

Rice Production Manual

Matching Equipment to Farm Size

1. Introduction

Selecting the correct size and type of equipment is important to maximize field efficiency and farm profitability. Matching equipment to a farm or business is a step by step process that requires an understanding of the most important tasks, the time required for their completion and the efficiency of each operation.



2. The Matching Process

1. Determine the most critical operation

For each farm, there will be a number of critical operations that must be done on time during the cropping cycle. In many rice growing localities the critical operations will be the land preparation and harvesting. It is important to know the window of time available to complete the different operations in a timely manner. This knowledge can be gained through local experience and climatic data and may also be influenced by other players such as the availability of labor or service providers.

2. Determine the area to be completed per hour. .

The size of the equipment is determined by knowing what area must be covered in the time available and the field efficiency of the operation. For instance most tillage operations should be completed within a 10 day period. If the farmer can work 10hrs per day then there is 100hrs available to complete the task. If 10ha of land must be plowed then the area that needs to be completed is 1000m² /hr.

3. Field Efficiency

When undertaking a task not all of the time is spent in productive work. For example when plowing, field efficiencies may range from 50-75% depending on the shape of the field, the soil conditions, the overlap of equipment and the number of stops taken by the operator. In the example above if the theoretical area needed is 1000m²/hr and the field efficiency is 50% then realistically the equipment must be able to cover 2000m²/hr.

4. *Speed of operation.*

The speed of operation depends on the power source, the type of equipment, soil type and moisture contents. A 4-wheel tractors can operate efficiently from 5-8 km/h where as a 2-wheel tractor's speed will be determined by the operation and the operator. Normal walking speed of the operator is between 3-5 km/h. The speed of operation using an animal will be determined by the animal and the operator- normally 1-3 km/h

5. *Width of equipment*

Once the speed of operation and the area per hour is known it is a mathematical calculation to work out the width of the implement. By dividing the area in m²/hr by the speed in meters /hr the width of the implement can be calculated

For instance if a 2 wheel tractor is required to plow 2000m and the operating speed is 5km per hour then the width of the equipment will be:

$$\begin{aligned} &= 2000 \text{ m}^2 / \text{h} / 5000 \text{ m} / \text{hr} \\ &= 0.4 \text{ m width.} \end{aligned}$$

6. *Determine power requirement of the tractor*

For each implement type and soil conditions the total draft requirement can be calculated. This requires some understanding of soil implement relationships. Most primary tillage implements will require between 4-6 KN or 400-600 kg/m pull per 1m width of plow. Secondary tillage requirements will be about 75% of this,

7. *Power requirement*

The power required is determined by the width of the implement, draft required to pull the implement, the forward speed and the efficiency of the tractor in converting engine power to drawbar power. The equation to determine engine power becomes

Engine power = Total draft x speed x tractor efficiency/ 3.6

If we need a plow of 0.4m wide, draft of 6kN /m and a speed of 4km/hr, and a tractor efficiency of 30% then the engine power can be calculated as follows:

$$\begin{aligned} \text{Actual engine power} &= 0.4 \text{ m} \times 6 \text{ kN/m} \times 4 \text{ km/hr} / 0.3 \text{ (tractor efficiency)} / 3.6 \\ &= 8.9 \text{ kW (9kW rounded up)} \end{aligned}$$

As the tractor cannot work continuously at maximum power, an allowance needs to be made- 70-80% are typical figures that can be used. This means that if an engine power requirement of 9kW has been calculated then allow another 25% -30% or 2-3kW.

Therefore the size of the 2-wheel tractor engine will need to be 11-12 kW.

A similar exercise can be done for selecting a planter, combine harvester or any other power driven piece of equipment

3. Other considerations

When selecting the tractor there are many other factors that need to be considered. Gear ranges available, traction capabilities, versatility of use and service and spare parts facilities. This also applies to all equipment with spare parts and service backup being much more important than the initial purchase price.