Tractor ballasting

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Reducing fuel use involves both the tractor setup and gear settings. Correctly setting ballast to match a tractor's main duties can result in fuel savings of five to eight percent. Establishing correct ballast involves identifying goal weights for your main operations and measuring the actual weights at each axle, ideally while equipment is mounted. Incorrect ballasting may result in increased fuel consumption, higher 'lifetime' service costs, and increased compaction of and damage to soil.

Quick tips

- **Don't overballast**. Farmers in Australia tend to overballast their tractors, which causes excessive rolling resistance.
- **Check axle weights and weight distribution (& the fulcrum effect)**. As outlined below there are a range of optimal ballasts depending on drive type, speed and adding weight to the front which may reduce weight on the rear.
- **Don't sweat it**! Provided your tractor weight is in the right ball park, ballast adjustments do not have an overwhelming impact on efficiency.
- **Cast-iron weights are better than fluid**. Although adding water to tyres is cheaper, it may harm and decrease the lifespan of your tyres. This is particularly the case for radial bias tyres.
- **Buy the right rims and tyres**. Make sure that the rims can accommodate cast-iron weights and the tyres are large enough to allow the use of lower pressures at any given tractor weight.
- **Read the manual**! Manufacturers provide optimal ballast recommendations for various applications.
- **Minimise labour and workplace health and safety (WH&S) risk**. If your operations demand changing ballast on a regular basis, consider hydraulic hitches that make it easy to pick up weight as required.
- **Tyre pressures are key**. Once the correct ballast has been established, tyre pressure can be used to optimise tractive efficiency.

Problems with an overballasted tractor

- Increased fuel consumption and a reduction in productive field output (because of hauling excessive weight).
- Increased mechanical wear as a result of higher torque loadings in the tractor's drive train.
- Increased soil compaction.

Problems with an underballasted tractor

- The potential for increased wheel slip that reduces field output and wastes fuel.
- Increased tyre wear in certain conditions.
- The creation of deep tyre furrows in very wet conditions.

Importantly, both overballasting and underballasting limit the driver's ability to optimise traction by adjusting the tractor's tyre pressure .

Caution

The information provided here is intended as general guidance only. Farmers should first check manufacturer's guidelines/manuals and follow safety precautions, especially when ballasting for potentially dangerous conditions, such as having a front loader or driving over uneven or hilly terrain.

The ballast set-up process

Adding the appropriate ballasting weight and positioning it correctly requires consideration of vehicle and operator weight, the optimal distribution of weight between axles, tyre pressures, mounted implements and travel speed.

The following six steps are suggested:

1. Consult your supplier and the tractor manual.
2. Identify your gross goal weight.

Table 1: Optimal gross tractor weight per PTO power (kg/kW) at various operating speeds[1]

Tractor type	Ground speed (km/hr)		
	<7 km/hr	8 km/hr	>9 km/hr
2WD & MFWD	80	75	65
4WD	65	60	55

3. Identify the goal-weight distribution by axle.

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

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

[1] Tables 1 & 2 adapted from Hanna, H. M., Harmon, J. D. & Petersen, D., 2010. *Farm Energy: Ballasting tractors for fuel efficiency. Agriculture and Environment Extension Publications*. Book 29, July.

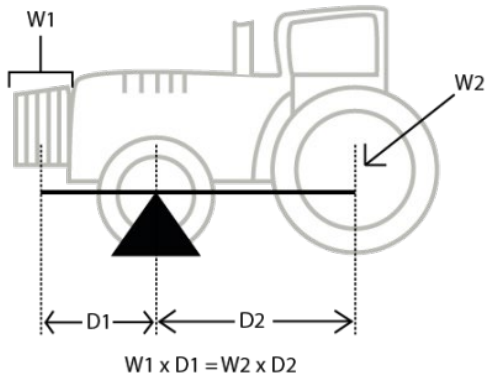
4. Measure the actual weight and its distribution.
5. Precisely adjust ballast to achieve goal weights.
6. Observe results in the paddock, then fine-tune by adjusting tyre pressures.

The ballasting process involves collecting data that is particular to your tractor, mounted equipment and operations. It is suggested that you create a table on which to record this information.

Fulcrum effects

When adding ballast, it is useful to understand and compensate for transfer effects when weights are added to the front of the tractor. As shown in Figure 1, the front axle may act as a fulcrum: transferring the moment of rotation, it effectively reduces the weight on the rear axle.

Figure 1: Calculating transfer effects when weights are added to the front of the tractor



Worked examples

1. With reference to Figure 1, how will the axle weights change if 400 kg in suitcase weights (W1) are added, the distance between the centre of the suitcase weights and the centre of the front axle (D1) is 1.5 m, and the distance between the front and rear axles (D2) is 4 m?

   W1 x D1 = W2 x D2
   400 x 1.5 = W2 x 4
   600 = 4 x W2
   W2 = 150 kg

   In this case, the front axle weight would increase by 550 kg (400 + 150) and the weight on the rear axle would decrease by 150 kg.

2. Optimally ballast a 4WD tractor with a rated PTO power of 150 kW to pull a towed tillage tool at 7 km/h.

   From Table 1, we calculate the optimum tractor weight. 150 kW x 65 kg/kW = 9,750 kg.

   We determine from Table 2 that we must distribute 55% of the weight on the front axle and 45% in the rear.

   Front axle weight = 0.55 x 9,750 kg = 5,363 kg

   Rear axle weight = 0.45 x 9,750 kg = 4,388 kg

   We weigh the tractor using portable scales and obtain the following unballasted weight on each axle:

   Front axle weight = 4,200 kg
   Rear axle weight = 5,600 kg

   This indicates that the front axle requires an additional 1,163 kg, while

the rear axle is over ballasted by 1,212 kg.

Using mounted suitcase ballasts on the front of the tractor will therefore allow one to increase the weight on the front axle, while decreasing it on the rear using the fulcrum dynamics explained in the first example.

Assuming the distances D1 and D2 remain 1.5 m and 4 m respectively, we can derive that:
Approximately 846 kg must be added as front suitcase ballasts (W1). This will reduce the weight on the rear axle by about 320 kg and means that only 890 kg of weight (W2) should be removed from the rear axle.

Case study

At Kensal Green, an irrigated farming property that grows cotton, wheat and other grains just south of Gunnedah NSW, it was calculated that proper ballasting (using tables 1 and 2) and management of tyre pressures of the farm's three tractors would result in fuel savings of approximately 10 percent.[2]

Further information

NSW Farmers ballast calculator

https://www.dpi.nsw.gov.au/v2/climate/energy/knowledge-hub/nsw-dpi-factsheets

List of pubic weighbridges locations in Australia

https://www.industry.gov.au/regulations-and-standards/buying-and-selling-goods-and-services-by-weight-and-other-measurements/weighbridges-used-for-trade/find-a-public-weighbridge

Ballasting calculators for John Deere Tractors

https://www.deere.com/asia/en/agriculture/calculator/calculators_listing/

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Please see this factsheet for more information about this topic.

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[2] https://www.aginnovators.org.au/initiatives/energy/case-studies/reduce-speed-reduce-cost-variable-speed-drives-pumping-systems-lead-irrigation-efficiency