

# DA-PHILRICE MULTICROP REDUCED-TILL PLANTER OPERATIONAL GUIDEBOOK

FOR RICE, CORN, AND MUNGBEAN



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DA-Philippine Rice Research Institute

2022



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# Foreword

**T**he Philippines has a very low level of mechanization in rice and corn production. Agricultural modernization increases production efficiency; hence, the need to address factors that incur the biggest cost in rice production. Hired labor expenses, for example, account for 30% of the total cost of rice production.

Our most widespread method of direct seeding is broadcasting on a tilled and furrowed field. While machines for crop establishment are being developed, most of these are focused on the irrigated environment. The use of mechanical seeders adapted to rainfed upland and lowland areas is scarce, particularly those that require minimum tillage before sowing.

This guidebook aims to provide information on the operation and maintenance of a locally developed multi-crop reduced-till planter for rice, corn, and mungbean. The planter is especially designed to work on semi-well-prepared soils at pre-calibrated seed rates, with an option to simultaneously apply basal fertilizer.

It is hoped that the intended users of this guidebook, such as our agricultural technicians, extension workers, service providers, and farmers, find it useful as a learning material for the proper operation and maintenance of the planter.



**John C. de Leon**

Executive Director, DA-PhilRice



*The Multicrop Reduced-Till Planter at work.*

# Introduction

Reduced tillage requires specialized seeding equipment designed to plant seeds into slightly prepared soil. Planting machines dispense seeds at controlled rates by means of metering devices, and drop them uniformly at a desired depth and spacing without injury. Some machines are also equipped with a fertilizer applicator, which applies fertilizers uniformly into the soil without mixing with the seeds.

In the Philippines, the most widespread method of establishing direct-seeded rice is by manually broadcasting seeds on tilled soil. Until recently, row seeding using the manual plastic drumseeder has started to gain interest among farmers. The major advantage of using mechanical row seeders is the reduction of labor requirement and further improvement of emergence because seeds are drilled at uniform depth. Row seeding also promotes uniform crop stand and facilitates efficient weeding between rows. However, reported constraints of mechanical direct seeders include limited seed flow and workability range. Most of the local mechanical row seeders that cater to several crops are driven by two-wheel tractors (Bautista et al., 2019) and can only accommodate small farm. Multi-crop planters drawn by small- to medium four-wheel tractors are imported; thus, costly for farmers to acquire.

The Department of Agriculture - Philippine Rice Research Institute (DA-PhilRice) developed this low-cost and locally manufactured multicrop reduced-till planter that can seed/drill different crops and can work in minimally tilled soil at a predetermined seeding rate, with an option to simultaneously apply basal fertilizer. This planter has a higher field capacity and can create business opportunity through customized machine-hiring services.

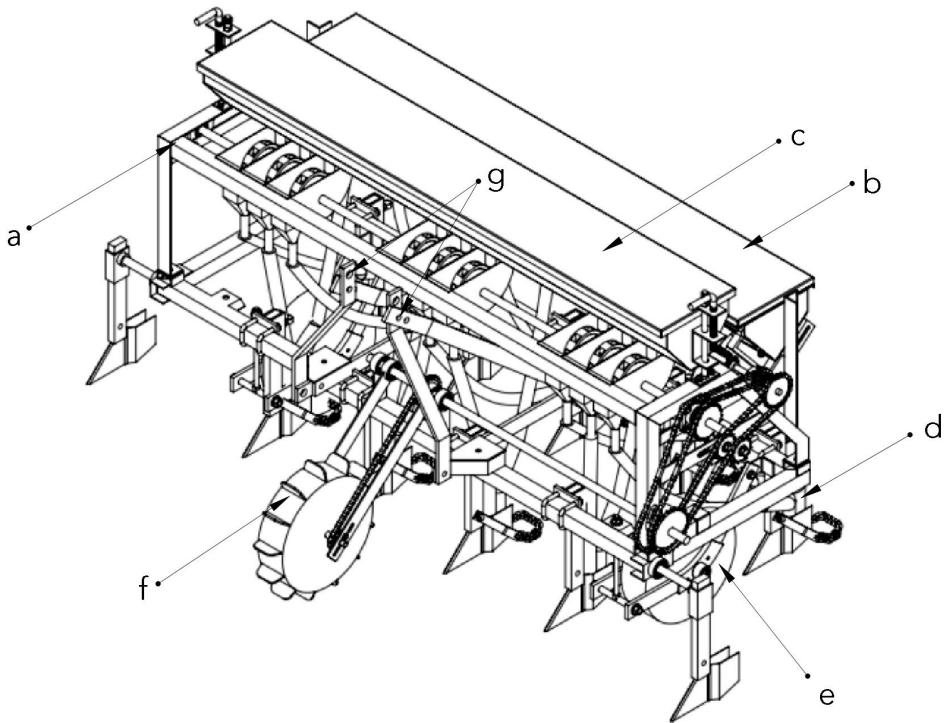
# Description of the multicrop reduced-till planter (MC RTP)

The MC RTP is a localized version of the multicrop zero-till planter from India (Kapil, 2012) that was modified by DA-PhilRice to suit local field conditions like those areas with heavy clay. It is fabricated using locally available materials. Unlike the zero-till planter, which directly drills seeds on undisturbed soil or with zero tillage, the MC RTP was designed to work on soils prepared using minimum or conventional tillage methods. It is thus equipped with a shoe-type furrow opener with a wider slit that facilitates the flow of water during irrigation, especially for corn.

Hitched to a four-wheel tractor, MC RTP can sow seeds of rice, corn, and mungbean with an option to apply basal fertilizer. This implement consists of seven major parts namely: a) frame assembly; b) seed metering and delivery systems; c) fertilizer metering and delivery systems; d) furrow opener assembly; e) depth guide wheel assembly; f) drive wheel assembly; and g) hitch assembly.



# Major parts of MC RTP



- a. Frame Assembly
- b. Seed Metering and Delivery Systems
- c. Fertilizer Metering and Delivery Systems
- d. Furrow Opener Assembly
- e. Depth Guide Wheel Assembly
- f. Drive Wheel Assembly
- g. Hitch Assembly

# Major parts of MCRTTP

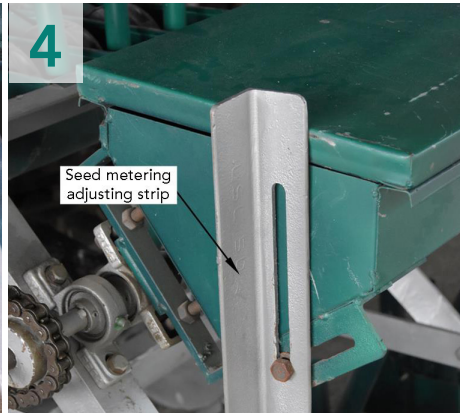
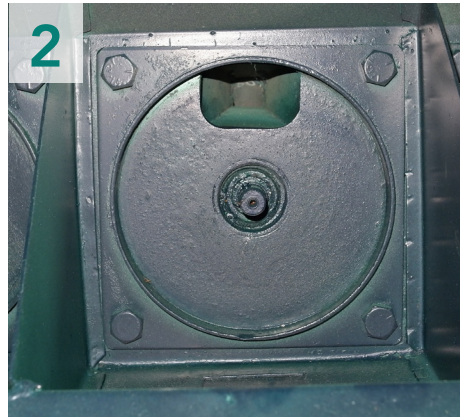
- A. Frame assembly** – Serves as the body or chassis of the planter to which all its parts are attached.



- B. Seed metering and delivery systems** – This whole system has the following components: a) seed loading assembly; b) seed metering assembly; c) seed metering transmission; and d) seed delivery pipe assembly.

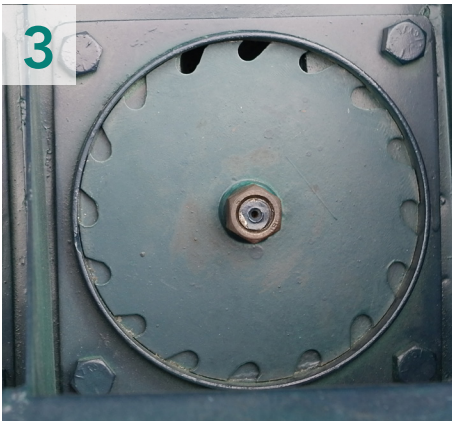
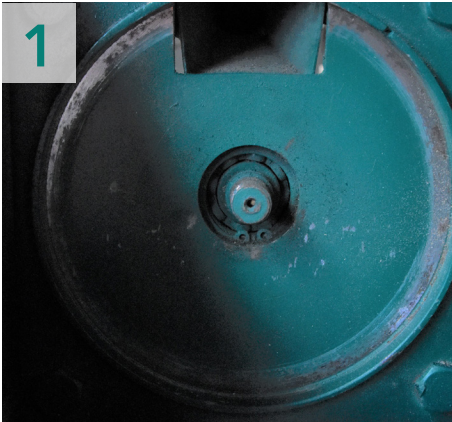
### a. Seed loading assembly

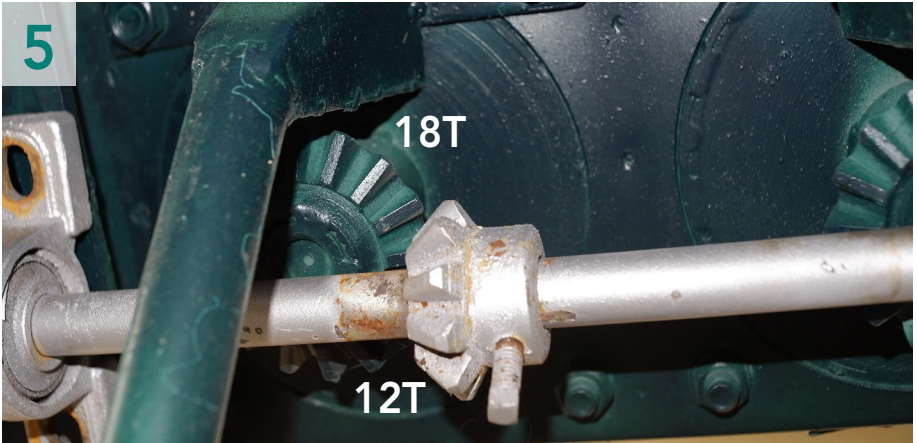
1. Seed box – holds or stores the seeds.
2. Seed metering plate housing – holds the seed metering plate.
3. Seed discharge chute – a sloping channel mounted at the outlet of the seed metering plate housing; it takes the seeds to the seed delivery pipe.
4. Seed metering adjusting strip – sets the seeding rate of the planter by adjusting it upward or downward.



### *b. Seed metering assembly*

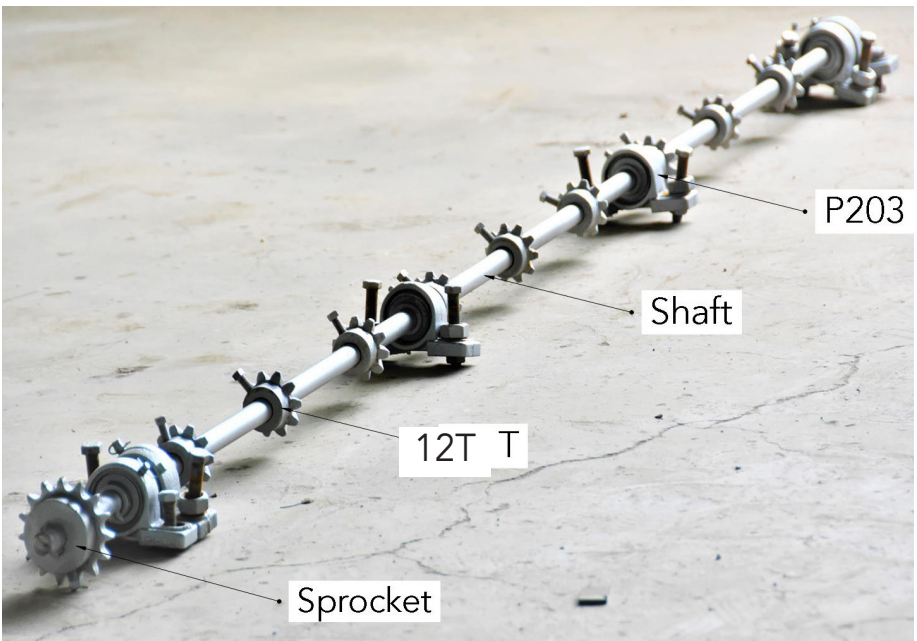
1. Seed metering plate shaft – drives the metering plate by means of bevel gears.
2. Key – small metal inserted in a slot or pocket of the seed metering plate shaft to lock or unlock the seed metering plate.
3. Inclined seed metering plate – metal plate that has several slots or holes; it is rotated by a bevel gear and dispenses the seeds into the seed box discharge chute.
4. Nut – used to tighten or loosen the seed metering plate.
5. Straight bevel gear – an 18T module 4 gear fixed on the seed metering plate shaft and driven by a 12T gear to rotate the seed metering plate.





### *c. Seed metering transmission*

It consists of a shaft with an attached sprocket and supported by a P203 bearing with a 12T bevel gear module 4, which is used to drive the seed metering plate.



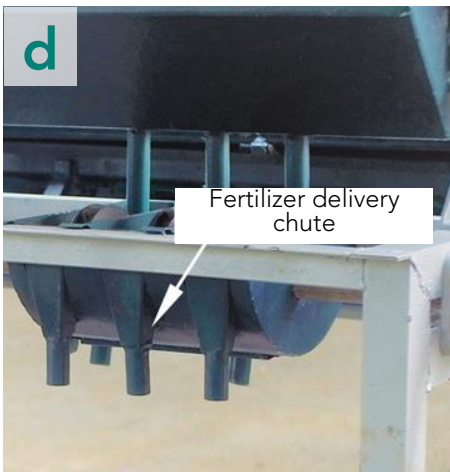
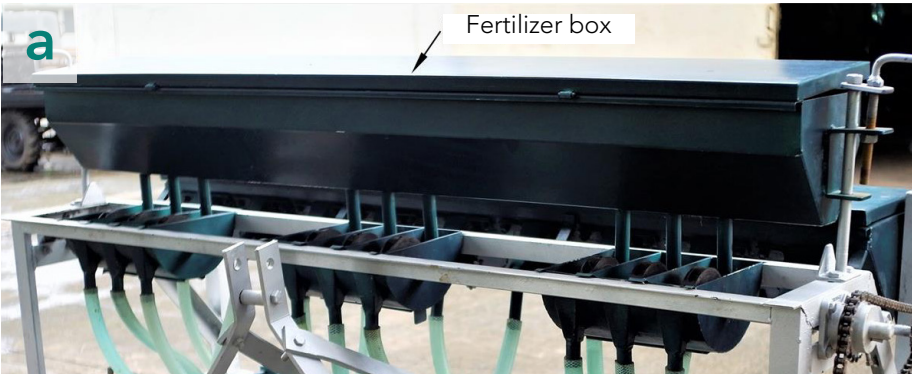
#### *d. Seed delivery pipe assembly*

It is mounted on the seed discharge chute to carry or convey the seeds to the seed boot.



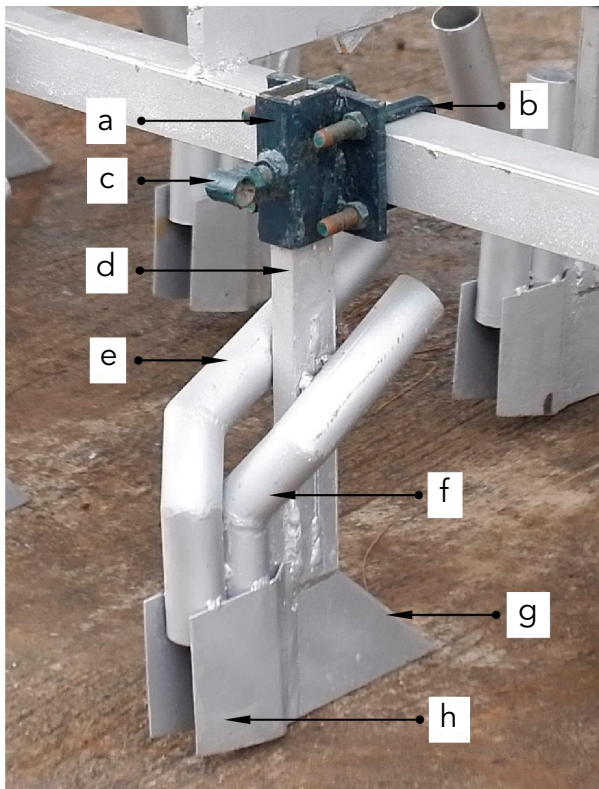
### **C. Fertilizer metering and delivery systems**

- a. *Fertilizer box* – holds the fertilizer.
- b. *Fertilizer rate adjusting nut* – used for increasing or decreasing the fertilizer rate.
- c. *Fertilizer metering roller* – guides the fertilizer granules and dispenses them to the fertilizer delivery pipe.
- d. *Fertilizer delivery chute* – holds the fertilizer metering roller and receives the fertilizer from the fertilizer box.
- e. *Fertilizer delivery pipe* – takes or conveys the fertilizer granules toward the fertilizer boot.



## D. Furrow opener assembly

- a. *Opener holder* – holds the furrow opener.
- b. *U-bolt* – used to tighten and fasten the opener holder.
- c. *Nut* – tightens the leg of the furrow opener.
- d. *Leg* – mild steel bar attached to the bottom of the frame, which holds the seed boot and slit.
- e. *Seed boot* – attached to the back of the fertilizer boot; it receives and drops the seeds into the slit.
- f. *Fertilizer boot* – pipe attached behind the leg of the furrow opener; it receives and drops the fertilizer into the slit.
- g. *Share* – cutting portion of the furrow opener.
- h. *Slit* – attached to the bottom of the furrow opener; it makes a long and narrow cut or opening.



**E. Depth guide wheel assembly** – It is attached to both sides of the main frame to control the depth of placement of the seeds and fertilizer in the soil, which is accomplished by regulating the depth of the furrow openers.



**F. Drive wheel assembly** – It is attached to the middle of the front bar of the frame; it transmits mechanical power to operate the seed and fertilizer delivery systems.



**G. Hitch assembly** – It is connected to the three-point linkage of the 4-wheel tractor that pulls/draws the frame.





Rice



Corn



Mungbean

## General specifications of MC RTP

Parameters	Types of Crop		
	Rice	Corn	Mungbean
Field capacity (ha/day)	2-3	2-3	2-3
Seeding rate (kg/ha)	20-60	15-20	15-20
Distance between rows (cm)	20	40-60	40-60
Number of rows	9	3-4	3-4
Labor requirement	1	1	1
Prime mover	4-wheel tractor with power requirement of 35-55hp		

# Field preparation requirements

- Rotovate the field once or twice, if necessary.
- Incorporate thoroughly the crop residues such as corn stalks, rice straw and weeds to avoid clogging of the furrow opener during seeding.
- The field should be leveled and well-prepared to avoid slippage of the drive wheel.
- Before seeding, ensure that the field has an optimum soil moisture (neither too wet nor too dry).



# Operation of the planter

1. Attach the MCRTTP to a four-wheel tractor with a power rating of 35-55hp and standard three-point hitch size dimensions: (a) top link pin diameter of 19mm; (b) lift arm pin diameter of 22mm; and (c) 710mm lower hitch spacing.



Positioning of MCRTTP in the 3-point hitch of the tractor.

Attachment of MCRTTP to the (a) top link and (b) lower link of the tractor using pins.

2. Select a seed metering plate depending on the type of seeds or crop to sow:
  - a. Rice – 10mm diameter with 16 holes
  - b. Corn – 12mm diameter with 7 holes
  - c. Mungbean – 12mm diameter with 8 holes



Rice



Corn



Mungbean

3. Mount the selected seed metering plate to the seed metering shaft connected in the seed box. Be sure to insert the key in the allotted slot in the seed metering shaft to lock the seed metering plate.

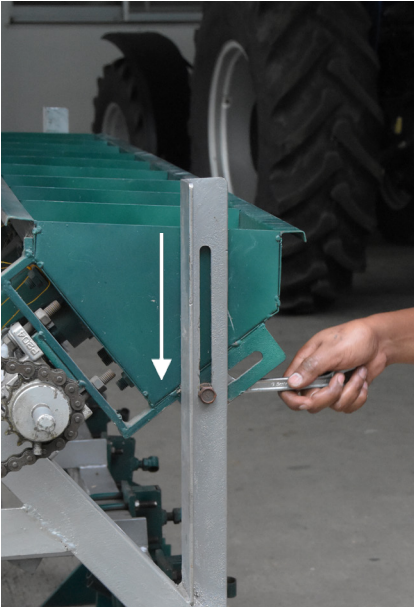


4. Tighten the nut after fixing the seed metering plate to its housing.



5. Adjust the seed metering strip downward to attain the desired seeding rates of 40-60kg for rice, 15-20kg for corn, and 15-20kg for mungbean.

Note: Loosen the nut and move the bolt and the strip upward to change the position of the seed box. This increases the seeding rate, if needed.



Adjustment of the seed metering strip (a) downward and (b) sideways to attain desired seeding rates.



Adjusted seed hopper.

6. Place the seeds in the box.

Note:

- a. Fill the seed box up to  $\frac{3}{4}$  only to prevent the seeds from dropping through the opening in the inclined seed plates during vibration under operation.
- b. Make sure that the seeds to be planted are clean and free from any impurity.



7. Place the fertilizer in the box and adjust the leveling screw to attain the desired fertilizer rate.

Note:

- a. Application of basal fertilizer during seeding is recommended for corn and mungbean only.
- b. Make sure that the fertilizer is free from clods.



8. Adjust the furrow opener to attain the desired row spacing.

Note: For corn and mungbean seeding, remove the other furrow opener to create 3-4 rows only with a row spacing of 40–60cm.



9. Adjust the depth wheel guide to attain the desired seed and fertilizer placement depth.

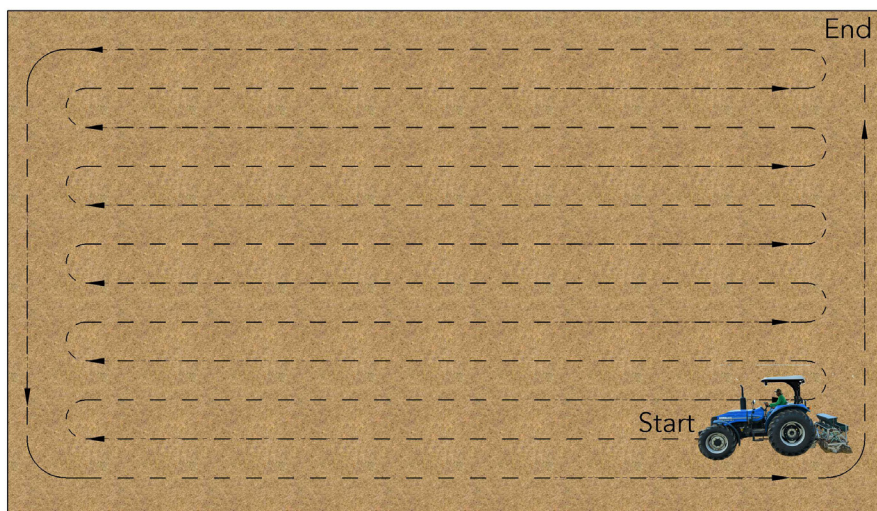


- Position the four-wheel tractor at one side of the field and set its required travelling speed.

Note: Set the engine speed of the tractor to 1,400rpm and the gear settings at 3<sup>rd</sup> gear low.



- Start the engine of the tractor and lower the MC RTP by engaging the hydraulic lever; follow the field operational pattern shown in the figure below.



# Maintenance

1. Before using the MCRTTP, check if all parts are in good condition and all the nuts and bolts are tightened to avoid any accident or delayed operation during seeding.
2. Before and after using the MCRTTP, lubricate all moving parts, such as gears, idler, chain, bearing, and sprocket, to reduce friction and wear, and to prevent corrosion and contamination with dirt.
3. Replace missing parts (nuts, bolts, keys, and pins) or repair parts that are damaged, worn out, and corroded.



4. Clean the MCRTTP before and after using, especially the following parts:

- seed and fertilizer box
- seed and fertilizer chute
- seed and fertilizer delivery pipe
- furrow opener and slit
- seed and fertilizer boot
- groundwheel



5. Store the planter properly after use.



# Troubleshooting

PROBLEMS	CAUSES	REMEDIES
Seed metering plate is not rotating	<ul style="list-style-type: none"> <li>• Key is missing in the seed metering plate shaft</li> <li>• Loose bolt in the 12T and 18T bevel gear</li> <li>• Drive wheel does not touch the ground/soil</li> </ul>	<ul style="list-style-type: none"> <li>• Replace the key to lock the plate</li> <li>• Tighten the bolts</li> <li>• Adjust the top link of the tractor to lower the drivewheel to get contact with the ground/soil</li> </ul>
Fertilizer metering roller is not rotating	<ul style="list-style-type: none"> <li>• Loose bolt in the roller</li> <li>• Drive wheel does not touch the ground</li> </ul>	<ul style="list-style-type: none"> <li>• Tighten the bolt</li> <li>• Adjust the top link of the tractor to lower the drivewheel to get contact with the ground</li> </ul>
Seeds / fertilizer is not dropping from furrow opener	<ul style="list-style-type: none"> <li>• Seeds/fertilizer is not properly distributed inside the box or the amount of seeds/fertilizer is not enough to be conveyed by the plate or roller from the furrow opener</li> <li>• Furrow opener is blocked by soil/weeds/rice straw/corn stalks</li> <li>• Both seed/fertilizer delivery pipes are not properly inserted into the seed boot</li> <li>• The drive wheel does not touch the ground</li> <li>• Broken chain/sprocket</li> </ul>	<ul style="list-style-type: none"> <li>• Distribute the seeds / fertilizer properly or refill seeds/fertilizer in the box</li> <li>• Remove the stuck soil/weeds/rice straw/corn stalks in the furrow opener</li> <li>• Insert the delivery pipe properly or replace pipe according to the size needed</li> <li>• Adjust the top link of the tractor to lower the drivewheel to get contact with the ground</li> <li>• Repair or change the broken parts</li> </ul>

# Troubleshooting

PROBLEMS	CAUSES	REMEDIES
Seeds and fertilizer not placed at desired depth	<ul style="list-style-type: none"> <li>• The depth control wheel is not properly adjusted</li> <li>• The land is not properly leveled</li> </ul>	<ul style="list-style-type: none"> <li>• Adjust the desired depth of furrow openers with the help of depth control wheel</li> <li>• Rotovate the land once or twice, if needed</li> </ul>
Unequal depth of seeding	<ul style="list-style-type: none"> <li>• Connection of three-point hitch to the MCRTF is not balanced</li> <li>• Attachment of the furrow opener is not proper</li> </ul>	<ul style="list-style-type: none"> <li>• Adjust the top link and connect the lower link point properly on a leveled ground</li> <li>• Attach the furrow opener on a leveled ground</li> </ul>
Broken seeds	<ul style="list-style-type: none"> <li>• Improper installation of seed metering plate</li> <li>• Poorly manufactured seed metering plate</li> </ul>	<ul style="list-style-type: none"> <li>• Install the seed metering plate properly</li> <li>• Replace seed metering plate</li> </ul>
Missing hills	<ul style="list-style-type: none"> <li>• Seeds stuck in the slot of the seed metering plate</li> <li>• Furrow opener clogged with soil/ straw/weeds</li> <li>• Drivewheel slippage</li> </ul>	<ul style="list-style-type: none"> <li>• Remove seeds stuck or replace the seed metering plate</li> <li>• Remove soil/straw / weeds stuck in the furrow opener and the field should not be too wet and free from weeds and straw</li> <li>• The field should be leveled properly</li> </ul>

## Benefit-cost on custom-hiring services

The economic potential of owning the MCRTTP can be shown through machine custom-hiring by an organized farmers' association. Custom-hiring can be the practical way to make expensive farm machinery available for use by other farmers without the need for individual farmers to buy such machine, and is potentially useful as an alternative source of livelihood (Paman et al., 2010).

Economic analysis of using MCRTTP with an initial investment cost of P170,000 shows that the total seeding cost is P777.10/ha (Table 1). To generate income from machine rentals, calculated custom hiring rate is P1,165.70/ha. This is far less costly than hiring many laborers to do manual seeding. For example, in Pangasinan, the prevailing rate of labor for planting is P350 per laborer-day. With a capacity of 0.02ha/h, it would approximately require seven laborer-days to plant a hectare. At P350 per day, the total cost would be P2,450/ha (double the MCRTTP rental). Additional labor to perform furrowing before seeding is also an extra cost in manual seeding. From the viewpoint of the owner-investor (e.g. farmers' association), investment cost can be recovered in 3.6 years at an annual machine utilization rate of 120ha. Break-even area planted is 240ha, while the benefit-cost ratio is 1.5 (Table 2).

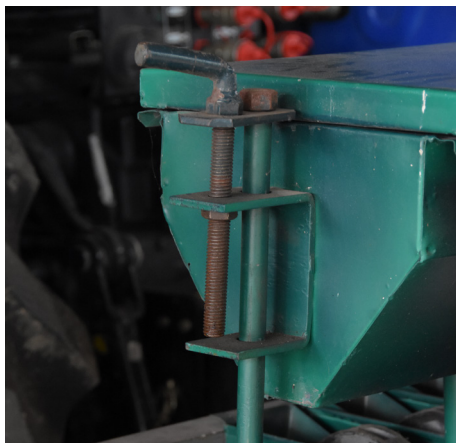
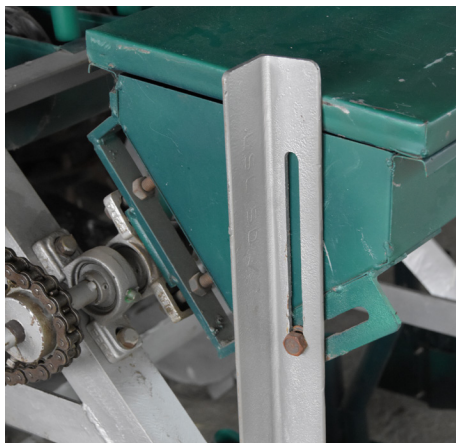
Table 1. Economic analysis of using the MC RTP through custom-hiring services.

Parameters	₱
Investment Cost	170,000.00
Fixed Cost, ₱ per day	
Depreciation	83.80
Interest on investment	55.90
Insurance	14.00
Sub-Total	153.70
Variable Costs, ₱ per day	
Fuel	969.00
Repair and maintenance	46.60
Labor	350.00
Lubrication	35.00
Sub-Total	1,400.60
Total Cost of seeding, ₱ per day	1,554.30
Total Cost of seeding, ₱ per yr	93,256.40
Capacity, ha/day	2
Seeding cost, ₱ per ha	777.10
Custom-hire service rate, ₱ per ha	1,165.70
Machine utilization, ha/yr	120
Gross Income derived, ₱ per yr	139,884.70
Net Income derived, ₱ per yr	46,628.20
Net Benefit derived, ₱ per ha	388.60
Payback period, yr	3.6
Break-even area planted, ha	240
Benefit-cost ratio	1.5

# Calibration of MC RTP for seed and fertilizer rates

## A. Laboratory calibration

1. Set the proper orientation of the seed/fertilizer box by adjusting the nut and leveling screw of the planter.



2. Place the seeds/fertilizer in the box and distribute it evenly.



Note: Make sure the seeds/fertilizer to be used in calibration is clean and free from soil and stones, or any impurity.

3. Put net/plastic bag in the seeds/fertilizer discharge chute to contain the seeds/fertilizer.



4. Jack up the drivewheel of the MCRTTP; put a reference point with a string or marker on the drivewheel to help in counting the revolutions of the drivewheel; rotate it manually to 10 full revolutions.



5. Collect the net/plastic bag with seeds/fertilizer in each discharge chute after 10 revolutions; weigh the seeds/fertilizer and record the weight.



6. Determine the nominal working width (W) of the MCRTTP using the formula:

$$W = n \times dr$$

Where       $n$       = Number of furrow openers  
               $dr$       = Spacing between the furrow openers

7. Determine the circumference of the drivewheel (Cd) using the formula:

$$Cd = \pi D$$

Where       $D$  = Diameter of the drivewheel

8. Calculate seed and fertilizer application rate per hectare using the formula:

$$\text{Seed rate (kg/ha)} = \{S_w / (C_d \times W \times n)\}$$

Where  $S_w$  (or  $F_w$ ) = Total weight of seeds or  
fertilizer released  
in 10 revolutions in grams  
 $C_d$  = Circumference of drive wheel  
 $W$  = Nominal working width  
 $n$  = Number of revolutions (10)

Note: If the results of the laboratory calibration do not match the desired rates of selected crop and fertilizer, check and repair the planter and repeat the process till the desired seed/fertilizer rates are obtained.

## B. Field calibration

1. Set the proper orientation of the seed/fertilizer box by adjusting the nut and leveling screw of the MC RTP.
2. Place the seeds/fertilizer in the box, distribute it evenly.
3. Put net/plastic bag in the seed/fertilizer discharge chute to contain the seeds/fertilizer.
4. Set the required rpm and adjust the desired gear settings of the four-wheel tractor to obtain the desired seeding rate of the planter.
5. Run the planter and record the time of travel at a given distance of 20m in the field.

- Collect the plastic/net bag with seeds/fertilizer in each discharge chute after the 20m run; weigh the seeds/fertilizer and record the weight.

$$\text{Seed rate (kg/ha)} = \{S_w / (d \times W)\}$$

Where Sw (or Fw) = Total weight of seeds or fertilizer released (kg)

d = Distance (20m)

W = Nominal working width (m)

Note: If the results of the field calibration do not match the desired seed rates of selected crop and fertilizer, check and repair the planter and repeat the process till the desired seed/fertilizer rates are obtained.

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# NOTES

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We are a government corporate entity (Classification E) under the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos.

With our "Rice-Secure Philippines" vision, we want the Filipino rice farmers and the Philippine rice industry to be competitive through research for development (R4D) work in our central and seven branch stations, including our satellite stations, collaborating with a network that comprises agencies strategically located nationwide.

We have the following certifications: ISO 9001:2015 (Quality Management), ISO 14001:2015 (Environmental Management), and ISO 45001:2018 (Occupational Health and Safety Assessment Series).

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