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CC279 Gear Up -- Throttle Down

David P. Shelton
*University of Nebraska-Lincoln, dshelton2@unl.edu*

Kenneth Von Bargen
*University of Nebraska-Lincoln*

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For most efficient operation, a tractor’s engine should be operated near its rated capacity. However, there are many field operations which do not require rated tractor horsepower. This is especially true when older implements, which were sized for a smaller tractor, are used with high horsepower tractors. Further, many operations must be performed at a fixed field speed. For these lighter operations, a substantial amount of fuel can be saved by shifting to a higher gear and slowing the engine speed to maintain the desired field speed.

This is confirmed by the Nebraska Tractor Tests. Information on fuel savings is given in three of the Drawbar Performance tests.

**Test One:** (Maximum Available Power). In a gear selected by the manufacturer, the pull and travel speed are measured and used to determine maximum available power. This test is performed at full throttle.

**Test Two:** (50% of Pull at Maximum Power). In the same gear and at full throttle, the tractor is tested at half of the pull of Test One.

**Test Three:** (50% of Pull at Reduced Engine Speed). The tractor is tested in a higher gear with a reduced throttle setting. Drawbar horsepower, speed, and pull are about the same as for Test Two.

During Test Three, most tractors use between 15 and 30 percent less fuel than during Test Two. Throttle setting and gear selection are the only factors changed between the two tests.

Twelve diesel tractors in the 90-120 drawbar horsepower range were selected as an example. These tractors are commonly purchased by Nebraska farmers. For Tests Two and Three, fuel consumption (gallons per hour) and fuel efficiency (horsepower-hours per gallon) were compared. A higher fuel efficiency means that the tractor produced more work per gallon of fuel used. This measure is not influenced by engine size and can, therefore, be used to compare efficiencies of tractors with different horsepowers.

<table>
<thead>
<tr>
<th>Test Two</th>
<th>(50% of Pull at Maximum Power)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>Drawbar horsepower</td>
<td>60.56</td>
</tr>
<tr>
<td>Gallons per hour</td>
<td>5.67</td>
</tr>
<tr>
<td>Horsepower hours per gallon</td>
<td>10.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Three</th>
<th>(50% of Pull at Reduced Engine Speed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>Drawbar horsepower</td>
<td>60.56</td>
</tr>
<tr>
<td>Gallons per hour</td>
<td>4.54</td>
</tr>
<tr>
<td>Horsepower hours per gallon</td>
<td>13.39</td>
</tr>
</tbody>
</table>

When the tractor was “geared up and throttled down,” fuel consumption was reduced an average of 25 percent, and fuel use efficiency was 20 percent better. Remember, both travel speed and drawbar horsepower were the same for the two tests. Only a change in throttle and gear occurred.

Normally, this practice can be used when loads require less than about 65 percent of a tractor’s power. It is generally safe to reduce engine RPM by 20 to 30 percent of the rated RPM. You should check the Operator’s Manual for specific recommendations for your tractor.

When using the practice of “gear up-throttle down,” the most important thing to remember is NOT to overload or lug the engine. Visible black smoke may be one indication of an overloaded
dice engine. An easy way to check to be sure that
the engine is not overloaded is to work for a short
time at the desired speed and throttle setting.
Then, rapidly open the throttle. If the engine
readily picks up speed, it is not overloaded, and the
original throttle setting is suitable. If the engine
does not respond normally, you should shift down
a gear or increase the engine speed. Again, check
for engine overload at the new settings.

There is no justification for operating either
turbocharged or naturally aspirated engines at full
throttle when full drawbar horsepower is not
required.

Five major tractor manufacturers who respond­
ed to an inquiry concerning the "gear up-throttle
down" practice indicated that the practice was
suitable for their tractors and capable of saving
fuel. Further, it was stated that this practice could
decrease maintenance, down time, and expenses
generally incurred from over-speeding mechanical
equipment.

However, there are two major drawbacks with
this practice. When engine speed is reduced, power
take off (PTO) speed is correspondingly reduced
and reaction time of the tractor hydraulics is
slower.

Suppose you need to perform an operation
which requires 55 drawbar horsepower. You have a
choice between two tractors. The first is rated at
56 drawbar horsepower and the second at 110
drawbar horsepower. Should you use the small
tractor at full throttle and full load, the large
tractor at full throttle and 50 percent load, or the
large tractor at 50 percent load but geared up and
throttled back?

Data in Table 2 show that the large tractor
when geared up and throttled back has the highest
fuel efficiency (13.55 horsepower-hours per gal­
lon). The savings is about 1 gallon per hour over
full throttle operation of the large tractor. In
addition, 0.29 gallons per hour are saved over the
fuel used by the small tractor. This shows that a
large tractor properly matched to a light load can
save energy compared to a tractor half the size
operating at full load. An added gain is increased
annual usage of the large tractor. This helps spread
the costs of owning a large tractor over an
extended time period.

Remember, fuel consumption and engine effi­
ciency can vary widely for specific tractors. Con­
sult the individual Tractor Test Reports for your

<table>
<thead>
<tr>
<th>Throttle setting</th>
<th>Small tractor</th>
<th>Large tractor</th>
<th>Large tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent load</td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Drawbar horsepower</td>
<td>55.79</td>
<td>56.67</td>
<td>56.72</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>4.49</td>
<td>5.23</td>
<td>4.20</td>
</tr>
<tr>
<td>(Gallons) Hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel efficiency</td>
<td>12.54</td>
<td>10.91</td>
<td>13.55</td>
</tr>
<tr>
<td>(Horsepower-Hours) Gallon</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Values are for two typical tractors).

Table 3. Appropriate metric conversions.

<table>
<thead>
<tr>
<th>Multiply</th>
<th>by</th>
<th>to obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons/hour</td>
<td>3.785</td>
<td>Liters/hour</td>
</tr>
<tr>
<td>Horsepower</td>
<td>0.746</td>
<td>Kilowatts</td>
</tr>
<tr>
<td>Horsepower-hours</td>
<td>0.197</td>
<td>Kilowatt-hours</td>
</tr>
</tbody>
</table>

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