Are radial tires cost effective?

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When Pirelli Co. developed the first radial tractor tire in 1957, the company claimed it would develop 20 percent greater traction with less slippage at equal load than an equivalent bias-ply tire. (Forrest, et al. 1962) Subsequent research has confirmed that radial tires have the advantage in tractive efficiency. H. Erdal Ozkan, state extension specialist at Ohio State University, has reviewed all available research results related to field performance of tractors equipped with radial and bias ply tires.

Field capacity and fuel consumption were studied.

<table>
<thead>
<tr>
<th>Author</th>
<th>Increase in tractive efficiency for radials</th>
<th>Reduction in fuel consumption for radials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seleznev and Kovalez (1986)</td>
<td>10.7 percent</td>
<td>13 percent</td>
</tr>
<tr>
<td>B.F. Goodrich Co. (1981)</td>
<td>12.3 percent</td>
<td>12.8 percent</td>
</tr>
<tr>
<td>Bohnert and Kenady (1975)</td>
<td>—</td>
<td>16.4 percent</td>
</tr>
<tr>
<td>Hauck and Kucera (1983)</td>
<td>2.1 percent</td>
<td>6.5-8.1 percent</td>
</tr>
<tr>
<td>Hausz and Akins (1980)</td>
<td>5-7 percent</td>
<td>6-10 percent</td>
</tr>
</tbody>
</table>

In most cases, the research was done with the same wheel slip for radial and bias tires. This may have kept the radial tires from reaching the predicted 20 percent advantage.

Drawbar pull tests were reported as follows:

<table>
<thead>
<tr>
<th>Author</th>
<th>Wheel slip</th>
<th>Soil</th>
<th>Advantage of radial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forrest (1962)</td>
<td>&lt;15 percent</td>
<td>Sand</td>
<td>8 percent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loam</td>
<td>23 percent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clay</td>
<td>21 percent</td>
</tr>
<tr>
<td>Thaden (1962)</td>
<td>16 percent</td>
<td>—</td>
<td>29 percent</td>
</tr>
<tr>
<td>Mumgaard &amp; Rudakov (1975)</td>
<td>15 percent</td>
<td>Firm</td>
<td>15.5 percent</td>
</tr>
<tr>
<td>Bohnert and Kenady (1975)</td>
<td>—</td>
<td>Tilled</td>
<td>14.6 percent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sod</td>
<td>18.8 percent</td>
</tr>
<tr>
<td>Gee-Clough (1977)</td>
<td>20 percent</td>
<td>—</td>
<td>5-8 percent</td>
</tr>
</tbody>
</table>

Conditions used by investigators were not constant, and results cannot be compared directly. Radial tires, however, do seem to have the advantage in every category except purchase price. Resistance to abrasive wear seems about the same for radial and bias tires, but radial tires have much longer tread life than bias tires. Radial tires will have service life 25 to 40 percent longer than equivalent bias tires (Ozkan, 1986).

Ownership cost usually includes depreciation, interest on investment, tax, shelter and insurance. For a comparison of tires, the difference in tax, shelter and insurance cost was thought to be negligible and was omitted. The capital recovery factor was used to estimate ownership cost because it accounts for both depreciation and return on investment. See Equation 1.
Total savings per hour and hours required to breakeven are computed as follows:

\[
NSH = (F_B - F_R) + (L_B - L_R) - (UTC_R + UTC_B)
\]

\[
BE = \frac{TP_R - TP_B}{NSH}
\]

**Example:** Assumed input data:
- Tractor maximum pto power = 150 hp
- Tractor annual use = 625 hr
  - 125 hrs stationary (tires not used)
  - 500 hrs mobile (tires used)
- Diesel fuel cost = $1/gal
- Cost for 2 radial tires = $1,500
- Cost for 2 bias tires = $1,000
- Expected bias tire life = 2,500 hrs (5 yrs)
- Labor cost = $5.20/hr
- Increase in field capacity for radial tires = 10 percent
- Expected increase in life for radial tires = 30 percent
- Expected fuel saving for radial tires = 6 percent
- Average interest rate = 9 percent
- Fuel efficiency for tractors with bias tires = 14 hp-hr/gal

**Calculations:**

**Annual tire ownership cost:** (Use Equation 1)

\[
TOC_R = 1500 \left[ \frac{.09(1 + .09)^5}{(1 + .09)^5 - 1} \right] = $385.64/yr
\]

\[
TOC_B = 1000 \left[ \frac{.09(1 + .09)^5}{(1 + .09)^5 - 1} \right] = $257.09/yr
\]
Unit tire cost: (Use Equation 2)

\[ UTC_B = \frac{\$257.09/yr}{500 \text{ hr/yr}} = \$0.51/\text{hr} \]

\[ UTC_R = \frac{\$385.64/yr}{500 \text{ hr/yr}} = \$0.77/\text{hr} \]

Fuel cost: (Use Equations 3 and 4)

Fuel efficiency with bias tires (given) = 14 hp-hr/gal

Fuel consumption = \( \frac{150 \text{ hp}}{14 \text{ hp-hr/gal}} \) = 10.71 gal/hr

\[ F_B = 10.71 \text{ gal/hr} \times \$1.00/\text{gal} = \$10.71/\text{hr} \]

\[ F_R = 10.71 (1-.06) = \$10.07/\text{hr} \]

Labor cost: (Use Equation 5)

\[ L_B = \$5.20/\text{hr} \]

\[ LR = \frac{L_B}{1 + IFC} = \frac{5.20}{1+.10} = \$4.72/\text{hr} \]

Total savings per hour: (Use Equation 6)

\[ NSH = (10.71-10.07) + (5.20 - 4.72) + (0.77+0.51) = \$0.86/\text{hr} \]

Use required to breakeven: (Use Equation 7)

\[ BE = \frac{1500 - 1000}{0.86} = 581.39 \text{ hr} \]

\[ \frac{581.39 \text{ hr}}{500 \text{ hr mobile use/yr}} = 1.16 \text{ yr} \]

References

B.F. Goodrich. 1981. Powersaver radials—save eight ways and then some! B.F. Goodrich Tire Division, 500 S. Main St., Akron, Ohio.


