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ADVANTAGES OF TIMELY HAYING

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INTRODUCTION

Few farm operations suffer more from adverse weather conditions than the field drying of hay. Prolonged periods of wet weather often ruin high protein alfalfa intended for dry hay. Weather forecasts that include information on expected drying rates are very helpful, but when the weather turns wet there is not much a farmer can do about it if he has cut forage intended for dry hay.

This publication illustrates the importance of being timely by using probability information for hay drying periods based on long-term climatic data. Examples are provided of expected yields in terms of protein and digestible nutrients from various systems of forage management.

HAY QUALITY

Timing of harvest is most important to ensure top quality forage feed. Optimum feed value depends on both timely cutting and a preservation system that provides a palatable feed and maximum nutrient content.

For stored feed, forage stands should be cut in the late bud to first flower stage. Cutting before this stage will provide a higher concentration of protein but total yield will be lower. Delayed cutting will result in higher dry-matter yields but will be offset by reductions in feed quality.

Table 1 shows the decline in crude protein as maturity approaches. Alfalfa cut at medium bud stage will contain approximately 22% crude protein on a dry matter basis. If cut later, at the early flower stage, the crude protein will have dropped to 17%. All the leaves, which contain 30% protein, are present by late bud. After the bud stage most of the growth occurs in the stems, which are low in protein, and the shaded bottom leaves begin to die and drop off.

A mixture yielding about 50% of each of grass and legume will contain only 17% crude protein at the bud stage and approximately 12% crude protein at full flower. Farmers wishing to achieve the 20% protein goal should seed to a pure legume stand and cut at the bud stage.

Table 1. Crude protein content of alfalfa and bromegrass at various stages of maturity (OAC data)

Stage of maturity*	Date	% Crude protein	
		Alfalfa	Bromegrass
Medium bud (boot)	June 4	21.5	13.4
Early flower (heads emerged)	June 20	17.0	10.0
Full flower (flower)	June 30	16.2	6.7
Early seed	July 6	15.6	5.8

**Alfalfa (brome)*

The decline in digestible dry matter with advancing maturity is shown in Table 2. Alfalfa cut at the medium bud stage will be approximately 72% digestible, while the same alfalfa cut later, at the early flower stage, will be approximately 65% digestible. The decline in digestibility of grasses with advancing maturity is slightly greater than that for legumes. Thus early cutting becomes essential if digestibility is to be maintained.

Table 2. In vitro dry matter digestibilities of alfalfa and bromegrass at various stages of maturity (OAC data)

Stage of maturity*	Date	% Digestibility	
		Alfalfa	Bromegrass
Medium bud (boot)	June 4	72.6	73.8
Early flower (heads emerged)	June 20	65.2	67.2
Full flower (flower)	June 30	62.1	60.6
Early seed	July 6	60.9	59.7

**Alfalfa (brome)*

Rain and sun account for much of the losses in forage quality. Rain on cut forage will leach sugars and protein, bleach color and increase the potential for leaf loss. The leaves of legumes contain up to 30% total protein and possess over 70% of the protein in the crop. Retaining the leaves should always be of primary concern when attempting to produce a quality hay product.

Raking is usually the greatest offender in lowering the feed value of forage. Almost all dry matter loss at raking is due to leaf shatter. Alfalfa raked for haylage (55 to 60% moisure) will suffer leaf losses of only 2 to 3% of dry matter compared with losses of over 20% if the same forage is raked just before baling (20 to 25% moisture). Further leaf loss will occur at time of baling. Conditioning, raking when gough and/or storing as silage are all practices which can help to retain the leaves.

HAY-DRYING PERIODS

Clear, warm weather with a light breeze is best for drying windrowed forage. This type of weather prevails when high pressure systems from the northwest invade Ontario. As the ridge of high pressure passes over a particular region, cold or cool air dominates for a day or two followed by a gradual warming trend. These periods can last anywhere from 3 to 7 or more days depending on the size of the air mass, its rate of travel, and whether another high pressure system follows close behind. Rain may follow depending on the position of the low pressure cell in the disturbance that usually follows. Only 3 or 4 days are required to dry windrowed forage down to 23% moisture or less in the clear dry air of a high pressure air mass.

A longer drying period is required when the high pressure air mass is of short duration or remains north of the main agricultural areas of Southern Ontario. When this occurs, low pressure disturbances dominate in the region bringing cloudy, humid and sometimes rainy weather. Under these conditions, 6 or more days may be required for windrowed forage to dry down to that desirable moisture (23%) for making good quality dry hay.

Tables 3 and 4 provide the expected number of hay drying periods per week on well drained soils. Drying periods are defined as the time required for windrowed hay to reach either 23% moisture for dry hay (Table 3) or 55% moisture for haylage (Table 4). To arrive at the number of hay drying periods it was assumed that every day of each week is a *potential* cutting day. Mid-June has been the usual first-cut haying time in Southern Ontario. However, from the data in Tables 3 and 4, it is apparent that drying periods are not plentiful during this period. Climate records indicate that there is a greater chance of having good haying weather during the week of June 7 to 13 compared to June 14 to 20. For example, a farmer located in Central Ontario who puts up dry hay would find from Table 3 that there are 2.3 drying periods of 4 days or less ($\leq$4 days) during the week of June 7 to 13 at the 4 out of 5 year probability level, but only 1.6 drying periods for the same probability level during the week of June 14 to 20. This emphasizes the importance of using weather forecasts to decide when to make the first cut. It should be remembered that cutting in early June at the medium bud stage also means a higher crude protein content.

Hay cut June 7 to 13 would likely undergo a second cut during the week of July 19 to 25, which has 3.1 drying periods at the 4 out of 5 year probability level. Similarly, July 26 to August 1, having 2.2 drying periods, would be the second-cut week for hay first cut during June 14 to 20. The third cutting in Central Ontario should take place before September 1. However there is practically no chance of drying hay in less than 4 days during the last full week of August (Table 3). There is only 1.0 drying period of 6 days or less at the same probability level in that week. Figure 1 illustrates the number of hay drying periods for a dry hay system as discussed above. It further illustrates similar drying periods for haylage, at the same probability level, and emphasizes the greater number of drying periods available to harvest haylage.

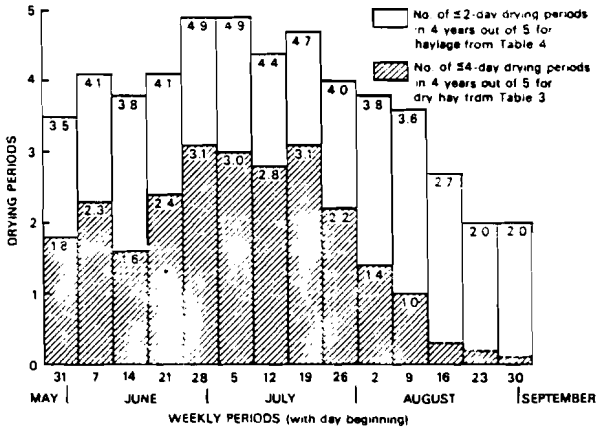

Figure 1. Number of drying periods per week for hay and for haylage 4 out of 5 years in Central Ontario.

Comparable statistics for Eastern, Southwestern and Northern Ontario can be obtained from Table 3 for dry hay and from Table 4 for haylage.

Using the expected number of hay drying periods in each week at a selected probability level, it is possible to calculate the expected quality of hay harvested and stored based upon the effect of cutting date on protein and digestible nutrient content. Examples that follow further describe the use of Tables 1, 2, 3 and 4 in arriving at a hay protein and digestible nutrient package for a farmer growing 30 hectares of alfalfa forage in Central Ontario.

to 55% moisture

Table 3. Expected number of hay drying periods* on well-drained soils at two probability levels based on 50 years of climatic records

Week of	≤ 4-day drying period*		≤ 6-day drying period*	
	2 out of 3 years	4 out of 5 years	2 out of 3 years	4 out of 5 years
Southwestern Ontario (Harrow)				
May 31 — June 6	3.1	2.3	5.4	3.9
June 7 — June 13	2.3	1.4	5.3	3.8
June 14— June 20	2.7	1.6	6.4	4.5
June 21— June 27	3.8	2.7	7.0	5.7
June 28 — July 4	4.9	3.9	7.0	6.7
July 5 — July 11	4.5	3.2	7.0	5.8
July 12 — July 18	4.4	3.6	7.0	5.9
July 19 — July 25	5.1	3.9	7.0	7.0
July 26 — Aug 1	3.8	3.0	6.7	5.6
Aug 2 — Aug 8	3.3	2.5	6.3	5.0
Aug 9 — Aug 15	3.2	2.3	6.0	5.3
Aug 16 — Aug 22	2.5	1.6	6.2	5.0
Aug 23 — Aug 29	1.6	0.5	5.1	2.7
Aug 30 — Sept 5	0.5	**	3.3	2.2
Sept 6 — Sept 12	**	**	1.7	**
Central Ontario (Guelph)				
May 31 — June 6	2.6	1.8	5.3	4.0
June 7 — June 13	3.1	2.3	5.9	4.0
June 14— June 20	2.9	1.6	5.6	4.2
June 21 — June 27	3.3	2.4	7.0	6.0
June 28— July 4	4.1	3.1	6.7	5.6
July 5 — July 11	4.1	3.0	6.4	5.3
July 12 — July 18	3.7	2.8	6.0	5.1
July 19 — July 25	3.8	3.1	7.0	5.7
July 26 — Aug 1	3.3	2.2	5.9	4.5
Aug 2 — Aug 8	2.0	1.4	5.4	4.2
Aug 9 — Aug 15	2.2	1.0	4.8	3.7
Aug 16 — Aug 22	0.9	**	3.7	2.3
Aug 23 — Aug 29	**	**	1.8	1.0
Aug 30 — Sept 5	**	**	1.7	0.7
Eastern Ontario (Ottawa)				
May 31 — June 6	2.4	1.6	5.3	4.2
June 7 — June 13	2.7	1.3	4.8	4.0
June 14 — June 20	2.5	1.2	5.3	3.6
June 21 — June 27	2.7	1.4	5.0	4.0
June 28 — July 4	3.3	2.0	6.2	5.2
July 5 — July 11	3.3	2.2	5.9	4.6
July 12 — July 18	3.7	2.8	6.9	5.3
July 19 — July 25	3.0	2.0	5.8	4.7
July 26 — Aug 1	2.2	1.3	5.1	4.0
Aug 2 — Aug 8	2.5	1.4	4.7	3.8
Aug 9 — Aug 15	1.2	**	4.3	2.7
Aug 16 — Aug 22	1.2	0.6	3.1	2.0
Aug 23 — Aug 29	0.9	**	2.6	0.5
Aug 30 — Sept 5	**	**	1.5	**
Northern Ontario (Kapuskasing)				
June 14 — June 20	1.8	0.7	4.2	3.2
June 21 — June 27	**	**	4.1	2.2
June 28 — July 4	1.4	0.7	4.0	3.0
July 5 — July 11	1.7	**	4.6	3.3
July 12 — July 18	1.8	1.2	4.0	3.0
July 19 — July 25	1.0	**	2.9	1.3
July 26 — Aug 1	**	**	2.8	1.8
Aug 2 — Aug 8	1.3	0.8	3.4	2.3
Aug 9 — Aug 15	**	**	1.2	**
Aug 16 — Aug 22	**	**	1.0	**

** A hay drying period is defined as the time required for windrowed forage to reach 23% moisture. Every day of each week is a potential cutting day. A ≤4-day (4 days or less) drying period is preferred as there is increased risk of rain damage for longer drying periods.*

***Drying periods fewer than 0.5 at these probability levels*

Table 4. Expected number of haylage drying periods* on well-drained soils at two probability levels based on 50 years of climatic records

Week of	≤ 2-day drying period*		≤ 3-day drying period*	
	2 out of 3 years	4 out of 5 years	2 out of 3 years	4 out of 5 years
Southwestern Ontario (Harrow)				
May 31 — June 6	4.9	3.3	5.9	4.6
June 7 — June 13	3.9	2.9	5.7	5.1
June 14— June 20	4.7	4.2	6.5	5.6
June 21— June 27	5.3	4.7	6.5	5.7
June 28— July 4	5.6	5.0	7.0	6.4
July 5 — July 11	5.5	5.1	7.0	6.7
July 12 — July 18	5.4	4.7	6.9	6.2
July 19 — July 25	6.0	5.2	7.0	6.3
July 26 — Aug 1	5.6	5.1	6.7	6.2
Aug 2 — Aug 8	5.0	4.3	6.4	5.8
Aug 9 — Aug 15	5.1	4.3	6.4	6.0
Aug 16 — Aug 22	5.1	3.9	6.5	5.9
Aug 23 — Aug 29	4.4	3.6	6.0	5.1
Aug 30 — Sept 5	3.5	2.5	5.6	5.1
Sept 6 — Sept 12	2.8	1.8	5.0	4.1
Central Ontario (Guelph)				
May 31 — June 6	4.5	3.5	6.0	5.0
June 7 — June 13	4.5	4.1	6.1	5.4
June 14 — June 20	4.7	3.8	6.2	5.3
June 21 — June 27	4.9	4.1	6.7	6.2
June 28 — July 4	5.4	4.9	6.6	6.1
July 5 — July 11	5.4	4.9	6.9	6.3
July 12 — July 18	5.1	4.4	6.4	5.7
July 19 — July 25	5.3	4.7	6.6	6.0
July 26 — Aug 1	5.0	4.0	6.3	5.4
Aug 2 — Aug 8	4.4	3.8	5.8	5.3
Aug 9 — Aug 15	4.5	3.6	6.3	5.6
Aug 16 — Aug 22	4.1	2.7	5.7	4.8
Aug 23 — Aug 29	3.0	2.0	4.8	4.0
Aug 30 — Sept 5	2.6	2.0	5.0	4.0
Eastern Ontario (Ottawa)				
May 31 — June 6	3.9	3.4	5.7	5.0
June 7 — June 13	4.5	3.5	5.9	5.1
June 14— June 20	4.3	3.3	5.6	4.9
June 21— June 27	4.4	3.7	5.8	5.1
June 28— July 4	5.0	4.2	6.5	5.8
July 5 — July 11	4.7	3.8	6.3	5.2
July 12 — July 18	5.0	4.1	6.3	5.6
July 19 — July 25	4.8	3.9	6.5	5.6
July 26 — Aug 1	4.7	4.0	6.3	5.2
Aug 2 — Aug 8	4.7	3.6	6.2	5.4
Aug 9 — Aug 15	3.7	2.9	5.6	5.0
Aug 16 — Aug 22	3.5	2.3	5.1	4.4
Aug 23 — Aug 29	3.2	2.5	5.1	4.1
Aug 30 — Sept 5	2.7	1.9	4.6	3.6
Northern Ontario (Kapuskasing)				
June 14 — June 20	3.7	3.2	5.5	5.0
June 21 — June 27	3.5	2.6	5.1	3.8
June 28 — July 4	3.7	3.2	5.5	5.1
July 5 — July 11	4.1	3.3	5.5	4.7
July 12 — July 18	3.3	2.4	5.1	4.3
July 19 — July 25	3.3	2.7	5.2	4.0
July 26 — Aug 1	3.0	2.3	5.2	4.2
Aug 2 — Aug 8	3.5	3.0	5.3	4.5
Aug 9 — Aug 15	2.4	1.8	4.2	3.2
Aug 16 — Aug 22	1.9	1.4	3.7	2.7

**A haylage drying period is defined as the time required for windrowed forage to reach 55% moisture and every day of each week is a potential cutting day. ≤2-day means drying periods of 2 days or less.*

EFFECT OF CUTTING DATE ON PROTEIN AND DIGESTIBLE NUTRIENT LEVELS

Using the tables for hay-drying periods, three hay harvesting systems are compared as to their effect on protein and digestible nutrient yield. Two of the systems involve dry hay while a third relates to haylage. In practice, combinations of these systems are often used, however, the examples chosen cover a wide range of farm operations in Ontario.

Table 5 illustrates a dry hay 2-cut system with the first cut being taken during the third week in June. Table 6 describes a dry hay 3-cut system with the first cut during the second week in June. Table 7 illustrates a haylage 3-cut system with the first cut being made during the first week in June. Data from Ontario Agricultural College were used to construct these tables.

An example farm situation is used to measure the effect of timeliness on the quality of hay harvested. The following assumptions are made:

1. Hay crop — 75% alfalfa + 25% bromegrass;
2. Area — 30 hectares;
3. Location — Central Ontario;
4. Drying period probabilities
   (a) Hay — In 2 out of 3 years the number of drying periods per week to dry forage down to 23% moisture;
   (b) Haylage — In 2 out of 3 years the number of drying periods per week to dry forage down to 55% moisture.
5. Leaf loss — 0.4 t/ha for dry hay systems
   0.0 t/ha for haylage system.

Weathering, raking and baling lead to considera leaf loss with dry hay systems. Experimentation shown that leaf loss can be as high as 0.8 t/ha. In dry hay examples an average loss of 0.4 t/ha has be used. Total dry matter, protein and digestible c matter have been adjusted in Tables 5 and 6 to refl this leaf loss.

Leaf loss should be much lower than with a dry h system since haylage is handled in a moist condition. the haylage example presented, proper harv management techniques have been assumed a therefore, leaf loss is considered negligible. T potential exists for high leaf loss when haylage is blov into uncovered wagons or covered wagons not proper vented by screened openings.

Table 5. Harvested yields of dry matter (DM), crude protein and digestible dry matter (DDM) from 30 hectares (ha) of forage grown in Central Ontario using a dry hay 2-cut system

	1st Cut		2nd Cut			Total	Total/ha
Harvest Week	**June 14-20**	**June 21-27**	**July 26-Aug 1**	**Aug 2-8**	**Aug 9-15**		
Harvest days/week	2.9	3.3	3.3	2.8	2.2	—	—
Hectares/week	14.5	15.5	14.5	10.3	5.2	—	—
DM yield t/ha	5.2	5.6	3.4	3.7	4.1	—	9.0
Leaf loss (0.4 t/ha)	5.8	6.2	5.8	4.1	2.1	24.0	0.8
Total DM (t)	69.6	80.6	43.5	34.0	19.2	246.9	8.2
% Crude protein	16.0	14.5	16.5	16.5	16.0	15.6	15.6
Total crude protein (t)	10.3	10.7	6.4	5.1	2.8	35.3	1.2
% Digestible DM	65.2	63.7	65.0	65.0	63.0	64.5	64.5
Total Digestible DM (t)	45.4	51.3	28.3	22.1	12.1	159.3	5.3

**Only 14.5 hectares has reached harvest maturity; could harvest up to 18.3 hectares*

Assumptions	**1ST CUT**	**2ND CUT**
Machine capacity (t/ha)	5.5	4.0
Hours per day	5.0	5.0
Capacity per day (t/day)	27.5	20.0
% of total yield	60.0	40.0

1. All weights on a dry matter basis.
2. Metric units employed throughout.

Table 6. Harvested yields of dry matter (DM), crude protein and digestible dry matter (DDM) from 30 hectares (ha) of forage grown in Central Ontario using a dry hay 3-cut system

	1st Cut		2nd Cut		3rd Cut		Total	Total/ha
Harvest Week	**June 7-13**	**June 14-20**	**July 12-18**	**July 19-25**	**Aug 16-22**	**Aug 23-?**		
Harvest days/week	3.1	2.9	3.7	3.8	0.9	**	—	—
Hectares/week	19.0	11.0	19.0 *	11.0	8.0	22.0 **	—	
DM yield t/ha	4.3	5.2	1.8	2.2	1.5	1.9	—	8.4
Leaf loss (0.4 t/ha)	7.6	4.4	7.6	4.4	3.2	8.8	36.0	1.2
Total DM (t)	74.1	52.8	26.6	19.8	8.8	33.0	215.1	7.2
% Crude protein	17.0	16.0	20.0	20.0	20.0	140.0	17.1	17.1
Total crude protein (t)	11.6	7.8	4.5	3.4	1.4	3.3	32.0	1.1
% Digestible DM	67.5	65.2	68.0	68.0	68.0	68.0	67.2	67.2
Total Digestible DM (t)	50.0	34.4	18.1	13.5	6.0	22.4	144.6	4.8

**Only 19.0 hectares has reached harvest maturity; could harvest up to 32.0 hectares.*
***There are no drying periods of 4 days or less for the week beginning August 23. The remaining 22 hectares will require more than 4 days to dry and thus it is assumed that a lower quality forage will be harvested. For this example the harvested forage is assumed to contain 14% crude protein.*

Assumptions	**1ST CUT**	**2ND CUT**	**3RD CUT**
Machine capacity (t/ha)	5.5	3.5	3.0
Hours per day	5.0	5.0	5.0
Capacity per day (t/day)	27.5	17.5	15.0
% of total yield	55.0	24.0	21.0

1. All weights on a dry matter basis.
2. Metric units employed throughout.

Table 7. Harvested yields of dry matter (DM), crude protein and digestible dry matter (DDM) from 30 hectares (ha) of forage grown in Central Ontario using a haylage 3-cut system

	1st Cut	2nd Cut	3rd Cut	Total	Total/ha
Harvest Week	**May 31-June 6**	**July 5-11**	**Aug 9-15**		
Harvest days/week	4.5	5.4	4.5	—	—
Hectares/week	30	30	30	—	—
DM Yield t/ha	3.7	2.0	1.7	—	7.4
Total DM (t)	111.0	60.0	51.0	222.0	—
% Crude Protein	21.7	20.0	20.0	20.9	20.9
Total Crude Protein (t)	24.1	12.0	10.2	46.3	1.54
% Digestible DM	72.6	58.0	68.0	70.3	70.3
Total Digestible DM (t)	80.6	40.8	34.7	156.1	5.2
Assumptions					
Machine capacity (t/ha)	5.5	3.5	3.0		
Hours per day	5.0	5.0	5.0		
Capcity per day (t/ha)	27.5	17.5	15.0		
% of total yield	50.0	27.0	23.0		

1. All weights are on a dry matter basis.
2. Metric units employed throughout.

The total yield of dry matter (DM), of crude protein (CP) and of digestible dry matter (DDM) for each of these three forage systems is summarized in Table 8. The three-cut **haylage** system produces the most crude protein. It also yields the highest quality forage in that CP = 20.9% and DDM = 70.3%. This is attributed to lower leaf losses and a greater chance of harvesting the forage in good weather.

Table 8. Yield comparisons of three hay harvesting systems from 30 hectares of forage

	Dry Hay 2 cuts	Dry Hay 3 cuts	Haylage 3 cuts
Harvest week of First Cutting	June 14-20	June 7-13	May 31-June 6
Total DM (t)	246.9	215.1	222.0
% Crude protein	15.6	17.1	20.9
Total crude protein (t)	35.3	32.0	46.3
% Digestible DM	64.5	67.2	70.3
Total Digestible DM (t)	159.3	144.6	156.1

1. All weights are on a dry matter basis.
2. Metric units employed throughout.

The **dry hay** 3-cut system produces higher quality hay than the **dry hay** 2-cut system. This is due solely to harvesting the forage at an earlier stage of maturity. The greatest dry matter yields are produced by the **dry hay** 2-cut system.

For those desiring a high protein roughage, the haylage system should be seriously considered in light of current cost for purchased protein supplement.

SUMMARY

Comparisons are provided for three common hay harvesting systems using an example farm in Central Ontario growing 30 hectares of hay. Yields of digestible dry matter (DDM) and crude protein are presented for each system based on: (1) published % DDM and % crude protein levels at different stages of forage maturity; (2) certain assumed cutting dates by week; and (3) an expected number of hay drying periods during each week based on 50 years of climatic records and a 67% probability level (2 years out of 3). The comparisons illustrate the advantages of early cutting and of haylage over a dry hay system for highest yields of crude protein and of percent digestible dry matter.