

Klasifikasi Traktor Pertanian

- Jumlah as * 1 – berjalan (hand tractor)
* 2 – riding
- Jumlah as (roda) penggerak:
 - * 1 (2) --- TWD, TWT
 - * 2 (4) --- FWD, FWT
- Elemen penggerak :
 - * Traktor roda karet
 - * Crawler tractor
- Penggunaan roda:
 - * Traksi – konvensional
 - * Propulsi/cultivasi (power tiller)

Type Useful Power

- Transmisi Traction – melalui gerbox (lihat gambar)
 - * Menghasilkan gerak lurus – menarik bajak
 - * Power losses : < 10%
- Transmisi PTO (power take-off)
 - * menghasilkan gerak putar – memutar rotary
 - * Power losses : < 5%
- Transmisi Hidrolik (oli)
 - * Menghasilkan tekanan hidrolik – pengaturan lower link
 - * Power losses : moderate, acceptable

Sistem Transmisi Daya Traktor

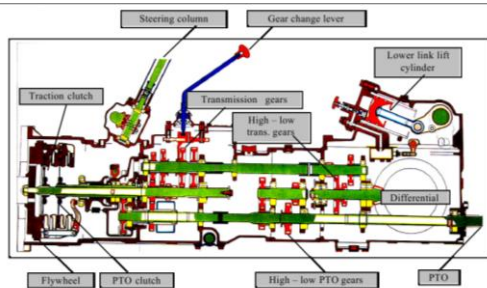


Figure 1.2: Transmission system for a conventional gear drive tractor (Kubota L345)
Reproduced with permission of Kubota Tractor (Australia)

Peralatan Traksi



Roda

- Funtion:
 - * support the tractor weight, limit the sinkage and the resultant rolling resistance.
 - * engage with soil, transmit the traction, limit slip
 - * provide ground ability (springing and shock absorption)
- Variables:
 - * size (diameter and width): determines tractive capacity and rolling resistance
 - * strength (ply rating): determines pressure and weight that the tyre can carry.
 - * tread pattern (thread): determines the engagement with the surface.

TRACTOR MECHANICS (NO LOSSES)

Speed Analysis

Drive wheel diameter = D

Engine speed = N_e

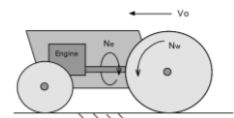
Overall transmission ratio $q = \frac{\text{Engine speed } N_e}{\text{Drive wheel speed } N_w}$

Drive wheel rotational speed $N_w = \frac{N_e}{q}$

Travel speed, V_o = Linear speed of wheels

$$= \pi D N_w$$

$$= \frac{\pi D N_e}{q}$$



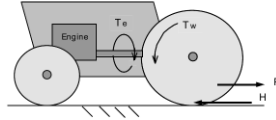
TRACTOR MECHANICS (NO LOSSES)

• Torque Analysis

For the tractor as shown in Figure 2.1(b):

$$\text{Engine torque} = T_e$$

$$\text{Drive wheel torque, } T_w = q T_e$$



Equilibrium requires that this torque is equal and opposite to the moment of the soil reaction, H on the wheel:

$$H \frac{D}{2} = T_w = q T_e$$

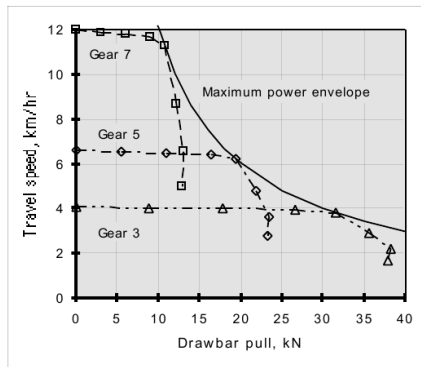
$$H = \frac{2 q T_e}{D}$$

If we assume that there are no other horizontal external forces acting (such as rolling resistance), equilibrium also requires that:

$$\text{Drawbar pull, } P = \text{Soil reaction, } H$$

$$P = \frac{2 q T_e}{D}$$

(2.2)



TRACTOR MECHANICS (NO LOSSES)

• Power Analysis

$$\text{Engine power, } Q_e = 2\pi T_e N_e$$

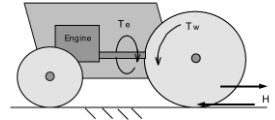
$$\text{Drawbar power, } Q_d = \text{Drawbar pull} \cdot \text{travel speed}$$

$$= P \cdot V_o$$

$$= \frac{2 q T_e}{D} \cdot \frac{\pi D N_e}{q}$$

$$= 2\pi T_e N_e$$

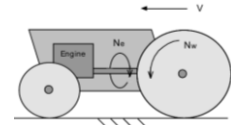
$$= \text{Engine power}$$



TRACTOR MECHANICS (W/ LOSSES)

• Speed Analysis

$$\text{Wheelslip, } i = \frac{V_o - V}{V_o}$$



Where, V_o = theoretical travel speed (as in Equation 2.1 above)
 V = actual travel speed

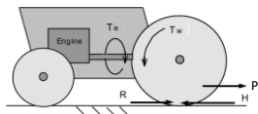
Substituting for V_o from Equation 2.1

$$V = V_o (1 - i) = \frac{\pi D N_e}{q} (1 - i)$$

TRACTOR MECHANICS (W/ LOSSES)

• Power Analysis

$$H = P + R$$



$$\text{Output power} = \text{Input power} - \text{Power loss}$$

$$\text{ie, Drawbar power} = \text{Wheel power} - \text{Power loss}$$

$$\text{Hence, Power loss} = \text{Wheel power} - \text{Drawbar power}$$

$$= 2\pi T_w N_w - P V$$

$$= 2\pi H \frac{D}{2} \frac{V_o}{\pi D} - P V = H V_o - P V$$

$$= H V_o - (H - R) V = H (V_o - V) + R V$$

$$= H V_o i + R V = H V_s + R V$$

TRACTOR MECHANICS

• Tractive Efficiency

$$\eta_t = \frac{\text{Output power}}{\text{Input power}} = \frac{\text{Drawbar power}}{\text{Wheel power}}$$

$$= \frac{P \cdot V}{H \cdot V_o} = \frac{(H - R)}{H} (1 - i)$$

$$= \left(1 - \frac{R}{H}\right) (1 - i)$$

$$= \frac{P}{(P + R)} (1 - i)$$

TRACTOR MECHANICS

• Tractive Efficiency

(i) $\frac{P}{(P+R)}$ which represents a 'force' efficiency; thus when there is no rolling resistance ($R = 0$) this factor in the tractive efficiency = 1.

(ii) $(1 - i)$ which represents a 'speed' efficiency; again when there is no wheelslip ($i = 0$), this factor in the tractive efficiency = 1.

Hence, it is necessary to determine the tractive efficiency by measuring drawbar and wheel power directly by measuring:

- (i) drawbar pull, P , with a tension load (force) cell between the tractor and a load vehicle or implement
- (ii) travel speed, V , by timing over a known distance
- (iii) wheel torque, T_w , with a torque load cell in the transmission to the driving wheels
- (iv) wheel speed, N_w , by counting wheel revolutions over a known time period

$$\text{Then tractive efficiency, } \eta_t = \frac{P V}{2 \pi T_w N_w}$$

TRACTOR MECHANICS

• Engine Efficiency

We can define engine efficiency:

$$\eta_e = \frac{\text{Power from engine}}{\text{Power in fuel}} = \frac{2 \pi T_e N_e}{1000 FC C}$$

where FC = fuel consumption rate, kg/min
 C = calorific value of the fuel, kJ/kg

The maximum value for engine efficiency is dependent on and strictly limited by the thermodynamics of the engine processes. A maximum value of about 35% for a diesel engine can be expected.

TRACTOR MECHANICS

• Tractive coefficient (pull - weight ratio)

$$\text{Tractive coefficient, } \psi = \frac{\text{Drawbar pull}}{\text{Weight on driving wheels}}$$

$$\text{Drawbar pull} = \text{Tractive coefficient} \times \text{weight on wheel}$$

TRACTOR MECHANICS

• Transmission Efficiency

We can define transmission efficiency:

$$\eta_r = \frac{\text{Power to wheels}}{\text{Power from engine}} = \frac{2 \pi T_w N_w}{2 \pi T_e N_e}$$

For good quality gears the maximum efficiency is about 98% per pair of gears; 3 pairs of gears in the change transmission and another 2 pairs in the differential / final drive, results in the maximum efficiency of $(0.98)^5 = 90\%$.

TRACTOR MECHANICS

• Overall Efficiency

We can also define the overall efficiency for the tractor:

$$\begin{aligned} \eta_o &= \frac{\text{Drawbar power}}{\text{Fuel power}} \\ &= \frac{\text{Engine power}}{\text{Fuel power}} \cdot \frac{\text{Wheel power}}{\text{Engine power}} \cdot \frac{\text{Drawbar power}}{\text{Wheel power}} \\ &= \text{Engine efficiency} \cdot \text{Transmission efficiency} \cdot \text{Tractive efficiency} \\ &= \eta_t \cdot \eta_r \cdot \eta_e \end{aligned}$$

Consider typical maximum values for these variables:

$$\begin{aligned} \eta_o &= 0.3 \times 0.90 \times 0.75 \\ &= 20\% \end{aligned}$$