Forage Equipment Performance in High-Yielding Switchgrass

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Hay and forage producers have a good understanding of what they can expect from their equipment when harvesting grass or alfalfa. There is growing interest in producing biomass crops such as switchgrass for energy production and some growers are interested in annual forages such as Sudangrass or Sorghum-sudangrass for chopped silage. These crops have different growth habits than traditional forages and can present unique challenges for harvesting and storage. Recent work at the University of Tennessee evaluated equipment performance of mowers, rakes, tedders, balers, and forage harvesters in high-yielding switchgrass. The results and observations will have value for machinery managers planning unconventional harvesting operations.

The harvest trials were conducted in Milan, TN in an established switchgrass stand (Var. Alamo) yielding 5.5 tons DM/ac. The equipment included a Kuhn 700-GII HD disc mower (9' cut), a Deere 630 mower-conditioner (10' cut), a Durabilt 1616 twin horizontal tedder (10'), a Kuhn GA4121GTH single horizontal rotary rake (13.5'), a Deere 458 Silage Special round baler (4 x 5) with MegaWide pickup, and a Deere 3975 pull-type forage harvester. There were two harvest schedules: one-cut in late November (or later after the first killing frost), and two-cut with a cutting in mid-June and another mid-November. While the two-cut harvest required a second pass over the field, it reduced the volume of material handled. In a one-cut system the switchgrass can be 9' tall and crop flow through the equipment can be a problem, particularly for producers with lower capacity equipment.

Uninterrupted crop flow through the machine was the greatest challenge with the one-cut harvest. The Kuhn disc mower performed well in the two-cut harvest, but in the one-cut harvest the crop dried while standing and the high-volume, light weight material did not flow well between the cutter bar and the curtain support, plugging the machine. Changing ground speed and using a cutter-bar crop deflector disk versus a sweeping rod did not improve crop flow. A possible solution would be to raise the curtain mount, although it would increase the potential for harm from thrown objects.

Disc mower in second cut switchgrass.

Mower conditioner in straight-standing, one-cut switchgrass.

The Deere mower-conditioner performed well in straight-standing switchgrass in both one-cut and two-cut harvests. When the moisture content of the standing crop was low (<18%, wet basis), the discharge chute was narrowed to create the windrow without raking. This led to crop pinching at the leading shield junctions. In lodged switchgrass, the mower- conditioner rolls became plugged due to uneven feeding across the entire mower-conditioner cut width. Portions of the field had 100% lodging with stems oriented >45° from vertical. Reducing travel speed improved material flow. It was very difficult to clear the machine because the roll compression system had reached its limits and the design did not allow for reversing the conditioning rollers.

Round Baler in one-cut switchgrass.

Mower conditioner in straight-standing, one-cut switchgrass (Model is 630).

Tedder in first of two-cut switchgrass. Drying study plots were being harvested.

Rotary rake in first of two-cut switchgrass. Drying study plots were being harvested.

The Durabilt tedder was used in the first-cutting of a two-cut harvest to speed drying. It operated near its limit based on the amount of tine flexing and bent tines from the matted, long switchgrass stems. Researchers recommend a tedder with stiffer tines and an increased tine spring constant for working in high-yielding switchgrass.

The Kuhn rake was used in both the two-cut and one-cut harvests whereby single swaths up to 9' wide were raked into windrows. The rake handled the dry, voluminous material nicely, creating well-formed, well-aerated windrows. Greater hitch height clearance above the swaths or windrows would reduce the potential for switchgrass entanglement.

The Deere round baler was used in both the one-cut and two-cut harvests. The baler experienced no pickup or baling issues even though the one-cut harvest windrows were voluminous. The MegaWide™ Plus pickup accommodated the large windrows of 9' stems by pulling them into the baler without any feeding problems. The average round bale density, based on 18% moisture, ranged from 10.2 lbs/ft^3 for the first cutting of the two-cut harvest to 12.7 lbs/ft^3 with the one-cut harvest. The density of net wrapped bales was greater than twine-wrapped bales.

The Deere forage harvester performed well. The pickup and cross feed auger handled the material without plugging but several pickup tines were bent by the heavy crop. The forage harvester pickup was not as robust as the baler pickup.

The observations and recommendations from this work will provide guidance for producers considering harvesting biomass and nontraditional crops, and benefit machinery manufacturers as they design equipment to meet producer needs.