Biomass Energy Production Alfalfa Supply System

Compare Harvest Systems

**MINNESOTA AGRIPOWER PROJECT
TASK II RESEARCH REPORT**

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Minnesota Agri-Power Project Final Report
Task IIf - Comparison of the Profitability of Various Harvest Systems
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Objectives

Our primary objectives for this task were to determine field performance and harvest losses for several types of cutting and baling equipment and to compare these values with those found in the literature. Originally, we had planned to study use of preservatives and their effect on harvest and storage losses, but since the MNVAP processing plant is not currently buying hay treated with preservatives, we did minimal work with preservatives during this phase of the project.

Activities

Activities undertaken to accomplish the task objectives included:

- Reviewing the literature and contacting hay harvest and storage researchers in other states
- Obtaining information from equipment manufacturers
- Conducting a harvest demonstration at the West Central Experiment Station at Morris MN
- Conducting harvest loss measurements on four cooperators' farms

Additional activities undertaken by Task IIf personnel included assisting with the hay storage study (Task IIg) at Morris MN, and assisting in trouble-shooting problems with leaf-stem separation and in trying to track apparent protein and dry matter losses during drying and pelleting at the MNVAP processing plant.

Challenges

Minnesota weather patterns in the last year have been very unusual. Although average annual temperatures and precipitation will probably turn out to be about normal, we experienced a number of alternating periods of exceptionally dry and exceptionally wet weather. Unpredictable weather made it very difficult for farmers and researchers to execute plans for harvesting hay and for collecting data on harvest performance and losses. Plans for gathering harvest data in late summer of 1996 had to be abandoned after adverse drying conditions resulted in several failed attempts to collect data. We tried again to collect data at the West Central Experiment Station in conjunction with the July 1, 1997 forage field day, but a week of very wet weather that followed cutting of the hay prevented collection of any meaningful data. We did operate balers for demonstration purposes at the field day, but hay moisture (38%) was much higher than normal harvest moisture - even for harvest with preservatives.

It also turned out that 1997 was a terrific year for sales of hay harvesting equipment, which led to difficulty in finding manufacturers who could provide equipment for our field day. The field day was well-attended and participants had a good opportunity to interact with the manufacturers' representatives who were there, but several major manufacturers were missing.

Finally, because producers are quite interested in the possibility of using large rectangular bales, and because there is little information in the literature on these balers, we had hoped to put considerable effort into studying these balers. Unfortunately, the balers that make large- and medium-sized

rectangular bales are relatively new to the project area and we were only able to make connections with one cooperator who had a baler that makes medium-sized rectangular bales.

Results

Literature Values

Dry matter losses (as percent of initial yield) for various hay harvesting operations found in the literature are:

Mowing/conditioning	3.6 to 6.5%
Raking	0.8 to 5.0%
Large round balers	2.0 to 10.9%
Large rectangular balers	no values found

Harvesting losses measured on cooperator's farms during this study are reported below. Cooperators adjusted and operated their balers as they normally do for the conditions at time of harvest. Losses were measured by hand picking leaves and stems found on the ground.

Cooperator No. 1

Hay: 2nd year, 2nd cutting, early bloom	Yield: 1.4 tons/acre
Mowing/conditioning: 12-ft sickle mower/roll conditioner, 6 mph	Losses: 2.1 to 3.2%
Baling: large round baler, 8 mph, 15.7% moisture (wet basis)	Losses: 0.1 to 1.6%

Cooperator No. 2

Hay: 2nd year, 3rd cutting, pre-bloom	Yield: 1.1 tons/acre
Mowing/conditioning: 12-ft disc mower/roll conditioner, 9 mph	Losses: 1.5 to 2.4%
Baling: large round baler, 7.5 mph, 12.4% moisture	Losses: 0.4 to 2.0%

Cooperator No. 3

Hay: new seeding, 2nd cutting, late bud	Yield: 1.0 tons/acre
Mowing/conditioning/raking: 12-ft sickle mower/roll conditioner, 6 mph; followed by 26-ft v-finger rake, 10 mph, 35% moisture	Losses: 0.0 to 0.1%
Baling: large round baler, 7.5 mph, 22.9% moisture, preservative applied	Losses: 0.4 to 0.7%

Hay: 2nd year, 3rd cutting, 10% bloom	Yield: 1.3 tons/acre
Mowing/conditioning/raking: 12-ft sickle mower/roll conditioner, 6 mph; followed by 26-ft v-finger rake, 10 mph, 35% moisture	Losses: ~0.0%
Baling: large round baler, 7.5 mph, 9.5% moisture, preservative applied	Losses: 0.1 to 0.4%

Cooperator No. 4

Hay: 5th year, 3rd cutting, 15% bloom	Yield: 0.7 tons/acre
Mowing/conditioning/raking: 18-ft sickle mower/roll conditioner, 4.5 mph	Losses: not measured
Baling: medium rectangular baler, 8.5 mph, 19.2% moisture	Losses: 0.3 to 5.2%*

* Light crop and ~50 mph winds resulted in blowing hay and higher than normal losses.

Morris Field Day

We collected harvest loss data after a public field demonstration with three different types of balers at the Morris forage field day. But because the hay was much wetter than it would be for normal baling, and because the balers were operated at higher than normal speed, we don't believe that the results are realistic and they are not reported here.

Observations and Conclusions

- The four farm cooperators who allowed us to measure harvest losses are doing an excellent job of adjusting and operating their equipment to minimize losses. It appears that under normal conditions, these farms experience less than 3% mowing and conditioning losses and less than 1% baling loss (except under very windy conditions). This compares to literature values of 3.6 to 6.5% for mowing and conditioning and 2 to 10% for baling.
- It appears that losses associated with harvesting hay during normal drying weather are relatively small compared to the large losses that can occur when poor drying weather follows cutting of hay. Perhaps future effort should be focused more on developing hay harvesting strategies that reduce losses caused by poor weather.
- We observed some bale breakage as medium-sized rectangular bales were handled during the storage study. To avoid losses in time and hay associated with broken bales, it is important to use twine that has sufficient knot strength for the large bales and to use handling equipment that minimizes stress on the twine.
- Baling rates (acres per hour) varied widely depending on the speed at which balers were operated (miles per hour) and on the width of the swaths. Narrow swaths usually result in faster field drying and lower pre-baling losses, but they require faster baler speeds to produce satisfactory baling rates. Modern large balers are designed to accommodate high ground speeds, but field conditions are often too rough to allow these high speeds. It is difficult for operators to stay in the tractor seat at high speeds and harvest losses increase when the baler pickup bounces over rough spots. To get satisfactory baling rates at lower baler speeds, farmers must use wider swaths, which slow drying, or rake several swaths together, which increases pre-baling losses. More work needs to be done to determine optimum sizes and types of cutting and baling equipment for Minnesota conditions.
- Farmers are concerned about the high cost of large-package balers (especially the rectangular ones) and the sizes of tractors needed to handle these large balers. Future work could include investigating the feasibility of sharing equipment between neighbors (one of our cooperators is trying this), setting up custom-harvesting operations, or using lower-cost harvesting equipment.

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- Equipment, time, and expertise offered by the forage testing lab
- Cooperation of four individual members of MNVAP who allowed us to make harvest loss measurements in their fields