

Rice Production Manual

Farm Power

Rationale

Farm power is one of the most expensive and critical inputs when growing a rice crop. All operations require a certain amount of power and often the success of a crop is dependent on the ability to get the task completed on time. In the past much of the power used on farm came from human inputs but with much of the rural labor force now moved to cities, farmers are becoming more dependent on machines to complete tillage, planting and harvesting operations.

Objectives

At the end of this lesson participants will:

- Have an understanding of the different power sources used in rice farming
- Identify the control levers for different types of tractors
- Conduct a preliminary maintenance check before starting a tractor.
- Have a basic understanding of how to safely operate a tractor

Key Activity

This lesson introduces the concept of farm power and the different types of power sources. It also provides hands on experience in basic tractor maintenance and operation.

Farm Power

1. Introduction

Farm power is one of the most expensive and critical inputs when growing a rice crop. All operations require a certain amount of power and often the success of the crop depends on the ability to get the task completed on time.

In the past much of the power used on farm came from human inputs but with much of the rural labor force now moved to cities, farmers are becoming more dependent on machines to complete tillage, planting and harvesting operations. Humans, animals and machines are all used as sources of power in agriculture production.



When undertaking different operations on a farm, a certain amount of work/energy is required to complete the task. When this work is undertaken over time, it is then called power. Power or the rate of doing work can be expressed as horsepower (hp) or Kilowatt (kW). One horsepower is equivalent to 0.75 Kilowatt. Often it takes the same amount of energy to complete a task and as the table shows, time is the major variable.

Table Comparisons of different power source to plow 1 ha.

	Human	2 -Animals	2-wheel tractor	4-wheel tractor
Power		1kW	12 kW	40kW
Distance	750 m-3 moved or 100 truckloads soil	50km	20km	5km
Time (days)	120-140	10-12	1	2hr
Hours/day	5-6	5-6	8-10	10-12
Energy (hour)	2MJ	22MJ	170MJ	775MJ
Work (MJ /ha)	1560	1584	1530	1550

2. Human Power

Many tasks on farm are still undertaken using people as the power source.

Manual tasks undertaken and time required include:

- Land preparation (120-160 days /ha)
- Plant establishment (25-35 days/ha)
- Weeding (30-40 days/ha),
- Crops harvesting and transporting (30-40 days /ha)
- Transport. (5-10 days)

In some instances manual labor is still more efficient and precise than machine.

Many countries are now suffering from rural labor shortages and have had to develop and use machines to complete tasks on time. In Africa between 80-90% of all farm tasks are still done manually.



3. Animal power

Animals are still widely used as the major power source in many countries. Land preparation, weed management, crop threshing and transport are undertaken using animal power. Oxen and caribou or buffalo are the most popular animal power source for agricultural practices although horses, donkeys, mules and camels are used in many countries for transportation. Caribou/buffalo are considered to be hardier and stronger than oxen. Oxen are normally used in pairs while buffalo are often used singularly. In Africa, between 10-15% of tasks are undertaken using animals

The advantages of using animals include they are cheap to maintain, have a multipurpose use for meat and milk, are self-replacement and produce manure.

The disadvantage of using animals include: they have limited daily working hours, animals need feeding and protection against pests and disease, they are slow, a high man/power ratio is needed, they have limited range of working conditions and they require training.

One animal will take approximately 10-12 days to plough 1 hectare and cost up to \$US 500 each.



4. Engine powered tractors

There are 3 broad groups of engine powered tractors used for rice production. These are 2 wheel tractors, 4 wheel tractors and track laying tractors.

Two wheel tractors (also called walking tractor, iron or steel buffalo, hand tractor)

Two wheel tractors are used in many rice producing countries. These tractors have a forward mounted engine which is counter balanced by the equipment attached behind the two drive wheels and the operator walking behind.



They are normally powered by 6-12 kW gasoline or diesel engines and are fitted with either rubber tires or steel cage wheels. Rubber tires are commonly used when dry land plowing and for transportation. Cage wheels are necessary for all wet workings. Most makes incorporate an independent drive clutch as well as individual steering clutches or brakes. Three forwards and one reverse working gear are most common.

Two wheel tractors are used for land preparation, which includes plowing and land leveling, transportation and pumping water. The attachments used with 2 wheel tractors are the moldboard plough, the disc plough, harrows, and rotovator.

The advantages of two wheel tractors are:

- Multi purpose vehicle especially for transport
 - Operate in harder conditions than animals or humans
 - Operate in both wet and dry conditions
 - Fairly simple mechanical design
- Disadvantage
- Cost of owning and operating
 - Operators fatigue, although rides on versions are now available.



The cost of a 9 kW (12 hp) walking tractor range from \$US110 to \$US270 per engine kW, depending on the make of the engine and location. Two wheel tractors in Africa are nearly double the price in Asia. One 9 kW walking tractor, with two operators, is capable of plowing 1 ha / day. While fuel usage depends on engine size and working conditions, fuel consumption will range from 2-5 liters per hour.

Four wheel tractors

Four-wheel tractors can be divided into 3 categories; two wheel drive, front wheel assist or unequal four wheel drive and equal four wheel drive tractors. Each one of these tractors has different tire configurations and different ballast requirements.

Two Wheel Drive tractors (2WD) are the most commonly used tractors in dry or upland farming situations and for transportation. They range in size from 4-150 kW and require 75%- 80% of the weight distributed over the rear axle to maximize traction. These tractors are capable of delivering 45-50% of their rated engine power at the drawbar.



The advantage of this type of tractor over other 4 wheel tractors is:

- Smaller turning circle,
- Simplicity of design,
- Fewer mechanical parts, and
- Lower purchase price.

The major disadvantage is the inability to work in very wet and muddy conditions. When these tractors are used in a wet farming situation they will require cage wheels attachments to the rear drive for traction.

Front Wheel Assist or Unequal Four Wheel Drive (FWA)

are the most popular 4 wheel tractor used in rice production in Asia and Africa. These tractors range in size from 15-180 kW and are capable of delivering between 50-55% of the rated power at the drawbar. The front drive tires, whilst larger than two wheel drive front tires, are smaller than the rear tires. These tractors require 40% of the weight over the front axle and 60% over the rear axle to maximize traction. As all four wheels turn simultaneously, the front and rear tires must travel at the same speed. Because the front tire is generally 30% smaller than the rear tire it must turn at least 30% faster. Tire pressures must also be set and maintained correctly (18psi front-14psi rear). Front wheel drive should be used at all times when the tractor is working in the field. If not at least 10% efficiency will be lost.



The major advantage of a FWA tractor is that it can deliver 10% more power to the ground for the same fuel consumption, and has much better traction and flotation capabilities than 2 wheel tractors of the same size. These tractors normally cost about 10-15% more than the same size 2-wheel drive tractor. A major disadvantage is that this tractor type has more mechanical failures, displays unequal tire wear front to rear and may be less maneuverable than a 2 wheel drive tractor.

Other Types of tractors

Equal Four Wheel Drive tractors (4WD) have all four tires of equal size and range in size from 25- 450kW. Irrespective of size, these tractors should be ballasted with 60% of the weight distributed over the front axle and 40% over the rear axle. This tractor type has the greatest power to weight ratio and can deliver between 55-60% of power at the drawbar. Very few of these tractors are used in rice production in Asia or Africa because of their large size, greater turning radius and high purchase price

Track laying tractors. (Chain tractor, crawler, Caterpillar)

Agricultural track layers range in size from 15 - 250 kW. Tracks can be made from rubber or steel and vary in width depending on the application. Weight distribution for agricultural purposes is different from that for industrial use. Because the load is applied to the rear of these tractors, weight distribution should be similar to that for an equal 4 wheel drive tractors. These tractors can deliver between 60-65% of their engine power at the drawbar and are most efficient where flotation is a problem.



Tracklayers have been imported into many rice growing countries but their major use has been in industrial and forestry regions. Very few are used in rice farming as they have high purchase price, high repair and maintenance costs and are not efficient when working in smaller paddy fields or water.

Table . Summary of Power sources

Power source	Human	Animal	2-wheel tractor	4 wheel tractor		Tracklayer
				2-wheel drive	4-wheel drive	
Common Names		Ox, Caribou, Buffalo, Camel, Donkey	Walking tractor, steel buffalo,		Front wheel assist	Caterpillar, Steel tractor
Power comparison	0.06	1	10-15hp	15-60 hp	60-120hp	40-200hp
Timeliness of plowing	129-160 days	10-12 days per ha	1ha/day	0.5 ha/ hr (40hp)	1 ha/hr (80hp)	
Distance travel (plow 1 ha)	50km	50km (20cm plow)	20km (50cm plow)	10km (1m plow)	5km (2m plow)	