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Hay Harvest and Storage

Russell D. Mathison, Agronomist

Hay Harvest

Yield, Quality and Persistence. Forage dry matter yield and stand persistence are usually greatest when harvest occurs at full flower on legumes and early heading on grasses. Forage quality declines as plant maturity progresses from vegetative to reproductive (flowering, heading) stages. The challenge for hay producers is when to harvest to reach the best compromise between yield, quality and persistence to meet their particular needs. The producers of beef-quality hay have more flexibility in harvest decisions than the producers of dairy-quality hay, as beef cows usually do not require as high a quality forage as a dairy cow. Some forage quality can be sacrificed for improved yield and persistence. Generally, try to harvest legumes at early flowering and grasses at early heading.

Hay Curing. A substantial portion of the losses that occur in hay production take place during the field curing phase. Slow drying increases the likelihood that rain damage will occur, so management emphasis should be placed on maximizing drying rates. It has been estimated that less than 50 percent of incident solar radiation penetrates deeper than 1 inch into a hay swath. Maintaining maximum swath width helps to intercept more sunlight and hastens drying. Severe crushing treatments may also adversely affect drying rates by making the swath more dense. Tedding may aid in maintaining a loose structure and maximum surface area. Tedding should be done shortly after mowing or early enough in the day that some moisture remains in the leaf to prevent excessive losses.

Hay Storage

Storage Losses. The shift to the use of round bales for hay storage occurred quickly after the introduction of that technology. A major reason for this shift is the lower labor cost for hay in round bales compared with rectangular bales handled by hand. Although the reduced labor input is a major advantage of round bales as a storage form, round bales stored outside can be subject to larger storage and feeding losses than bales protected from weathering.

Losses during hay storage commonly average 25 percent for round bales stored outside on the ground for one season.

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1998 Minnesota Beef Cow/Calf Day

Provided by:

University of Minnesota Extension Service • North Central Experiment Station

When: Wednesday, February 18, 1998
Where: Sawmill Inn, Hwy 169 South, Grand Rapids, MN
Registration 5:30 pm; Program 6:00-10:00 pm
Registration Fee - $6/Farm (Refreshments Served)
No pre-registration required - Dinner on your own beforehand.

Topics/Speakers:

- Critical Success Factors for High Producing & High Profit Herds
  Harlan Hughes, Livestock Economist, North Dakota State-Fargo
- Tips for Avoiding a Visit from the MPCA & Potential Solutions for Problems
  Jerry Hildebrandt, Pollution Control Specialist, MPCA-Rochester
- Grazing Management, Fertility and Weed Control
  Greg Cuomo, Agronomist, U of M WCES-Morris
- Renovating Pastures to Increase Forage Production
  Russell Mathison, Agronomist, U of M NCES-Grand Rapids
- Bull Management to Maximize Reproductive Efficiency
  Brad Seguin, Veterinarian/Reproductive Physiologist, U of M-St. Paul

Local Sponsors:

- **ABS Global Inc.**
- **Aitkin Implement Co.**
- **Floodwood Farm & Feed**
- **Hibbing Feed & Seed**
- **Itasca County Farm Service**

Other 1998 Dates/Locations

Feb. 19, **Staples** - contact Jim Carlson, 320/632-0161
Feb. 21, **Hinckley** - contact Terry Salmela, 320/679-6342
Feb. 24, **Rushford** - contact Jerry Tesmer, 507/765-3896
Feb. 25, **Pipestone** - contact Philip Berg 507/825-5416
Feb. 26, **Glenwood** - contact Bill Zimmerman 320/589-7423

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Strawberry Mulch Removal

David K. Wildung, Horticulturist

The timing of spring mulch removal from strawberries can vary depending upon the earliness or lateness of the season. Bad timing can result in reduced fruit production and/or loss of plants. Two systems of timing of mulch removal are using soil temperatures and growing degree days. A third system is identifying common phenological markers such as yellowing of strawberry plants under the mulch or common landscape growth stages. The advantage of phenological markers is that they would eliminate the need to have soil thermometers or calculating degree days. Such phenological markers could be easily identified and used to trigger mulch removal. This study compares several systems of timing for mulch removal.

Results of the mulch removal treatments that were measured during all four years of the study are presented in the table. Data on growing degree day mulch removal plots were omitted because as the study progressed there was much variability. Degree day measurements were based on air temperatures and had little to do with what was going on at the strawberry plant level. The system was not used at all by the fourth season. The reverse was true of using flowering bulbs as triggers for mulch removal. During the first year several bulb types were evaluated, including crocus, scilla and tulips. By the fourth year we were concentrating on crocus primarily. We will continue to evaluate soil temperatures and crocus emergence. These comparisons will be reported at a later date.

While mulch removal dates varied each season, the trends in the strawberry parameters measured were quite similar. Mulch removal dates varied the most for the treatments. For example in 1995 the as soon as possible (ASAP) treatment was removed on March 16 while the next treatment was removed on April 20 (35 days later). Over the four years the ASAP treatment was removed on an average date of April 5, 17 days earlier than the next earliest treatment (35° at 4 inch soil depth). Removal this early would seem risky but in three of the four years this treatment produced the greatest yields. Over the four seasons it was the best yielding treatment. The soil temperature mulch removal treatments followed a natural progression with total yield, earliness and bloom dates related to date of mulch removal. Mulch removal when soil temperatures at 4 inches are warmer than 45° will greatly reduce yields.

Not mulching at all does appear to be risky. Yearly yields varied greatly depending upon natural snow depth. In 1996 the no mulch treatment yields were second highest, in 1997 they were third lowest. The one consistent thing with not mulching was that it was the earliest treatment to bloom and mature. It ripened over 50% of its crop in the first three harvests. This factor is both good and bad. Frost control would more likely be needed but the producer would be able to market earlier. The other negative to not winter mulching is that a summer mulch is still necessary to keep the fruit clean.

Phenological markers do show promise for triggering mulch removal. First vegetative bud stage on lilac would appear the most useful parameter at this time. Crocus bloom and emergence also appear quite useful. We did find a difference in the emergence and bloom dates of newly planted and established crocus beds. It appears that mulched established beds of crocus with the mulch removed as soon as it can be removed may be an excellent phenological marker for strawberry mulch removal. Phenological markers can be very site specific and add some color to the strawberry field in early spring.

Strawberry Mulch Removal (1994-1997)

Mulch Removal Treatment	Date of			%		Yield (Lbs/Acre)		
	Mulch Removal	First Bloom	Full Bloom	Plant Stand	Fruit Size (GR)	Early	% Early	Total
No Mulch	---	04 Jun	13 Jun	78	12.0	3876	53	7399
ASAP	05 Apr	04 Jun	14 Jun	82	12.8	3865	42	9396
4" Soil Temp 35F	22 Apr	06 Jun	15 Jun	81	12.7	3274	38	8392
4" Soil Temp 40F	27 Apr	06 Jun	16 Jun	79	12.3	3081	36	8392
4" Soil Temp 45F	01 May	07 Jun	17 Jun	77	11.7	2627	32	7926
4" Soil Temp 50F	18 May	08 Jun	20 Jun	74	11.0	1513	22	5758
4" Soil Temp 55F	25 May	09 Jun	21 Jun	74	10.9	743	17	4309
Lilac 1st Veg Bud	01 May	06 Jun	17 Jun	84	12.4	3100	33	8690
Lilac 95% Veg Bud	08 May	06 Jun	18 Jun	78	11.7	2119	31	6540
LSD 5%	10 Days	1 Day	1 Day	NS	0.8	512	5	1470

Hay Harvest and Storage, continued...

Round bale storage losses are greater than is commonly understood, due partly to the shape of the package. For example, a 2" layer weathered on the surface of a round bale has significant effects on storage losses (Table 1). A round bale 4.5 ft in diameter and 4 ft wide occupies a total volume of 64 cubic feet. Even though 2 inches is only 4% of the bale diameter, a weathered layer 2 inches deep over the entire outer surface of the bale, including the ends, would contain 22% of the total package volume. Generally, the greatest proportion of the total loss on bales stored outside on the ground occurs on the bottom, due to wicking of moisture from the soil. An inexpensive solution that may reduce losses from about 25% down to 16-18% is to break soil/bale contact by elevation bales on crushed rock, poles, pallets or some other means of creating air space between the bottom of each bale and the soil surface.

Table 1. Percentage of Bale Volume Affected.

Bale diameter	Bale width	Depth of weathered layer (Inches)			
----feet----		2	4	6	8
		----% of bale volume weathered----			
4	4	16	31	44	56
5	4	13	25	36	46
6	5	11	21	31	40

Dry Matter and Quality Loss. Some yield loss occurs during hay storage even when bales are stored inside. A rule of thumb is that 1% of the yield will be lost for each 1% moisture that must be lost in order to reach equilibrium storage moisture. For example, if hay is baled at 20% moisture and then dries to 14% during storage, it will suffer a dry matter yield loss of 6%. Data in Table 2 show that bales stored outside lose a larger proportion of dry matter than those stored inside; weathering results in an actual dry matter loss. Creating an air space between the soil surface and the bottom of the bales stored outside reduces the amount of dry matter lost.

Table 2. Storage losses for grass hay in round bales, including the weathered hay in the loss fraction.

Storage Method	DM loss, including weathering (%)
Outside-on the ground	23.2
Outside-on crushed rock	14.5
Inside	8.0

It is important to consider the weathered fraction separately because its quality is reduced compared with the portion of the bale protected from weathering. Table 3 shows quality data for the weathered portion of grass-legume and pure grass hay compared with that of the whole bale. Weathering reduced the digestibility of the mixed grass-legume hay much more than it reduced the digestibility of pure grass hay. However, digestibility was reduced drastically regardless of species. Crude protein concentration was higher in the weathered layer of both hay types, a response considered to be due to dilution. The basic principle is that, in addition to crude protein, hay contains several other constituents, notably sugars and some minerals, that are much more subject to removal by leaching than is crude protein. Thus, under leaching conditions, these other constituents are removed to greater extents than is crude protein.

Table 3. Quality of weathered and unweathered portions of grass and grass-alfalfa hay in round bales.

Hay Type	Bale Portion	Digestibility	Crude Protein	Acid Detergent Fiber
		----%		
Grass	Unweathered	58.8	13.5	44.4
Grass	Weathered	42.5	16.4	49.4
Grass-legume	Unweathered	56.5	14.3	45.0
Grass-legume	Weathered	34.2	16.9	48.7

Summary. A number of recommendations can be developed from the information discussed above to minimize losses in both yield and quality that occur during round bale hay storage:

1. Shape the bales carefully. Firm bales of uniform diameter will store better.
2. Larger bales lose a smaller proportion of their total mass to the effects of weathering.
3. Store bales off the ground. Elevation reduces losses by about 50% at a low cost.
4. Legume hay is more susceptible to outside storage losses than grass hay.

News from North Central

David L. Rabas, Head

This is usually the time of year when I say hello to our "snowbird" friends in Arizona, etc. and tell them how lucky they are to have missed winter. Winter isn't over yet so we could still have some difficult weather but thus far this has been one of the best winters in recent memory. According to Art Elling, weather observer at the USDA Forest Sciences Laboratory (our neighbors on the west side of the NCES Campus), December 1997 was the warmest December on record. January could also be near a record (weather records date back to 1916). December 1997 had an average temperature of 23.3 degrees. This is 11.2 degrees warmer than the most recent 30 year average and 24.8 degrees warmer than the coldest December on record, which was December 1983.

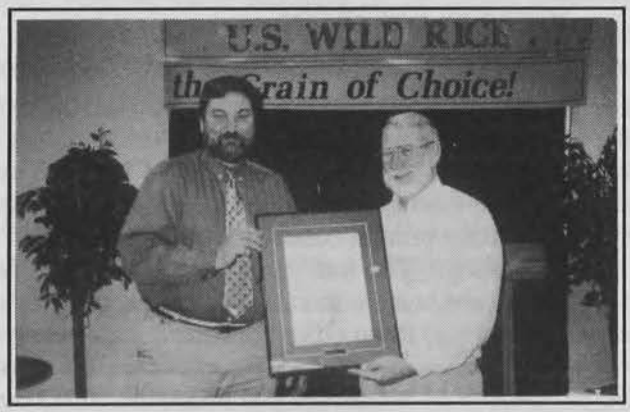
February is a very active time at our station. Winter meetings are at a maximum and staff are busy completing summaries and analyses of 1997 data and planning new research for the coming year. I am working with the legislature and friends of NCES to support our capital request for an addition to our administration building to correct handicapped access problems in the existing building and to provide for expansion of our research and outreach program.

We are excited about the potential for the building addition to provide facilities for video conferencing and an interactive television studio for sending and receiving University of Minnesota credit classes and extension/outreach programs. We are looking forward to the potential for joint curriculum and degree programs with Itasca Community College and other state colleges and universities. We intend for the new facility to greatly expand access to the University for all citizens in northern Minnesota.

We are excited about the possibility for locating additional extension/research staff at the station and expanding the scope and diversity of programs and activities we can provide to the people of our area and state. I should know by the summer issue of the Quarterly which of the proposed positions will actually come to NCES. In any event there will be staff additions and changes at NCES as our new facilities are developed.

Funding and budget problems still persist. We are working on ways to provide for long term budget stability. We are very dependent on gifts and grants to maintain quality research and outreach programs and to allow us to respond to new research and information needs. Currently we are at the beginning of a three year campaign to raise additional funds to support our horticulture research and education programs. I hope all our gardener friends and the commercial horticulture industry will consider supporting our Horticulture Fund Campaign.

Rod Skoe, Chairman of the Minnesota Cultivated Wild Rice Council, presented Dr. Robert Nyvall, Plant Pathologist at North Central Experiment Station, with the "Outstanding Service Award" at their annual meeting in January. This prestigious award was established two years ago by the Council and is given once a year. The award this year was in recognition of Dr. Nyvall's work on cultivated wild rice diseases. Examples include his work on the epidemiology of fungal brown spot caused by *Bipolaris oryzae* and spot blotch caused by *B. sorokiniana* which allows growers to more accurately apply fungicide applications and determination of overwintering and survival sites for the two causal organisms. Other work has included the effect of scab and leaf sheath and stem rot on cultivated wild rice. Congratulations Bob!



Rod Skoe (l) presents Bob Nyvall (r) with the "Outstanding Service Award."

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