Lect.- 9
Numerical on field capacity and power requirement of implements.

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Field Capacity

- The field capacity of a farm machine is the rate at which it performs its primary function,

  i.e., the number of hectares that can be ploughed per hour or the number of tons of hay that can be baled per hour.

  The most common measure of field capacity for agricultural machines is expressed in hectares covered per hour of operation.
- Measurements or estimates of machine capacities are used to schedule field operations, power units, and labour, and to estimate machine operating costs.

Theoretical Field Capacity

Theoretical field capacity (TFC) depends only on the full operating width of the machine and the average travel speed in the field.

It represents the maximum possible field capacity that can be obtained at the given field speed when the full operating width of the machine is being used.

It can be calculated from equation

$$\text{TFC (ha/hr)} = \frac{W \times S}{10}$$

where W = Width of implement in m

S = Speed of travel in km per hr

Effective Field Capacity

- The effective field capacity (EFC) of a machine in the field can be easily calculated by dividing the hectares completed by the hours of actual field time. Recording hectares and hours for several fields over the whole season can be used to find an average field capacity in differing area and weather conditions.
- The effective field capacity of a machine in ha/hr is a function of operating width of machine (measured width and percentage of width actually used).

$$\text{EFC (ha/hr)} = \frac{W \; x \; S \; x \; Ef}{10 \; x 100}$$

where *Ef* = Field efficiency in percentage.

Field efficiency

- A machine cannot maintain its TFC for very long periods of time. The ratio of actual or effective field capacity (EFC) to TFC is called the machine's field efficiency (FE).
- Field efficiency is expressed as the percentage of a machine's TFC actually achieved under real conditions.
- It accounts for failure to utilize the full operating width of the machine (overlapping) and many other time delays. These might include turning, filling seed and pesticide in hoppers, emptying grain tanks, cleaning a plugged machine, checking a machine's performance and making adjustments, and operator rest stops.
- Delay activities that occur outside the field, such as daily service, travel to and from the field and major repairs are not included in a field efficiency measurement.

Machine's material capacity

The working capacity of harvesting machines is often measured by the quantity of material harvested per hour. This capacity is called the machine's material capacity (MC), expressed as tons per hour. It is the product of the machine's EFC and the average yield of crop per ha.

Draft of plough

Total draft- The horizontal component of pull in the direction of motion is known as the total draft.

Unit draft- It is defined as the total draft per unit area of the furrow cross- section.

It is generally used to compare the draft requirements of various ploughs.

It is affected by type of plough, type and condition of soil, depth of ploughing, width of cut, sharpness of cutting edge, speed of ploughing and plough attachments.

$$\text{H.P. developed} = \frac{\text{Draft (kg)} \times \text{Speed (m/sec)}}{75}$$

Numerical

Q.1 Find out the horse power developed by a pair of bullock in pulling a plough at the forward speed of 3 kmph. The plough makes a furrow 20 cm wide and 11 cm deep. The dynamometer indicates an average draft of 85 kg. What will be the unit draft?

Solution:

$$\text{H.P. developed} = \frac{\text{Draft (kg)} \times \text{Speed (m/sec)}}{75}$$

Draft = 85 kg

Speed = $\frac{3 \times 1000}{60 \times 60}$ = $\frac{5}{6}$ m/sec = 0.833 m/sec

H.P. developed = $\frac{85 \times 0.833}{75}$ = 0.944 hp

Unit draft = $\frac{\text{Total draft}}{\text{Cross section of the furrow (cm}^2\text{)}}$

= $\frac{85}{20 \times 11}$ = 0.386 kg/cm^2

Q 2. While testing a two bottom tractor drawn MB plough the following observations were noted:

Total draft indicated by the dynamometer = 1200 kg

Distance moved by the tractor while ploughing = 50 m

Time taken to move 50 m by the tractor = 30 sec

Calculate the drawbar hp developed and the forward speed in km/hr.

Solution:

$$\text{H.P. developed} = \frac{\text{Draft (kg)} \times \text{Speed (m/sec)}}{75}$$

Draft = 1200 kg

Speed = $\frac{50}{30}$ m/sec = 1.666 m/sec

H.P. developed = $\frac{1200 \times 1.666}{75}$ = 26.66 hp

Forward speed (km/hr) = $\frac{50 \times 60 \times 60}{30 \times 1000}$ = 6 kmph

Q 3. Calculate the cost of ploughing a hectare of land by

(a) 15 cm wide indigenous plough

(b) 15 cm wide M.B. plough

pulled by a pair of bullocks walking at an average speed of 2.5 km/hr. Assume that only 80% of the time is effectively utilized in doing the job. Assume cost of ploughing per hectare for indigenous plough and M. B. plough are 4 and 6 Rs, respectively.

Solution:

No. of hours to cover a hectare by indigenous plough

$$\frac{10000}{0.15} \text{ X } \frac{1}{2.5 \; x \; 1000} \text{ X } \frac{100}{80} = 33.34 \text{ hrs}$$

Cost of ploughing by indigenous plough = 33.34 x 4

= 133.36 Rs/ha Say Rs 133 per ha

Similarly number of hours to cover one hectare by M. B. plough = 33.4 hrs

Therefore; cost of ploughing by M. B. plough = 33.34 x 6

= 200.04 Rs/ha Say Rs 200/- per ha

Q 4. A four bottom 35 cm plough is working at a speed of 5 kmph by a tractor. The resistance of the soil is 0.70 kg/cm^2. How much hp is required at draw bar if the plough is penetrating 20 cm deep?

Solution:

Size of plough = 4 x 35 = 140 cm

Depth of ploughing = 20 cm

Area of cross- section = 140 x 20 = 2800 cm^2

Total draft = 2800 cm^2 x 0.7 kg/cm^2 = 1960 kg

$$\text{Draw bar H.P.} = \frac{\text{Total draft (kg) x Speed (m/sec)}}{75}$$

$$= \frac{1960 \times 5 \times 1000}{75 \times 60 \times 60} \text{ hp} = 36.3 \text{ hp}$$

Q 5. A grass field was being cut using mower of width 2 m. The speed of the mower is 4 kmph and efficiency is 80%. How much time it will take to cut the field of 5 ha?

Solution:

Width of the mower cutter bar (w) = 2 m

Speed of mower (s) = 4 kmph

Efficiency = 80%

Effective field capacity = $\frac{w \times s \times Ef}{10 \times 100}$

$= \frac{2 \times 4 \times 80}{10 \times 100}$ ha/h = 0.64 ha/h

Time required for 5 ha = $\frac{5}{0.64}$ = 7.8 hr.