Rakes and Mergers*

Ronald T. Schuler
Extension Agricultural Engineer

Hay and forage producers have a wide variety of equipment options for raking and merging swaths or windrows. Selecting the proper equipment and operating it correctly will insure high quality hay and forage with a cost effective harvesting system. Numerous studies have provided results on equipment performance and selection that fit specific forage harvesting systems.

Rakes/mergers are often used for four purposes:

1. create a narrow swath in windrow sufficiently narrow to meet the width of the harvester or baler pickup,
2. merge swaths together to match the windrow density with the harvester or baler capacity,
3. invert the crop to allow wet forage on the bottom of the swath to be exposed to sun and wind for faster drying, and
4. move the swath from wet to dry ground.

MACHINES AVAILABLE

The machines include rakes (wheel, parallel bar and rotary), mergers, and tedders-inverters used manipulate swathes. Each of these machines has strengths and weaknesses which allow the producers to select a machine that best fits their production system needs.

Rakes

Wheel rakes are not powered directly by the tractor PTO or hydraulic system. Rather, forward motion of the tractor and the engaging of the rake wheels in the crop and/or soil to drive the rake wheels. These machines may have difficulty moving wet, heavy swaths or windrows. As a result, wheel rakes are frequently limited to raking drier crops that will be harvested as dry hay. These rakes are known for gently handling the swaths. The rake wheels are supported with springs having adjustable tension. Excessive tension may cause the wheel to float over the crop and leave some crop behind. Inadequate tension will cause more rapid tooth wear and greater contamination of the forage with soil, rocks, and other debris. The twin or double rake design has become more popular to meet the needs of large hay production systems. Rake widths in excess of 36 feet are available which permits the merging of two passes of an 18 foot mower-conditioner. The wheel rake is the lowest cost rake and these machines can have features such as, larger diameter rake wheels, more teeth per wheel, and hydraulic controls versus manual folding and width adjustments.

*Revision of ‘Equipment to Rake and Merge Hay and Forage’, Proceedings of the 2003 Wisconsin Forage Council

Parallel bar rakes were the most popular rake years ago. Because of costs and limited widths, these machines are less available. Twin frame rakes are available for the larger production systems but they are more costly than wheel rakes and are more limited respect to raking widths which do not exceed 30 feet.

Rotary rakes were introduced into the US in the 1980s and sales have slowly increased since. Single rotary rakes are most popular but multiple rotor rakes are readily available. The two primary features that differentiate single rotor rakes are the rotor diameter and the number of arms. Larger diameter rotors and more arms will increase the capacity. Standard twin rotor rakes are typically designed to sweep two swaths toward the center forming a single merged windrow. The distance between the two rotors, and hence the coverage width, may be adjustable. These rotors are not directly side by side so that one rotor leads the other. Some twin rotor rakes can be adjusted so that all hay is moved in the same direction. This allows merging to the side of the machine, rather than the center, so that when the next pass is made, another merged windrow is laid beside the first. This may be done to meet the capacity of a large self-propelled forage harvester. These machines would typically be used to merge crop for large self-propelled forage harvesters. Rotary rakes have a deserved reputation for creating a well-formed, fluffy, less roped windrow that allows good air circulation and good crop drying. For this reason, these rakes are becoming increasingly popular to merge the crop for large square balers because of the need to get hay very dry in these large bales. Care must be taken with this rake not to sweep the ground to aggressively to minimize soil and rock contamination of the windrow. Another important adjustment is the rotor to ground speed ratio. The correct combination of tractor gear and engine speed must be found so that the crop is completely swept into the windrow, but the rotor is not turning so fast that leaves are shattered from the stem. Rotary rakes are the most expensive rake type discussed because they require the heavy frame and the cam-actuated gearbox that drives the rotor is more complicated and expensive. The cam/gearbox can be quite expensive to repair if failure occurs.

Mergers

As forage harvesters have increased in capacity, the need for merging more swaths into a single windrow. The major difference between the rakes and mergers is that the mergers lifts the crop onto a belt conveyor that is used to move and deposit the swath into the desired location so the crop is never dragged along the ground. The merger can be used for either silage or dry hay although its primary use is silage. Most machines can deposit the crop to the left or right simply by changing the direction of the hydraulically driven belt conveyor. Most merger manufacturers have single merger but double and triple mergers have become available. The double merger picks up two swathes and places them on a third swath. With this merger, the operator can return on the other side of the merged swathes and place two more swathes on the three. One manufacturer has a 30 foot wide continuous pickup, which can pickup a wide range of swath widths. If 30 foot mower conditioner with three ten-foot sections which create three swaths, this machine would be capable of picking up the three swaths and is considered a triple merger.

Another example of a triple merger is one capable of picking up three swathes and depositing them on a fourth. Another manufacturer mounts a single merger on the front of the tractor which tows a double merger. The merger on the front of the tractor picks up a swath and lays it on the adjacent swath. The double merger towed behind the tractor picks up three swaths (a single swath and the double swath) and lays them on a fourth swath.

Before purchasing a merger, the compatibility of the mower-conditioner width, merger pickup width and the forage harvester or baler pickup width should be checked. For the double and triple mergers the spacing of the pickups should be easily adjustable using hydraulics.

Tedders and Inverters

Windrow inverters pickup one windrow and lay it on the ground up side down. They are configured quite similar to windrow mergers with a conventional or belt-type pick-up, cross-conveyor belt and inverter shield at the conveyor output. The primary differences between a merger and inverter are that the inverters have a narrow pick-up that can only accommodate a narrow windrow and the inverter is lighter-duty than a merger. The inverter is not intended as a merging device. Rather, the inverter is intended to move an already formed windrow off of wet ground and invert it for faster drying to dry hay moisture.

Two types of machines are available, rotary and parallel bar. Rotary tedders are used to spread crop into a swath potentially as wide as the cut width of the mower-conditioner. This not only aerates the swath, but more importantly it allows all the sunlight that is striking the field to be used to dry the crop. The parallel bar tedder fluffs the swath and minimal impact on the swath width. Tedding is an aggressive action and is acceptable for grasses where leaf loss is less of a concern. But for alfalfa there is concern that tedders will cause unacceptable leaf loss, especially if the tedding is done when the crop is partially dry and the leaves are brittle. Tedding adds an additional step in the hay making process: cutting, tedding, raking, and baling.

MACHINE PERFORMANCE STUDIES

The evaluation of rakes and mergers can be based on field losses, drying rates, windrow shape and condition, ability to move large swaths, and ability to create a windrow free of contamination of rocks, soil and other debris.

Losses and drying rates

Selection and operation of this equipment should be based on minimizing losses and maintaining rapid field drying which will ensure high quality forage. How this equipment handles the swath impacts the loss and the resultant windrow condition. Handling methods go from picking up the swath and laying it down to rolling the swath across the ground surface.

Most of the research has involved the losses and drying rates associated with these machines. In numerous cases the forage quality was evaluated with respect to the losses, usually high quality leaves, and drying rate.

In a study by Savoie et al. (1982), a parallel-bar and rotary rakes were compared in conditioned and non-conditioned alfalfa. They found no difference in the drying rate but the rotary rake had slightly higher losses. Raking was done near 40 percent moisture, wet basis. They found tedding increased the drying rate slightly but the results were not very consistent. During good drying conditions, tedding did not appear to be beneficial but may be beneficial after a heavy rain, which creates a windrow that was dense and matted.

In an Ohio study reported by Claas, three rakes (wheel, rotary and parallel-bar) were compared with respect to drying rate based on moisture content as forage dry down approached baling moisture. In the first cutting for a orchard grass-alfalfa mix, the rotary rake had the lowest moisture (20.9 percent) while the wheel rake had the highest moisture (25.0 percent). The parallel-bar rake was intermediate. For the second cutting alfalfa, the rotary rake had lower moisture (20.4 percent) than the other two rakes (22.5 percent for the parallel-bar and 23.0 percent for the wheel rake). In a third cutting of alfalfa of a orchard grass mixture, the differences in moisture between rake types were not significant.

Garthe et al. (1988) compared a parallel-bar rake with a windrow inverter and found no difference between the two devices in terms of drying rate or crop quality (based on crude protein content). Shearer et al. (1992) compared a parallel-bar rake with two different windrow inverters. They found no difference between the three machines with respect to the drying rates or losses. In a study of several rakes and a windrow inverter, Hoover (1996) found that the inverter and the parallel-bar rake had significantly less loss than the other rake types which included a wheel rake and several rotary rakes. In this study, the drying rate among the different rakes was very similar.

Savoie and Beauregard (1988) studied four windrow inverters that significantly increased the drying rate compared to a control with no manipulation of the forage in a windrow. In addition they indicated that an inverter could advantageously replace a hay tedder.

Although no research has been reported on windrow mergers, their losses would be expected to be similar to the windrow inverters because they both pickup the windrow and do not move it across the ground. The drying rate of forage gathered with a windrow merger is generally not an issue because merging usually takes place right before the forage harvester.

Windrow Shape and Condition

To produce a consistent, high quality hay and forage, the raked or merged windrow must be uniform to ensure the moisture is uniform throughout the windrow. Based on field experience and observations, the rotary rakes produce a more uniform and less roped

windrow than wheel or parallel-bar rakes. Windrow inverters and mergers will not produce a roped windrow but can often produce non-uniform windrow if the belt does not properly take the crop off the pick-up. In all cases, the equipment must be properly adjusted and operated to obtain the most uniform windrows.

Producing windrows free of rocks, soil, and other debris to avoid problems is important with respect to forage harvester knife wear, knife damage, clostridia fermentation (especially in high moisture silage) and excess ash content in feed. Equipment that rolls and slides the crop across the ground will have a greater risk of rock and soil contamination in the swath. This becomes more important with high capacity forage harvesters requiring a greater distance for the crop to be moved when raking. Machines that pickup the crop and displace it with a cross conveyor and then lay it down on the ground at another location will have less risk of contaminating the crop.

With the increased forage yields, raking and merging equipment must be sufficiently aggressive to move the large quantity of forage. Equipment that is ground driven will have greater difficulty picking up these swaths. These would include the wheel rakes and ground driven parallel-bar rakes. PTO and hydraulic driven rakes and mergers can become more aggressive by maintaining higher operating speeds relative to the forward travel speed.

Today, forage producers have many options in equipment for moving swaths and creating swaths. Careful selection of this equipment should be made to choose a system and machine that best meets the needs with respect to crop yield and cutting and harvesting machine size. Also, proper adjustment and operation of these machines are important to insure minimum losses and rapid drying.

References:

Garthe, J. W., P. M. Anderson, R. J. Hoover and S. L. Fales. 1988. Field test of a swath/windrow hay inverter. ASAE Paper 88-1549. ASAE, St. Joseph, MI. 15 pp.

Hoover, L.L. 1996. A comparative rake study of dry matter loss, drying rate, and rock movement in alfalfa fields. B.S. Honors Thesis. The Pennsylvania State University. 33 pp.

Rotz, C. A. and P. Savoie. 1991. Economics of swath manipulation during field curing of alfalfa. Applied Engineering in Agriculture. 7(3)316-323

Savoie, P. C. and S. Beauregard. 1988. Hay windrow inversion. ASAE Paper 88-1548. ASAE, St. Joseph, MI. 13 pp.

Savoie, P., C. A. Rotz, H. F. Bucholtz and R. C. Brook. 1982. Hay harvesting system losses and drying rates. Transaction of the ASAE. 25(3) 581-585, 589.

Shearer, S. A., G. M. Turner, M. Collins and W. O. Peterson. 1992. Effect of swath and windrow manipulation on alfalfa drying and quality. Applied Engineering in Agriculture. 8(30) 303-307.