Traction Improvement: Ballasting, Tires, & Inflation Pressure

Top Farmer Crop Workshop, 2007
Purdue University

Dennis Buckmaster

Outline

- Perspective
- Ballasting
- Performance curves
- Tire selection
- Inflation Pressures
Perspective – let me confuse you first

- Tire load affects slip
- Slip affects pull
- Axle loads change
- Pull determines speed
- Implement draft changes

Perspective

- Draft of implement determines pull
- Pull alters load balance
- Load balance determines wheel reactions
- Wheel reactions alter slip
- Slip changes speed
- Speed affects implement draft
Key resource:
An ASABE Distinguished Lecture Series paper, presentation, and spreadsheet model.

How to read traction plots
On Magnitude – what is 7 out of 70?

Performance of single tire (Firestone 710/70R38 AIR) at two inflation pressures in tilled (loose) tractive conditions.

Tractive efficiency affects

- Tire wear
- Fuel consumption
- Time for the work
  - Machine time
  - Labor
  - Timeliness
On Slip …

- Some is good
- Optimal level depends on
  - Tires
  - Soil
- Controlled by
  - Pull/weight ratio
  - Tire selection & inflation

Today’s focus

The major factors affecting tractor drawbar performance during field operations are tires and ballasting. Tires are usually selected at the time of purchase, while ballasting changes can be made at any time. In practice, ballast weights are not often changed as soil and operational conditions change.

From a tractor performance standpoint, the general rule for tire selection should be “bigger is better.” The second rule should be that larger diameter is preferred over larger width, again from a performance standpoint. In either case, tires should be operated at the correct pressure for the load being carried. Lower tire pressures are helpful from a compaction standpoint, as ground pressure is roughly equal to tire pressure. In addition, lower pressures help control power hop as they allow a wider range of tire pressure adjustments to be made. Larger tires can operate at lower pressures for the same weight. Correctly inflated radial-ply tires provide a 5% to 7% efficiency improvement over bias-ply tires.

While ballasting is important to optimize a particular situation, bigger gains would probably be made at the time of purchase by proper sizing of tires to allow operation at lower tire pressures (increasing Bu) at any given weight.

Excerpts from Zoz & Grisso, 2003
Ballasting


### Table 1. Optimum total tractor weight pounds per PTO horsepower

<table>
<thead>
<tr>
<th>Speed</th>
<th>3WD</th>
<th>FWD &amp; 4WD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>5</td>
<td>135</td>
<td>115</td>
</tr>
<tr>
<td>6</td>
<td>110</td>
<td>95</td>
</tr>
</tbody>
</table>

### Table 2. Optimum weight distribution percentages

<table>
<thead>
<tr>
<th>Tractor/Implement</th>
<th>Front Axle</th>
<th>Rear Axle</th>
</tr>
</thead>
<tbody>
<tr>
<td>3WD/Towed</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>2WD/Semi-mounted</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>2WD/4WD mounted</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>FWD/Towed</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>FWD/Semi-mounted</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>4WD/Towed</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>4WD/4WD mounted</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

### RESULTS

- W/P ratio: 94 lb/hp
- Total Tractor Weight: 14100 lb
- Front Axle Percentage: 60%
- Rear Axle Percentage: 40%
- Front Axle Weight: 8460 lb
- Rear Axle Weight: 5640 lb

Ballast Example

- 180 hp
- MFWD
- 5 mph
- towed implement

- 117 lb/hp (weight/PTO hp)
- 21000 lb total
- 40% or 8400 lb front
- 60% or 12600 lb rear
Different soil conditions

Figure 27. Performance of 20.8R42 dual tires on three surfaces (8300 lb axle load, 83 kPa tire pressure).

Different tire pressure & load

Figure 28. Performance of single tire (Firestone 710/70R38 ATR) at two inflation pressures in tilled (loose) tractive conditions.
Different tire size (with correct pressure)

![Graph showing the performance of two sizes of single tires at correct inflation pressures in tilled (loose) tractive conditions.](image)

1. Little effect on slip
2. Little effect on max pull
3. 10% boost due to tire selection

Figure 29. Performance of two sizes of single tires at correct inflation pressures in tilled (loose) tractive conditions.

Different weight (tire load) & pressure

![Graph showing the performance of a single tire (Goodyear 528/85R46 DTR) at two weights with correct pressures in tilled (loose) tractive conditions.](image)

50% more load capacity with correct pressure

Figure 30. Performance of single tire (Goodyear 528/85R46 DTR) at two weights with correct pressures in tilled (loose) tractive conditions.
Inflation Pressure

- Best illustrated via example, same 180 hp MFWD tractor @ 6 mph with towed implement → 12,600 lb rear or 6,300 lb/tire

  - www.firestoneag.com
  - 20.8R42 has capacity of 8550 lb @ 29 psi
  - 12,600 lb/axle with singles requires 15 psi

---

Inflation Pressure

- Not to confuse you, but …
- Same tractor, different make of tire
- www.michelinag.com Agribib
- 20.8R42 (520/85R42) has capacity of 9080 lb @ 23 psi
- Pressure calculator considers speed
  (note more load on rear tires during field action)
- 14 psi recommended
Resources

- Ag Tire sites
  - [www.firestoneag.com](http://www.firestoneag.com)
  - [www.michelinag.com](http://www.michelinag.com)
  - [www.titanstore.com](http://www.titanstore.com)
  - [www.trellco.com](http://www.trellco.com)
- Dr. Bobby Grisso, VT
  - [http://filebox.vt.edu/users/rgrisso/Tractor.htm](http://filebox.vt.edu/users/rgrisso/Tractor.htm)
    - Traction model with database
    - NE test data database

For a limited time only …

[http://cobweb.ecn.purdue.edu/~dbuckmas/TFCW](http://cobweb.ecn.purdue.edu/~dbuckmas/TFCW)

- This presentation
- Ballast Assistant spreadsheet
- A couple related articles and documents