

01

Reference Manual on

Land Preparation

A Compilation of Resources



Philippine Center for Postharvest Development and Mechanization (PHilMech), 2020

Published by: Department of Agriculture Philippine Center for Postharvest Development and Mechanization (PHilMech) CLSU Compound, Science City of Muñoz, Nueva Ecija, Philippines

Disclaimer: The appearance of names/photos of branded agricultural machines is meant to present available products in the market. It does not mean endorsement of the products by PHilMech.

2020

ISBN: 978-971-9947-12-7

Cover Design by: Jett Molech G. Subaba





Philippine Center for Postharvest Development and Mechanization (PHilMech), 2020

FOREWORD

The Philippine Center for Postharvest Development and Mechanization (PHilMech) is mandated to generate, extend and commercialize appropriate and problem-oriented agricultural and fishery postharvest and mechanization technologies and systems.

With this mandate, PHilMech works diligently at mechanizing the production or postproduction operations of all agricultural commodities available in the country. Rice is one of the major programs of PHilMech in terms of mechanization especially in the advent of free trade and the passing of the Rice Tariffication Law or the RA 11203. Through this law, the Rice Competitiveness Enhancement Fund or RCEF was funded where farmers are groomed to be as competent as its neighboring countries.

As stated in the law, PHilMech will receive 50 percent of the 10 billion peso-fund each year for RCEF Mechanization Program to facilitate the distribution of the machinery grants to qualified rice-producing farmers' cooperatives and associations (FCAs).

To support and make sustainable the program in mechanization, extension services like training courses, enterprise development and communication support have also been funded to educate, train and empower these FCAs.

In the area of communication support, the project aims at increasing the knowledge and interest of the farmers to adopt and utilize rice mechanization technologies in their production to postharvest operations.

One way to increase their knowledge is by producing helpful and comprehensive references on rice production and postharvest systems that can guide them toward the path of competitiveness. Thus, PHilMech compiled reliable and comprehensive sources of information both from other agencies and from our experts to come up with this manual.

The series of reference manuals for FCAs include topics on the different farm operations from land preparation, plant establishment, harvesting and threshing, grain drying and up to rice milling. Each includes principles, knowledge and practices to effectively mechanize farm operations. This will not only educate the farmers but also reach even the new generation of farmers among the different FCAs in the country.

Land Preparation	1
What is land preparation?	1
Why is land preparation important?	1
What are the two systems of tilling rice fields?	1
Principles and Systems of Land Preparation for Rice Production	2
What is tillage?	2
What is the purpose of tillage?	2
What are the types of tillage and their usage?	2
Why is equipment matching important in land preparation?	3
What are the things to consider in equipment matching?	3
What are the advantages and disadvantages of the tilling systems?	3
What are the steps in using wetland tillage system for rice field preparation?	3
What are the steps of rice field preparation using combination of dryland and wetland preparation?	4
What are the factors that influence the method of land preparation for rice production?	4
What are the types of tillage implements and their applications?	5
What is the importance of tillage patterns?	7
What are the common patterns used in tilling a field?	7
What field preparation conditions are suitable for mechanical transplanting?	8

1

Dperation and Maintenance of Land Preparation Machinery and Equipment	1
What are the functions of tractors and implements?	1
What are the controls and safety levers of four-wheel drive tractors?	1
What are the pre-operation activities when using a four-wheel drive tractor?	1
How to operate a tractor at optimum efficiency?	1
What are the pre-start safety checks in using a tractor?	1
What are the few safety measures in using a tractor?	1
What are the basics of driving a tractor?	1
How to attach and remove a trailed implement on a tractor?	ź
How to connect and remove trailed implements with remote hydraulics?	2
How to attach and remove a PTO-driven implement?	é
How to attach and remove a three-point linkage implement?	2
Maintenance, Troubleshooting and Management	é
What are the malfunctions and basic troubleshooting of engine?	é
What are the basic preventive maintenance for land preparation machinery?	3
What are the site asst apprective management activities?	3

Land Preparation

A. What is land preparation?

Land preparation is the process of preparing the soil to provide a favorable soil environment for plant germination and growth.

B. Why is land preparation important?

Land preparation is essential to have better crop yield and favorable soil environment. It is through land preparation that the rice field is properly prepared and ready for planting.

Conventional land preparation methods are mainly done to control weeds, incorporate fertilizers, increase soil porosity and aeration, mix the soil to bring up leached deposits, and give the soil a fine texture for better adsorption, puddling and leveling.

C. What are the two systems of tilling rice fields?

In the country, there are two identified systems of rice culture, namely wet land preparation and dry land preparation.

Wet land preparation

- Has access to a nearby water supply
- The field has a loamy to clay soil type
- Paddy embankments are established enabling field to be flooded

Dry land preparation

- Limited water supply of rain fed areas
- Limited labor power
- The field has a sandy soil type
- The field has a well-established hard pan

One of the interventions of the RCEF Rice Mechanization Program is the provision of land preparation machinery and equipment. It aims to reduce production cost through appropriate use of the technologies such as four-wheel drive tractor, hand tractor and floating tiller.

Principles and Systems of Land Preparation for Rice Production

A. What is tillage?

Tillage is the process of mechanically altering some physical characteristics of the soil for it to be ideal for growing crops.

Land preparation covers different practices like zero tillage, minimum tillage and full tillage.

- Zero tillage or no-till farming involves no disturbance of the current soil condition prior to planting hence the name zero tilling.
- Minimum tillage refers to cultivation of the soil with minimal physical change to the soil structure like the still-strip method.
- Full tillage or intensive tilling operation involves the total breaking of the soil structure creating a different physical property for the rice field. It is the most laborious type of tilling operation.

B. What is the purpose of tillage?

- Tillage loosens and aerates the top layer of soil, which facilitates planting the crop.
- It helps mix harvest residue, organic matter and nutrients evenly into the soil.
- It mechanically destroys weeds.
- It manages soil water.
- It destroys insects and their eggs, larvae and breeding places.

C. What are the types of tillage and their usage?

- Primary Tillage
 - Primary tillage is the first tillage activity after the last harvest. Normally, this is the most aggressive tillage operation. It is normally done using primary tillage implements such as disc plow and moldboard plow.
 - It is usually done at a depth of 10 to 15 cm with varying clod sizes. It destroys weeds and promotes soil aeration and water accumulation.

· Secondary Tillage

- It is done after the primary tillage using tillage implements such as disc harrow, rotavator, or peg tooth type harrow.
- In wet preparation of paddy field for rice production, secondary tillage is usually done 2 to 3 times.
- This tillage also controls weeds, puddles the soil, incorporates fertilizers and levels the soil surface

D. Why is equipment matching important in land preparation?

Equipment matching and correct selection of tillage equipment and implements are important in land preparation. Mismatching of equipment and implements can affect the cost of tillage, field efficiency of the equipment, effectiveness of the equipment, time required to finish the work to be done and maintenance wear and tear of equipment and implements.

E. What are the things to consider in equipment matching?

- Knowing the specific and critical operation that need to be done at a certain period of time
- Determining the area to be accomplished
- Available prime mover, facilities, equipment and implements
- · Field efficiency and capacities of available technologies

F. What are the advantages and disadvantages of the tilling systems?

Tabla	1 Advantance	and diand	100t0000	aftha i	Lillian automa
lanie	I AUVADIADES	and disad	VANIANES	(1)	HIIINA SUSIEMS
		0110 01000	101100900		and gogotorno

	Advantages	Disadvantages
Wetland Tillage	 Improves weed control Facilitates incorporation of organic materials and soil amendments Provides good soil condition for crop establishment 	 Needs high water requirement Unfavorable for subsequent establishment of rice-based crops
Dryland Tillage	 Requires less water Helps control golden snail Promotes soil aeration 	 High power requirement Lack of suitable equipment

G. What are the steps in using wetland tillage system for rice field preparation?

- Repair the dike to impound water
- Irrigate the field
- Perform primary tillage operations
- Keep the field submerged for 5 to 7 days to soften the clods and to decompose organic materials
- · Harrow the field 2 to 3 times with 5 to 7 days interval
- Level the field

H. What are the steps of rice field preparation using combination of dryland and wetland preparation?

- Plow the field at dryland condition. Use a disc harrow semi-mounted to a four-wheel tractor
- · Use a rotavator mounted to a four-wheel tractor for light soil
- Harrow the soil using a rotavator at dry condition

I. What are the factors that influence the method of land preparation for rice production?

• Source of irrigation water

- Water is an important element in land preparation. Its volume or quantity, and its availability for use at farm level influence the method of land preparation to be employed.

Rice establishment systems

- Direct seeding or transplanting as system of rice establishment requires specific methods of land preparation.

- A well puddled and leveled field prepared at least a day or two before transplanting is favorable for mechanical transplanting.

· Availability of technology

- Land preparation technologies, equipment and implements have their own specific design capacities, applications and power requirements. Knowing their availability would fit the different methods of land preparation.

Cost and sustainability

- An approach to increase productivity of rice production is to reduce cost and expenses in land preparation and other processes of production.

- One major issue is the sustainability of rice production. Land preparation practices will determine the sustainability.

- Right timing and appropriate land preparation method should be carefully studied to ensure sustainability of the rice farming.

Characteristics of the soil and vegetation

- Soil type, soil characteristics and existing vegetation should be considered in determining what method to employ in land preparation.

- In lowland rice production, the depth of the hardpan is very important. Its depth will affect the method of land preparation.

J. What are the types of tillage implements and their applications?

000		
Tillage Implements	Functions	Application
Moldboard Plow	 Causes total inversion of the soil sod and relies on the digging point for penetration Causes the least damage to soil structure; works well in very hard soil conditions but does not have built-in stump or obstacle protection mechanism Has very heavy power requirement. Kills weeds through inversion and pulverization of the soil sod 	 Commonly used in animal and 2-wheel powered tractor All systems are mounted on the tractor, either 2-wheel tractor or 4-wheel tractor (The moldboard normally throws the soil in one direction but reversible models are available for larger 4-wheel tractors)
One way Disc	 Causes total inversion of the soil sod and relies on the plow's built-in weight for penetration Works well in hard soil and heavy trash conditions and can ride over stumps or obstacle in the soil Will ride out of the ground if soil conditions are very hard 	 Used in 2-wheel and 4-wheel tractor (The number and size of disc shares vary according to the power source. 2-wheel tractors will use 2 or 3 disc plows, while a 4-wheel tractor will pull 3, 4 or 7 disc versions)
Offset Disc	 Very aggressive action of the plow gives good weed control and cuts and buries crop residues 	 Only used on 4-wheel tractors and are very versatile Widely used in upland areas (An offset plow can be operated in any plowing pattern and can be either 3-point linkage mounted or a trailed)
Rotavator	 Commonly used for secondary tillage although in some cases when moisture of soil is favorable, rotavator is also used for primary tillage 	 Can be used in dry or wet tillage

Table 2. Primary tillage implements and their functions and applications

Г

Table 3. Secondary tillage implements and their functions and applications

Tillage Implements	Functions	Application
Peg Tooth	 Degree of aggression is determined by the angle of operation. The more upright the harrow the more aggressive is the action. 	 Widely used in animal and 2-wheel tractor for second tillage activities, soil puddling and land levelling
Disc Cultivator	 Degree of aggression is determined by the gang angle relative to the forward travel Normally used in dry fields The very aggressive action of the plow gives good weed control and cuts and buries crop residues. This plow is also widely used in upland areas. 	 Used in 4-wheel tractors and are made up of either 2 or 4 gangs of discs (The discs are smaller than on a one-way or offset plough and the machine is much lighter)
Tined Cultivator	 Very versatile implements as they can be used for secondary tillage and modified to be used as a seed drill Used only in dry working situations as they cut the soil rather than invert the soil and kill weeds by cutting and lifting the weeds to the surface (Sweeps range from 50mm to 200mm in width). 	 Used with animals and 4-wheel tractors and are very versatile (These plows can be configured as 3-point linkage mounted or trailed)
Rotavator	 Have a very aggressive action, which pulverizes the soil and buries weeds and crop residues. 	 Used with 2-wheel and 4-wheel tractors in both upland and flooded fields (Can also be used for primary tillage in flooded situations)

K. What is the importance of tillage patterns?

- To minimize the number of turns and maximize the length of the tillage runs
- · An optimal tillage pattern reduces the time spent in non-productive work

L. What are the common patterns used in tilling a field?

· Circuitous pattern

The machine begins working along a boundary, continues along the other boundaries of the land, then returns to its starting point. This pattern works from the outside to the center of the field and is the most commonly used system for plowing in Asia. It uses moldboards, discs and offset discs.

This is the system common with animal-power tillage. It requires less spatial judgment by the operator than working in a land type system. The major disadvantage of this system is that the field ends up with a large cut out furrow in the center.

Up and back or headland pattern

The field is plowed running parallel to each other. It starts at one boundary of the field and ends at the opposite with turns being made on the headlands. This system can only be used for tined implements, rotavators, harrows and reversible plows. It is the most field efficient system and if the equipment is correctly set up and operated, it will not leave furrows in the field.

Land system

This system requires plowing to begin in the center of the field and works out to the edges. It requires some measurement of the field to establish the center point and if done correctly leaves a level field with drainage channels on the edges. This system can be used with all types of plows. In very large fields, a number of lands may be plowed.





M. What field preparation conditions are suitable for mechanical transplanting?

Field Preparation	Usual Practice	Effects	Recommendations	Benefits
Properly levelled rice fields	Presence of high spots especially at the corners and upper part of the paddy field	 High percentage of missing hills Soil stick to transplanter wheels Water stressed resulting in: (stunting, rolling of leaves, burning of leaf tips, leaf drying or senescence, delayed flowering, possible whiteheads (with tillers attached to the stem) 	 Field levelling can be done using a leveler Maintain a flat even surface when harrowing High spots can be determined by flooding the paddy field 	 Higher yield Better weed control Larger farming area Faster seedling/Less work Better use of water
Right soil condition	Right soil condition Harrowing and levelling is done a day before or the day of planting		 Soil should be firm enough to hold the rice seedlings when transplanted Field levelling at least 1-2 days before transplanting Newly puddled soil is not recommended to be planted immediately by mechanical transplanting 	 Good placement of seedlings Fast recovery of planted seedlings Less mortality rate
Correct level of water in the field	-No water -Too shallow -Too deep water	 No water or too shallow – soil stick to the wheel and picking fork Too deep – high percentage of seedlings will float 	 When planting, maintain a uniform depth of 1-2 cm standing water while transplanting and up to 4-5 days after planting Too deep: more than 4 cm Too shallow: 0 cm 	 Easier operation of transplanter Correct distance between hills can easily be maintained Uniform distribution of seedlings per hill and between hills Faster recovery of seedling

Table 4. Suitable field preparation conditions

Table 4. (Continuation)

Field Preparation	Usual Practice	Effects	Recommendations	Benefits
Right depth of puddled soil	Too deep	 Transplanter floater pushes the soil Uneven distance between hills and rows Low field efficiency performance of transplanter High missing hills 	 Prepare the fields to a depth of 5-10 cm (2-4 inches) using a harrow or cultivator. Puddled fields should be levelled and the soil allowed settling for 12-24 hours The hardpan depth should be at 20 cm depth. More than 25 cm depths of field, the transplanter can no longer work efficiently 	 High performance efficiency Easy operation of the transplanter
Well decomposed weeds and straws and properly mixed with the soil	Presence of fresh weeds and stubbles in the puddled field	 Yellowing of rice plant Uneven growth of rice plant Debris gets clogged at the transplanter floater 	 Weeds, rice straw, and stubble should be plowed under the soil and are thoroughly decayed For weedy field, it takes at least 21 days to prepare the field so as to ensure decomposition of weeds Less weedy fields requires lesser time to prepare the rice field for planting 	 Uniform and good plant growth High presence of organic matter like humus
Paddy field should be free from debris and stones	Presence of debris and stones		 Remove stones and debris in the field Do not use mechanical transplanter in stoney rice field 	 Damage of picking pins and fork of the transplanter can be avoided if the field is free from debris and stones

Г

Operation and Maintenance of Land Preparation Machinery and Equipment

A. What are the functions of tractors and implements (IRRI, 2011)?

Table 5. Functions of tractors and impleme
--

Machine	Function	Advantage	Disadvantage
Two-wheel drive tractors (2WD)	 For dry or upland farming and for transportation Range in size from 10 to 30 HP Need 80 percent of the weight distributed over the rear axle to maximize traction Capable of delivering 45 to 50 percent of their rated engine power at the drawbar 	 Have smaller turning radius Simple design Fewer mechanical parts Cheaper 	 Inability to work in very wet and muddy conditions Requires cage wheels on the rear drive when used in wet soil condition
Front-wheel assist (FWA)	 Most popular four-wheel tractor used in rice production Range in size from 35 to 45 HP Require 40 percent of the weight distributed over the front axle and 60 percent over the rear axle Capable of delivering between 50 to 55 percent of the rated power at the drawbar 	 Can deliver 10 percent more power to the ground for the same fuel consumption Have much better traction and flotation capabilities Cost about 10 to 15 percent more than the same size two-wheel drive tractor) 	 Have more mechanical failures Displays unequal tire wear front to rear More difficult to maneuver than a two-wheel drive tractor
Equal four-wheel drive	 Have four equal size tires Range in size from 45 to 95 HP Should be ballasted with 60 percent of the weight distributed over the front axle and 40 percent over the rear axle 		 Very few of these tractors are used in rice production in the Philippines because of their large size Greater turning radius and price

B. What are the controls and safety levers of a four-wheel drive tractor?

Stop pulling knob

- Most important control device of the tractor
- It is essential for operators to know where this device is located and how it works
- Works by pulling the knob out, but in many new models of tractors the knob is replaced by a key and functions by turning the key off

Brakes

- Brakes are built with two independent pedals which are fitted to be interlocked when operating for transport. When the tractor is used in the field, the lock is removed to allow the operator to pivot, turn and improve maneuverability

· Clutch pedal

- For disengaging the tractor's drive train to the engine and for shifting the gears
- One of the clutch pedal's major functions is to engage and disengage the power-take-off (PTO)

Throttles

- Hand throttle is used when operating the tractor in the field
- Pedal throttle is only used when operating on roadways, and not when in the field

Gear levers

- First lever has two ranges namely, high and low and is usually labeled as hare and turtle.
- Second lever also known as the "main shift gear" lever has three to four gear shifts and one reverse gear. Other more advanced tractors have 18 forward gears and two reverse gears

Light switches and warning lights

- Head lights are used when operating at night
- Signal lights are used as warning lights for road travel
- Other warning lights on the dashboard indicate problems like malfunctioning components and overheating of the engine

PTO control lever

- Activates the PTO shaft to power the implements like rotary tillers, mowers, pumps and cultivators
- Shaft is located between the rear wheels behind the tractor differentials

· Front wheel engagement lever or button

- Improves the traction of the front wheels by engaging the front axle of the tractor. Its indicator light engages when used

Draft control lever

- Activates the tractor's lift arm, also known as the rockshaft, that enables the vertical movement of the attached implement

Position/height/depth control lever

- Manages, controls or adjusts the implement during operation in the field
- Controls how deep the implement should dig the soil

• External hydraulic control valve

- Raises and lowers the attached drawbar implements like plows, trailers and buckets mounted in front of the tractors by activating this valve

Drop valve

- Controls how the implement is being dropped. Too much speed during lowering may cause damage to the implement and injury to the operator. For safety, the speed of the drop valve is adjusted slowly

Differential lock

- Located at the side of the driver seat
- Commonly activated when the drive wheels do not have enough traction or when the wheels begin to slip causing the machine to bog down

C. What are the pre-operation activities when using a four-wheel drive tractor?

Field assessment

- Field inspection and preparation
 - Check if the field conditions are suitable for the assigned task
- Removal of obstructing materials or objects
 - Remove stones, tall grasses, foreign materials like bottles, cans, plastics to avoid damage to the tractor implements and to have a smooth maneuverability of machinery
 - Cut tree branches to allow sun light into the field

• Preparation of machine

- Machines and implements
 - Check and adjust the machine to ensure that the proper implement for specific task is securely hitched
 - Check if tires are properly inflated
 - Check the oil, water and fuel levels and air cleaner condition. This precaution prevents delay on operations and maximizes the operating time of the machine
 - For transporting, check tractor side mirrors and signal lights
- Safety and personal protection
 - Safety check

- Wear suitable clothing and foot wear. Avoid wearing loose clothing or any dangling accessories that may clip or catch on moving parts of the tractor.

- Rollover protective structure (ROPS)

- A feature of the farm tractor that protects the operator when a rear rollover occurs. This safety feature of agricultural tractors combined with fastening of seatbelt puts the operator within a safety frame that prevents the operator being tossed out of the tractor during operation.

NOTE: Do not remove or make any indentions, holes or revisions on the ROPS.

D. How to operate a tractor at optimum efficiency?

- · Know your equipment and its limitations.
- Pay special attention to the danger, warning and caution labels on the tractor itself.
- Use ROPS in almost all applications. ROPS will reduce the risk of serious injury or death, in case the tractor overturns/ roll over incidents.
- Do not operate the tractor or any implement attached to it while under the influence of alcohol, in medication or feeling exhausted.
- Check the vicinity before operating the tractor or any implement attached to it. Check also the overhead clearance which may interfere with ROPS. Do not allow any bystanders around or near the tractor during the operation.
- Before allowing other people to use the tractor, explain how to operate it and have them read the manual before operation.
- Use appropriate clothing when operating the tractor to avoid any accident.
- Do not allow any passenger to ride on any part of the tractor at any time. The operator must remain in the tractor seat throughout the operation.
- Check brakes, clutch, and other mechanical parts for improper adjustment and wear. Replace worn or damaged parts promptly. Check the tightness of all nuts and bolts regularly.
- · Keep the tractor clean to avoid personal injury.
- · Use implements meeting the specifications and approved by the manufacturer.
- Use proper weights for the front or rear of the tractor to reduce the risk of upsets. Follow the safe operating procedures specified in the manual.
- The narrower the tread, the greater the risk of a tractor upsets. For maximum stability, adjust the wheels to the widest practical tread width.
- Do not modify the tractor. Unauthorized modification may affect the function of the tractor and may cause personal injury.

E. What are the pre-start safety checks in using a tractor?

Preliminary checking

- Check that safety guards are in place. Check for loose or damaged parts, such as nuts and bolts, drawbar and three-point linkage pins. Check the drawbar and three-point linkage security
- Check for oil, fuel or water leaks from pipes and hoses. (Inspect the ground directly underneath the tractor for drips or wet areas)
- Check the tire treads and walls that may have cracks, tears and uneven wear or embedded pieces of steel or timber

Free play of clutch and brake pedals

The free travel measurement is the distance these pedals can be depressed before resistance is noticed.

Brakes

Make sure that both pedals are unlocked before you check the brakes. Check each brake separately and make sure that each has exactly the same free travel. Checkout the operator's manual as the correct measurement varies between makes and depends on the type of brakes. Approximately 20 mm of brake pedal free travel is usual in a mechanically-operated shoe brakes. If the measurement is not correct, adjust it by shortening or lengthening the linkages. As required, once completed, lock the pedals together again.

Clutch

For recommended free travel distance and where to take the measurement, always refer to the operator's manual. The free travel distance may range from 13 to 50 mm or more depending on the machine and where the distance is measured.

If an adjustment is necessary, locate the pedal adjusting mechanism. The adjustment is usually made near the pedal or it may be anywhere along the linkage leading to the clutch release mechanism. Adjust the linkage until the clutch pedal has the proper amount of free travel.

Check brake and clutch fluid levels

- For correct fluid levels, check the brake and clutch reservoirs (if applicable). If a level is excessively low, top it up with recommended fluid and investigate the cause of fluid loss

• Steering wheel free play

- Some tractors may need the engine running to test the steering free play. Refer to the operator's manual

• Check steps and handrail

- Ensure that the steps and handrail are in place, secured, undamaged, and clean

• Check the operator's platform

- Check and remove obstructions such as ropes, rags, tools, toolboxes, chains and anything else that obstructs the operator's platform

• Be ready with a fire extinguisher

- Check that the fire extinguisher is fitted and operational. Refer to the workplace occupational health and safety (OHS) policy about the location and operation of fire extinguishers

• Have a first aid kit

- Ensure that the first aid kit is available and accessible in a service vehicle or in a dust proof area of the tractor

F. What are the few safety measures in using a tractor?

- Rollover Protection Structure or ROPS
 - The ROPS will protect the operator when an overturn happens. The seatbelt is an important part of it.
- PTO shield
 - The PTO shield is the little metal guard that keeps articles of clothing or hair or anything like that from getting tangled in the PTO shaft when it is turning.

- Never get off the tractor and do anything with the implement or with the PTO shaft when it is running.

Clutch safety switch or starter interlock

- This little device will not allow the starter to engage unless the clutch pedal is fully pressed.

Implements

- When transporting with implements raise them up on lift or use a front-end loader in front of the tractor. Move around with those implements as low as possible to avoid imbalance and decrease the likelihood of an overturn.
- But with these on the front, raise the three-point lift and pick the implement up in the back, counterweight. To keep everything stable, keep the front wheels of the tractor on the ground.

G. What are the basics of driving a tractor?

- Before starting
 - Carry-out daily checks and maintenance tasks. Make sure to take an all-round check for obstacles and people before mounting the tractor
 - Make sure the footbrakes are latched together and the hand brake firmly applied. Identify and understand all the controls
 - Always sit in the driver's seat when starting the engine. Buckle and adjust seat belt. Put on ear protection. Select the correct gear for the conditions
 - Refer to the operator's manual for detailed instructions and specifications of the tractor
 - Check that all gear levers are in neutral. Place PTO and hydraulic levers in neutral position. Leave implements down
 - Check that fuel cut-out control is in the run position. This is normally a push/ pull knob which is pushed in to start and run. However, this can vary in different tractors
 - Open throttle to fast idle and check that the handbrake is applied. Depress the clutch pedal fully then turn the key to the start position

- When the engine starts, release the clutch pedal slowly. When the engine is running, check that all warning lights have gone out and that the instrument gauges show correct readings
- Do not allow the engine to idle for long periods. Do not leave the tractor running unattended

Moving off

- Double check for all-round clearance of people and obstacles. Check that all items of equipment are secured. Check the cowling latches and brake pedal latches. Ensure reading instruments are working correctly. Make passengers (if any) safely positioned in legally approved passenger seats
- Depress the clutch (first stage on a two-stage clutch) and select required gear.
 Release the parking brake. If the tractor starts to roll, hold it with the foot brake.
 Open throttle control sufficiently to prevent stalling the engine when load is applied.
 Don't over rev the engine
- Release the clutch pedal slowly and steadily. As the load is taken, release the foot brake. If the engine revs tend to drop, increase throttle's setting slightly. When the clutch is completely engaged, remove foot from the pedal. (Never ride the clutch or brake pedal)
- Adjust the throttle to suitable operating speed. Check the instruments and gauges at frequent intervals. Check that the brakes are functional

Safe driving

- Smoothly engage the forward gears to suit the appropriate speed and load. Drive at a safe speed at all times. Fast driving is the cause of many accidents. Do not drive tractors with thumbs wrapped around the inside of the steering wheel. Some steering systems other than power steering may cause injury to the thumbs if an obstacle is struck
- Engage the lower gear before starting to go down a slope. Never change gears while descending and do not rely on the brakes. Avoid turning uphill on very steep slopes. If it is essential to do so, turn gradually and at minimum speed. It is safer on two-wheel-drive tractors to keep the larger wheels uphill, even to the extent of reversing up slopes

Slowing to halt

- Always use the throttle to slow down then use the clutch and footbrakes to stop

- Remember, tractor brakes will not stop as quickly as car brakes
- Be extra careful on loose surfaces

• In an emergency

- Slow down to halt but know how to stop the engine. In many tractors, turning the key will not stop the engine. A fuel shut-off lever has to be pulled or pushed
- Check the operator's manual

• Parking a tractor

- 1. Choose a site. If possible, park on a flat ground with the tractor out of gear or in park. Place the fuel cut-off stop to "off" position
- 2. If unavoidable to park on sloping ground, leave the forward gear when facing up a slope or leave the reverse gear when facing down a slope
- 3. Disengage gears and PTO
- 4. Apply the parking brake
- 5. Lower all hydraulically-operated equipment
- 6. Stop the engine. Normally the tractor is parked with the implement down, handbrake on and out of gear
- 7. Close throttle
- 8. Operate the fuel cut-off
- 9. Switch off ignition and all electrical equipment
- 10. Remove the key. If the tractor will not be used again that day, refuel

• Reversing and turning a tractor

Tractor (without trailer)

- 1. Position the tractor square on to the implement
- 2. Engage reverse gear and put your feet on the clutch and brake pedals (locked together)
- 3. Check for all-round clearance; insist that no one is in the tractor's path
- 4. Reverse at slowest speed, minimum throttle setting and lowest gear ratio
- 5. Be careful when backing up to an implement, it requires maximum care and concentration on the part of the operator, an error could seriously damage the equipment, kill or injure a co-worker

Tractor (with trailer)

- 1. Sit in the driving seat to see the back corners of the trailer deck or sides
- 2. Start with the tractor and trailer in a straight line
- 3. Do not watch the front wheels, the front of the tractor or the drawbar. Just watch the back of the trailer
- 4. Attempt to back the trailer in a straight line, using the LOW ratio reverse gear, proceed slowly backwards, watching the trailer as it veers off line
- 5. If it veers to the right, turn the steering wheel down to the right also known as right hand down, until the trailer stops moving off to the right
- 6. Try as far as possible to keep movements or turning of the steering wheel to minimum

Tractor (turning with trailer)

- 1. Have the competency and skills before doing this task
- 2. Turn the steering wheel in the opposite direction of where the trailer will go
- 3. Remember, every movement of the steering wheel will require a correction to straighten the tractor and trailer to go to the desired direction
- 4. In turning while reversing a trailer, always use a low ratio, not high

20

H. How to attach and remove a trailed implement on a tractor?

• Hitch the implement

- Always adjust the drawbar height as recommended by the operator's manual. When attaching an implement to the drawbar, use a jack, jack stand, or block to hold the implement tongue at the height of the drawbar. Do not try to lift heavy equipment by hand for it may result to injury.
- Position the tractor square-on to the implement and slowly back the tractor until the drawbar hole aligns with the implement hitch hole(s). If there are problems on aligning the hitch, back the tractor beyond the hitch points with the implement and tractor drawbars in line. Insert the drawbar pin in the implement hitch hole then inch forward or back. When the holes align, the pin will drop into place.
- Place the tractor in park and apply the handbrake before dismounting. Place the drawbar pin through the holes. Secure it to prevent it from coming out during operation. Use drawbar pins that have locking devices to keep them in place. Never use fingers to align the holes or to raise or remove any implement.

Unhitch and detach the implement

- Check the operator's manual for the hitching and detaching of the implement. Implements are usually stored in lowered position.
- Stop the tractor and place it in park with the handbrake on. To uncouple wheel-carried equipment on sloping ground, chock the wheels to prevent it from rolling. If the ground is soft, position a bearing plate (e.g. solid timber) under all support stands. Lower stands or position supports, as many implements are not balanced when unhitched from the tractor. Support the implement drawbar in a correct height for easy hitching next time. Remove and store drawbar pin.

Work safely

- Be careful when attaching and unhitching heavy equipment.
- Ensure that both the operator and the assistant know the appropriate hand signals.
- Before attaching or removing any type of implement, always consult the operator's manual for safe and correct procedures, both for the tractor and the implement.
- If possible, always connect and disconnect implements on flat ground.
- Never try to operate the tractor when attaching or removing implements. Reverse towards the implement slowly.

- Hitch only to the drawbar
- Be careful with heavy loads when travelling downhill. Select appropriate gear and trailer loading.
- Do not allow passengers on towed equipment.
- Maintain safe travel speeds.
- Use transport links (safety chains)
- Put wide machines in transport position
- Watch out for overhead hazards.
- Be careful when making sharp turns.

I. How to connect and remove trailed implements with remote hydraulics?

• Hitch the implement

- 1. Use a jack, jack stand, or block to hold the implement tongue at the height of the drawbar. Do not try to lift heavy equipment by hand.
- 2. Position the tractor square-on to the implement and slowly reverse the tractor until the drawbar and implement hitch holes align.
- 3. Place the drawbar pins through the holes then secure them to prevent them form coming out during operation.
- 4. Use drawbar pins that have locking devices to keep them in place. Never use fingers to align holes.

Connect remote hydraulics

- 1. Determine whether the hydraulic ram is single-acting or double-acting and if the tractor supplies one-way, two-way or both types of pressure.
- 2. Check that there is no pressure in the hose from the previous operation.
- 3. Connect the hoses to the remote hydraulic couplings by pushing the hose end into the tractor coupling until engaged.

22

• Operate hydraulic system

- If the implements are with double acting hydraulic rams, connect both hoses to the tractor before operating the implements.
- Do not operate double acting hydraulic rams with one hose disconnected because the ram can multiply the applied pressure from the tractor (e.g. 2,000 psi or 14,000 kPa).
- The ram seals or hoses may rupture and spray high pressure oil; the remote hydraulics will usually work even if the hoses are placed incorrectly.

Disconnecting hydraulic hoses

- 1. Drive the tractor and implement to a firm, level and well-drained site.
- 2. Lower all hydraulically-operated components.
- 3. Disconnect the hoses in turn and stow them away from dust and water.
- 4. Ensure that connections and dust caps are clean. Replace the dust caps as soon as each hose is disconnected.
- 5. Make sure the hoses are not kinked or twisted when stowed.

Unhitching and detaching the implement

- 1. To prevent from rolling, chock the wheels when uncoupling a wheel-carried equipment on a sloping ground. If the ground is soft, position a bearing plate (e.g. solid timber) under support stands.
- 2. Lower stands or position supports because many implements are not balanced when unhitched from the tractor.
- 3. Support the implement drawbar at the correct height so that it will be ready for the next hitching. Remove and store the drawbar pin.
- 4. Check the manufacturer's instructions for the implement. Store implements in lowered positions.

J. How to attach and remove a PTO-driven implement?

• Before attaching a PTO shaft

- 1. Make sure that the tractor parking brake is on, the PTO drive is disengaged and the tractor is out of gear or in park with the engine stopped.
- 2. Attach the mounted implement to the three-point linkage or hitch trailed implement to the tractor.
- 3. Fasten the drawbar at the center position when attaching a PTO-driven trailed implement to a tractor.
- 4. If you are using a three-point linkage implement, check if the tractor drawbar will be in the way of the PTO shaft or the implement.
- 5. Ensure that the implement is leveled and adjusted for safe and efficient operation.

Check the coupling

- Check the coupling of the power shaft to make sure it has the same number of splines or grooves as the stub shaft on the tractor.
- The 540 rpm stub shaft has six splines while the 1,000 rpm stub shaft has 21 splines.
- If the tractor has a high speed (1,000 rpm) and low speed (540 rpm) PTO, use the correct coupling to suit the implement to be operated.

Check the power shaft

- Check that when the power shaft is fully extended, enough part of the sliding shaft remains in the housing (at least 150 mm) so that the shafts do not separate when the tractor is in motion.
- Make sure that the sliding shaft does not bottom out when the shafts are fully compressed.
- Check that the two halves of the PTO have the correct lengths and section sizes for the implement in use, and are securely connected with the universal joints in the same plane.

Spring loaded lock

- 1. Turn the tractor's engine off then slide the power shaft onto the stub shaft until resistance is felt.
- 2. Depress the pin and move the shaft about 1 cm further, and then release the pin.
- 3. Push the shaft forward and the locking mechanism will snap into a slight groove in the stub shaft and the power shaft will be locked in place.
- 4. Try to move the power shaft back and forth to see if it slides in the stub shaft. If it does, the mechanism has not locked.
- 5. Always check that the locking mechanism has engaged before you operate the tractor.

Disconnecting the PTO shaft

- 1. Apply the parking brake, disengage the PTO drive then put the tractor in neutral or park.
- 2. Lower the implement and stop engine before attempting to disconnect the PTO shaft.
- 3. Reverse the connection steps and slide the power shaft off the PTO stub shaft.
- 4. Do not hammer the universal joint when removing it from the stub shaft.
- 5. Make sure the power shaft is off the ground and stored securely, replace the PTO stub shaft cover as soon as the power shaft has been disconnected.
- 6. Replace the PTO master shield then disconnect and store the implement.

K. How to attach and remove a three-point linkage implement?

Method 1

This method is used when the ground is not level or the implement has a 'floating' or 'non-fixed' head stock.

- Reversing the tractor up to implement
 - Reverse slowly towards the implement, make small, careful tractor movements, always use a low reverse gear and slip the clutch to control the speed and distance of the movements.

- Use the height or position control to set the ball end of the left draft link to the correct height
- After the tractor is correctly positioned, apply the handbrake and stop the engine.
- Move all controls to neutral before dismounting from the tractor

Connect the left draft link

- Attach the left draft link first because the right lift link is usually equipped with a crank adjustment to position the right draft link if it is too low or high for connection.
 If the left draft link ball does not align with the pin because it is too far forward or rearward, start the tractor and move it into position.
- Attach the left draft link and secure it with a linchpin. Never use a finger to align any holes. Check all linchpin spring rings are in good condition; replace when necessary.

• Connect the right draft link

- If the right draft link ball does not align with the pin because it is too low or too high, then adjust the right lift link with the crank adjustment.
- If the right draft link ball is too far forward or rearward, adjust the position of the tractor by using the steering and moving the tractor forward or rearward.
- Apply the handbrake and put the tractor in neutral then attach the right draft link and secure with a linchpin.

Connect the top link

- Set the turn buckle of the top link so it is exactly in the center, there must be an even amount of thread extending from each end.
- Adjust the top link by turning the turn buckle so it can be connected to the head stock of the implement.
- Insert the linkage pin into the appropriate hole of the head stock and secure with a linchpin.
- Do not use a finger to align any holes. Raise the implement. Fit stabilizer bars/ check chains if necessary then fit all locking devices.

· Level the implement

- To raise or lower the implement make necessary adjustments
- Level the implement from side to side and front to rear. Adjust the top link to level from front to rear, adjust the right linkages to level from side to side and adjust the stabiliser bars/check chains if necessary and secure all adjustments.

· Lowering the implement before detaching the implement

- Drive the tractor into the required position and place any needed wooden blocks and/or stands in place to support the implement before lowering it.
- Do not support implements on stones, bricks or rotted timber
- Before lowering the implement, set the rate of drop control according to the weight of the implement if necessary.
- After lowering the implement, check if it is fully supported and secured before detaching it from the tractor.

• Detaching the implement

- Stop the engine, apply the parking brake and check that the gear and PTO levers and hydraulic controls are in neutral positions.
- Always follow the correct order: (1) Disconnect all hydraulic connections, (if applicable); (2) Disconnect PTO shaft (if applicable). Replace PTO cover over PTO as soon as the shaft has been disconnected. Do not engage the PTO drive after the shaft has been disconnected; (3) Remove stabilizer bars/check chains (if fitted); (4) Disconnect 3-point linkage by reversing the hitching steps; and (5) Always safely store top link, linkage pins, linchpins and bushes.

Method 2

Method 2 is easier to use than method 1 but use this method only where the ground is level and the implement has a fixed headstock.

Method 3

This method is used for unstable implements that may tip or roll forward or backwards during connection (for example rotary hoes).

Maintenance, Troubleshooting and Management

A. What are the malfunctions and basic troubleshooting of engine?

- Engine fails
 - Inspect/check the injection pump solenoid together with the wiring system. Replace solenoid when needed
 - Replace fuel pump if damaged
 - Replace the fuel filter and clean or replace the air filter when air filter or fuel filter is saturated
 - Bleed the filter if air is in the fuel system
 - Change/replace the cover that holds the breather if clogged
 - Drain the tank and refill with proper fuel if water invades the fuel tank or incorrect fuel is used
 - See brand dealer for problems in valve seat, valve spring and internal engine wear

• Engine constantly stops

- Replace the injection pump solenoid if necessary
- Replace fuel pump if damaged
- Replace or clean fuel filter if air and/or fuel filter is saturated
- Bleed filter if air invades the fuel system
- Change/replace the cover that holds the breather if clogged
- Drain the fuel tank and fuel filters if water invades the fuel tank
- Clean the engine breathing tube when oil pan breathing tube is clogged

• Excessive fuel consumption

- Change lubricating oil with manufacturer's recommended lubricating oil
- Replace and clean the air or fuel filter when air or fuel filter is saturated

28

- Change nozzle of injection pump if malfunctioning
- Adjust injection timing when injection quality is uneven and improper
- Drain oil tank and refill with proper diesel fuel
- Remove and clean the tube using solvent when oil pan breathing tube is clogged
- Check proper implement is attached to the tractor or check if the adjustment is correct when there is excessive load in the equipment
- Excessive lubricating oil consumption
 - Change the oil using the manufacturer's recommended oil
 - Clean or change the filter if air filter is saturated
 - Replace valve sleeve, rings or valve guides if worn out

Internal knocking

- Caused by improper or defective injector, incorrect injection timing, incorrect valve play, incorrect oil level, loosen engine flywheel and worn out internal parts of the engine. Consult with the manufacturer for necessary solution

• Excessive pressure in the oil pan

- Remove the tube and clean with solvent when breather-tube is blocked
- Replace sleeves and rings, valve retainers, guides and worn out valves as prescribed by manufacturer

Overheating

- Perform a general cleaning of the radiator when external obstruction occurs at the radiator's core
- Clean or replace the filter external element if air filter is saturated
- Change oil with manufacturer's recommended lubrication oil
- Check or replace the injection pump nozzle if it's malfunctioning

- Perform a general internal cleaning of the radiator if thermostatic valve or water pump malfunctions or there is clogging
- Regularly check the water level of the radiator
- Replace head gasket or check with dealer
- Replace broken valve springs or check with manufacturer
- Excessive lubricating oil consumption
 - Change the oil using the manufacturer's recommended oil

Low oil pressure

- Regularly check the level of oil in the crankcase
- Change the oil using the manufacturer's recommended lubricating oil
- Ask assistance of dealer when marker malfunctions

• White-smoke

- Drain the tank and refill with pure and clean fuel when water invades in the fuel tank

Blue-smoke

- Change oil using manufacturer's recommended lubricating oil
- Remove and clean the breathing tube when breathing tube is clogged

• Black-smoke and lack of power

- Change the fuel pump if damaged
- Drain tank and refill with the proper fuel
- See manufacturer or dealer when injection pump malfunctions and injection timing is incorrect

• Engine does not start

- Check battery if it is not charging or its terminals/links have poor or loose contact
- Check engine starter engine relay might be defective
- Check level of fuel and fuel filter
- Drain fuel tank and refill it with pure and clean diesel. Bleed the system when air or water invades the feeding system
- Clean and replace the air and fuel filters that are clogged or saturated
- Check if the injector pump solenoid or connections are defective listen if there's a small crank noise inside the solenoid when turning the ignition key to the first position. Otherwise, the electrical connection is interrupted or the solenoid is clogged. In this case replace the solenoid

· Battery does not reach the load even when working

- Have the battery tested. Replace it if it is sulfated (there is build-up of sulfate crystals), or damages vases due to lack of maintenance of the solution level or due to long inactivity without charge
- Trace where short circuit occurs and replace
- Clean all the components using hot water, then air dry and polish with sand paper after drying

Fuse and bulbs frequently blow

- Trace where short circuit occurs. See dealer or manufacturer if necessary
- Battery could be overloaded. Check regulator or alternator. Call dealer or manufacturer if necessary
- Use appropriate bulb for the machine

Excess slippage

- Use compatible implement for the machinery and adjust properly

- Replace tires when tire claws are worn
- Use proper tires. For ground with poor support use tires with high claws. For high traction services in hard ground use tires with low claws with proper width

• Gearbox "scratched" the gears

- The use of oil with improper degree GL (clutch oil) causes the scratching of the gears even in the synchronized gearboxes
- Adjust the clutch play when incorrect play in the clutch pedal happens
- Always step on the pedal all the way until the end of its course when incomplete pressure of the clutch pedal occurs

B. What are the basic preventive maintenance for land preparation machinery?

- Daily servicing of a tractor
 - Cooling system. Check for leaks, underneath the radiator and engine. Also check the radiator hoses between the engine and the radiator as well as the engine components and accessories for oil leaks
 - Drawbar and three-point linkage. Check tire treads and walls for cracks, tears and uneven wear or embedded pieces of steel or timber
 - Engine oil. To check the engine oil level, the tractor must be standing on level ground, allow approximately 10 minutes after the engine has stopped for the oil to drain down into the sump
 - Water cooling. Use a cloth to remove the cap and inspect when the engine is cool
 - Engine cooling. Check the radiator, cooling fins, fans and air ducts
 - Fuel filter system
 - Air cleaner (dry type)
 - Air cleaner (oil bath type)
 - Lubricate and grease fittings

C. What are the cite post-operation management activities?

• Waste management

Proper waste management for unwanted solid and liquid materials from farm activities must be done to avoid health risk. In accordance to existing Philippine Laws on proper disposal and usage of waste material farm operators can attain safe and effective working environment.

- Solid waste
- Liquid waste

• Work area management

- Clean and maintain according to OHS and enterprise requirements
 - A considerable amount of farm accidents may be prevented when the work place is properly cleaned, and properly maintained
- Lighting
 - Lights must be free from cobwebs, shelves must be located on areas where it doesn't destruct the flow of light into the work area making ample visibility when working
- Cleanliness
 - Floor and working tables must be free from clutter and unused tools to avoid accidents. Tools and small materials like nails and screws are to be placed on shelves and containers for safe keep and longer tool life
- Signage
 - Visible hazard signage and information materials are strategically posted around the work area. Shelves are recommended to be labelled.
- Observe 5S implementation:
 - Sort
 - Systematize
 - Shine
 - Standardize
 - Sustain

Records system management

o Record keeping for tractor maintenance and safety

- Proper record of activities and maintenance for farm machineries is a good practice for future reference and liability.

Sample of recording system:

Tractor Maintenance Record

Tractor type:

Date	Activity	Findings	Maintenance Done	Name of Mechanics	Remarks

Tractor Operation/Utilization Record

Tractor type:

Date	Activity	Findings	Maintenance Done	Name of Mechanics	Remarks



RM No. 1: Land Preparation

Г

NOTES



RM No. 1: Land Preparation

Г

REFERENCES

- Barger, E. L., J. B. Liljedahl, W. M. Carleton and E. G. McKibben. 1963. Tractors and their Power Units. 2nd ed. New York, New York: Wiley.
- Bureau of Postharvest Research and Extension. 2008. Postharvest Reference Guide. Science City of Munoz, Nueva Ecija , Philippines: BPRE.

Gravely. Undated. Professional 2-wheel Tractor, Owner/Operator's Manual. USA: Ariens Company.

Hunt, D. 2001. Farm Power and Machinery Management. 10th ed. Ames, Iowa: Iowa State Press.

- IKISAN Agri-Informatics and Services Division. Nagarjuna Fertilizers and Chemicals Limited. Undated. Cultivation Practices. Hyderabad, India. http://www.ikisan.com/cultivationpractices. html
- IKISAN Agri-Informatics and Services Division. Nagarjuna Fertilizers and Chemicals Limited. Undated. Rice Land Preparation. Hyderabad, India. http://www.ikisan.com/ap-ricelandpreparation.html
- Informed Farmers. Undated. Quality Information for Busy Farmers. Retrieved from http://www. informedfarmers.com/
- IRRI. Undated. Rice Knowledge Bank. Retrieved from http://www.knowledgebank.irri.org/
- Kepner, R. A., R. Bainer and E. L. Barger. 1978. Principles of Farm Machinery 3rd ed. Westport, USA: AVI Publishing Company, Inc.
- Klein, P. and A. Zaid. 2002. "Land Preparation, Planting Operation and Fertilisation Requirements". Date Palm Cultivation. FAO Plant Production and Protection Paper 156 Rev. 1. In http://www.fao.org/docrep/006/y4360e/y4360e0a.htm.
- Philippine Agricultural Engineering Standards. Volume 1 (118:2001) and (119:2001). Laguna, Philippines: UPLB, AMTEC.
- Philippine Rice Postproduction Consortium. 2003. Rice Postproduction Technology A Technical Reference Guide. 101 E. Rodriguez Sr. Ave., Quezon City, Philippines: Philippine Rice Postproduction Consortium (PRPC).
- PhilRice. Undated. Land Preparation Manual. Science City of Muñoz, Nueva Ecija. http://www.scribd.com/
- The Rice Postproduction Operations Committee. 2001. The Philippines recommends for rice prostproduction opeartions. Los Banos, Laguna: PCARRD, BPRE, and PARRFI.
- Yanmar Co. Ltd., Undated. Yanmar Service Manual, Industrial Diesel Engine. Osaka, Japan: Yanmar Co. Ltd.

38

EDITORIAL BOARD

Subject Matter Specialists: Engr. Raul R. Paz Aldrin E. Badua, Ph.D. Engr. May Ville B. Castro Engr. Niño D. Bengosta

Editors:

Milagros B. Gonzalez, Ph.D. Bezt Gee S. Magararu Jett Molech G. Subaba

> Editorial Assistant/ Layout Artist: Christine V. Ang



Website | www.philmech.gov.ph

Facebook | @philmech

Email Address | rcefmechanization@gmail.com



Philippine Center for Postharvest Development and Mechanization (PHilMech) Science City of Muñoz, Nueva Ecija, 3120, Philippines