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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.

Author	Increase in tractive efficiency for radials
Seleznev and Kovalez (1968)	13 percent
Bohnert and Kenady (1975)	7 percent
Hoffman (1983)	8-9.5 percent
Hausz and Akins (1980)	7-13 percent

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:

Author	Wheel slip	Advantage of radial	
		Soil	
Forrest (1962)	<15 percent	Sand	8 percent
		Loam	23 percent
		Clay	21 percent
Thaden (1962)	16 percent	—	29 percent
Mumgaard & Rudakov (1975)	15 percent	Firm	15.5 percent
Bohnert and Kenady (1975)	—	Tilled	14.6 percent
		Sod	18.8 percent
Gee-Clough (1977)	20 percent	—	5-8 percent



Field capacity and fuel consumption were studied.

Author	Increase in field capacity for radials	Reduction in fuel consumption for radials
Seleznev and Kovalez (1986)	10.7 percent	13 percent
B.F. Goodrich Co. (1981)	12.3 percent	12.8 percent
Bohnert and Kenady (1975)	—	16.4 percent
Hauck and Kucera (1983)	2.1 percent	6.5-8.1 percent
Hausz and Akins (1980)	5-7 percent	6-10 percent

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.

(Equation 1)

$$TOC = TP \left[\frac{IR (1 + IR)^n}{(1 + IR)^n - 1} \right]$$

- TOC = Tire ownership cost (\$)
 TP = Tire purchase price (\$)
 IR = Annual interest rate (decimal)
 n = Average service life (years)

Unit cost is computed as shown in Equation 2.

(Equation 2)

$$UTC = \frac{TOC}{AU}$$

- UTC = Unit cost (\$/hr)
 AU = Annual tire use (hrs/year)

Fuel cost for radial and bias tires may be computed using Equations 3 and 4.

(Equation 3)

$$F_B = GPH \times UFC$$

- F_B = Fuel cost for bias tires (\$/hr)
 GPH = Fuel consumption for bias tires (gal/hr)
 UFC = Unit fuel cost (\$/gal)

(Equation 4)

$$F_R = F_B (1 - RF)$$

- F_R = Fuel cost for radial tires (\$/hr)
 RF = Reduction in fuel consumption for radial tires (decimal)

Labor cost for radial and bias tires may be estimated as follows:

(Equation 5)

$$L_R = \frac{L_B}{1 + IFC}$$

- L_B = Labor cost for bias tires (the assumed hourly wage rate)
 IFC = Increase in field capacity for radial tires (decimal)

Total savings per hour and hours required to breakeven are computed as follows:

(Equation 6)

$$NSH = (F_B - F_R) + (L_B - L_R) - (UTC_R + UTC_B)$$

- NSH = Net savings per hour (\$/hr)
 UTC_R = Unit ownership cost for radial tires (\$/hr)
 UTC_B = Unit ownership cost for bias tires (\$/hr)

(Equation 7)

$$BE = \frac{TP_R - TP_B}{NSH}$$

- BE = Tire use required for radial cost to breakeven with bias cost (hrs)
 TP_R = Tire purchase price for radial tires (\$)
 TP_B = Tire purchase price for bias tires (\$)

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)

$$TOC_B = 1000 \left[\frac{.09(1 + .09)^5}{(1 + .09)^5 - 1} \right] = \$257.09/\text{yr}$$

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

Unit tire cost: (Use Equation 2)

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

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

Fuel cost: (Use Equations 3 and 4)

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

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

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

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

Labor cost: (Use Equation 5)

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

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

Total savings per hour: (Use Equation 6)

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

Use required to breakeven: (Use Equation 7)

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

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

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