Calculation of power required for cutting

Diameter of the stalk = 12 mm

Area of single stalk $= \frac{\pi}{4} d^2 = \frac{\pi}{4} 12^2 = 113$ mm^2

Cutting force required to cut one stalk of 113 mm^2 area = 36.79 N

Cutting force required for 1 mm^2 area = 0.325 N

Average number of productive tillers per hill = 6

Number of hills in 1 row of 30 × 10 cm spacing = 5 Nos

Total number of productive tillers in the row = 20

Force required for cutting five hills with 30 stalks, N = 36.79 × 30= 1103.7

Force required for idle running of the cutting unit, N = 25.8 kg = 253

Total force required for cutting (N) = 1103.7 + 253 = 1356.7

Cutting stroke, mm = 76.2

Radius, m (r) $= \frac{\text{cutting stroke}}{2}$ = 76.2/2

= 38.1 mm = 0.0381

Torque, Nm = Force (N) × Radius (m)

= 1356.7 × 0.038 = 51.69 Nm

Velocity of cutter bar, m/s (V) = 1.5

V = r ω

ω = 1.5/0.0381 = 39.4 rad s^{-1}

$\omega = \frac{2\pi N}{60}$

$N = \frac{39.4 \times 60}{2 \times \pi}$

= 375.95 strokes min^{-1}

Power $= \frac{2\pi NT}{60} = \frac{2 \times \pi \times 375.95 \times 51.69}{60}$

Power, P_1 = 2034 kW = 2.7 hp

Assume 20 % loss towards transmission and friction,

Power required for single cutting unit $= \frac{2.7}{0.8}$ = 3.3 hp

Power required for conveying, windrowing and collecting

Linear speed of the conveyor belt, ms^{-1} $= \frac{\pi DN}{60}$

Where,

D =Diameter of the pulley, m

N= Speed of the pulley, rpm

Load on the conveyor = weight per hill × No of hills × Safe factor

= 0.25 × 5 × 2 = 2.5 kg

Safe factor = 2

Self-weight of belt with lugs = 2.2kg

Total load on the conveyor, W, kg = Load on the conveyor + Self-weight of belt with lugs

= 2.5 + 2.2 = 4.7 kg

Power required for conveying $(P_2) = \frac{WV}{75} \times$ Factor of safety

$= \left(\frac{4.7 \times 1.47}{75}\right) \times 2$ = 0.18 hp

Power required for driving the screw conveyor $(P_3) = \frac{q_m (L\lambda + h)}{102}$

Where,

Q_m = material feed rate, kgs^{-1}

L = total length of the conveyor, m

λ = material resistance coefficient (1.2 to 4.2)

h = effective elevation at which material is conveyed, m

$$= \frac{0.0022\ (1.6 \times 4.2 + 0)}{102}$$

= 0.00019 hp