Masaganang ANI Mataas na KITA

RICE COMPETITIVENESS

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MECHANIZATION PROGRAM

03

Reference Manual on

Harvesting & Threshing

A Compilation of Resources

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

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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.

BALDWIN G. JALLORINA, Ph.D.
Director IV

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HARVESTING

Disclaimer: *Some parts (texts and photos) under this topic is directly taken from the International Rice Research Institute (IRRI) Rice Knowledge Bank for the purpose of presenting a more comprehensive information. PHilMech do not intend to own any part of the knowledge product.*

1. What is harvesting?

- It is the process of collecting the mature rice crop from the field.
- The harvesting activities include cutting, stacking, handling, threshing, cleaning and hauling of paddy.
- Good harvesting methods maximize grain yield and minimize grain damage and quality deterioration.

2. What are the five basic harvesting operations?

- **Cutting** - cutting the mature panicles and straw above-ground
- **Threshing** - separating the paddy grain from the rest of the cut crop
- **Cleaning** - removing immature, unfilled and non-grain materials
- **Hauling** - moving the cut crop to the threshing location
- **Bagging** - bagging the threshed grain for transport and storage

3. What are the other operations involved in harvesting?

A. **Field drying** (After cleaning) - leaving the cut crop in the field and exposing it to the sun for drying

B. **Stacking/Piling** (After hauling) - temporarily storing the harvested crop in stacks or piles

Figure 1. *Harvesting operations, cutting, hauling, threshing, and cleaning*

4. Why is timely harvesting important?

Correct timing of harvest is crucial to prevent losses. Grain losses can be due to rats, birds, insects lodging of rice plants, and shattering of grains.

Table 1. Importance of timely harvesting vs untimely havesting

Timely	Untimely	
	Too Early	Too Late
• Ensures good grain quality and high market value	• Larger percentage of unfilled or immature grains • Higher grain breakage during milling	• Excessive losses • Increased breakage in rice

5. How to determine the correct harvesting time?

- **Moisture content (MC)**
  Between 20 and 25 percent (wet basis) is the ideal MC. Grains should be firm but not brittle when squeezed between the teeth.

- **Ripe grains per panicle**
  Crop should be cut when 80 to 85 percent of the grains per panicle are straw (i.e., yellow-colored).

- **Number of days after sowing**
  The ideal harvest time for late mature varieties is between 130 to 136 days after sowing, for mid-maturing varieties, 113 to 125 and for early-maturing varieties 110 days.

- **Number of days after heading**
  For dry season harvesting, an optimum time is 28 to 35 days after heading. In wet season harvest, optimum time is 32 to 38 days after heading.

- **Other considerations**
  Harvesting also needs to be timed so that threshing can be done as soon as possible to avoid rewetting and to reduce grain breakage. If the crop has a lot of surface moisture, (e.g. from previous rainfall or early dew in the morning), it is advisable to wait until the surface moisture evaporates.

6. What are the different methods of harvesting?

- **Manual harvesting**
  - o This includes cutting the rice crop by simple hand tools like sickle for cutting 15 to 25 cm above ground level, and simple hand-held knives for cutting just below the panicle.
  - o Though labor intensive, its very effective in lodged crop conditions.
  - o Manual harvesting requires 40 to 80 person-hours per ha. It will take an additional labor to manually collect and haul the harvested crop.

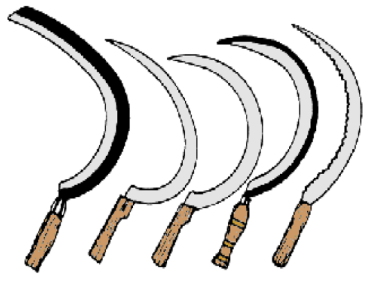

Figure 2. *Manual harvesting tool*

- **Mechanical harvesting**

    - A reaper with a cutting-width of 1.5 m can operate at a rate of 1 to 1.5 ha/day. For proper operation of reapers, fields need to be levelled and drained. It is difficult to reap crop that is lodged (lying on the ground).
    - This operation is faster and more efficient compared to manual harvesting.

Figure 3. *Rice reaper machine*

7. What are the different practices after harvesting?

- **Windrowing**
  Also known as in-field drying of harvested rice panicles. This is done to reduce moisture content of the harvested palay to lessen the risk of damage in case of delays in threshing or drying. This is also practiced by most farmers who intend to sell fresh palay to traders.

- **Hay Stacking**
  This is also known as "Talumpok". It is done to prepare the palay for threshing. Harvested rice panicles are stacked in bundles usually in rectangular or circular piles.

Figure 4. *Piling and stacking of rice straws*

How to operate a mechanical reaper?

1. What are the parts of a mechanical reaper?

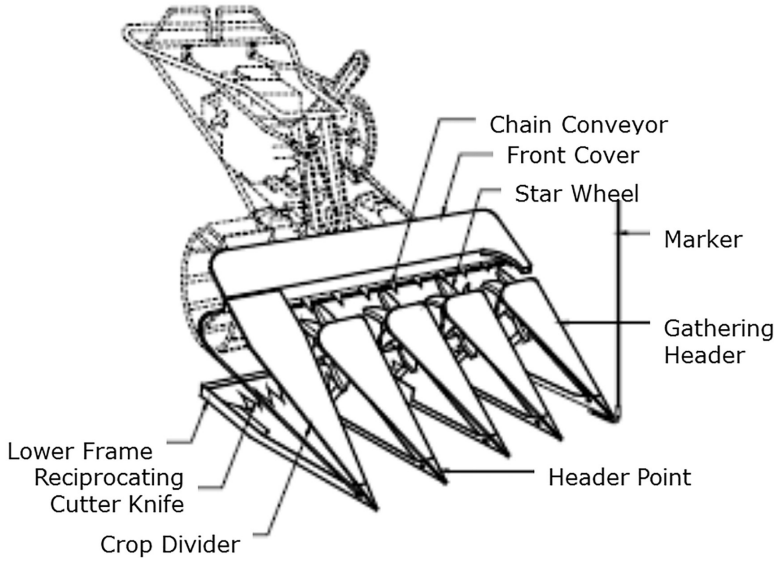

Figure 5. *Parts of the rice reaper*

2. What are the pre-operation procedures for mechanical reaping?

- Plan the field pattern to use. Determine the entry point and exit to next field.
- Drain the field 7 to 10 days before the expected harvest date, or when the upper grains in most of the tillers are in the hard dough stage turning from green to yellow.
- Cut manually the area, to the size of the header, at the entry point.
- Cut manually the crop at the corners and all standing crop on the field edges that may not be cut by the machine.

Figure 6. *Rice field*

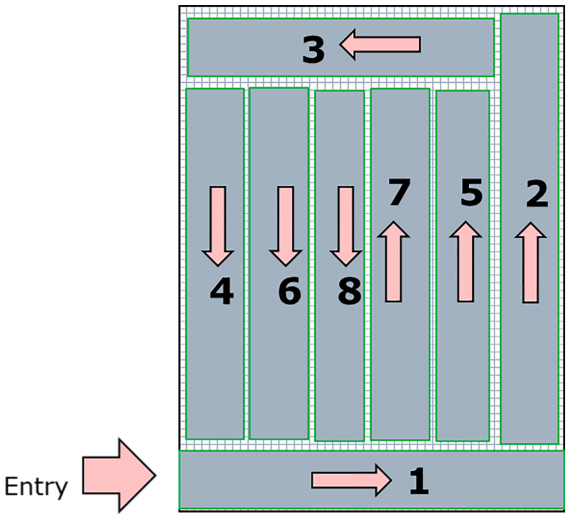

Figure 7. *Field pattern*

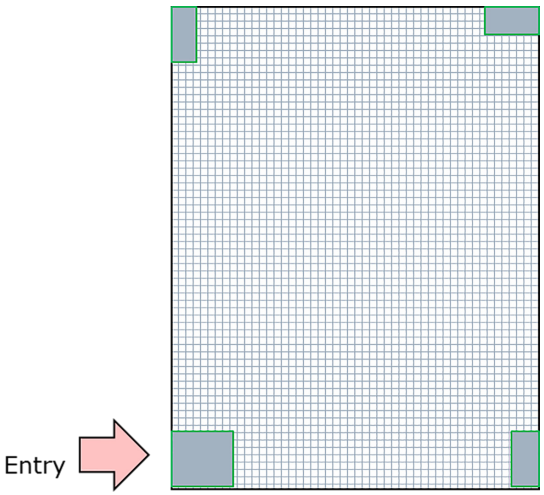

Figure 8. *Cut in the entry point*

3. How to operate the mechanical reaper in the field?

- Always check if the machine, engine and all parts are functioning well. Make a quick test run.
- Adjust the reaper engine speed at ¾ setting of the accelerator to attain the right cutting and conveying speed with less grain shattering loss.
- Position the reaper at the starting point.
- Operate reaper following the appropriate field pattern (figure 7 and 8).
- Make efficient turning on corners; reverse clutch must be engaged when turning at the corner to prevent lodging of the harvested crop and minimize grain loss.

Figure 9. *Rice reaper*

Figure 10. *Rice reaper operation*

4. What are the post-operation procedures for mechanical reaper?

- The cut rice panicles may be gathered and stacked immediately.
- Build small hay piles to avoid heating of grains; use underlays for the rice hay stacks.
- Pile the harvested crop separately for each variety immediately after cutting to eliminate the chance of mixing other varieties while on the field. When laying the cut crop in the field make sure that the panicles with the grains stay dry and are off the ground.

Figure 11. *Gathering the cut rice panicles*

THRESHING

Disclaimer: *All parts (texts and photos) under this topic is directly taken from the International Rice Research Institute (IRRI) Rice Knowledge Bank for the purpose of presenting a more comprehensive information. PHilMech do not intend to own any part of the knowledge product.*

1. What is threshing?

- It is a process of separating the grains from the straw either by impact, friction or combing action.

2. What are the considerations in threshing?

- Any delay between cutting and threshing causes rapid deterioration of the grains. Poor threshing can also cause high threshing and scattering losses.
- To avoid losses and deterioration in seed quality, distance between cutting and threshing should be kept to a minimum.
- Primary considerations are speed and high capacity threshing that could result to reduced losses, clean grains and high head rice yield.

3. What are the methods of threshing?

- **Manual threshing practices**

  - **Foot threshing or trampling**
    - Use of bare feet or animals to thresh the crop. To do this successfully, the crop is spread over a mat or canvass and workers trample with their feet. This method is tedious, labor intensive and in most cases impractical.

Figure 12. *Manual foot threshing*

Figure 13. *Threshing using livestocks*

  - **Beating against a threshing rack**
    - The farmer holds the crop by the sheaves and threshes it against a slatted bamboo, wooden platform or any other hard object such as a steel oil drum.

Figure 14. *Beating the harvested rice*

Figure 15. *Beating against threshing rack*

- **Flail**
  - the use of a flail or stick for threshing the crop

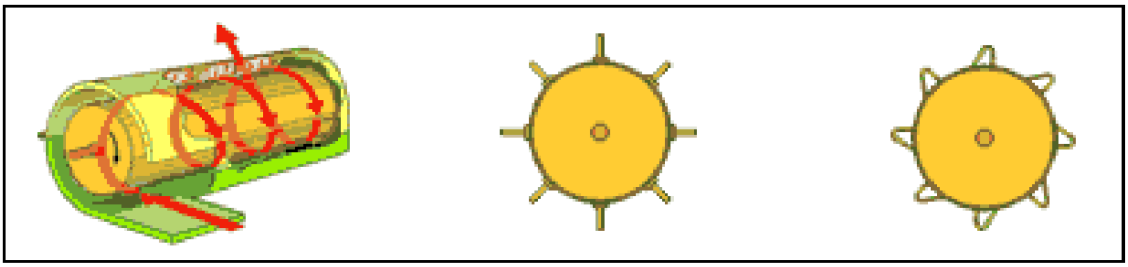

Figure 16. *Mechanism of a mechanical thresher*

- **Mechanical threshing**

Mechanical thresher works with a drum as axial where the crop turns. The drums have "teeth" on the surface which makes the grains separate from the straw by beating it.

Figure 17. *Mechanism of a mechanical thresher*

- **Pedal thresher**
  - A semi-mechanized threshing equipment where the crop is held against a threshing drum that is operated by a foot crank.

- **Completely mechanized axial flow thresher**
  - Mechanical threshers have a drum on an axial and the crop turns around the axle. The grain is dislodged from the straw as it beats against the teeth of the drum. These machines can be partially automated using crank shafts to run them, or fully automated using a motor to run them.

Figure 18. *Axial flow thresher*

Figure 19. *Threshing*

How to operate a rice thresher?

1. What are the pre-threshing activities for rice thresher?

- Position the thresher on a level area close to the crop stack to minimize handling and shattering losses.
- Spread cloth, canvas, or mat underneath the thresher to collect spilled grain from the grain discharge chute or due to shattering during handling.
- Install the cylinder, cover, and feed tray if dismantled during field transport.
- Position the thresher so that the straw is thrown with the direction of the wind. This will eliminate the blowing of straw, chaff, and dust back toward the operator and the threshed grain.
- Check each belt's alignment and tension. Adjust the idler pulley on the blower/cylinder belt to correct tension. Improper alignment and tension are the major causes of premature belt failure.
- Check pulley surfaces. Rough grooves must be smoothened with a fine file if nicked. Cracked pulleys should be replaced immediately.

Figure 20. *Belt alignment*

Figure 21. *Thresher belt*

Figure 22. *Threshing cylinder*

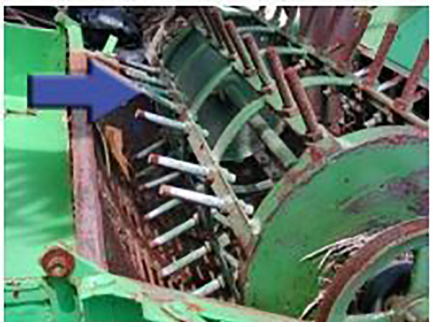

Figure 23. *Peg teeth*

- Open the cover and check all pegs on the threshing cylinder for tightness. Loose pegs will damage the machine and can be dangerous to the operators.
- Examine the peg teeth for wear. Maximum wear occurs at the feed end of the cylinder and is more prominent at the leading side in the direction of rotation.
- Worn pegs must be rotated 180 degrees or interchanged with those located near the straw paddles. Badly worn pegs must be replaced or rebuilt by welding.
- Rotate the threshing cylinder manually at least five revolutions to ensure that there are no obstructions or interferences.
- Make sure there are no loose or missing bolts and set screws. Tighten or replace as necessary.
- Lubricate all bearings with good quality grease. The belt idler and oscillating screen eccentric bearings are lubricated for life, thus require no lubrication.
- Check engine oil and fuel levels. Follow the engine manufacturer's recommendations.
- Start the engine and allow it to warm up. Feed the thresher with the crop to be threshed for performance checking. Increase cylinder speed if excessive amounts of unthreshed and unseparated grain are observed with the straw.
- Optimum threshing and cleaning is obtained with cylinder speeds of 600 to 700 rpm.

2. How is the threshing operation done?

- Start the engine to recommended speed (600-700 cylinder rpm).
- Load the feed tray with the harvested crop. Three to four persons are required to operate the machine. Use a stick to remove clinging straw from the oscillating screen to protect hands from possible injury.
- Harvested crops must be placed on the feed tray with the panicle away from the operator. Feed panicle first into the thresher.

- Feed the crop at a uniform rate and maintain maximum feeding rate without overloading the engine.
- For wet crops or crops with decomposed straw, reduce the feed rate to avoid overloading the cleaning screen.
- For higher threshing efficiency, briefly hold the crop bundles at the feed opening for partial threshing when the material is longer than 40-50 cm. Longer cut material will reduce machine output and may result in poor threshing and clogging of the machine.

Figure 24. *Cleaning the Thresher*

- Short panicle-harvested materials (cutting just above the flag leaf) may result in high unthreshed losses because the panicles move rapidly through the thresher without receiving sufficient threshing. Recycling the straw is necessary in this case.
- Adjust blower openings (shutters) to give the air flow needed for winnowing. Open slowly to provide more air for a cleaner output until a small amount of mature grain flows over the wind board.

Figure 25. *Threshed grain*

Figure 26. *Blower opening*

- The angle of the wind board and the blower opening must be adjusted to suit the threshing conditions. For dry paddy, the wind board should be set at its maximum inclination and the blower should be gradually adjusted until the desired grain cleanliness is obtained.
- For threshing wet paddy, the inclination of the wind board must be reduced and the air shutter opening increased to blow the heavier wet leaves and other impurities.
- To obtain extra-clean paddy, set the wind board at a low inclination and increase the air shutter opening. This process will blow more grain over the wind board, but this can be recovered by recycling the separated impurities through the thresher.
- The stripper bars prevent straw from wrapping around the cylinder and aid in threshing hard–threshing varieties. Use of stripper bars reduces capacity and increases the amount of finely chopped straw that passes through the concave when threshing overly mature crops, thus they should be installed only when necessary.

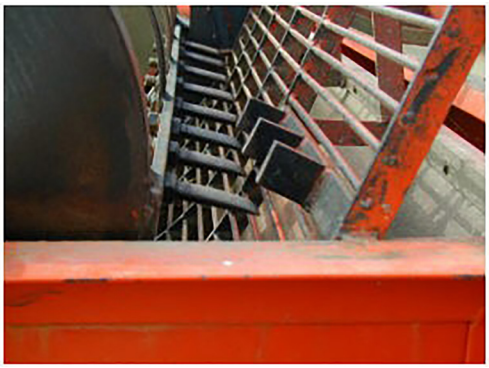

Figure 27. *Stripper bar straw*

Figure 28. *Feeding the thresher*

- Reduce feeding rate when threshing wet or partially decomposed materials to avoid overloading.
- Open the cylinder cover periodically to remove straw and chaff accumulation at the lower concave.

3. How is the threshing machine maintained?

- Lubricate cylinder and fan bearings with a good-quality general purpose grease every 25 hours of operation. Periodically apply a small amount of oil to all hinge points.
- Inspect the machine regularly for loose, worn, or damaged peg teeth, concave bars, cylinder, discharge paddles and other parts, and tighten, repair, or replace them immediately. Missing bolts or nuts must also be replaced.
- Reduce belt tensions by loosening the idler pulley and engine mounting bolts when the machine will not be used for an extended period to minimize deterioration.
- Check engine crankcase oil level at least every four operating hours and follow the engine manufacturer's recommendations for oil change intervals and oil grade. Be sure the recommended oil level is maintained.
- Service the air cleaner, fuel filter, fuel line, carburetor, and spark plug regularly according to engine manufacturer's instructions.
- Clean the machine thoroughly; remove belts and store in a dry place and cover to reduce damage from dust accumulation.
- Paint parts that need repainting; clean and apply oil to exposed metal surfaces to prevent rusting.

COMBINE HARVESTING

Disclaimer: *Some parts (texts and photos) under this topic is directly taken from the Biomass Management for Folder & Energy, Lesson 8 and Pinoy Rice Knowledge Bank for the purpose of presenting a more comprehensive information. PHilMech do not intend to own any part of the knowledge product.*

1. What is combine harvesting?

- This operation uses a machine that "combines" several harvesting operations such as cutting, feeding into threshing mechanism, threshing, cleaning, and discharge of grain into a bulk wagon or directly into bags.

2. What are the features of the combine harvester?

- Combine harvesters for rice come in different sizes, usually with tracks as undercarriage for increased mobility. They are equipped by a set of cutting knives and threshing system with either a bulk or bagged discharge of grains. The use of combine harvesters become necessary when there is a shortage of labor.

Figure 29. *Rice combine harvester*

Figure 30. *Operating combine harvester*

3. What are the parts and functions of a combine harvester?

A combine harvester consists of several major components: the cutting section, the thresher, devices for separating the straw, a cleaner and a grain collection system.

- The cutting section usually consists of straw lifters especially for lifting lodged crop, a cutter bar for cutting the straw above the ground, a reel for feeding the cut crop into the conveying system and conveyors for transporting the crop to the threshing components.

- The thresher consists of one or more threshing cylinders and a concave. The threshing unit can be conventional but in most cases rice combines have axial-flow threshing and straw separation units, which are better in handling wet straw and do not require straw walkers for separating the straw.

- A conventional combine has a set of straw walkers for separation of the grain from the straw because the crop passes the concave very quickly and a lot of threshed grains are therefore still contained in the straw. On the straw walkers the remaining grains are separated from the straw by gravity.

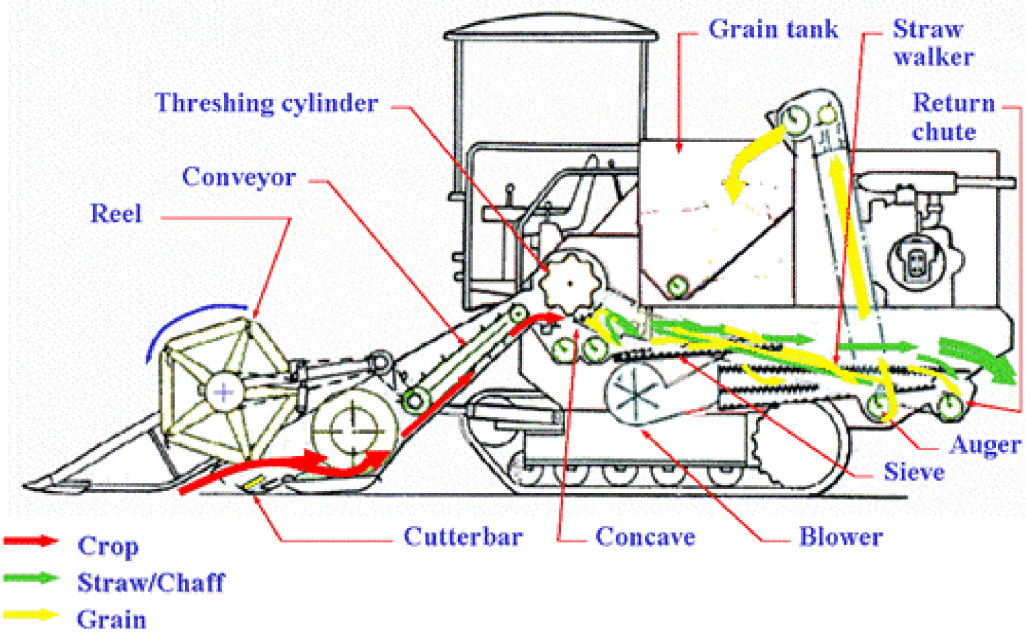

Figure 31. *Parts of a Combine Harvester*

Figure 32. *Cutting section*

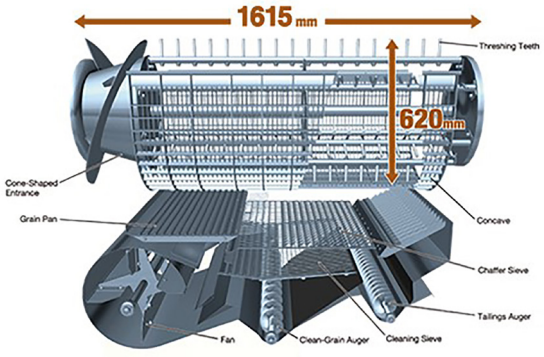

Figure 33. *Straw walkers*

- All combines contain a cleaner in which chaff, immature grains and small straw particles are separated from the grains. The cleaner consists of a blower and several oscillating sieves.

- For grain collection the combine either has a grain tank or is equipped with a grain bagging station. For transporting the grain and other fractions inside the combine and for unloading the grain tank there are several conveyors, which can be bucket elevators or screw conveyors.

Figure 34. *Grain collection*

4. How to operate a combine harvester?

Figure 35. *Commercially available combine harvester*

- Before using a combine harvester:
  Thoroughly clean the combine harvester parts such as the cutting assembly, auger conveyors, thresher, and the cleaning component to avoid seed contamination. Clean the sacks to be used in loading grains to prevent impurities.

- In using a combine harvester:

  - Do the basic check-up procedure on the combine harvester before going to the field.

  - Remove all bamboo stakes in the field.

  - Harvest first the corners of the field and the rows near the dikes use sickle to prevent lodging and grain loss

Figure 36. *Combine harvester operation*

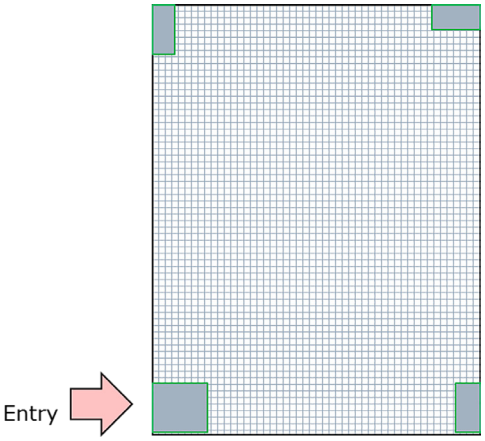

Figure 37. *Harvesting pattern*

  - Adjust the combine harvester's engine based on the recommended speed.

  - Use the reverse clutch when turning at the corner to prevent lodging and to minimize grain loss.

  - Transfer grain-filled sacks immediately to the road or dry place to prevent contact with water and mud that may deteriorate grain quality.

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