

Developing a round manual hay baler

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Introduction

The hay balers that shape today's agricultural landscape are powerful, gas-driven machines, but their size and cost leave a significant gap in accessibility for small scale farms. Instead, manual balers are often used due to their smaller size and practicality. These frequently rectangular manual balers operate by a plunger system, where multiple loads and compressions of hay are necessary to produce a bale (Kanaris, 2021). To eliminate the excess time needed to create a bale, a round claw shape baler was created so that a larger mass of hay could be placed into the baler for only one compression. In addition, a ratchet system was also implemented, with a compression lever harnessing the most mechanical advantage possible.

The quality of a hay bale is determined by multiple factors, such as mass, density, crude protein loss, and nutrient loss (Awgichew et al., 2021). Baling rate can be used as a standard, so it was the variable of focus for this project. Baling time, bale mass, and baling rate were the factors measured and calculated, so that the efficiency of the created baler could be compared to other manual balers.

Materials and Methods

The manual hay baler was designed entirely using Autodesk Fusion. The main system of the hay baler was based on a ratchet mechanism, where the lever arm contains a spring pawl that locks onto a gear and allows the system to only rotate in one direction. The lever arm is pushed toward the ground to close the claw and compress the hay, which can then be rotated back to be pushed down again to use more mechanical advantage. Once the model and simulated motion were completed, all parts were produced on a plasma table and were assembled using a Millermatic 211 welder. Part files were posted on a CNC file sharing group. The hay baler was also designed to be easily disassembled for transport and storage. The rate of hay bale production was calculated by dividing the mass of one bale by the respective time it took to produce that bale. This is a standard called baling rate and was used to compare bales of all styles and sizes. The baling rate of traditional machine balers is about 7,500 kg/hour. That means for this study, the most valuable comparison was between the custom round hay baler and other manual balers also produced on small scale farms.

Materials and Methods (continued)

To determine the baling rate, the most efficient baling procedures were determined through research and trial and error. To create a bale using this round manual baler, three lengths of twine were laid out over the inside of the hay baler once the upper claw is open. Then, a tool similar to a bedding fork was used to scoop sections of hay into the open claw baler. Hay was loaded into the baler until both sides were filled. The upper claw was lowered down onto the hay, and then further pressed and compressed using the lever ratchet system. The upper claw was pushed down into the hay to compress it into a bale. The twine pieces were then gathered from either side and tied around the formed hay bale. Once tied, the upper claw was lifted from the baler by the twine handles, and the completed hay bale was removed.

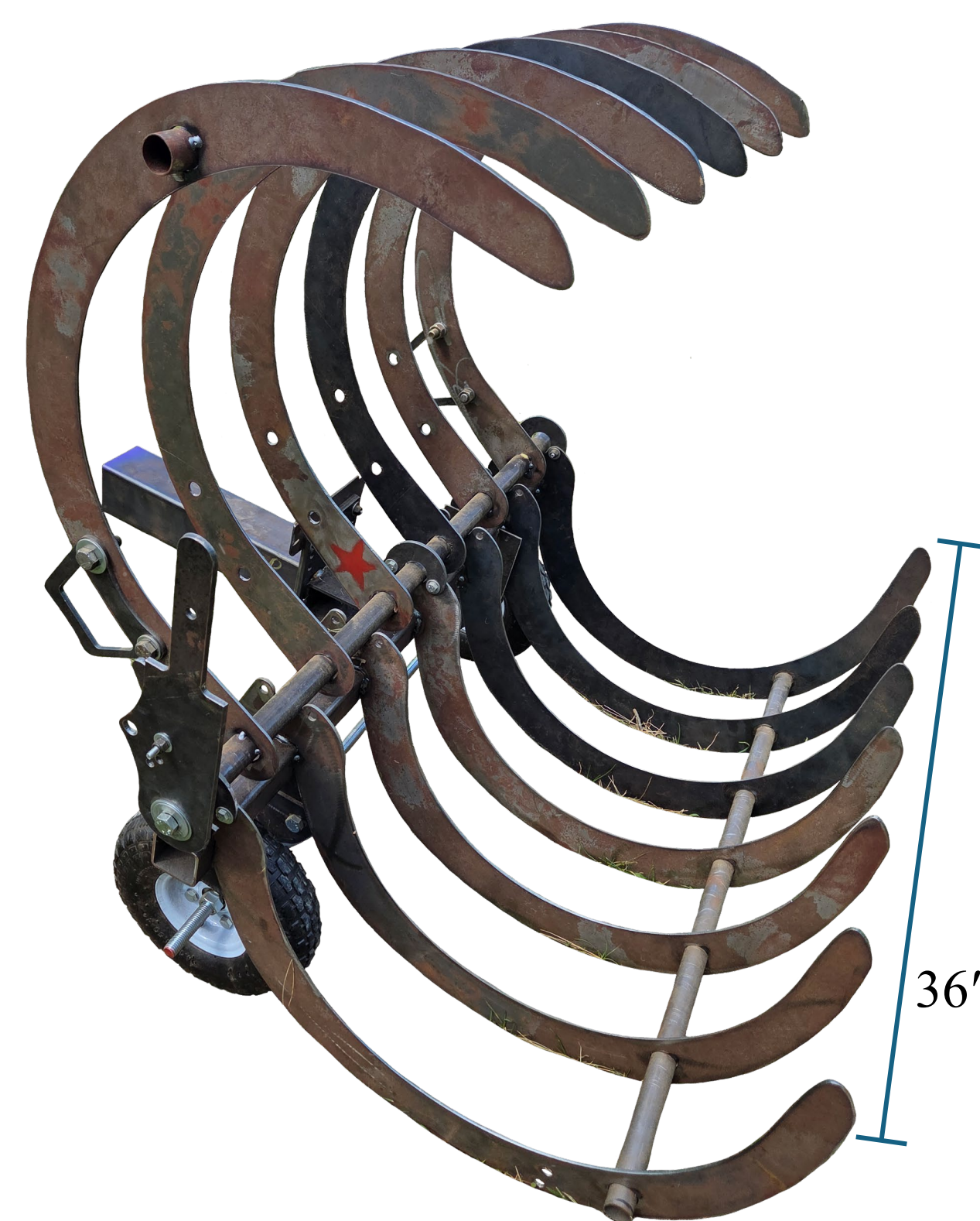


Figure 1 (left): This is the developed Hopp baler in an open rest position. This is the position that was used while loading hay into the baler. The lever arm above the wheel was fitted with a three-foot pipe to aid in the mechanical advantage of the compression. The mechanical system just behind the lever arm allowed the upper claw to be easily opened again once the hay bale was compressed and tied. The back of the hay baler includes a three-inch square tube so that a ball hitch could be attached for easy transportation.

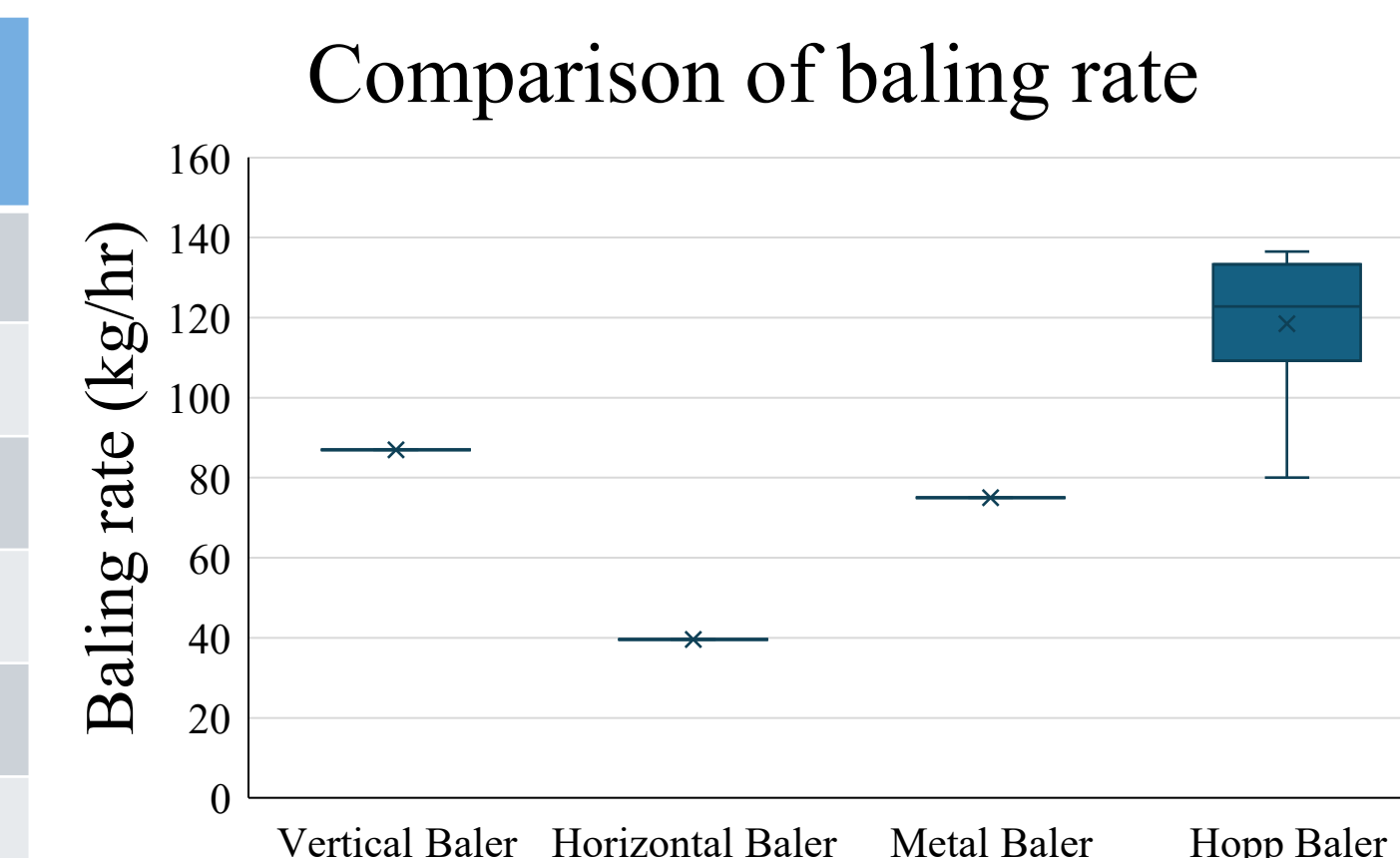


Figure 2 (right): This image shows one of the hay bales produced by the claw hay baler. The bale has a mass of 8.3 kilograms and was produced in 3.95 minutes. Compared to other bales, it required less production time while still achieving a higher mass, aiding in a favorable baling rate calculation. Notably, this was one of the first bales produced using the Hopp Baler and its success demonstrates both the practicality and user-friendly design of the round baling system.

Results

Baling time (min)	Bale mass (kg)	Baling rate (kg/hr)
4.10	7.5	109.8
4.01	7.2	107.7
3.95	8.3	126.1
4.60	8.6	112.2
3.78	8.6	136.5
3.75	8.4	134.4
4.07	8.1	119.5
3.88	8.6	133.0
4.38	9.2	126.0
3.6	4.8	80.0

Table 1 (above): This table shows the baling time, mass, and the baling rate of the developed Hopp Baler. The baling rate is the calculated standard



Graph 1 (above): This graph shows the mean baling rate of three manual balers used in comparison to the Hopp baler. While statistical analysis could not be completed due to lack of individual data from the other balers reported, the means can be compared plainly. With the Hopp baler demonstrating a mean baling rate of 118.5 kg/hr, this value is greater than the mean baling rates of the vertical baler (87.0 kg/hr), horizontal wood baler (39.6 kg/hr), and horizontal metal baler (75 kg/hr) (Awgichew et al., 2021).

Conclusion

The custom round manual hay baler proved effective at producing consistent hay bales, and a simple comparison of means between the round baler and other rectangular balers showed that baler style can influence baling rate. While manual systems cannot match machine output, the round design reduces repetitive motions and streamlines the baling process. The availability of modifiable production files also supports broader use and adaptation, making this baler a practical option for small-scale or low-resource operations.

References

- Awgichew, A., Keberedin, A., & Hailu, G. (2021). Adaptation and evolution of manual hay baller. *Sirish Interdisciplinary Journal of Science & Research*, 4(4), 15–21. <https://dx.doi.org/10.2139/ssrn.3814149>
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