The measurement of performance and power in engines is important because today's farming is much more competitive and has a tighter profit margin than in past years. Efficiency is an integral part of good management so understanding the farm's power needs can save many dollars.

Terms Used in Measuring Power

a. **Horsepower:** The standard unit by which power is measured; one horsepower is equivalent to 33,000 pounds lifted one foot in one minute

$$HP = \frac{\text{Force (lbs.)} \times \text{Distance (ft.)}}{33{,}000 \text{ (ft.lbs./min.)} \times \text{Time (min.)}}$$

NOTE: Metric HP = U.S. Horsepower X 1.18 (approximately)

b. **Torque:** A twisting force measured from the center of rotation

Units are Inch Pounds, Foot Pounds, or Newton Meters.

Torque = Lever Arm Length (in. or ft.) X Force (lbs.)

c. **Work:** Work is done when force travels through a distance.

Force (lbs.) X Distance (ft.) = pounds foot of Work

d. **Energy:** The capacity for doing work

1) Potential Energy - stored energy or energy of position (for example, a ball at the top of a ramp)

2) Kinetic Energy - energy possessed by a moving body by virtue of its motion (for example, a spinning top)

e. **Power:** the rate at which work is done or the amount of work done in a unit of time (HP is only one type of power.) Electrical power is measured in watts, 746 watts = 1 HP

f. **Force:** That which changes or tends to change the condition of rest or motion of the body acted upon; it is measured in pounds. Force has three characteristics: direction, place of application, and magnitude.

Types of Horsepower There are five major types related to farm machinery:

Theoretical HP The calculated horsepower which the design engineer determined the engine should develop.

Indicated HP The power generated by the explosion pressure in the cylinder that is received by the piston.

Brake HP Sometimes called flywheel HP, measured at the flywheel; the actual amount of horsepower that is available to do useful work. (It was originally measured by attaching a braking device, (Prony brake) to the flywheel and measuring the force generated from this unit.)

Rated HP The amount of power that the manufacturer states an engine will create at a specified engine RPM

PTO (power-take-off) HP The horsepower generated at the power-take-off shaft at 540 or 1000 RPM shaft speed

DBHP (drawbar HP) Power developed at the hitch or drawbar and available for pulling or similar tractive effort

(DBHP takes into account wheel slippage as a loss.)

Friction HP The amount of HP loss due to mechanical and friction consumption within the engine or drive train.

Horsepower and Torque

1. As a measure of power, the horsepower formula can be developed around several different constants. The most common are listed below:

$$\textbf{DBHP} = \frac{\text{Force (lbs.)} \times \text{Distance (ft.)}}{33{,}000 \text{ (lbs.)} \times \text{Time (min.)}} \quad \textbf{or}$$

$$\textbf{DBHP} = \frac{\text{Force (lbs.)} \times \text{Distance (ft.)}}{550 \times \text{Time (sec.)}}$$

$$\textbf{Shaft HP} = \frac{\text{Force} \times \text{RPM} \times \text{Length of Torque Arm}}{5252}$$

$$\textbf{Hydraulic HP} = \frac{\text{Pump GPM} \times \text{psi}}{1714}$$

2. Torque is a measure of force exerted to rotate a shaft, where the distance from the center of the shaft and the force are expressed as follows:

Torque = Force (lbs.) X Distance from Center (Length)

Combining the shaft HP formula and the torque formula we can see:

$$\textbf{HP} = \frac{\text{Force X Length X RPM}}{5252} \quad \textbf{or}$$

$$\textbf{HP} = \frac{\text{Torque X RPM}}{5252}$$

Torque then is:

$$\textbf{Torque} = \frac{\text{HP X 5252}}{\text{RPM}}$$

Agriculture Certificate Horsepower

Compute the two problems below:

1. How much horsepower is generated by a tractor that can pull a load of 8500 lbs. over a distance of 655 feet in 2.75 min.?

2. What is the torque generated by an engine running at 2000 RPM and producing 76.16 horsepower? ans. _____ft. lbs.

Determine your own horsepower by going up a set of steps several times and timing how long it takes to do this task. Proceed as follows:

1. List your weight _____lbs. X number of times stairs climbed

2. Height of stairs climbed _____ feet

3. Time to complete task _____seconds

$$\text{Formula: HP} = \frac{\text{Total Wt. X Height Stairs (ft.)}}{550 \text{ X Time (seconds)}} = \text{ans.}\_\_\_\_\_.$$