Improving Fuel Efficiency in Field Operations

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Source: Tiller’s International

Not Ready to Give Up Your Tractors?

Source: “The Horse and the Tractor” John Woodmorappe

Equipment Selection

- Match implements to the tractor or the other way around
- Consider tractor horse power, speed, draft requirement and soil type when sizing implements
- Pulling implements at higher speeds reduces drivetrain wear and soil compaction
- Virginia Tech and Iowa State have spreadsheets for matching tractors and implements

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Equipment Selection

- **PTO hp** = width (feet) x speed (mph) x draft (lbs/ft) x soil factor ÷ 375
- Soil Factors
  - Firm soil 1.5
  - Tilled soil 1.8
  - Sandy or soft soil 2.1
- Tables listing the draft requirements per foot of width at specified speeds for various implements are available

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Equipment Selection

- Example:
  - 21 foot soil finisher (draft of 300 lbs. per foot)
  - Pulled at 5 mph
  - Sandy or soft soil (soil factor of 2.1)
- PTO hp = 21 feet x 5 mph x 300 lbs per foot x 2.1 ÷ 375
- PTO hp required = 176.4

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Match the Tractor to the Job

Tractor Horsepower	Fuel Cost Per Hour ($2.50 per gallon)
70	$7.67
100	$10.95
150	$16.42

Source: Coping With High Diesel Prices, University of Tennessee

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Gear Up and Throttle Down

- Shift to a faster gear and reduce engine speed on light load operations
- Improves fuel efficiency by 13 to 20%
- Stay within the engine RPM range specified in the operator's manual
- Don't overload the engine

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Gear Up and Throttle Down

- Not recommended when operating PTO driven equipment
- Some manufactures offer transmissions that gear up and throttle down automatically (CVT and IVT)
- Nebraska Tractor Test Laboratory provides information on fuel consumption http://tractortestlab.unl.edu/

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Nebraska Tractor Test
John Deere 7810 IVT

50% Load	Power (hp)	Engine Speed (rpm)	Fuel Consumption (gph)
Rated RPM	72	2226	6.36
Reduced RPM	71	1901	5.46
Auto IVT	71	1243	4.71

150 hp tractor operating at 4.9 mph.

Source: “Fuel Savings: Shift Up – Throttle Down and CVT/IVT”, Ronald Schuler

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Ballasting – The Essential First Step To Increasing Tractor Performance

- Optimum ballast is a compromise between wheel slip and rolling resistance
- Determine the optimum amount of ballast to add
- Determine how to distribute the ballast between to the front and rear axles
- Decide how to add weight to each axle

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Ballasting – The Essential First Step To Increasing Tractor Performance

- Fluid can be used in radial tires
  - Check with the manufacturer
  - Don’t exceed 40% fill in rear tires
- Cast Iron wheel and suitcase weights provide more flexibility but cost more than fluid ballast
- Check and adjust ballast as needed
- How should ballast be checked?
- Reduce ballast when performing low draft operations

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Tractor Ballasting Example

- Determine type of tractor, operating speed and PTO hp
  - **MFWD**
  - **4.5 mph**
  - **200 PTO hp**

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Optimum Tractor Weight

Tractor Type	4.5 mph	5 mph	5.5 mph
2 WD & MFWD (lbs. per PTO hp)	130	120	110
4 WD (lbs. per PTO hp)	110	100	90

Source: “Saving Fuel in Field Operations”, Mark Hanna

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Tractor Ballasting Example

- Multiply the optimum weight per PTO hp by the engine PTO hp of your tractor
  - **200 hp x 130 lbs./PTO hp = 26,000 lbs.**

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Tractor Ballasting Example

- Decide how to split the weight between the front and rear axles
  - tractor type
    - **MFWD**
  - implement type
    - **Towed tillage tools**

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Front-to-Rear Axle Weight Ratios

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

Source: “Saving Fuel in Field Operations”, Mark Hanna

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Tractor Ballasting Example

- Decide how to split the weight between the front and rear axles (tractor type and implement type)
  - **Front: = .35 x 26,000 lbs. = 9,100 lbs.**
  - **Rear: = .65 x 26,000 lbs. = 16,900 lbs.**

- Subtract the un-ballasted front and rear axle weights from the ballasted axle weights
  - **Front: 9,100 lbs. – 8,930 = 170 lbs.**
  - **Rear: 16,900 lbs. – 12,570 lbs. = 4,330 lbs.**

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How Does Adding Suitcase Weights Affect The Front and Rear Axle Weights?

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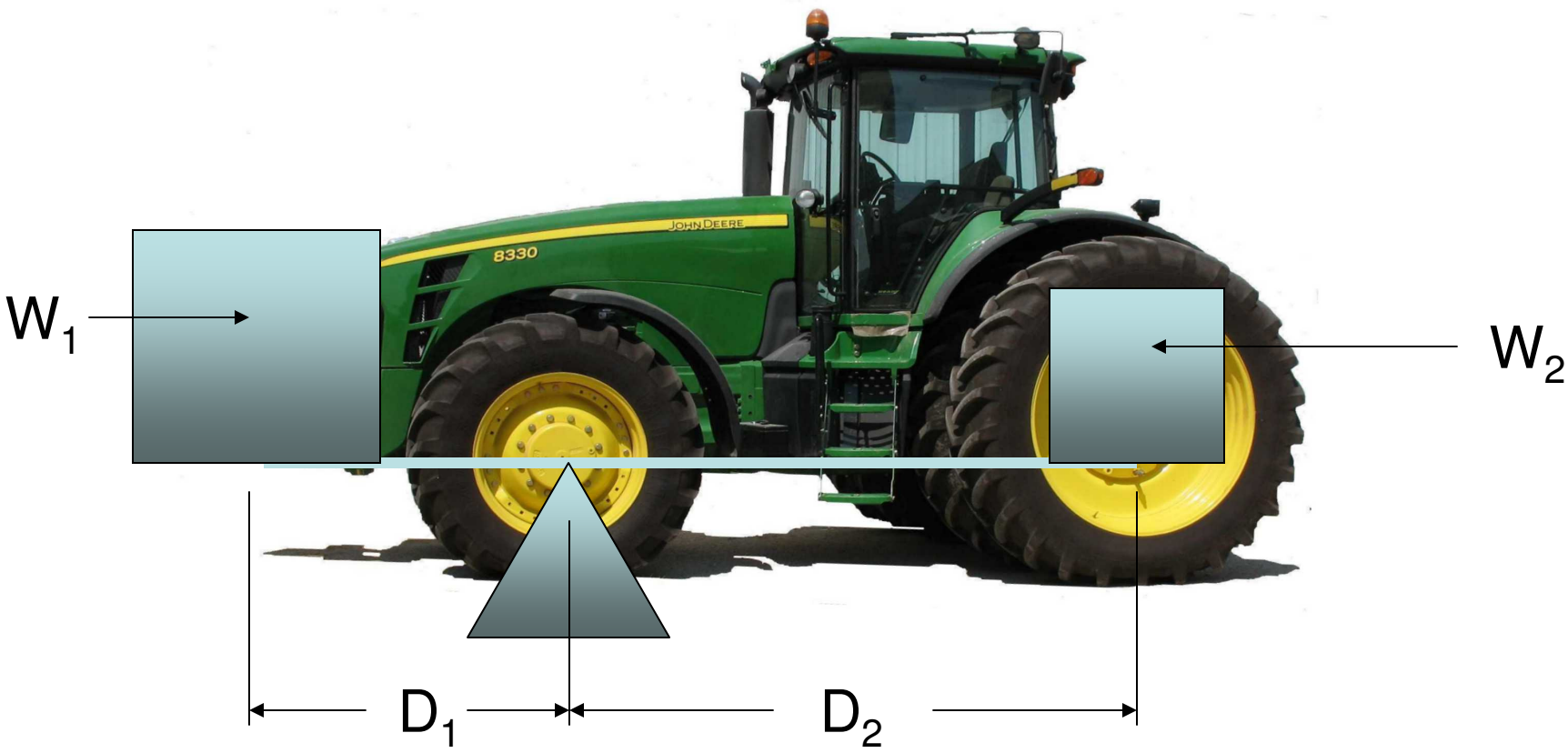
The Effect of Adding Suitcase Weights on the Front and Rear Axle Weights



$$W_1 \times D_1 = W_2 \times D_2$$

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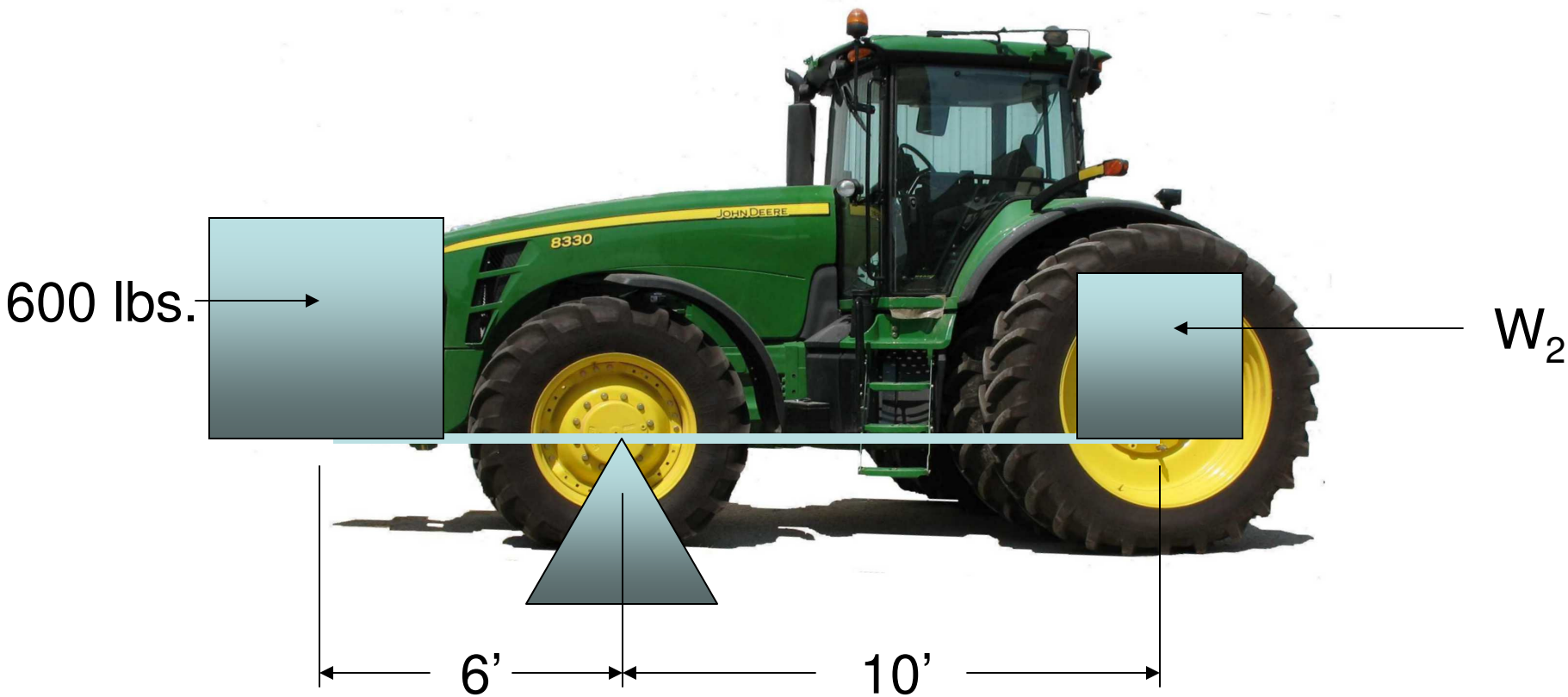
The Effect of Adding 600 lbs. of Suitcase Weights on the Front and Rear Axle Weights



$600 \times 6 = W_2 \times 10$

$3600 = 10W_2$

$360 = W_2$

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The Effect of Adding 600 lbs. of Suitcase Weights on the Front and Rear Axle Weights

Rear axle weight is *decreased* by 360 lbs.

Front axle weight is *increased* by 960 lbs.

(600 + 360 = 960 lbs.)

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Proper Tire Inflation Improves Fuel Efficiency

- Properly inflated radial tires improve fuel efficiency by 6 to 8%
- The main effect is reduced wheel slip resulting in greater field capacity (acres/hour)
- Reduced soil compaction, longer tire life and improved ride are additional benefits

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Tire Inflation Demonstration at MSU's AG Expo

Source: Dr. Tim Harrigan, MSU Extension Specialist

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Tire Inflation Tips

- Ballast the tractor properly first
- Determine the weight per axle
  - Three point hitch implements
  - Grain carts
- Divide the axle weights by the number of tires per axle
- Use load and inflation tables provided by the tire manufacturer

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Tire Inflation Tips

- Set all tires on the axle to the recommended pressure
- Check air pressure when tires are cold
- Use a high quality air pressure gauge
- Over inflation is more common than under inflation

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Tire Inflation Example

- Tractor from the ballasting example
  - Front axle weight = **9,100 lbs.**
  - Rear axle weight = **16,900 lbs.**

- Determine the weight per tire
  - Front: 9,100 lbs. ÷ 2 = **4,550 lbs.**
  - Rear: 16,900 lbs. ÷ 4 = **4,225 lbs.**

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Sample Load and Inflation Data for a Michelin 480/80R46 Tire

Load per tire at (20 mph)	Inflation Pressure
3,900 lbs.	6 psi
4,650 lbs.	9 psi
5,390 lbs.	11 psi
6,890 lbs.	17 psi
8,380 lbs.	23 psi
9,210 lbs.	29 psi

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Sample Load and Inflation Table for a Goodyear 480/80R46

	Inflation (psi)	6	9	12
Single	Load/tire	3640	4300	5080
Dual	Load/tire	3200	3780	4470
Triple	Load/tire	2980	3530	4170

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Sample Load and Inflation Data for a Michelin 420/90R30 Tire

Load per tire (20 mph)	Inflation Pressure
3,040 lbs.	7 psi
3,530 lbs.	9 psi
3,900 lbs.	11 psi
4,290 lbs.	14 psi
4,660 lbs.	17 psi
5,050 lbs.	20 psi

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Auto Guidance/Auto Steer

- Purdue University evaluated the economic benefit of three guidance systems in 2002
  - Manual Guidance
  - DGPS Auto Guidance
  - RTK Auto Guidance

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Estimated Time Required for Field Operations on 1,800 Acres

Guidance System	Time Required
None	496 hours
Manual Guidance	439 hours
DGPS and RTK	411 hours

Source: Matt Watson and Jess Lowenberg-DeBoer, Purdue University

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Eliminate Tillage Passes

- Long-term no-till soybean yields are comparable to tilled beans in the corn belt
- Tillage operations use more fuel than other field operations
- Avoid creating field conditions that require tillage operations
  - Soil compaction
  - Deep ruts

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Fuel Requirements for Various Tillage Operations

Field Operation	Fuel Consumed (gallons per acre)
Subsoil 14”	2.10
Chisel Plow 8”	1.25
Tandem Disk	.55
Field Cultivate	.60

Source: “Fuel Requirements for Various Tillage-Planting Systems,

D.R. Griffith and S.D. Parsons

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Perform Routine Maintenance

- Air filters
- Fuel filters
- Use the correct engine oil
- University of Missouri researchers demonstrated that replacing fuel and air filters lowered fuel use by 4%.

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Don't Let Tractors Idle For Long Time Periods

- Modern diesel engines should be shut down when not used for 5 to 10 minutes
- Idling wastes fuel and can also lead to carbon build up on injector spray holes and valves

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Maintain and Operate Tillage Tools Properly

- Depth
- Speed
- Keep ground working parts maintained
- Perform multiple operations in a single pass

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Summary of Fuel Saving Tips

- Match tractors and equipment
- Use Nebraska Tractor Test Information
- Gear up and throttle down
- Ballast tractors properly
- Radial tires (properly inflated)
- Use guidance systems
- Reduce or eliminate tillage passes

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Summary of Fuel Saving Tips

- Stay on a maintenance schedule
- Shut tractors off
- Maintain and operate tillage tools properly

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Questions?

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