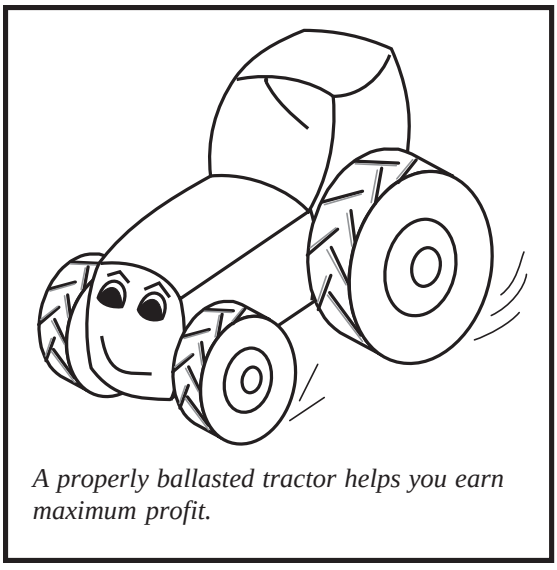
Recognizing an improperly ballasted machine is only the first step. Now, we must determine how to get the ballast "tuned in" to obtain target wheel slip.

You can make some preliminary estimates by using two key factors: horsepower and travel speed. You probably expected horsepower would be a key factor, but what difference does travel speed make?

Generally, higher travel speeds require less ballast, and the mechanical properties of soil only allow so much deformation (i.e. slip) to occur in a given period of time. For example, a faster rolling tire has less time to cause deformation on a given area of soil; slip is reduced, and less ballast is required.

This means, that if you're determined to transfer all of your tractor's available horsepower to the ground at slower speeds, you will need to increase the ballast. If you try to go too slow, you will need so much weight that you will eventually enter over-ballast territory. Most tractors are good for 4 to 4.5 mph (6.5 to 7 kph) at full power and optimum slip, but no slower. Your tractor's creeper gears are really just for PTO work, not traction!

At 5 mph (8 kph), a very rough starting point for estimating the ideal total tractor weight (including ballast) is between 95 and 110 lb/engine hp (79 kg/kW) (check for manufacturers recommendations). This should provide a slip percentage somewhere in the correct range when the tractor is fully loaded. But, be aware of the effect of different speeds: to get the same slip percentage at 4 mph (6.5 kph) requires 163 lb/hp (99 kg/kW) for proper ballast; at 6 mph (9.5 kph), only 108 lb/hp (66 kg/kW) is required.



A properly ballasted tractor helps you earn maximum profit.

Compare this guideline to the actual weight of your tractor. A grain elevator scale is a good way to check your actual weight. Or, you can usually get your tractor's shipping weight, complete with additional equipment, from your dealer. These figures are intended as a starting point only; actual measured wheel slip, at full power, is the real determining factor for optimum performance.

Your tractor's operator manual should include a section on measuring wheel slip. The procedure usually compares the number of wheel turns over a fixed distance, with the tractor unloaded, to the number of turns over the same distance, while under full load. (See the sidebar, *Measuring Wheel Slip*).

An alternate method, that's just as accurate, has you measure the distances, loaded and unloaded, for the same number of wheel turns each time. If your tractor is a newer one, it may have a radar sensor with additional electronics that will tell you "actual slip" on the go. Regardless of your measurement procedure, you should use the actual wheel slip for your tractor in your conditions to determine proper ballasting.

Front to Back Weight Distribution

Weight distribution between the front and back wheels should not be overlooked. Here, your tractor type is the important factor: the total ballasted weight that you determined from horsepower and travel speed should be split 30% front/70% rear for 2WD, 40% front/60% rear for FWA and 55% front/45% rear for 4WD. Again, you can check these weights with the cooperation of your friendly neighbourhood elevator agent. The 30% on the front wheels of a 2WD tractor may appear light, but for many tractors, you will have to add front weights to achieve this.

There is some controversy over chloride ballast versus cast weights and radial versus bias ply tires.

Regardless of what you choose, your target wheel slip remains the same, and you'll need to perform the same measurement procedure. Many prefer chloride ballast because its much cheaper than cast weights.

However, chloride has been suspected to cause corrosion problems with valve stems and rims, plus its not easily removed (or added) if you use your tractor for different jobs and want to accordingly adjust the ballast. Tire and tractor manufacturers recommendations vary. Some recommend the use of tubes when using chloride ballast; others do not. If you use chloride ballast in tubeless tires, it's good practice to monitor rims for corrosion. Rim corrosion is a less critical issue when using chloride ballast with tubed tires.

It has been said that for the same weight added, chloride seems to steal power when climbing hills compared to cast weights. AFMRC and others have published data that does not show any difference.

No Magic

If you've been questioning your tractors fuel efficiency and tire life, these guidelines are where you should start. There's nothing magic or difficult about optimizing tractor weight if you understand the basics.

More Information on Tractors

Evaluation Report 707, Comparison Tests on Tire Pressure Gauges, available from PAMI or AFMRC

Research Update 726- Nine Tips for Efficient Tractor Operation, available from PAMI

Research Update 727- Tractor Testing, available from PAMI

Tracks versus Wheels- Which is for You?, available from AFMRC see information box on last page of this report for contact information.

Tractor Performance- What's Best for You?, available from AFMRC

Northern Tractor Resource Centre, Montana State University, P.O. Box 7751, 2 Cowan Drive Havre, MT 59501 Phone: (406) 265-3700 FAX: (406) 265-3777

Tire Tips

• Recommendations vary about the amount of calcium chloride solution to use as ballast in tractor tires. Some say less than 75% full will expose the rim and may cause corrosion. More work needs to be done to confirm this claim.

• A properly inflated radial tire is 6 to 8 per cent more efficient than a bias ply tire. However, radial tires require 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 or tires. Consult your owner's manual or tire manufacturer's guidebook for specifications.

• Check tire pressures regularly. Make sure the pressure is appropriate for the load.

• Never exceed 35 psi (241 kPa) inflation pressure, as severe damage or personal injury can occur.

• The pressure recommendations molded into the side of the tire are ***maximum pressures*** *for* ***maximum load****. Using these pressures at less than maximum load can adversely affect tire and tractor performance.*

• Use an accurate pressure gauge for measuring low pressures. An error of 2 psi (14 kPa) won't have a big affect on performance with a 30 psi (207 kPa) tire pressure. But with pressures of 12 psi (83 kPa) or less, 2 psi (14 kPa) is a 20% error.

• Follow manufacturer's tire pressure recommendations when inflating tires (duals) on the same axle.

• Remember that changing your tire size will change your travel speed—a factor to consider when adjusting ballast to match travel speeds.

Air Cleaner Servicing, Coolant Test Kit information, available from Donaldson Company Inc., Box 1299, 1400 West 94th Street, Minneapolis, Minnesota 55440 Phone: (612) 887-3131.

Measuring Slip

Measuring wheel slip is simple and only takes a few minutes. You'll need two people, two stakes, and a piece of chalk.

1. Choose a typical, un-worked flat area in a field that represents normal working conditions.

2. Mark the side of a drive tire using chalk.

3. Allow the tractor to come up to speed with the tillage implement in the ground.

4. Your observer will drop a stake beside the tire (but not in the path of the implement) when the chalk mark touches the ground.

5. The observer walks along side the tractor and counts ten full revolutions of the marked tire. On the tenth revolution the second stake is dropped where the chalk mark touches the ground.

6. Raise the implement out of the ground and turn around to drive the tractor beside the newly tilled soil (see the illustration).

7. Drive the course beside the tilled soil at the same speed, but with the implement out of the soil. When the marked tire passes the stake, the observer will note the position of the mark and starts counting.

8. Again, the observer walks alongside the tractor and counts the revolutions of the tire. As the tractor passes the second stake, estimate the last revolution to the nearest quarter turn.

9. Calculate the percent slippage with the following formula:

Percent slip =

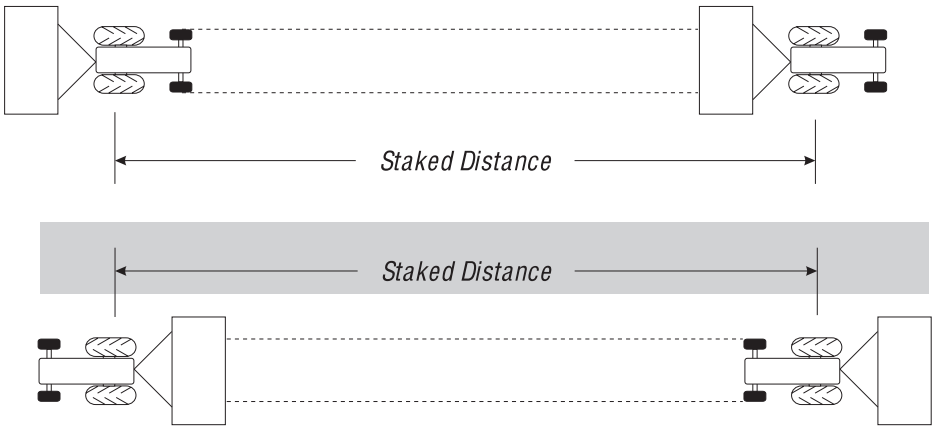
$$\frac{10 - \text{Number of revolutions without load}}{10} \times 100\%$$

Example:

It took 8.75 revolutions with no load to cover the same distance as 10 revolutions under load.

$$\frac{10 - 8.75}{10} \times 100\% = 12.5\%$$

Wheel slippage should be between ten and fifteen percent for 2WD and eight to twelve percent for 4WD in normal working conditions.



Top: *Stake the distance for ten revolutions of the drive wheel with the implement out of the ground.*

Bottom: *Drive back along side the staked distance with the implement in the ground, counting the revolutions of the drive wheel to the nearest quarter turn.*

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