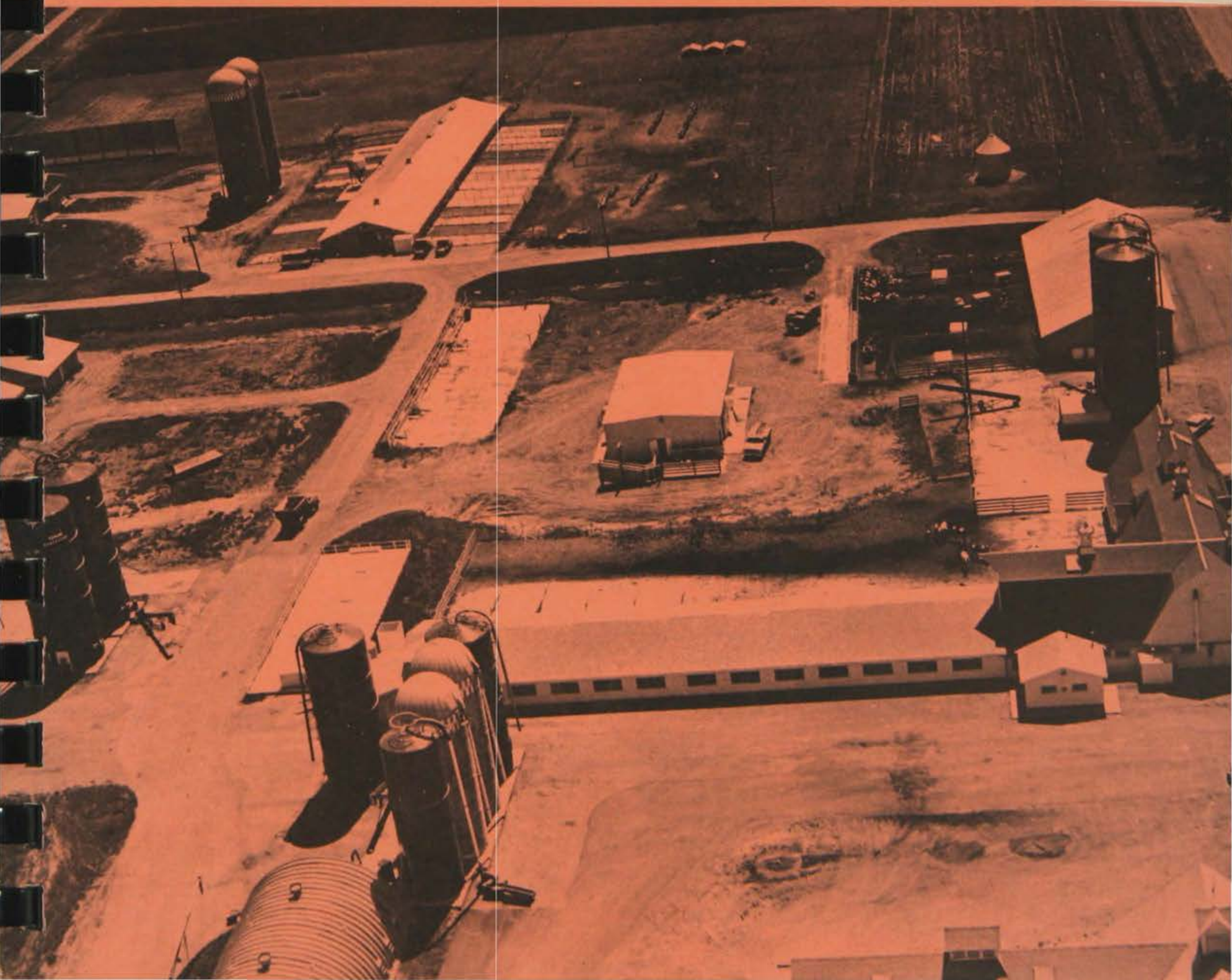
High Moisture Barley & Haylage Seminar

August 1, 1974

UNIVERSITY OF MINNESOTA
Northwest Experiment Station
Crookston, Minnesota



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9:30 a.m.	Coffee, lemonade and cookies, ARC Auditorium.
10:00 a.m.	RESEARCH MISSION--NORTHWEST EXPERIMENT STATION. Dr. B. E. Youngquist, Superintendent
10:30 - 11:30 a.m.	REVIEW OF HARVESTING, PROCESSING AND FEEDING DATA WITH HAYLAGES AND HIGH MOISTURE BARLEY FOR DAIRY CATTLE. Dr. George D. Marx, Dairy Scientist
11:30 - 12:30 p.m.	REVIEW OF HAYLAGES AND HIGH MOISTURE BARLEY FOR BEEF CATTLE. Dr. Harvey F. Windels, Meat Animal Scientist
12:30 - 1:30 p.m.	LUNCH - Bede Hall, Technical College.
1:30 - 4:00 p.m.	*FIELD DEMONSTRATION OF HARVESTING HIGH MOISTURE BARLEY. Mr. Jim Jacobson, Farm Foreman

*The barley is barely ready as the weather cooled down and the rains came. We'll harvest the material with a M. F. 410 combine, direct cut.

WELCOME

This Agricultural Experiment Station is the northwest arm of the agricultural research mission of the University of Minnesota headquartered at St. Paul, Minnesota, and is part of the state-wide effort.

The Station has pioneered a number of farm production practices for the northwest section of the state. In the last decade and a half, we have led the trend towards the use of high quality haylage for dairy and beef farmers. We were the first to work with high moisture barley, and the Station led the research and promotion for the sunflower industry.

The Station operates about 1,200 acres of land and has about 1,400 head of livestock along with manpower and machinery to engage the mission of applied research. A staff of ten professional research personnel provides the leadership and cooperative effort. Particular emphasis has been on the production of high quality forage using various kinds of upright silo structures as well as a number of exotic materials useful as high quality forage for roughage consuming livestock.

We trust this day will be useful to your business or industry.

B. E. Youngquist, Superintendent

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HIGH MOISTURE BARLEY FOR DAIRY CATTLE

Dr. George D. Marx, Dairy Scientist
University of Minnesota
Northwest Experiment Station, Crookston

Barley is a major ingredient in dairy concentrate rations in northern Minnesota and other northern and western states and Canada. Studies in the utilization of high moisture barley or "wet" barley for milking dairy cows were conducted at the Northwest Experiment Station, Crookston. Comparisons of high moisture and dry barley were conducted using 36 animals with 18 fed on each of the test rations. Animals used in the comparison study were paired and randomly assigned to one of these two groups according to daily milk production, producing ability, age, weight and stage of lactation.

The small grain was harvested as high moisture barley at 28.7 percent average moisture content of the kernel and stored in an oxygen limiting structure. Barley was rolled daily with an electrically powered Bear Cat grain roller mill just prior to feeding. The stationary roller mill was situated alongside the door opening and material fell directly from the unloader into the roller mill hopper and was rolled between two 10" diameter corrugated rollers.

Group I was fed dry barley and Group II was fed high moisture barley. High moisture and dry barley were compared on an equal dry matter intake basis with Group I receiving 12.2 pounds of 12.1 percent "dry" barley and Group II receiving 15 pounds of 28.7 percent "wet" barley daily. The balance of the animals' concentrate ration, fed according to production, consisted of a mix of equal parts corn, oats, barley and beet pulp. Additionally, animals were fed a commercially prepared mineral-vitamin mix at 2 percent of the concentrate mix. The forage consisted of one feeding each of corn silage and alfalfa haylage. All feedstuffs were weighed separately for each animal every day. Weigh-back or refusal was taken daily for each animal.

High moisture barley analyses were similar to dry barley except that protein was slightly higher and had a higher percentage of crude fiber in the high moisture barley probably due to lack of maturing time in the earlier harvested material for conversion of more nutrients to starches and sugars.

Cows on high moisture barley consumed more of their total feed than the dry barley group. Weigh-back was considerably less on the high moisture barley fed group indicating increased palatability of feed or stimulated appetite. Total dry matter intake was higher in this group.

On a dry matter basis barley acreage harvested as high moisture barley yielded 212 pounds more per acre than acreage harvested as dry barley indicating less field and harvesting losses when high moisture barley is harvested. The advantage was a 7.4 percent greater yield or approximately five bushels per acre.

Average weights of animals remained about the same during the experimental period. Loss of weight did not occur even though animals were producing heavy indicating that sufficient net energy was being consumed and utilized by the cow.

Milk production of animals fed high moisture barley was 52.6 lbs per day per cow and was slightly higher than those fed dry barley which produced 50.9 pounds of milk daily. Official DHIA production records were used in determination of milk fat and solids-not-fat percentage. Milk fat and solids-not-fat percentage was not changed by feeding 15 pounds of high moisture barley per cow daily. Fat corrected milk (4% FCM) produced was 4.5 percent higher on the high moisture barley fed group.

In this study, where high moisture barley was compared with dry barley on an equal dry matter consumption basis, it was demonstrated that high moisture barley is a very satisfactory feed for dairy cattle and can replace dry barley in the ration. Studies at the University of California and University of Alaska also demonstrated that high moisture barley can be used successfully in the grain ration of the dairy cow to replace part of the dry grain or concentrate in the conventional herd grain mixture fed to dairy animals.

In conclusion, the utilization of high moisture barley in a dairy cattle feeding program is an important factor to consider. The advantages of high moisture barley are summarized below.

1. No artificial drying expense
2. No field losses due to delayed combining
3. Harvest 5-10 days earlier
4. Can harvest with dew or light mist
5. Reduce weather risks - hail, wind, rain
6. Increase yield - less shattering loss
7. Easier to combine - less powdering and mealing
8. Reduced lodging losses - increase cutter bar height
9. Green patches not a problem
10. Weeds are better controlled - cut before mature
11. Harvest wild oats before shattering
12. Decreases competition for new seedlings
13. Eliminate swathing - direct combining
14. Combine more hours in a day
15. Increase after harvest time
16. Less dusty
17. Results in high quality feed - higher protein
18. Better feed conversion
19. No bloat problems
20. No nutritional disorders - very palatable

Presented at the High Moisture Barley and Haylage Seminar, August 1, 1974 at the University of Minnesota, Northwest Experiment Station, Crookston.

HARVESTING, STORING AND FEEDING HIGH MOISTURE BARLEY TO LACTATING DAIRY COWS*

G. D. Marx
University of Minnesota, Crookston

A trial comparing high moisture barley and dry barley was conducted at the Northwest Experiment Station, Crookston, Minnesota, with 36 milking Holstein cows. Animals were paired according to milk production, stage of lactation, age and weight and assigned to one of two groups which received either high moisture barley or dry barley for 90 days. One group was fed 6.8 kg of high moisture barley per cow per day and the other group was fed an equivalent of dry barley.

Larker barley was harvested as high moisture grain at 71.3 percent dry matter, stored in an oxygen-limiting structure and unloaded with a sweep-arm chain type bottom unloader. High moisture barley was rolled daily just prior to feeding with an electrically powered stationary grain roller mill using two ten-inch diameter corrugated rollers.

In addition to the high moisture or dry barley, animals were fed a herd mix consisting of equal parts corn, oats, barley and beet pulp for the remainder of the animals' concentrate ration. Daily forage fed consisted of one feeding each of alfalfa haylage and corn silage. All feedstuffs were weighed separately for each animal and weigh-back taken daily.

Table I presents the proximate analysis of dry and high moisture barley. High moisture barley was slightly higher in protein and crude fiber percentage as compared to dry-harvested barley.

Feed intake and consumption by both groups is presented in Table II along with barley yield. Dry matter feed intake was similar in both groups. A smaller amount of weigh-back or refusal was noted with the high moisture barley fed groups indicating palatability of feed was not a problem.

Barley harvested as high moisture barley outyielded conventionally harvested dry barley by seven percent or 242 kg per hectare on a dry matter basis. Easier combining and reduced field losses account for the small increase in yield for the high moisture barley.

Mean weights of animals in both groups are noted in Table III. Weights remained about the same throughout the experiment with only a small increase observed during the duration of the experiment.

Milk production data of the cows fed dry barley or high moisture barley is shown in Table IV. No significant differences between treatments resulted for the production of milk, solids-not-fat and milk fat. Milk fat and solids-not-fat percentage was not changed by feeding high moisture barley at the level fed in this trial. Four percent fat-corrected milk produced by both groups of cows was similar.

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* Presented at the 68th annual meeting of the American Dairy Science Association June 24-27, 1973. Washington State University, Pullman. Paper No. 8267, Scientific Journal Series, Minnesota Agricultural Experiment Station.

In summary, this study demonstrated that high moisture barley can be used successfully in the grain ration of the lactating dairy cow to replace a major portion of the dry grain or concentrate fed. Harvesting and storage of high moisture barley presented no unusual problems. Several other advantages using high moisture barley were noted. Barley can be harvested up to ten days earlier than dry barley and under more adverse weather conditions making it possible to combine more hours in a day. A dew or light rain does not hamper harvesting operations and does not preclude artificial drying as does dry stored barley harvested under less than ideal weather conditions. Sprouting in the swath also can occur with wet weather and delayed harvest but this is eliminated by harvesting grain as high moisture barley. Other weather risks are also reduced, particularly losses during a hail or windstorm due to shelling and lodging.

Labor in harvesting can be reduced by the elimination of swathing. High moisture grain also has less shattering loss resulting in increased yields and less powdering and mealing occurs in the combine. Dust is greatly reduced both in harvesting and feeding. Losses due to lodging, rodents and birds are lessened Weeds are better controlled and many are cut before they mature in the field. Early combining of the grain nurse crop decreases competition for the new legume and grass underseedings. No nutritional problems or bloat problems are associated with feeding high moisture barley. High moisture barley is palatable and acceptable as a concentrate grain for dairy cows and was equal to dry barley in this feeding trial.

TABLE I

Chemical analysis of dry and high moisture barley

Analysis (DM basis), %:	Dry Barley	High Moisture Barley
Moisture	12.1	28.7
Dry Matter	87.9	71.3
Crude Protein	13.8	14.6
Crude Fat	1.5	1.6
Crude Fiber	5.7	7.1
Nitrogen free extract	75.5	73.4
Ash	3.5	3.3

TABLE II

Consumption of feed by lactating dairy cows and barley yield	Group I		Group II	
As fed and DM basis (Avg) lb:	Dry Barley		High Moisture Barley	
Number of cows/group	18		18	
Number of days on test	90		90	
	As Fed	DM	As Fed	DM
Barley daily/cow	12.2	10.72	15.0	10.70
Barley per 100 lbs body weight	0.92	0.80	1.09	0.78
Barley per 100 lbs 4% FCM	26.18	23.01	30.85	21.99
Alfalfa haylage/cow/day	29.47	15.74	29.61	15.81
Corn silage/cow/day	13.83	6.18	14.22	6.35
Herd grain mix/cow/day	10.28	9.21	10.17	9.11
Feed weigh-back/cow/day	8.93	5.29	7.48	4.44
Yield:				
Barley yield/acre (lbs)	3264	2870	4325	3082
Barley yield/acre (bu)	68.0	59.8	90.1	64.2

TABLE III

Body weights of dairy cows on barley	Group I	Group II
Weights, (Avg) lb:	Dry Barley	High Moisture Barley
Initial/cow	1332.6	1378.0
Final/cow	1355.9	1386.4
Change in weight	+23.3	+ 8.4
Net daily increase	0.26	0.09

TABLE IV

Milk production of Holstein cows fed dry or high moisture barley	Group I	Group II
Production (Avg), lb:	Dry Barley	High Moisture Barley
Total milk/cow (90 days)	4427.7	4567.9
Milk/cow/day	49.19	50.75
% Milk fat	3.63	3.71
Total fat	161.1	169.5
Milk fat/cow/day	1.79	1.88
% SNF	8.36	8.44
Total SNF	370.3	385.53
SNF/cow/day	4.12	4.29
Total 4% FCM	4190.1	4369.0
4% FCM/cow/day	46.55	48.56

High Moisture Wheat Utilization in Dairy Ration

George D. Marx, University of Minnesota
Northwest Experiment Station, Crookston

Wheat was harvested as a high moisture grain and utilized as a feed for lactating dairy cows. The purpose of this study was to determine the feasibility and feed value of using high moisture wheat as part of the ingredients in the conventional dairy grain ration. Successful results obtained when feeding high moisture barley to beef and dairy cattle combined with favorable market price of wheat in relation to other cereal grains also prompted this study.

High moisture wheat was combined at 28 percent moisture and stored in an oxygen-limiting Harvestore unit. The high moisture wheat was processed through a Wetmore hammer-mill blower. No screen is used in this feed mill.

The ensiled high moisture wheat was compared with a standard dry grain ration of equal parts oats and barley as part of the grain ration. The trial was designed and conducted utilizing 20 Holstein cows between 45 and 135 days of the lactation cycle. Animals were paired and randomly assigned to one of two groups according to daily milk production, producing ability, age, weight and stage of lactation. All animals were on a two-week standardizing period prior to the trial.

Group I was fed high moisture wheat for a period of three months (92 days). High moisture wheat was fed at a daily rate of 12.5 pounds (9.0 lbs DM) per animal. The balance of the ration consisted of equal parts oats, barley, beet pulp and corn along with one percent trace mineralized salt and one-half percent dicalcium phosphate and one-half percent urea. The same amount of concentrate based on dry matter was fed to group II. In this group high moisture wheat was replaced with equal parts of oats and barley. The balance of the ration consisted of the same ingredients used in group I. Total concentrate fed to both groups was at the rate of 1 lb per 3 lbs of 4% FCM.

Table I presents the chemical analysis of the high moisture wheat and control rations. Grain consumption, body weights and milk production of animals in both groups are found in Tables II, III and IV respectively.

Animals fed high moisture wheat produced slightly less total percent FCM than those fed dry oats and barley grain. Nonsignificant differences were obtained between rations in total milk yield, total fat yield, and total solids-not-fat produced. During the experimental period both groups gained weight. Weight gain difference between groups is almost identical and insignificant. Weight gains were primarily due to growth of the younger cows and increased conditioning as the lactation cycle advances.

In summary, favorable results were obtained when high moisture wheat was used to replace part of the dry grain ration for dairy cows. High moisture wheat was well liked by milking dairy cows and no unnatural or undesirable effects occurred; however, it took a few animals three to four days to become accustomed to this grain and subsequently consumed their entire ration. Palatability was no problem.

The comparative economy of producing high moisture wheat for dairy cattle feed is a major factor. Cost per unit of feed must be considered including costs of production, storage and feeding. Competition for human food is also a factor to consider; but with emphasis being placed on new high-yielding varieties, wheat does compete favorably with other grains for livestock feed.

Other advantages of using high moisture wheat were observed. Wheat can be combined one to two weeks earlier than dry grain and under more adverse weather conditions with more combining hours per day. One also minimizes harvesting and field losses (losses due to shattering, lodging, birds and rodents) and grain quality is maintained. The weed problem is diminished with earlier combining and the wild oat problem so prevalent in the Red River Basin of the North is greatly reduced. Several rehandling operations are eliminated prior to feeding and high moisture wheat is more adaptable to mechanized handling resulting in reduced labor costs.

TABLE I

Chemical analysis of composite samples of high moisture wheat and dry grain mix

Analysis (DM basis), %:	High Moisture Wheat	Equal Parts Oats & Barley
Dry Matter	72.0	90.0
Crude Protein	19.1	13.1
Crude Fat	2.5	4.4
Crude Fiber	4.2	9.8
Nitrogen free extract	72.4	68.6
Ash	1.8	4.1

TABLE II

Grain consumption by dairy cows on high moisture wheat or dry grain mix

	Group I	Group II
Consumption, lb:	High Moisture Wheat	Equal Parts Oats & Barley
Number of cows/group	10	10
Average daily/cow (as is basis)	12.5	10.0
Average daily/cow (DM basis)	9.0	9.0
Per 100 lbs body weight	0.65	0.64
Per 100 lbs of 4% FCM	24.9	23.8

TABLE III

Body weights of dairy cows on high moisture wheat or dry grain mix

Weights, (Avg), lb:	Group I High Moisture Wheat	Group II Equal Parts Oats & Barley
Initial/cow	1373.3	1399.5
Final/cow	1446.3	1475.5
Change in weight	+ 73.0	+ 76.0
Increase/day	0.79	0.81

TABLE IV

Milk production of cows consuming high moisture wheat or dry grain mix

Production, (Avg), lb:	Group I High Moisture Wheat	Group II Equal Parts Oats & Barley
Total milk	3591.0	3699.0
Milk/cow/day	39.0	40.2
% Milk fat	3.48	3.63
Total fat	124.9	134.4
Milk fat/cow/day	1.38	1.46
% SNF	8.20	8.37
Total SNF	294.4	309.8
SNF/cow/day	3.20	3.36
Total 4% FCM	3309.9	3495.6
4% FCM/cow/day	36.0	37.9

GROWING, HARVESTING, STORING AND FEEDING HAYLAGE

Dr. George D. Marx, Dairy Scientist
Northwest Experiment Station, Crookston

Utilization of forage as haylage (low or medium moisture silage) is becoming more popular among dairymen. Last year 43% of the dairymen in Minnesota with herds of 50 cows or more incorporated haylage into their forage feeding program. Acreage harvested as haylage is increasing substantially every year. The haylage system is probably the best way to harvest and store feed if one is interested in obtaining a consistently high quality forage. Management factors concerning the growing, handling, harvesting and storing of forage also have much to do with obtaining a top quality feed. In this area alfalfa is the most common forage that is fed as haylage. Some of the management techniques that can be used to insure satisfactory results in obtaining good alfalfa forage include the following practices.

GROWING

1. Alfalfa grows best on well drained and properly fertilized soils as determined by soil tests. Fertile soils with a pH of 7.0 are ideal. Top-dress with fertilizer annually.

2. Proper seeding is important--A firm seedbed prepared on fall plowing is preferable; seed at 1/4 to 1/2 inch depth in a band or broadcast; fertilizer should not come in direct contact with the germinating seed; seed at a rate of a minimum of 10 to 12 pounds per acre.

3. Use only certified seed of a high yielding variety; inoculation of the seed is essential for maximum nitrogen fixation; use good quality seed to help insure an excellent stand of alfalfa.

4. Weed and insect control is essential on infested fields to obtain maximum yield; control diseases and grow resistant varieties when possible. New varieties are being developed that have resistance to phytophthora root rot which is a real problem in Minnesota, particularly on wet soils.

HARVESTING

1. Cut alfalfa early--The highest yield of digestible nutrients per acre is obtained when alfalfa is cut between the bud and early bloom stage. Harvest first crop of established stands at late bud or first flower. Second and third crop should be cut between mid-bud and first flower. New seedlings, if cut during the year of establishment, should be in full flower.

2. Do not harvest or cut alfalfa after September 1 in Minnesota. Research shows that yields the following year are decreased if alfalfa is cut after that date. Reduce winter kill by leaving strips or leaving a 6-inch stubble on last cutting to catch the snow.

3. Condition and windrowing--Cut, condition (crimp, crush or roll) and windrow in one operation if possible. Windrows should be fluffy and not too large for fast drying. Conditioning the forage reduces drying time and saves leaves.

4. Raking--Never turn or rake hay that is less than 50 percent moisture and do not exceed 4-5 miles per hour. In case of hard rains that saturate the windrow turn the swath one-half turn with a side delivery rake before leaves are completely dry to prevent shattering losses of the leaves. Protein content of the forage is decreased proportionately to increased leaf loss.

5. Maintain proper drying rate by cutting at least twice each day if possible. This regulates drying so that chopping can be done over a longer period during the day and more adequately maintains proper moisture level of the haylage harvested.

6. Chop the material at 1/4 to 3/8 inch theoretical length. Not more than 10 percent of the material should be over 1½ inches in length. A fine chop makes the forage easier to unload, is more palatable to livestock and reduces the possibility of spoilage because of better packing; however, do not chop too fine (less than 1/4 inch) or grind forage for dairy cattle.

7. Chopper knives must be kept sharp. Sharp knives will reduce wear and tear on the machine, require less power, and increase capacity of the chopper. A long, raggy chop decreases storage unit capacity and results in forage that is harder to unload which increases wear and tear on the unloader.

8. Weather factor--Watch the weather forecasts and be aware of major weather systems coming into the area and developing high and low pressure systems. Cut forage on the tail end of a low pressure system to take full advantage of the high pressure system for drying. Do not cut forage when dew is on or when wet as this increases drying time.

STORING

1. Store at 40 to 60 percent moisture; 40 to 50 percent is ideal for an oxygen-limiting structure. Alfalfa silage stored at over 60 percent moisture will result in poor fermentation, seepage losses, poor palatability and produce offensive odors.

2. Fill rapidly to decrease spoilage: Exclude as much air as possible during the filling process. Air will deteriorate silage causing excessive heating and mold to develop.

3. Sticky and gummy material is sometimes a problem when the pectin content of the forage is high. A small amount of water added to the blower to clean the accumulation from the pipe will correct this situation.

FEEDING

1. Haylage takes two to three weeks to ferment properly before feeding, however feeding immediately after filling can be accomplished but is not highly recommended.

2. Haylage can be fed to all dairy animals including calves, yearlings, bred heifers, dry and milking cows. This forage is also compatible when fed along with corn silage.

3. Feeding forage as haylages insures a nutritious and highly palatable feed with consistently high quality when proper management is applied through GROWING, HARVESTING, STORING and FEEDING of the forage.

Additional advantages of haylage as compared to hay include:

1. Reduced field losses - shorter drying time, saves leaves due to shattering when dry.

2. Reduces weather risks by decreasing "down" time that forage is exposed to weather, less bleaching and leaching of forage by the elements.

3. Higher quality - more TDN or energy, higher protein forage.

4. Labor requirement for harvesting haylage is nearly 50 percent less than labor for baling hay by conventional methods.

5. Haylage system maximizes production per acre or milk per acre.

6. Little or no protein supplement necessary when feeding haylage.

7. Cattle consume all of the forage when chopped as quality haylage, no waste in feeding.

8. Alfalfa haylage can be fed as an only source of forage or can be fed with corn silage in a dairy feeding program.

9. Highly palatable feed which increases feed intake resulting in higher production.

10. Practical way to harvest, store and feed and offers flexibility to the system.

11. Complete mechanization of feeding is possible which results in less labor requirement.

12. Less dusty and easier to achieve a consistently higher quality forage.

Characteristics which result in high quality alfalfa forage include:

1. Early maturity

2. Conditioned when cut

3. Green and leafy

4. Fine stems

5. Proper storage moisture

6. Relatively weed free

7. Free of pesticides

8. Over 16% crude protein

9. Under 30% crude fiber

10. Over 50% TDN

ALFALFA HAYLAGE FOR DAIRY CALVES AND REPLACEMENT HEIFERS

Dr. George D. Marx, University of Minnesota
Northwest Experiment Station, Crookston

A five-year study was completed on the merits of feeding alfalfa haylage or alfalfa hay as an only forage to dairy heifers from birth to one year of age. Each heifer calf born was alternately assigned to a group receiving alfalfa haylage or a group receiving alfalfa hay. Eighty calves were studied in each group and fed in pens inside a conventional dairy barn. Calves received grain to nine months of age and whole milk at the rate of ten percent of body weight daily until five weeks of age, at which time they were weaned. In addition, 40 of these dairy heifers were continued on experiment for their second year in a loose housing dry-lot situation on the same forage treatment. No grain was fed to yearling heifers on this experiment. Minerals and water were supplied on a free choice basis.

Both the alfalfa hay and haylage were of excellent quality. An average analysis of the two forages is presented in Table I. The protein content of the alfalfa haylage was 2.4 percent higher as a result of saving more of the leaves during the harvesting operation which is a distinct advantage in feeding haylage. (Average analysis of the alfalfa haylage was 18.5 percent protein and alfalfa hay was 16.1 percent protein.) Crude fiber content of the alfalfa haylage averaged 27.8 percent and alfalfa hay was 31.0 percent. This also indicates a quality advantage for haylage as compared to hay.

Growth rate of calves is presented in Table II and for animals fed alfalfa haylage was 1.61 lbs per day and for animals fed alfalfa hay was 1.57 lbs per day. Data on forage intake and growth rate for dairy youngstock are presented in Table III. Yearling heifers on alfalfa haylage gained 1.46 lbs per day and those on hay gained 1.34 lbs per day. Both calves and yearling heifers on alfalfa haylage gained slightly more than animals on hay. Forage fed on a dry matter basis was about equal for each group; however, the group on hay wasted some of their forage by trampling and leaving some of the more coarse stems. The group on alfalfa haylage did not waste as much forage by trampling and did a more adequate job of cleaning out their forage bunk. Consistency of the fecal droppings on the hay group was more firm than the group fed alfalfa haylage.

Prior to conducting this study, many dairymen were reluctant to raise calves on haylage as their only source of forage. This experiment indicates that calves from birth utilized alfalfa haylage and performed as well as calves fed excellent quality alfalfa hay. Yearling heifers performed slightly better on haylage than heifers fed hay as their only source of energy feed. A dairyman can use an all-haylage forage program for all of his dairy animals including small calves. Haylage (low moisture silage) is an excellent feed for all ages of dairy animals.

TABLE I

Average composition of alfalfa haylage and alfalfa hay fed to young dairy animals (dry matter basis)

Analysis, %:	Alfalfa Haylage	Alfalfa Hay
Dry matter	53.8	88.4
Crude protein	18.5	16.1
Crude fat	2.0	1.9
Crude fiber	27.8	31.0
Nitrogen free extract	41.8	41.4
Ash	9.9	9.6

TABLE II

Performance of dairy heifer calves fed alfalfa haylage or alfalfa hay

	0-12 months old	
	Haylage	Hay
Heifer calves/group, no.	80	80
Forage fed/calf/day, lbs DM	10.93	11.07
Grain fed/calf/day, lbs DM	1.80	1.80
Feed/pound of gain, lbs DM	7.91	8.20
Gain/animal/day, lbs	1.61	1.57

TABLE III

Performance of dairy yearling heifers fed alfalfa haylage or alfalfa hay

	13-24 months old	
	Haylage	Hay
Yearling heifers/group, no.	20	20
Forage fed/heifer/day, lbs DM	20.34	20.97
Grain fed/animal/day	0.0	0.0
Feed/pound of gain, lbs DM	13.93	15.65
Gain/animal/day, lbs	1.46	1.34

Alfalfa Haylage for Lactating Dairy Cows

George D. Marx, Dairy Scientist
Northwest Experiment Station, Crookston

Enthusiasm among dairymen in utilizing alfalfa haylage for milking dairy cows has grown the past several years. This interest prompted a study at the Northwest Experiment Station to compare conventional baled alfalfa hay and alfalfa haylage. Alfalfa haylage, also known as low moisture silage, was experimentally fed to milking cows to determine production response along with consumption or intake and body weight changes.

A total of 32 registered Holsteins from the Experiment Station herd was used in this trial and paired into two groups on the basis of age, weight, stage of lactation, milk production and producing ability. Group I was fed good quality alfalfa hay and Group II was fed alfalfa haylage for the duration of the trial extending for a period of 120 days. Cows were fed grain concentrate at the rate of one pound of grain for each three pounds of milk produced. Both forages were fed to appetite or ad libitum.

Alfalfa was cut, conditioned and windrowed in one operation. The alfalfa haylage was stored in a 17 x 40 oxygen-limiting Harvestore structure and the baled hay was stacked inside a two-story barn. Both were harvested as first cutting alfalfa with similar maturity. Samples were taken at weekly intervals throughout the experimental period and composited for a complete proximate analysis. The results of the nutrition determination are shown in Table 1.

Protein content of the haylage was two percentage points above the baled hay. Crude fiber was slightly higher in the hay. Presumably, the harvesting losses in baling hay accounted for these two differences.

Table II presents the data on forage consumption, body weights and production including milk, fat and solids-not-fat produced by each of the treatment groups for the four-month period.

Forage intake was similar between the two groups. Cows fed alfalfa haylage produced 3.4 percent more 4% fat-corrected milk than the cows fed alfalfa hay (49.2 vs. 47.5 lbs/day). Milk fat and solids-not-fat percentages were similar with both groups. Amount of fat and solids produced by each group favored the alfalfa haylage treatment but differences were not statistically different. Body weights of animals were similar with both groups gaining some condition during the four-month period.

UTILIZATION OF POTATO CHAFF HAYLAGE FOR FEEDING LIVESTOCK

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Large quantities of low quality and waste potatoes are available every year which make suitable feed for livestock. Many of these low grade potatoes, waste by-products of potato processing plants and even surplus potatoes are being dumped in this country that could otherwise be used for the production of meat and milk. During the processing season 500 tons of potato wastes are available daily from plants in this area of the Red River Valley alone. (Crookston, Minnesota and Grand Forks, North Dakota) These waste potatoes include the cull potatoes unsuitable for human consumption, peelings, off-flavor french fries and potato chips and other residues from the processing of potato flakes and instant potato mixes.

A research project was designed and conducted at the University of Minnesota Northwest Experiment Station, Crookston, with the cooperation and aid from commercial potato processing plants in the Red River Valley of the North to deal with the problem of disposing of potato waste. City and community dumps were closing their gates to the dumping of large quantities of potato waste which was contributing to a substantial pollution problem. One of the objectives of the study was to determine the utilization of this polluting material as a potential valuable feed for dairy animals.

Preservation of potato wastes until fed is one of the real problems as potatoes require proper storage to maintain quality. Potato processing wastes discolor, become black, and give off an undesirable odor very soon after processing. To eliminate this problem of preservation the potato wastes were mixed with dry chaff and ensiled in an oxygen-limiting Harvestore structure. Potato waste and "screenings" off the processing line are high in moisture averaging 77.2% which is too high to make suitable silage if ensiled alone. Equal parts chaff and potato waste material were ensiled simultaneously using a self-unloading chopper box wagon to dump the chaff and an elevator to incorporate the potato waste into the blower. The larger potatoes were smashed to smaller bits and pieces in the blowing process which eliminated chopping or cutting the potatoes before ensiling. (Large whole potatoes can theoretically cause choking in animals if swallowed whole and accidentally become lodged in the upper tract. This problem can also essentially be eliminated if a rail is installed above the feed bunk to force animals to keep their heads down while eating, but this was not necessary with the ensiled potatoes).

The chaff used to mix with the potatoes to lower the moisture is another good feed that is normally wasted in the field. The chaff, sometimes called combine wastes, was salvaged with a combine mounted chaff-saver which blows the chaff material into a collecting wagon or the standard self-unloading chopper box. The chaff was obtained when harvesting both oats and wheat and was stockpiled temporarily before ensiling with potatoes. The chaff consisted primarily of small grain leaves, light kernels that normally blow over the sieves, some straw and weed seeds. Many cattle raisers use this chaff as a feed for wintering beef cows. This is a low cost feed and harvesting the chaff is inexpensive as collection takes place as the grain is harvested and no extra trip over the field is required.

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The only expense involved in these waste by-products was the cost of hauling, ensiling and storing. These relatively inexpensive feeds, potato wastes and combine wastes, were fed to Holstein males from the dairy herd at the Northwest Experiment Station. A total of 44 head averaging 700 pounds consisting of half bulls and half steers was used in the first of two feeding trials which extended for a period of 140 days. The potato-chaff haylage was compared to alfalfa haylage. Haylages were fed once daily and animals were free to consume all they wanted. In addition, all animals received six pounds of barley per head per day. Animals on potato-chaff haylage also received 0.1 pound of urea daily to supplement the protein requirements. The steers were implanted with 24 mg of diethyl stilbestrol. All animals had free access to trace mineralized salt and a commercial phosphorus, calcium, vitamin mix.

The second trial involved 36 head of Holstein beef and was conducted similarly to the first trial except that the potato waste was mixed and ensiled with chopped alfalfa hay rather than chaff. This trial was conducted over a period of 160 days with animals fed in a fence line bunk. Similar comparisons were made using alfalfa haylage for the control group and barley as a concentrate on both groups. No protein supplements were necessary in this trial.

Tables I, II and III present the results of the first trial and Tables IV, V and VI present the results of the second trial. There was essentially no difference in conformation and carcass grades between groups. The conformation and carcass grades reflect the high forage finishing ration fed. Marbling scores were virtually identical on all groups and were graded "slight" and "trace". All animals were given "A" in maturity. Weight gains, feed intake and carcass characteristics were about equal between groups within each of the trials. This indicates that potato haylage mixtures and alfalfa haylage fed groups perform equally well.

Some differences were observed between the bulls and steers. Steer carcasses graded one grade higher and had considerably more fat cover and greater marbling than bulls. Loin eye area on bulls averaged one square inch more than steers. Weight gains on stilbestrol implanted steers were similar to bulls.

A statistical analysis of the data resulted in highly significant differences between carcass traits of bulls and steers in marbling score, fat depth and carcass grade ($P<.01$). Significant differences were noted in loin eye area and percent kidney, heart and pelvic fat ($P<.05$) between carcass characteristics of bulls and steers.

The data was further analyzed on the influence of size of sire on carcass trait characteristics of these dairy males. Half the animals in each lot were sired by large-type sires and half by small-type sires of the Holstein breed. Marbling score and carcass grade were significantly different at $P<.01$ between large and small sired animals. No significant differences were observed in rib eye area, fat depth, percent kidney, heart and pelvic fat, conformation score and daily gain between large and small sired animals.

In summary the following conclusions were reached on the utilization of ensiled potato waste products:

1. Potato waste can be preserved satisfactorily by ensiling with drier forage to reduce moisture content. This mixture can be fed over a long period of time without deterioration of the feed.

2. Both mixtures of potato waste and chaff or chopped hay resulted in low moisture silage that was well preserved and upon fermentation had a pleasant and mild odor.

3. No real problems occurred in handling, mixing or blowing the potato waste into the tower storage structure. A tight box on the hauling vehicle is required to prevent any spillage on the highway.

4. No problem was experienced in getting animals to eat potato haylage. However, animals should start on feed gradually to avoid upsetting the rumen flora.

5. Potato haylage mixtures were palatable, were readily consumed and consumption was similar to alfalfa haylage. Animals did not try to separate potatoes from the all-in-one mixed feed.

6. Potato haylage mixtures were not laxative, fecal material was of average consistency and no urinary calculi or bloating problems occurred while feeding potatoes.

7. Potato waste-chaff mixtures supplemented with non-protein nitrogen were an excellent feed particularly from the standpoint of cost advantage. In this trial performance of the cattle was equal to the cattle fed alfalfa haylage.

8. Potato waste-chopped hay mixtures resulted in good quality low moisture silage and was equal to alfalfa haylage in this trial.

9. Animals made satisfactory gains on potato waste and carcass characteristics on dairy beef animals were similar to control animals.

10. Potato haylage mixtures were a satisfactory feed for dairy replacement stock, yearlings and bred heifers as well as dairy beef animals. (The balance of the ensiled potato waste mixtures was fed to replacement dairy animals after completion of the dairy beef trials.)

11. Analysis of potato wastes indicates a very nutritious feed high in carbohydrates which is a good source of energy.

12. Raw potato waste can be used as a substitute for part of the forage fed to livestock.

13. Utilization of potato wastes for cattle feed can eliminate a substantial pollution problem in the potato industry.

Table I. Potato Waste-Chaff Mix vs. Alfalfa Haylage.

TRIAL I

Lot or Group No.	I	II
No. Animals	22	22
No. Days Fed	140	140
Alfalfa Haylage	Ad Lib	--
Potato-Chaff Mix	--	Ad Lib
Silage D.M., %	48.8	50.5
Ground Barley, Lb	6.0	6.0
Urea, Lb	--	0.1
Forage/Animal/Day, Lb as Fed	31.64	31.25
Forage/Animal/Day, Lb D.M.	15.44	15.78

Table II. Chemical Analysis of Ensiled Feedstuffs Fed in Trial I.

Analysis	Potato Waste	Chaff	Potato-Waste Chaff-Mix	Alfalfa Haylage
Moisture, %	77.2	10.9	49.5	51.2
Dry Matter, %	22.8	89.1	50.5	48.8
Dry Matter Basis, %:				
Protein	6.9	11.0	9.5	15.1
Fat	8.0	3.2	3.6	2.0
Fiber	4.4	35.3	25.3	29.5
Ash	1.5	11.3	11.0	8.3
NFE	79.1	39.2	43.5	45.1
Calcium	0.05	0.91	0.8	1.7
Phosphorus	0.14	0.21	0.2	0.3
Starch	57.1			
Reducing Sugars	1.3			

Table III. Results and Comparisons of Feeding.

ALFALFA HAYLAGE vs. POTATO WASTE-CHAFF MIX

TRIAL I

Characteristic	Alfalfa Haylage	Potato Waste-Chaff
Shipping Weight	1132	1096
Slaughter Weight	1103	1067
Carcass Weight	620.1	599.9
Dressing Percentage	56.2	56.2
Loin Eye Area	11.15	10.75
Fat Cover	0.078	0.075
KHP Fat	1.35	1.30
Marbling Score	2.82 (T-)	2.74 (T-)
Maturity - Age	2.0 (A)	2.0 (A)
Conformation Grade	8.08 (S+)	8.15 (S+)
Carcass Grade	7.15 (S)	7.15 (S)
Total Gain, 140 Da	305	307
Average Daily Gain	2.18	2.19

Table IV. Potato Waste-Chopped Hay Mix vs. Alfalfa Haylage.

TRIAL II

Group No.	I	II
No. Animals	18	18
No. Days Fed	160	160
Alfalfa Haylage	Ad Lib	--
Potato-Hay Mix	--	Ad Lib
Silage D.M., %	51.8	49.5
Ground Barley, Lb	6.0	6.0
Forage/Animal/Day, Lb as Fed	29.05	28.09
Forage/Animal/Day, Lb D.M.	15.05	13.91

Table V. Analysis of Feedstuffs Fed in Trial II.

Analysis	Alfalfa Haylage	Potato Waste-Hay Mix	Barley
Moisture, %	48.2	50.5	10.5
Dry Matter, %	51.8	49.5	89.5
Dry Matter Basis, %			
Protein	19.4	16.8	12.4
Fat	1.7	2.2	1.2
Fiber	33.0	30.1	7.3
Ash	9.2	8.6	4.1
NFE	36.7	42.3	75.0

Table VI. Results and Comparisons of Feeding.

ALFALFA HAYLAGE vs. POTATO WASTE-CHOPPED HAY MIX

Characteristic	Alfalfa Haylage	Potato Waste-Hay Mix
Shipping Weight	1314	1301
Slaughter Weight	1269	1261
Carcass Weight	737	745
Dressing Percentage	58.1	59.1
Loin Eye Area	11.94	12.85
Fat Cover	0.12	0.19
KHP Fat	2.76	2.77
Marbling Score	4.04 (Sl)	4.18 (Sl)
Maturity - Age	2.0 (A)	1.9 (A)
Conformation Grade	9.3 (G-)	9.8 (G)
Carcass Grade	9.2 (G-)	9.1 (G-)
Total Gain, 160 Da	337.1	356.6
Average Daily Gain	2.11	2.23

HARVESTING AND FEEDING SMALL GRAIN HAYLAGE

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HARVESTING

A dairyman or livestock producer who may be short on alfalfa acreage might want to plan for additional forage using small grains. Oats (oatlage) or barley (barlage) harvested as forage can be used as a substitute for alfalfa haylage.

Proper management in harvesting and storing is the key in obtaining a good quality small grain forage. Obtaining a high quality oatlage or barlage is more difficult to obtain than is alfalfa haylage. Higher yields are experienced by growing later maturing, longer straw varieties. Oatlage or barlage should be cut while the grain is still in the boot or sheath. A less desirable forage which is lower in protein is obtained when the small grain is cut for silage after it has headed although it has a slight advantage in yield.

Two cuttings of barley or oats can be obtained if the first crop is cut above the first node or joint and at the boot stage of maturity. The second cutting will contain about half new seeding alfalfa along with the small grain forage; however, if rust, weeds, or if a dry season results, only one good crop can be expected yearly. Alfalfa seedlings generally do better if the small grain is cut for low moisture silage. The young seedling has the advantage of getting more of the moisture and sunlight it needs to become firmly established. Yields of small grain forage do not approach that of alfalfa haylage or corn silage; but when your forage supplies are short, low moisture small grain silage can be used successfully to replace the conventional forages for dairy cattle.

FEEDING

Oat and barley crops were utilized as oatlage and barlage in two recent trials conducted by the Northwest Experiment Station, Crookston. Trial I utilized 45 lactating Holstein cows on three different treatments with the individual groups receiving oatlage cut at the boot stage, oatlage cut at the dough stage, and alfalfa haylage, respectively. Trial II utilized 33 lactating Holstein cows which were divided into three treatment groups with individual groups receiving boot-stage oatlage, boot-stage barlage, or alfalfa haylage. Each trial was conducted over a period of three months and was preceded with a two-week standardizing period.

Animals in each group were balanced for stage of lactation, daily milk production, producing ability, age and weight. All haylages were offered ad libitum and weighed separately for each individual cow. In addition, animals were fed 1 lb of grain concentrate per 3 lb 4% FCM. Cows in Trial II each received 15 lb (4.97 lb DM basis) of corn silage daily. No corn silage was fed to animals in Trial I. Samples of individual forages were collected on a weekly basis for analysis. All forages fed were stored in oxygen-limiting Harvestore structures and the quality was excellent. Data collected on these experiments are presented in Tables I, II, III and IV and include forage analyses, milk production, milk fat, solids-not-fat, forage consumption and body weight.

The following is a summary of the results of these experiments:

1. Low moisture small grain silage (oatlage or barlage) is an excellent forage for lactating dairy cattle and can be used as a substitute for alfalfa haylage when additional forage is needed.

2. Alfalfa haylage was higher in crude protein than either oatlage or barlage. Crude protein of oats cut at the dough stage was lower than oats cut while the grain was still in the boot. Exact percentages of constituents for individual haylages are given in Table I.

3. Dry matter intake and consumption time on the various haylages used in this trial were nearly equal. No palatability problems occurred with feeding small grain haylage. Table II presents consumption levels of the various forages by the cattle.

4. Milk yield, milk fat, and solids-not-fat production were similar in each treatment group as presented on Table III. Oatlage and barlage compare favorably to alfalfa haylage for producing milk.

5. Cows in all groups gained slightly during the experimental period indicating sufficient intake of energy. Weights before and after the trial are presented in Table IV. Mean weight gains were similar in animals on all treatments.

6. Field drying time of alfalfa haylage and small grain haylages was about equal. All forages in this trial were cut, conditioned, and windrowed in one operation.

7. Other advantages of harvesting the small grain crop as haylage or low moisture silage rather than dry grain include:

    a. Increased nutrients - higher protein content and yield of feed energy per acre.

    b. Two crops can be harvested in a single season - when first crop is cut at the boot stage of development and above the first joint on the stem.

    c. Alfalfa seedlings benefit by removing the companion grain crop early - increased moisture and sunlight availability.

    d. Weeds were better controlled by early cutting - less weeds reach maturity

    e. Possibility of lodging is greatly reduced when grain is cut for haylage - easier to harvest and less chance of smothering the underseeding.

8. Small grain haylage compares favorably with alfalfa haylage as an efficient and useful forage for milk production.

TABLE I

Chemical analysis of forages on dry matter basis

Trial I

Analysis, %:	Boot Stage Oatlage	Dough Stage Oatlage	Alfalfa Haylage
Dry matter	44.3	48.0	52.3
Crude protein	13.6	11.5	18.3
Crude fat	2.7	2.1	2.0
Crude fiber	28.8	36.8	28.6
Nitrogen free extract	43.6	37.9	41.4
Ash	11.3	11.7	9.7

Trial II

Analysis, %:	Boot Stage Oatlage	Boot Stage Barlage	Alfalfa Haylage
Dry matter	45.8	41.4	53.9
Crude protein	15.9	16.4	17.1
Crude fat	3.2	3.3	2.4
Crude fiber	25.5	26.1	31.2
Nitrogen free extract	45.0	42.6	39.6
Ash	10.4	11.6	9.7

TABLE II

Forage consumption of lactating dairy animals on various low moisture silages

Trial I

	Boot Stage Oatlage		Dough Stage Oatlage		Alfalfa Haylage	
Number of cows/group	15		15		15	
Number of days on test	92		92		92	
Consumption, lb.:	As Fed	DM	As Fed	DM	As Fed	DM
Total LMS intake/cow	4278.6	1895.3	4171.2	2002.0	4244.9	2220.2
Daily LMS intake/cow	46.53	20.61	45.30	21.76	46.07	24.09
LMS/100 lb. body wt.	3.57	1.58	3.44	1.65	3.51	1.83
LMS/100 lb. 4% FCM	94.97	42.07	95.55	45.89	91.76	47.98

Trial II	Boot Stage Oatlage		Boot Stage Barlage		Alfalfa Haylage	
Number of cows/group	11		11		11	
Number of days on test	92		92		92	
Consumption, lb.:	As Fed	DM	As Fed	DM	As Fed	DM
Total LMS intake/cow	3858.4	1767.1	4183.3	1731.8	3531.0	1903.2
Daily LMS intake/cow	41.94	19.21	45.47	18.77	38.37	20.68
Daily corn silage intake/cow	15.0	4.97	15.0	4.97	15.0	4.97

TABLE III

Milk production of Holstein cows fed various low moisture silages

Trial I

Production, lb.:	Boot Stage Oatlage	Dough Stage Oatlage	Alfalfa Haylage
Total milk/cow	4620.9	4454.3	4734.2
Milk/cow/day	51.35	49.39	52.60
% milk fat	3.69	3.72	3.70
Total milk fat	170.5	165.7	174.9
Milk fat/cow/day	1.89	1.83	1.93
% SNF	8.65	8.49	8.70
Total SNF	399.5	378.2	412.1
SNF/cow/day	4.44	4.20	4.58
Total 4% FCM	4408.8	4265.8	4520.1
4% FCM/cow/day	48.88	47.41	50.20

Trial II

Production, lb.:	Boot Stage Oatlage	Boot Stage Barlage	Alfalfa Haylage
Total milk/cow	4238.1	4471.1	4449.9
Milk/cow/day	46.01	48.60	48.36
% milk fat	4.06	3.89	4.05
Total milk fat	172.0	173.8	180.4
Milk fat/cow/day	1.87	1.89	1.96
% SNF	8.67	8.58	8.68
Total SNF	367.8	383.7	386.1
SNF/cow/day	4.01	4.16	4.20
Total 4% FCM	4275.3	4394.9	4483.8
4% FCM/cow/day	46.46	47.76	48.73

TABLE IV

Body weights of lactating dairy animals fed various low moisture silages

Trial I

Weight, lb.:	Boot Stage Oatlage	Dough Stage Oatlage	Alfalfa Haylage
Initial/cow	1302.0	1316.0	1313.4
Final/cow	1339.8	1329.9	1362.5
Change in weight	+37.8	+13.9	+49.1
Increase or decrease/day	+0.42	+0.15	+0.53

Trial II

Weight, lb.:	Boot Stage Oatlage	Boot Stage Barlage	Alfalfa Haylage
Initial/cow	1261.9	1292.9	1206.7
Final/cow	1311.8	1376.1	1263.9
Change in weight	+49.9	+83.2	+57.2
Increase or decrease/day	+0.55	+0.90	+0.62

OAT AND PEA HAYLAGE FOR GROWING DAIRY ANIMALS

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Oat and pea mixtures were grown and harvested as low moisture silage (haylage) and fed to Holstein dairy steers and dairy calves. Two trials were conducted in two different years using oat and pea haylage in comparison with alfalfa haylage.

Two bushels of a long-straw, late-maturing variety (Lodi) oats and one bushel of Chancellor field peas were seeded per acre. The combination crop was harvested 68 days following seeding in the early dough stage of the oat kernel. Oats and peas were cut with a grain swather and were not crushed or crimped. Many of the peas inside the pod are lost if the material is conditioned at time of cutting. The whole plant was then wilted to a predetermined moisture content of 50% before ensiling. The pea and oat forage was stored in an oxygen-limiting Harvestore structure both years.

The use of peas with oats will increase the protein content of the forage mixture over oats alone. Peas are a legume; and if the seed is inoculated, bacteria will fix nitrogen in the root nodules. Energy content of pea silage containing the filled pods is equal to corn silage, however, the protein content is twice that of the corn. Peas did not lodge when grown with the oats as the oat plant will help support the pea vine. No problems were encountered with harvesting this crop. Oats and peas cut as forage will produce double the amount of TDN per acre over harvesting as dry grain.

The analyses of the oat and pea forage ensiled mixture and the control alfalfa haylage are shown in Table I and IV for each of the two trials. Analyses of oats and peas are similar to alfalfa haylage except for protein content which is several percentage points higher as presented in these tables.

The feeding data, carcass characteristics and weight gains of dairy beef are shown in Tables II and V for Trial I and II respectively. Feed consumption in relationship to gain was nearly equal with animals fed either of the two forages. Carcass traits were similar in both groups and for each of the two trials. Rate of gain was slightly higher on the alfalfa haylage fed animals particularly in Trial II.

Oat and pea haylage was also compared to alfalfa haylage with both male and female Holstein calves. Rate of gain and forage intake are presented in Table III for Trial I and in Table VI for Trial II. Gains were higher with the alfalfa haylage group in Trial II. Presumably this is primarily because of the excellent quality of the alfalfa as can be observed by the analysis in Table IV. In the first trial using average quality alfalfa haylage, weight gains of calves were similar to the groups fed oat and pea haylage. Dairy calves responded very well to oat and pea haylage which can be used as a suitable forage for feeding this age group of dairy animals.

TABLE I

Chemical analysis of ensiled forages on dry matter basis
Trial I

Analysis, %	Oat & Pea Haylage	Alfalfa Haylage
Dry matter	49.1	49.3
Crude protein	15.3	17.6
Crude fiber	29.2	28.8
Crude fat	3.9	2.0
NFE	43.3	42.1
Ash	8.3	9.5
Calcium	0.56	1.71
Phosphorus	0.29	0.22

TABLE II

Forage comparisons: consumption, carcass traits and weight gains of dairy beef
Trial I

	Oat & Pea Haylage	Alfalfa Haylage
Feeding Data		
Animals, no.	17	17
Days fed, no.	166	166
Forage/animal/day, lbs as fed	29.89	34.09
Forage/animal/day, lb DM	13.45	15.77
Barley/animal/day, lbs as fed	6.00	6.00
Barley/animal/day, lb DM	5.36	5.36
Forage/lb gain, lb DM	6.91	7.23
Barley/lb gain, lb DM	2.75	2.45
Total feed/lb gain, lb DM	9.66	9.68
Carcass data		
Slaughter weight, lb	1188.3	1162.5
Carcass weight, lb	671.0	672.5
Dressing percentage	56.47	57.85
Marbling score	5.00 (Sm)	4.75 (Sm)
Conformation score	8.67 (G-)	9.00 (G-)
Kidney, heart, pelvic fat, %	2.67	2.50
Loin eye area, sq. in.	10.37	10.80
Fat depth cover, in.	0.22	0.16
Maturity--age	1.67 (A)	1.50 (A)
Carcass grade	10.50 (G+)	9.75 (G)
Weight gain data		
Total gain, lb	323.7	361.9
Average daily gain, lb	1.95	2.18

TABLE III

Forage comparisons, consumption and weight gains of dairy calves

Trial I

	Oat & Pea Haylage		Alfalfa Haylage	
	Males	Females	Males	Females
Animals, no.	16	22	16	22
Days fed, no.	123	123	123	123
Initial weight, lb	150.8	236.9	139.0	235.6
Final weight, lb	308.3	410.3	306.3	415.2
Forage/animal/day, lb as fed	12.60	12.60	13.25	13.25
Forage/animal/day, lb DM	6.19	6.19	6.53	6.53
Grain/animal/day, lb as fed	3.00	3.00	3.00	3.00
Grain/animal/day, lb DM	2.59	2.59	2.59	2.59
Forage/lb gain, lb DM	4.83	4.38	4.79	4.46
Grain/lb gain, lb DM	2.02	1.83	1.90	1.77
Total feed/lb gain, lb DM	6.85	6.21	6.69	6.23
Total gain, lb	157.5	173.4	167.3	179.6
Avg. daily gain, lb	1.28	1.41	1.36	1.46

TABLE IV

Chemical analysis of ensiled forages on dry matter basis

Trial II

Analysis, %	Oat & Pea Haylage	Alfalfa Haylage
Dry matter	45.0	46.3
Crude protein	14.8	19.4
Crude fiber	30.5	26.0
Crude fat	4.3	2.5
NFE	42.4	43.2
Ash	8.0	8.9
Calcium	0.50	1.51
Phosphorus	0.31	0.28

TABLE V

Forage comparisons: consumption, carcass traits and weight gains of dairy beef
Trial II

	Oat & Pea Haylage	Alfalfa Haylage
Feeding data		
Animals, no.	12	12
Days fed, no.	182	182
Forage/animal/day, lb as fed	31.51	36.81
Forage/animal/day, lb DM	15.47	18.14
Barley/animal/day, lb as fed	6.00	6.00
Barley/animal/day, lb DM	5.41	5.41
Forage/lb gain, lb DM	7.37	7.20
Barley/lb gain, lb DM	2.59	2.18
Total feed/lb gain, lb DM	9.96	9.38
Carcass data		
Slaughter weight, lb	1182.5	1276.7
Carcass weight, lb	665.8	714.7
Dressing percentage	56.30	55.98
Marbling score	4.57 (Sl)	4.48 (Sl)
Conformation score	9.83 (G)	10.17 (G)
Kidney, heart, pelvic fat, %	2.58	2.50
Loin eye area, sq. in.	11.13	12.22
Fat depth cover, in.	0.09	0.12
Maturity--age	1.83 (A)	1.83 (A)
Carcass grade	10.00 (G)	10.33 (G)
Weight gain data		
Total gain, 182 days, lb	383.0	459.3
Average daily gain, lb	2.10	2.52

TABLE VI

Forage comparisons, consumption and weight gains of dairy calves
Trial II

	Oat & Pea Haylage		Alfalfa Haylage	
	Males	Females	Males	Females
Animals, no.	18	19	18	19
Days fed, no.	110	110	110	110
Initial weight, lb	243.4	308.9	242.6	316.0
Final weight, lb	386.3	451.7	441.8	532.9
Forage/animal/day, lb as fed	16.22	16.22	20.23	20.23
Forage/animal/day, lb DM	7.30	7.30	9.36	9.36
Grain/animal/day, lb as fed	3.00	3.00	3.00	3.00
Grain/animal/day, lb DM	2.75	2.75	2.75	2.75
Forage/lb gain, lb DM	5.61	5.63	5.16	4.76
Grain/lb gain, lb DM	2.11	2.11	1.51	1.40
Total feed/lb gain, lb DM	7.72	7.74	6.67	6.16
Total gain, lb	142.9	142.8	199.2	216.9
Avg. daily gain, lb	1.30	1.30	1.82	1.97

SUNFLOWERS FOR FORAGE

Dr. George D. Marx, Dairy Scientist
University of Minnesota, Northwest Experiment Station, Crookston

In the 1930's thousands of acres of sunflowers were used for silage in Minnesota. Most of this acreage was later shifted to corn with the introduction of high yielding hybrids. A renewed interest in using sunflowers for forage came in 1972 when farmers were permitted to grow several specialized crops including sunflowers on set-aside acres with only a slightly reduced government payment.

Many questions were asked concerning the value of modern day varieties of sunflowers for livestock feed. The Northwest Experiment Station planted 5.5 acres specifically for harvesting and feeding as silage. Seeding in 30-inch rows at a rate of 5 pounds per acre resulted in approximately a 20,000 plant population. The variety seeded was of the confectionary type (Dahlgren 694). A total of 50.2 ton of 68.5% moisture silage was harvested from this plot and ensiled for subsequent feeding.

Sunflower silage and alfalfa haylage were compared in a trial using 38 head of dairy beef animals divided among two equal lots. Animals were fed 8 pounds of barley per head daily plus all the silage they would eat. Animals fed sunflower silage consumed 46.2 pounds (as fed) or 15 pounds of dry matter daily per head and animals fed alfalfa haylage consumed 34.8 pounds (as fed) or 16.2 pounds of dry matter daily. Average daily gain on dairy beef steers fed sunflower silage was 2.12 pounds and for animals on alfalfa silage was 2.31 pounds.

Weekly samples of the silage were taken and composited for analysis. On the dry matter basis sunflower silage was 11.1% protein, 33.5% fiber, 7.15% fat, 9.5% ash, 0.83% calcium and 0.32% phosphorus.

No protein supplement was necessary in the sunflower silage ration which is an advantage of sunflower silage over corn silage, however, corn silage will outyield sunflowers. The other main limitation of sunflower silage seems to be the high moisture content at time of harvest. We harvested the field on October 10 following several frosts which resulted in some field-shatter loss of both leaves and heads. Prior to this period the plant was too high in moisture for optimum ensiling.

The research work on sunflower silage is limited to date, but intake and palatability of this feed are both acceptable. Performance of cattle is somewhat less than for animals fed alfalfa silage due to the lower energy and protein content of the sunflowers.

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IMPORTANCE OF FORAGE FOR PRE-WEANED DAIRY CALVES

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Performance data of 57 calves was collected in a trial to determine the importance of forage in the diet of milk fed baby calves. A controversy still exists in the dairy industry regarding the necessity of feeding forage to young calves. Many dairymen are not feeding any forage to calves until after weaning and indicate forage is not necessary in the diet of these young calves if an adequate grain starter is fed along with milk.

Calves from the Northwest Experiment Station Holstein herd were assigned alternately to one of three groups at birth. One group was fed alfalfa haylage and calf starter free choice. A second group was fed alfalfa hay and starter free choice, and a third group was fed starter but no forage. All calves received eight pounds of milk daily and were weaned at 35 days of age.

The period of the experiment covered the pre-weaning period of 32 days--from three days of age to 35 days. Calves were kept in individual 4 ft. x 6 ft. pens on a bedded concrete floor with free access to water at all times. The calf starter was pelleted, contained 16% protein and included the necessary vitamins and minerals. Both hay and haylage consisted of good quality alfalfa forage and were fed in individual feed boxes. All the feed fed was weighed and samples were collected weekly for nutrient analyses.

The results of the experiment are summarized in the table following this article. The calves fed forage consumed more total dry matter than the non-forage fed group, but forage intake was small with this age of calf. All groups consumed similar amounts of the starter grain ration. Groups on either alfalfa haylage or hay gained 0.1 lb daily more and had less incidence of scours than the group not receiving any forage.

Performance of dairy calves on hay vs. haylage vs. no forage

	Alfalfa Haylage	Alfalfa Hay	No Forage
Animals, no.	19	19	19
Days fed, no.	32	32	32
Birth weight, lb	94.32	90.11	92.11
Initial weight, lbs at 3 days of age	94.58	90.37	91.32
Final weight, lbs @ 35 days of age	120.59	116.94	114.68
Forage consumed/day, lb as fed	0.27	0.11	0
Forage consumed/day, lb DM	0.14	0.10	0
Starter consumed/day, lb as fed	0.40	0.43	0.41
Starter consumed/day, lb DM	0.36	0.39	0.38
Whole milk consumed/day, lb as fed	8.0	8.0	8.0
Forage + Starter/lb gain, lb DM	6.17	5.90	5.21
Scour treatments, no.	12	12	23
Avg. treatments/animal, no.	0.63	0.63	1.21
Total weight gain, lb	26.01	26.47	23.36
Avg. daily gain, lb	0.81	0.83	0.73

FEEDING BEET TOPLAGE TO DAIRY BEEF ANIMALS

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The objective of this study was to determine the value of beet top silage for dairy beef animals. Holstein dairy males from the milking herd at the Northwest Experiment Station were used in a feeding trial comparing ensiled beet toplage (tops and crowns) and oatlage (low moisture oat silage). Thirty-six head, half bulls and half steers, were fed on this experiment for a period of 120 days. Twenty-five of these animals were slaughtered as finished beef at the end of the trial and carcass data collected. The forage part of the ration was fed free choice and grain (barley) was limited to five pounds per head daily. Trace mineral salt, dicalcium phosphate and water were accessible to animals at all times. Animals were weighed at monthly intervals and representative samples of the feed were composited for analyses. Feed was fed in outside fence line bunks and animals were kept in a conventional bedded loose housing barn with access to an outside lot area. The feeding trial began on December 5 and ended on April 5 which covered the period of most severe weather conditions. The summary of the results appears in the following table:

Characteristic	Beet Toplage Fed Group	Oatlage Fed Group
Slaughter weight (lbs)	1187	1170
Carcass weight (lbs)	633	610
Dressing percentage (yield)	53.3	52.1
Loin eye area (sq. in.)	10.9	10.7
Fat cover (in.)	0.09	0.08
Kidney, heart, pelvic fat (%)	1.2	1.7
Marbling score	2.6 (Trace-)	2.5 (Trace-)
Conformation score	7.1 (Standard)	7.4 (Standard+)
Carcass grade	6.8 (Standard)	6.7 (Standard)
Forage/animal/day (lbs as fed)	63.3	37.6
Forage/animal/day (lbs dry matter)	19.7	17.3
Dry matter/cwt gain (lbs)	1035.8	845.1
Total gain/animal (lbs/120 days)	228	245
Average daily gain (lbs)	1.90	2.04

Dairy beef fed beet top silage gained 0.14 lb/day less than those on oatlage, however, they sold more actual pounds of carcass resulting in a higher dressing percentage or yield. This indicates animals fed beet tops and crowns carried less body fill than those fed low moisture oat silage. Carcass characteristics including loin eye area, fat cover, conformation and carcass grades were similar in each group. Bulls had larger loin eyes, less fat cover, less marbling and resulted in lower market grades than steers, however, gains were 0.28 lb/day greater on bulls than steers.

Animals fed beet tops consumed 18.4 percent more dry matter than animals fed oatlage. This indicates beet tops were very palatable. The probable reason for decreased feed efficiency on beet tops results from the high ash content of the feed. Beet tops are low in fiber and contain 13.5 percent protein and can be considered good quality feed for livestock. Caution should be taken, however, not to feed beet tops treated with pesticides or herbicides not approved for feeding meat producing animals. Beet tops, where available, are an economic and cheap source of energy for feeding livestock especially now with the high market price of grain and forage.

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TRITICALE HAYLAGE

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Triticale was the first man-made small grain hybrid developed and much interest in the use of this crop as a livestock feed has been generated the past few years. This cereal grain crop was developed by crossing wheat (Triticum) with rye (Secale) which has the advantage of higher yield, higher protein and more forage production than either of its original parent stocks. One disadvantage is that triticale is susceptible to ergot, a fungus that is a real problem which develops with certain humid and wet weather conditions. This problem is partially controlled when harvesting the crop as a forage rather than dry grain.

In a study at the Northwest Experiment Station, Crookston, Rosner triticale was seeded at the rate of 100 pounds per acre for harvesting as a forage crop for ensiling as low moisture silage (triticalage). One cutting was taken at the early dough stage of maturity and ensiled in a oxygen-limiting Harvestore structure. Many producers obtain two crops if they cut the grain before it heads and leave a 4-5 inch stubble. The chopped material is more fluffy and less dense then most silages and somewhat harder to pack to exclude air, however, this is not a problem in the oxygen controlled storage units.

A feeding trial was designed to utilize this exotic type forage for feeding-growing dairy beef cattle. A total of 32 head of Holstein steers was paired and divided into two uniform groups for comparing the triticale with a control forage, alfalfa haylage. Animals were fed ad libitum on the forage plus six pounds of barley per head daily for a period of 91 days. Minerals were fed free-choice with a conventional mineral feeder.

The triticalage resulted in an excellent, well-preserved forage with high acceptability. No feeding or palatability problems occurred during the trial. Intake of the triticalage was similar to alfalfa haylage (32.5 lb of triticale and 33.9 lb of alfalfa daily per animal as fed). Weight gains on the animals consuming the triticalage averaged 1.87 pounds daily and on alfalfa haylage animals gained 1.84 pounds daily. Animals were fed outside during a period of the most severe winter weather which normally depresses gains.

In this study animal performance was equal on both of the forages. The use of triticale as forage appears promising for livestock feeders. Research also shows good success with triticalage as a forage for milking dairy cows.

RECONSTITUTING BALED HAY

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Baled hay was reconstituted using a Wetmore Grinder-Blower and adding water at a special inlet into the machine. The hay and water were mixed during the blowing and ensiling process. Water was metered into the machine at 16 gallons (132 lb) per minute with a standard water metering device. The capacity of this machine was 320 pounds of baled hay per minute or 6 1/3 average size bales. This is equal to 9.6 ton of baled hay per hour of operation.

The dry matter content of the baled hay was 35% and was reconstituted to 60% dry matter. This required 830 pounds of water (100 gallons) per ton of baled hay. Water input was no problem as water was taken directly from a fire hydrant. The water volume could easily have been doubled if needed. An ordinary garden hose delivered 6 gallons per minute and would not have been sufficient. A booster pump from a water tank or reservoir could be used if the regular water supply is not adequate.

The machine took a full height and width bale upon removing the twine ties. A small hatchet with a 16-inch handle and sickle section was used to cut the twine. Bales were taken from an outside stack, loaded on a wagon flatbed rack and hauled to the reconstitutor. The reconstituted material was blown and stored in a 2050 Harvestore structure. A 40-20 John Deere was adequate for power on the PTO.

Two groups of growing Holstein heifers in two separate trials are being utilized to compare reconstituted baled hay and stacked baled hay which was taken from the same field. The first trial involved 28 head and the second trial, presently in progress, has 40 head on experiment. Factors including weight gains, forage intake, palatability and forage waste are being compared between the two treatment groups.

To date, reconstituted and ensiled baled hay has resulted in a number of advantages over baled hay from a stack:

1. Increased gains on growing dairy heifers

2. Increased forage consumption

3. Increased palatability of the forage

4. Decreased feed waste, consume all of the forage fed

5. Reduced exposure time of baled hay to deterioration in the stack

6. Mechanizes the feeding operation

ECONOMICS OF FORAGE HARVESTING OPERATIONS AND NUTRIENT ANALYSES OF ALFALFA, SUGARBEET TOPS, OATS, BARLEY AND CORN HARVESTED AS FORAGE*

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Methods and Procedures

Time requirements for harvesting forage crops including alfalfa, corn, oats, barley and sugarbeet tops were collected over a four-year period at the University of Minnesota, Northwest Experiment Station, Crookston. Labor inputs in swathing, chopping, baling, hauling and storage operations were recorded for each of these crops harvested as forage. Baling and chopping systems were compared on harvesting three yearly cuttings of alfalfa for four seasons.

Alfalfa and small grain forage was cut, conditioned and windrowed in one operation with a self-propelled swather. Beet tops were topped and windrowed in one operation with a three-row scalper. A self-propelled forage harvester (chopper) with a pick-up attachment for windrows and two-row corn head was utilized in chopping these forage crops. A PTO conventional pull type baler with a bale chute leading to an attached flatbed wagon with a man for piling bales was utilized in this study. Hauling and storing time includes travel time both empty and loaded from field to storage. The chopped forage was mechanically blown into upright storage structures and bales were manually piled in stacks. Labor data involving maintenance and repair was recorded and includes breakdown time, greasing, adjusting, knife sharpening, gumming (coating of pipes) and plugging problems where time was lost.

Data was collected on individual daily log sheets designed especially for the chopper operator, swather operator, baler crew, hauling and storing crew and farm foreman. Average hauling distance from field to storage was 1.54 kilometers. Every load of forage was weighed on a 10-ton beam scale and weight punched on a separate scale ticket for each load. A moisture test was determined on each wagon load of forage with a heated air dryer. Forage samples were taken from each load and composited by field for nutrient content. Field size averaged 10.1 hectares. Analyses for dry matter, crude protein, crude fiber, ether extract and ash content were determined on all cuttings of alfalfa and for all forages.

Results and Conclusions

Table I presents the results of all labor operations required for harvesting five different forages using the chopper system. Corn silage required the least amount of time to harvest on the basis of hours of labor required per metric ton harvested (1.09 hr/MT). The third cutting of alfalfa required an average of 16.3% more labor per MT than the average of the first two cuttings primarily because of less yield which was only 19.1% of the total yield for the year. The first cutting produced 41.6% and second cutting produced 39.3% of the average yearly total yield. Chopping time for harvesting low moisture grain silages (oats and barley) was similar to alfalfa. Chopping time for beet top silage was similar to that of corn silage. The four-year average of labor required for chopping corn silage was 0.28 hr/MT or an operator can chop 3.6 MT/hr with the two-row corn head under conditions used in this study.

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A partition of the labor in forage harvesting operations is presented in Table II. Hauling and storing requires the major portion of labor in the harvesting operation ranging from 56% in alfalfa to 70% for corn silage of the total time expended for harvesting. Maintenance and repair of the equipment during the harvesting operation required an average of 5.2% of the total time involved in harvesting the various forages.

Time requirement for harvesting baled hay is given in Table III. Labor to bale alfalfa hay requires 77.8% more man power than chopping alfalfa on an equal dry matter amount of material handled. This is primarily because of the extra man required to stack bales on the flatbed of the wagon pulled behind the baler. Some of the new bale-throwing devices on the market will help decrease this labor requirement for the baling operation. Overall baling required 31% more labor than chopping when combining all of the harvesting operations. Fourteen percent more labor was involved in harvesting the third cutting than the first two cuttings for an equal amount of dry matter harvested. As yield decreased labor/MT dry matter harvested increased. Additionally, 5.8% less yield was obtained by harvesting the alfalfa as baled hay as compared to chopping and harvesting as low moisture silage.

A comparison of the labor requirement for the chopping system and baling system is presented in Table IV. A total of 2939.4 MT of alfalfa was chopped and 690.6 MT were baled over the four-year period of this study. Low moisture alfalfa silage averaged 51.3% dry matter and required 0.76 hr/MT to complete all harvesting operations as chopped material or 1.49 hr/MT on the dry basis. Baled hay averaged 81.5% dry matter and required 1.59 hr/MT to harvest as baled or 1.96 hr/MT on the dry matter basis to complete all harvesting operations. In the chopper system 0.67 MT of alfalfa dry matter per man was harvested per clock hour. The baling system produced 0.51 MT of dry matter alfalfa per man per hour, a substantial decrease over the chopping system when combining all handling and harvesting operations.

Individual field samples of forages in this same study were chemically analyzed for nutrient content. Results are presented in Table V. Crude protein was higher and crude fiber lower in second and third cuttings of alfalfa as compared to the first cutting. Oat silage, barley silage and beet top silage were similar in protein content, just over 14%, but were considerably lower than alfalfa which averaged 19.8% crude protein. Beet top silage was high in ash content (24.5%) as a result of a high proportion of soil in the harvested forage. Crude fiber content of beet top silage averaged 13.7% and was substantially lower than any of the other forage crops analyzed in this study.

Acknowledgments: J. Torvi, Farm Foreman, M. C. Jacobson, Assistant Scientist, E. C. Miller, Agricultural Engineer, E. Moran, Farm Equipment Operator and R. Drellack, Senior Farm Laborer.

TABLE I

Time requirement for harvesting forage (chopper system)

Forage	Hours of labor/MT (DM) Swathing	Chopping	Hauling Storing	Maintenance Repairing	Total Hr/MT
Alfalfa - 1st crop	0.22	0.36	0.86	0.08	1.52
Alfalfa - 2nd crop	0.20	0.35	0.80	0.06	1.41
Alfalfa - 3rd crop	0.28	0.39	0.93	0.10	1.70
Corn silage		0.28	0.76	0.05	1.09
Oat silage	0.31	0.33	0.91	0.06	1.61
Barley silage	0.30	0.37	1.42	0.14	2.23
Beet top silage	0.35[1]	0.26	1.27	0.13	2.01

[1] Wescon Scalper-topper-windrower machine

TABLE II

Partition of labor in forage harvesting operations (chopper system)

Forage	Percent of labor/harvesting operation Swathing	Chopping	Hauling Storing	Maintenance Repairing
Alfalfa - 1st crop	14.83	23.65	56.30	5.22
Alfalfa - 2nd crop	14.36	25.06	56.53	4.05
Alfalfa - 3rd crop	16.35	22.61	54.79	6.26
Corn silage		25.65	70.23	4.12
Oat silage	19.45	20.68	56.42	3.46
Barley silage	13.38	16.72	63.54	6.37
Beet top silage	17.35	12.77	63.25	6.64

TABLE III

Time requirement for harvesting hay (baling system)

Alfalfa	Hours of labor/MT (DM) and percent of time/operation Swathing	Baling	Hauling Storing	Maintenance Repairing	Total Hr/MT
First crop (hr)	0.22	0.58	0.97	0.07	1.85
(%)	11.98	31.51	52.46	4.04	
Second crop (hr)	0.20	0.63	1.00	0.06	1.89
(%)	10.69	33.12	52.99	3.20	
Third crop (hr)	0.29	0.71	1.04	0.08	2.13
(%)	13.67	33.44	48.86	4.02	

TABLE IV

Time requirement summary for harvesting alfalfa (chopping vs. baling)

	Chopping system		Baling system	
	As Chopped	DM Basis	As Baled	DM Basis
Alfalfa harvested (MT)	5725.5	2939.4	847.9	690.6
Alfalfa dry matter (%)	51.34	(100)	81.45	(100)
Yield (MT/ha)	2.13	1.09	1.26	1.03
Swathing time (hr)	655.60		165.35	
Swathing hr/MT	0.11	0.22	0.19	0.24
Swathing operation labor (%)	14.87		12.18	
Chopping vs. baling time (hr)	1060.05		444.06	
Chopping vs. baling (hr/MT)	0.18	0.36	0.52	0.64
Chopping vs. baling labor (%)	24.04		32.73	
Hauling & storing time (hr)	2477.15		695.82	
Hauling & storing (hr/MT)	0.43	0.84	0.82	1.01
Hauling & storing labor (%)	56.17		51.32	
Maintaining & repairing time (hr)	217.08		51.02	
Maintaining & repairing (hr/MT)	0.04	0.07	0.06	0.07
Maintaining & repairing labor (%)	4.92		3.76	
Total harvesting time (hr)	4409.88		1356.25	
Total (hr/MT)	0.76	1.49	1.59	1.96

TABLE V

Nutrient analyses of various forages (DM basis; %)

Forage	Field Samples	Dry Matter	Crude Protein	Crude Fat	Crude Fiber	Ash	Ca	P
Alfalfa - 1st crop	49	51.7	18.7	1.8	32.8	9.1	1.53	0.22
Alfalfa - 2nd crop	48	51.9	20.5	2.1	30.1	9.3	1.56	0.21
Alfalfa - 3rd crop	35	48.7	20.4	2.0	28.4	9.3	1.61	0.24
Corn silage	13	38.6	8.9	2.0	25.5	5.0	0.19	0.23
Oat silage	8	45.9	14.2	2.9	27.4	11.1	0.33	0.36
Barley silage	4	48.8	14.6	3.1	28.8	10.7	0.35	0.32
Beet top silage	5	41.7	14.5	1.4	13.7	24.5	0.97	0.22

MOISTURE DETERMINATION OF HAYLAGES

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The Northwest Experiment Station, Crookston, has been studying methods that will speed up the determination of moisture in forages. The only approved methods for moisture testing to date involve heat or forced air for drying and will take a minimum of 20 minutes to dry a sample. Some of these oven drying methods take up to 24 hours to accurately dry a sample. This involves a considerable amount of time and a livestock producer cannot afford to wait this length of time during the haying season for a moisture or dry matter analysis on his forage.

Various types of electronic moisture testers have been researched, including the Agri-Quick-Tester, and three experimental models of the Dole-Radson Tester. One of these was designed for testing forage in the windrow. All of these electronic testers are portable (operated by a 9-volt transistor battery) and they give instantaneous readings of moisture content which is a real advantage over the conventional heat drying methods; however, the accuracy of the electronic testers for determination of moisture in various forages has not been satisfactory.

Comparisons of 276 forage samples were made with both the electronic and standard heat drying methods to determine accuracy and dependability of the electronic testers. A total of 60.9% of the samples fell within 5 percentage points of the Koster (heated air) Tester, 82.6% of the samples fell within 10 percentage points of the Koster Tester and 17.4% of the samples were more than 10 percentage points from the Koster readings. Only those samples falling within 5 percentage points (60.9% of samples) of the standard heat dry methods would be in the acceptable range of accuracy for this type of work.

The results of this study indicate that to date the electronic testers are not satisfactory for checking moisture content of forages, including alfalfa haylage, corn silage, beet toplage and oatlage. Electronic testers have been used for several years for testing grains under 20% moisture and have been dependable and accurate for these types of determinations.

Some of the variable results we obtained were caused by a number of factors. We observed differences with temperature of the material. If forage is taken from a refrigerator, it must be warmed to standard room temperature. Differences also occur with fineness of chop, amount of packing, density of the forage, stage of maturity, cutting and type of forage crop. These differences cause variation on the electronic tester read-out as compared to standard heat drying (forced air) Koster Moisture Tester readings.

Field testing was accomplished for several years at the Northwest Experiment Station with a unit (Dexter Moisture Tester) which slipped onto the exhaust pipe of a truck or tractor. The heat from the exhaust dried the samples in 20 minutes. Scientists testing forage checked the results from this equipment in the field against laboratory dried samples taken from the same load of chopped forage and found them to average within one percent of the Koster Heated Air Dryer. At today's fuel prices this method of muffler exhaust drying of forage becomes quite expensive.

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HARVESTING AND FEEDING OF EARLY AND LATE CUT CORN SILAGE TO LACTATING DAIRY COWS

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In a preliminary two-year experiment, corn silage was harvested at two-week intervals beginning in mid-September (prefrost) and ending the last week in December. Dry matter yields were determined at various stages of maturity at these intervals on replicate fields. Storage of this material in tower silos and utilization of this corn silage cut at bi-weekly intervals for dairy cattle seemed quite successful and prompted us to conduct this trial comparing early cut and late cut corn silage for lactating dairy cows.

Thirty registered Holstein cows of the Northwest Agricultural Experiment Station herd were utilized in this study and paired according to stage of lactation, daily production, producing ability, age and weight. One member of the pair was randomly assigned to Group I receiving early cut corn silage harvested the last week in September and the other animal to Group II receiving corn silage harvested the first week in November. The corn variety used was Minn. Hybrid 803. Additionally, animals received 1 lb of concentrate per 3 lb of 4% FCM produced and an average of 12.8 lb DM alfalfa haylage per cow per day in each group.

Chemical analysis of the early and late cut corn silage is presented in Table I.

The early harvested material averaged 31.0% dry matter content versus 51.9% dry matter for the late cut corn silage. Small decreases in crude protein and crude fiber content were noted in the more mature corn silage. This is due to the laying down of more sugars and starches in the more mature ears.

Cows fed late cut corn silage produced significantly more 4% FCM per day (44.61 lb vs. 42.02) and consumed significantly more dry matter (9.4%) than those fed early cut corn silage; however, the latter group ate more total kilograms of corn silage (as fed basis) than Group II. Milk fat yield, fat percentage, SNF yield and SNF percentage were similar between groups. A slight increase in final body weight over initial weight per cow was noted in both groups as presented in Table II over this 92-day experimental period.

In this study, favorable results were obtained in storing (no spoilage in either early or late cut) and feeding corn silage with a six-week difference in maturity. Early cut corn silage yielded 8.3% more dry matter per acre than late cut corn silage but cows produced 6.2% more 4% FCM on the late cut corn silage.

Less dry matter obtained on the late cut corn silage indicates some field losses, dropped ears, stalk breakage, leaf loss (wind) and animal damage. One can, however, make greater use of silos by cutting some corn late, increasing your capacity to store more forage (economical advantage). The late cut was just as palatable as early cut and was most desirable for efficient milk production.

TABLE I

Chemical analysis of early and late cut corn silage.

Analysis (D.M. basis), %:	Early cut Corn silage	Late cut Corn silage
Dry matter	31.0	51.9
Crude protein	9.9	9.4
Crude fat	2.9	3.1
Crude fiber	24.0	21.4
Nitrogen free extract	58.9	62.1
Ash	4.3	4.0

TABLE II

Corn silage consumption, milk production and body weights (lb)

	Group I Early cut	Group II Late cut
Number of cows/group	15	15
Number of days in trial	92	92
Dry matter consumed, lb:		
Daily/cow	12.65	13.83
Per 100 lb of body wt.	1.01	1.08
Per 100 lb of 4% FCM	30.10	31.02
DM yield/acre	5924.3	5467.1
Milk production (Mean), lb:		
Total milk	4060.1	4370.0
Milk/cow/day	44.11	47.49
Milk fat (%)	3.68	3.60
Total fat	149.5	157.2
Milk fat/cow/day	1.63	1.69
SNF (%)	8.39	8.35
Total SNF	340.8	359.3
SNF/cow/day	3.70	3.89
Total 4% FCM	3866.5	4107.0
4% FCM/cow/day	42.02	44.61
Body weights (Mean), lb:		
Initial/cow	1251.6	1283.1
Final/cow	1282.9	1304.1
Change in wt.	+31.3	+21.0
Increase/day	0.34	0.23

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INITIAL STUDIES ON THE HARVESTING, STORING AND FEEDING OF HIGH MOISTURE BARLEY[1/]

Presented by Harvey F. Windels

This research on the harvesting, storing and feeding of high moisture barley to beef steers at the Northwest Experiment Station was conducted from 1960 to 1964.

The objectives of the studies were to determine the comparative merit of high moisture barley vs. dry barley in respect to:

1. Labor, equipment and machinery needs
2. Field losses
3. Effect on wild oats control
4. Feeding value

PROCEDURE

Uniform fields of Traill barley were selected and divided into comparable strips ranging in size from 4 to 10.3 acres. The odd numbered strips were harvested by direct combine with cutter bar when grain was approximately 30% moisture and stored in a 14' x 40' Harvestore silo in whole kernel form. The even numbered strips were swathed and harvested as dry barley in the conventional manner. Types of data recorded were combine and shattering losses, combine setting and adjustments, calculated and actual yields, labor, equipment and machinery utilized in harvesting, storing and feeding, soil test, weather conditions at harvest, chemical analysis of barley, wild oats development, shattering and germination.

Three feeding trials with beef were conducted to compare dry and high moisture barley; first one in fall and winter, 1960-61; second one in fall and winter 1961-62 and third one in fall and winter 1963-64.

In each trial, forty "medium" grain yearling Hereford steers were divided into four lots of 10 on the basis of liveweight and feeder grade. The steers were housed in an open pole-type structure equipped with combination hay-grain feeders and frost-free automatic waterers under roof. They were hand-fed twice daily and all feed fed and refused was weighed. One-half of the steers in each lot were implanted with 24 mg. of stilbestrol.

1/ Presented at the Northwest Experiment Station High Moisture Barley and Haylage Seminar, August 1, 1974, Crookston, Minnesota.

This section excerpted from the reports and work of the following researchers at the Northwest Experiment Station: Edward C. Frederick, D. Reimer, E. C. Miller, B. C. Beresford, O. C. Soine, B. E. Youngquist and G. D. Marx.

Table 1. The Experimental Design of Beef Trials 1 and 2

	Rolled dry barley*		Rolled high moisture barley*	
No. of head	10	10	10	10
Supplement	1 lb barley supplement**	4 lb alfalfa hay	1 lb barley supplement**	4 lb alfalfa hay

* Barley fed ad lib after on full feed.
** Barley supplement--60% dehydrated alfalfa meal, 30% dried beet pulp and 10% ground feeding limestone.

Table 2. The Experimental Design of Beef Trial 3

	Rolled dry barley		Rolled high moisture barley	
No. of head	10	10	10	10
Phase 1 110 days*	Haylage	Beet top--beet pulp silage	Haylage	Beet top--beet pulp silage
Phase 2 65 days**	Beet top--beet pulp silage at 10 lb per head daily			

* Phase 1 - Forages ad lib; barley 7.5 lb D.M. per head daily
** Phase 2 - Barley ad lib

RESULTS

Harvesting

1. Labor, equipment - No serious problems were encountered in harvesting the high moisture barley by direct cut with a 14-foot self-propelled Massey Ferguson. Barley can be combined direct at least up to 38% moisture satisfactorily. Only slight changes were made in the combine settings.

   An average of 3.8 acres of barley was combined/hour conventionally compared to 2.8 acres/hour for high moisture barley; however, the latter can also be combined at night, with dew or in light rain because of the much wider range of acceptable moisture percent. The elimination of swathing in direct cut harvesting of high moisture barley saved machinery, labor and most likely barley heads.

2. Weather conditions - Because of the warm weather and hot dry winds in 1960 the barley kernel moisture dropped rapidly from 36 to 23 percent in two days resulting in combined moisture levels of 16.0 to 23% and necessitating the addition of some water at the silo blower to bring the moisture level to 30%.

3. Yield - Barley yields equated to 13% moisture were greater for the high moisture barley both years. In 1960, under ideal harvesting conditions, high moisture barley averaged 64.1 bushels per acre compared to 58.5 bushels per acre for dry barley. Due to drought in 1961, maturity was irregular and high moisture barley had an even greater advantage, 42.9 bushels per acre versus 34.4 for dry barley. For the two years, high moisture barley had an average yield advantage of 17.2%.

4. Combine and shattering losses - Plot data on these losses were inconsistent and did not give any conclusive reason for the difference in yield. The reduced amount of shatter and the increased percent of wild oats appeared to account for much of the increased yield of high moisture barley over dry barley. The remainder was presumably due to the plumpness of the green kernels which are retained when harvested wet but would pass through the screens when dried.

5. Wild oats - Much of the wild oats was still in the head when the high moisture barley was harvested; therefore, a higher percentage of wild oats was harvested. Approximately twice as much wild oats was found in the high moisture barley compared to dry barley. None of the wild oats germinated after being ensiled for two months whereas 90-95% germination was obtained on wild oats in the dry barley.

Storage and Processing

1. High moisture barley was stored successfully in a properly sealed oxygen-limiting silo with a sweep-arm chain type bottom unloader (14 x 40 Harvestore).

2. No freezing or unloading problems were noted.

3. Barley taken from the Harvestore silo had a bright yellow color, apple cider smell, alcohol content of about 2.2% and ranged from 25.4 to 34.3% moisture.

4. Daily removal and rolling of high moisture barley as needed for feeding appeared to be the most desirable method of handling. During below freezing temperatures, high moisture barley could be stored several weeks; however, in warm weather storage time decreased so that at approximately 70° F it heated within two days.

5. Scrapers had to be installed on the roller mill to prevent "gumming up" on rollers.

6. It took longer to auger and roll high moisture barley than dry barley. Augering and rolling times were 12 and 30 minutes per ton respectively for high moisture barley and 10 and 24 minutes per ton for dry barley.

7. High moisture barley kernels had to be cracked to prevent whole kernels from going through the cattle. When properly rolled, a uniform, flattened, flakelike kernel resulted.

Feeding

Trials 1 and 2 (Data in Table 3)

1. The rolled high moisture barley was palatable. Cattle ate it readily from the outset.

2. No difficulties from bloat, stiffness or scouring were encountered after the cattle were on full feed. In the first trial a few isolated cases of mild founder occurred during the early part of the feeding period but these conditions disappeared shortly after the cattle were on full feed. No founder was noted in the second trial, possibly because a longer period of time was taken to bring the cattle up to full feed (56 vs. 42 days).

3. Average daily gain was not significantly different statistically for cattle fed dry or high moisture barley; however, those fed high moisture barley gained 0.08 pounds more per day.

4. In both trials, the average daily dry matter feed intake was slightly greater for steers receiving alfalfa hay in their rations. However, no significant difference in barley dry matter intake occurred.

5. Feed conversion was slightly better for steers fed high moisture barley plus the special barley supplement than for those fed dry barley plus supplement (793 vs. 822/cwt. of gain). Feed conversion efficiency was reduced when alfalfa hay was used as the supplement. The latter can be expected because alfalfa hay increases the fiber content of the ration.

6. In both trials, the margin over feed costs was greatest for cattle fed "wet" barley plus special barley supplement and poorest for those fed "dry" barley plus special barley supplement.

7. Carcass data characteristics were inconsistent. In the first trial, steers fed "dry" barley with either supplement had significantly higher marbling scores and carcass grades than those fed "wet" barley plus special barley supplement whereas in the second trial essentially no differences occurred.

8. In both trials, steers fed "dry" barley plus alfalfa hay exhibited the greatest response to stilbestrol implants (20.6% and 23.6%) whereas steers fed "wet" barley plus alfalfa hay showed the least response to implanting (+3.2% and -5.0%). The stilbestrol responses on the other two treatments were intermediate.

Trial 3 (Data in Table 4)

1. In both phases, the difference in gain (0.08) was small but in favor of the high moisture barley (Phase 1, 2.43 vs. 2.35) (Phase 2, 2.19 vs. 2.11).

2. In Phase 2 steers receiving "wet" barley consumed more feed daily (16.8 vs. 15.8 pounds) and required somewhat more feed dry matter per pound of gain (835 vs. 806).

Table 3. Performance data of steers fed rolled dry barley vs high moisture barley with and without alfalfa hay. Trial 1: October 1960-April 1961 (170 days); Trial 2: October 1961-March 1962 (140 days)

Lot no.	I		II		III		IV	
Rations fed	Rolled "dry" barley				Rolled "wet" barley			
	+ Barley supplement		+ Alfalfa hay		+ Barley supplement		+ Alfalfa hay	
Trial no.	1	2	1	2	1	2	1	2
No. of steers	10	10	10	10	10	9[a]	10	10
Av. initial wt., lb.	776	792	776	792	776	797	776	792
Av. final wt., lb.	1136	1127	1159	1156	1184	1161	1156	1136
Av. daily gain, lb.	2.12	2.39	2.25	2.60	2.40	2.60	2.22	2.46
Av. daily feed intake, lb.[c]								
Barley	15.2	16.0	15.5	16.2	16.8	15.9	16.1	15.5
Alfalfa hay	1.6	2.9	4.2	5.1	1.6	4.1	4.3	6.0
Barley supplement	0.7	0.6	0	0	0.7	0.6	0	0
Total[b]	17.5	19.5	19.7	21.3	19.1	20.6	20.4	21.5
Av. feed/cwt. gain, lb.[c]								
Barley	719	670	688	625	699	610	726	630
Alfalfa hay	76	121	188	196	66	159	195	244
Barley supplement	34	24	0	0	30	22	0	0
Total[b]	829	815	876	821	795	791	921	874

[a] One steer removed from Lot III because of high temperature and rapid weight loss. Severe liver abscess noted on slaughter.

[b] Minerals not included.

[c] Figures are on a dry matter basis.

Table 4. Performance of yearling steers fed "wet" vs "dry" barley with alfalfa haylage or beet top-dried beet pulp silage. Phase 1: December 1963-April 1964 (110 days); Phase 2: April-June (65 days).

Treatments	Haylage		Beet top-beet pulp silage	
	Wet barley	Dry barley	Wet barley	Dry barley
No. steers	10	9[a]	10	9[a]
Av. daily gain				
Phase 1	2.52	2.54	2.33	2.16
Phase 2[d]	1.99	2.07	2.38	2.15
Phase 1 + 2	2.32	2.37	2.35	2.16
Av. daily feed total[b,c]				
Phase 1	19.1	19.0	16.3	15.5
Phase 2[d]	17.1	15.9	16.4	15.6
Feed/cwt gain total[b,c]				
Phase 1	739	721	686	699
Phase 2[d]	927	831	743	780

[a]One steer removed from Lot 2 and 4 due to founder in Phase 1.
[b]Minerals not included.
[c]Figures on a dry matter basis.
[d]All lots received 10 lb of beet top-dried beet pulp silage per head daily in Phase 2.

3. Carcass data favored steers fed wet barley in that they had somewhat higher marbling scores (4.85 vs. 4.45) and carcass grades (8.85 vs. 8.08)

4. In this experiment implanted stilbestrol did not have as marked an effect as in the previous two trials. Stilbestrol increased rate of gain only 5.4% compared to 12-14% previously.

5. No animals foundered on "wet" barley whereas two animals foundered on the dry barley treatments.

Advantages and Disadvantages of High Moisture Barley

The main advantages of harvesting barley in the high moisture state appear to be:

1. Increased yield (average of 17.2% for 2 years) due to elimination of swathing.
   a. Less shattering and head breakage from wind.
   b. Lower loss from immature heads and kernels.
   c. Larger harvest of wild oats.
   d. Less bird damage.

2. Increased yield due to reduced exposure risks.
   a. Less exposure to hail damage and to wind damage (lodging) (at least five days).
   b. No loss from barley sprouting in wet swath.
   c. Less risk of loss from fire in field.
   d. Less risk of major bird damage.

3. Can combine under more adverse weather conditions and more hours per day.

4. Aid in controlling wild oats.

5. High moisture barley is more palatable to finishing cattle, reduces scouring and founder, go on feed easier and stay on feed better than with dry barley.

6. Elimination of dust - more healthful and eliminates explosion hazard.

7. Eliminates wind loss from feed bunks.

8. Retains powdery micro-ingredients added to a complete mixed ration.

The main disadvantages are:

1. To store satisfactorily, oxygen must be excluded.

2. Cannot roll barley ahead in warm weather.

3. Under certain weather conditions, barley may all be ready at same time and may dry down too fast (may avoid by planting different varieties and spacing plantings).

4. Useful only for livestock feed.

SUMMARY

It appears that high moisture barley can be harvested satisfactorily by direct combine, stored successfully in an oxygen-limiting silo at about 30% moisture and successfully fed in beef finishing rations.

Alternate strips of barley harvested as high moisture barley or as conventional dry barley from uniform fields indicated a 17.2% advantage in yield when harvested as high moisture barley.

Feeding trials indicated that rolled high moisture barley was palatable and readily eaten by yearling beef steers. The performance of cattle fed high moisture barley or dry barley was not greatly different; however, the advantage was slightly in favor of the "wet" barley. There were also no consistent differences in carcass characteristics. No difficulties were encountered from bloat, stiffness or scouring on high moisture barley after the cattle were on full feed.

COMPARISON OF DRY OR HIGH MOISTURE BARLEY AND HOUSING SYSTEMS FOR FEEDLOT CATTLE[1/], [2/]

by Harvey F. Windels

Introduction

Although a considerable number of research trials comparing high moisture and dry barley have been conducted in the United States and England from 1960 to 1970, all of the trials had a couple of things in common: (1) relatively small numbers per lot (6 to 10 head), (2) housed in conventional type buildings, and (3) most of them presumably used straw for bedding.

Most of the reports indicated that less bloat, founder and scouring occurred, however, they did not indicate the severity of the problems nor did they appear to attach proper significance to the problems in that often the animal(s) were removed from trial and their data excluded. Such procedures can bias performance data when a small number of animals are used per lot and per trial.

For the 1970-71 season, the Northwest Experiment Station made several changes in beef feeding, namely: (1) the addition of 96-foot, four lot, open confinement slatted floor barn, (2) conversion to complete mixed rations with a mixer-feeder truck equipped with an electronic scale, and (3) increased cattle numbers from 10 head to 25-30 head per lot, made possible with the use of complete mixed rations.

Apparently as a consequence of the higher cattle densities, bloat became a problem in cattle fed growing and finishing rations consisting of dry barley and alfalfa haylage.

Thus, additional work with high moisture barley was initiated to determine the extent of its reported bloat controlling characteristics, particularly in the slatted floor barn with cattle density at 17 sq. ft. per head and no bedding. It was also anticipated that with a larger number of animals per lot and per trial, feedlot problems and performance data would be more clear cut. Additionally, with larger numbers, feeding procedures would be more normal such as the withdrawing and rolling of high moisture barley daily instead of every 2-3 days or weekly as often was done when small lots were used.

The objectives of the two trials reported herein were to:

1. Compare the effect of dry or high moisture barley-alfalfa haylage rations on performance and carcass characteristics of cattle housed at relatively high densities in a conventional pole barn or in a cold confinement slatted floor barn.

2. Compare the incidence of bloat and founder as influenced by dry or wet barley and type of housing.

1/ Presented at the Northwest Experiment Station High Moisture Barley and Haylage Seminar, August 1, 1974, Crookston, Minnesota.

2/ Includes excerpts from the University of Minnesota 1973 Beef Research Report B-187 by H.F. Windels, R.D. Goodrich and J.C. Meiske.

Procedures

In Trial I (1972-73) one hundred sixteen yearling Hereford steers from two herds were randomly allotted from within herds to four groups of 29 head. In Trial II (1973-74) one hundred yearling Hereford steers from one herd were randomly allotted to four groups of 25 head. Each year the four groups were randomly assigned to one of the following treatments (2 x 2 factorial arrangement of treatments):

1. High moisture barley-conventional pole barn
2. High moisture barley-cold confinement slatted floor barn
3. Dry barley-conventional pole barn
4. Dry barley-cold confinement slatted floor barn

The animals were allowed 17 sq. ft. per head in the slatted floor barn and animals in the conventional barn had 23 sq. ft. of bedded area under roof, 25 sq. ft. of paved lot outside and outside covered bunks. Straw was used for bedding in the conventional barn. All lots had automatic water fountains. Bunk space was equalized at 9.0 inches per head. The animals were vaccinated against IBR, PI_3, blackleg, malignant edema, enterotoxemia and pasteurella multocida and hemolytica and were wormed and treated for grubs and lice.

Complete mixed rations were fed once daily with a mixer-feeder truck equipped with electronic scales. The high moisture barley was removed from the silo and rolled just prior to feeding and the dry barley was ground. Performance and feed consumption data during the initial 4-week period, during which they were changed from a high roughage to a high grain ration, are included in the data for these studies. Once on full feed, the cattle were fed 3.0 lb of alfalfa haylage dry matter per head daily and barley *ad libitum*.

Uniform fields of Larker barley were harvested in alternate strips to obtain the high moisture and dry barley. The high moisture barley was stored in a 14 x 40 oxygen-limiting silo equipped with a chain type bottom unloader.

The compositions of feedstuffs for Trial I are shown in Table 1. With the exception of the moisture content of the high moisture barley which was about 30%, the feedstuffs for Trial II are not completely analyzed at this time.

Table 1. Dry Matter, Crude Protein and Crude Fiber Contents of Feedstuffs.

Feedstuff	Dry matter, %	Crude protein, % of dry matter	Crude fiber, % of dry matter
Alfalfa haylage[a]	51.7	16.6	35.3
Barley, dry[b]	88.3	13.4	6.1
Barley, high moisture	60.5	12.8	6.7

[a] First crop
[b] Weight of 47.5 lb/bu

Results and Conclusions

Trial 1

1. No statistically significant differences in performance or carcass characteristics of cattle occurred due to type of barley. However, an advantage of 0.08 lb of gain per day (2.32 vs. 2.24) 65 lb less feed/100 lb of gain and carcass grades were in favor of the cattle fed high moisture barley (Table 2).

2. Considerable bloat problems were encountered in cattle fed dry barley. Bloat occurred on the dry barley-slatted floor treatment about 2 months after the cattle were on full feed. One steer on this treatment became a chronic bloater about December 1. On December 23, three steers showed bloat. A poloxylene premix was mixed in the feed at the rate of 1 oz. per head for 4 days and then discontinued. Two days later four different steers showed bloat, with one requiring treatment. Poloxylene was then put into the feed for that group of cattle. One ounce of poloxylene premix per head daily was required to completely control bloat under these conditions.

   Four weeks later (Jan. 18), bloat occurred in three steers in the conventional barn-dry barley treatment. When they again required treatment for bloat three days later the cattle in that lot were also fed poloxylene premix at 1 oz. per head daily for the remainder of the trial. The occurrence of bloat in the dry barley-conventional barn treatment indicated that limited straw and exercise did not prevent bloat on a dry barley-alfalfa haylage finishing ration.

3. No cases of bloat occurred in cattle fed high moisture barley in the slatted floor or the conventional barn.

4. No founder occurred on any of the treatments. It must be pointed out that the standard procedure used at the Northwest Experiment Station to bring cattle up to a full feed of barley from a 5-lb of barley per head growing ration or warm-up ration is to increase the barley at the rate of 1/2 pound per head daily. This change-over requires 3 to 4 weeks but apparently helps to eliminate the approximately 10% founder on dry barley rations reported in the field. Field reports indicate that founder is greatly reduced on high moisture barley rations. In these two studies, dry and wet barleys were increased on a dry matter equivalent basis, thus no information was obtained on the reported ease of putting cattle on feed when feeding high moisture barley.

5. Some difficulty was encountered in rolling barley at 40% moisture. The rolled barley would freeze to the rollers at temperatures below zero. The roller mill was housed in a relatively small unheated enclosure. Heat lamps were used to warm up the rolls on days when temperatures were between zero and -35°F. This problem could be alleviated with use of a semi-heated silo-feed room enclosure.

   At 40% moisture barley particles also tended to build up behind the rolls on this particular roller mill with only fair factory built scrapers. In addition to requiring frequent cleaning out, this task was difficult because it was not designed to be cleaned out.

Considerably less difficulty with freezing on rollers and buildup behind the rolls occurred with the 30% moisture barley used in the 1973-74 season. A different roller mill has been purchased for subsequent rolling of high moisture barley.

6. High moisture barley from 30-40% moisture is a very palatable feed and no difficulty was encountered in feeding 40% moisture barley in very cold weather. High moisture barley is also much less of a problem than dry barley in rainy weather because animals do not seem to notice a little extra wetness caused by rain. Care should be taken to keep feed fresh and not let material build up and get moldy in harder to reach spots in the bunk such as corners.

7. High moisture barley is very pleasant to process and feed with no dust or barley particles blowing around. It also requires much less handling from field to animal.

Trial 2

1. Cattle fed high moisture barley gained 0.3 lb more per head daily (2.74 vs. 2.44) than those fed dry barley (Table 3). Summarization of feed consumption and feed conversions have not been completed and no statistics have been run yet.

2. As in Trial 1, bloat again became a problem in cattle on the dry barley treatments after about 2 months on the trial. Bloat appeared in the conventional barn and slat barn essentially at the same time and in about the same frequency. Closer observation and individual treatment, as necessary, were used throughout this trial, whereas in Trial 1 poloxylene was used to control bloat on a group basis after it became a problem. During the last 2 weeks haylage was decreased to 1.5 lbs of dry matter daily with complete alleviation of bloat on the dry barley ration. In another recent trial, reducing the haylage dry matter to 1.5 lbs per head did not decrease incidence of bloat on a haylage-dry barley ration.

3. No bloat occurred on the high moisture barley treatments.

4. No founder occurred on any of the treatments.

Other trials in which high moisture barley was used as all or part of the ration on a routine basis:

1. In 1971-72, high moisture barley was used as the barley source in an alfalfa haylage-barley ratio study utilizing 40 head of steers with no incidence of bloat.

2. Also in the 1971-72 season, no bloat occurred when 2/3 of the barley in the diet was high moisture barley fed with 3.0 lb of alfalfa haylage to all 130 head of steers and heifers on the steer-heifer x housing trial.

3. During the current feeding season no bloat occurred in the 52 beef steer calves fed a ration containing 30% alfalfa haylage dry matter, 35% high moisture barley and 35% dry ground barley.

4. Corn silage also appears to be excellent for controlling bloat in cattle on dry barley growing and finishing rations.

Table 2. Performance of Yearling Steers Fed Dry or High Moisture Barley and Housed in a Conventional Pole Shed or in an Open Confinement Slatted Floor Barn. (October 2, 1972 to February 26, 1973--147 days).

Item	Type of housing / Type of barley	Conventional Dry	Conventional High Moisture	Slatted floor Dry	Slatted floor High Moisture
No. steers		28[a]	29	28[b]	29
Initial weight, lb		735.3	734.0	734.3	739.1
Final weight, lb[c]		1086.7	1096.6	1039.6	1056.8
Avg daily gain, lb[c]		2.39[d]	2.47[d]	2.08	2.16
Avg daily feed, lb of dry matter					
Barley		15.20	14.26	14.10	13.86
Haylage		5.14	4.87	4.85	4.75
Supplement[e]		0.89	0.89	0.89	0.89
Total		21.23	20.02	19.84	19.50
Feed/100 lb gain, lb of dry matter					
Barley		636	578	679	641
Haylage		215	197	234	220
Supplement[e]		37	36	43	42
Total		888	811	956	903
Carcass grade[f]		12.0	12.0	11.9	12.2

[a] One steer accidentally killed during bloat treatment.
[b] One steer removed from trial because of chronic bloating, midway in the trial.
[c] Adjusted to a dressing percentage of 61.71.
[d] Cattle fed in conventional housing gained significantly ($P<.01$) faster than those housed in the slatted floor unit.
[e] Composition of the supplement was ground dry barley 79%, trace mineral salt 10%, ground feeding limestone 10%, and Vit ADE premix 1% which supplied 15,000 IU of Vitamin A and 5,000 IU Vitamin D per head daily.
[f] High good = 11; low choice = 12; average choice = 13; high choice = 14.

Table 3. Performance of Yearling Steers Fed Dry or High Moisture Barley and Housed in a Conventional Pole Shed or in an Open Confinement Slatted Floor Barn. (October 19, 1973 to February 20, 1974--124 days).[a]

Item	Type of Housing / Type of Barley	Conventional Dry	Conventional High Moisture	Slatted Floor Dry	Slatted Floor High Moisture
No. steers		25	25	24[b]	25
Initial weight, lb		819	818	818	820
Final weight, lb[c]		1157	1187	1088	1131
Average daily gain, lb		2.72	2.97	2.17	2.51
Carcass grade[d]		11.6	11.3	10.8	11.2

[a] Feed consumption and feed efficiency data have not been completely processed and statistics have not been run on average daily gains at this date.
[b] One steer removed from trial Jan. 15 because of a twisted abomasum.
[c] Adjusted to a dressing percentage of 60.7.
[d] High good = 11; low choice = 12; average choice = 13; high choice = 14.

GENERAL COMMENTS ON THE MERITS OF ALFALFA HAYLAGE

by Harvey F. Windels
Northwest Experiment Station

The Northwest Experiment Station routinely uses alfalfa haylage as the basic roughage in rations for beef, sheep and dairy.

The major advantages of haylage over hay are as follows:

1. Lower field losses in harvesting (25% for hay and 14% for haylage) (Table 1). Most reports indicate a 25-50% field loss for making hay. The 50% figure would take into account the often or occasional complete loss of portions of a crop.

2. Since forage material only needs to be dried to about 50% moisture, haylage harvesting can generally begin earlier without nearly as much regard to weather conditions. This results in better quality and greater total tonnage (three crops instead of two crops in northern Minnesota). Generally speaking the only conditions that will completely hold up haylage making are heavy rains and wet ground.

3. With equal seriousness of effort it is much easier to make good haylage than it is to make good hay.

4. Less labor is required to harvest forage as haylage and the work is much easier.

5. Feeding can be more readily mechanized.

6. Basically because of the change to a haylage system at the Northwest Experiment Station, the dairy herd and the sheep flock numbers have doubled and feeder beef have increased about 10-15 fold since 1955 with about the same amount of labor.

7. Haylage mixes well with grains in the mixer-feeder truck. Haylage does not blow around as much as chopped hay and it also dampens dry grain enough to reduce wind loss from the bunks.

8. All of the material fed is consumed. Animals that are full-fed hay pull out and tramp on about 25% of it and/or won't eat the stems. Hay made from coarse mature alfalfa will hardly be consumed, whereas, the same material put up as haylage will be eaten without waste. When using haylage in experimental rations there is no weighback.

Critical management considerations in making haylage:

1. Size of operation and kind of harvesting equipment (use smaller and less sophisticated equipment on smaller operations).

2. Moisture level should not be under 40 or over 55% for oxygen-limiting silos and not under 45 or over 65% moisture for concrete stave silos. If moisture exceeds about 60%, the material will be silage and not haylage. Alfalfa silage, if real wet, may not be palatable, may actually spoil, has a very offensive odor in barns and will freeze. Preservatives are not needed for making haylage within the proper moisture level. We have found that the Koster crop dryer (a moisture tester) is an essential piece of equipment for making good haylage.

3. Obtain a good chop so it will pack well. Packing and oxygen exclusion determine the amount of heating and consequently the quality of haylage. In a study conducted by the Animal Science Department at the University of Minnesota, St. Paul, haylage was made with and without packing in seal-vac plastic silos. The digestible protein was greatly reduced in the poorly made heated haylage (Table 2).

4. Beet tops ensile well in tower silos but great difficulty is encountered in getting the material out and it is very hard on the unloading equipment.

Table 1. Harvesting and storage losses and feeding value of alfalfa-brome stored in three forms and fed to beef calves (1970)1/

	Hay (13% moisture)	Haylage (52% moisture)	Alfalfa silage (60% moisture)
Average daily gain, lb	1.24	1.17	1.04
DM loss harvesting	25.4	14.6	12.4
DM loss storage	5.0	7.5	11.0
Beef gain/acre, lb	442	473	442

1/ El Serafy, et al. Animal Science, University of Minn., St. Paul, 1971 Beef Research Report B-156.

Table 2. Influence of heat damage on haylage quality.1/

	Control haylage	Heated haylage
Crude protein	19.0	18.7
Crude fiber	22.6	21.7
Digestion coefficient	70.8	43.0
Digestible protein	13.5	8.0

1/ Pierson, et al. Animal Science, Univ. of Minn., St. Paul, 1971 Beef Research Report B-155.

HAYLAGE IN BEEF RATIONS

by H. F. Windels
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1. High quality haylage is an excellent forage for feeder beef because of its high protein and TDN; however, if fed with dry barley, there are some limitations and cautions to be followed because of the possibility of bloat:

   a. Haylage can be fed with high moisture barley in the finishing rations without danger of bloat.

   b. In growing rations haylage should be fed in combination with corn silage to prevent bloat and to take full advantage of the high protein content of good haylage.

   c. Perhaps the haylage should be 50:50 alfalfa-brome if fed alone or with dry barley.

2. Haylage is at least equal to hay in feeding value and results in greater yield per acre (Tables 1, 2, 3). Good winter gains are obtained on hay or haylage when supplemented with about 5.0 lbs of barley per head daily.

3. It did not appear necessary to feed hay with haylage as is usually recommended with corn silage (Tables 4, 5). It is possible that the addition of hay to haylage-dry barley rations may reduce bloat and increase gains at high cattle densities in light of the fact that we often use alfalfa-grass hay to treat animals with borderline bloat. However, reportedly bloat occurs frequently on alfalfa hay-dry barley rations.

4. We recently conducted a two-year study to compare the performance of Holstein and Angus x Hereford steers fed high or medium haylage levels in barley finishing rations. Although the steers performed somewhat better on the medium haylage rations (2.94 vs. 2.74), they also did quite well on the high haylage ration and would have required about two extra weeks of feeding to reach equal weight and grade (Table 6).

5. Newly weaned beef calves are usually fed alfalfa-grass for a few days after arrival because they are generally more accustomed to hay and it allows better observation for scours and coccidiosis associated with shipping fever and other stresses. Calves are gradually switched to haylage or haylage-corn silage mixtures.

6. Pre-weaned calves and yearlings are fed mixed hay for one or two days and then switched to a warm-up ration of one-half corn silage and one-half haylage by weight plus a couple pounds of hay per head daily for three or four days.

Table 1. Harvesting and storage losses and feeding value of alfalfa-brome stored in three forms and fed to beef calves (1970)[1/]

	Hay (13% moisture)	Haylage (52% moisture)	Alfalfa silage (60% moisture)
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[1/] El Serafy, et al. An. Sci., Univ. of Minn., St. Paul, 1971 Beef Research Report B-156

Table 2. Alfalfa haylage vs. alfalfa hay for growing beef cattle. (132 days) 1964-65. Northwest Experiment Station.

	Haylage	Hay
No. steers	14	14
Initial wt., lb	557	557
ADG, lb	2.33	2.14
Daily feed intake (DM), lb	17.4	16.3
Feed/gain (DM)	745	765

a) Haylage 1st crop (55% DM); hay 2nd crop.
b) Grain fed at 4.5 lb/head/day for first 84 days and 9.0 lb/head the next 48 days.

Table 3. Alfalfa haylage vs. alfalfa hay for growing beef cattle. (168 days) 1965-66. Northwest Experiment Station.

	Haylage	Hay
No. steers	22	22
Initial wt., lb	465	465
ADG, lb	1.97	1.87
Daily feed intake (DM), lb	15.3	15.1
Feed/gain (DM)	778	808

a) Haylage 1st crop (65% DM); hay 1st crop same field.
b) Grain fed at 5.0 lb/head/day for first 112 days and 7.5 lb/head/day the next 56 days.

Table 4. Alfalfa haylage fed with and without alfalfa hay to growing beef cattle. (125 days) 1966-67. Northwest Experiment Station.

	Haylage	Haylage + 2 lb hay
No. steers	10	10
Initial wt., lb	471	474
ADG, lb	2.15	1.96
Daily feed intake (DM), lb	15.8	15.2
Feed/gain (DM)	692	727

a) Haylage was 1st crop (64% DM); hay 3rd crop.
b) Barley fed at 5.0 lb/head daily.

Table 5. Alfalfa haylage fed with and without alfalfa hay to growing beef cattle. (136 days) 1967-68. Northwest Experiment Station.

	Haylage	Haylage + 2 lb hay
No. steers	20	20
Initial wt., lb	469	469
ADG, lb	2.03	1.94
Daily feed intake (DM), lb	15.1	14.9
Feed/gain (DM)	739	765

a) Haylage was 1st crop; hay 2nd crop.
b) Barley fed at 4.5 lb/head/day.

Table 6. Alfalfa Haylage : Barley Ratios for Dairy and Beef Steers, 1970-72. Northwest Experiment Station.[a]

	Beef Crossbreds		Holsteins	
	High Haylage	Medium Haylage	High Haylage	Medium Haylage
No. of steers	20	20	20	20
Days fed	147.5	147.5	179.5	179.5
Avg. daily gain, lb	2.86	3.08	2.61	2.79
Avg. daily feed, DM				
Barley	6.6	10.2	7.7	11.8
Haylage	14.1	10.1	14.0	9.1
Supplement	0.9	0.9	0.9	0.9
Total	21.6	21.2	22.6	21.8
Feed/100 lb gain DM	765	704	878	790
Carcass grade[b]	12.0	12.3	10.2	10.8

[a] 1972 Beef Research Report B-179
[b] Average good = 10, high good = 11, low choice = 12

HAYLAGE FOR SHEEP

Harvey F. Windels
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1. Haylage works extremely well in sheep rations.

2. Haylage can be full-fed without any feed being wasted, whereas, under similar conditions much hay would be wasted.

3. On a full-feed of good alfalfa hay sheep often bloat because they eat all the leaves and tops first. We have never had a sheep bloat on haylage.

4. Haylage serves as an excellent carrier for gain in complete mixed rations. Crowding at the feed bunk is minimal with complete mixed rations compared to feeding a pound or two of grain alone in bunks. It also saves one feeding operation.

5. Cautions in the use of haylage for sheep:

   a. They must be limit-fed at about 3 to 4 lbs of dry matter per head daily, depending on the quality of haylage and size of ewes, during the dry period and first half of gestation or they will get too fat.

   b. It also appears that during the last month of gestation ewes will eat too much and those carrying multiple fetuses could rupture if allowed a full-feed of haylage.

   We basically feed 3.0 lb of haylage dry matter and 1 lb of barley during the last 3-4 weeks of gestation and this is divided into a morning and afternoon feeding. After each ewe has lambed, it goes back on once-a-day feeding.

6. Nursing lambs begin eating haylage before grain and will eat about 1.5 lb of haylage and 1.5 lb of grain creep feed by 9-10 weeks of age.

7. Feedlot lambs can be fed haylage and grain in a complete mixed ration once daily.