PROCEEDINGS

2014 Idaho Hay and Forage Conference

Best Western Burley Inn, Burley, Idaho
27-28 February, 2014

IDAHO HAY AND FORAGE ASSOCIATION, INC.
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Welcome
to the
Idaho Hay & Forage Conference

Burley, Idaho, 27-28 February 2014

On behalf of the planning committee, we welcome you to this gathering of the state's leaders in alfalfa and forage production. This conference will start with an emphasis on alfalfa and forage crop management and conclude on the second day discussing corn and other forages. Our objectives are to: 1) extend research information; 2) provide continuing education on forage irrigation, export markets; forage pests, weeds, and diseases; new markets and genetics, organic forage production, and corn grasses, and silage issues; 3) learn from producers and consumers about effective ways of producing and using forages; 4) give an opportunity to the forage-related industries to provide information about equipment, products, and services they can provide; and 5) provide opportunity for the Idaho Hay & Forage Association to inform everyone about regulatory, political, and business issues affecting agriculture.

We express our appreciation to the speakers who provide this excellent program and proceedings. These people have generously taken the time to share their knowledge with you. We are also thankful to the many sponsors and exhibitors of the conference. Their contributions have made it possible to keep registration fees low and provide a quality program!

This is truly a cooperative effort between the Idaho Hay & Forage Association, the forage industry, and the University of Idaho Extension System.

Welcome to the Idaho Hay and Forage Conference!

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We also express our appreciation and thanks to the following sponsors and exhibitors of the conference. Their contributions have made it possible to keep registration fees low and provide a quality program.

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Table of Contents

Thursday, February 27, 2014

Friday, February 28, 2014

HAY STORAGE LOSSES

Glenn E. Shewmaker[1]

ABSTRACT

The effects of several months storage of hay was studied to quantify changes in forage quality parameters. The acid detergent fiber (ADF) increased from 2.7 to 5.3% from initial to final points across all hays. The change in neutral detergent fiber (aNDF) was inconsistent for the 4 hays. The RFV index did not change in the alfalfa/grass mix hay, but declined by 14, 21, and 11 units in the other 3 alfalfa hays. The NDF digestibility in 48 hours (NDFD48, as % of NDF) declined an average of 2.9% across the 4 hays. The net energy for lactation (NE/Lact), digestible dry matter, relative feed value (RFV), and relative forage quality (RFQ) declined about the same magnitude across the 4 hays. Lignin, an indigestible fiber fraction, increased an average of 4.3% across the 4 hays. This paper documents the changes of hay quality in storage.

Keywords: Alfalfa, *Medicago sativa*, hay storage, forage quality loss

INTRODUCTION

Hay loses weight (mass) and degrades in quality with the passage of time. The magnitude of storage losses is not well recognized by hay producers due to the difficulty of measurement. Harvested hay must be stored properly to minimize further degradation. Even in barn storage, shrinkage during several months is typically from 5 to 10% weight loss from fresh-baled hay, about 5% in dry matter loss and the remainder in moisture. Moisture content will reach an equilibrium level in relation to relative humidity. Hay moisture will stabilize at about 10% in arid climates, and about 15% in humid climates. The external surfaces of bales on sides of stacks can reach 19% moisture during winter. Several factors affect the storage and preservation of high-quality hay: forage species, maturity, harvest management, and storage management. Weathering effects: sunlight, heat, and precipitation, can be controlled with storage facilities, preservation materials, and proper storage management.

A study was conducted in 2013-2014 to quantify changes in forage quality parameters over a several month period. This paper provides information about the causes of hay losses in storage and how management can minimize the losses.

METHODS

Two first-cutting and two second-cutting hay stacks were sampled by coring 10 bales on each side of stack at chest height. Stack A was first cutting alfalfa/orchard grass 50%/50% mixture in 3ft x 4ft x 8ft bales with a tarp on top. Stack B was first cutting alfalfa hay in 4ft x 4ft x 8ft bales. Stack C was second-cutting alfalfa hay in 4ft x 4ft x 8ft bales with a tarp on top. Stack D was second-cutting alfalfa hay 4ft x 4ft x 8ft bales, with elevated pad and tarps on the bottom, sides and top. Coring was done with a Star Quality Probe (0.5in diameter) to a depth of 14 inches in the butt end of bales: initial (soon after baling and stacking), mid-storage, and final. A composite cored sample, 20 from each stack, was mixed, sealed in plastic bags, and submitted for grinding. Subsequent cores were extracted from the same bales about 6 inches from the previous core. Samples from each sampling site and date were dried for at least 1 hour at

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150°F (65°C) and ground through a 1-mm screen in a Udy Cyclone mill before quality analysis by near infrared reflectance spectroscopy by AgSource Laboratories, Jerome, ID. Prediction equations for crude protein (CP), neutral detergent fiber (NDF), and neutral detergent fiber digestibility (NDFD) were calibrated by wet chemistry. Prediction equations for other measurements were provide by AgSource Laboratories

Caution! Since this was a case study the analysis is based on limited numbers of samples, analysis of variance statistical tests are not appropriate. The reader is cautioned to not assume the results are statistically significant. Stack B had 4 points on a time series, so the data were satisfactory for linear regression analysis. This is preliminary data and we intend to continue the study in 2014.

The sampling and laboratory error, assumed to be 5%, is used to estimate errors for several of the primary forage quality parameters in Table 1. The standard laboratory error for near infra-red reflectance spectroscopy (NIRS) analysis determined by Marten et al. (1989) is also given in Table 1. If the change in parameter values from this study is greater than the potential error for sampling and laboratory analysis, or the SLE listed in Table 1, there is some assurance the change is significant.

Table 1. Potential sampling and laboratory error in forage quality analysis. The standard laboratory error (SLE) for NIRS was determined by Marten et al. (1989).

Forage quality parameter	**Concentration, %**	**@ 5% error**	**SLE**
Crude protein (CP)	20	1	0.6
Acid detergent Fiber (ADF)	30	1.5	1.2
Neutral detergent fiber (NDF)	40	2	1.5
Relative Forage Value (RFV)	160	8	

RESULTS AND DISCUSSION

Initial moisture concentrations were all below 8%, probably because of very dry baling conditions and limited precipitation during most of the storage period. Crude protein was lower in stack A (Table 2) than other stacks because the hay was 50% grass. Crude protein in stack A increased 2.1units from initial to final storage, but the 3 other stacks did not change for crude protein (Tables 3, 4, and 5).

Table 2. Forage quality parameters at beginning, mid, and ending points of storage. This stack was first cutting 3ft x 4 ft x 8 ft bales of alfalfa/grass (50%/50%) mixture baled on 30 June 2013 and stacked (tarp) on 1 July 2013. Concentrations are expressed as a percent of dry matter unless otherwise indicated.

Stack A 1st Cutting Alfalfa/Grass Mix	**Initial**	**Mid**	**Final**	**Absolute Change**
Assays by NIR	**7/1 /2013**	**7/9 /2013**	**12/14 /2014**	**In 166 d**
Moisture as received, %	7.8	7.5	6.5	-1.30
Dry matter as received, %	92.2	92.5	93.5	1.30
Crude protein, %	14.6	15.0	16.7	2.10
Heat Dame. Protein, %	0.6	0.6	0.7	0.10
Acid Det. Fiber (ADF), %	35.2	34.5	37.9	2.70
aNDF, %	46.3	45.9	44.7	-1.60
Ash, %	9.20	9.20	8.50	-0.70
Fat, %	1.30	1.20	1.00	-0.30
Lignin, %	5.7	7.1	8.1	2.40
48HR dNDF	20.2	20.9	18.5	1.8
NDFD48, % of NDF	43.7	45.6	41.3	-2.40
Calculations				
Adj. Crude Protein, %	14.6	15.0	16.7	2.10
NE/LACT, MCAL/LB	0.61	0.62	0.58	-0.03
Dig. Dry Matter, %	61.5	62.0	59.4	-2.10
Relative Feed Value	124	126	124	0.10
Rel. Forage Quality	120	126	123	2.80
Crude Fiber, %	27.8	27.3	29.9	2.10
TDN EST., %	54.9	55.4	55.7	0.80
Lignin as % NDF	12.3	15.5	18.1	5.80

The acid detergent fiber concentration (ADF) increased from 2.7 to 5.3% from initial to final points across all hays. The change in neutral detergent fiber (aNDF) was inconsistent for the 4 hays. The RFV index did not change in the alfalfa/grass mix hay, but declined by 14, 21, and 11 units in the other 3 alfalfa hays. The NDF digestibility in 48 hours (NDFD48, as % of NDF) declined an average of 2.9% across the 4 hays. The net energy for lactation (NE/Lact), digestible dry matter, relative feed value (RFV), and relative forage quality (RFQ) declined about the same magnitude across the 4 hays. Lignin, an indigestible fiber fraction, increased an average of 4.3% across the 4 hays.

Table 3. Forage quality parameters at beginning, mid, and ending points of storage. Stack B was first cutting 4ft x 4 ft x 8 ft bales of alfalfa baled and stacked (no-tarp) on 14 June 2013. Concentrations are expressed as a percent of dry matter unless otherwise indicated.

Stack B 1st Cutting Alfalfa	**Initial**	**Mid1**	**Mid2**	**Final**	**Absolute Change**
Assays by NIR	**6/14 /2013**	**7/24 /2013**	**11/7 /2013**	**1/28 /2014**	**in 188 d**
Moisture as received, %	7.2	7.0	8.3	7.4	0.2
Dry matter as received, %	92.8	93.0	91.7	92.6	-0.2
Crude protein, %	17.2	17.9	17.7	18.1	0.9
Heat Damaged Protein, %	0.5	0.5	0.4	0.6	0.1
Acid Det. Fiber (ADF), %	32.1	31.3	34.7	36.2	4.1
aNDF, %	39.7	38.6	39.9	39.8	0.1
Ash, %	10.2	10.3	12.1	9.50	-0.7
Fat, %	1.80	1.80	1.3	1.70	-0.1
Lignin, %	3.2	3.8	6.8	5.1	1.9
48HR dNDF	17.2	16.9	16.2	15.2	-2.0
NDFD48, % of NDF	43.2	43.9	40.5	38.1	-5.2
Calculations					
Adj. Crude Protein, %	17.2	17.9	17.7	18.1	0.2
NE/LACT, MCAL/LB	0.65	0.66	0.6	0.60	-0.1
Dig. Dry Matter, %	63.9	64.5	61.9	60.7	-3.8
Relative Feed Value	150	156	144	142	-13.6
Rel. Forage Quality	144	151	133	134	-17.0
Crude Fiber, %	25.4	24.7	27.4	28.6	3.9
TDN EST., %	57.7	58.5	57.3	57.2	-1.3
Lignin as % NDF	8.06	9.84	17.0	12.8	3.0

Table 4. Forage quality parameters at beginning, mid, and ending points of storage. Stack C was second cutting 4ft x 4 ft x 8 ft bales of alfalfa baled on 27 July 2013 and stacked (tarp) on 29 July 2013. Concentrations are expressed as a percent of dry matter unless otherwise indicated.

Stack C 2nd Cutting Alfalfa	**Initial**	**Final1**	**Final2**	**Final (avg)**	**Absolute Change**
Assays by NIR	**7/29 /2013**	**1/23 /2014**	**1/23 /2014**	**1/23 /2014**	**in 147 d**
Moisture as received, %	6.6	7.1	7.0	7.1	0.5
Dry matter as received, %	93.4	92.9	93.0	93.0	-0.5
Crude protein, %	20.8	20.9	20.7	20.8	0.0
Heat Damaged Protein, %	0.6	0.7	0.8	0.8	0.2
Acid Det. Fiber (ADF), %	30.2	35.0	35.9	35.5	5.3
aNDF, %	36.8	38.3	40.7	39.5	2.7
Ash, %	11.0	9.3	8.7	9.0	-2.0
Fat, %	1.70	1.50	1.10	1.3	-0.4
Lignin, %	3.0	5.5	4.4	5.0	2.0
48HR dNDF	14.5	13.9	17.0	15.4	0.9
NDFD48, % of NDF	39.4	36.3	41.7	39.1	-0.4
Calculations					
Adj. Crude Protein, %	20.8	20.9	20.7	20.8	0.0
NE/LACT, MCAL/LB	0.67	0.62	0.61	0.6	-0.1
Dig. Dry Matter, %	65.4	61.6	60.9	61.3	-4.2
Relative Feed Value	165	150	139	145	-20.8
Rel. Forage Quality	149	138	140	139	-9.6
Crude Fiber, %	23.9	27.7	28.4	28.1	4.2
TDN EST., %	60.9	59.6	59.2	59.4	-1.5
Lignin as % NDF	8.15	14.4	10.8	12.6	4.5

Final 1 and 2 samples from stack C (Table 4) are duplicate NIR analyses of the same composite core sample. Note that there are some differences in parameter values even in a 1-gram ground sample. This demonstrates the normal analytical variation, which is usually smaller than sampling variation.

Table 5. Forage quality parameters at beginning, mid, and ending points of storage. Stack D was second cutting 4ft x 4 ft x 8 ft bales of alfalfa baled and stacked on 24 July 2013 and tarped underneath, sides, and top. Concentrations are expressed as a percent of dry matter unless otherwise indicated.

Stack D 2nd Cutting Alfalfa	**Initial1**	**Initial2**	**Initial (avg)**	**Final**	**Absolute Change**
Assays by NIR	**7/24 /2013**	**7/24 /2013**	**7/24 /2013**	**1/28 /2014**	**in 189 d**
Moisture as received, %	5.6	6.0	5.8	5.9	0.1
Dry matter as received, %	94.4	94.0	94.2	94.1	-0.1
Crude protein, %	18.8	17.6	18.2	19.8	1.6
Heat Damaged Protein, %	0.6	0.5	0.6	0.6	0.0
Acid Det. Fiber (ADF), %	34.0	31.7	32.9	37.1	4.3
aNDF, %	41.1	39.1	40.1	41.0	0.9
Ash, %	10.8	10.2	10.5	9.60	-0.9
Fat, %	1.60	1.90	1.8	1.50	-0.3
Lignin, %	4.6	3.3	4.0	5.6	1.7
48HR dNDF	17.0	16.1	16.6	15.4	-1.2
NDFD48, % of NDF	41.5	41.1	41.3	37.5	-3.8
Calculations					
Adj. Crude Protein, %	18.8	17.6	18.2	19.8	1.6
NE/LACT, MCAL/LB	0.63	0.65	0.6	0.59	-0.1
Dig. Dry Matter, %	62.4	64.2	63.3	60.0	-3.3
Relative Feed Value	141	153	147	136	-11.0
Rel. Forage Quality	132	142	137	127	-10.3
Crude Fiber, %	26.9	25.0	26.0	29.3	3.4
TDN EST., %	58.4	58.1	58.3	58.2	0.0
Lignin as % NDF	11.2	8.44	9.8	13.7	3.9

Rate of Change

Stack B showed some consistent trends in assayed forage quality parameter changes (Figure 1). The crude protein did not change significantly. A small amount of crude protein was likely degraded, however, since the soluble carbohydrates (sugars and starch) are used by microbial respiration, ADF and lignin increase in concentration. Although the absolute amount of protein may decline a little the loss of total dry matter results in the concentration of crude protein slightly increasing. Although NDF did not change, ADF increased 0.0243% each day of storage (r^2=0.89). In other words, the number of days of storage explained 89% of the variation in ADF concentration. Lignin increased 0.035% each day of storage (r^2=0.63). Although laboratory measurement and prediction by NIR of lignin is not precise, even small changes in lignin have a large impact on digestibility.

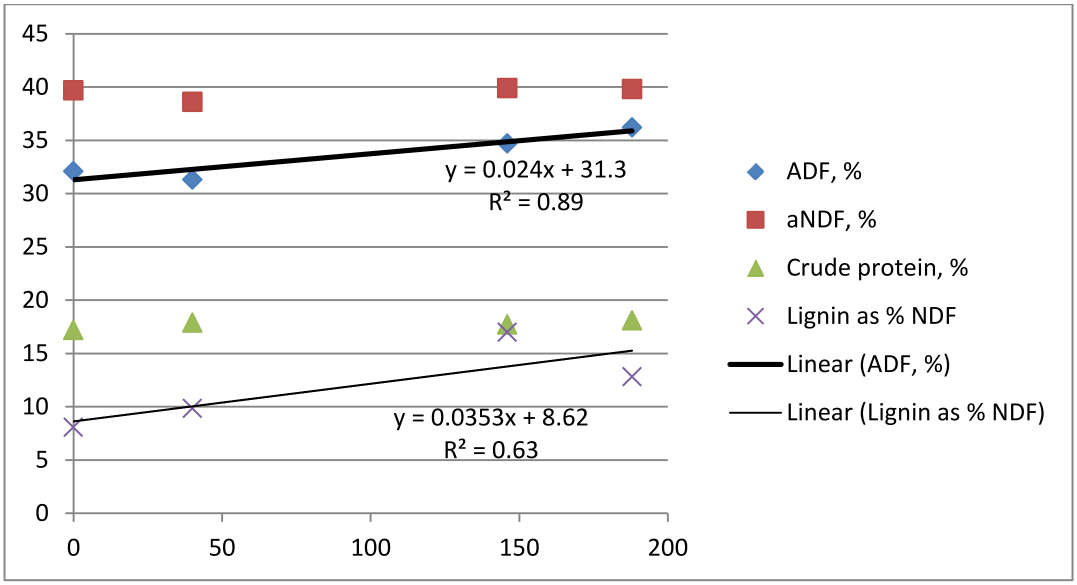

Figure 1. Rates of change of assayed forage quality parameters of stack B.

Stack B also showed consistent trends in calculated or predicted forage quality parameters (Figure 2). Relative Feed Value (RFV) declined -0.057 index points for each day of storage (r^2=0.69). Relative Forage Quality (RFQ) declined -0.080 index points for each day of storage (r^2=0.72). The estimated Total Digestible Nutrients (TDN) did not change much.

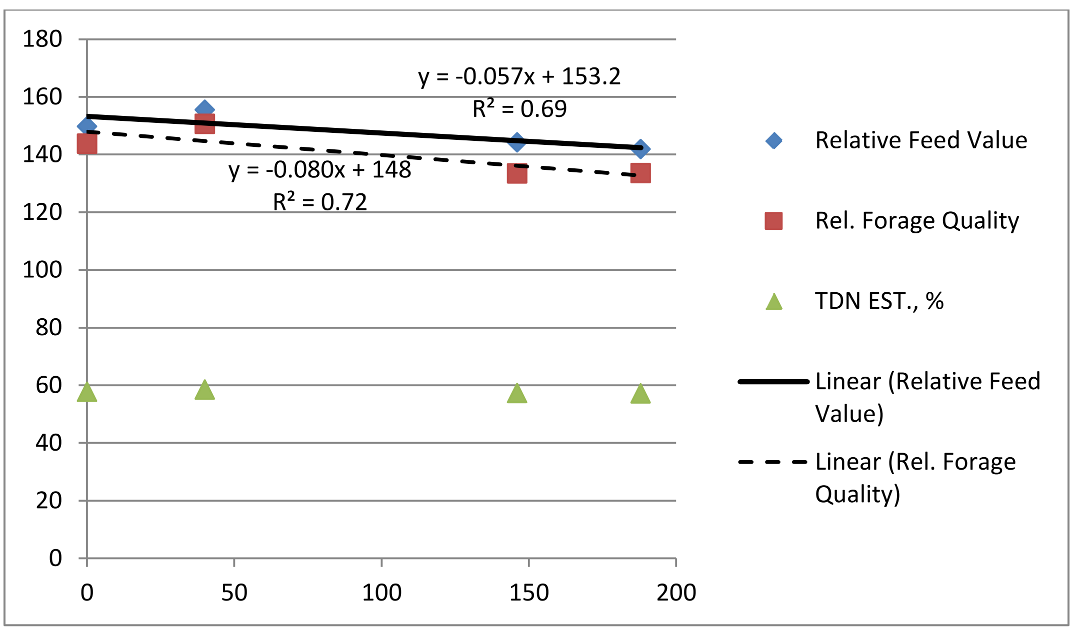

Figure 2. Rates of change of calculated forage quality parameters of stack B.

SYNTHESIS OF THE LITERATURE

Moisture Effects on Tonnage and Quality

Hay with less than 15% moisture is relatively stable and little respiration occurs. Alfalfa hay baled at 16% moisture can be expected to lose 3.5% of its dry matter (mass) in four months. Anderson et al. (1981) showed that storage dry matter losses average three percent of harvested dry matter weight for indoor storage and 14 percent for outside storage. Rotz and Abrams (1988) reported changes in untreated alfalfa hay during 6-months storage were 5% dry matter loss in hay baled from 11 to 20% moisture. Losses are greater--up to 10% loss of dry matter--in hay baled at higher moisture levels. Alfalfa hay baled at 16% moisture and stored as a stack outside on the ground for 6 months in Pennsylvania lost 11.3% of the initial dry matter (Nehrir et al. 1978). Hay baled at 13% moisture with high leaf shatter will not decrease in quality as much as hay baled at 20% moisture with little leaf shatter.

Higher moisture provides a significant opportunity for mold growth and other micro biotic activity. In hay containing more moisture, microbial respiration causes the hay to heat during the first 3 to 5 weeks of storage. The amount of heating and the associated loss increase with moisture content. Dry matter losses during the first month of storage vary from 1% in hay of 15% moisture to 8% in 30% moisture hay (Nelson, 1966, 1968; Rotz et al., 1991). Although a major portion of the loss may occur in the first month, a small loss of about 0.5% DM per month continues throughout storage even in dry hay (Rotz et al., 1991).

Small rectangular hay bales are likely to develop visible mold when baled with moisture levels above 20%. Large round or rectangular bales are likely to develop mold at when baled at 18% moisture. Large rectangular bales (1/2 to 1 ton) should have moisture levels less than 16% if no preservatives are used to minimize dry matter loss.

Weathering Effects

Dry matter losses can be as low as 3% for hay stored in a barn or as high as 15% for similar bales stored outside on soil or sod surface over winter. Quality losses can be as high as 14% for bales stored outside. Solid plastic-wrapped bales that are ensiled may lose from 10 to 25% of dry matter and quality.

Moisture content of bales stored outside on soil without covers increases sharply during storage. The outer 2 to 3 inches of the bale may increase in moisture by as much as 120%. A 1-inch rain adds about 20 gallons of water to a 4-foot x 8-foot bale surface. Weathering begins slowly, but once a wet layer forms, a bale does not shed water well and moisture levels inside the bale are likely to continue to increase. The wet, moldy area on the top of the bale deepens, and less drying occurs between rains. The best strategy is to prevent weathering initially and to limit exposure of hay to weathering as much as possible.

Weathering can also occur from the ground. Dry hay touching damp soil or concrete draws moisture into the bale. If hay and soil are in contact up to 50% of total dry matter loss in storage may be in the bottom bale(s). Russell and Huhnke (1997) reported different storage conditions and compared them to barn storage (Table 6). Only 87% of digestible dry matter is conserved when stacked outside, on the ground, and uncovered compared with barn storage.

Table 6. Conservation of dry matter and digestible dry matter (DDM) in hay with barn storage compared to outside stacks. Source: Russell and Huhnke 1997.

	Percentage of barn storage	
Storage method	**DM, %**	**DDM, %**
Barn	100	100
Ground, no cover	91.3	87.3
Drained surface	97.6	93.2
Plastic cover on tops	96.8	96.4
Drained surface + plastic cover	99.7	101.4
Net wrap	98.5	
Plastic sleeve	99.4	
Pyramid stack + plastic cover	96.3	

Climatic Factors and Outside Storage

High humidity slows drying of stacked wet hay. Warm, humid, and overcast conditions favor microbial growth in hay. Cold, arid, and sunny conditions are unfavorable to microbial growth in hay. Well-ventilated conditions are also conducive to hay drying. Frequent precipitation is more damaging than the same amount of precipitation coming all at once.

Heating and Forage Quality Losses

Heating may occur when bacteria, molds, and other microbes use some of sugars and starches in hay for their own growth and reproduction. Respiration causes a low amount of dry matter (DM) and nutrient loss to continue during hay storage (Wilkinson and Hall, 1966; Wood and Parker, 1971). Hay moisture is far below the 40% level, so plant enzymatic activity is very low (Honig, 1979). Minor heating occurs in dry hay stored under cover and DM loss over 6 months of storage is about 5% (Collins et al., 1987; Rotz and Abrams, 1988; Rotz et al., 1991c). Similar loss occurs with either large round bales or small bales stored in a shed (Collins et al., 1987). Hay stored outside and unprotected experiences additional loss of 10 to 15% in round bales from weathering of hay on the exposed surface.

Respiration reduces forage quality by removing some of the most digestible nutrients. This causes an increase in proportions of acid detergent fiber (ADF) and neutral detergent fiber (NDF) in the hay. Hay tonnage and quality decrease after storing in a stack. Anderson et al. (1981) studied the effect of weathering on hay quality (Table 7). Total crude protein content declines with time, but the concentration may increase due to the loss of soluble carbohydrates (sugar and starch) to the microbes. However, as microbial respiration heats the hay, the usable protein becomes much less because of the browning (Maillard) reaction. Severe browning reactions occur when mold growth heats the hay above 100 degrees F, and amino acids and sugars combine to form insoluble nitrogen forms. A by-product of heating is caramelization and production of a tobacco-like odor. Cows like the taste or aroma so they eat the forage well but are unable to utilize many of the nutrients.

Table 7. Forage quality of interior and exterior portions of alfalfa round bales stored outside. The ADF refers to acid detergent fiber and IVDDM refers to *in vitro* digestible dry matter. Source: Anderson et al. 1981.

Portions of bales	Crude protein	ADF	IVDDM
	---------------------- % of dry weight ----------------------		
Interior	18.9	38.6	61.4
Exterior	19.4	45.8	46.9

Hay Storage Recommendations

- Position uncovered stacks to take advantage of prevailing winds to blow snow off top bales and to dry them. A north-south position is usually best, but stacks should also be positioned up and down slope, or have a good drainage system.
- Allow at least three feet between stack rows. Stacks too close can become a trap for livestock.
- For stacks that are not covered, a single row is best.
- Separate stacks of 100 tons by at least 50 feet so that if fire starts the loss will be minimal. Check with your insurance company for their criteria on hay stack coverage.
- Stack yards should be well drained. An elevated rock pad of 1 to 3-inch rock is best.
- Mesh covering (net wrapping) of round bales will reduce the weathering effects on bales, stabilize the hay better than twine, but costs more than twine.

The best situation for marketing hay is to sell the hay in the field at its best quality and pass the storage and management costs on to the buyer. If a grower wants to speculate on a rising hay market, one must consider the added storage costs of dry matter and quality loss--and these are considerable.

SUMMARY

- Storage results in dry matter losses, lowered forage quality, and reduced feed intake and utilization.
- The more valuable the hay, the easier it is to justify spending time and money to improve storage conditions.
- If barn or shed storage is not available, place stacks in sunny, breezy locations, on an elevated pad of rock, and cover stacks with tarps.
- Well-formed, tight bales, and the proper moisture content will minimize storage loss.

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GRASS AND LEGUME VARIETIES IN IDAHO

Jonathon M. Hogge[1], John B. Hall, Glenn E. Shewmaker, and Greg Blaser

ABSTRACT

Sixty-two percent of Idaho's land area produces forage, including approximately 47 percent of the states acreage suitable for crop production. In addition, domestic and wild animals graze much of Idaho's forested land. Forage production is a critical requirement for over 2 million cattle in the state. Irrigation is essential for large-scale production of alfalfa, legumes and grass hay production. Conservative estimates indicate that by managing irrigated grass and legume pastures their production could be doubled from current production models. Forages support Idaho's and neighboring states' livestock industries and, among all farm commodities, grass, legume pastures and alfalfa hay rank second only to potatoes for on-farm cash value and total value of production.

Grass and Legume Varieties Under Irrigation

Pastures are remarkable places. They beautify the landscape, protect soil from erosion, capture carbon to reduce greenhouse gases, release oxygen for us to breathe, produce feed for livestock, and provide habitat for wildlife. Ecologically diverse, well-managed pastures are relatively resistant to the scourges of diseases and insects, and they seldom need chemical inputs to control weeds. What more could we want? Forages provide most of the digestible nutrients for Idaho livestock. They are the main and most economical source of energy (carbohydrates) in livestock rations and a vital source of necessary protein, minerals, and vitamins for the production of meat, milk, and wool. Most of Idaho's hay, pasture, and rangelands produce far below their forage potential. Conservative estimates indicate per-acre production of hay and animal products could be doubled using improved plant species and management techniques. Good management of many irrigated forages in Idaho can result in per-acre yields exceeding 1,000 pounds of beef, 18,000 pounds of milk, or 8 tons of hay. In addition to producing food for livestock and wildlife, grasses and legumes protect soils from wind and water erosion. Their roots help hold the soil in place and improve its structure and rate of water intake. Their fibrous root systems improve soil tilth and fertility by contributing to soil organic matter. Legumes biologically fix atmospheric nitrogen for their own use and contribute nitrogen to other plants in the community or to subsequent crops grown in rotation. The use of forage grasses and legumes in rotation can reduce the incidence of insect and disease infestations in rotated crops.

The following is a list of the grasses and legumes that are currently being studied for their growth potential their forage yield and for their forage quality. The (NIRS) Near Infrared Reflectance Spectrophotometer instrument is being used to determine the forage quality. An example of the quality date will include the crude protein, acid detergent fiber, fat, lignin, net energy, and relative feed value just to name a few.

List of Grasses and Legumes:

Orchard grass, Smooth Brome, Quack grass, White Clover, Red Clover, Reed Canary Grass, Tall Fescue, Sanfoin, Birds Foot Trefoil, Cicer Milk Vetch, Creeping Foxtail, Meadow Brome.

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SCIENCE AND FOOD POLICY MYTHS

Peter J. Ballerstedt[1]

The 2010 Dietary Guidelines for Americans recommends restricting our intake of saturated fat to less than 7 percent of calories, and our cholesterol intake to less than 300 mg per day (less than two eggs). They promote the use of low-fat milk and lean meat, and the use of "meat substitutes" in school lunches. These recommendations are consistent with the official dietary policy that began in 1977 with the release of the first Dietary Goals for the United States by the United States Senate Select Committee on Nutrition and Human Needs. These guidelines were not justified by the then-available science. They were adopted despite the concerns of researchers and physicians. Subsequent research has disproven the hypothesis upon which they were based. They have failed to produce the promised benefits. Since animal products are a significant source of saturated fat and cholesterol, the official advice has been to limit the consumption of animal products in general and red meat in particular. At best animal products have been wrongly accused and unfairly impacted by public policy; at worst vast physical and fiscal harm has been done to the American public.

INTRODUCTION

A thorough discussion of diet, health and human nutrition is beyond the scope of this paper. The comprehensive review by Taubes (2008) is highly recommended. Rather, this will be a brief examination of the dietary cholesterol and saturated fat recommendations.

In 1977 the United States Senate Select Committee on Nutrition and Human Needs chose one side of an on-going scientific debate. They endorsed the unproven diet-heart hypothesis, which proposed that the excessive consumption of fat in our diets – particularly saturated fats – raises serum cholesterol levels and so causes atherosclerosis, heart disease, and untimely death (Taubes, 2008). That decision was antithetical to the then-mainstream paradigm of the fattening carbohydrate, since low fat diets are higher in carbohydrates by definition. Ultimately, the goal of all dietary policy became reducing heart disease, and what was good for the heart must be good for every other diet-related matter. Thus an unproven hypothesis became the unquestioningly accepted basis for dietary recommendations for over a generation. The 2010 Guidelines, the "federal government's evidence-based nutritional guidance to promote health, reduce the risk of chronic diseases, and reduce the prevalence of overweight and obesity," (USDA, 2011) continues to maintain this position. The USDA's admission that despite their dietary advice, "more than one-third of children and more than two-thirds of adults in the United States are overweight or obese." (USDA, 2011) suggests the need for a thorough re-evaluation of the diet-heart hypothesis. A brief examination of the effect of dietary cholesterol upon serum cholesterol levels, and the relationship between saturated fat and coronary heart disease will demonstrate that this hypothesis was not true and that advice to limit the consumption of animal products is groundless.

DISCUSSION

At the time of the Committee's decision there was a vigorous scientific debate about the diet-heart hypothesis. "Two strikingly polar attitudes persist on this subject, with much talk from each and little

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listening between." (Blackburn, 1975). Three years later, the year after Dietary Goals was released, Thomas Dawber wrote: "It must still be admitted that the diet-heart relation is an unproved hypothesis that needs much more investigation." (Dawber, 1978). Indeed, the Committee didn't even know if their recommendations would work. The first entry on their list of "Important questions, which are currently being investigated" was "Does lowering the plasma cholesterol level through dietary modification prevent or delay heart disease in man?" (Senate Committee, 1977) Available research suggested it would not.

Two Columbia University biochemists had demonstrated in 1937 that dietary cholesterol has little or no influence on serum cholesterol (Rittenberg, Schoenheimer, 1937). This finding has never been refuted. For most individuals, the effect of following the recommendation would be "clinically meaningless." (Howel et al., 1997). Nevertheless, we are still advised to eat less cholesterol because "telling people they should worry about cholesterol in their blood but not in their diet has been deemed too confusing" (Taubes, 2008). Lowering serum cholesterol by replacing saturated fat with polyunsaturated fats had produce mixed results. Such cholesterol lowering interventions occasionally reduced heart disease mortality, but they increased cancer mortality (Dayton et al., 1969), so there was no decrease in total mortality. More deaths were recorded in the intervention group of one study, but the results went unreported for 16 years (Franz et al., 1989), because "we didn't like the way it turned out." (Taubes, 2008). This relationship between low cholesterol and increased cancer mortality has been repeatedly observed (Feinleib, 1983).

Ironically Ancel Keys, the father of the diet-heart hypothesis, reported seven years after the Guidelines were released that neither high cholesterol nor saturated fat consumption predicts total mortality (Keys et al, 1984). Keys later recanted the idea that dietary cholesterol raises blood levels: "Cholesterol in food has no effect on cholesterol in blood and we've known that all along." "I've come think that cholesterol is not as important as we used to think it was," he said, "Let's reduce cholesterol by reasonable means, but let's not get too excited about it." (Boffey, 1987).

Just when the Committee was forming the guidelines that would shape the eating habits of every American, the first reports on Low Density Lipoprotein (LDL) cholesterol and High Density Lipoprotein (HDL) cholesterol were emerging from the Framingham, San Francisco, Puerto Rico, Albany and Honolulu cohort studies. They demonstrated that: Total cholesterol does not predict future heart disease; LDL cholesterol is a "marginal risk factor;" HDL cholesterol is a 4-fold better predictor of risk than LDL cholesterol and the only reliable predictor of risk for men or women over 50. It was demonstrated that saturated fat raises HDL cholesterol while carbohydrates lower it (Castelli et al, 1977, Gordon et al, 1977). It was reported in 1981 that saturated fat and total fat were positively associated with longevity (Gordon et al, 1981, Feinleib, 1981).This information would not deter policy makers from labeling saturated fat "artery-clogging" and that carbohydrates were "heart-healthy diet food." The 2010 Guidelines, still state that "Healthy diets are high in carbohydrates." (USDA, 2010)

The basis for recommending low-fat and low-saturated fat diets has been further disproven by recent research. Meta-Analyses on "Reduced or modified dietary fat for preventing cardiovascular disease" found no effect on longevity, and no "significant effect on cardiovascular events." (Hooper et al, 2001). An analysis of "Multiple risk factor interventions for primary prevention for coronary heart disease" demonstrated that "The pooled effects suggest multiple risk factor intervention has no effect on mortality." (Ebrahim et al. 2006) The Women's Health Initiative failed to prove several frequently-stated dietary myths, although policy hasn't been affected. "The intervention did not reduce risk of CHD or stroke." (Howard et al. 2006) "A low-fat dietary pattern did not result in a statistically significant reduction in the risk of invasive breast cancer..." (Prentice et al. 2006). "There is no evidence that a low-fat dietary pattern intervention reduces colorectal cancer risk..." (Beresford et al. 2006). "A low-fat dietary pattern among generally healthy postmenopausal women showed no evidence of reducing diabetes risk..." (Tinker et al. 2008). Prior to the release of the 2010 Guidelines, the FAO stated that "The available evidence from cohort and randomized controlled trials is unsatisfactory and unreliable to make judgment about and substantiate the effects of dietary fat on risk of CHD." (FAO, 2010, Skeaff, Miller, 2009). And in 2010 "A meta-analysis of prospective epidemiologic studies showed that there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of CHD or CVD." (Siri-Tarino et al 2010) Yet the recommendations to restrict total fat and saturated fat consumption continue.

Substantial evidence has accumulated that these recommendations are in fact harmful. "The low-fat, high-carbohydrate diet, promulgated vigorously ... by the USDA food pyramid, may well have played an unintended role in the current epidemics of obesity, lipid abnormalities, type II diabetes, and metabolic syndromes." (Weinberg, 2004).

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DRIP IRRIGATION OF ALFALFA

Jerry D. Neufeld[1]

INTRODUCTION

The Treasure Valley of Idaho produces many diversified and specialized crops. The primary irrigation systems are furrow and sprinkler irrigation. Imperfect irrigation often results in loss of crop yield and quality through water stress, or excessive irrigation that favors diseases. Irrigation induced erosion causes sediment, phosphate, and temperature contamination in surface waters and deep percolation causes nitrate contamination in groundwater. For these and other reasons, in recent years there has been increased interest in using drip irrigation on Treasure Valley crops.

Some of the most advanced irrigation technology is drip irrigation. Drip irrigation is the slow, frequent application of small amounts of water to the soil through emitters located on a delivery line placed either on top of, or beneath the soil surface. Drip allows for highly productive crop production without leaching or runoff. Only the amount of water needed by the crop on a daily, or other very frequent basis need be diverted from a stream or reservoir, thus helping to protect water quality.

BENEFITS OF DRIP IRRIGATION

- Increased water and nitrogen use efficiency
- Reduced water percolation through the root zone
- Reduced runoff from the tail end of gravity irrigated fields
- Reduced evaporation from the soil surface
- Increased water distribution uniformity throughout a field
- Reduced energy usage
- Reduction of moisture stress to plants

In my view, two of the greatest benefits of drip irrigation are increased water and nitrogen use efficiency (WUE and NUE). In unpublished research conducted from 2003 to 2007, I was able to demonstrate an increase in NUE and WUE in drip irrigated Treasure Valley onion fields as compared to furrow irrigated onion fields. Over the five year period of this project, the furrow irrigated fields averaged 46.9 inches of applied water per acre, while the drip irrigated fields received an average of 30.1 inches of water per acre, a difference of nearly 17 inches. The furrow irrigation system produced an average of 22.3 Cwt of onions per inch of applied irrigation water while the drip irrigation system produced an average of 33.1 Cwt per inch of applied water. In the same study, the drip irrigated onion fields were more efficient in the use of nitrogen. Over the five years of this project, the furrow irrigated onions received an average of 275 pounds of nitrogen per acre (0.52 lbs N/Cwt) while the drip irrigated onions received an average of 162 pounds of nitrogen per acre (0.42 lbs N/Cwt).

LIMITATION OF DRIP IRRIGATION

- High initial investment cost with a smaller recurring annual cost
- Steep learning curve compared to other irrigation systems

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- Additional novel equipment is required to convert to drip irrigation
- Initial drip irrigation design and service is highly recommended
- Drip tape recycling for annual systems is burdensome
- Gophers can cause significant damage to the system when used for perennial crops

Drip irrigation also has some drawbacks, it is not for everyone. If you choose to install a drip system for some of your crops you must make sure to take proper care of the system to insure its long term viability. If you plug the emitters on a drip system, there are not many options available for fixing it. As you irrigate, you will most likely need to treat your irrigation water to lower the pH. This can usually be done with acid based fertilizers. You will need to flush fine sediment from the system on a regular basis so the emitters do not become plugged. You will need to monitor the flow rates and pressures regularly to insure the system is performing the way it was designed. If these, and other measures, are not adequately addressed it is likely your experience with drip irrigation will be troublesome.

DRIP IRRIGATION IN ALFALFA SEED

In the spring of 2001 an eight acre subsurface drip irrigation (SDI) system consisting of two four acre blocks was installed in a one year old alfalfa seed field in Canyon County. Ten mil dripperline was shanked into the field to a depth of approximately 12 inches on 44 inch centers. Emitters in the tape were 18 inches apart and delivered 0.36 gallons of water per hour per emitter. The water source was groundwater filtered with sand media filters.

Water use and yield data were collected from the SDI field in 2001 and 2002. In 2001, 8.5 inches of water was applied to the SDI field, and in 2002 10.9 inches of water was applied to the SDI field. During the same years, a furrow irrigated field of alfalfa seed received between 30 to 35 inches of water. In 2001, the clean seed yield was 880 pounds per acre on the SDI field and 820 pounds per acre on the furrow irrigated field. Seed yield in 2002 on the SDI field was 1018 pounds of seed. Two years of system operation show that SDI uses water very efficiently in alfalfa seed. In this project we maintained seed yields while using considerably less water than with furrow irrigation.

As mentioned earlier, gophers can cause significant damage to drip systems in perennial crops, especially alfalfa. In the spring of 2002 the drip system had many leaks caused by overwintering gophers. Many hours of repair work was required to fix approximately 150 gopher strikes to the drip tape. Additionally, the water distribution uniformity of the system and ultimately seed yield were negatively impacted by the gophers.

DRIP IRRIGATION IN ALFALFA HAY

In the summer of 1995, an SDI system consisting of 18 plots was installed and planted to alfalfa hay at Lovelock, Nevada. Nine plots on one end of the field were irrigated with dripperline placed at 18 inches in depth and spaced 36 inches apart. Individual emitters were 24 inches apart along the dripperline with each emitter having a flow rate of 0.62 gallons per hour. Nine plots on the other end of the field were established using the same materials and spacing except the tape was placed at a 12 inch depth (Figure 1). Three irrigation treatments of 75, 100 and 125 percent of measured evapotranspiration (ET) were randomly located within each side of the SDI field.

Irrigation with the SDI system was scheduled weekly based on readings taken at the field from an ET Gage Atmometer. An atmometer is an irrigation scheduling device designed to estimate evapotranspiration from the canopy of an alfalfa crop. Readings were taken every few days and then averaged over the time period between two readings to estimate the daily ET rate. The daily ET rate was then multiplied by 0.75, 1.00, and 1.25 respectively to determine irrigation application rates. The flow rates were determined for each set of six plots and an irrigation controller was programmed to apply the correct amount of water for each treatment. Plots were irrigated twice daily starting at 6:00 a.m. and 6:00 p.m.

The SDI system was shut down before yield samples were taken at harvest and remained off until the producer removed the bales from the remaining plot area. Yield samples were taken with a plot-harvesting machine three times a year prior to each cutting. The area sampled was taken from the center of each plot and was 3' wide and 20' long. The forage from the plot was immediately raked and weighed. Grab samples from each plot were bagged to determine moisture percentage of each sample by drying in a soil oven at 105 degrees Fahrenheit for 24 hours.

Maintenance operations on the system were performed after startup in the spring, after each cutting, and at shutdown in the fall. To reduce the growth of algae in the system, the pH of the water was first lowered to approximately 5.0 with sulfuric acid during each maintenance operation. Then, twelve percent chlorine was injected downstream of the acid injection point at a concentration of 50 parts per million total chlorine (ppm). This solution was allowed to fill the system and then flushed out after about 12 hours. The irrigation clock was then reprogrammed to start irrigating again. In late October just before the system was shut off for the winter, Treflan herbicide was injected into the system to stop root intrusion into the emitters, then all above ground equipment was drained and the laterals were blown out with compressed air.

Water Use Efficiency

Jensen and Miller (1988) conducted a study near Wadsworth, Nevada during the 1984 and 1985 growing seasons and determined that required ET rates ranged from 6.1 to 8.4 inches to produce a ton of alfalfa. Wadsworth is located approximately 60 miles southwest of the Lovelock in a similar climatic zone, making direct comparisons of water use efficiencies meaningful. WUE values on the SDI plots ranged from 1.94 to 6.65 inches per ton (rainfall included) over the 1997 growing season (Figure 2). In 1998 WUE values ranged from 2.33 to 6.08 inches of water per ton (Figure 3). The control plot wasn't included in the WUE comparisons because we weren't able to accurately quantify the amount of applied water. In both years of this study the cooperating grower used his full allotment of 3 acre-feet per acre on the control plot.

The publication entitled "Evaluation of Empirical Methods for Estimating Crop Water Consumptive Use for Selected Sites in Nevada" (1980) shows the historical amount of pan evaporation from April to the end of September is approximately 31.6 inches at Lovelock. In the same publication the Modified Penman and Blaney Criddle ET estimates are 36.7 and 41.8 inches respectively for the same time period. During the 1997 growing season, 27.9 inches of water was applied to the 125 percent ET plots, 22.5 inches was applied to the 100 percent ET plots, and 18.5 inches was applied to the 75 percent ET plots. In 1998 these values were 26.8, 22.8, and 18.6 (Figure 4). The data shows that SDI maintained acceptable production while using less water than estimated ET cited in the literature or the normal water allotment of 36" per year in the PCWCD.

Yield

The average alfalfa yield in Nevada in 1997 was 4.5 tons per acre and the average yield in Pershing County during the same time period was 5.2 tons per acre (Nevada Agricultural Statistics, 1997-98). Average yields in the SDI plots for 1997's three cuttings ranged from 7.45 to 8.07 tons per acre and the

Control plot yield was 6.80. Average yields in the SDI plots for 1998's cuttings ranged from 5.83 to 6.71 tons per acre and the Control plot was 5.83 (Figure 5). All yield values are based on a zero percent moisture basis. Nearly the entire difference in the average yields between 1997 and 1998 is attributable to the first crop of 1998. That crop received excessive rainfall and consequently had a reduced yield. Yield reductions for the first cutting of 1998 ranged from 37 to 63 percent less than the first cutting of 1997. The average precipitation from April to September at Lovelock is 2.66 inches. In 1997, precipitation at Lovelock was 2.20 inches and in 1998 Lovelock's precipitation was 11.43 inches for this time period. The precipitation amounts from May, June and July of 1998 are records that still stand today. In fact, the control plots were not even irrigated for the first cutting of 1998.

CONCLUSION

Drip irrigation is used on a variety of crops in the Treasure Valley because of the benefits it provides. Water use efficiency and other benefits found in Treasure Valley crops are consistent with research results reported in Nevada. However, in most Treasure Valley drip irrigated fields drip tape is installed in the spring and taken out in the fall prior to harvest. There are a few applications where drip irrigation is being used in perennial crops. Even though data demonstrates the benefits of drip irrigation in alfalfa hay and alfalfa seed, the gopher strikes occurring during the winter months are a very serious problem. There are some products that can be injected into the drip system to repel gophers during the growing season, but there is nothing available for use during the winter months when the most damage occurs. Until the gopher damage problem is resolved, using drip irrigation on perennial crops such as alfalfa hay or alfalfa seed is not recommended.

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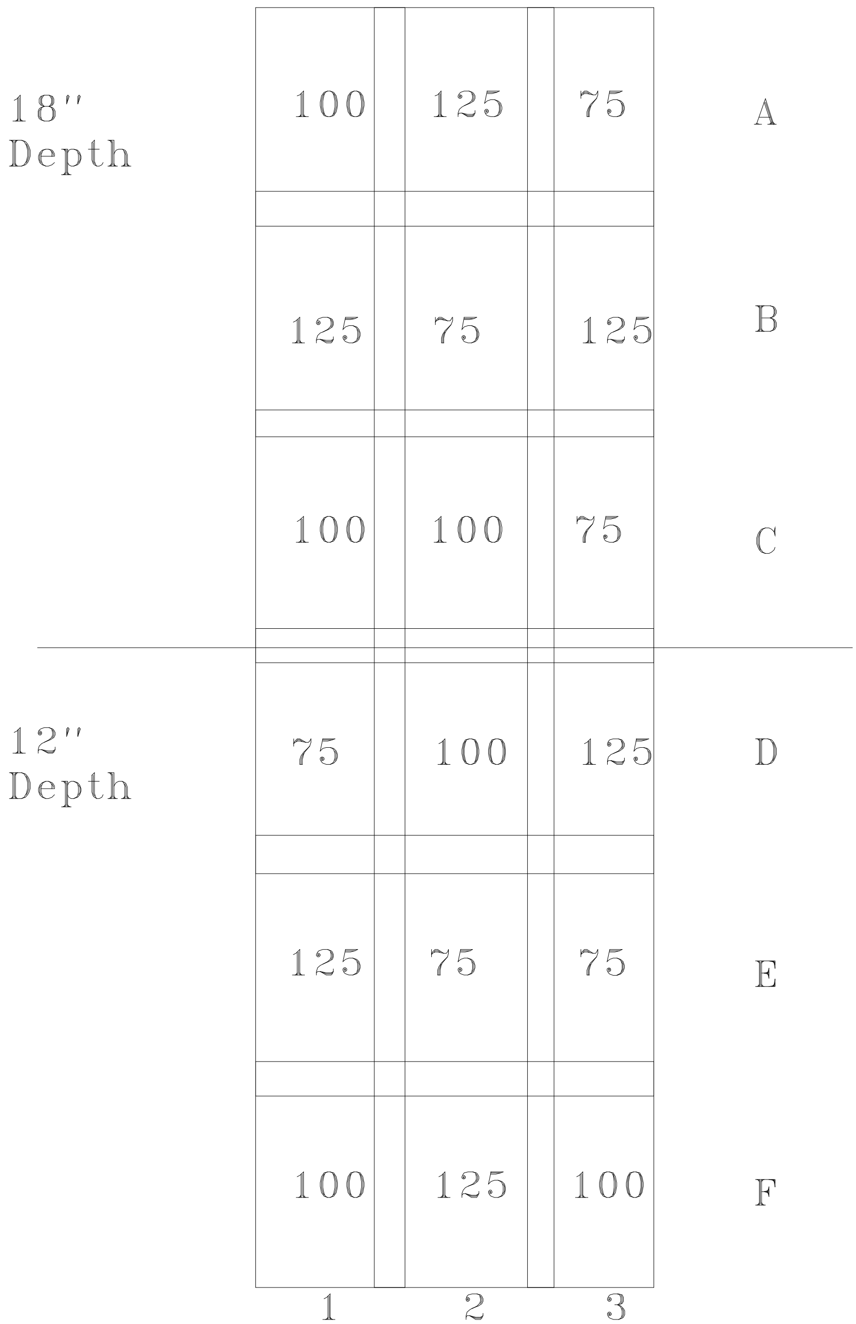

Figure 1. Plot diagram for subsurface drip irrigation of alfalfa at Lovelock, Nevada.

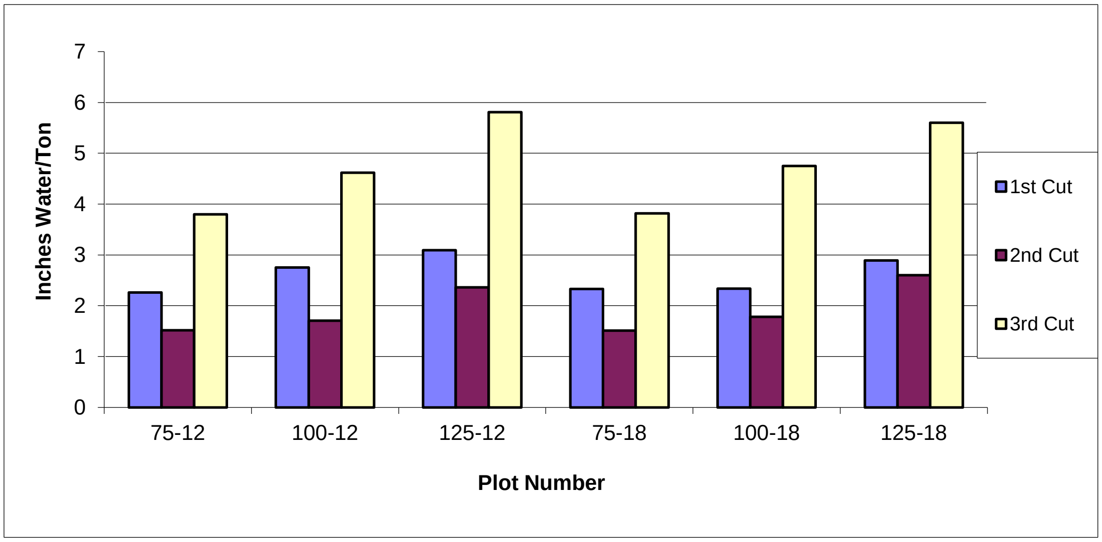

Figure 2. Amount of water used to produce one ton of alfalfa in the SDI plots in 1997 (rainfall included).

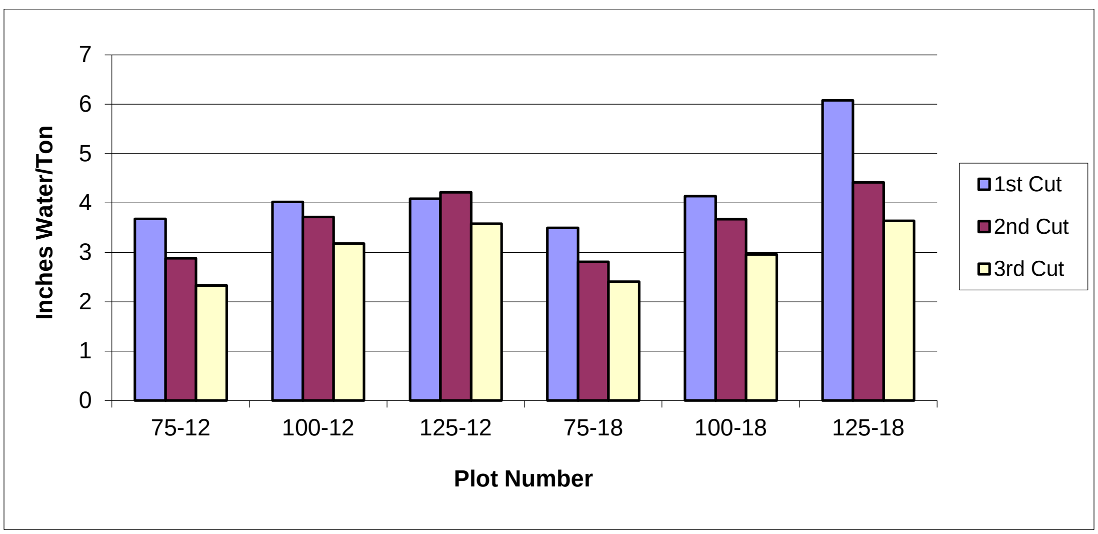

Figure 3. Amount of water used to produce one ton of alfalfa in the SDI plots in 1998 (rainfall included).

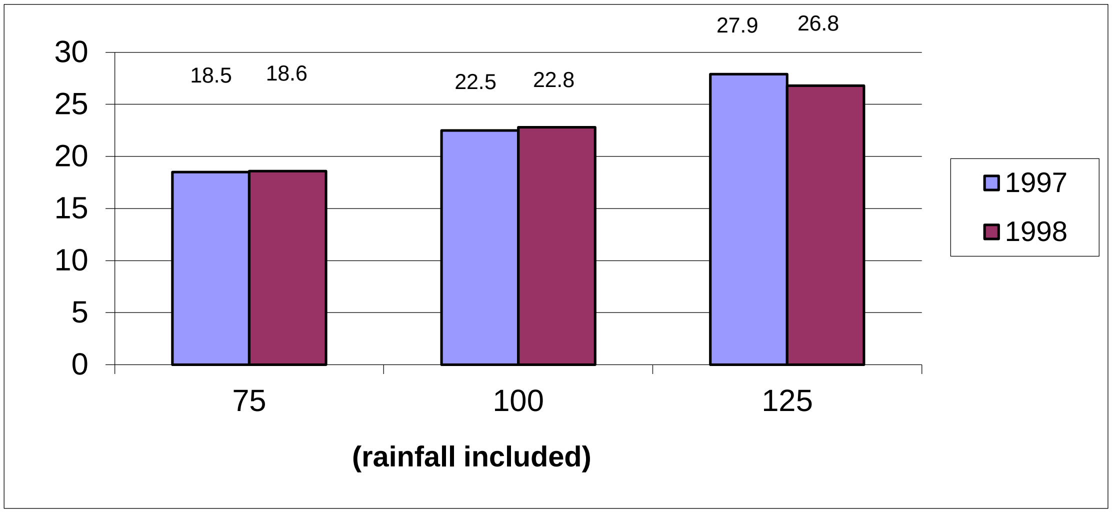

Figure 4. Total water applied to SDI plots in 1997 and 1998 (rainfall included).

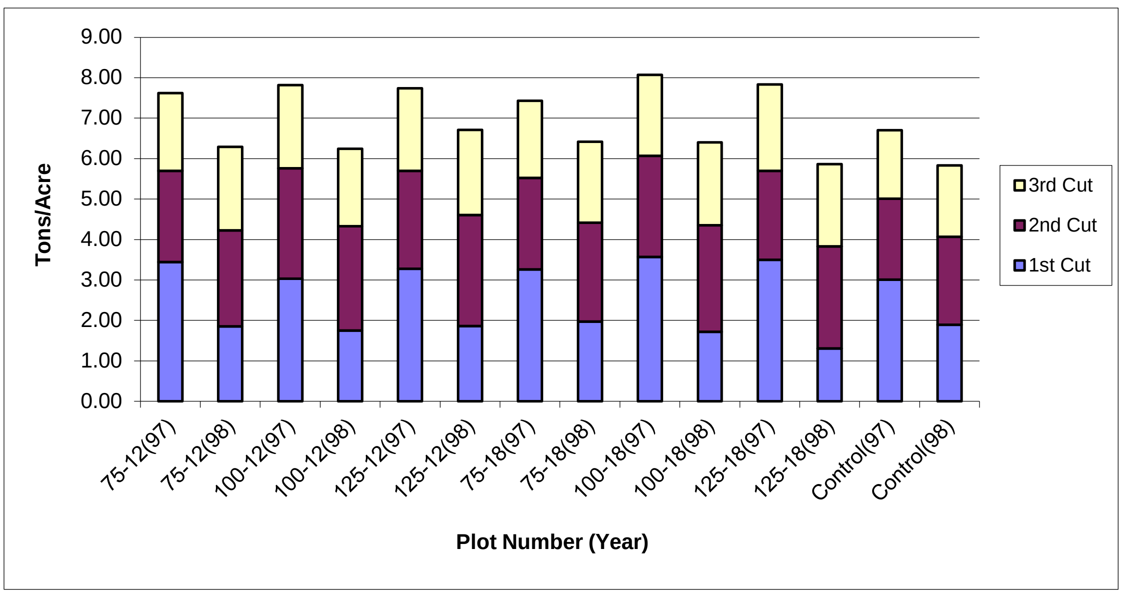

Figure 5. Yield totals for the SDI and control plots for the three cuttings of 1997 and 1998. 0 percent moisture basis.

IRRIGATION MANAGEMENT
IN FORAGE PRODUCTION – LIMITED WATER SUPPLY CONDITIONS

Howard Neibling[1]

ABSTRACT

Water management and irrigation system maintenance can help maximize forage production with a limited water supply. Currently reservoir storage is low, giving little carryover water to augment a potentially short snow year. Although recent storms have increased snowpack, given low reservoir carryover and the uncertainty of forecasting future snow accumulation, this looks like a year to carefully manage early-season irrigation and perform needed system maintenance.

Keywords: irrigation, irrigation water management, irrigation system maintenance, forage

Water Management

Alfalfa and corn benefit from adequate early-season soil moisture. In alfalfa, adequate water as the crop is breaking dormancy leads to more early vigor and plant growth. In Southern Idaho, each inch of water applied before first cutting will produce about 510 lbs of hay per acre, with production of about 400 lbs per acre for each inch of irrigation after first cutting (yields on a Dry Matter basis). Early season water stress in corn, particularly around V6-V7 stages will reduce ear size and number of kernels per ear. The other critical crop stage where stress significantly reduces yield is during pollination.

A new University of Idaho publication "Center Pivot Irrigation for Corn: Water Management and System Design Considerations in Southern Idaho" by Steve Hines and Howard Neibling is available at the new University of Idaho drought website: www.uidaho.edu/extension/drought. This publication discusses a number of design and management ideas to better use limited water. Most of the system design ideas apply equally well to either corn or alfalfa.

Irrigation System Maintenance

A study conducted by University of Idaho personnel for Idaho Power in 2012 measured the number and size of different types of leaks and the degree of nozzle wear in sprinkler irrigation systems. Over 30 set system lines were tested. Average measured water lost to pipe, sprinkler and drain valve leaks in wheel lines was 14% of the line design flow. Losses for hand lines were even higher.

Flow from over 900 sprinkler heads was also measured. Individual nozzle discharge for an older line needing maintenance and a line with nearly new sprinkler heads is shown in Figure 1. Note the variability in the older system and the degree of excess nozzle flow. Excess line flow due to worn or incorrect nozzle size averaged 13% of design flow. Average excess energy use due to incorrect nozzle size or worn nozzles on the systems tested was 151kWh/acre.

To put this in perspective, consider a 1300 foot line on 40x50 spacing (50-foot moves) which would cover about 1.5 acres per set. If this line was moved 10 times per irrigation, the total area covered would

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be 15 acres. Assume 10 feet of lift from a pond, system pressure of 60 psi, and pumping plant efficiency of 65% (average of a large number of systems tested in the Magic Valley) The system operates for 1500 hours per year, with water losses due to leaks of 21 gpm (about 14% of system capacity). At $0.079/kWh electricity cost (average 2014 irrigation rate per Idaho Power source), the average cost per line of the extra water pumped due to leaks would be $107 per year. Adding in the cost of pumping extra water due to worn nozzles of $97 (19 gpm or 13% average loss) /line per irrigation, the average total cost of leaks and worn nozzles for the lines tested would be $204/line per year. The total excess water pumped (about 27% of design flow) represents a great deal of water applied in locations in excess of what was needed. This typically leads to local areas of nitrate loss to leaching, areas of fungal disease initiation, and a large amount of water that could be used effectively somewhere else when water supply is short.

Growing season cost per acre for 40 gpm loss to leaks and worn nozzles (average of measured lines) for 1000 and 2000 hours of yearly operation, poor (60%) and good (80%) pumping plant efficiency, and lifts for pumping from a pond (10 and 20 foot lift) and deep well turbine (100-400 foot lift) are shown in Table 1. Costs can get quite large as the lift, or operating hours increase, or as pump efficiency decreases.

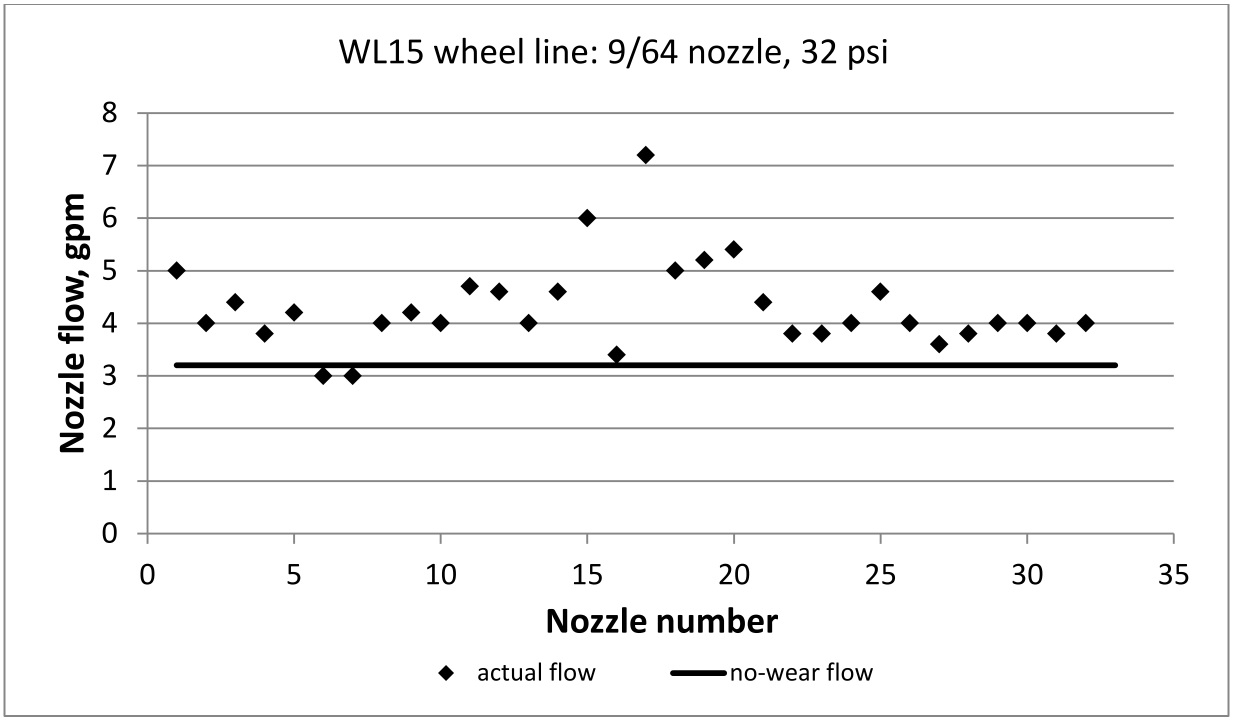
An additional problem created by excessive leaks and worn nozzles is the reduction in system pressure it produces. For most impact sprinklers, an operating pressure of about 50 psi produces the most uniform water application. A decrease in measured water application uniformity as sprinkler operating pressure is reduced from 50 to 30 psi is shown in Figure 2. Catch cans were placed on a 10-foot grid.

Uniformity of water application was also measured for a number of center pivot systems. Catch containers were placed at 10 foot intervals along a radial line in front of the advancing pivot. Depth of water collected at each location was recorded. An industry-standard measure of system uniformity (coefficient of uniformity or CU) was calculated for each pivot tested. Test results for about 30 pivots ranged from 69% to 94%. A value in the low 90's is generally considered the best level of uniformity that can actually be achieved in the field. Values of CU less than 85% (about 60% of the pivots tested in this study) indicate that the system application package needs significant maintenance or replacement.

Figure 3 shows visually the difference in uniformity of water application for pivots with CU= 93 and CU=77. The random-appearing pattern of low uniformity is probably caused by sticking pressure regulators on the pivot sprinkler drops. As regulators age, moving parts can stick in any position (too high, too low, or just right pressure regulation) due to hard water or debris deposits. Design life for pressure regulators is about 10,000 hours. For Idaho crops and conditions, this translates to 5-7 year life before replacement. Poor water application uniformity will result in poor uniformity of any water-applied fertilizer or pesticides and may also result in over-watering since irrigation may be increased somewhat to assure good crop appearance in the areas of low water application.

Careful irrigation management to apply the correct amount of water at the correct time will most effectively utilize limited water to give best crop yield and quality. A variety of irrigation scheduling techniques and equipment are available. A number of these are discussed on the drought website.

Correction of leak and worn nozzle problems in both set and center pivot systems can be fixed with routine system maintenance and will allow limited water supplies to be better utilized. Cost-share funding is available from Idaho Power to help pay for the component updates, which will result in significant water and energy savings, reduction in disease potential, reduced labor requirements, and increase profit.



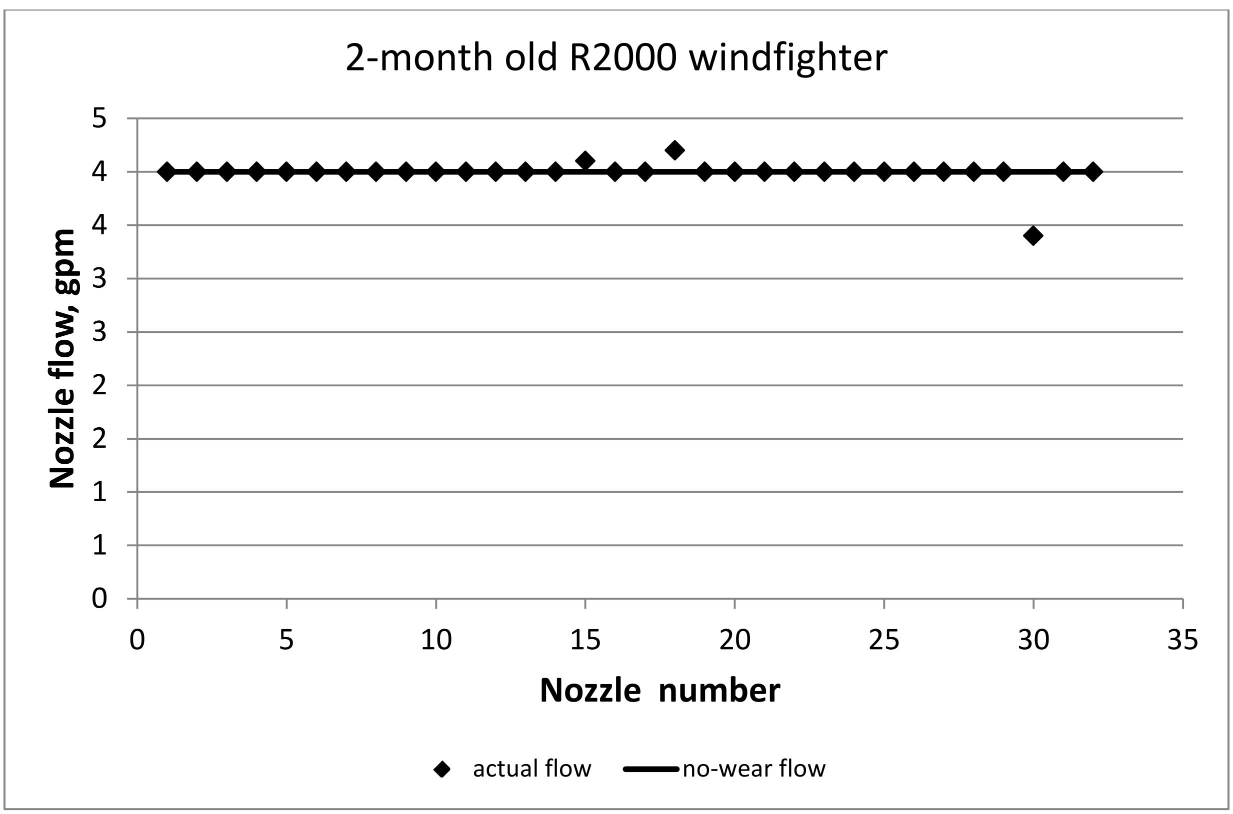


Figure 1. Nozzle flow rate and variation along wheel line WL15 (last maintenance 15-20 years ago) and WL 16 (nearly new R2000 sprinkler heads) compared to design rates.

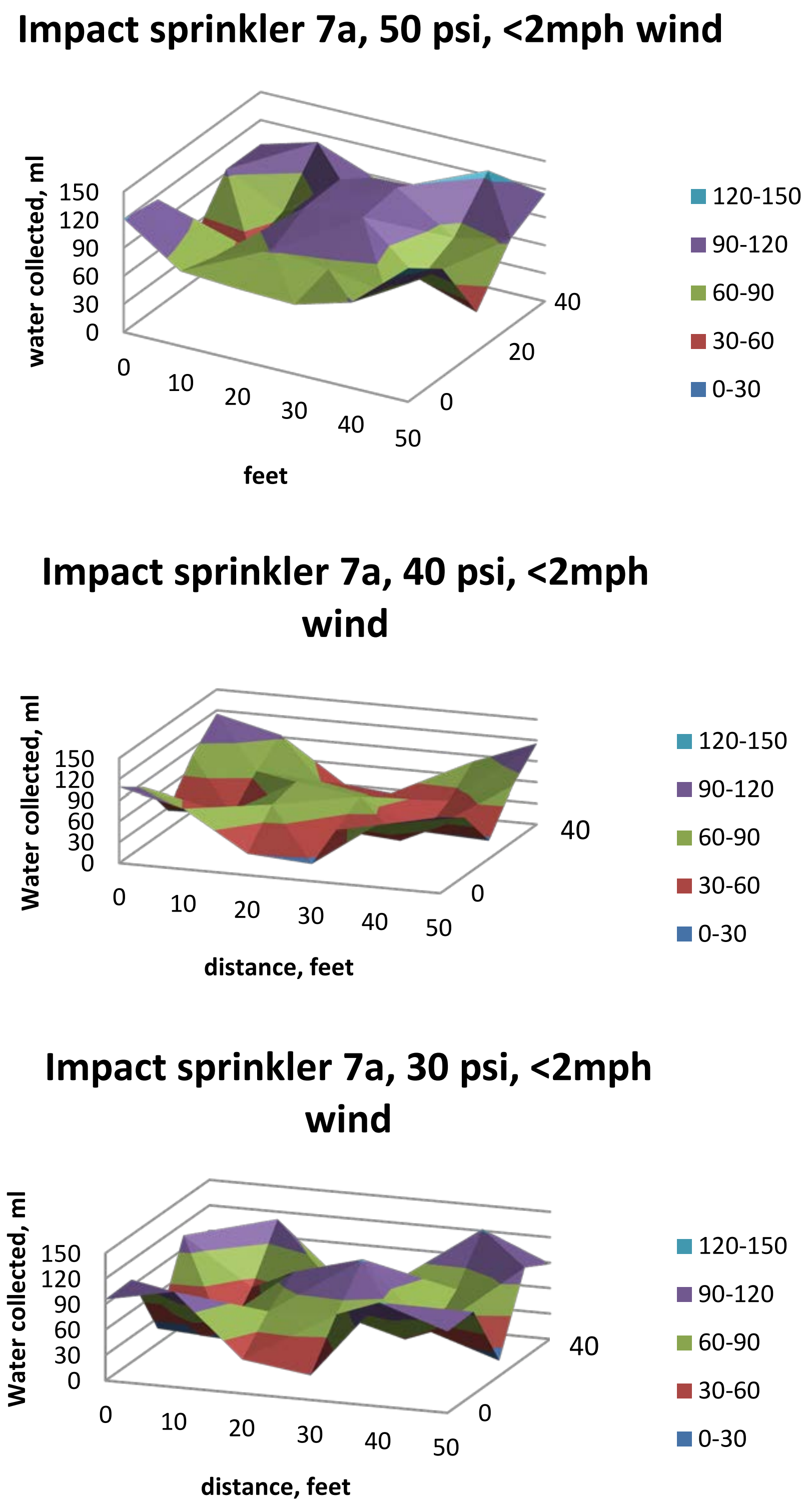


Figure 2. Measured water application pattern under the same brass impact sprinkler at 50, 40 and 30 psi pressure. Sprinkler spacing is 40 x 50 feet with heads on each corner. Catch cans were spaced on a 10 x 10 foot grid. Christiansen's CU is 78%, 61% and 56%, respectively for the 50, 40 and 30 psi tests. (W.H. Neibling, unpublished data).

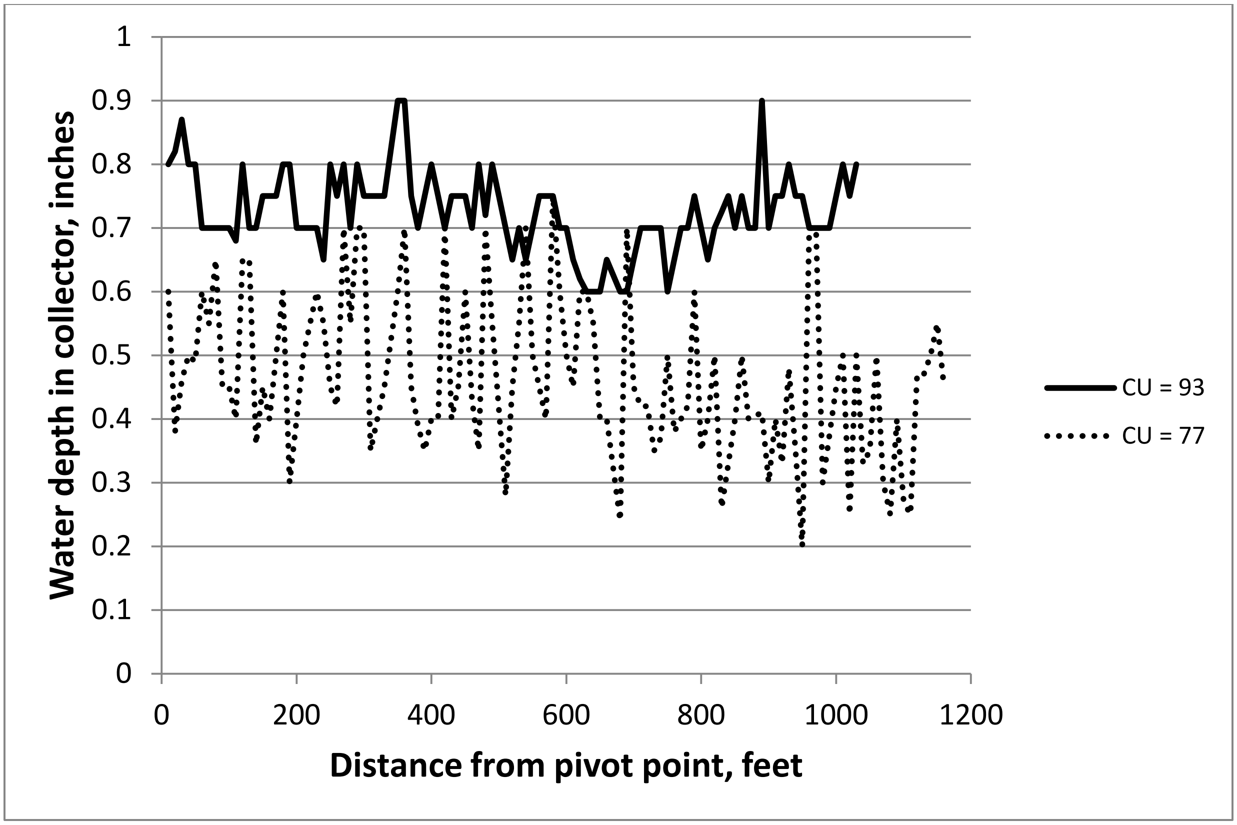


Figure 3. Depth of water collected in catch containers spaced 10 feet apart under a 3-year old pivot (CU = 93) and an older pivot needing maintenance (CU = 77).

Table 1. Growing season cost per acre for 40 gpm loss to leaks and worn nozzles (about 27% of a "typical" 33-nozzle sprinkler line). Costs are calculated for lifts of 10 to 400 ft, 60 and 80% pumping plant efficiency, and 1000 and 2000 operating hours per year.

Cost per acre, $				
	60% efficiency		**80% efficiency**	
lift, ft	**1000h**	**2000h**	**1000h**	**2000h**
10	10	20	7	15
20	11	21	8	16
100	16	32	12	24
150	19	38	14	29
200	22	45	17	34
300	29	58	22	44
400	36	71	27	53

United States Department of Agriculture

A Risk Management Agency Fact Sheet
Spokane Regional Office — Spokane, WA

September 2013

Pasture, Rangeland, Forage Pilot

VEGETATION INDEX — Idaho, Oregon

Crop Insured

For the purpose of this policy, the crop is **Pasture, Rangeland, or Forage** which is grown for the purpose of grazing or haying; located on insurable acreage; intended for harvest by haying, or grazing by livestock and that was initially planted prior to July 1 of the previous year.

Program Summary

The Vegetation Index uses Normalized Difference Vegetation Index (NDVI) data from the U.S. Geological Survey Earth Resources Observation and Science data center. The NDVI is a measure indicating the density of photosynthetic biomass on the ground, resulting from the processing of satellite imagery. In general, the healthier the plants in a given grid, the higher the NDVI value. With this plan of insurance, producers may select one or more 3-month time period(s) that represent a producer's forage species production. These time periods are called index intervals. Losses calculated using the Vegetation Index are indemnified based on the deviation from normal (average NDVI 1989—present) within the grid and index interval(s) selected.

Crop Types Insured

Haying: Severance of the plant from its root by mechanical equipment and cured. Haying does not include earlage, green chop or grain which may be fed to livestock or silage.

Grazing: Used solely as pasture for livestock to roam and feed on.

Index Intervals & Insurance Period

The period of time during which NDVI data is collected and used to calculate the expected grid index and final grid index. See the actuarial documents for which months constitute each interval. The crop year begins on January 1 and ends on December 31.

Availability in RMA Spokane Region

Idaho: All counties in Idaho
Oregon: All counties in Oregon

Important Dates

Sales Closing .... November 15
............................(preceding the start of the crop year)
Acreage Report Date .... November 15
Cancellation & Termination Date .... November 15

Coverage Available

Coverage is expressed as a dollar amount of protection. The dollar amount of protection per acre will be the county base value per acre for each crop type, multiplied by the coverage level selected (70-90 percent); and multiplied by the productivity factor selected by the insured. The insured may select only one dollar amount of protection per acre for each county and crop type. The selected coverage level multiplied by the expected grid index is the trigger grid index. If the final grid index for the insured unit falls below the trigger grid index, an indemnity (loss) payment may be due.

Acreage Report

Insured producers must report all of the acreage which they have a share, whether insured or uninsured, and a listing of all the Grid IDs containing all haying and grazing acreage they elect to insure under this policy within the county, their share, intended use, and the Farm Service Agency (FSA) farm number, tract number and field numbers. Producers do not have to insure one hundred percent of their insurable acreage.

Causes of Loss

The only insurable cause of loss is when the final grid index is less than the insured's trigger grid index. The reduction in the final grid index must be due to natural occurrences.

This fact sheet gives only a general overview of the crop insurance program and is not a complete policy. For further information and an evaluation of your risk management needs, contact a crop insurance agent.

Additional Definitions

County - Any county, parish or other political subdivision of a state shown on your accepted application.

County Base Value Per Acre - FCIC's determined value of the crop in the county as contained in the actuarial documents.

Expected Grid Index: A grid index determined by Federal Crop Insurance Corporation (FCIC) based on the mean Normalized Difference Vegetation Index (NDVI) values by index interval, calculated using the historical NDVI gridded data, normalized, and expressed as a percentage, such that the mean is 100.

Final Grid Index: A grid index determined by FCIC based on the current NDVI values, using the current NDVI gridded data, for each grid ID and index interval, expressed as a percentage.

Grid: An area identified by longitude and latitude used to determine the expected grid index, final grid index, premium and indemnity. For the Vegetation Index policies, the grid is an 8 kilometer by 8 kilometer area established using NDVI gridded data.

Grid ID: A specific number assigned to each grid.

Productivity Factor - A percentage factor selected by you that allows you to individualize your coverage based on the productivity of the acreage of the insured crop, and ranges from 60 through 150 percent.

Grid ID Locator, Decision Support Tool, Historical Indices

The purpose of this tool is to aid users in selecting the appropriate coverage to best manage producer risks. It is intended to provide producers and agents with additional information of how the "group" program correlates to the individual's production risk. These tools can be found on the RMA webpage at: http://www.rma.usda.gov/policies/pasturerangeforage/

Where to Buy Crop Insurance

All multi-peril crop insurance (MPCI), including CAT policies, are available from private insurance agents. A list of crop insurance agents is available at any USDA Service Center or on the RMA web site: http://www3.rma.usda.gov/tools/agents/

Regional Contact

USDA/Risk Management Agency
Spokane Regional Office
11707 E Sprague Ave #201
Spokane Valley, WA 99206
Telephone: 509-228-6320
Fax: 509-228-6321
E-mail: rsowa@rma.usda.gov

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http://www.rma.usda.gov/aboutrma/fields/wa_rso/

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United States Department of Agriculture

A Risk Management Agency Fact Sheet

Spokane Regional Office — Spokane, WA

2014 Crop Year
Revised September 2013

Written Agreement—Requesting Insurance When Not Available in Your County

Alaska, Idaho, Oregon, Washington

Risk Management Agency (RMA)

The Risk Management Agency (RMA) administers commodity programs for the Federal Crop Insurance Corporation (FCIC), including Multi-Peril Crop Insurance (MPCI), which is Federally subsidized (a portion of the premium is paid by USDA) and insures against many weather-related losses on 135 + crops, nationally.

If MPCI Coverage for a Crop, Type or Practice is not generally available in a county, producers may request insurance coverage by completing and submitting a Request for Actuarial Change form through a crop insurance agent. This option is available to producers in all counties nationwide as long as MPCI for the crop, type or practice is generally available in another county.

Crops Available to be Covered by Written Agreement

For a complete list of crops covered nationwide, see: http://www.rma.usda.gov/policies/

Requirements for Making a Request

Each request for Actuarial Change will require documentation supporting the special circumstance you are requesting coverage for. Your agent and insurance company will assist you in identifying the necessary information pertinent to your request.

Important Dates

Generally, actuarial requests for insuring a crop or unclassified acreage in a county must be initiated or renewed with your insurance agent on or before the sales closing / cancellation date listed in policy provisions for the particular crop, type or practice where insurance coverage is generally available. More details are included within RMA's Written Agreement Handbook (FCIC 24020) available on the RMA web site: http://www.rma.usda.gov/handbooks/24000/index.html

The Risk Management Agency may request additional information in order to properly evaluate unique cases and situations.

A written agreement can only be approved if the required conditions outlined in the Written Agreement Handbook are met.

Product Delivery

Products reinsured by RMA and approved by FCIC's Board of Directors are delivered through private crop insurance agents nationwide.

For a list of agents in your area, visit your local USDA Service Centers or the Risk Management Agency's online agent locator at: http://www3.rma.usda.gov/tools/agents

Additional Information and Regional Contact for RMA

Alaska, Idaho, Oregon and Washington agriculture producers may request additional information by contacting USDA RMA Spokane Regional Office at:

Telephone: 509-228-6320
Postal Mail: USDA/RMA/Spokane Regional Office, 11707 E. Sprague, Suite 201, Spokane Valley, WA 99206-6125
Email: rsowa@rma.usda.gov
Fax: 509-228-6321
RMA Spokane Regional Office web site page: http://www.rma.usda.gov/aboutrma/fields/wa_rso/

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United States Department of Agriculture

A Risk Management Agency Fact Sheet
Spokane Regional Office — Spokane, WA

July 2013

Forage Production

Oregon

Crop Insured

Forage production is insurable in a county where a premium rate is provided by the actuarial documents; you have a share in the crop; and it is grown after the establishment year.

Counties Where Available

Klamath and Malheur

Practice and Types

Irrigated alfalfa (a pure stand of alfalfa or a stand of alfalfa and grass where 60 percent or more of ground cover is alfalfa.)

Causes of Loss*

Adverse weather conditions[1]
Earthquake
Failure of irrigation water supply[2]
Fire[2]
Insects[3]
Plant disease[3]
Volcanic Eruption
Wildlife

[1]Natural perils such as hail, frost, freeze, wind, drought, and excess moisture.
[2]If caused by an insured peril during the insurance period.
[3]But not damage due to insufficient or improper application of control measures.
*Not damage that occurs after removal from the windrow.

Important Dates

Sales Closing	September 30
Acreage Report Date	December 15*
Insurance Attaches	October 16*
Cancellation and Termination Date	September 30

*For new spring-seeded acreage, insurance attaches on April 15 of the year after seeding, and a **revised** acreage report may be submitted until **July 15**.

Adequate Stand

Required minimum number of live alfalfa plants (per square foot as shown in the Special Provisions) that exist at the beginning of the insurance period.

Insurance Period

Insurance attaches on acreage with an adequate stand on the later of:

1) The day we accept your application;
2) October 16; or
3) April 15 after a year of establishment for new spring-seeded acreage.

Insurance ends on the earliest of:

1) Total destruction of the forage crop;
2) Removal from the windrow or the field, for each cutting;
3) Final adjustment of the loss;
4) Abandonment of the forage crop;
5) The date grazing starts on the forage crop; or
6) October 15.

Insurance coverage will continue for acreage that is grazed after it has gone into winter dormancy. Winter dormancy is defined as the suspension of growth and development of the alfalfa plants during the fall and winter months. You must remove all livestock from insured fields before the forage emerges from winter dormancy.

Acreage Report

You must report to your insurance agent all of the acreage of the insured crop within the county which you have a share (your share at the time insurance attaches).

Production Reporting

Talk to your insurance agent for special reporting instructions, if you plan to use more than 25 percent of your production on the farm (for example, livestock feed).

This fact sheet gives only a general overview of the crop insurance program and is not a complete policy. For further information and an evaluation of your risk management needs, contact a crop insurance agent.

Coverage Level and Price Election

You can choose a percentage of your approved average yield, from 50 percent to 75 percent. The price election is the price you receive if you suffer a loss. Choices vary by coverage level. (Please check with your crop insurance agent for price election changes for this crop year.)

Replant Payments

Not available on forage production policies.

Excluded Coverage

The policy does not insure any acreage:

- That does not have an adequate stand at the beginning of the insurance period;
- That is grown with a non-forage crop; or
- Where the farming practices carried out on the insured acreage do not follow or comply with established good farming practices for your area.

Late or Prevented Planting

Not available on forage production policies.

Catastrophic Coverage

Catastrophic Risk Protection coverage (CAT) is available at 50 percent of your actual production history (APH) yield and 55 percent of the established price election. The total cost for CAT coverage is an administrative fee of $300 per crop per county. Administrative fees and premium costs for coverage levels above CAT are $30 per crop per county. Waivers of administrative fees for **all** coverage levels (CAT and additional) are available for limited resource farmers.

Loss Example - Forage Production

Assume a 65-percent coverage level, a 100-percent price election of $230 per ton, and an average yield of 4 tons per acre.

4	Tons per acre (APH)
x 65	Percent coverage level
2.6	Tons per acre guarantee
- 1.3	Harvested tons per acre production
1.3	Tons per acre loss
x $230	Price election
$299	**Indemnity payment per acre**

Where to Buy Crop Insurance

All multi-peril crop insurance (MPCI), including CAT policies, are available from private insurance agents. A list of crop insurance agents is available at all USDA Service Centers and on the RMA web site: http://www3.rma.usda.gov/tools/agents/

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IDAHO ALFALFA VARIETY TRIALS 2013

Glenn E. Shewmaker[1], Greg Blaser, Ron Roemer, Jim Church, and Ken Hart

INTRODUCTION

Alfalfa is the most productive and widely adapted forage species. Idaho alfalfa acreage was 1.04 million acres in 2012 (NASS 2013) which was up 40,000 acres from 2011, and down from about 1.25 million acres in 2003. Production was 4.16 million tons with an estimated gross value of $799 million in 2012, third in the US. Forage yield and quality vary widely across Idaho environments and operations. The Idaho Agricultural Experiment Station (IAES) conducts alfalfa variety performance trials at several sites in southern Idaho including the Kimberly Research and Extension Center. Over 300 alfalfa varieties are available to US producers, and these performance trials are designed to assist producers in choosing their varieties.

Alfalfa varieties are tested for forage yield for at least three production years on irrigated sites. All trials are planted as randomized complete block experiments, with four or six replications. Trials receive adequate fertilization, irrigation, and weed control for optimum production. A 2011 trial was planted in May 2011 at the Kimberly R&E Center, and in August at the Brigham Young University-Idaho farm in Rexburg, ID in cooperation with Greg Blaser, agronomist BYU-Idaho. A 2012 trial was planted in May 2012 at the Kimberly R&E Center, and two trials in Northern Idaho with Jim Church and Ken Hart. Seedling-year production results are limited in value for predicting future performance.

The seed industry contributes significantly to the variety trials. Besides donating the seed, they pay a significant fee to offset our costs of doing the work. The Plant, Soil, and Entomological Science Department of the University of Idaho also contributes significantly in salary and equipment—the 5-ft forage harvester purchased for our use costs as much as a big machine.

OBSERVATIONS

1. Forage variety trials give **potential yields**. The yields are measured on fresh forage with a moisture percentage of about 75%. Yields are corrected to 100% dry matter but there is very little harvest loss in our trials. Harvest losses for raking, baling, and stacking dry hay can be as much as 20% of the total dry matter production. We also intensely manage the plots and we don't have traffic on the plots 5-9 days after cutting. Thus I would expect realistic hay yields about 80 to 90% of these, however, green chop or haylage yields would be closer.

2. Phosphate and potash fertilizer was applied pre-planting.

3. Varieties are listed in alphabetical order.

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gshew@uidaho.edu; G. Blaser, BYU-Idaho; R. Roemer, Univ. of Idaho; J. Church, Idaho County Extension Educator; K. Hart, Lewis County Extension Educator. Published **In**: Proceedings, Idaho Hay and Forage Conference 27-28 February 2014, Burley, ID, University of Idaho Extension.
http://www.extension.uidaho.edu/forage/

4. Don't put too much emphasis on 1-year's data from one location. I suggest looking at results from the Intermountain region of Northern California, Utah State University trials, and others similar in climate.

5. Kimberly Trial: This was the second production year for the 2011-planted trial. The summer was unusually warm with average daily air temperatures 3 to 5 degrees above normal in 2013. First cutting produced an average 3.4 tons/acre compared to 2.9 tons/acre in 2012 and to 3.68 ton/acre average in the years from 2003-2008. The 2^{nd} was near normal but 3^{rd} cutting was likely affected by near record heat and evapotranspiration rates that exceeded the plants ability to be most productive. The stands are good.

6. Rexburg Trial: This was the second production year for the 2011-planted trial. The summer was unusually warm with average daily air temperatures 3 to 5 degrees above normal in 2013. First cutting produced an average 2.5 tons/acre and a 4^{th} cutting was harvested, which is not normal. The stands are good.

7. Northern Idaho Trials: This was the first production year for the 2012-planted trials in Idaho and Lewis Counties. These are rain-fed sites which get 1 cutting, and precipitation was well below normal.

8. Check Varieties: Vernal and Oneida are public check varieties used in all trials. The mystery checks are several year old commercial varieties that we use to compare results in other locations.

Yield is the most important economic factor for alfalfa profitability. Average yield over a period of years and at several locations is a good measure of disease resistance and plant persistence. Generally, the top yielding 1/3 of the varieties are not significantly different for yield. University trials offer neutral testing of varieties but will not test blends--if the source is different every year, there is no point to test it. Industry data can be valuable because it usually is for a longer period of time, but you should ask for the complete data from the trial, not just a section of it. Avoid data with only one year or a single harvest.

Forage Quality--Plant more than one variety, especially if you have large acreage and are seeking dairy-quality hay. Varieties with different maturities will reach the cutting time up to about a week apart, allowing you to cut more hay at the pre-bud or bud stage. Harvesting at the correct maturity and agronomic practices (proper irrigation and weed control) has a larger effect on quality than does variety.

Variety selection is important but not the only factor affecting yield and quality. Soil fertility management, irrigation management, weed control, and harvest management may affect your profit more than variety. However, almost all newer varieties will yield more and be more resistant to pests and diseases than the old public varieties!

Sources of Variety Information

University of Idaho Forage Extension: http://www.extension.uidaho.edu/forage/

Idaho Hay and Forage Association: http://www.idahohay.com/

National Alfalfa and Forage Alliance's: http://www.alfalfa.org

North American Alfalfa Improvement Conference: http://www.naaic.org/

University of California, Davis: http://alfalfa.ucdavis.edu/

University of Idaho: Alfalfa Variety Trials, 2013 Harvest Dates: May 22, June 24, July 22, October 22, 2013 Kimberly Variety Test Planted: August 23, 2011 2013 Forage dry matter yield						
	2 Year Ave.	**Total**	**1st**	**2nd**	**3rd**	**4th**
Variety	- - - - - - - - - - - - - - **Tons/Acre** - - - - - - - - - - - - -					
4R200	8.25	8.51	3.65	2.06	1.62	1.18
54QR04	8.02	7.94	3.50	1.76	1.62	1.06
54VR03	8.39	8.72	3.65	1.93	1.83	1.32
AmeriStand 407TQ	8.21	8.35	3.45	2.09	1.59	1.22
DG 4210	8.38	8.48	3.52	2.00	1.77	1.18
GrandStand	8.32	8.37	3.79	1.87	1.57	1.14
MasterPiece II	7.77	7.84	3.56	1.61	1.52	1.14
Mystery check 1	8.16	8.04	3.59	1.79	1.37	1.28
Mystery check 2	7.98	8.11	3.61	1.78	1.60	1.12
Oneida VR	7.89	8.01	3.51	1.71	1.52	1.27
R57W213	8.60	9.05	3.62	2.24	1.83	1.36
Vernal	7.67	7.74	3.19	1.72	1.48	1.35
Mean	8.14	8.26	3.55	1.88	1.61	1.22
LSD (.05)	0.52	0.75	0.29	NS	NS	NS
CV %	7.2	7.2	6.3	16.3	17.3	20.5
Pr>F	0.018	0.034	0.042	0.077	0.273	0.693

University of Idaho: Alfalfa Variety Trials, 2013

Harvest Dates: May 22, June 24, July 22, October 22, 2013

Kimberly Variety Test

Planted: MAY 21, 2012

2013 Forage Dry Matter Yield

	Total	**1st**	**2nd**	**3rd**	**4th**
Cultivar	**- - - - - - - - - - - - Tons/Acre - - - - - - - - - - - - -**				
55Q27	8.18	3.24	1.94	1.67	1.33
AGRMS-101	8.29	3.13	1.99	1.73	1.45
AGRMS-102	8.42	3.32	1.93	1.65	1.53
AGRMS-103	7.74	3.44	1.82	1.20	1.28
BB1011	7.99	3.41	1.66	1.40	1.52
FG R48W203	8.42	3.53	2.02	1.57	1.30
FG R57W213	8.80	3.34	2.14	1.81	1.51
FSG423ST	8.33	3.47	1.88	1.57	1.41
Magnitude	8.63	3.58	1.95	1.59	1.51
Oneida VR	8.59	3.54	1.95	1.70	1.40
PGI 557	8.90	3.56	2.04	1.82	1.49
Vernal	8.04	3.50	1.71	1.40	1.43
Mean	8.36	3.42	1.92	1.59	1.43
LSD (.05)	NS	NS	0.2	0.3	NS
CV %	7.0	12.1	10.0	15.5	10.6
Pr>F	0.11	0.84	0.02	0.01	0.12

University of Idaho and BYU- Idaho (Rexburg) Alfalfa Variety Test Harvest Dates: May 30, June 27, July 23, Aug 23, Sept 20 2013 Planted: August 23, 2011												
	Dry Matter Yield							**1st Cutting Forage Quality**				
	2012-13	**Year Total 2013**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**CP**	**ADF**	**NDF**	**RFV**	**RFQ**
Variety	**2 Yr Ave.**	**- - - - - - - - - - - - - - Tons/Acre - - - - - - - - - - - - -**						**(%)**	**(%)**	**(%)**	**Index**	**Index**
4R200	10.1	11.9	2.19	2.42	2.76	2.16	2.34	29.1	25.2	29.3	222	231
AmeriStand 407TC	10.4	12.2	2.37	2.45	2.76	2.35	2.28	29.0	24.2	28.7	228	238
DG 3210	10.4	12.1	2.60	2.32	2.66	2.31	2.16	28.8	25.2	29.9	216	225
DG 4210	10.1	12.1	2.32	2.27	2.71	2.43	2.35	28.3	25.2	30.4	213	223
GrandStand	10.9	12.6	2.61	2.51	2.81	2.38	2.28	28.4	25.9	30.9	207	217
Mystery Check 1	10.5	12.0	2.43	2.60	2.68	2.28	2.04	29.6	23.7	28.6	230	240
Mystery Check 2	10.0	11.8	2.17	2.39	2.77	2.34	2.18	28.8	25.4	30.0	215	225
Mystery Check 3	10.4	12.3	2.80	2.33	2.74	2.28	2.14	28.4	25.8	31.4	209	218
Mystery Check 4	10.3	12.0	2.48	2.52	2.73	2.23	2.06	28.9	25.2	29.7	218	228
Oneida VR	10.3	12.0	2.51	2.26	2.66	2.35	2.25	29.3	24.4	29.3	223	233
R57W213	10.0	12.0	2.57	2.19	2.78	2.40	2.06	28.2	24.7	30.1	212	221
Vernal	10.4	12.1	2.50	2.75	2.64	2.06	2.14	29.7	24.2	28.2	232	245
Mean	10.3	12.1	2.46	2.42	2.73	2.30	2.19	28.9	24.9	29.7	219	228
LSD (.05)	NS	NS	0.37	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	19.6	5.8	11.7	13.9	7.9	8.2	10.4	2.9	4.9	4.9	5.9	5.9
Pr>F	1.00	0.933	0.050	0.367	0.977	0.156	0.351	0.215	0.272	0.116	0.141	0.112

Entry information for Kimberly and Rexburg Trials Planted in 2011

Variety	Marketer	FD	WS	Bw	Vw	Fw	An	PRR	SAA	PA	BAA	SN	Aphanomyces Race 1	Aphanomyces Race 2	Southern Root Knot Nematode	Northern Root Knot Nematode	Roundup Ready
4R200	Eureka Seed	4	2.1	HR	HR	HR	HR	HR	R	R	MR	HR				R	Y
54QR04	Pioneer Hi-Bred Int'l, Inc.	4		HR	HR	HR	HR	HR	HR	R		R					Y
54VR03	Pioneer Hi-Bred Int'l, Inc.	4		HR	HR	HR	HR	HR		R							Y
AmeriStand 407TQ	Americas Alfalfa	4	2	HR	HR	HR	HR	HR	R	HR		MR	HR	R			N
DG 3210	Crop Production Services	3	1	HR	HR	HR	HR	HR		R		R				R	
DG 4210	Crop Production Services	4	1	HR	HR	HR	HR	HR		R		R	HR			HR	
GrandStand	Crop Production Services	4	2	HR	HR	HR	HR	HR		R		R					N
MasterPiece II	JR Simplot Co	5		HR	HR	HR	HR	HR		HR		HR				HR	N
Mystery check 1		4	2	HR	HR	HR	HR	HR	MR	R		MR	HR	R			N
Mystery check 2		4		HR		HR	HR	HR		R		HR	R			R	N
Mystery Check 3		4		HR	HR	HR	HR	HR		R							N
Mystery Check 4		4		HR	HR	HR	HR	HR	HR	R		R					N
Oneida VR	Public--std check	3		R	HR	HR	MR	MR									N
R57W213	Eureka Seed	5	2.5	HR	HR	HR	HR	HR				HR					Y
Vernal	Public--std check	2		R		MR										MR	N

Ratings for Alfalfa Varieties	
Code	**Description**
FD	Fall dormancy
WS	Winter survival
Bw	Bacterial wilt
Vw	Verticillium wilt
Fw	Fusarium wilt
An	Anthracnose race 1
PRR	Pytophthora root rot
SAA	Spotted alfalfa aphid
PA	Pea aphid
BAA	Blue alfalfa aphid
SN	Stem nematode
NRKN	Northern root knot nematode
MLE	Multi-foliate expression
GT	Continuous grazing tolerance

Resistance Ratings		
% Resistant plants	**Resistance class**	**Class abbreviation**
0-5%	Susceptible	S
6-14%	Low resistance	LR
15-30%	Moderate resistance	MR
31-50%	Resistance	R
>50%	High resistance	HR

Winter Survival Ratings		
Category	**Check variety**	**Score**
Superior	ZG 9830	1
Very good	5262	2
Good	WL325HQ	3
Moderate	G-2852	4
Low	Archer	5
Non winter-hardy	Cuf 101	6

Fall Dormancy Ratings	
Check variety	**Rating**
Maverick	1
Vernal	2
5246	3
Legend	4
Archer	5
ABI 700	6
Dona Ana	7
Pierce	8
CUF 101	9
UC-1887	10
UC-1465	11

Forage Quality Analysis Terms:

Forage quality analysis was determined by NIRS (Near Infrared Spectral) analysis.

CP = Crude protein. Higher protein levels indicate less need for more expensive supplements in the ration.

ADF = Acid detergent fiber. A measure of the less digestible components in the forage. Lower ADF is more desirable. Higher ADF is generally related to more mature plants.

NDF = Neutral detergent fiber. A measure of the total fiber content. Relates to feed intake level in livestock. Lower NDF is more desirable.

ADL =Acid detergent lignin. Indigestible plant component, giving the plant cell wall its strength and water impermeability. It increases as plant matures and reduces NDF digestibility. Higher temperatures during the growing season tend to increase lignin.

Ash. An estimate of the total mineral content. The residue remaining after burning a sample. Levels below 10% are desirable.

dNDF = Digestible neutral detergent fiber. *In vitro* NDF digestibility of forages are evaluated by incubating forage in buffers and live rumen fluid, at body temperature, under anaerobic (no air) conditions.

IVTD 24 hr = In vitro digestible dry matter. A measure of digestibility at 24 hours in the rumen. Higher digestibility is more desirable

RFV = Relative feed value. An index for ranking cool season grasses and legume forages based on intake of digestible energy. RFV is calculated from ADF and NDF. Feeder quality hay is <160 and dairy quality hay is >160. Hay with RFV >180 should be fed with a total mixed ration or blended with lower quality hay.

RFQ = Relative forage quality. An index for ranking all forages based on intake of TDN calculated by estimating digestible portions of protein, fatty acids, fiber (NDF), and non-fibrous carbohydrates. RFQ is based on a more comprehensive analysis than RFV and it should be more reflective of the feeding value of the forage, especially grasses. RFQ is based on the same scoring system as RFV. The higher the RFQ, the better the quality.

University of Idaho, North Idaho Variety Trials Planted: May 29-30, 2012; Harvested: 6/21 and 6/28 2013			
Variety	**Average**	**Idaho Co.**	**Lewis Co.**
	- - - - - - Ton DM/Acre - - - - - -		
4R200	1.13	1.48	0.78
AgRMS-101	1.45	1.58	1.32
AgRMS-102	1.54	1.84	1.24
AgRMS-103	1.66	1.83	1.49
BB-10-11	1.30	1.54	1.05
Big Sky Ladak	1.51	1.48	1.54
Cooper	1.60	2.09	1.10
DKA34-17RR	1.12	1.12	1.12
DKA43-22	1.25	1.48	1.02
Dryland	1.57	1.69	1.44
FG 27C102	1.06	1.35	0.77
FG 310M150	1.12	1.27	0.96
FG 46M126	1.29	1.40	1.19
FGR47M312	1.17	1.30	1.03
FGR48M137	1.23	1.52	0.93
Graze N Hay 3.10RR	1.08	1.36	0.79
Hybri Force - 2400	1.50	1.71	1.28
Magnum - 7	1.76	2.00	1.51
Maxi-Graze	1.51	1.63	1.39
Melton	1.60	1.81	1.39
MsSunstra - 803	1.75	1.59	1.90
PGI 215	1.72	1.48	1.96
PGI 424	1.82	1.70	1.94
Rugged	1.84	1.74	1.94
Sanfoin (Shoshone/Remont)	2.00	1.85	2.16
Shaw	1.46	1.94	0.99
Spredor 5	1.28	1.59	0.98
TS 4010	1.73	1.56	1.90
TS 4013	1.73	1.71	1.74
Vernal	1.63	1.62	1.65
Whitney	1.43	1.66	1.20
WL 319HQ	1.46	1.66	1.26
WL 354HQ	1.28	1.66	0.91
WL 355RR	1.92	1.40	2.45
Mean	1.48	1.6	1.36
LSD (.05)	0.43	0.38	0.56
CV %	29.5	16.8	29.2

University of Idaho, North Idaho Variety Trials Idaho County Planted: May 29, 2012; Harvested: 6/21 2013									
Variety	**CP**	**ADF**	**NDF**	**ADL**	**Ash**	**dNDF**	**IVTD**	**RFV**	**RFQ**
	% of Dry Matter								
4R200	13.8	36.2	44.1	7.2	3.1	19.9	74.0	126	154
AgRMS-101	14.5	35.3	47.2	6.8	3.5	18.7	72.4	120	120
AgRMS-102	9.9	42.1	56.1	7.6	2.8	20.9	64.6	92	80
AgRMS-103	15.7	29.4	37.4	5.3	4.4	18.3	82.5	163	199
BB-10-11	4.2	40.7	58.3	6.1	1.6	22.3	68.2	90	81
Big Sky Ladak	10.9	37.7	49.7	7.2	4.0	20.8	70.7	110	113
Cooper	11.6	38.3	52.7	6.3	1.6	20.7	72.7	103	113
DKA34-17RR	13.3	30.5	38.8	6.2	5.1	17.9	79.1	155	175
DKA43-22	18.0	27.6	35.6	5.1	5.6	16.1	79.7	174	197
Dryland	12.6	28.7	36.3	5.5	5.0	18.4	79.2	169	188
FG 27C102	12.5	33.0	41.8	6.4	4.4	18.5	75.2	139	147
FG 310M150	16.1	34.1	43.1	6.6	4.5	17.2	72.6	133	138
FG 46M126	7.9	30.9	39.8	2.8	4.2	17.7	79.7	150	168
FGR47M312	15.3	35.1	46.2	6.1	3.7	19.8	77.0	123	150
FGR48M137	8.8	40.6	55.7	8.4	1.9	20.0	66.3	94	88
Graze N Hay 3.10RR	13.6	32.3	42.6	6.0	4.5	18.0	75.6	138	143
Hybri Force - 2400	12.1	38.2	54.2	5.4	2.3	21.5	68.2	100	102
Magnum - 7	15.8	28.8	37.7	5.3	6.2	16.2	78.2	163	174
Maxi-Graze	11.5	33.8	44.2	5.9	4.3	20.5	77.7	130	142
Melton	14.2	40.7	55.3	6.7	3.0	20.2	72.8	95	98
MsSunstra - 803	12.4	30.2	38.3	5.9	4.9	18.1	80.8	157	172
PGI 215	10.9	39.9	51.8	7.5	3.1	20.2	69.3	102	109
PGI 424	12.3	39.0	51.6	7.1	3.9	18.3	68.5	104	101
Rugged	15.3	31.0	39.6	5.8	4.9	17.2	77.3	151	165
Sanfoin(Shoshone/Remont)	16.8	30.6	39.2	5.6	5.1	17.9	78.6	153	178
Shaw	13.9	32.0	41.2	6.5	4.6	18.5	78.1	143	154
Spredor 5	15.0	31.3	40.5	6.3	4.4	17.6	77.7	147	169
TS 4010	15.8	31.2	39.4	5.7	4.9	17.5	78.5	151	166
TS 4013	12.5	37.3	49.0	6.8	4.2	19.3	71.2	112	110
Vernal	15.2	33.5	42.5	6.2	4.3	18.8	76.6	136	159
Whitney	14.5	37.6	49.2	7.3	3.4	18.8	70.0	111	115
WL 319HQ	14.4	43.2	56.4	8.2	2.9	19.9	62.9	90	83
WL 354HQ	14.1	40.2	55.5	6.1	3.0	21.5	67.7	95	101
WL 355RR	10.9	32.6	42.3	5.8	4.2	20.0	76.8	138	153

University of Idaho, North Idaho Variety Trials Lewis County Planted: May 30, 2012; Harvested: 6/28 2013									
Variety	**CP**	**ADF**	**NDF**	**ADL**	**Ash**	**dNDF**	**IVTD**	**RFV**	**RFQ**
	% of Dry Matter								
4R200	13.6	31.8	40.7	6.2	4.6	18.2	75.6	145	158
AgRMS-101	13.7	30.6	39.6	6.1	4.8	18.6	78.3	151	163
AgRMS-102	12.5	30.7	39.6	6.0	4.9	18.8	74.9	151	163
AgRMS-103	12.9	31.3	41.0	5.9	4.8	18.5	77.6	145	155
BB-10-11	16.6	30.9	39.3	5.9	5.4	18.0	78.3	152	170
Big Sky Ladak	11.0	32.3	42.1	6.0	4.8	19.4	77.0	140	146
Cooper	13.6	32.2	41.3	6.4	4.8	18.3	77.5	142	155
DKA34-17RR	10.9	31.6	41.7	5.9	4.3	19.8	78.9	142	157
DKA43-22	11.7	34.8	47.1	6.3	2.7	19.5	72.5	121	128
Dryland	18.5	31.4	42.7	5.0	5.0	17.8	74.6	139	151
FG 27C102	11.1	38.0	49.2	7.1	3.2	19.9	67.6	111	112
FG 310M150	12.0	43.1	57.2	7.1	4.0	20.7	64.9	89	81
FG 46M126	17.0	30.8	39.9	5.3	5.3	18.4	80.2	150	179
FGR47M312	13.1	29.4	38.3	5.7	4.5	17.6	81.0	159	175
FGR48M137	13.9	29.2	40.1	4.9	4.7	18.2	83.9	152	169
Graze N Hay 3.10RR	15.4	31.4	39.6	6.0	4.2	17.3	77.5	150	172
Hybri Force - 2400	13.3	28.6	38.3	5.1	4.8	19.3	82.2	160	181
Magnum - 7	16.6	30.5	38.4	5.8	5.2	17.6	77.7	156	175
Maxi-Graze	13.3	33.6	44.7	6.0	4.3	19.2	75.5	129	139
Melton	14.5	28.4	37.1	4.9	5.3	18.5	80.8	166	179
MsSunstra - 803	16.4	29.9	38.4	5.7	5.5	17.7	79.2	158	183
PGI 215	13.8	28.3	37.2	5.4	4.9	17.3	80.1	166	181
PGI 424	11.1	27.8	37.2	5.0	6.0	19.2	82.0	167	178
Rugged	11.7	30.9	40.3	6.1	4.7	19.0	80.2	148	162
Sanfoin(Shoshone/Remont)	11.8	37.6	48.5	7.3	4.5	20.1	71.4	113	118
Shaw	13.4	32.4	45.5	5.7	4.4	18.4	73.6	129	127
Spredor 5	16.2	31.3	39.7	6.1	5.6	18.7	77.3	150	170
TS 4010	17.1	32.2	39.8	6.3	4.5	18.8	77.6	148	185
TS 4013	14.2	32.6	41.7	6.2	4.7	17.5	74.8	140	148
Vernal	16.7	28.5	36.8	5.7	5.8	17.5	80.0	167	188
Whitney	20.0	25.6	33.4	4.5	6.5	16.4	83.2	190	215
WL 319HQ	14.4	29.3	38.2	5.6	5.1	18.3	77.9	160	178
WL 354HQ	15.1	35.0	45.0	6.5	4.8	19.0	72.8	126	135
WL 355RR	13.6	36.9	51.5	5.5	2.2	22.6	74.2	107	138

UNIVERSITY OF IDAHO TWIN FALLS COUNTY 2013 SILAGE CORN VARIETY TRIALS

Steven L. Hines[1]

ABSTRACT

Idaho is ranked 3rd in the nation for milk production and 4th in number of dairy cows. As the Idaho dairy industry has grown, acres of corn produced for silage have increased as well. In 1989, Idaho producers planted 78,000 acres for silage production. In 2013, Idaho producers planted approximately 225,000 acres of corn for silage. Idaho ranks 6th in the U.S. for tons of corn silage produced. In 2008, a corn grain variety trial program was started through the University of Idaho Twin Falls County Extension office, and in 2009 the program was expanded to include silage varieties. The data from these trials can be combined with industry data to help producers choose the best corn varieties for their growing conditions and management objectives.

Keywords: Corn, silage, variety trials, yield, quality

INTRODUCTION

The 2013 corn variety trial was conducted by the University of Idaho Jerome County Extension office. The trial location was the University of Idaho Kimberly Research and Extension Center farm located near Kimberly, Idaho. Table 11 lists the entries for silage and Table 12 lists entries for grain. Hybrids ranged between 82-108 days relative maturity (RM).

METHODS

The trial was a randomized complete block design with 4 replications. Silage varieties were split into 3 separate trails based on RM: 82-91, 92-99, and 101-108. Individual plots were 4-30 inch rows x 20 feet. The center two rows were harvested for evaluation. Silage was evaluated for yield and quality. The silage corn population was approximately 38,000 plants per acre. Grain was evaluated for yield, moisture, and test weight. Population was approximately 36,000 plants per acre.

Silage Analysis

Silage quality analysis was determined by NIRS (Near Infrared Spectral) analysis, and wet chemistry, on a composite sample of fresh silage by first combining a subsample from each individual varietal replication and then selecting a sample for analysis. The quality traits are:

1. IVTD 24 hr = In vitro digestible dry matter. A measure of digestibility at 24 hours in the rumen. Higher digestibility is more desirable
2. CP= Crude protein. Higher protein levels indicate less need for more expensive supplements in the ration.
3. TDN=Total Digestible Nutrients. The sum of the digestible protein, digestible non-fiber carbohydrates, digestible NDF and 2.25X the digestible fat.

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4. ADF= Acid detergent fiber. A measure of the less digestible components in the forage. Lower ADF is more desirable. Higher ADF is generally related to more mature plants.
5. NDF= Neutral detergent fiber. A measure of the fiber content of the silage. Relates to feed intake level in livestock. Lower NDF is more desirable.
6. Starch= Starch. A measure of the energy portion of the silage. Higher starch is more desirable.
7. NFC=Non-fiber carbohydrates. Non-cell wall carbohydrates consisting of starch, sugar, pectin and fermentation acids that serve as energy sources for the animal. Higher NFC is better.
8. NEL= Net energy for lactation. An energy measurement used in estimating amount of energy available for milk production. Higher NEL is more desirable.

Agronomic Information

The field is located approximately 1 ½ miles north east of Kimberly Idaho. Soils are Portneuf silt loam and Bahem silt loam. The farm is approximately 3880 feet in elevation. Irrigation is by furrow application. The trials were amended with 46-0-0 to achieve 340 lbs N, according the University of Idaho fertilizer guide for a 40 ton yield goal. No additional phosphorus or potassium was added. Surpass was applied at the rate of 2 pts/acre pre plant incorporated. No additional herbicides were used in the trials. No insecticides were used. The plots were planted May 9th with an Almaco Twin Plate 2 vacuum planter. Silage varieties were harvested with a John Deere #35 two row forage harvester. Grain was harvested with a Wintersteiger plot combine outfitted with a Grain Gauge electronic data recorder. Spider mite infestations were moderate in August. Very few western corn root worm adults, *Diabrotica virgifera virgifera*, were observed. Early maturing sweet corn was planted around the borders of the trial to reduce bird feeding damage. The summer of 2013 was above average temperatures and base 50 Growing Degree Days were well above average. Heat stress was evident by poor pollination at ear tips. The 82-91 RM varieties were harvested September 9th. The 92-99 RM varieties were harvested September 13th. The 101-108 RM varieties were harvested September 18th. Grain varieties were harvested November 4th.

RESULTS NOTATIONS

Silage samples were unprocessed and analyzed fresh. The varieties should not be ranked by milk lbs/ton based on NIR data in tables 2, 5 and 8 as quality results were not replicated. The data should only be used for comparison purposes and individual variety potential. The wet chemistry data are in tables 3, 6, and 9 following the respective NIR data. As stated above, the quality results for silage were not replicated and thus no comparative statistics are shown. Many factors and management skills influence yield and quality of a given crop and these results are for comparison only. Actual production results will vary. All quality analysis was conducted by CRI AgSource in Jerome, Idaho. Grain yield data has been corrected to 15.5% moisture and 56 lbs test weight.

In all yield analysis tables, varieties with the same letter for Test Means Separation indicate there is no significant difference in yield between those varieties. Complete results can be viewed at the University of Idaho Jerome County Extension web site.

Results

Table 1. Yield results for 82-91 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Test Means Separation-Yield
Eur 7161	33.4	A
Eur 3029	31.4	A B
FOS HDS 90	31.0	A B
MC 3221	30.8	A B
Eur 3027	30.8	A B
FOS HDS 85	30.3	A B
Eur 3028	29.0	B
MC 4050	28.3	B
Mean	30.6	
LSD (.05)	3.9	
CV%	8.61	

Table 2. Quality results for 82-91 RM silage varieties **(NIR).**

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	48 HR dNDF	48 HR NDFD	NEL Mcal/lb	Milk lbs/ton DM
Eur 7161	33.4	6.5	43.0	75.3	18.4	32.3	21.4	66.4	.83	3725
Eur 3029	31.4	6.8	35.9	72.5	21.7	37.4	24.1	64.5	.77	3629
FOS HDS 90	31.0	6.8	35.9	72.0	22.3	36.6	24.6	67.2	.77	4097
MC 3221	30.8	6.8	34.7	70.8	23.8	38.8	25.1	64.7	.74	3617
Eur 3027	30.8	7.0	39.0	73.7	20.3	32.0	20.6	64.3	.80	3736
FOS HDS 85	30.3	6.6	36.0	72.1	22.2	35.6	21.3	59.9	.77	3837
Eur 3028	29.0	7.0	32.9	70.8	23.8	38.3	26.5	69.1	.74	4077
MC 4050	28.3	6.7	37.9	73.6	20.4	32.7	21.6	65.9	.80	4041

Table 3. Quality results for 82-91 RM silage varieties (Wet Chemistry).

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	NEL Mcal/lb	Milk lbs/ton DM
Eur 7161	33.4	5.6	40.7	74.8	19.0	33.9	.82	3725
Eur 3029	31.4	5.7	34.9	72.7	21.5	38.0	.78	3629
FOS HDS 90	31.0	5.6	34.5	73.0	21.2	37.1	.78	4097
MC 3221	30.8	5.6	30.1	71.5	22.9	39.3	.76	3617
Eur 3027	30.8	6.0	35.0	74.8	19.1	32.6	.82	3736
FOS HS 85	30.3	5.4	32.3	72.6	21.6	36.9	.78	3837
Eur 3028	29.0	5.5	33.7	72.0	22.3	38.9	.77	4077
MC 4050	28.3	6.2	37.5	74.5	19.4	33.8	.81	4041

Table 4. Yield results for 92-99 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Test Means Separation-Yield
Eur 2048	34.0	A
FOS HDS 95	31.3	A B
Eur 7227	31.3	A B
Eur 7190	30.3	B C
Eur 2024	28.0	B C
MC 4590	27.0	C
Mean	30.3	
LSD (.05)	3.7	
CV%	8.1	

Table 5. Quality results for 92-99 RM silage varieties **(NIR).**

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	48 HR dNDF	48 HR NDFD	NEL Mcal/lb	Milk lbs/ton DM
Eur 2048	34.0	6.3	33.7	70.8	23.7	38.3	22.9	59.7	.74	3762
FOS HDS 95	31.3	5.8	32.2	71.9	22.4	33.2	23.1	69.6	.76	3715
Eur 7227	31.3	6.5	34.5	71.9	22.5	36.9	23.4	63.4	.76	3899
Eur 7190	30.3	6.1	33.9	71.2	23.3	37.1	22.8	61.3	.75	3766
Eur 2024	28.0	6.7	32.2	70.8	23.8	40.8	24.8	60.9	.74	3767
MC 4590	27.0	6.7	27.9	68.5	26.4	41.5	28.7	69.0	.70	3854

Table 6. Quality results for 92-99 RM silage varieties **(Wet Chemistry).**

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	NEL Mcal/lb	Milk lbs/ton DM
Eur 2048	34.0	5.7	32.6	70.9	23.6	39.3	.74	3762
FOS HDS 95	31.3	6.2	32.6	72.2	22.1	37.9	.77	3715
Eur 7227	31.3	5.5	33.2	71.0	23.5	38.3	.75	3899
Eur 7190	30.3	5.6	32.4	70.6	24.0	38.7	.74	3766
Eur 2024	28.0	5.3	29.2	69.7	25.0	42.4	.72	3767
MC 4590	27.0	5.4	27.0	69.1	25.7	42.9	.71	3854

Table 7. Yield results for 101-108 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Test Means Separation-Yield
Eur 2027	39.3	A
Eur 2026	34.5	A
Eur 3026	34.0	A B
FOS Pure Maize	28.8	B
Mean	34.1	
LSD (.05)	5.8	
CV%	10.5	

Table 8. Quality results for 101-108 RM silage varieties **(NIR).**

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	48 HR dNDF	48 HR NDFD	NEL Mcal/lb	Milk lbs/ton DM
Eur 2027	39.3	6.7	36.6	72.1	22.2	34.8	21.3	61.1	.77	3892
Eur 2026	34.5	6.7	31.7	69.8	24.9	39.8	26.6	66.9	.72	3966
Eur 3026	34.0	6.7	39.2	72.8	21.4	34.3	20.9	61.0	.78	3585
FOS Pure Maize	28.8	6.1	23.8	67.1	28.1	45.7	29.0	63.5	.67	3507

Table 9. Quality results for 101-108 RM silage varieties **(Wet Chemistry).**

Treatment	DM Corrected Yield 32%	Crude Protein % DM	Starch % DM	TDN %DM	ADF %DM	aNDF %DM	NEL Mcal/lb	Milk lbs/ton DM
Eur 2027	39.3	5.9	34.6	73.0	21.2	36.1	.78	3892
Eur 2026	34.5	5.8	29.4	71.0	23.5	40.6	.75	3966
Eur 3026	34.0	6.2	35.1	74.3	19.6	35.4	.81	3585
FOS Pure Maize	28.8	5.5	24.7	68.2	26.8	44.6	.69	3507

Table 10. Grain corn variety results.

Variety	% Moisture	Test Weight	Corrected Yield bu/A*	Test Means Separation-Yield
Eur 2048	15.4	51.4	275	A
Eur 2024	16.1	53.5	262	A B
Eur 2025	16.7	53.6	252	A B C
Eur 7190	14.9	51.6	242	A B C D
Eur 3026	16.8	54.2	241	A B C D

Eur 3028	14.9	53.9	226	B C D E
Eur 3027	15.0	52.4	224	B C D E
Eur 2042	15.8	51.6	209	C D E
Eur 3029	13.3	49.4	209	C D E
Eur 7227	16.8	55.2	200	D E
Eur 3030	13.3	54.2	200	D E
Eur 7161	15.0	54.3	182	E
Mean	15.3	53.0	227	
LSD (.05)	1.0	4.4	45.6	
CV%	4.4	5.8	14.0	

Table 11. Index of silage varieties.

Variety*	**RM**
MC 3221	82
Eur 7161	85
Eur 3029	85
Eur 3028	87
FOS HDS 85	88
FOS HDS 90	90
MC 4050	90
Eur 3027	91
Eur 7190	92
Eur 2048	95
MC 4590	95
Eur 2048	95
FOS HDS 95	97
Eur 2024	97
FOS HDS 95	97
Eur 7227	99
Eur 7227	99
Eur 3026	101
Eur 2026	107
FOS Pure Maize	107
Eur 2027	108

Table 12. Index of grain varieties.

Variety*	**RM**
Eur 3030	80
Eur 3029	85
Eur 7161	85
Eur 3028	87
Eur 3027	91
Eur 7190	92
Eur 2048	95
Eur 2048	95
Eur 2042	96
Eur 2024	97
Eur 2024	97
Eur 7227	99
Eur 2025	101
Eur 3026	101
Eur 2025	101

*
Eur-Eureka Seed
FOS-Foundation Organic Seeds, LLC.
MC-Masters Choice

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