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Efficiency of round bale feeders: comparison of Tombstone versus Hay Saver

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Hay wastage when feeding round bales due to contamination, deterioration, and animal refusal can accrue large financial losses for farmers. The present study investigated the efficiency of the conventional Tombstone-style feeder system compared to the Hay Saver feeder system to reduce hay wastage in feeding round hay bales. Mares were distributed equally into two groups, Tombstone and Hay Saver, and fed six bales per group over 48 days. Hay wastage was collected daily, dried, and weighed, while the mares were weighed weekly. Overall, the Hay Saver feeder showed less hay wastage, higher mean mare weight, and higher consumption rate per horse. The results of this study indicated that the Hay Saver feeder system had higher efficiency compared to the Tombstone feeder system.

Key words: *animal husbandry, hay feeder, hay wastage, horse*

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Hay wastage from round bale feeders can equate to major financial losses for farmers over time [4]. These feeders attempt to lower the amount of wasted hay generated via animal trampling, chemical and physical deterioration, fecal contamination, and general livestock refusal; however, all still show high wastage amounts. For example, the Tombstone feeder loses 10–30% due to the trampling of hay falling outside the feeder [3]. Storage losses, such as mold contamination or pest infestation, account for 6–16.5% of hay waste, depending on the storage container (i.e., open storage, bin storage, etc.) [3]. Further losses are incurred from weather damage; hay left uncovered may be exposed to damaging sun rays, leading to protein denaturation, oxidation of fats, and an overall loss of nutrients [5]. Additionally, inclement weather such as snow and rain may lead to an accumulation of water inside the hay bale. This moist environment can lead to the growth of bacteria, fungi, and molds, which can be toxic to animals feeding on the bale and can also lead to nutrient loss [3, 5].

The Klene Pipe system, also known as the "Hay Saver" feeder, is a model of round bale feeder that combines the sun and rain protection of covered feeders with a shelf to lift bales away from the ground, preventing moisture and organismal permeation, and gravity-controlled grills that lower as the round bale is consumed. To our knowledge, no studies have compared conventional round bale feeders, such as the Tombstone feeder, to covered-shelf bale feeders with gravity-controlled grills, like the Hay Saver feeder.

Therefore, the present study aimed to compare the efficiency of the Tombstone and Hay Saver round bale feeder systems by evaluating the following end points: (i) amount of hay waste, (ii) mare weight, and (iii) consumption rate.

This study was carried out at Southern Illinois University Carbondale (SIUC) after approval by the Institutional Animal Care and Use Committee (protocol #20-031**)**. Healthy mixed breed mares (n=10) ranging from 8 to 15 years old and 460 to 545 kg were used. All mares were kept in two separate dry lot pastures with similar dimensions (20 m × 43 m).

Two hay feeders were utilized during this experiment: the conventional Tombstone-style feeder (Equine Pro Hay Feeder, Tarter Farm & Ranch Equipment, Dunnville, KY, USA; cost=USD399.99) and the Hay Saver feeder (H-8 7' Big Bale Feeder with Gravity Controlled Grills and Roof Material, Klene Pipe Structures Inc., Greensburg, IN, USA; cost = USD2,145). Over the course of the experiment, six bales (547.5 kg each) per group were consumed, with each bale counting as one replicate. The bales were replaced

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when the levels in the feeders reached approximately 30 cm and 10 cm for the Tombstone and Hay Saver feeders, respectively. These levels were chosen based upon previous observations of mare refusal due to either accumulation of water, mold, and mud (Tombstone) or difficulty in accessing remaining hay (Hay Saver).

Prior to the start of the study, the mares were randomly assigned to the following groups: (i) Tombstone group: mares (n=5; initial body weight=505.4 ± 15.0 kg) fed using the Tombstone feeder (Fig. 1A) and (ii) Hay Saver group: mares (n=5; initial body weight=511.8 ± 87.0 kg) fed using the Hay Saver feeder (Fig. 1B). After a three-day acclimation period, the feeders were placed with the appropriate group, and hay that fell outside the feeders was considered waste [2]. Immediately after daily collection, any large chunks of mud were removed and the wasted hay from each group (Fig. 1C) was allowed to dry spontaneously for three days to reduce excess moisture. For drying, the wasted hay was taken to an indoor, temperature-controlled building, spread into a single, even layer, and allowed to dry. After the drying period, any mud remaining on the hay waste was shaken off, and the waste was weighed. Weights of individual animals were collected and recorded weekly, and consumption rates were calculated using the following equation: (Initial bale weight–∑(Daily bale wastage))/(5 mares). Due to limitations on time and the number of horses able to be utilized for the experiment, a cross-over experimental design that allowed for statistical analysis could not be performed. Therefore, the present, descriptive results are preliminary and do not include any statistical tests.

Throughout the experiment, six round bales of hay were consumed for each treatment group over a total of 48 days (8 days per bale). Considering the mean weight of hay wastage per feeder system throughout the whole experiment (Fig. 2A), 221.0 ± 17.4 kg of hay per bale was wasted using the Tombstone system, versus 53.8 ± 7.2 kg of hay per bale using the Hay Saver system. This finding equates to an overall savings of 167.2 kg of hay per bale during this study when using the Hay Saver feeder compared with the Tombstone feeder. Through the course of the experiment, 1,326 kg of hay in total was wasted with the Tombstone feeder, while 323 kg of hay in total was wasted with the Hay Saver feeder, meaning that the Tombstone feeder produced 1,003 more kilograms total of hay wastage than the Hay Saver. Therefore, each horse in the Tombstone group generated approximately 265.2 kg/head of wasted hay, while each horse in the Hay Saver group produced approximately 64.6 kg/head of wasted hay. This corresponds to approximately 44.2 kg/head/bale of hay wastage per single bale per horse for the Tombstone group mares, while the Hay Saver group mares generated approximately 10.8 kg/head/bale of hay wastage per single bale per horse. Throughout the course of the experiment, it was noted that the hay bales within the Hay Saver system remained dry and mold-free during the study, while the hay in the Tombstone system collected water and became infested with mold toward the end of each bale. While studies have shown that hay rings, like the Tombstone system, reduce hay waste by preventing fecal and urine contamination and trampling of a majority of the hay [2, 4, 5], the hay within the ring is still in contact with the ground and without cover, unless additional preventative measures are taken (i.e., purchasing additional roofing and/or flooring). Round bales that are left uncovered and directly touching the ground lead to decreased hay quality, and animals are less likely to eat this hay, so it is considered waste [6]. This decreased hay quality could also be seen in the present study after the drying period. The hay wastage collected from the Tombstone system appeared to have far more mold contamination than the wastage from the Hay Saver system. Furthermore, there was often a foul odor emanating from the Tombstone hay waste, likely another sign of mold and other microorganismal growth.

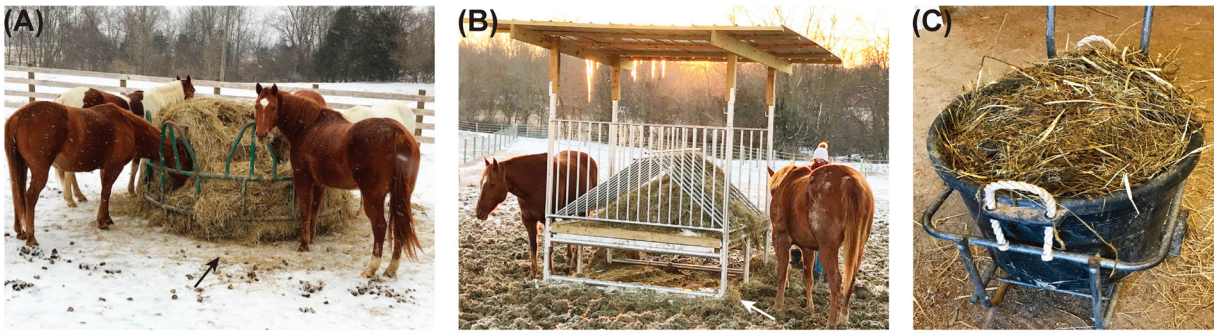

Fig. 1. Illustration of feeder systems and experimental conditions. For several weeks of the experiment, snow and cold temperatures were observed. (A) Mares feeding from the Tombstone feeder in snowy conditions. (B) Mares resting close to the Hay Saver feeder after a night of snow. (C) A portion of the collected hay wastage. (A, B) Arrows indicate wasted hay close to the feeders.

The elevated bottom shelf and attached covering of the Hay Saver system work together to eliminate both ground and weather exposure while combining the benefits of reducing trampling and animal waste contamination, likely leading to the decreased hay wastage observed in the present study.

The hay wastage for each group was then used to tabulate the financial losses (in USD) of each feeder for a variety of hay types and qualities using prices from Southern Illinois (Table 1). For the good-quality grass hay that was used in this study, the Hay Saver system saved a total of USD161.42 worth of hay waste throughout the study (i.e., six bales). This equates to an average savings of USD26.90 per bale. Moreover, when calculating the hypothetical savings using the premium-quality grass hay in the Hay Saver system, approximately USD44.23 per bale and USD265.35 over the six bales would have been saved during the whole study. One important factor a farm owner or manager commonly uses to help decide what feeder to buy is payback: how many months it takes for financial savings from waste reduction to pay back the price of that feeder [4]. In this study (good-quality grass hay), the payback when switching from a Tombstone system to the Hay Saver system is estimated to be approximately 22 months. However, when using premium-quality grass hay bales in the Hay Saver system, the estimated payback time drastically reduces to about 13 months. Thus, despite the increased acquisition cost of purchasing a Hay Saver system, the financial savings provided by the Hay Saver system will pay back this cost in time.

Throughout the experiment, the mares in the Hay Saver group weighed more than the Tombstone mares (Fig. 2B). On average, the Hay Saver mares gained 4.4 ± 3.1 kg per week, while the Tombstone mares gained only 0.6 ± 3.7 kg per week. The weight increase in the Hay Saver mares is

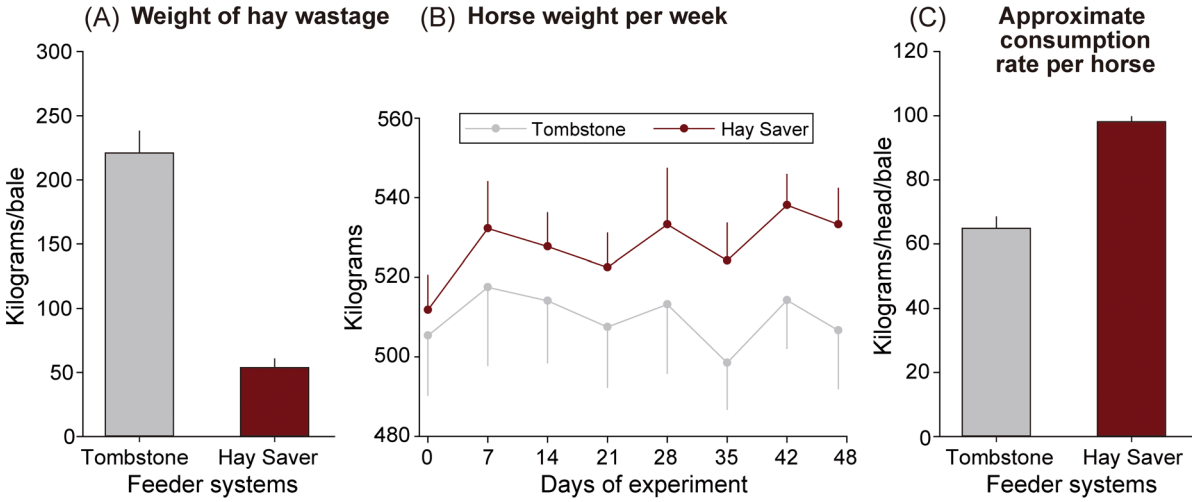

Fig. 2. Mean (± SEM) (A) overall hay wastage weight evaluated between the two feeder groups (Tombstone and Hay Saver), (B) horse weight per week for each group, and (C) consumption rate per horse per bale for each group are shown. Over the course of the whole study, six round bales of hay were consumed for each treatment group, with each bale lasting 8 days, over a total of 48 days.

Table 1. Prices (in USD) of various hay types and qualities for Southern Illinois and calculated costs of hay wastage and savings for each of the two feeding systems, Tombstone and Hay Saver, accumulated over the course of feeding six round bales in each feeder

Hay type	Cost per kilogram (USD)	Waste cost Tombstone (USD)	Waste cost Hay Saver (USD)	Savings with Hay Saver (USD)
Alfalfa (premium)	0.183	242.64	59.10	183.53
Alfalfa (good)	0.165	219.25	53.41	165.84
Alfalfa (fair)	0.139	184.17	44.86	139.31
Grass-alfalfa (good)	0.161	213.40	51.98	161.42
Grass-alfalfa (fair)	0.141	187.09	45.57	141.52
Grass (premium)	0.265	350.80	85.45	265.35
Grass (good)	0.161	213.40	51.98	161.42

Cost of hay per kilogram calculated using listed prices for Southern Illinois [1].

likely related to the observation that these mares consumed more hay from each bale than in the Tombstone feeder group. This is reflected in the approximate consumption rate per horse per bale throughout the whole experiment (Fig. 2C), with the Tombstone mares consuming approximately 64.9 ± 3.7 kg of hay per bale and the Hay Saver mares consuming 98.1 ± 1.8 kg per bale. It is worth noting that, in some cases, this increased weight gain is ideal; however, in other scenarios, it may be unwanted. Thus, a Hay Saver owner may choose to use a forage with lower nutritional value to avoid weight gain and still benefit from the lower hay wastage and subsequent financial savings of the Hay Saver system.

In conclusion, this study showed that the Hay Saver system displayed increased efficiency in reducing hay wastage, weight gain, and consumption rate compared to the traditional Tombstone system. This increased efficiency and maintenance of hay quality leads to significant financial savings that increase over time. However, an inspection of the Hay Saver system for proper functioning is recommended at least once a week, as is the case with any feeder system. Future research exploring the use of the Hay Saver system assessing longer-term use, as well as comparing its efficiency when using different types of hay to a variety of other hay feeder systems and to no feeder system at all, is warranted.

Competing Interests

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of this work.

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