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Equipment Efficiency and Capacity

9.1. Objectives

1. Understand the concept of efficiency and be able to apply it to agricultural operations.
2. Understand the concept of capacity and be able to apply it to agricultural machines.
3. Be able to calculate effective field capacity.
4. Be able to calculate the throughput capacity of agricultural machines.

9.2. Introduction

To be efficient means being able to produce the desired results with a minimum of effort, resources, or waste. This is a concept that permeates our lives. A part of every occupation is the desire to improve the product or services by producing more for less or a better product for the same input. Engineers are constantly trying to improve the efficiency of operations by reducing the energy requirements and/or wastes from agricultural and manufacturing processes. When referring to machinery, efficiency is an evaluation of how well a machine does the tasks that it is designed to perform.

Capacity is a measurement of the amount of performance that has occurred. The evaluation of a machine’s capacity is an important evaluation because under utilization of a machine increases the production costs and over utilization can lead to increase repair, maintenance costs, and shorten machine life.

9.3. Efficiency

In this chapter, we will use the concept of efficiency to evaluate how well a machine performs its designed task in terms of quantity and/or quality of performance. Owners and managers of farm enterprises are deeply concerned with efficient operation of equipment and other resources because inefficient operation leads to
Efficiency greater operating expenses and reduced profits. Efficiency is usually expressed as a percentage. A percentage is calculated by comparing to quantities and multiplying by 100. Because efficiency is a ratio of two quantities having the same units, the units cancel.

Efficiency can be expressed mathematically in several forms. In the most general terms, efficiency can be expressed as:

\[
\text{Efficiency (E)} = \frac{\text{output}}{\text{input}} \times 100
\]

Efficiency is the ratio of what we get out of something relative to what we put in. If the output is 9 units (pounds, hours, etc.) and the input 10 units, the efficiency is:

\[
\%E = \frac{9 \text{ units}}{10 \text{ units}} \times 100 = 90\%
\]

Or, if the output is 5 units and the input 10 units, the efficiency is:

\[
\%E = \frac{5 \text{ units}}{10 \text{ units}} \times 100 = 50\%
\]

Efficiency can also be determined by comparing the actual performance to the theoretical performance. This equation is:

\[
\%E = \frac{\text{actual}}{\text{theoretical}} \times 100
\]

It is important to remember that an efficiency calculation provides a mathematical answer to a problem. It is only a tool or information that can be used to make a decision. For example, if you determine that the fuel efficiency of an automobile is 20 miles per gallon that is not sufficient information to determine if the automobile is performing satisfactory. This number must be compared to the historical performance, manufacturer’s guidelines or other data to make a decision on its acceptability.

9.3.1. Mechanical Efficiency

Mechanical efficiency has to do with how well machines convert energy from one form to another. For example, an internal combustion engine converts the chemical energy in fuel into power. Internal combustion engines are not 100% efficient because all the energy in fuel is not converted power (the majority of the heat produced escapes through the radiator and out the exhaust). A typical gasoline engine is about 22% efficient; a diesel engine is 30 to 33%. An electric motor converts electrical energy into power with an efficiency of 95 to 98%. The efficiency of mechanical power trains and other mechanical devices can be determined if accurate numbers for the power in and power out can be determined.