

Rice straw baler



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1. Introduction

Using combine harvesters in harvesting rice leaves rice straw spread out in the field, making it difficult to gather and increasing the collection cost. This creates a negative impact on businesses that use rice straw. This issue led to the demand for mechanized straw collection, and this technology is demonstrated and disseminated by IRRI projects such as CORIGAP and the BMZ rice straw management project.

Intensification of rice production is another reason for the increased amount of rice straw biomass left in the field after harvest. Intensification is done to meet the increasing demand for food due to population growth, particularly in Asia; however, the lack of options to manage rice straw and the very short window for fallow lead to the rampant *in situ* burning of rice straw biomass before the next cropping season. Thus, the introduction of a mechanical rice straw baler offers a good opportunity for farmers to make better use of collected rice straw and earn extra income from the biomass, which is normally considered a waste product in the field.

2. Technology options

Collecting rice straw involves three main operations: picking up of rice straw from the field, compressing it into bales, and transporting the bales to the bunds. A machine, called a baler, is used for mechanized collection, which is referred to as baling. The baler collects the straw and then compresses it into bales. A stationary baler, with only a compaction unit, can be used to compress the straw disposed by a stationary rice thresher, which throws straw in a pile. On the other hand, a mobile baler (either self-propelled or pulled by a tractor) is suitable for collecting rice straw left spread out in the field by combine harvesters. There are two main types of balers defined by the principle of operation of the compacting unit. The roller-type is used to make round bales (Figure 1), and the piston-type in making square bales (Figure 2).

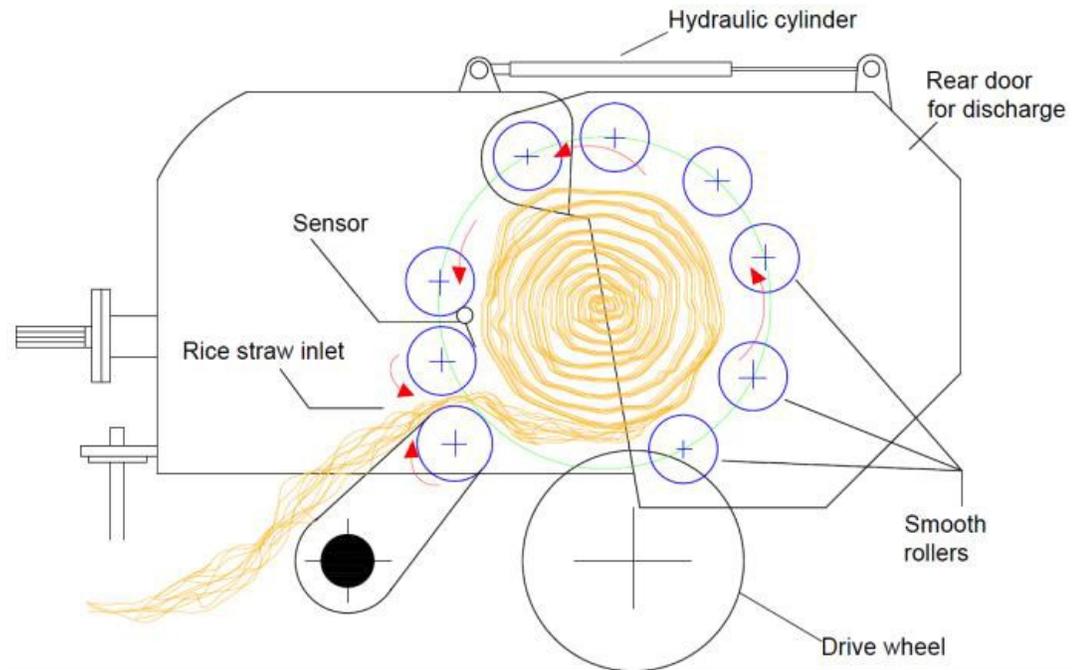


Fig. 1. Principle of a roller-type rice straw baler (side view).

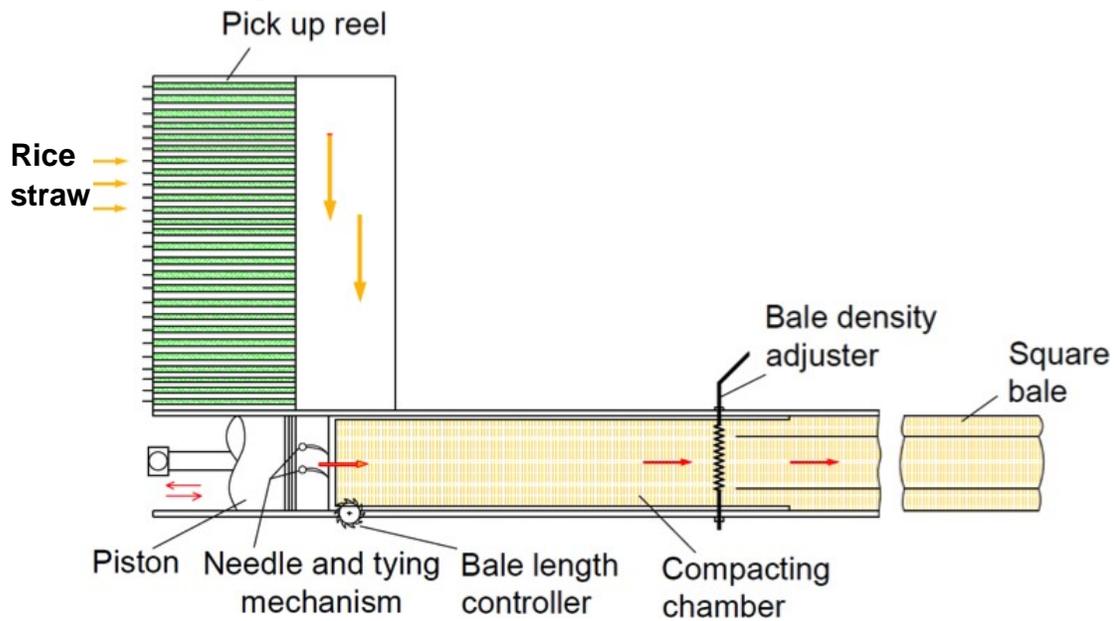


Fig. 2. Piston-type rice straw baler (top view).

Table 1 shows a summary of the balers currently used in collecting rice straw in Southeast Asia.

Table 1. Characteristics of currently used balers for rice straw collection.

Feature	Large-scale roller baler (Fig. 3)	Small-scale roller baler (Fig. 4)	Self-propelled baler (Fig. 5)	Square baler (Fig. 6)
Capacity (tons/h)	3–4	1.3–1.6	1–1.3	1.5–2
Bale weight at 14% moisture content (kg/bale)	500–600	13–15	13–15	15–20
Investment cost in 2016 (USD)	19,000–25,000	5,000–8,000	12,000–15,000	16,000–18,000
Engine/pulled by tractor (hp)	80	30	45	50
Fuel (diesel) consumption (L/ton straw)	3–4	2–3	3–4	3–4

The collecting machines include:

- 1) Large-scale roller baler (500 kg/bale; 3–4 tons/h) (Figure 3): This baler is pulled by a tractor and gathers the straw into bales but leaves it in the field to be collected and transported to the bunds in a separate operation. This type of baler cannot work continuously; its operation should stop periodically to tighten and unload straw bales.
- 2) Small-scale roller baler (13 kg/bale; 1.3–1.6 tons/h) (Figure 4): The operation of this baler is the same as the first one.
- 3) Self-propelled baler (13 kg/bale; 1–1.3 tons/h) (Figure 5): This type both bales the rice straw and transports the bales to the bund. Although this baler has a higher capacity engine (45 hp) than the roller baler (30 hp), its collection capacity is slightly lower, as it moves on rubber-chain wheels. However, because of these rubber-chain wheels, this baler can be used in wet fields.
- 4) Square baler (15–20 kg/bale; 1.5–2 tons/h) (Figure 6): This baler operates similarly to roller balers, except that it makes square bales. This baler uses a piston (Figure 2). With this principle, it can move continuously without needing to stop to unload bales as roller balers do.



Fig. 3. Large-scale roller baler - (500 kg/bale).



Fig. 4. Small-scale roller baler - (13 kg/bale).



Fig. 5. Self-propelled baler.



Fig. 6. Square baler.

A summary of the cost of rice straw collection, based on a recent assessment in the Philippines and Vietnam, is shown in Table 2.

Table 2. Cost of rice straw collection (USD).

Item cost	Large-scale roller baler	Small-scale roller baler	Self-propelled baler	Square baler
Depreciation + maintenance + interest	6.4	2.5	5.8	5.4
Diesel consumption	2.0	1.4	4.7	2.0
Labor	4.0	3.6	2.2	4.0
Rope for baling	3.0	3.7	3.7	3.5
Total	15.4	11.3	16.4	14.9

3. Operating manual for roller balers

3.1. Structure of the baler

The following are the specifications of the Star roller baler MRB 0855T (Figure 7):



Fig. 7. Roller baler MRB-0855T.

- Dimensions of the baler (length x width x height): 115 x 130 x 130 cm
- Machine weight: 330 kg
- Dimensions of the tires: 16 x 6.50x8x4PR
- Width of the reel for gathering straw: 80 cm
- Capacity: 80–120 bales/h
- Weight of the straw bale: 12–14 kg/bale
- Dimensions of the straw bale (diameter x length): 50 x 70 cm
- Tractor (for pulling the baler): 25–50 hp, PTO 540–600 RPM
- Moving speed (when operating): 3–5 km/h

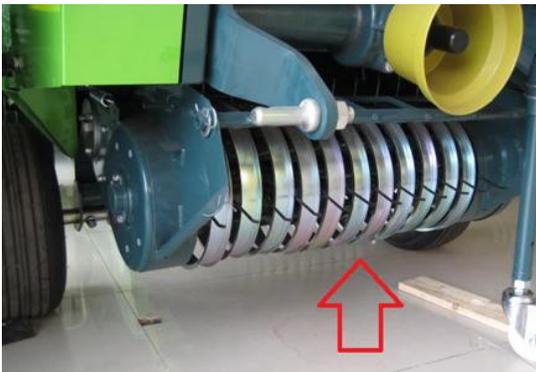


Fig. 8. Pick-up for collecting rice straw in the field.

Pick-up is the part of the machine that collects loose straw scattered in the field.

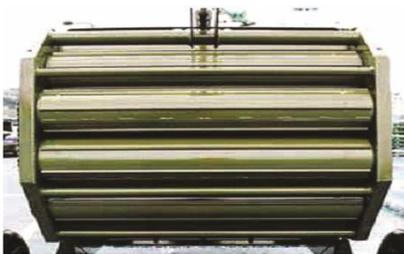
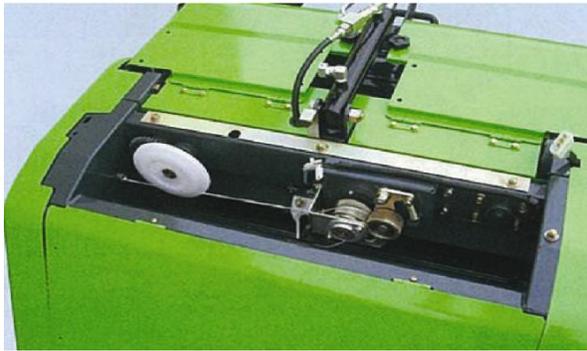


Fig. 9. Rollers of the baling component.

These are free-wheeling steel rollers that help facilitate the rotation and compaction of baled straw inside the baling chamber.



This component guides the twine in tying the baled straw tightly.

Fig. 10. Component for tightening baled straw (automatic).



The hydraulic piston (encircled in red) enables unloading of baled straw when baling is completed and tying is done.

Fig. 11. Hydraulic piston used to unload straw bales.

3.2. Baler assembly and operation

3.2.1. Connecting the tractor and its power take-off to the baler

The baler is connected to the tractor through a three-point linkage (Figure 12), and then its universal shaft is connected to the tractor's power take-off (PTO, Figure 13) to make the operating system shown in Figure 14.



Fig. 12. Three-point linkage for connecting the baler to the tractor.

The three-point linkage of the baler machine is used to connect the baler to the tractor's unadjustable left linkage, adjustable right linkage, and top linkage.



Fig. 13. The universal shaft connected to the tractor's PTO.

The universal shaft of the baler, which is located in front of the machine, is connected to the PTO of the tractor.



Fig. 14. Baler-tractor linked system.

The baler is ready for operation in the field when the three-point linkage and PTO are connected.

3.2.2. Threading (tightening the bale)

The main components of threading for tightening straw bales are shown in Figures 15 and 16. The structure and steps for threading the twine are shown in Figure 17.

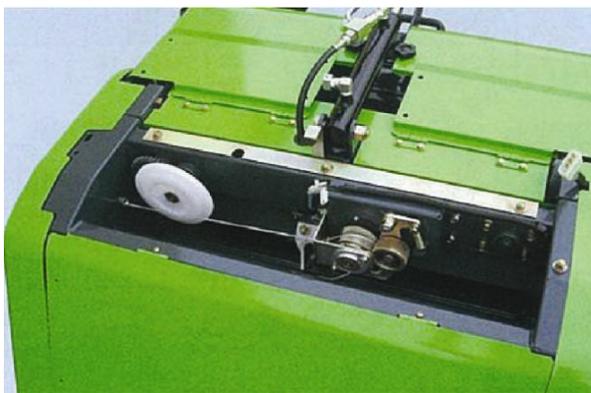


Fig. 15. Thread roller and sensing rod of the baler.

A sensing rod communicates to the tying mechanism when straw is already baled, and facilitates the tying of the straw bales automatically through the thread-roller guide.

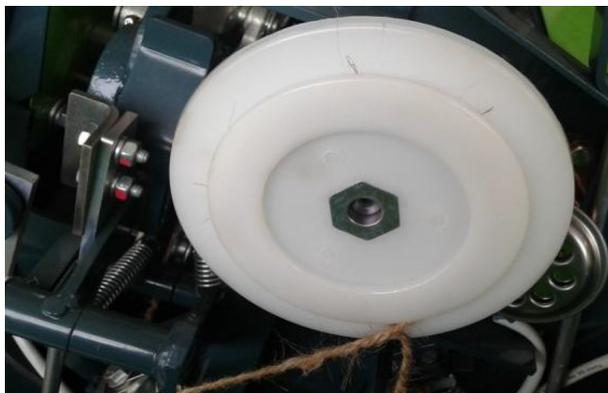


Fig. 16. Threading on the roller.

The thread-roller guide adjusts the twine windings depending on the size of the baled straw.

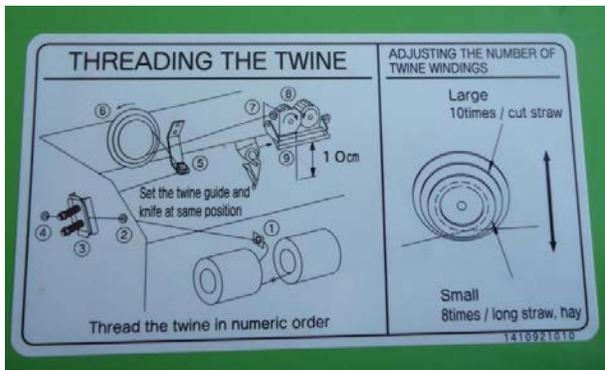


Fig. 17. Guide for threading the twine (for tightening straw bales).

3.2.3. Adjusting the compaction of straw bales



Fig. 18. Adjusting bale compaction.

The compaction of straw bales can be controlled by adjusting the rod shown in Figure 18. To tighten, pull the lever and slide the rear notch to the protruding slot; to loosen, push the lever and slide the front notch to the protruding slot.



Fig.19. Hydraulic lever of the tractor.

Besides the main steps mentioned for assembling and adjusting, the height of pick-up of the baler can be controlled by adjusting the hydraulic system of the tractor.

3.2.4. Control box or terminal

The control box allows the operator to operate the baler directly from the driver's seat. This can be used to either automatically or manually control the release of the straw bales. The control box contains the switches needed to start the operation and open the gate (cap) of the baler.



Fig. 20. Control box of a Star baler.

The basic functions are:

Switch: Auto/Off/ Manual

Function: Selects the mode of the controller

Auto: Finalizing and releasing the bale is done automatically.

Manual: The operator needs to control finalizing and releasing the bale.

Off: The baler is not operating.

Button: Draw out

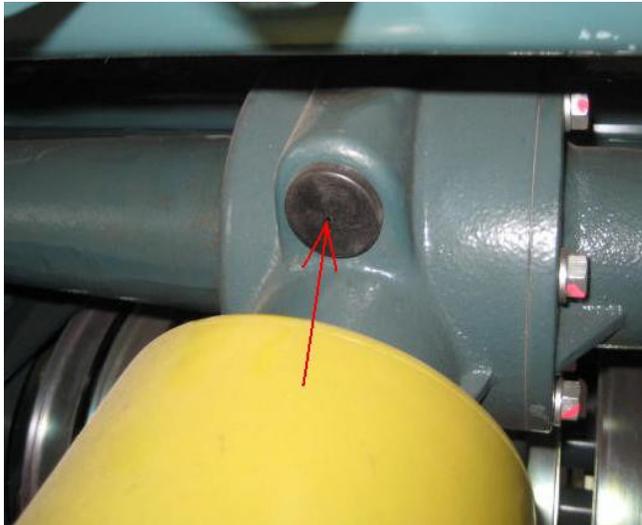
Function: This button is activated when the machine starts running in the field.

Button: Gate Open

Function: Opens the cover/cap of the baler machine at the back.

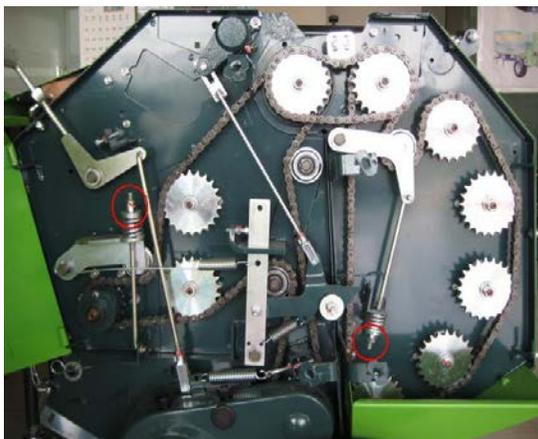
3.3. Maintenance

All moving parts of the baler machine must be checked and maintained regularly every after use.



Periodically change the lubricating oil following the manufacturer's manual. Do this at the location marked with a red arrow in Figure 21.

Fig. 21. Location for changing the lubricating oil.



Regularly check and adjust the tension of the transmission chains properly. Tighten or loosen the nuts (red circles in Figure 22) to adjust the chain tension. Clean and lubricate this system after every working day.

Fig. 22. Transmission chains and sprockets of the baler.

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