PROCEEDINGS

2010 Idaho Alfalfa and Forage Conference

Best Western Burley Inn, Burley, Idaho
16-17 February, 2010

IDAHO HAY AND FORAGE ASSOCIATION, INC.

IHFA

University of Idaho Extension

Idaho Forage Team

Additional copies of these proceedings are available from:
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Welcome to the
2010 Idaho Alfalfa & Forage Conference
Burley, Idaho, 16-17 February 2010

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 marketing and legal issues, and continue with a panel about how to better secure getting paid. During lunch the Idaho Hay and Forage Association will conduct a short business meeting and give an update on legislative issues. Four topics about weed and pest management for forages will be presented and will provide 2 credits for the Idaho Pesticide Recertification. A new approach to fertility management by tissue testing will be presented and as well as a look into the future of low lignin alfalfa and the status of Roundup Ready™ alfalfa. The last day of the conference will cover forage crop management and conclude with discussing corn silage topics. Our objectives are to: 1) extend research information; 2) provide continuing education; 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 and the University of Idaho Extension System. Welcome to the 2010 Idaho Alfalfa and Forage Conference!

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IDAHO ALFALFA VARIETY TRIALS 2009

Glenn Shewmaker[1], Greg Blaser, and Ron Roemer

INTRODUCTION

Alfalfa is the most productive and widely adapted forage species. Idaho alfalfa acreage is about 1.25 million acres, and produced 5 million ton—third in the US--with an estimated gross value of $1 billion in 2008. 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. The 2008 Kimberly Alfalfa variety trial was planted on September 2, 2008 at the University of Idaho's Kimberly Research and Extension Center. A 2006 trial was planted May 17, 2006 at the Brigham Young University-Idaho farm in Rexburg, ID in cooperation with Greg Blaser, agronomist BYU-Idaho. 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 rank of highest average yearly yield. The "LSD" statistic given at the bottom of the table tells us that varieties with yield-differences less than that value in that column are not significantly different. For example, the BYU-Idaho 2009 3 year average yield LSD value is 0.42 tons/acre. So yield from '4R200' (8.93 tons/acre) is not statistically different than 'Legendairy 5.0' (8.53 tons/acre) or any yield between 8.93 and 8.53. There is a page full of good varieties!

[1] G. Shewmaker, Univ. of Idaho Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-1827. Published **In**: Proceedings, Idaho Alfalfa and Forage Conference 16-17 February 2010, Twin Falls, ID, University of Idaho Extension.

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, Oregon’s Malheur Station trials, and others similar in climate.

5. The forage quality data is preliminary and may change due to NIRS recalibration. However, relative differences will probably not change.

6. Kimberly Trial: This was the first production year. The spring was unusually cool and since the first cutting was first cutting in the establishing year, it produced only about 0.74 ton/acre hay. The 2nd, 3rd, and 4th cuttings were normal yields. The stands are good.

7. BYU-Idaho Trial: Good stand, cool June weather and rain limited 2nd cutting yield, but an excellent yield for the elevation.

8. Check Varieties: Vernal is a public check variety used in all trials. Vernal should yield near the bottom of the list. Check 1 and check 2 are several year old commercial varieties.

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 Alliance's: http://www.alfalfa.org

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

Montana State University Extension: http://www.animalrangeextension.montana.edu/Forage/forage.htm

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

University of Idaho Alfalfa Variety Trials, 2009 BYU- Idaho Commercial Test Harvesting Date: June 1, June 26, July 31, September 9, 2009 3rd Year, Planted May 2006						
	2007-9	2009 Forage dry matter yield				
	3 Year Average	Year total	1st	2nd	3rd	4th
Cultivar	Tons/Acre	- - - - - - - - - - - - - - Tons/Acre - - - - - - - - - - - - -				
4R200	8.93	7.71	2.69	0.41	2.22	2.39
WL343HQ	8.67	7.63	2.90	0.30	2.30	2.13
Magnum VI	8.63	7.75	2.99	0.34	2.10	2.32
Marvel	8.63	7.71	3.05	0.32	2.08	2.27
FSG408DP	8.57	7.42	2.94	0.31	1.63	2.53
MasterPiece	8.56	8.09	3.42	0.30	1.89	2.49
DKA41-18RR	8.55	7.56	2.91	0.30	2.01	2.35
Lariat	8.54	7.26	2.75	0.30	1.94	2.27
FSG406	8.53	7.58	2.71	0.26	2.25	2.36
Legendairy 5.0	8.53	7.34	2.73	0.34	2.01	2.26
Mystery check1	8.50	7.37	2.61	0.34	2.01	2.41
TS-5010	8.48	7.47	2.74	0.30	1.99	2.46
54V09	8.48	7.49	2.95	0.33	2.02	2.19
Whitney	8.45	7.11	2.72	0.34	1.92	2.13
9429	8.39	7.68	2.75	0.33	2.19	2.42
Vernal	8.39	7.50	2.99	0.29	1.72	2.51
Arapaho	8.37	7.60	2.87	0.38	1.85	2.50
DKA34-17RR	8.34	7.71	2.88	0.35	2.23	2.25
54Q25	8.32	7.25	2.80	0.29	1.88	2.28
Kingfisher 30-30Q	8.32	7.78	3.25	0.31	1.76	2.46
Oneida VR	8.29	7.38	2.84	0.27	1.92	2.36
Melton	8.22	7.75	3.21	0.38	1.73	2.43
Ameristand 403T	8.18	7.37	2.64	0.30	2.07	2.35
Shaw	8.13	7.33	2.86	0.33	1.79	2.35
FSG351	8.11	6.88	2.43	0.26	1.84	2.35
Mariner III	8.08	7.73	3.13	0.34	1.93	2.33
Mean	8.43	7.52	2.87	0.32	1.97	2.35
LSD (.05)	0.42	NS	NS	NS	0.32	0.24
CV %	6.1	6.0	13.7	32.4	11.5	7.3

University of Idaho Alfalfa Variety Trials, 2009

Kimberly Variety Test

Harvesting Date: May 20, June 23, July 23, October 10, 2009

First Year, Planted: September 2, 2008

2009 Forage dry matter yield

	Total	1st	2nd	3rd	4th
Cultivar	Tons	- - - - - - - - - - - - -	Tons/Acre	- - - - - - - - - - - - -	
Withstand	6.67	0.81	2.16	2.38	1.32
Phoenix	6.96	0.76	2.40	2.50	1.30
eXalt	7.03	0.83	2.26	2.63	1.32
CW045035	7.16	0.83	2.36	2.60	1.38
CW044031	6.84	0.77	2.29	2.46	1.31
eXceed	7.12	0.72	2.32	2.69	1.39
PGI459	6.83	0.71	2.17	2.52	1.44
DKA43-13	6.85	0.71	2.25	2.49	1.40
Rebound 5.0	7.12	0.81	2.27	2.55	1.50
Mountaineer 2.0	6.53	0.78	2.06	2.37	1.32
DKA50-18	6.85	0.66	2.18	2.56	1.46
WL343HQ	6.78	0.71	2.13	2.65	1.29
WL363HQ	6.67	0.64	2.25	2.49	1.30
FSG528SF	6.96	0.69	2.32	2.57	1.38
FSG639ST	6.95	0.68	2.16	2.61	1.49
FSG429SN	6.70	0.80	2.09	2.40	1.41
06KH17B	6.85	0.75	2.09	2.61	1.41
TS 4028	7.23	0.79	2.40	2.65	1.38
TS5026	6.55	0.69	2.10	2.40	1.36
Lightning IV	7.00	0.80	2.34	2.48	1.39
Vernal	6.92	0.63	2.21	2.61	1.48
Oneida	7.05	0.70	2.31	2.57	1.47
54V09	6.71	0.77	2.15	2.55	1.24
Check1	6.86	0.70	2.25	2.56	1.36
Mean	6.88	0.74	2.2	2.5	1.38
LSD (.05)	NS	NS	NS	NS	NS
CV %	6.3	23.4	9.4	8.4	10.8

University of Idaho Alfalfa Variety Trials, 2009

Forage Quality on Harvesting Date: June 1, 2009

BYU- Idaho Commercial Test

Entry	1st Cut	CP	ADF	NDF	$dNDF_{48}$	Lignin	Ash	Fat	NE_L	NE_m	NE_g	RFV	NDFD	NFC	TDN1	RFQ	Milk/ Ton	Milk/ Acre
	Tons/A	(%)	(%)	(%)	(%)	(%)	(%)	(%)	Mcal/lb	Mcal/lb	Mcal/lb	Index	(%)	(%)	(%)	Index	lb/T	lb/A
9429	2.75	23.3	29.0	35.8	22.4	6.85	12.2	2.44	0.70	0.71	0.44	174	62.6	28.3	66.7	210	2411	5909
4R200	2.69	23.1	30.0	35.7	21.7	6.80	11.9	2.13	0.69	0.69	0.42	172	61.1	29.3	66.1	207	2394	6465
54Q25	2.80	23.6	29.0	34.5	21.0	7.15	12.0	2.12	0.70	0.71	0.44	180	61.2	30.0	66.5	213	2435	6808
54V09	2.95	23.6	29.8	35.4	21.2	6.91	11.8	2.13	0.69	0.69	0.42	173	60.0	29.2	66.0	205	2407	7130
Arapaho	2.87	23.0	29.7	35.5	21.0	7.25	11.8	2.00	0.69	0.70	0.43	173	59.2	29.7	65.5	202	2379	6868
DKA34-17RR	2.88	22.1	30.7	37.3	22.6	7.55	11.6	2.33	0.68	0.68	0.41	162	60.5	28.8	65.9	195	2373	6827
DKA41-18RR	2.91	23.3	29.8	36.1	21.9	7.14	12.0	2.18	0.69	0.70	0.43	171	60.7	28.6	65.8	203	2373	6911
DS417	2.99	23.3	29.5	35.3	21.3	7.06	11.6	2.20	0.70	0.70	0.43	174	60.2	29.5	66.3	206	2429	7235
FSG351	2.43	23.3	30.3	36.9	22.0	7.09	11.5	2.19	0.68	0.69	0.42	166	59.7	28.0	65.5	197	2373	5738
FSG406	2.71	23.0	29.6	34.7	21.0	7.37	11.7	2.17	0.69	0.70	0.43	177	60.5	30.5	66.6	211	2453	6633
FSG408DP	2.94	22.3	30.8	37.2	22.2	7.70	11.9	2.13	0.68	0.68	0.41	163	59.9	28.6	65.2	193	2327	6799
Kingfisher 30-30Q	3.25	22.8	30.5	37.6	22.7	7.14	11.8	2.16	0.68	0.69	0.42	162	60.3	27.8	65.3	193	2330	7558
Lariat	2.75	23.1	29.0	35.3	21.6	7.02	11.7	2.35	0.70	0.71	0.44	176	60.8	29.3	66.5	208	2436	6633
Legendairy 5.0	2.73	23.7	29.2	34.8	21.3	6.94	11.7	2.16	0.70	0.71	0.44	178	61.3	29.7	66.7	213	2449	6674
Mariner III	3.13	23.3	30.5	36.5	21.9	6.95	11.8	2.20	0.68	0.69	0.42	167	60.0	28.3	65.6	198	2368	7386
Marvel	3.05	23.2	29.8	35.3	21.2	6.98	12.4	2.12	0.69	0.70	0.43	174	60.2	29.1	65.5	205	2362	7210
MasterPiece	3.42	22.4	31.4	37.9	22.6	7.20	11.4	2.23	0.67	0.67	0.40	159	59.9	28.2	65.5	192	2357	8022
Melton	3.21	23.2	30.0	36.3	21.5	7.10	11.9	2.13	0.69	0.69	0.43	169	59.2	28.6	65.3	197	2356	7485
Mystery check1	2.61	23.3	30.0	36.0	21.8	7.67	11.9	2.19	0.69	0.69	0.42	170	60.4	28.6	65.8	202	2381	6250
Oneida VR	2.84	23.5	29.0	34.3	21.2	7.14	11.8	2.15	0.70	0.71	0.44	181	62.0	30.4	67.1	218	2468	6980
Shaw	2.86	23.3	29.1	34.7	21.7	6.88	11.5	2.29	0.70	0.71	0.44	178	62.5	30.2	67.5	217	2490	7084
TS-5010	2.74	23.5	29.7	35.9	21.5	6.93	11.5	2.29	0.69	0.70	0.43	172	60.0	28.9	66.2	204	2427	6585
Vernal	2.99	23.3	29.8	35.9	22.2	6.88	11.7	2.27	0.69	0.70	0.43	175	61.9	28.8	66.7	206	2419	7198
Whitney	2.72	22.8	30.5	37.1	21.9	7.01	11.6	2.23	0.68	0.69	0.42	165	59.2	28.4	65.4	195	2362	6362
WL343HQ	2.90	22.8	30.6	37.3	22.4	6.91	12.0	2.21	0.68	0.68	0.42	163	59.8	27.7	65.1	192	2317	6670
Ameristand 403T	2.64	23.4	30.2	36.7	22.1	6.90	12.0	2.14	0.69	0.69	0.42	166	60.2	27.8	65.3	197	2336	6187
Mean	2.87	23.1	29.9	36.0	21.8	7.10	11.8	2.20	0.69	0.7	0.4	171	60.5	28.9	66.0	203	2393	6831
LSD (.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	13.7	5.1	5.0	6.7	5.5	6.9	3.6	8.7	2.6	3.3	5.1	8.5	3.0	6.3	2.1	8.6	4.2	14.7
Pr>F	0.26	0.98	0.82	0.82	0.78	0.41	0.29	0.62	0.82	0.77	0.74	0.85	0.38	0.74	0.58	0.75	0.67	0.43

University of Idaho

Kimberly Variety Trials

Forage Quality Harvested: May 20, 2009

Entry	1st Cut	CP	ADF	NDF	$dNDF_{48}$	Lignin	Ash	Fat	NE_L	NE_m	NE_g	RFV	NDFD	NFC	TDN1	RFQ	Milk/ Ton	Milk/ Acre
	Tons/A	(%)	(%)	(%)	(%)	(%)	(%)	(%)	Mcal/lb	Mcal/lb	Mcal/lb	Index	(%)	(%)	(%)	Index	lb/T	lb/A
Withstand	0.808	24.6	22.7	26.2	13.9	12.5	5.4	1.93	0.77	0.81	0.52	254	53.0	36.9	66.8	262	2614	2040
Phoenix	0.757	24.2	23.3	26.3	14.4	13.1	5.8	1.92	0.77	0.80	0.52	251	54.9	36.7	66.7	263	2648	1750
eXalt	0.830	23.8	23.6	26.9	14.4	12.8	6.0	1.87	0.76	0.79	0.51	244	53.7	36.8	66.4	254	2591	2092
CW045035	0.825	24.5	23.5	26.6	14.3	12.4	5.8	1.94	0.77	0.79	0.51	248	53.8	36.6	66.9	260	2656	2081
CW044031	0.768	24.7	23.1	26.3	14.1	12.6	5.8	1.97	0.77	0.80	0.52	251	53.4	36.4	66.7	260	2642	2187
eXceed	0.720	24.4	23.4	26.6	14.5	12.2	5.7	1.91	0.77	0.80	0.51	248	54.5	36.9	67.2	262	2600	1951
PGI459	0.705	24.9	22.6	25.7	14.2	12.6	5.5	1.92	0.78	0.81	0.53	260	55.2	37.0	67.4	272	2665	1730
DKA43-13	0.707	24.3	24.1	27.4	14.5	12.4	5.9	1.90	0.76	0.78	0.50	239	53.0	36.0	66.3	249	2571	1950
Rebound 5.0	0.805	23.6	25.4	28.9	15.1	12.6	6.2	1.86	0.74	0.77	0.49	224	52.3	35.0	65.2	232	2477	2048
Mountaineer 2.0	0.782	23.8	24.3	28.1	15.1	12.7	6.0	1.88	0.76	0.78	0.50	233	53.9	35.5	65.9	243	2570	1713
DKA50-18	0.657	24.5	22.4	26.0	14.0	12.9	5.5	1.91	0.78	0.81	0.53	258	53.9	36.7	66.6	266	2668	1846
WL343HQ	0.713	24.1	23.0	26.6	14.3	12.6	5.6	2.00	0.77	0.80	0.52	249	53.6	36.8	66.7	258	2642	2077
WL363HQ	0.637	25.0	23.1	26.4	14.6	12.8	5.7	1.93	0.77	0.80	0.52	251	55.4	35.9	67.0	264	2665	1746
FSG528SF	0.688	24.6	23.7	27.1	14.6	12.5	5.7	1.92	0.76	0.79	0.51	242	53.8	35.9	66.5	253	2588	1803
FSG639ST	0.683	24.1	24.5	27.8	15.0	12.4	6.1	1.92	0.75	0.78	0.50	235	54.2	36.0	66.6	249	2599	1962
FSG429SN	0.800	25.5	21.8	25.2	14.0	12.8	5.2	1.99	0.79	0.82	0.54	266	55.8	36.6	67.7	279	2700	1973
06KH17B	0.748	24.5	23.1	26.4	14.5	12.8	5.8	2.00	0.77	0.80	0.52	251	55.1	36.3	67.0	264	2643	1904
TS 4028	0.792	24.1	24.4	27.8	15.0	12.2	5.9	1.95	0.76	0.78	0.50	234	53.7	35.9	66.6	247	2591	1731
TS5026	0.688	25.4	22.9	26.1	14.4	12.9	5.6	1.89	0.77	0.80	0.52	254	55.0	35.7	66.8	265	2673	1991
LightningIV	0.795	24.5	23.6	26.8	14.6	12.5	5.8	1.91	0.76	0.79	0.51	244	54.5	36.4	66.9	258	2621	2140
Vernal	0.628	22.9	25.6	29.3	15.4	12.5	6.4	1.94	0.74	0.76	0.48	220	52.8	35.4	65.4	230	2523	1547
Oneida	0.695	24.1	23.9	27.3	14.8	12.5	5.9	1.95	0.76	0.79	0.51	241	54.3	36.2	66.7	254	2625	1514
54V09	0.772	24.1	24.2	27.5	14.9	12.5	6.0	1.90	0.76	0.79	0.50	238	54.2	36.1	66.5	250	2630	2117
Check1	0.700	25.7	23.4	26.8	14.3	12.9	5.5	1.83	0.77	0.80	0.51	248	53.5	34.8	66.1	255	2615	1773
Mean	0.74	24.4	23.6	26.9	14.5	12.6	5.8	1.92	0.76	0.79	0.51	245	54.0	36.2	66.6	256	2617	1903
LSD (.05)	NS	NS	1.7	2.0	NS	0.7	NS	NS	0.02	0.03	0.02	22	NS	NS	NS	24	107	NS
CV %	23.4	4.9	5.2	5.2	4.4	6.6	3.8	4.1	1.9	2.3	3.1	6.5	3.5	3.3	1.4	6.8	2.9	22.5
Pr>F	0.813	0.41	0.01	0.02	0.06	0.01	0.59	0.43	0.01	0.01	0.00	0.02	0.67	0.47	0.16	0.05	0.04	0.78

Entry information for BYU-Idaho Trials

Marketer	Variety	FD	WS	Bw	Vw	Fw	An	PRR	APH	SAA	PA	BAA	SN	NRKN
Northwest Seed	9429	4	3	HR	R	HR	HR	HR	-	R	HR	HR	R	R
Tri-West Seed	30-30Q	3	2	HR	HR	HR	HR	HR	HR	R	R	-	-	-
Northwest Seed	4R200	4	2	HR	HR	HR	HR	HR	-	R	R	-	HR	R
Pioneer	54Q25	4	-	HR	HR	HR	HR	HR	-	R	R	-	HR	HR
Pioneer	54V09	4	-	HR	HR	R	HR	HR	-	R	HR	-	HR	HR
Tri-West Seed	Arapaho	3	2	HR	R	HR	R	HR	-	-	MR	-	R	HR
Mystery check	Check1	3	2	-	-	-	-	-	-	-	-	-	-	-
Mystery check	Check2	4	2	-	-	-	-	-	-	-	-	-	-	-
Dekalb	DKA34-17RR	3	2	HR	HR	HR	HR	HR	HR	-	HR	-	R	-
Dekalb	DKA41-18RR	4	2	HR	HR	HR	HR	HR	HR	R	HR	-	R	-
Dairyland/Tri-West Seed	Magnum VI	4	2	HR	HR	HR	HR	HR	HR	-	MR	-	R	HR
Farm Science Genetics	FSG351	3	2	HR	R	HR	R	HR	-	R	HR	R	R	HR
Farm Science Genetics	FSG406	4	1	HR	HR	HR	HR	HR	-	-	R	-	R	R
Farm Science Genetics	FSG408DP	4	2	HR	R	HR	HR	HR	-	-	R	-	R	HR
Simplot Grower Solutions	Lariat	3	1	HR	HR	HR	HR	HR	HR	-	HR	-	R	R
Cropland Genetics	Legendairy 5.0	3	2	HR	HR	HR	HR	HR	R	R	R	-	MR	LR
Allied Seed, LLC	Mariner III	4	2	HR	HR	HR	HR	HR	-	-	R	-	R	-
Allied Seed, LLC	Marvel	4	2	HR	HR	HR	HR	HR	-	R	R	-	-	-
Simplot Grower Solutions	MasterPiece	4	-	HR	R	HR	HR	HR	R	R	-	R	HR	R
Montana State Univ.	Melton	3	-	R	R	R	-	HR	-	MR	R	-	R	HR
Public--std check	Oneida VR	3	-	R	HR	HR	MR	MR	-	-	-	-	-	-
Montana State Univ.	Shaw	3	-	HR	MR	-	MR	R	-	R	R	-	MR	HR
Target Seed	TS-5010	4+	-	R	R	R	R	HR	-	R	R	R	HR	R
Public--std check	Vernal	2	-	R	-	MR	-	-	-	-	-	-	-	-
Northwest Seed	Whitney	4	3	HR	HR	HR	HR	HR	-	R	HR	-	HR	R
W-L Research	WL343HQ	4	2	HR	HR	HR	HR	HR	-	MR	R	MR	MR	-

Entry information for Kimberly Trials

Marketer	Variety	FD	WS	Bw	Vw	Fw	An	PRR	SAA	PA	BAA	SN	NRKN
Allied Seed, LLC	Withstand	4	2	HR	HR	HR	HR	HR		HR			
Allied Seed, LLC	Phoenix	5	4	HR	HR	HR	HR	HR		HR		HR	MR
AgSeeds	eXalt	4	2	HR	HR	HR	HR	HR	R	R		R	HR
Calwest Seeds	CW045035	4		HR	R	HR	R	HR		R	MR		
Calwest Seeds	CW044031	5		HR	R	HR	HR	HR		R	MR		
AgSeeds	eXceed	4	2	HR	HR	HR	HR	HR		R		HR	HR
Producer's Choice Seed	PGI459	4	2	HR	HR	HR	HR	HR		R		HR	HR
Monsanto	DKA43-13	4	2	HR	HR	HR	HR	HR		R		R	R
Cropland Genetics	Rebound 5.0	4	2	HR	HR	HR	HR	HR		R			
Cropland Genetics	Mountaineer 2.0	5		HR	R	HR	HR	HR	R			HR	
Monsanto	DKA50-18	5	2	HR	HR	HR	HR	HR					
W-L Research	WL343HQ	4	1	HR	HR	HR	HR	HR	R	HR	MR	R	MR
W-L Research	WL363HQ	5	2	HR	HR	HR	HR	HR	R	R	MR	HR	R
Farm Science Genetics	FSG528SF	5	2	HR	HR	R	HR	R		R			
Farm Science Genetics	FSG639ST	6	3	HR	R	HR	R	HR		R		HR	HR
Farm Science Genetics	FSG429SN	4	2	HR	HR	R	HR	HR	R	HR		HR	R
FFRL, Logan UT	06KH17B												
Target	TS 4028	4	2	HR	HR	HR	HR	HR					
Target	TS-5026	5	3	HR	HR	HR	HR	HR					
Eureka Seed	LightningIV	4.3	1.5	HR	HR	HR	HR	HR		R			HR
Public--std check	Vernal	2											
Public--std check	Oneida												
Pioneer	54V09	4		HR	HR	R	HR	HR		HR		HR	HR
Mystery check	Check1	4	2	HR	R	HR	R	HR	R	R		HR	MR

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

UNIVERSITY OF IDAHO TWIN FALLS COUNTY 2009 SILAGE CORN VARIETY TRIALS

Steven L. Hines[1]

ABSTRACT

Idaho is the 4th ranked state in the nation for milk production. 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 2009, Idaho producers planted 215,000 acres of corn for silage. 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 trails 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 2009 corn variety trial was conducted by the University of Idaho Twin Falls County Extension office. The trial location was the University of Idaho Kimberly Research and Extension Center farm located at Kimberly, Idaho. There were 27 entries by 4 seed companies for silage and 9 entries by 2 companies for grain. Hybrids ranged between 79-110 days relative maturity (RM).

METHODS

The trial was a randomized complete block design with 4 replications. Silage varieties were split into 3 separate trials based on RM (79-87, 91-99, and 100-110). Individual plots for silage were 4-30" rows x 20 feet. The center two rows were harvested and evaluated for yield and quality.

Silage Analysis

Silage quality analysis was determined by NIRS (Near Infrared Spectral) analysis 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 hrs in the rumen. Higher is more desirable.
2. CP= Crude protein. Higher protein levels indicate less need for more expensive supplements in the ration.
3. ADF= Acid detergent fiber. A measure of the less digestible components in the forage. Lower is more desirable. Higher ADF is generally related to more mature plants.
4. NDF= Neutral detergent fiber. A measure of the fiber content of the silage. Relates to intake level in livestock. Lower is more desirable.
5. Starch= Starch. A measure of the energy portion of the silage. Higher is more desirable.
6. NEL= Net energy for lactation. An energy measurement used in estimating amount of energy available for milk production. Higher is more desirable.

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Agronomic Information

The field is located approximately 1 ½ miles northeast 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 previous 3 crops were potatoes in 2008, oats in 2007, and alfalfa planted in 2003. Soil amendments included 58 units of 11-52-0/ac and 51 units of 46-0-0/ac. Herbicide treatment included one application of Dual Magnum at a rate of 1.5 pints/ac pre-plant incorporated. Volunteer potato plants were removed by hand. No additional herbicides were used. No insecticides were used. The plots were planted with an Almaco Twin Plate 2 vacuum planter. Silage varieties were harvested with a John Deere two row forage harvester. Late in the season aphids were very evident across the trials. Very few western corn root worm adults (*Diabrotica virgifera*) were observed. Hail storms created minor damage on June 5 and July 5, 2009.

RESULTS

79-87 days relative maturity- Plots were planted May 11, 2009. Harvest took place on September 9, 2009. Harvest moisture was corrected to 32% dry matter. The results for yield are shown in Table 1. The results for quality are shown in Table 2. For all results in this report, quality data were not statistically analyzed as there was only one sample for each variety submitted for quality testing. Milk per acre is given as one method to compare the quality data and not meant to be the only method. In the yield tables, varieties with the same means separation letter (A, B, or C) indicate no statistical difference between those varieties.

Table 1. Yield results for 79-87 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Days to Silk	Stand Density	Test Means Separation-Yield
EU 9083	28.50	58	37450	A
EU 9087	27.25	60	38158	A
EU 9057	27.25	61	37609	A
Mean	27.67	59.67	37756	
LSD (.05)	2.63	2.58	5222.3	
CV%	2.45	2.45	2.45	

Table 2. Quality results for 79-87 RM silage varieties.

Variety	Relative Maturity	Harvest Moisture %	Tons DM/a	Crude Protein % DM	ADF %DM	NDF %DM	Starch % DM	IVTD 24 hr % DM	NEL Mcal/ lb	Milk lbs/a
EU 9087	79	64	9.7	7.2	22.6	37.8	34.3	82	0.71	34623
EU 9057	81	67	8.8	6.6	27.0	42.9	25.4	78	0.63	28483
EU 9083	87	67	9.4	7.7	26.5	39.6	23.7	80	0.62	28318

Quality results not replicated. Only ranked by Milk lbs/acre

90-99 days relative maturity-Plots were planted May 11th. The plots were harvested September 17th. Harvest moisture was corrected to 32% dry matter. The results for yield are shown in Table 3. Results for quality are shown in Table 4.

Table 3. Yield results for 90-99 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Days to Silk	Stand Density	Test Means Separation-Yield
EU 9074	41.00	64	38957	A
MY 494	40.00	64	41228	A
MY 422	38.50	65	40022	A B
MC 490	38.25	66	36294	A B
EU 7130	38.00	64	41557	A B
DA 6991	37.25	64	40022	A B
EU 9081	35.25	61	35198	B C
EU 9085	33.25	61	36952	C
Mean	37.69	63.53	38734	
LSD (.05)	3.85	1.42	2375.5	
CV%	2.08	2.08	2.08	

Table 4. Quality results for 90-99 RM silage varieties.

Variety	Relative Maturity	Harvest Moisture %	Tons DM/a	Crude Protein % DM	ADF %DM	NDF %DM	Starch % DM	IVTD 24 hr % DM	NEL Mcal/lb	Milk lbs/a
EU 9074	95	69.8	12.4	6.5	23.0	37.9	34.1	80	0.70	43634
EU 9085	92	63.8	11.9	7.4	20.8	36.0	37.3	79	0.72	40043
MY 422	94	69.4	11.6	7.4	24.3	40.6	30.6	77	0.69	39128
DA 6991	99	71.2	10.9	7.0	24.7	39.9	31.8	77	0.69	37177
MY 494	97	71.1	11.6	7.4	24.5	39.2	29.9	77	0.67	36888
EU 9081	91	67.3	11.4	7.0	22.8	36.6	32.2	78	0.68	36464
EU 7130	95	71.8	10.7	6.8	24.7	39.8	31.2	78	0.69	36049
MC 490	98	70.5	11.2	6.7	28.8	46.4	26.8	71	0.63	31881

Quality results not replicated. Only ranked by Milk lbs/acre

100-110 days relative maturity-Plots were planted May 11th. The plots were harvested September 28th. Harvest moisture was corrected to 32% dry matter. The results for yield are shown in Table 5. Results for quality are shown in Table 6. During planting a hydraulic leak created a drop in vacuum at the planter and 24 replications were either not planted or planted sporadically as a result. This situation was not identified until emergence at which time replanting was not an option. Because of the loss of these replications, some varieties were replicated 2X, some 3X, and some 4X. This made running any meaningful statistical difference impossible. By ranking the varieties based on corrected yield, differences can be observed, though not quantified statistically.

Table 5. Yield results for 100-110 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Days to Silk	Stand Density	Test Means Separation- Yield *
MY 622	42.00	71	41667	*
MY 716	41.50	71	40131	*
EU 9047	40.00	68	40351	*
DA 7081	39.75	69	40351	*
MY 635	39.50	71	41008	*
EU 9089	39.00	71	41447	*
MC 922H	39.00	68	38158	*
EU 9048	38.67	66	38158	*
MC 931H	38.00	71	33334	*
MC 530	37.00	67	41228	*
DA 8041	36.67	64	39181	*
EU 9042	35.00	65	38816	*
EU 9041	34.33	67	39766	*
EU 9068	34.00	64	39912	*
MY 587	34.00	65	40789	*
EU 9084	33.50	64	39802	*
Mean	37.43	67.28	39671	
LSD (.05)	*****	*	*	
CV%	2.08	2.08	2.08	

***** Means separation and LSD were not calculated due to loss of a number of plots.

Table 6. Quality results for 100-110 RM silage varieties.

Variety	Relative Maturity	Harvest Moisture %	Tons DM/a	Crude Protein % DM	ADF %DM	NDF %DM	Starch % DM	IVTD 24 hr % DM	NEL Mcal/ lb	Milk lbs/a
MY 716	109	66.2	13.9	6.3	25.2	40.8	34.3	79	0.7	50512
EU 9048	105	65.6	13.1	6.2	20.9	35.9	39.3	80	0.74	47085
EU 9042	105	61.9	13.3	6.2	22.3	38.1	36.4	80	0.7	46699
DA 7081	108	66.4	13.4	6.3	24.5	38.9	32.2	79	0.69	46408
EU 9047	102	64.9	14.0	6.5	19.6	33.9	42.1	77	0.76	46332
MC 530	105	63.3	13.6	6.8	19.3	33.6	41.2	79	0.75	45435
DA 8041	104	62.5	13.5	6.6	18.4	32.1	41.4	80	0.73	44550

MY 622	109	70.7	12.3	6.9	25.8	43.1	27.5	80	0.69	43834
MC 922H	107	69.3	12.0	7.1	22.7	36.4	35	79	0.73	43402
EU 9089	105	64.3	13.9	6.3	20.6	34.8	38.6	77	0.72	42590
MC 931H	105	66.6	12.7	6.5	23.2	37.7	34.1	77	0.70	41490
MY 587	105	66.4	11.4	6.4	24.6	40.6	32.9	78	0.71	41001
EU 9084	102	62.4	12.4	6.7	20.6	35.3	40.6	79	0.73	40922
EU 9068	102	61.6	13.1	6.7	19.2	32.9	41.0	79	0.72	40722
MY 635	110	71.7	11.3	7.3	22.5	37.5	32.0	83	0.71	40016
EU 9041	104	62.6	12.7	6	26.1	42.8	30.5	75	0.65	39674

Quality results not replicated. Only ranked by Milk lbs/acre

CONCLUSION

The full report including results for the grain varieties can be found on the Twin Falls County Extension website (http://www.extension.uidaho.edu/twinfalls/Crops/2009%20final%20report.pdf). The Idaho on-farm corn silage production average yield is 25.5 tons/acre. All results in the 2009 variety trial exceeded this average. These yields were obtained on small plots under careful management. There will likely be some yield reduction under farm scale production due to differences in soil type, fertility levels, planting densities, weed controls, and irrigation practices to name a few.

CENTER PIVOT DESIGN AND MANAGEMENT FOR FORAGE PRODUCTION

W. Howard Neibling, Glenn E. Shewmaker, and Christi L. Falen[1]

ABSTRACT

Center pivots provide an energy and labor-saving, highly uniform method for irrigation of alfalfa and other forage crops. However, surface runoff and excessive wheel rutting can be a problem on some low-intake soils. By the nature of the system, water application rate must increase with distance outward from the pivot point, producing high runoff potential. On some low-intake soils, additional design factors and management practices must be considered to prevent runoff. To encourage deeper root development and reduce water stress during cutting and high ET periods, the entire root zone depth should be filled to field capacity before irrigation is stopped for the first cutting. Adequate system water application capacity provides more management options and minimizes periods of water stress.

INTRODUCTION

Center-pivot irrigation is a reduced-energy, labor-saving, highly uniform water application method for irrigating alfalfa and other forage crops. Typically, low-pressure water application packages for pivots require about half the system pressure of set systems (solid set, hand line or wheel line), and have application efficiencies of about 80-85% when compared to values of 60-70% for set systems. When considering both the reduced pump output pressure required and the higher fraction of pumped water actually delivered to the soil surface with pivots, energy consumption for pivots should be about half that for set systems. However, care must be used in system design and management to avoid surface runoff and the resulting serious rutting that can occur with pivots.

Pivots should be managed to provide the right amount of water at the right time to maximize forage or pasture yield and quality. Water should be uniformly applied at a rate which will not produce surface runoff, and scheduled to minimize water movement below the plant root zone. In forage or pasture production, additional constraints such as system management around harvest, or integrating irrigation and grazing schedules must be considered when designing systems and selecting equipment components.

FACTORS THAT IMPACT CENTER PIVOT MANAGEMENT

Center pivot management decisions require consideration of soil depth, water holding capacity and infiltration rate of crop water requirements, and timing / magnitude of allowable water stress. More management options are available for a properly-designed system with an adequate application rate.

Crop Properties

Crop properties such as timing and amount of crop water use determine the required timing and rate of water addition by irrigation equipment. Rooting depth and root water extraction pattern, along with soil properties, help determine the maximum amount of a single irrigation and the time between irrigations.

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Alfalfa has a tap root type of root system with water extraction commonly occurring to depths of at least 3 feet, with significant water extraction occurring to 5 feet in deep southern Idaho soils (Falen and Neibling, unpublished data). If soil water content is sufficient, water extraction is relatively uniform with depth. It is important to note that this rooting depth information is for deep, uniform soils with no restrictive soil layers. If a restrictive soil layer (such as a hardpan, bedrock, or a previous tillage-induced layer) is near the soil surface, it will limit plant rooting depth. In some areas, a seasonally high water table may also limit the depth of root development.

Crop Water Use

Evapotranspiration (ET**)** is the sum of evaporation and transpiration. Evaporation is water loss from plant leaves or bare soil surfaces. Transpiration is water vapor loss through small openings in leaves called stomata. ET then represents the water that must be supplied on a daily, or other frequency, to support desired plant growth and yield. The seasonal crop water use pattern establishes the timing of variation in water supply required over the course of the growing season. This pattern must be considered in irrigation water management to avoid plant water stress or over-irrigation during the growing season.
Daily ET for a number of crops is available on-line for 83 stations in the Pacific Northwest from the U.S. Bureau of Reclamation AgriMet (http://www.usbr.gov/pn/agrimet) network, with sites located in Idaho, Montana, Oregon, Washington Nevada, and Wyoming.

As shown in **Figure 1**, ET rates for alfalfa are low early in the season, when temperatures are low and days are short. ET increases as temperature and day length increase. Maximum ET occurs with long days, peak solar radiation, and high temperatures—conditions seen during midseason. It decreases in the fall with decreasing day length and cooler temperatures. Seasonal ET patterns also depend on elevation and latitude. At a given latitude, peak water use is delayed as elevation increases. At a given elevation, peak water use is delayed as latitude increases.

Curves for both long-term average and low / high year of record are given for Twin Falls, Idaho in **Figure 1**. Long-term averages are useful for understanding seasonal variability and timing of peak ET. However, be careful when using averages for irrigation scheduling, since they can underestimate peak ET for many years. In **Figure 1**, note the wide range of expected water use.

Soil Properties

The combination of water holding capacity and root zone depth defines the maximum amount of water that can be stored in the root zone for use by plants. This stored water acts as a buffer to allow continued crop growth during periods when irrigation water cannot be applied, such as around harvest or grazing, or during periods when ET is greater than daily water application.

Each soil can hold only a certain amount of water. Following irrigation and drainage of free soil water, the soil is said to be at field capacity. If additional water is applied, it will run off the soil surface or move below the root zone and perhaps into the groundwater. Both scenarios waste water and may negatively impact water quality. Water-holding capacity varies with soil texture. For example, clay soils can hold more water than sandy soils (see Figure 2). Water-holding capacity also increases with increasing organic matter, while compaction reduces soil pore space and therefore reduces water-holding capacity.

Information on available water for a specific soil can be obtained from the local USDA-NRCS soil survey (http://websoilsurvey.nrcs.usda.gov/app/). NRCS reports available water for each distinct soil layer (expressed as inches of water per inch of soil depth). To obtain the total water-holding capacity for a soil depth, multiply the value given times the depth in inches.

Another way to estimate water-holding capacity is to obtain a soil textural analysis. Knowing a soil's texture and organic matter content enables you to estimate water-holding capacity. **Table 1** shows average values (expressed in inches per foot of soil depth) obtained from laboratory testing of over 50 southern Idaho soils. In the absence of specific information, these numbers provide a reasonable estimate of water-holding capacity.

MATCHING WATER APPLICATION RATE TO SOIL INTAKE RATE

One of the most common difficulties with sprinkler systems is that water is applied at a rate higher than the soil can absorb. As a result, water intended for one spot does not move into the soil at that point, but flows to a lower area and contributes excess water at that point, resulting in dry and wet spots within the field. Yellowed crop appearance, particularly in areas with chronically wet soil, may indicate that nitrogen has been leached below the plant roots and is no longer available for plant use, or that excess water has reduced soil oxygen content below desired levels. Collection of surface runoff in low areas is the most important factor in causing pivot tower drive wheel ruts to deepen and ultimately stop pivot movement. Therefore, elimination of surface runoff is the major factor in reducing pivot rut problems.

Surface runoff occurs after water application rate exceeds the intake rate for a sufficiently long period to fill surface depressions. Infiltration rate (the rate that water will move into the soil) starts out high at the beginning of irrigation and drops off to a nearly constant rate that can be sustained for a long period of time (**Figure 3a**). These steady-state design intake rates are given in **Table 2** for a range of soils and land slopes. They are well-suited for set system design but do not apply directly to center pivot design. Because center pivots apply water to areas near the outer end for a relatively short time, the application rate can be higher than steady-state (**Figure 3b)**. Given a 2.5 day rotation speed and the wetted diameter of the application packages shown in **Figures 3a** and **3b**, the time of water application was calculated and is shown on the x-axis. The area under each of the curves represents the depth of water applied and is equal for all cases (0.75 inch net irrigation). The water application curve for acceptable packages should lie near or under the infiltration curve.

As shown in **Figures 3a** and **3b**, the maximum acceptable application rate at specific points along the pivot depends on the shape of the infiltration curve. This information is difficult to obtain for sprinkler-applied water, so in most cases, the maximum water application rate (or slowest rotation time) must be determined by trial and error. As a general guide, experience in Southern Idaho indicates that applications in excess of about 0.75 inch per revolution tend to produce runoff on silt loam soils. Application rates of 1 inch or higher per revolution may be acceptable on sandy loam or other more coarse-textured soils. Runoff potential can be further reduced by creating surface storage with pitting devices. Water is held in these depressions until it can infiltrate.

Water application rate is low near the pivot point since little area is covered by a sprinkler during one revolution. Application rate increases with distance from the pivot point as shown in **Figure 4**. Center pivot application rates for three types of application packages are shown in **Figure 4**. As the wetted diameter of the application package increases, applied water is spread over a larger area, resulting in lower application rate per unit area and reduced potential for surface sealing or runoff. Additional benefits in runoff reduction can be achieved by using booms on the outer pivot spans to further enlarge the water application pattern and further reduce peak water application rate.

Current USDA-ARS research (Dr. Bradley King, personal communication) indicates that the area over which water is applied has more of an effect on initiation and continued surface runoff than does drop size. Therefore, sprinkler wetted diameter and the use of offset booms appear to be more important in reducing runoff than water drop size. Applying this information to a "typical" sandy loam situation, **Figure 4** would suggest that spray heads (20 ft diameter) are acceptable for the inner 200 feet. Low-pressure sprinklers such as Wobblers or Rotators are acceptable out to 500 feet. Beyond that point, offset booms should be used. On very tight or other runoff-prone soils, another possibility to eliminate runoff is to use shorter lateral length on multiple machines (e.g. two 40-acre pivots vs. one 80-acre windshield wiper). In most cases, this will reduce the application rate at the outer end to an acceptable level.

SYSTEM DESIGN CAPACITY IMPACT ON MANAGEMENT

The combination of soil water storage and irrigation system application must be able to supply the peak water requirements or production will be reduced. Given the variability in peak use shown in **Figure 1**, judgment must be exercised in selecting the design capacity. Selection of appropriate design capacity is beyond the scope of this paper. However, some management implications resulting from a range of design capacities will be discussed.

Gross and Net Irrigation Rate

Irrigation industry personnel typically refer to system capacity in terms of gallons per minute per acre of irrigated area (e.g. gpm/ac), which may be obtained by dividing the system hydraulic capacity (in gpm), by irrigated area in acres. This form of system capacity is useful for hydraulic calculations such as pipe and pump sizing. However, irrigation scheduling calculations require system capacity in terms of depth of water applied per unit time, usually inches per day. To convert gpm/ac to inches/day, multiply by 0.05303. For example, 7 gpm/ac*0.05303 = 0.37 inch/day. This is the gross application rate, the water pumped per day spread uniformly over the area to be irrigated.

However, only a portion of the water applied by irrigation is used by plants. The rest is lost to evaporation, wind drift, runoff, or deep percolation. Application efficiency (AE) refers to the fraction of applied water that is stored in the root zone and is usually expressed as a percentage. Net irrigation, the quantity used in irrigation scheduling calculations, may be obtained by multiplying gross irrigation by AE/100. This represents the water that actually reaches the ground for use as ET. Typical AE values are 70% for high-pressure pivots and 80 to 85% for low-pressure systems. A value of 80% would be used for systems with nozzle height at 6 feet or higher, while 85% would be used for nozzles placed closer to the ground. For example, id gross irrigation is 0.37 in/day, net irrigation for an AE of 80% is 0.37 inches/day * (80/100) or 0.30 inches/day.

Application Depth / Return Time

A properly designed irrigation system applies water to take advantage of the deep rooting characteristics of alfalfa. Assuring that soil is filled to the full rooting depth reduces plant water stress during the period when irrigation is off for harvest, or during periods of reduced water supply. However, some physical constraints such as soil intake (infiltration) rate limit water application rates, and therefore, depth of wetting. For example, center pivots often apply 1 inch of water or less per revolution to minimize surface runoff and excessive pivot track deepening. On a silt loam or other medium- to heavy-textured soil, 1 inch of water usually wets the soil to a depth of only 15 to 18 inches. Deeper soil is not refilled. Because roots do not grow in dry soil, the irrigation system effectively limits root depth. In a sandy soil, 1 inch of water usually is adequate to re-wet soil depths of 2 to 3 feet. **Table 1** also shows the relationship between amount of water applied and depth of wetting for the most common soil textures.

Return time for pivots and linear-move systems is not usually based on root zone water holding capacity but on how much water can be applied per pass without excess runoff occurring. For example, on many soils, net application (considering AE = 85%) of about 0.9 inches or more per pass results in excess runoff and rutting. For average ET of 0.3 in/d and net irrigation of 0.9 inches, return time is 0.9/0.3 or 3 days. With this return time, average root zone soil water content (assuming a 2-foot root zone) is still relatively moist (about 75% available for sandy loam and 81% available for silt loams), but the top portion will be drier than deeper soil layers (70% for sandy loam and 78% for silt loam, assuming 60% water usage from top foot and 40% from second foot).

IRRIGATION SCHEDULING AROUND HARVEST – WATER STRESS AND COMPACTION ISSUES

In crops like alfalfa or grass hay, a window of non-irrigation for each cutting must be considered. To minimize soil compaction, irrigation should be stopped several days before cutting so that soil moisture is reduced to below field capacity in the top foot of soil by the time of cutting. This not only reduces potential for soil compaction but also allows the crop to be dropped on drier soil which should reduce drying time. The ET pattern considering reduction due to cutting and re-growth is shown in **Figure 5**. Assuming a 7-day period for drying and harvest, the minimum time without irrigation will be about 10-11 days for silt loam soils, 10 for sandy loam and 9 for sandy soils (**Table 5**). Estimated ET for the time without irrigation ranges from about 1.4 to 1.7 inches. Even though ET is reduced following cutting, the ET deficit during drying is still about 1 inch. Adequate system capacity will allow this deficit to be re-filled before the next cutting. Another method of evaluating the cumulative effect of system capacity is shown in **Figure 6**. The cumulative water added was limited to meeting ET before first cutting. The ET shown by the solid line is the 30-year average for Kimberly, Idaho. A system capacity of 7.5 gpm/ac will be able to re-fill the root zone after each cutting and have minimal water stress. If the system is managed to enter the first cutting with a full root zone, an additional 1-3 inches of water can be stored in the soil for future use. This would allow the 7.0 gpm/ac capacity to be sufficient and the 6.5 gpm/ac system to be nearly sufficient **in an average year.**

Proper irrigation system maintenance provides additional protection against water stress due to high ET conditions or short water supplies. A well-maintained system will apply water more efficiently and uniformly than a poorly-maintained system, resulting in a larger portion of the field receiving adequate water, and less area over or under-irrigated. Each extra gallon of water pumped, whether the result of leaks, poor uniformity, or excessive irrigation, represents water that could be used to grow the crop and is a direct energy cost.

CONCLUSION

Center pivots with design capacity selected to nearly meet peak ET provide a reduced-energy, highly uniform, low- labor irrigation method for irrigating alfalfa and other forages. Adequate system capacity provides more management options around harvest, increases active rooting depth, and reduces water stress throughout the growing season. Managing pivots to provide deeper soil water storage during hay cutting / drying periods reduces potential for water stress and encourages faster re-growth. Surface runoff and resulting excessive wheel rutting can be a problem on low-intake soils. This problem can be reduced by selecting water application packages that spread the water over a large wetted diameter, limiting water application per revolution, using offset booms on the outer spans of the pivot lateral, managing irrigation and field traffic to minimize soil compaction, and by periodic use of aeration equipment to open the soil surface and provide some temporary surface water storage.

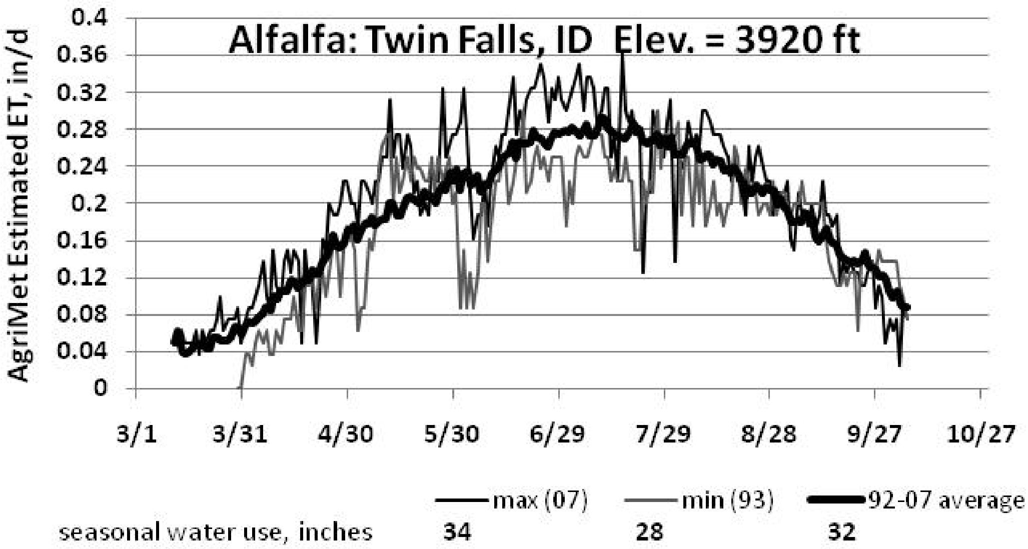

Figure 1. High, low, and average AgriMet-estimated daily and seasonal ET at Twin Falls, ID.

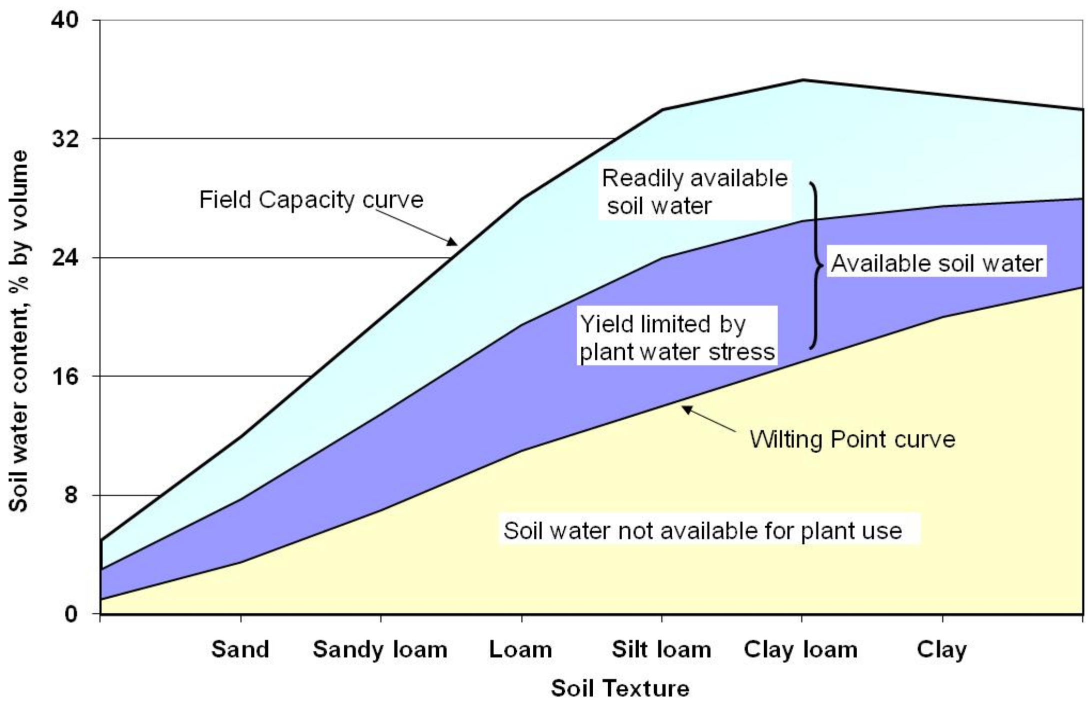

Figure 2. Soil water holding relationships as a function of soil texture. Field capacity increases from sand to silt loam and then levels off. As soil texture becomes finer (more silt and clay), the wilting point is reached at a higher soil water content. Available water (AW) is the amount of soil water held between wilting point and field capacity. Readily available water is approximately one half of AW for pasture and alfalfa. When soil water content falls below 50 percent AW, plant stress will cause yield reduction. Individual soils may differ from this general representation.

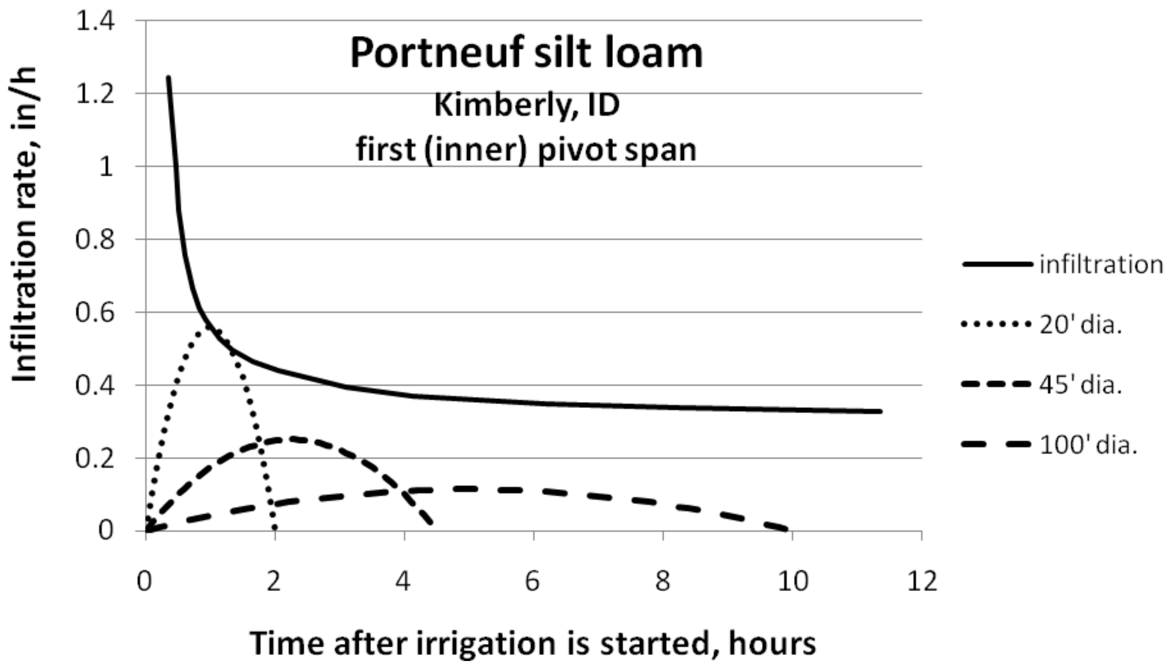

Figure 3a. Infiltration and water application rate patterns **under the first span** of a 1300-foot center pivot lateral. Net application rate (assuming 85% application efficiency) is 0.75 for all water application packages. The pivot is operated to make one complete revolution in 2.5 days.

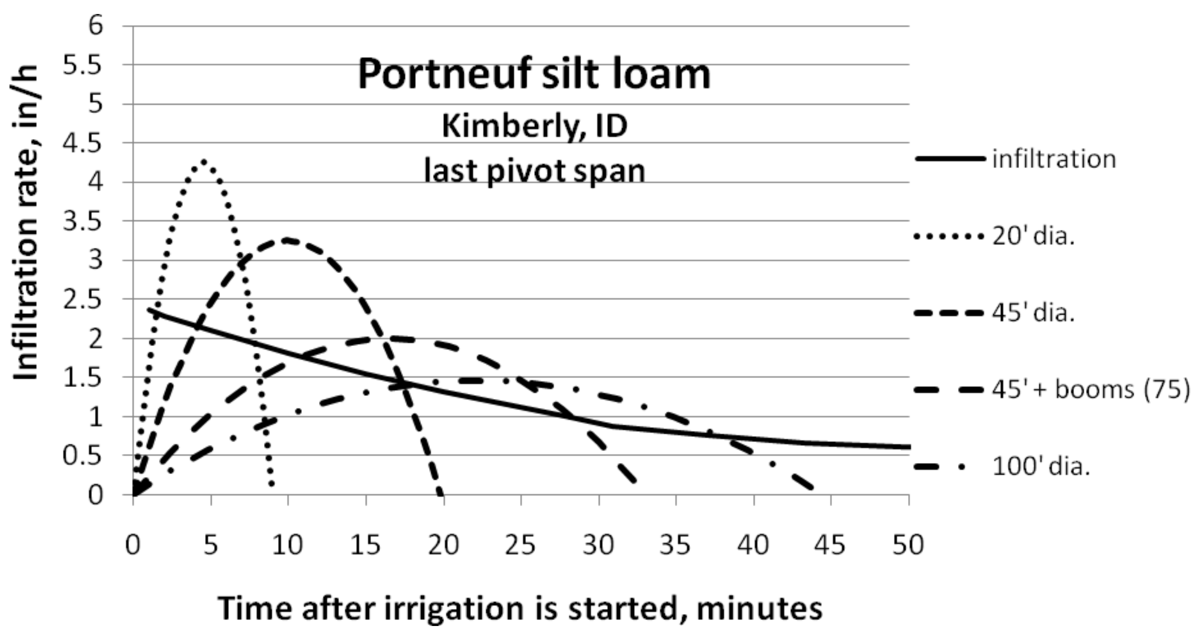

Figure 3b. Infiltration and water application rate patterns **under the last span** of a 1300-foot center pivot lateral. Net application rate (assuming 85% application efficiency) is 0.75 for all water application packages. The pivot is operated to make one complete revolution in 2.5 days.

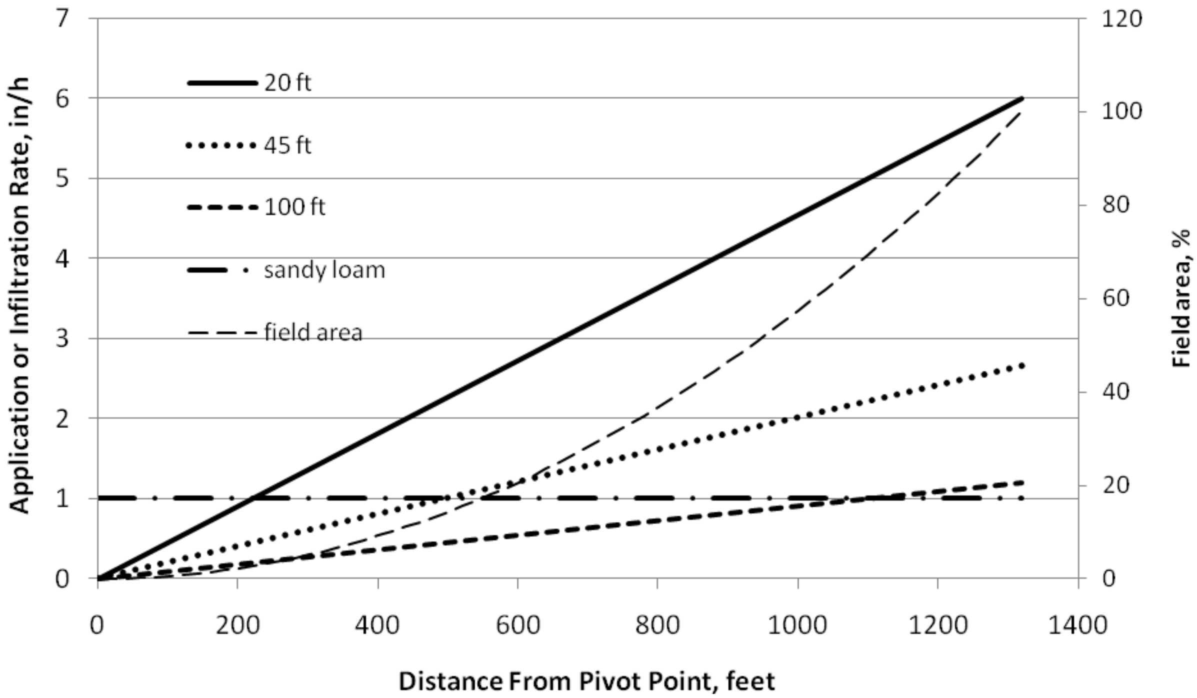

Figure 4. Average sandy loam intake rate and average water application rate outward along a center pivot lateral with application package wetted diameters of 20, 45 and 100 feet. Lateral length = 1320 feet and design flow is 850 gpm.

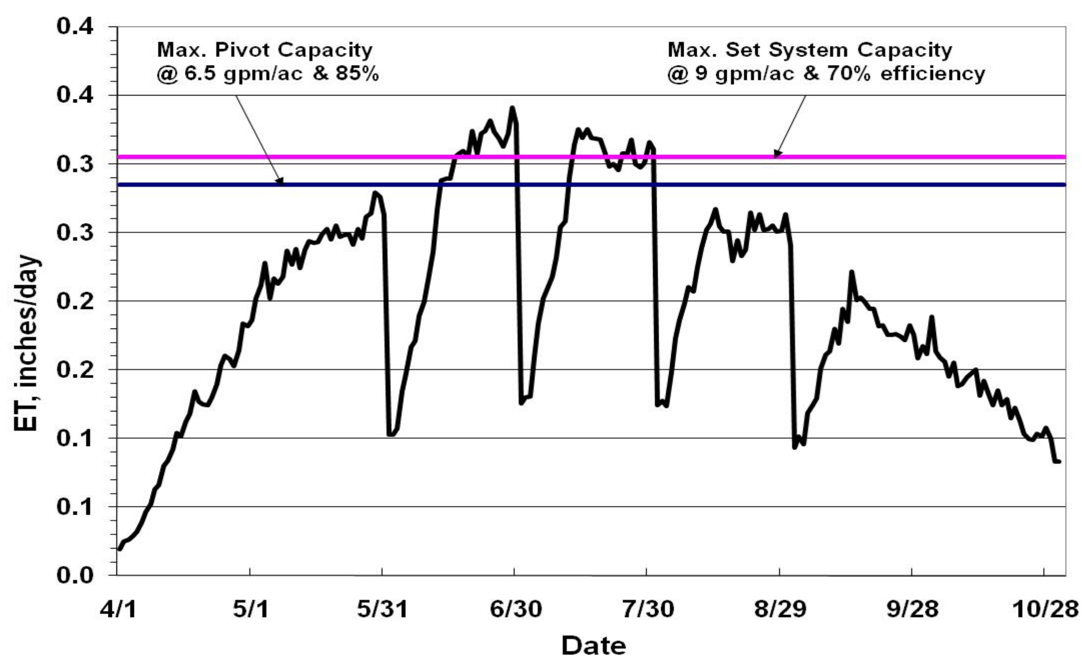

Figure 5. The 30-year average ET for alfalfa cut four times for hay is graphed as a function of calendar date. The source of the average ET data is the Kimberly Penman ET from J.L. Wright, Northwest Irrigation and Soils Research Laboratory.

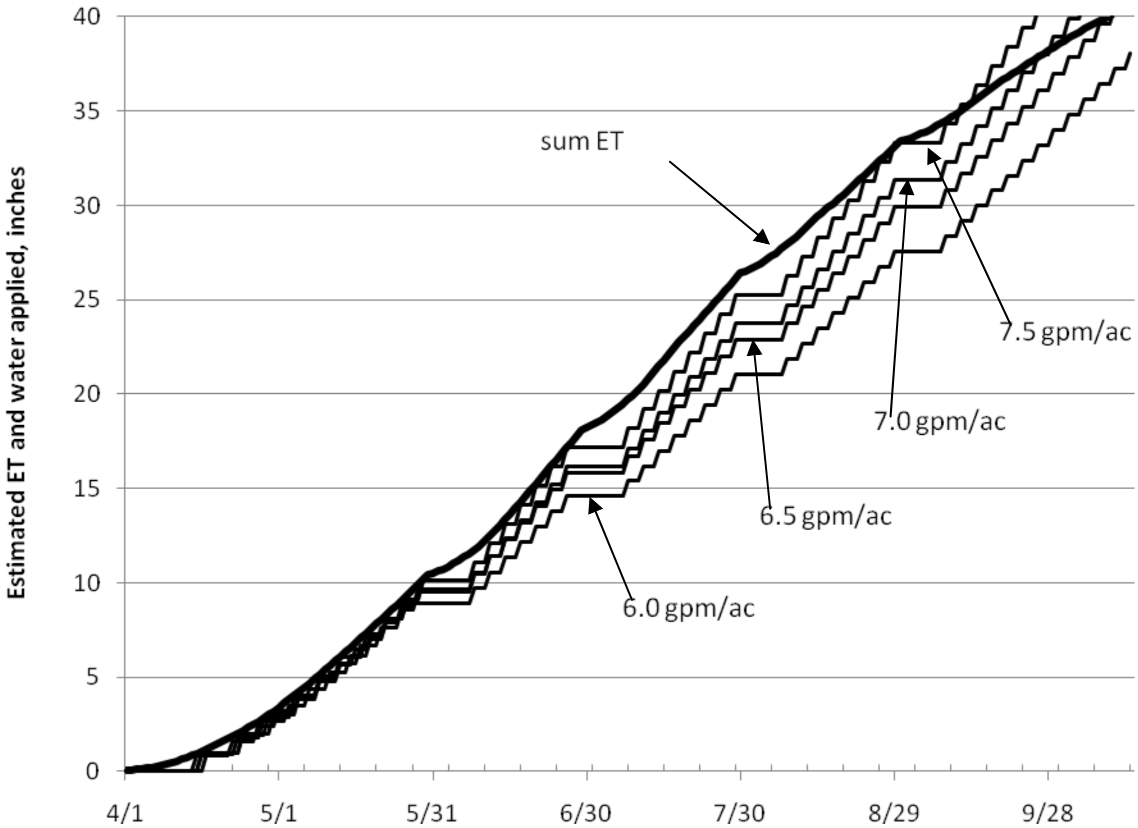

Figure 6. Cumulative average 30-year estimated ET, including cutting effects, and irrigation water applied by center pivot at 4 irrigation system capacities for Kimberly, ID conditions.

Table 1. Average water holding capacity and soil moisture content impact on depth of wetting by a 1-inch net water application (assuming uniform soil properties and uniform soil moisture with depth) for common soil textures.

	Sand	**Sandy Loam**	**Silt Loam**	**Clay**
Average Water Holding Capacity (in/ft)	1.0	1.7	2.1-2.4	2.2
Moisture Content (% Depleted)	**Soil Depth (Inches)**			
25	48	28	20	22
35	34	20	14	16
50	24	14	10	11
75	16	9	7	7
100	12	7	5	5

Table 2. Suggested maximum water application rates (in inches per hour) for sprinklers for average slope, soil and cultural conditions.* (Source: *USDA-NRCS National Engineering Handbook*, Chapter 11, 1983.)

Soil Texture and Profile	0-5 % Slope (inch/hour)	5-8 % Slope (inch/hour)	8-12 % Slope (inch/hour)	12-16% Slope (inch/hour)
Coarse sandy soil to 6 feet	2.0	1.5	1.0	0.5
Coarse sandy soils over more compact soils	1.5	1.0	0.75	0.4
Light sandy loam to 6 feet	1.0	0.8	0.6	0.4
Light sandy loam over more compact soils	0.75	0.5	0.4	0.3
Silt loam to 6 feet	0.5	0.4	0.3	0.2
Silt loam over more compact soils	0.3	0.25	0.15	0.1
Heavy-textured clays or clay loam	0.15	0.1	0.08	0.06

* **For average soil conditions on all crops except grasses and alfalfa. For grass and alfalfa, values may be increased by 25 percent. For bare ground and poor soil conditions, reduce values by 25 percent.**

Table 3. Approximate depth of water to add and resultant depth of wetting for alfalfa with peak ET of about 0.25 in/day on a silt loam soil in southern Idaho.

Irrigation interval	Net mid-season water required, inches	Actual water to apply, inches	Soil Water Depletion, %	Approx. depth of wetting (inches) silt loam soil
Daily	0.25	0.36	10	3
Every-other-day	0.5	0.72	21	6
Every 3rd day	0.75	1.07	31	9
Every 4th day	1.0	1.43	42	12
Every 5th day	1.25	1.79	52	15

Table 4. Inches of water that must be applied to refill one foot of soil with a **pivot or linear**. Numbers shown are larger than net plant water requirements because they include losses such as evaporation and wind drift.

% Available Soil Water	Fine-textured Silt Loam 2.25 in/ft	Coarse-textured Silt Loam 1.97 in/ft	Loam 1.41 in/ft	Sandy Loam 1.67 in/ft	Fine Sand 0.6 in/ft
100	0	0	0	0	0
85	0.42	0.37	0.26	0.32	0.11
80	0.56	0.49	0.35	0.42	0.15
75	0.70	0.62	0.44	0.52	0.19
70	0.84	0.74	0.53	0.63	0.22
65	0.98	0.86	0.62	0.73	0.26
60	1.12	0.98	0.70	0.84	0.30
55	1.26	1.11	0.79	0.94	0.34
50	1.41	1.23	0.88	1.04	0.38
40	1.69	1.48	1.06	1.25	0.45
30	1.97	1.72	1.23	1.46	0.52

Table 5. Kimberly, ID 30-year average ET (inches) for the pre-cut period required to reduce soil moisture in the top 1 foot to about 75% available for silt loam, sandy loam, and sandy soil textural classes and a 7-day drying period. This assumes that the soil profile is filled to field capacity by the last irrigation before cutting, and that 60% of total ET comes from the top foot of soil.

Cut #	Silt loam (2.4 in/ft)			Sandy loam (1.8 in/ft)			Sandy (1.0 in/ft)		
	ET and days before cut ( )	ET drying	Total	ET and days before cut ( )	ET drying	Total	ET and days before cut ( )	ET drying	Total
1	0.6 (4)	0.9	1.5	0.45 (3)	0.9	1.35	0.25 (2)	0.9	1.15
2	0.6 (3)	1.1	1.7	0.45 (3)	1.1	1.55	0.25 (2)	1.1	1.35
3	0.6 (3)	1.1	1.7	0.45 (3)	1.1	1.55	0.25 (2)	1.1	1.35
4	0.6 (4)	0.8	1.4	0.45 (3)	0.8	1.25	0.25 (2)	0.8	1.05

HOW DAIRIES ARE SURVIVING: IMPACT ON FORAGES

Mireille Chahine[1], Glenn E. Shewmaker[2], Richard J. Norell[3], and C. Wilson Gray[2]

ABSTRACT

A mail-in survey was conducted to evaluate the impact of the current economic situation on Idaho dairies and to identify trends in forage use. The survey was mailed to every dairy producer registered in the state of Idaho. Dairies were categorized as small (n < 201 cows; 48.8%), medium sized (n = 201 to 1000 cows; 30.2%) or large (n > 1000 cows; 21.0%). All the respondents were dairy owners that used alfalfa hay in their lactating cow's ration. Twenty six percent of respondents indicated that cost and/or price limited the use of alfalfa hay on their dairies. Quality, constraints from nutritionists, and supply were cited by a smaller percentage of respondents as important factors. During the crisis, 35% of respondents reduced the amount of alfalfa hay stored on their dairy. No significant reduction was encountered in the amount of alfalfa hay used in the ration while minerals, vitamins, additives, grains, and protein supplements were reduced. Several of the dairy producers were very preoccupied about the severity of the economic crisis.

Key Words: dairy, economic crisis, forages

INTRODUCTION

The dairy industry has experienced a severe collapse in milk price during the last year. Prices have fallen drastically to their lowest levels in 30 years while cost of production remained at historic high levels creating a very challenging financial situation for dairy producers. Most dairy owners continue to struggle to keep their businesses afloat. A survey was designed to evaluate the impact of the current economic crisis on the dairy industry in the state of Idaho and to identify trends in the use of forages in dairy cow rations.

PROCEDURES

A draft questionnaire was reviewed by University of Idaho personnel and extension specialists, and feedback was incorporated in the final version. The final questionnaire was mailed by first class postage to all individual dairy producers in the state of Idaho (n = 518). Questions on the survey were a mix of open- and close-ended questions with multiple choice where applicable. Following a protocol outlined by Dillman (1978), an initial survey, cover-letter and postage-paid return envelope were mailed to dairies. A postcard reminder was sent two weeks afterward followed one month later by a reminder letter and a second survey. The data gathered were categorical. The PROCSURVEYMEANS of SAS (SAS Inst., Inc., Cary, NC) was utilized to produce estimates of survey proportion in each category. Some participants chose not to answer all the questions; thus, the reported percentage was the percentage response to the individual question. Some questions allowed several answers, and, thus, data might not add to 100%. The results reported in this paper are preliminary because at the time of printing we were still receiving survey responses.

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RESULTS AND DISCUSSION

Forage use on Idaho Dairies. To obtain basic information about Idaho dairies, the survey included questions about operation leadership, dairy size, and location. Dairies were categorized based on current herd size. Herd size categories were small (<201 lactating cows), medium (201 to 1000 lactating cows), and large (>1000 lactating cows). All the individuals completing and returning the surveys were dairy owners. The largest number of survey participants represented small (48.8%) dairies followed by medium-sized (30.2%) and large (21.0%) dairies. Small dairies averaged 87 cows, medium dairies averaged 518 cows, and large dairies averaged 1,697 cows.

All respondents used alfalfa hay in their lactating cows' rations with an inclusion rate in the forage base varying between 10% and 100%. Respondents were asked what limited the use of alfalfa in their ration. The answer to this question was open ended with 26% of respondents indicating price and/or cost as a limiting factor and 19% of respondents indicating nothing limited the amount of alfalfa in their ration. A smaller percentage of respondents cited quality (14%), constraints from nutritionists (14%) and supply (9%) as important factors. Only two respondents indicated that price of other forages affected the use of alfalfa hay in their rations. This demonstrates that alfalfa is still a very important part of the western dairy ration.

The survey asked participants to rate the importance of several issues related to the use of forages in lactating dairy cows from 1 = highest to 9 = lowest. Results are summarized in table 1. The answers to this question were very variable with every issue being rated 1 or 8 at least once. .

Table 1. Importance of several issues associated with forages in lactating dairy cows

Issue	*Importance (1 = highest; 9 = lowest) ± SE*
Price per unit of energy	3.5 ± 0.5
Consistency of forage quality	3.6 ± 0.4
Price per unit of protein	3.8 ± 0.4
Fiber (NDF) value	4.0 ± 0.4
Availability	4.4 ± 0.5
Forage quality laboratory test	4.6 ± 0.6
Forage dry matter	5.0 ± 0.5
Ease of storage	5.8 ± 0.5
Transportability	6.6 ± 0.5

Dairy producers were asked about the levels of ADF, NDF, CP, RFV, NDFD, RFQ and TDN they seek in forage analyses for alfalfa. Table 2 includes the summarized values for CP, ADF, NDF and RFV. Fifty-eight percent of respondents listed a value of RFV compared to only 11.6% that listed a value for both RFV and RFQ indicating that the majority of dairy producers are more familiar with RFV than with RFQ. CP, ADF and NDF are also commonly used to evaluate quality of alfalfa hay. On average, dairy producers in the state of Idaho seek alfalfa hay that has a minimum 177 RFV, 20% CP and a maximum 29% ADF.

Table 2. Idaho dairy producers seek the following values in forage analyses for alfalfa hay

Component	*Value ± SE*	*Minimum*	*Maximum*
CP, %	More than 20.4 ± 1.9	18.0	24.0
ADF, %	Less than 29.1 ± 0.4	25.0	32.0
NDF, %	Less than 34.3 ± 1.1	29.0	40.0
RFV	More than 177.4 ± 2.5	150.0	200.0

Impact of the economic crisis on Idaho dairies. Several questions were included to gain an understanding of the economic situation effect on forages and rations on dairies. Thirty-five percent of respondents indicated that, since this economic crisis has started, they have reduced the amount of alfalfa hay stored on their dairy. The amount of alfalfa hay used in the ration, however, does not appear to have been impacted with 70% of respondents indicating they did not change the amount of alfalfa hay included in their ration compared to 16% who increased the amount of alfalfa hay fed to lactating cows and 14% who decreased that amount.

The most drastic change in ration was observed in minerals, vitamins, and additives' supplementation with 44% of respondents indicating they have decreased the amount used in the ration. Grain and protein supplements were also significantly reduced in 37% and 26% of the dairies respectively. This is in contrast with the relatively small change observed with alfalfa hay inclusion rate which could indicate that dairy producers consider alfalfa hay to be a cheaper source of protein and digestible fiber than other components of the ration.

Dairies economized in every way they can by culling heavily, eliminating new equipment purchases and capital expenditures that do not have short term pay offs, lowering medication costs, purchasing cheaper semen, trimming labor, reducing employee benefits, purchasing cheaper teat dips and keeping low inventory of supplies. We asked dairy producers how long it would take them to eliminate the debt they had accumulated since last fall. The answers varied from 6 months to 5 years. A dairy producer indicated that most dairies have depleted equity and worried that another crisis in the next two years will lead to an exodus of the industry.

Dairy producers were asked what measures they would prefer to see implemented either by the government, industry initiatives or individuals to reduce the risk of volatile milk prices in the future. The response to this question was very variable with some dairies favoring a quota system and other dairies wanting the government completely out of the picture.

CONCLUSION

This study provides important timely information about the impact of the current crisis on the dairy industry. We conclude that during the crisis, dairy producers reduced the inventory of alfalfa hay stored on their facilities but did not decrease the amount included in the ration. Other components of the ration were, however, reduced. Dairy producers implemented a wide range of cost savings techniques. Most dairy producers are still worried about the future of the dairy industry.

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MEASURING CORN SILAGE DENSITY ACROSS SOUTHERN IDAHO USING THREE DIFFERENT METHODS

Steven L. Hines, Richard J. Norell, Mireille Chahine, Tianna E. Fife, Mario E. de Haro Marti, Stuart C. Parkinson[1]

ABSTRACT

Dry matter loss during the storage period, as well as during feedout is directly related to silage density and face management. Research suggests silage density should be at least 15 lbs./ft^3 (dry matter basis) to minimize dry matter loss. There are several factors that affect final density such as crop moisture, rate of delivery, and packing layer thickness. University of Idaho Extension personnel recognized a need to determine a baseline for silage density in Idaho and verify which available methods of measurement are accurate and practical. A field trial was conducted on 18 dairy farms and feedlots across southern Idaho. Silage density was assessed on each farm by three different methods: core sampling using a forage probe, the University of Wisconsin density calculator spreadsheet, and the University of Wisconsin silage feed out spreadsheet. The results of each method and site were compared to determine reliability of the methods used. The probe measures a specific volume and weight and is considered the standard. This method was used to compare the other two methods. The mean dry matter densities did not differ between the three methods (14.32 lbs./ft^3, 14.66 lbs./ft^3, and 16.17 lbs./ft^3 for the core, density calculator, and feedout spreadsheet, respectively; $p=0.18$). The core sampling measurements and the silage density calculator were correlated ($r=0.70$; $p<0.001$). However, the feed out spreadsheet and core sampling measurements were not correlated ($r=-.06$; $p=0.82$). Based on the results of the study, it is recommended to use the forage probe for directly assessing silage density and the density calculator as an alternative method.

Purpose of the study

The purpose of the study was to evaluate three known methods for estimating corn silage pile density. The researchers were ultimately interested in determining dry matter losses related to silage storage. Before being able to estimate those losses, the density of corn silage piles had to be determined. There are three known methods for determining silage density: a forage probe, the University of Wisconsin density calculator spreadsheet, and the University of Wisconsin silage feed out spreadsheet. This study evaluated the three methods to determine accuracy, efficiency, and ease of use.

Methods

Eighteen silage storages were sampled in the first year of the study, with an additional 20 samples the second year. This report focuses on the first year of the study as one year was sufficient to evaluate the three methods. Various data were collected at each of the silage storage sites for each of the methods.

Probe-The forage probe method uses a metal probe, of a known diameter, that is drilled into the pile as far as a possible. The probe is removed and the depth of the remaining hole is measured and recorded.

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This measurement is used with the known diameter to determine volume. The core sample is then weighed. The volume and weight of the sample are then used to calculate the density of the sample in pounds per cubic foot (lbs/ft^3). Each pile is sampled at 3 locations (middle and both sides) approximately half way up the face (area between the ground and top of the pile). Care is made not to sample in areas that are known to be poorly packed such as the sides of the pile or the end of the pile.

Density calculator spreadsheet-This method uses several inputs gathered from the producer as well as manual measurements of the pile. The inputs are entered into the computer spreadsheet and an estimated average dry matter density and a maximum achievable dry matter density are given. The inputs needed are: side slope ratio, bottom width, top width, height, silage delivery rate (tons/hour) to the storage site, silage dry matter content, packing layer thickness, and weight, or proportioned weight, of the packing tractor(s).

Feed out spreadsheet-This method requires taking physical measurements of the pile and then coming back to the storage facility two more times and taking physical measurements again. The livestock producer must keep good records of actual weight of silage fed out during the time between visits. The following information is recorded at each visit: width of bottom and top of pile, pile height, length of pile, a weight estimation of any slough or feed that was knocked down but not yet fed, and a weight estimation of any spoilage that has been removed. The first visit is to establish the total volume of the pile. Each subsequent visit is to record the volume of the pile and the amount of feed removed since the previous visit. After all records have been collected, then density can be calculated by using the volume and weight of the removed feed.

Results

The results of the three methods are discussed below. A major caution must be given here. Silage piles are dangerous places to be. Pile faces can slough hundreds of pounds of silage onto workers below and climbing tall piles to measure their height can cause the face to give way under the worker on top of the pile. Large livestock facilities usually involve constant use of feed machinery and workers must be aware of loaders and feed trucks moving about the area. Farm workers may not be aware anyone is near the pile. Again, great caution must be exercised when working around stored silage. For this discussion, the term silage pile will be used interchangeably to mean a bunker or pile storage system.

Probe- The forage probe proved to be the most simple and useful method of the three. Because it was reliable and easily repeatable, it became the benchmark to which the other methods were compared. The average density for the 18 silage piles was 14.32 lbs/ft^3 on a dry matter basis with a standard deviation of 1.58 and standard error of 0.37.

Density Calculator Spreadsheet-Once the data is gathered from the storage site it is easy to enter into the spreadsheet to determine density estimation. The spreadsheet gives an average density on both as fed and dry matter basis, as well as a maximum achievable density based on the parameters entered by the user. The average density for the 18 silage piles was 14.66 lbs/ft^3 on a dry matter basis with a standard deviation of 2.18 and standard error of 0.51.

Feed out Spreadsheet-The reliability and repeatability of this method is questionable because it proved to be the most difficult to manage . This particular method was time and labor intensive and depends on very accurate data from the feed manager. The average density for the 18 silage piles was 16.71 lbs/ft^3 on a dry matter basis with a standard deviation of 4.71 and standard error of 1.11.

DISCUSSION

The forage probe proved to be the most reliable and easy to use method. The simplicity of the tool in design and use made it the best choice for those wanting to sample pile density. A person can quickly and easily take many samples of a pile instead of just 3 or 5, or it allows a person to sample just one section, such as the sides of the pile, to determine density on only that part of the pile. That data could be used to improve packing technique in the next season. For this method, the tools needed are the probe, a measuring dowel or metal tape, a battery powered drill, and a ladder. For this project we used an 18V ½ inch drill. High torque was necessary. A spare battery will be essential for taking more than about 10 cores on one charge. The metal probe used in this project came with a smooth cutting edge. Cutting in teeth with a triangle file greatly improved cutting speed and made touch up sharpening quick and easy, however this modification greatly increased load on the drill due to increasing cutting speed. For fast and accurate sampling of a pile, the forage probe is the best method.

The density calculator spreadsheet has the potential to be accurate, but the time involved to get reliable data is substantial. Taking the physical measurements of the pile is simple enough but piles are not perfect in dimension and vary in width and height along the length of the pile. The remainder of the data must be collected from the individual who did the harvesting. In the case of this study, most of this was done by a custom harvester and getting accurate data was difficult at best. The spreadsheet requires accurate inputs of silage delivery weight and rate, packing layer thickness, and packing tractor weight. The researches left a worksheet for the producers to fill out with the required information. Unless each load was weighed, weight and rate were estimates. Packing layer was also an estimate. Packing layer thickness is the single most important factor and a variance of plus or minus two to three inches will make a significant difference in the final answer. Most producers answered six inches as this is the recommended thickness. Getting accurate tractor weight, and percentage of packing time if two tractors were used, was also difficult. This method is time consuming and getting accurate data is difficult and may require someone present during the entire course of harvest on a single storage structure.

The feed out spreadsheet method was the least accurate of the three methods evaluated. The research team determined there were too many variables that introduced error into the calculations. As with the density calculator method, taking the pile physical measurements is easy enough. Beyond that point, gathering reliably accurate data was difficult. Unless the pile face was even, taking length measurements require trying to get averages. If there is a large amount of slough or a pile the loader operator broke loose and piled for feeding, then estimation must be made as to the total weight of that loose material. Also, estimation must be made as to the weight of spoiled material that has been removed from the top and sides. Finally, the feed manager must provide accurate daily feed out weight. At least in the case of the data gathered by the author, it was determined most feed weight was a guess based on how many loader buckets were dumped into the feed truck.

CONCLUSION

Research suggests 15 lbs/ft^3 on a dry matter basis as the minimum silage density for good feed quality and to reduce dry matter losses. Excellent silage quality is a result of proper harvest maturity, a delivery rate that allows the packing equipment sufficient time to do the job, proper layer thickness of not greater than six inches in depth, packing equipment that is heavy enough to do the job properly, and finally finishing the storage off with a good air tight seal. Results of this study indicate silage in southern Idaho is slightly less than that minimum of 15 lbs/ft^3. This is possibly due to the large size of the piles, the high delivery rates due to high capacity harvest equipment, and insufficient packing time. Proper packing speeds the ensiling process and reduces dry matter losses that occur until the ensiling process has stabilized. Once the silage is in place and the packing process is finished, it is not possible to correct insufficient packing. There is little doubt that silage piles in southern Idaho could be packed to a higher density. As forage harvesters get larger and harvest capacity continues to increase, this situation is likely to see little improvement. Silage piles are reaching a size where packing tractors must have dual and triple tires just to keep them from tipping over while working on the sides of piles. The addition of tires makes the job safer, but reduces the compaction efficiency of the tractor. On one silage pile sampled in the second year of the study, the compaction was done with a sheep's foot compactor. The average density using the forage probe method was 21 lbs/ft^3 on a dry matter basis. In this situation the dairyman owned the compactor and harvest equipment and was able to deliver and pack at the rate he wanted to. While it isn't practical for this type of machine to be used on a custom basis, it does show that with some effort, silage density can be increased significantly from current levels.

OPTIMIZING PROFITS BY ADJUSTING CUTTING SCHEDULES

Glenn Shewmaker and C. Wilson Gray [1]

ABSTRACT

Profitability in producing alfalfa hay is mostly a function of optimizing yield and quality relative to cost per ton. However, to the animal that consumes hay, forage quality is very important, especially in high-producing dairy cows where intake may be limited. Four factors change as the harvest date is delayed: 1) the physical yield, 2) the forage quality, 3) the value/ton, and 4) the harvest cost/A. How does a producer determine his best opportunity for profit given the dynamic changes in yield and quality in different environments and cuttings? The best strategy is to arm yourself with information such as past production and quality records, determine the current status of the forage crop, and predict the future status of the hay crop. Then you have information to optimize the yield versus quality curves and negotiate the best price for your crop. This paper provides some historical data from studies in Idaho—which may not fit your environment but provides examples to demonstrate a process.

Key Words: cutting management, yield versus quality

INTRODUCTION

In negotiating a price, knowledge is your best friend so that you can determine profitability in producing a forage crop that is in demand.

Ultimately, the dietary requirements of the livestock being fed dictates how alfalfa should be harvested to obtain feed of a given quality. As alfalfa matures through several identifiable morphological stages, feeding value declines with the rate of change being strongly influenced by temperature. Thus, harvesting at more immature stages (vegetative to bud) dictates a shorter cutting interval (Putnam et al, 2005). Different environments provide different rates of change in yield and quality. Our best advice is to learn and follow a process to predict the most profitable time to cut, given the market values and estimated rates of change in yield and quality. Proper marketing of alfalfa and other forages as a cash crop for animal feed requires a greater understanding of the relationship between forage yield and quality. Our objective in this paper is to outline a logical procedure to adapt cutting management to market conditions.

RATES OF YIELD INCREASE AND QUALITY DECLINE

Premiums are paid for quality but some of the higher price for increased forage quality is offset by lower yields of hay cut early for the higher quality. The best alternative is difficult to assess since both alfalfa growth and change in forage quality vary considerably depending on environmental conditions, and because we have to forecast several variables.

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Yield change per day around harvest time varies considerably and has ranged from 0 to 200 lbs per acre per day. The daily yield increase will be less in cool, cloudy weather, and if insects, disease or drought occur. It may be greater in periods of good moisture, sunshine and 75 to 85 degree weather.

Experiment 1 Yield. Yield increased more rapidly at Kimberly, Idaho during the second and third harvest periods (180 lb/acre/day) than during the first harvest period, at 120 lb/acre/day (Martin et al., 2006; Table 1). The elevation at Kimberly is 3,800 ft above sea level and the temperatures are shown in Table 2.

Table 1. Linear regression equations describing trends for the change in yield and quality of alfalfa harvested initially at late vegetative stage, and every 5 days thereafter, to 20 days of maturity during three harvest periods in Idaho in 2005. Source: Martin et al. 2006.

Cut	Yield (lb/A)	R^2	NDFD (%)	R^2	CP (%)	R^2
1	y = 3990 + 120x	0.84	y = 55.8 - 0.3x	0.70	y = 26.8 - 0.2x	0.97
2	y = 1590 + 180x	0.93	y = 60.9 - 0.6x	0.98	y = 27.1 - 0.3x	0.86
3	y = 2110 + 180x	0.95	y = 54.3 - 0.5x	0.98	y = 28.2 - 0.4x	0.92

NDFD = neutral detergent fiber digestibility
CP = crude protein
R^2 = the coefficient of determination, the proportion of variability in a data set that is accounted for by the statistical model. The closer to 1.0, the better the prediction.

Table 2. Air temperature monthly average, maximum, and minimum at the Twin Falls (Kimberly) AgriMet weather station in 2005. Source: U.S. Dept. of Interior, Bureau of Reclamation AgriMet Program: http://www.usbr.gov/pn/agrimet/index.html

	Air temperature (degrees F)						
2005	MAR	APR	MAY	JUN	JUL	AUG	SEP
Ave	42.1	46.2	55.0	59.8	72.5	68.8	58.1
Max	52.6	56.5	65.7	72.9	80.9	77.0	70.4
Min	33.9	35.8	43.7	46.7	65.1	57.2	47.0

Experiment 1 Forage Quality. Forage quality of first cutting in Idaho changed at a slower rate than in Wisconsin and Pennsylvania. In Idaho, acid detergent fiber (ADF) increased 0.2, 0.3, and 0.5 % per day during first, second, and third cuttings. In mid-western environments first cutting decreases about 5 pts relative feed value (RFV) per day, second cutting decreases 2 to 3 points per day and third and fourth cutting during the growing season decline 1 to 2 points per day. Thus environment—primarily climate components such as air temperature and amount of sunshine—can result in profound differences in forage quality change.

The rate of increase within harvests over all harvest periods differed for ADF and NDF in Idaho. ADF increased slower than NDF. Acid detergent fiber was not correlated to neutral detergent fiber digestibility (NDFD) at any harvest period in Idaho, (R^2 of -0.18, -0.08 and -0.13 for spring, early summer and late summer harvests). However, a significant negative correlation was determined at all harvests in Pennsylvania and Wisconsin. Therefore, determining the fiber digestibility (NDFD) is especially important in Idaho. The late fall growth may change little in forage quality during mid to late September and early October. Relative Forage Quality (RFQ) will change about the same as RFV on first cutting. In contrast to RFV, RFQ will show differences due to fiber digestibility in hot-season cuttings and decline about 3 points per day on 2nd, 3rd and 4th cuttings during the growing season.

Experiment 2 Yield. The average yields and rate of change for established alfalfa stands, by cutting and across 5 years, are shown in Table 3. These are averages across all varieties which represent over 1,000 data points in the University of Idaho variety trials at Kimberly. Forage dry matter yields averaged 3.7, 2.2, 2.1, and 1.5 tons/acre for first, second, third, and fourth cuttings, respectively. Yield increased an average of 186 lbs/acre/day for first cutting. Second and third cuttings averaged about 134 and 124 lbs/acre/day, and fourth cutting averaged 64 lbs/acre/day increase.

Experiment 2 Forage quality. The average of 5 years' forage quality data for established stands in University of Idaho variety trials is shown for first cutting in Table 3. These calculations assume that on average frosts occur until April 15, thus harvestable growth starts then and normally we need to take first cutting by May 24 to meet dairy quality hay criteria. Note the estimated beginning values for forage quality in Table 3. These are assumptions that we don't have much data to support, so be aware that these are more based on opinion than on data. These values are from grab samples of fresh alfalfa, so be aware there is minimal leaf loss compared to drying in a windrow and being baled for hay. Harvesting alfalfa as dry hay usually has a loss of 10 to 20% of forage quality because of lost leaves.

We estimate that crude protein declines by 0.15 percentage points per day to 21% CP on first harvest date. The fiber measurements increase at 0.19 percentage points ADF/day and 0.28 percentage points NDF/day. The total digestible nutrients (TDN) declines by 0.15 percentage points per day and relative feed value index (RFV) declines by 2.5 points per day for first cutting. Using these predictions, alfalfa hay would decline about 1 percentage point in CP and TDN in one week for first cutting.

Table 3. Estimated daily change in alfalfa forage yield and quality in established (2 to 4 year old stands) alfalfa variety trials at Kimberly, Idaho.

Year	Total Yield	Yield per cutting				First cutting quality				
		1st	2nd	3rd	4th	CP	ADF	NDF	TDN	RFV
	(Ton/acre)					(%)	(%)	(%)	(%)	index
		Estimated beginning values								
		0	0	0	0	27	22	24.7	71.5	270
		Harvest averages								
2003	8.40	3.22	1.77	1.80	1.65	21.3	29.3	33.6	66	183
2004	10.20	4.02	2.78	2.28	1.12	20.0	29.7	36.9	65	166
2006	10.20	4.02	2.78	2.28	1.12	20.0	29.7	36.9	65	166
2007	9.61	3.30	1.84	2.26	2.21	21.7	28.4	35.4	66	176
2008	8.40	3.86	1.84	1.89	1.51	22.2	29.7	35.2	64	174
Average	9.36	3.68	2.20	2.10	1.52	21.1	29.4	35.6	65	173
		Average rate of change/day								
		(lb/day)				(%/day)				(points /day)
2003		174	122	112	67	-0.15	0.20	0.24	-0.16	-2.4
2004		201	155	111	51	-0.19	0.19	0.31	-0.15	-2.6
2006		206	155	143	52	-0.18	0.20	0.31	-0.16	-2.7
2007		174	123	146	85	-0.14	0.17	0.28	-0.13	-2.5
2008		175	115	108	69	-0.11	0.17	0.24	-0.17	-2.2
Average		186	134	124	65	-0.15	0.19	0.28	-0.15	-2.5

Experiment 3 Yield. The average yields and rate of change for **fall planted, first year alfalfa**, by cutting for only 1 year, are shown in Table 4. These are averages across all varieties which represent over 100 data points in the University of Idaho variety trials at Kimberly. Forage dry matter yields averaged 0.7, 2.2, 2.5, and 1.4 tons/acre for first, second, third, and fourth cuttings, respectively. The first cutting yield of a new seeding is much lower than on established stands, but the 2nd, 3rd, and 4th cuts are similar to the established stand yields. Yield increased an average of only 42 lbs/acre/day for first cutting. Second and third cuttings averaged about 144 and 164 lbs/acre/day, and fourth cutting averaged 35 lbs/acre/day increase. Note: Use caution when interpreting these data with only 1 year.

Experiment 3 Forage quality. The average quality data for **fall-planted, first year alfalfa** in a University of Idaho variety trial are shown for first cutting in Table 4. Forage quality for the first cutting of newly established stands of alfalfa changes much more slowly than on established stands, because the rate of yield increase is much slower. Using these predictions, alfalfa hay would decline about 0.5 % CP, 1% TDN, or 5 RFV points in one week for first cutting.

Table 4. Estimated daily change in alfalfa forage yield and quality in first year stands of fall-planted alfalfa variety trials at Kimberly, Idaho.

Year	Total Yield	Yield per cutting 1st	2nd	3rd	4th	First cutting quality CP	ADF	NDF	TDN	RFV
	(Ton/acre)					(%)	(%)	(%)	(%)	index
		Estimated beginning values								
		0	0	0	0	27	22	24.7	71.5	270
		Harvest averages								
2009	6.88	0.74	2.23	2.54	1.38	24.4	23.6	26.9	245	66
		Average rate of change/day								
		(lb/day)				(%/day)				(points/day)
2009		42	144	164	35	-0.07	0.04	0.06	-0.66	-0.15

DISCUSSION

Forage quality. Most studies have reported that the decline in alfalfa forage quality is more rapid in the summer than in the spring because higher temperatures increase the rate of morphological development (Marten et al., 1988). Results from Idaho and California support those findings, where both NDFD and CP concentration declined more rapidly during mid summer harvest periods than during the first (Table 1). However, every year has slightly different environmental conditions, indicating the need to carefully monitor changes in quality during all harvest periods.

Forage quality index. Relative forage quality (RFQ) is an index used for legumes and grasses based on potential intake and fiber digestibility (Undersander and Moore, 2002). The index is used to price forage and to allocate forage to appropriate ruminant livestock performance levels. In Idaho, RFQ dropped an average of 2.2, 5.3 and 3.3 units for spring, early summer and late summer, respectively. We highly recommend using the newer forage quality tests for NDFD and RFQ because they are more representative of the value to the animal than ADF, RFV, and especially TDN which is just calculated from ADF. The summative equation TDN as defined in the Nutrient Requirements for Dairy Cattle (National Research Council Dairy 2001) is: The sum of digestible crude protein, fat (multiplied by 2.25), non-fibrous carbohydrates, and digestible NDF.

Determining Hay Cutting Date. A spreadsheet to assist in determining hay cutting date is available from the University of Wisconsin (www.uwex.edu/ces/forage) to estimate optimum return based on yield and value of quality. Dairy quality hay in the West is generally considered to be 180 RFV (RFQ) or higher, in contrast to the Midwest where 150 RFV is used. An example of using HAYCUTDATE.XLS to estimate the profit-maximizing harvest date is provided in the following tables and figure. The inputs are given in Table 5.

Table 5. Inputs and assumed values used to predict the profit maximizing date. Adapted from: HAYCUTDATE.XLS spreadsheet developed by Lazarus and Undersander (2005).

	Inputs:	***Units***
Earliest harvest date being considered	10-May	
Yield expected on that date, tons/A	1.0	tons/A
RFV expected on that date:		
Scissors-cut or standing crop RFV	200	RFV as standing in the field
RFV loss expected during harvest	15%	harvesting loss
As-harvested RFV expected	170	RFV as harvested
Yield and quality changes/day expected after the date entered above:		
Yield, lbs/A	175	lbs/A
RFV	-2.5	
Enter RFV of Base Price Hay (usually RFV 150)	180	RFV
Enter the Price of the base 180 RFV hay	$120	/ton
Premium per point of RFV +/- 180	$ 0.70	
Harvesting cost/A expected	$29.00	/A
What is the usual tons/A yield that this harvesting cost is based on?	1.50	tons/A
How would a one-ton difference in yield above or below this usual yield, affect this expected harvesting cost/A?	$ 5.00	/ton

Calculate the price per RFV or RFQ point by dividing the value per ton by the RFV index associated with that value per ton of hay as shown in Table 6.

Table 6. Example of alfalfa maturity and resulting RFV and calculation to determine price per RFV point.

Alfalfa maturity	**RFV**	**Value**	**Price per RFV point**
Vegetative	200	$ 140	0.70
Pre-bud	180	$ 120	0.67
Bud	150	$ 100	0.67
1/10 bloom	120	$ 80	0.67
Full bloom	100	$ 70	0.70

The data in table 7 shows the average monthly differences between Supreme grade hay at an assumed 190 RFV value and premium, good and fair quality grade hay. Figures are dollars per ton and dollars per RFV point assuming a 20 point difference between each grade. Thus the difference in points between supreme and premium is 20 points, between supreme and good is 40 points and between supreme and fair is 60 points.

Table 7. Monthly average differences between supreme (RFV = 190) and premium, good, and fair classes of alfalfa hay. Source: Idaho Hay Market News Reports 2000-2009, USDA-AMS, Moses Lake, WA.

Monthly average differences between Supreme @ RFV 190 and						
Month	**Premium**	**Good**	**Fair**	**Premium @ 170**	**Good @ 150**	**Fair @ 130**
	Dollars per Ton			**Dollars per RFV Point**		
January	13.03	30.23	39.35	0.65	0.76	0.66
February	13.65	30.58	40.37	0.68	0.76	0.67
March	12.50	24.70	35.30	0.63	0.62	0.59
April	11.18	24.52	32.95	0.56	0.61	0.55
May	11.05	28.18	42.44	0.55	0.70	0.71
June	7.42	28.98	41.40	0.37	0.72	0.69
July	10.56	29.31	46.06	0.53	0.73	0.77
August	8.52	29.42	43.60	0.43	0.74	0.73
September	10.95	28.57	44.41	0.55	0.71	0.74
October	13.57	30.37	46.51	0.68	0.76	0.78
November	11.04	28.16	41.45	0.55	0.70	0.69
December	12.82	29.17	41.68	0.64	0.73	0.69
Highest	13.65	30.58	46.51	0.68	0.76	0.78
Lowest	7.42	24.52	32.95	0.37	0.61	0.55
Ann. Ave.	11.36	28.52	41.29	0.57	0.71	0.69

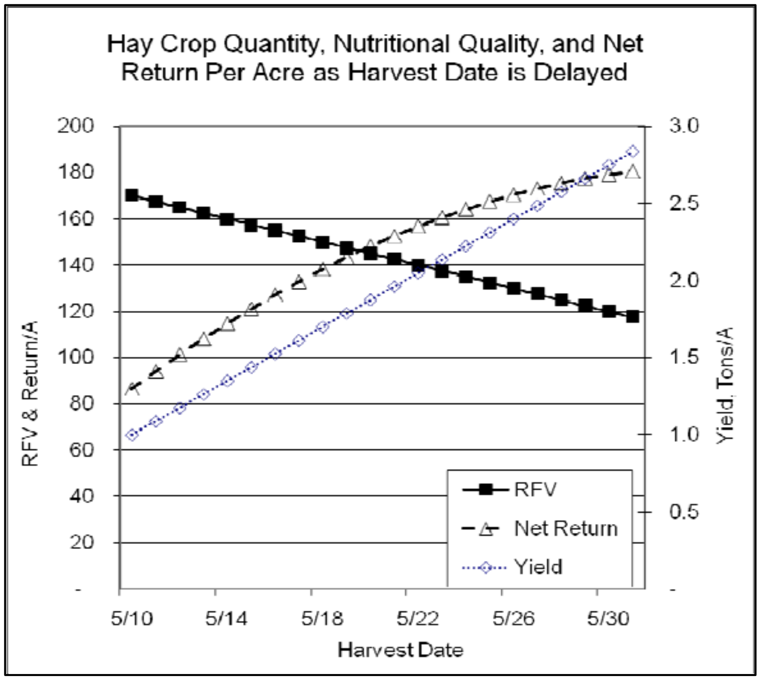
The results from HAYCUTDATE.XLS are shown in Table 8. Given the assumptions and input values entered into the spreadsheet, June 4 is the profit maximizing harvest date. In this scenario, the premium paid for higher quality hay is not adequate to compensate for the increased yield gained by waiting to harvest. CAUTION! Input values must be reasonable or results will not be reasonable!

Table 8. The profit-maximizing harvest date; and yield, RFV, hay crop value, and net revenue predicted from inputs into HAYCUTDATE.XLS.

Results:	
4-Jun	Profit-maximizing harvest date
3.19	Yield on this date, tons/A
108	RFV if harvested on this date
$69	Hay crop value/ton if harvested on this date
$37	Harvesting cost/A if harvested on this date
$183	Net revenue/A if harvested on this date

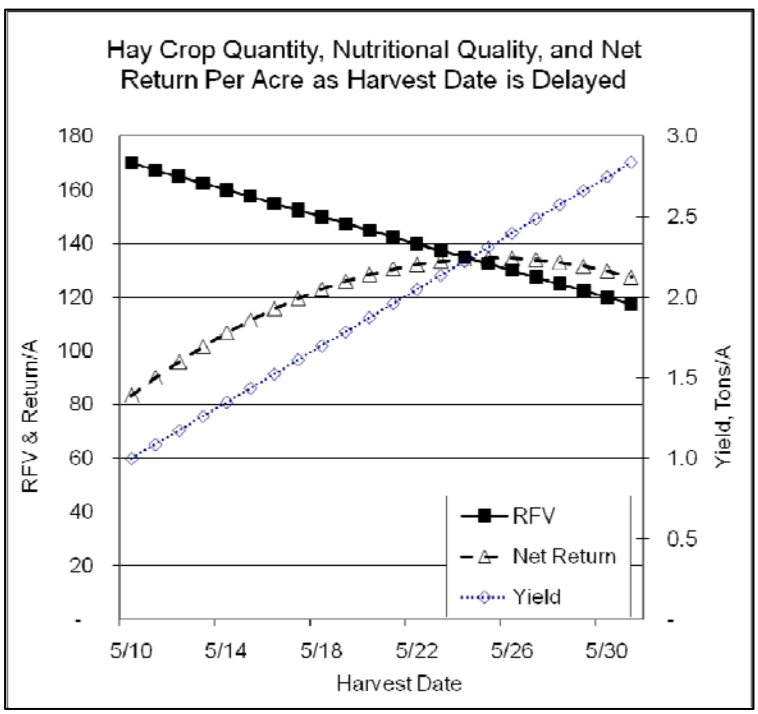
Determining your break-even price and premium needed to produce quality hay are the preliminary steps to marketing your hay. Remember that you still must be able to sell the product. Producing a large quantity of hay that few want is not a good strategy for financial success! However, knowing the production opportunities and economic variables will allow you to be a more informed negotiator.

Figure 1. Hay crop quantity, nutritional quality, and net return per acre as harvest date is delayed are estimated by the HAYCUTDATE.XLS Excel[TM] spreadsheet The estimated historic price per RFV point is calculated in table 6 as **$ 0.70 per point**.



The HAYCUTDATE.XLS spreadsheet is useful to empirically model production and price variations to optimize profitability. By adjusting the values in the "Sensitivity_analysis" tab in the spreadsheet, we discover that with a $1 per point RFV premium, the profit-maximizing harvest date comes earlier, May 25, so a higher quality but lower yielding hay harvest is now more profitable than the first scenario (Figure 2).

Figure 2. Hay crop quantity, nutritional quality, and net return per acre as harvest date is delayed are estimated by the HAYCUTDATE.XLS Excel[TM] spreadsheet The price per RFV point is empirically set at **$1 per point** in this scenario.



A STRATEGY FOR CUTTING MANAGEMENT

There are several steps that should be taken to analyze for the best opportunity for profit:

1. Know your cost of production. It doesn't cost much more to harvest a 3-ton yield than it does a 1-ton yield. When you know your breakeven price, you know the price you must receive given the yield you can produce to meet the consumer's criteria. Hay Budgets and budgeting software are available from the University of Idaho's web page at http://www.cals.uidaho.edu/aers/r_crops.htm and http://www.cals.uidaho.edu/aers/r_software.htm.
2. Keep and review past harvest records. Know your historic yield and quality for typical harvest dates.
3. Monitor yield and vegetative stage. The alfalfa prediction stick is a good tool to accomplish this. Determine average height for the most mature stems in a field with the prediction stick and predict forage quality for that date.
4. Project the calendar date that will provide the forage quality required by the market criteria. You need to know the rate of change in yield and quality for that harvest period in your environment.
5. Adjust the projected cutting date to allow for the quality lost during harvest. For example, ADF usually increases 1-2% because of leaf shatter during hay harvesting.
6. Estimate the yield on that date.
7. Determine the projected profit or loss if marketed using that scenario. Seasonal indexes on hay prices by quality grade are in the article Seasonal Patterns of Idaho Hay Prices in this proceeding. Price differentials between quality grades and by month are also provided. These can give the potential for changes in values as the time of marketing moves through the year.
8. Consider effects of early or late harvest on future cuttings and stand life.
9. Negotiate for the best profitability while balancing for stand life, reducing your risk, and establishing a long-term relationship with a consumer.

CONCLUSIONS

The first harvest has the largest proportion of the annual yield in established stands, thus cutting management decisions on first harvest impact not only first cutting but subsequent cuttings. Harvest management considerations are most critical for the first harvest period. Predicting the quality of subsequent cuttings is more problematic, so cutting on a calendar basis may be the best strategy for those cuttings.

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RECENT ADVANCES IN ALFALFA TISSUE TESTING

Steve Orloff, Dan Putnam and Rob Wilson[1]

INTRODUCTION

Adequate plant nutrition is paramount to achieving high alfalfa yield. In addition, nutrient management is an important environmental issue and cost for agriculture. Growers sometimes question the profitability of applying fertilizer, especially when alfalfa prices are poor as they have been this last year. When profit margins are slim it is particularly important to properly assess the fertilizer status of your alfalfa field.

ASSESSING THE NUTRITIONAL STATUS OF AN ALFALFA FIELD

To predict whether a fertilizer application will result in an economic return requires an accurate assessment of the current nutritional status of a field. Many growers currently fertilize based on past practice alone, virtually guaranteeing that many fields have either too much or too little fertilizer applied. Excess fertilizer applications increase production costs unnecessarily and in some cases can cause environmental degradation. On the other hand, too little fertilizer can result in dramatically lower yields and poor profitability.

Several diagnostic tools may be used to estimate the nutrient needs of a field. These include visual plant symptoms, soil analysis, plant tissue analysis, and fertilizer test strips to confirm a suspected nutrient deficiency.

Visual Plant Symptoms. As a rule, plant symptoms are unreliable because many deficiency symptoms are not definitive or readily observable. For example, phosphorus deficiency (the most common nutrient deficiency) is characterized by stunted plants with small leaves that are sometimes dark blue-green. However, these symptoms are also caused by several other common conditions including moisture stress. In addition, significant yield losses may occur before visual symptoms become apparent.

Soil Analysis. Soil analysis is a valuable diagnostic tool and its use should be encouraged. However, soil tests only provide an estimate of what the plants may be able to uptake. They are more accurate for detecting some nutrient deficiencies than others (Table 1). However, plant tissue analysis is usually a better indicator because it more accurately reflects actual plant uptake. Soil tests are best prior to planting but thereafter plant tissue tests are usually superior to detect nutrient deficiencies. Table 1 shows the relative reliability of soil and plant tissue analysis for detecting a nutrient deficiency.

Plant Tissue Tests. Despite the reliability of plant tissue tests, most alfalfa growers at the present time do not conduct tissue testing to assess fertilization needs. The standard University

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of California (UC) recommended method for plant tissue analysis is to collect 40 to 60 stems from an alfalfa field at 10 percent bloom. The sample is divided into three parts (tops, mid stem, and mid-stem leaves). The lower third is discarded. The tops are analyzed for boron, molybdenum and copper, the mid stem leaf portion for sulfur, and the mid stem portion for phosphorus and potassium. Over the years this technique has proven to be valuable.

Table 1. Relative reliability of soil and plant tissue testing for nutrient deficiency.

NUTRIENT	SOIL TESTING	TISSUE TESTING
Phosphorus	Good	Excellent
Potassium	Good	Excellent
Sulfur	Very poor	Excellent
Boron	Poor	Excellent
Molybdenum	Not recommended	Excellent

There are several drawbacks and practical considerations that have limited the adoption of this practice. This technique is time consuming. Growers are typically extremely busy during the season when fields are being cut and do not take the time to collect samples. Drying the samples and fractionating them into the respective plant parts is rather tedious and it is easy to forget which plant part is used for the different analyses. Samples must be collected prior to cutting obviously making it impossible to sample fields after the growing season is over. Many other alfalfa-producing states recommend using the top one-third of the plant for nutrient analysis. This is simpler than fractionating the plants, but the sample collection process is still time consuming and usually does not get done.

Cored Bale Samples For Nutrient Analysis. With the current emphasis on testing alfalfa for the dairy industry, many growers routinely take cored samples of haystacks for forage quality analysis (ADF, NDF, CP and DM). *Could these cored baled samples serve a dual purpose for both forage quality analysis and to assess the nutritional needs of the crop?* If this technique is valid, it could be incorporated into routine testing practices and greatly simplify the tissue analysis process and reduce costs. Also, due to the fact that core sampling of hay stacks represents a wide range of plant material (greater than grab samples of the standing crop), it may be more successful at representing the overall nutrient status of a field. A multiyear project was initiated to compare soil samples, cored-hay samples, whole top samples, and

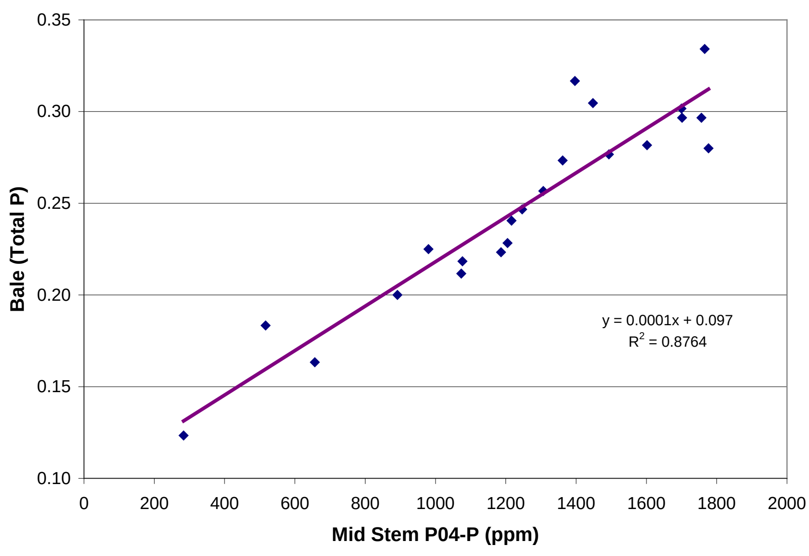

Figure 1. Relationship between mid-stem PO4-P concentration and the total phosphorus concentration of cored bale samples.

fractionated stem samples using the UC technique.

The results indicated that cored-baled samples provided results very similar to the fractionated stem samples. The mid-stem samples were analyzed for phosphate phosphorus (PO_4-P) and potassium and the mid-stem leaves were analyzed for sulfate sulfur (SO_4-S). Cored bale samples and whole-top plant samples were analyzed for PO_4-P, total phosphorus, total sulfur, SO_4-S, and potassium. Figure 1 shows the relationship between mid-stem PO_4-P concentration and the total phosphorus content of the cored bale samples. The two sampling methods were closely related. Likewise there was a strong relationship between the fractionated stem samples and cored bale samples for potassium and sulfur concentration. These results suggest that the cored bale sampling technique could be used successfully in lieu of fractionated stem samples.

Alfalfa Growth Stage for Tissue Testing. Current tissue level guidelines are based on alfalfa at one-tenth bloom growth stage. However, to produce highly digestible alfalfa for the dairy industry, growers harvest alfalfa in the bud stage and many fields never reach one-tenth bloom. Additional research was conducted to evaluate the change in nutrient concentration with advancing maturity. Alfalfa plant tissue samples were collected from 5 different alfalfa fields for all three cuttings. Samples were collected at early bud, late bud and one-tenth bloom. Whole plant samples, fractionated plant samples (using the UC protocol) and top 6-inch samples were collected at each sampling time. Plants were analyzed for phosphorus, potassium, sulfur, boron and molybdenum.

Phosphorus concentration declined considerably with advancing maturity, which is in agreement with previous research. Potassium and sulfur also declined with advancing maturity but to a lesser degree than did the phosphorus concentration. This confirms that plant maturity must be considered when interpreting plant tissue test results. For example, if the values are not adjusted for maturity, a sample collected at early bud stage may appear to have adequate phosphorus but if the same plants were sampled at one-tenth bloom the tissue values may indicate they are deficient. The concentration of the micronutrients boron and molybdenum decreased slightly with advancing maturity but it did not appear to be enough that it is necessary to adjust critical values.

The effect of maturity on nutrient concentrations observed in this study was used to adjust established *deficient, marginal, adequate* and *high* plant analysis values for whole plant or cored bale samples. These values should be considered preliminary, as further research is planned to validate these values.

Table 2. Preliminary values to interpret test results for cored bale samples of alfalfa hay collected at different maturities.

		PLANT TISSUE VALUE			
NUTRIENT	UNIT	DEFICIENT[a]	MARGINAL	ADEQUATE	HIGH
Phosphorus					
Early bud	%	<0.26	0.27–0.29	0.30–0.39	>0.39
Late bud	%	<0.23	0.24–0.25	0.26–0.34	>0.34
10% bloom	%	<0.20	0.21–0.22	0.23–0.30	>0.30
Potassium					
Early bud	%	<0.91	0.92–1.24	1.25–1.60	1.60–3.42
Late bud	%	<0.87	0.88–1.19	1.20–1.53	1.53–3.27
10% bloom	%	<0.80	0.81–1.09	1.10–1.40	1.40–3.00[b]
Sulfur					
Early bud	%	<0.23	0.23–0.26	0.27–0.35	>0.47
Late bud	%	<0.22	0.22–0.24	0.25–0.33	>0.44
10% bloom	%	<0.20	0.20–0.22	0.23–0.30	>0.40[c]
Boron					
All stages	ppm	<15	16–20	21–80	>200[d]
Molybdenum					
All stages	ppm	<0.3	0.4–1.0	1–5	5–10[e]

a. An economic yield response to fertilizer applications is very likely for values below the deficient level, somewhat likely for values in the marginal level and unlikely for values over the adequate level.
b. Alfalfa having greater than 3% potassium may cause animal health problems, particularly if the magnesium concentration is not greater than 0.25%.
c. Alfalfa having greater than 3000 ppm SO_4-S or approximately 0.4% sulfur may intensify molybdenosis in ruminants.
d. A concentration over 200 may cause reduced growth and vigor.
e. A concentration over 10 may cause molybdenosis in ruminants. Copper concentrations should be twice as high as molybdenum concentrations.

EXTREME VARIATION IN NUTRITIONAL STATUS OF FIELDS

Numerous alfalfa fields throughout the Intermountain Region were sampled in the study mentioned above comparing baled samples with whole tops and fractionated plant samples. A total of 117 samples were collected over two years representing 39 fields (three sampling areas per field). Table 3 shows the results for some of the analyses. The range in values is striking. The average pH was 7.2 with values ranging from 5.6 to 8.1. This illustrates the diversity of soils encountered in the Intermountain Region of California. Soil phosphorus levels averaged 17.1 but ranged from a low of 2.0 (well below the deficiency level) to a high of 74.7 ppm (nearly 4 times the “High” level). Mid-stem phosphorus levels also averaged in the adequate range (1327 ppm) but ranged from 230 to 2220 ppm. Soil potassium levels ranged from very deficient (25 ppm) to extremely high (632 ppm) and averaged in the “High” range at 192 ppm. Tissue values also averaged in the “High” range but some locations were as low as 0.74 ppm K. Most of the Intermountain region has adequate or even high potassium levels but deficiencies occur in some isolated locations. The high tissue levels are not a reflection of potassium fertilization practices, but instead high inherent soil potassium levels. On average sulfur levels were high (2390 ppm) but ranged from 180 to 5350. This represents extremely deficient levels to over 5 times the high level.

Table 3. The average and range of soil test values (pH, Olsen P, and K) and plant tissue levels (PO4-P, K and SO4-S) found for 117 samples collected from 39 alfalfa fields in the Intermountain Region of northern California.

	Soil			Mid-Stems		Mid-Stem Leaves
	pH	**Olsen P** Ppm	**K** ppm	**PO_4-P** Ppm	**K** %	**SO4-S** ppm
Average	7.2	17.1	192	1327	2.03	2390
Low	5.6	2.0	25	230	0.74	180
High	8.1	74.7	632	2220	4.18	5350
Deficient		<5	<40	300–500	0.4–0.65	0–400
Marginal		5–10	40-80	500–800	0.65–0.80	400–800
Adequate		10–20	80-125	800–1500	0.80–1.50	800–1000
High		>20	>125	Over 1500	>1.5	Over 1000

The significance of this table is that it illustrates how much nutrient levels can vary between fields depending on the inherent fertility of the soil and past fertilization practices. To predict whether you will have an economic response to fertilizer, it is critical that you use soil tests or plant tissue tests to evaluate the current status of the field. The yield response from a fertilizer application is far greater if the field is deficient than if soil tests or plant tissue tests indicate that the fertility status of the field is in the medium or adequate range.

CONCLUSION

With low hay prices and slim profit margins, it is more important than ever to use soil tests or plant tissue tests to more accurately assess the fertility status of a field. These analyses should be used to guide fertilization practices rather than simply following past practices without knowing the actual fertility status of individual fields. Soil analysis is recommended prior to planting a new field of alfalfa and periodically through the life of a stand, especially when a nutritional problem is suspected. Plant tissue testing is a typically a more accurate reflection of plant uptake for all nutrients but especially for some nutrients such as sulfur, boron and molybdenum. It appears that a new method of tissue testing using cored bale samples shows significant promise to assess the fertility status of an alfalfa field. This method is far easier and convenient for growers to use and is likely to encourage the adoption of plant analysis in alfalfa. Additional testing is underway to further refine the sufficiency ranges to account for the effect of plant maturity.

REDUCED LIGNIN ALFALFA AND STATUS OF ROUNDUP READY ALFALFA

Peter Reisen[1], Mark McCaslin[1], David Weakley[2] and Matthew Fanta[1]

BACKGROUND

In 2003 three groups came together to start an inter-institutional, interdisciplinary research program to use plant biotechnology to improve key alfalfa characteristics that affect forage quality and efficiency of use by dairy cows. The Consortium for Alfalfa Improvement (CAI) was formed by the U.S. Dairy Forage Research Center, the Samuel Roberts Noble Foundation and Forage Genetics bringing together acclaimed experts in plant biochemistry, molecular biology, plant breeding, agronomy and ruminant nutrition. This interface between animal and plant scientists; and public and private institutions is recognition of both the complexity of the tasks at hand, and the challenges of translating ideas into commercial products benefitting alfalfa and dairy producers.

Increased Fiber Digestibility

Lignin is an indigestible cell wall component that increases in content with advancing maturity of the alfalfa plant, and is the key factor in limiting cell wall (NDF) digestibility by ruminant animals. Noble Foundation Scientists having been working on biotech manipulation of the lignin pathway since the early 1990's. This work has been the foundation of the Reduced Lignin project at the CAI. "Gene knockout" is a biotech process whereby expression of a specific individual gene is greatly reduced. Knocking out a gene coding for a specific lignin biosynthetic enzyme generally results in transgenic plants with significant changes in lignin content and/or lignin composition. The CAI Reduced Lignin project has now characterized multiple gene knockouts in the lignin biosynthetic pathway and has identified gene candidates with 10-20% improvement in fiber digestibility, and normal agronomic performance. Preliminary results from animal feeding trials have provided *in vivo* confirmation of NDF digestibility. Agronomic trials have shown that NDFD of Reduced Lignin Alfalfa harvested at 10% bloom is equal to or better than conventional alfalfa harvested 7 days earlier at the early bud stage. This potential for delayed harvest increases flexibility in harvest management and potentially reduces the number of harvests per year, without sacrificing forage quality.

ROUNDUP READY UPDATE

Background

Roundup Ready alfalfa was approved for sale in June 2005. During late 2005, 2006 and early 2007 the technology was successfully utilized by 4,000+ growers on more than 200,000 acres.

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In March of 2007 a Federal Court judge ruled that the USDA's environmental analysis of Roundup Ready Alfalfa was deficient in that it did not include a "hard look" at, 1) the potential impact on organic and other alfalfa growers that are producing for non-genetically engineered (non-GE) markets; and 2) a potential incremental effect that Roundup Ready Alfalfa commercialization may have on the generation of glyphosate resistant weeds. In June of 2007 the judge issued a permanent injunction that vacated the original deregulation decision pending the [1]USDA/APHIS preparation of an Environmental Impact Statement (EIS). The ruling acknowledged the FDA's finding that Roundup Ready Alfalfa was safe for food and feed, and allowed the continued harvest of existing Roundup Ready Alfalfa forage and seed production fields. However the injunction prohibited any new planting of Roundup Ready Alfalfa until, and unless, a new deregulation decision was made by USDA/APHIS based on the EIS.

The injunction did enable existing stands of Roundup Ready alfalfa hay to remain in production, so the Roundup Ready alfalfa trait has continued to be actively utilized by farmers. Current user studies conducted in the fall of 2006 and fall of 2008 demonstrate that growers continue to see value and benefits in the technology. Overall customer satisfaction increased from 90% to 98% in this timeframe. In 2006, current users of the technology self reported a $49/acre advantage inclusive of seed, trait, herbicide and other costs compared with a comparable acre of conventional alfalfa. In the 2008 study, current users reported a .9 ton/acre yield advantage in their Roundup Ready alfalfa stands.

Draft Environmental Impact Statement

During the previous 30 months the USDA/APHIS has worked to complete the draft EIS. The draft was published on December 14, 2009. It can be found on the internet at: http://www.aphis.usda.gov/biotechnology/downloads/alfalfa/gealfalfa_deis.pdf . The document consists of an executive summary, a detail written summary and an appendix with the documents and information used to prepare the draft EIS.

In its summary, the draft proposes the following:

> "APHIS is proposing to grant nonregulated status to genetically-engineered glyphosate-tolerant alfalfa lines J101 and J163 based on the agency's analysis and conclusions that these genetically-engineered alfalfa lines are unlikely to pose plant pest risks. Additionally, APHIS has preliminarily concluded in this Draft Environmental Impact Statement (DEIS) that granting nonregulated status to glyphosate-tolerant (GT) alfalfa lines J101 and J163 will not result in significant impacts to the human environment."

A comment period, enabling the public to comment on the draft EIS was opened on December 18th, 2009. Growers can comment by going to the www.regulations.gov website. Comments need to be received by February 16th, 2010.

REDUCING INPUTS TO IMPROVE PROFITS: Good Or Bad Idea?

Steve Orloff and Dan Putnam[1]

ABSTRACT

After a low price year like 2009, alfalfa growers scramble to find ways to improve profitability and often consider reducing inputs. However, many inputs are closely linked to yield or forage quality and cutting back could reduce overall profitability. Here, we consider several of the inputs where it may be feasible to cut costs and alternatively identify inputs that should not be reduced or eliminated. Seeding rates can be reduced in many cases provided the seedbed is optimum. However, growers should not cut corners when it comes to selecting an adapted high-yielding variety. Weed control in seedling alfalfa is critical but lower rates may be used in some cases when treatments are applied early. Similarly, weed control in established alfalfa is cost effective, and weedy hay is difficult to sell in a depressed market, but it may be feasible to use soil active herbicides alone without a contact herbicide when applied early in the season. Soil or plant tissue analysis is more important than ever in low price years to assess the fertility status of fields to predict the level of response to fertilizers. A reduced rate or skipping a year may be feasible. Irrigation water is closely linked to yield and other than by improving uniformity, opportunities to reduce irrigation without reducing yield are limited. While it is critical to examine costs in a low-priced year, some expenditures are clearly worthwhile since they result in improved profitability.

INTRODUCTION

The 2009 alfalfa production season has been one of the most challenging on record. Most people did not expect the record high prices of 2008 to continue indefinitely, but who at that time would have predicted that the price would plummet more than $100 per ton. Prices received in 2009 were equal to prices of decades ago but input prices were more reflective of current-day prices. Additionally, sales have been sluggish, especially for mediocre quality hay.

Growers are preparing for the next season with caution. A common approach, when faced with this situation, is to pull back on inputs. It is wise to carefully scrutinize inputs, especially in years when profit margins are slim; however, reducing inputs can lower yield and ultimately diminish profit. Rather than indiscriminately reduce inputs, it is critical to carefully examine each input to determine which are truly cost effective and which are less critical. Our objective in this article is to evaluate some of the inputs involved in alfalfa production and make a value judgment where a savings could and could not be made.

STAND ESTABLISHMENT

Stand establishment is unquestionably one of the most critical aspects of alfalfa production. The goal is to achieve a dense vigorous stand of alfalfa that will remain productive for a minimum of

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3 to 4 years—and much longer than that in some production areas. Hence, don't scrimp on inputs that are likely to detract from your ability to achieve this goal. This said there may be some opportunities to reduce inputs if the producer is willing to accept a little more risk.

Deep Ripping. Deep ripping is perhaps the most costly of all stand establishment operations. The degree and depth of ripping or subsoiling necessary to establish a stand of alfalfa is not readily apparent and there is no set formula for all sites. One of the best ways to asses the need for deep ripping is to dig a backhoe pit prior to removing an old alfalfa stand and carefully examine the soil profile, root distribution and the presence of any visible impediments to root growth. If roots proliferate unimpeded to at least 3 to 4 feet deep, deep tillage is likely unnecessary. Moderate tillage that fractures subsurface impediments down to 12 to 14 inches is generally sufficient to break up compacted layers from equipment traffic.

Seeding Rate. There is a surprisingly wide range of seeding rates used by alfalfa producers in the West. Seeding rates range from as low as 10 to as high as 40 pounds per acre. However, *how much seed is actually needed*? One pound of alfalfa seed per acre equates to approximately five seeds per square foot. So four pounds of alfalfa seed per acre would result in 20 plants per square foot, the number of plants considered to be an adequate stand. However, only about 60 percent of the seeds typically germinate and emerge and 40 to 60 percent of the emerged seedlings may die in the first year. The standard recommendation for California has been to seed 15 to 20 pounds per acre for drilled seedings and 20 to 25 pounds per acre for broadcast seedings to provide a cushion of insurance. Many states recommend lower seeding rates. When alfalfa prices are low and growers are searching for areas to cut costs, we believe it is feasible to reduce seeding rates without risking the success of the alfalfa planting provided the seedbed is properly prepared and effective seeding equipment is used. When Roundup Ready alfalfa was available with its higher seed costs, many growers realized it was possible to reduce seeding rates without jeopardizing productivity. Most studies conducted by alfalfa researchers suggest that there is little benefit to seeding over 10 pounds of pure live seed per acre. A seeding rate of 10 to 15 pounds is probably sufficient, especially when seeding with the press wheels found on some of the newer drills and more precise seeding depth. However, be sure to pay particular attention to depth control and soil preparation to assure high rates of stand success.

Coated vs. Raw Seed. Sometimes growers can select between raw seed and coated seed. The coating comprises about one-third of the weight of coated alfalfa seed so there is less seed per pound. The coating is primarily made of inert materials which may also contain fungicides, Rhizobia bacteria and sometimes fertilizers. Seed coating is used for several reasons but a common reason is simply to extend seed supplies when seed is in short supply. Coatings are also used to provide a fungicide or Rhizobium bacteria in close proximity to the seed to enhance seedling survival and development. Coated seed has not been found to be consistently better than raw seed in research trials. Therefore, unless seedling diseases are common in your area you may be willing to assume some risk and forgo coated seed and plant raw seed at a lower.

Planting a Less Expensive Variety. Is it a good idea to buy the cheapest alfalfa seed? The price of alfalfa seed can vary greatly, especially between a top yielding new variety with improved germplasm and an older public variety (like Vernal or Moapa 69) or a VNS (variety not stated) bag of seed. The potential savings for a grower can be as much as $30 per acre or more. However, this is an example where being ‘penny wise’ is likely to be ‘dollar foolish’, at least in most cases. Improved alfalfa varieties are worth hundreds of dollars more per acre in potential yield compared with older, unimproved seed, or seed of questionable origin. This has been shown consistently in University variety trials throughout the United States. Remember that it only takes less than 1 tenth of a ton yield increase each year to pay for even a $2/pound increased seed price, an amount that is easily surpassed by many improved lines. Figure 1 shows that the yield increase in the first year alone was enough to more than cover the cost of an improved variety using data from an alfalfa variety trial in Tulelake CA. The returns over the life of a stand can be significantly more (one study from the Central Valley of California showed up to $900 per acre higher returns over three years with an improved variety).

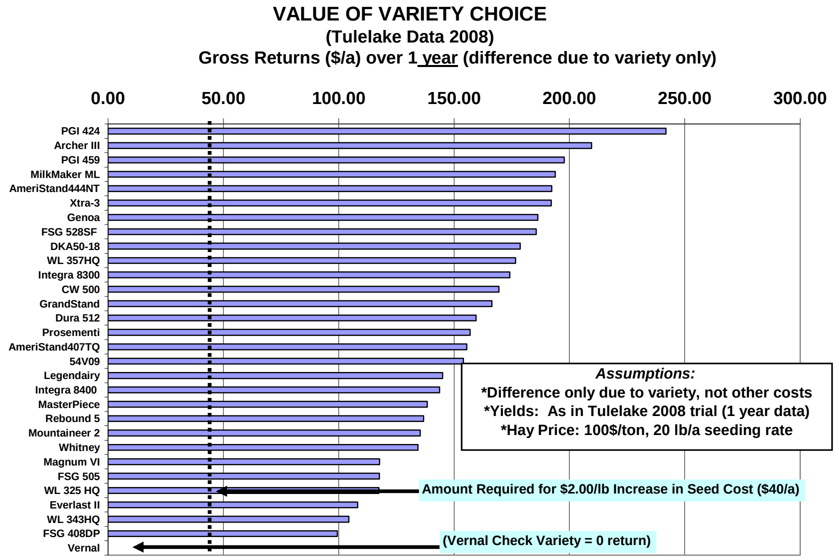

Figure 1. Comparative gross returns ($/A) of varieties planted at the Tulelake Research and Extension Center, Tulelake, CA considering only one year of production, data from UC alfalfa trials.

Weed Control. It may be tempting to consider eliminating chemical weed control sometime over the life of an alfalfa stand; however, the seedling phase is not the time. Weeds always compete with alfalfa for light, nutrients, water and space but this competition is especially intense in seedling alfalfa. Weeds not only reduce the quality of the first harvest but dense weed infestations can thin alfalfa stand density reducing the long-term productivity of the stand. Also, weeds left uncontrolled will set seed and cause problems for years to come. Chemical weed control in seedling alfalfa is almost always economically justified.

The key to effective weed control in seedling alfalfa is proper weed identification. Most growers rely completely on postemergence herbicides for weed control in seedling alfalfa. This allows proper weed identification before selecting the herbicides. Common treatments include Raptor (imazamox) alone to more elaborate tank mixes such as Pursuit plus Select (imazethapyr plus clethodim) or Raptor plus Pursuit plus 2,4–DB. When you figure a price reduction in the neighborhood of at least $20 per ton for weedy seedling alfalfa and a first cutting yield of 1.5 to 2.0 tons, the cost of the herbicide is often covered by the difference in price alone, not counting the improvement in alfalfa vigor, stand density and the reduction in the weed seed bank.

Cutting back on seedling weed control practices to cut costs is shortsighted if it results in a significantly reduced level of weed control. However, there may be ways to achieve nearly perfect weed control at a lower cost. Treating at the optimum time is a way to cut costs. Simply stated, small weeds are easier to kill so treat at the minimum alfalfa growth stage stated on the label. Oftentimes growers wait to treat until it is obvious that weeds are a problem but by that time it is ordinarily too late. By treating early it may be feasible to use the middle rate stated on the label rather than being forced to apply the highest label rate.

FERTILIZATION

Of all the different inputs involved in alfalfa production, fertilizer is perhaps the first one that growers consider eliminating when hay prices fall. However, oftentimes the growers that consider not fertilizing in low-price years are the ones that can least afford to do so. They are typically the ones that may have scrimped in the past and the fertility level of their field is low enough that fertilizer is important even in a low price year. Growers that have fertilized most years and have maintained at least adequate fertility levels may be able to cut back or skip fertilizing for a year.

Soil and tissue testing. The importance of either soil testing or plant tissue testing to determine the fertility status of your fields cannot be overstated—especially in a low price year. Many growers fertilize using a recipe or "cookbook" approach. They settle on continually applying a fixed amount of fertilizer that seems to have worked in the past. Eventually this approach results in over- or under-fertilization because the current fertility status of the field is not evaluated. A "prescription" fertilizer program using soil analysis or plant tissue analysis is far more cost effective because fertilizer application rates are tailored to the actual needs of the field, avoiding the costs associated with over fertilization or lost yield due to under fertilization.

Reduced rate. If your soil or tissue test indicates that a field is clearly deficient, then a full application rate is justified. However, if your field falls into the upper end of the marginal category, or the lower end of the adequate category, and you plan a maintenance application, it is feasible to apply a rate that is two-thirds or three-quarters of a typical rate when hay market conditions are poor. The greatest response is from the initial increments of fertilizer and the rate of return declines as the soil fertility level approaches adequate to high levels (Figure 2). Therefore, in a high price year it is easier to recover the cost of fertilizer through increased yield and peak profitability occurs near maximum yield. However, in a low price year the point of maximum economic yield occurs at a lower fertilizer rate. Provided your field is not real deficient, reduced rates may be fine for a year or two when hay prices are low. A word of caution though—after applying reduced rates successively for more than a year, the soil can become depleted and it may take high rates to return soil fertility to acceptable levels. Skipping a year or fertilizing with a lower

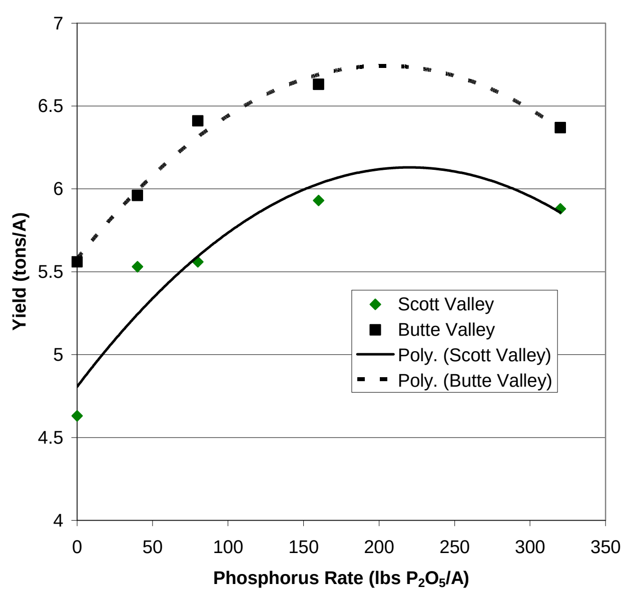

Figure 2. Annual yield response to applied phosphorus fertilizer at two locations in the Intermountain Region. Results show a typical fertilizer response curve.

rate can help reduce costs in the short term during low-priced years but is not a sustainable long-term solution.

Selecting the appropriate fertilizer. While always a wise practice, it is especially important in low-price years for producers to select the most cost-effective fertilizer materials. Rather than just considering the cost per ton of the fertilizer or the cost of a “typical” application, purchase fertilizer materials based on their cost per pound (often referred to as unit by growers) of the actual nutrient needed. For example, when purchasing a phosphorus-containing fertilizer, select the fertilizer that is cheapest per pound of phosphate (P_2O_5). In most cases this will be 11-52-0. Some growers apply complete mixed fertilizers or even foliar fertilizers. These fertilizers are typically not cost effective. Alfalfa removes large quantities of nutrients from the soil and it is usually more expensive to apply those quantities with a liquid foliar fertilizer or a complete blend that often contain nutrients that are not deficient. Research trials have not shown an economic yield advantage with foliar fertilizers or special blends compared with granular fertilizers.

WEED CONTROL IN ESTABLISHED STANDS

Weed control is a continual battle for alfalfa producers and most growers in the West use herbicides each year to control weeds. It is tempting to forgo herbicide applications to save money in a down year but is this really a wise practice? The answer obviously depends on the weed infestation level and the type of weeds present in a field. Unfortunately, even if a grower has employed an effective weed management strategy in the past, the weed seed bank is so vast that if weeds are left uncontrolled for a year, the weed infestation is sufficient to reduce the quality of the hay.

Economics of winter and summer weed control. Judging by the hay market reports, the reduction for hay infested with winter annual weeds is at least $15 to $30 per ton. The larger discount is for higher weed infestations and less palatable weeds like cheatgrass. The discount would be greater still for weeds like hare barley or poisonous weeds like common groundsel. The price reduction also climbs if the weed infestation drops the forage quality of the hay into a lower category. Typical weed control costs including the application for winter dormant treatments are in the neighborhood of $24 to $32 per acre depending on the herbicide program used. First cutting yields are typically at least a ton and a half in many warmer growing season areas and 2 tons or greater in the Intermountain West. Hence, weed control is generally economical even in low price years. Not only is weedy hay severely discounted, it may be extremely difficult to sell at all when hay sales are sluggish and buyers can purchase other hay at low prices.

Summer grasses are a problem in some alfalfa production areas, especially the Central Valley of California. Hay market sources show that alfalfa hay with a little grass is often discounted $15 to $20 per ton within a hay grade. If the presence of grassy weeds causes the hay quality to drop a grade or two, the penalty would be much greater. Considering the fact that summer grasses can infest nearly all the summer and early fall cuttings (in excess of 5 tons per acre per year) in warmer growing season areas, an application of Prowl (pendimethalin) or Treflan (trifluralin) to control summer grasses is likely to be economical.

Opportunity to lower costs. There may be some opportunities to reduce weed control costs. Just like with seedling alfalfa, it is essential to know the weeds that will be present in your field to select the proper herbicides. Knowing the weeds that infest your fields helps with the selection of the proper herbicide and rate. Many producers apply winter dormant weed control treatments late in the season and are forced to use tank mixes of a soil residual herbicide (such as Velpar, Karmex, Sencor or Chateau) with Gramoxone (paraquat) to control large emerged weeds. Some growers could potentially save money on their weed control program by applying herbicides earlier in the season when the weeds are tiny or not yet emerged and using the soil residual herbicide alone. Again, this requires an understanding of the weeds present and their susceptibility to herbicides to determine if the soil residual herbicide alone can control the weeds.

INSECT CONTROL

Not just in poor market years but in all years, the decision to apply an insecticide to control insect pests should be based on integrated pest management (IPM) practices and economic thresholds. Base treatment decisions on insect counts noting the presence of beneficial insects rather than treating on a calendar basis. Even in poor price years, an insecticide application is generally warranted when pest populations reach or exceed the economic threshold. Generic forms of many insecticides are available—which is an option to reduce the cost of treatment in poor price years. It does not take much of a yield increase to justify the cost of many insecticide treatments even in a low price year. Oftentimes the yield increase needed is only one tenth of a ton per acre and the potential yield decrease caused by some insects far exceeds that value.

Another option to carefully consider in low price years is to cut the crop early instead of applying an insecticide. The viability of this approach depends on the growth stage of the alfalfa and how much time is left until the desired cutting date. Ordinarily, if the pest population is above the threshold and there are at least two weeks before cutting, an insecticide treatment is advisable. Yield and quality are inversely related meaning that as yield goes up with advancing maturity, quality goes down. The yield penalty from cutting too early may be too severe and an insecticide application may be more economical in the long run. Another factor to keep in mind with early cutting is that while cutting controls most pests, this is not always the case. Alfalfa weevil, a common pest in California and other Western states, can occasionally survive a cutting and congregate under the windrow causing serious damage.

IRRIGATION

Irrigation water is critically important for alfalfa production in the West and therefore, there is very little dryland alfalfa in this region. However, in very low price years can overall profitability be improved by reducing the amount of water applied? There are two basic approaches to deficit irrigation of alfalfa. One involves making the same number of cuttings per season but reducing the amount of applied water for each cutting. The other approach involves ceasing irrigation early and forgoing a cutting or several cuttings. Ordinarily, these practices are not considered economical but when prices are as low as they have been this year, this question deserves another look.

Reduced irrigation amount. This strategy involves applying less water throughout the season than the crop actually requires for full yield. Numerous studies have shown that alfalfa yield increases in a linear fashion as evapotranspiration (ET) increases. The relationship between ET and yield varies between environments but the relationship is linear. What this means is that yield increases with every increment of ET up to full ET for the crop. After that point, yield remains constant.

However, that doesn't mean that every additional drop of irrigation water results in higher yields. Unlike the relationship between yield and ET, the relationship between yield and applied water is not quite linear. Irrigation systems are imperfect. Because irrigation systems are not completely uniform, some portions of the field receive more than what is needed and other areas less than ET due to the non-uniformity of water applications.

In years when the alfalfa price is high and/or water is inexpensive, it is typically economical to apply enough water so that very little of the field is deficit irrigated, even though some areas of the field will be over-irrigated. However, when the alfalfa price is low and/or water price is high, it may be economical in some situations to allow parts of the field to receive less than full ET. Determining exactly what that quantity is can be difficult. The main point is that severe deficit irrigation (where no area of the field receives full ET) is not economical because the yield penalty is too great.

The key during low-priced years is to increase your level of irrigation management. The key to maximizing profit is to know how much water your irrigation system applies, identify the amount needed to satisfy ET and account for inefficiencies in the irrigation system, and apply only that amount and not more. This is done through soil moisture monitoring and/or weather-based irrigation scheduling. Improving irrigation efficiency can also improve profits by reducing the amount of applied water needed to ensure that at least most of the field is receiving enough water to satisfy peak ET.

Irrigation cutoff. This strategy involves partial season irrigation—irrigation ceases part way through the season and subsequent cuttings are foregone. Alfalfa yield in most areas declines the second half of the growing season compared with the first half. In addition, all or nearly all of the crop's water needs must be met with irrigation because there is very little rainfall during the second half of the growing season.

When prices are low, growers are tempted to quit irrigating and end the production season early. Considerable research has been conducted to evaluate the feasibility of early-season irrigation termination. The results have shown that this practice is agronomically feasible—yield is reduced but in most locations stand loss does not occur and yield rebounds fully the following year. So, is partial season irrigation cost effective in poor market years? It is difficult to give a set answer that applies for all situations and locations. The answer obviously depends on the cost of water, the anticipated yield and the alfalfa price.

The question is how much yield is required to cover the cost of irrigation and harvest costs (Figure 3). In theory, this partial budget analysis is sufficient because other costs are primarily fixed costs or inputs that have already been supplied (like fertilizer applications or pest control that are done earlier in the season). Figure 3 shows the minimum yield required for a cutting to cover harvest and irrigation costs at various hay prices and irrigation costs. Harvest costs were assumed to be $43.35 per acre, which are the total harvest costs calculated by Klonsky *et al* for a sickle-bar swather and small three-tie bales. Your harvest costs may be lower or higher so this analysis should be adjusted accordingly. For example, if the total irrigation costs for a cutting are $50 per acre (this is the acre feet of water used for a cutting multiplied by the cost of the water plus irrigation labor costs) and the hay price is $100 per ton, a yield of nearly 1.0 ton per acre is needed to break even. In most areas, irrigation costs per cutting are less than $50. Hence, under most conditions it is still profitable to irrigate for many if not all of the summer cuttings even when the price is only $100 per ton. However, the economics might be different if the water not used for irrigation was sold for another use, or used to irrigate a more profitable higher value crop.

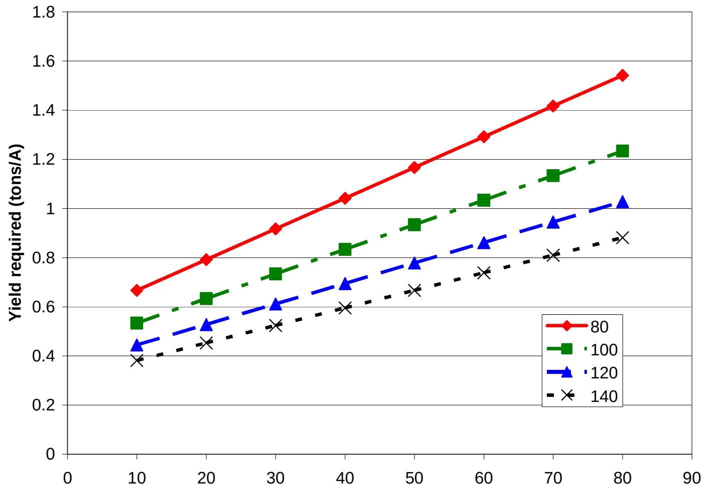

Figure 3. Yield required to justify irrigation and harvesting costs for a single cutting at various prices of alfalfa hay, and costs for water applications.

CONCLUSION

While it is tempting to eliminate nearly all inputs during a time of low or negative profitability, this strategy rarely makes sense. Reducing inputs often results in lower production or quality, which can diminish overall profitability. The key in low price years is to examine each input and identify the appropriate level that results in maximum economic yield rather than maximum yield. The inputs we identified that might be reduced are deep tillage (depends on the site conditions), seeding rate (as long as the seedbed is in excellent condition), herbicide rate or the need for a tank mix (provided application timing is optimum and weeds properly identified), short-term reduction in fertilizer applications (along with careful monitoring), and possibly a slight reduction in irrigation so that not quite as much extra water is applied to account for non-uniformity in the irrigation system. While high levels of management are important in all years, they are especially critical in low-price years. Reducing inputs often results in an increased level of risk and a need for a higher level of management.

SEASONAL PATTERNS OF IDAHO HAY PRICES

C. Wilson Gray[1]

Most agricultural commodities exhibit seasonal price fluctuations. These are primarily related to supply and demand changes as the production year progresses to harvest and seasonal use needs change for the users. Commodities may also show longer term price trends as production and usage changes over long time periods. Some commodities also exhibit cyclical trends. Cattle have definitive cycles lasting from 10 to 12 years trough to trough. Hogs typically have a 3 – 4 year cycle. Some crops, such as wheat, exhibit cycles that are usually 2-4 years in length.

SEASONALITY OF PRICES

Seasonal price movements are typically a reflection of the production and marketing activities by farm operators during a marketing year. Because most producers are on similar schedules, at least within geographic regions, production may be "bunched" or marketed in the same time frame. Prices may decline during harvest periods and then prices may increase as available supplies become limited in the off season. Seasonal price patterns differ slightly based upon the class of hay marketed. Seasonal price pattern charts are included for USDA’s Hay Market News classifications – supreme, premium, good and fair. Seasonal price patterns can be easily described by a monthly index that shows a summary of monthly historical prices. Each monthly index is given as its relation to the annual average. Therefore, a monthly index of 1.00 (100 percent) means that month is equal to the annual average. An index of .95 (95 percent) means prices in that month average 5 percent below the annual average. The indices in the accompanying tables were calculated using a 12 month centered moving average. This method removes cyclical and trend factors from the resulting index.

MONTHLY VARIATION

The charts are indices of historical prices received each month. Shown along with the index is the standard deviation, an indicator of the variability of the index. Based on the price series used to calculate the index, prices would be expected to lie plus or minus one standard deviation $^2/_3$'s of the time. When the standard deviation is narrow the index is more reliable (less risky) than when the range is wider. Maximum and minimum indices for each month also indicate the degree of variability.

USING THE INDEX TO PROJECT PRICES

Price indices can be used to project prices for budget and planning purposes. This is accomplished by using the index to project a price for some later month based on the current price. In addition, the range of variation (+/- one standard deviation) could be calculated to determine the likely price range of hay.

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As an example, suppose a producer normally markets some hay in November and the April price for that class of hay is $95.00 per ton. The ratio of the November and April indices should be equal to the ratio of the November and April prices.

$$\frac{\text{November Price}}{\text{April Price}} = \frac{\text{November Index}}{\text{April Index}}$$

You can use this relationship to project the price for November as:

$$\text{November Price} = \frac{\text{November Index X April Price}}{\text{April Index}}$$

$$\text{Expected November Price} = \frac{1.012 \text{ x } \$95}{0.894} = \$107.54$$

A range of expected prices can also be projected by using the standard deviations above and below the expected price. It is calculated as shown here. Using the variance to "bracket" the projection gives a range where one would expect the price to be at least 2/3's of the time.

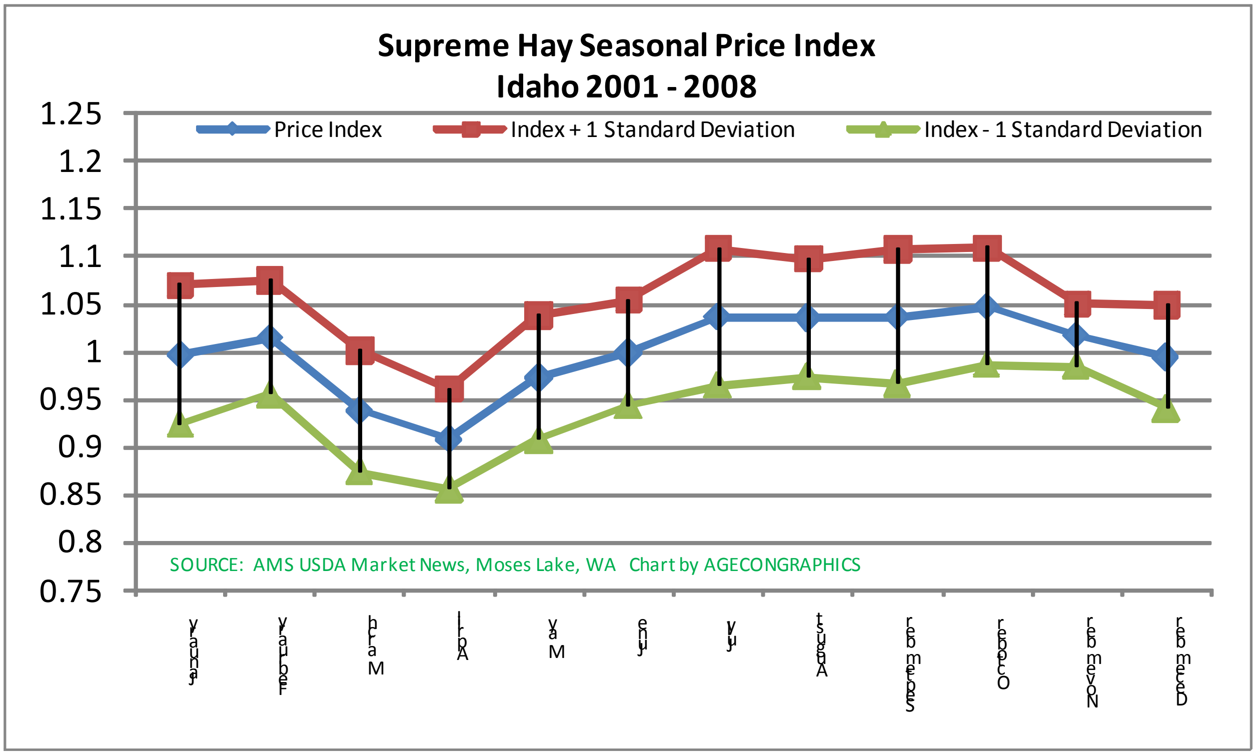
$$\text{Highest Expected Price} = \frac{1.050 \text{ x } \$95}{0.894} = \$111.58$$

$$\text{Lowest Expected Price} = \frac{.973 \text{ x } \$95}{0.894} = \$103.39$$

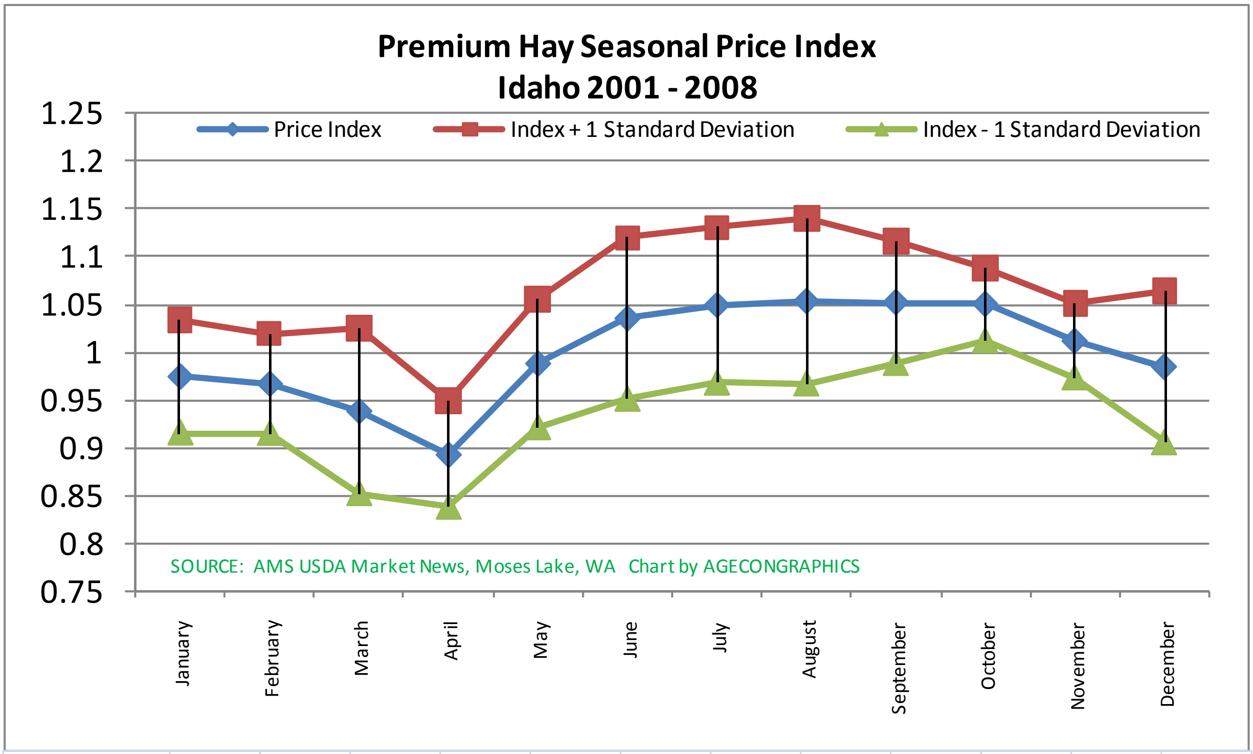
The corollary here is that a price of $107.54 is probable, but the actual price should likely fall within an $8 range ($103.39 to $111.58). Using the maximum and minimum indices for a projected month may give more indication of the absolute variation in the potential price. The smaller the variability the more reliable the monthly index factor. If the range is wide that may be partly due to the scarcity of hay in that class being available at a particular time. It may also indicate that over the period used to develop the indices prices fluctuated over a wide range. If the volume of hay marketed in late spring is low, there would be fewer reported prices in that time period.

Rather than calculating the expected price once at budget time and forgetting it, the projection should be updated at least once a month during the year or more frequently as marketing time approaches. This will allow projections with more current prices and should improve the accuracy of the estimate.

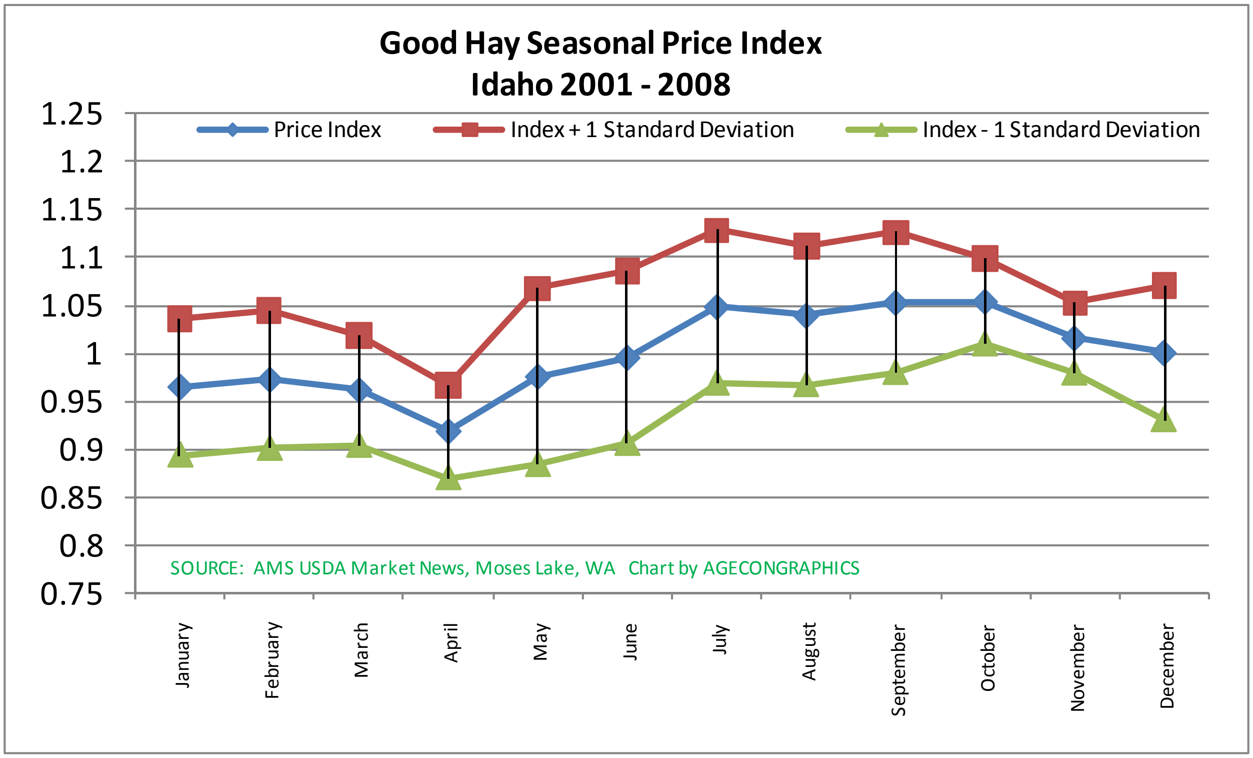
Seasonal Indexes of Hay Prices – Charts and Tables



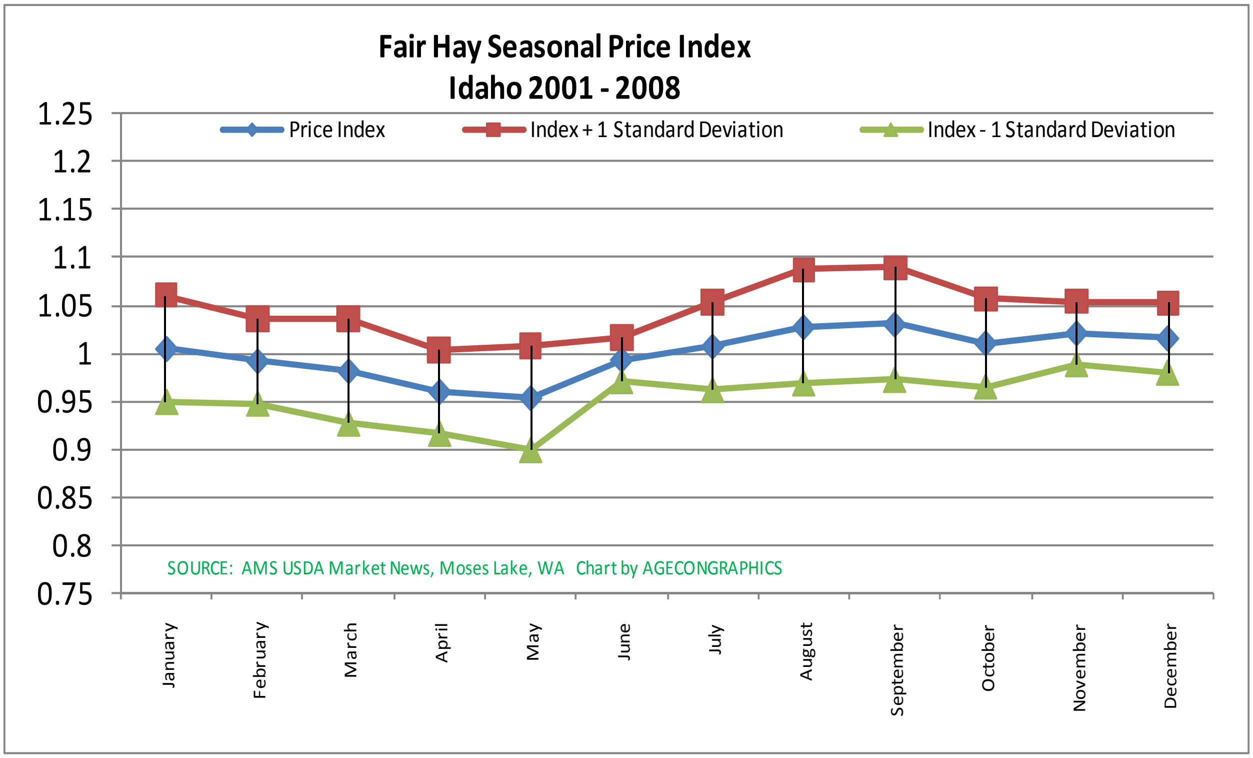
	January	February	March	April	May	June	July	August	Septembe	October	November
Index	0.997	1.015	0.938	0.909	0.973	0.999	1.037	1.036	1.037	1.048	1.018
Standard Deviation	0.073	0.060	0.063	0.052	0.066	0.055	0.072	0.062	0.070	0.061	0.033
Max Index	1.063	1.116	1.015	1.001	1.048	1.074	1.163	1.179	1.184	1.180	1.058
Min Index	0.874	0.946	0.811	0.818	0.889	0.917	0.941	0.987	0.973	0.984	0.973
Index + 1 SD	1.070	1.075	1.002	0.961	1.039	1.054	1.108	1.097	1.107	1.109	1.050
Index - 1 SD	0.924	0.955	0.875	0.857	0.907	0.944	0.965	0.974	0.966	0.987	0.985



	January	February	March	April	May	June	July	August	September	October	November	December
Index	0.975	0.967	0.939	0.894	0.988	1.035	1.049	1.053	1.052	1.050	1.012	0.985
Standard Deviation	0.059	0.052	0.087	0.056	0.067	0.084	0.081	0.086	0.064	0.038	0.039	0.080
Max Index	1.076	1.056	1.097	0.961	1.089	1.159	1.189	1.204	1.170	1.100	1.083	1.069
Min Index	0.902	0.893	0.828	0.808	0.883	0.881	0.937	0.961	0.992	0.992	0.950	0.816
Index + 1 SD	1.034	1.020	1.026	0.950	1.055	1.119	1.130	1.139	1.116	1.088	1.050	1.065
Index - 1 SD	0.916	0.915	0.852	0.838	0.921	0.951	0.968	0.967	0.988	1.012	0.973	0.905



	January	February	March	April	May	June	July	August	September	October	November	December
Index	0.965	0.973	0.962	0.919	0.976	0.995	1.048	1.039	1.053	1.054	1.016	1.001
Standard Deviation	0.071	0.072	0.058	0.049	0.092	0.090	0.080	0.072	0.073	0.045	0.037	0.070
Max Index	1.117	1.093	1.053	0.980	1.132	1.126	1.151	1.182	1.154	1.124	1.060	1.069
Min Index	0.890	0.882	0.899	0.844	0.858	0.854	0.951	0.955	0.916	0.994	0.947	0.876
Index + 1 SD	1.036	1.044	1.019	0.967	1.068	1.085	1.128	1.111	1.126	1.099	1.052	1.070
Index - 1 SD	0.894	0.901	0.904	0.870	0.884	0.906	0.969	0.967	0.980	1.010	0.979	0.931



	January	February	March	April	May	June	July	August	September	October	November	December
Index	1.005	0.992	0.982	0.960	0.953	0.993	1.008	1.028	1.031	1.011	1.021	1.016
Standard Deviation	0.056	0.044	0.055	0.044	0.054	0.023	0.046	0.059	0.058	0.046	0.033	0.036
Max Index	1.089	1.060	1.054	1.031	1.023	1.032	1.071	1.142	1.129	1.100	1.058	1.047
Min Index	0.938	0.919	0.914	0.905	0.887	0.957	0.922	0.962	0.968	0.965	0.958	0.934
Index + 1 SD	1.061	1.036	1.036	1.004	1.007	1.016	1.053	1.087	1.089	1.057	1.054	1.052
Index - 1 SD	0.949	0.948	0.927	0.916	0.899	0.971	0.962	0.969	0.972	0.965	0.989	0.980

SILAGE ADDITIVES AND MANAGEMENT ISSUES

Richard E. Muck[1]

INTRODUCTION TO INOCULANTS

Inoculants are the most common silage additives in the United States. These products contain lactic acid bacteria to supplement the lactic acid bacteria naturally on the crop and help insure a consistent fermentation in the silo. The standard type of silage inoculant that has been marketed for several decades contains one or more homofermentative species of lactic acid bacteria. *Lactobacillus plantarum* is the most common species used. However, *Lactobacillus casei*, various *Pediococcus* species and *Enterococcus faecium* are all homofermentative species that may be included in these products. Recently, a heterofermentative species, *Lactobacillus buchneri*, has begun to be marketed alone or in combination with homofermentative species. The entry of the *L. buchneri* products has made it more difficult to know what, if any, inoculant should be used in making silage.

What are the differences between the homofermentative species and *L. buchneri*? The homofermentative species ferment 6-carbon sugars like glucose and fructose to lactic acid alone whereas *L. buchneri* and other heterofermentative species produce lactic acid and other products such as acetic acid, ethanol, and carbon dioxide (Table 1). The *L. buchneri* strains used in inoculants can produce lactic and acetic acids from 6-carbon sugars, but they can also ferment lactic acid to acetic acid.

Generally, lactic acid is the preferred end product of fermentation in the silo. Lactic acid is a stronger acid than acetic. Thus one would expect homofermentative inoculants to lower pH compared to those of untreated or *L. buchneri*-treated silages. Low pH inhibits the growth of many detrimental microorganisms and helps reduce proteolysis and other plant enzyme activity. Homofermentative fermentation produces no CO_2 and should therefore improve dry matter (DM) recovery from the silo compared to untreated silage. Rumen bacteria ferment lactic acid whereas acetic acid is a product of rumen fermentation, and ethanol may be fermented in the rumen but can also be absorbed through the rumen wall without fermentation. So, there should be a small benefit to rumen microbial growth from producing lactic acid in the silo rather than other common end products. The only downside to lactic acid is that acetic acid is a better inhibitor of yeasts and molds. So, *L. buchneri* by producing acetic acid is more likely to improve aerobic stability or bunk life than a homofermentative inoculant. Overall, if you want a silage to remain as close as possible nutritionally to the crop at harvest, you would like the fermentation of the lactic acid bacteria to be directed toward lactic acid production alone. If your principal concern is aerobic stability, then a silage fermentation that produces enough acetic acid to inhibit yeasts and molds is desired.

Table 1. Fermentation reactions by lactic acid bacteria.

Type of Fermentation	Reaction
Homofermentative	1 6-C Sugar → 2 Lactic Acid
Heterofermentative	1 6-C Sugar → 1 Lactic Acid + 1 Acetic Acid + CO_2
	1 6-C Sugar → 1 Lactic Acid + 1 Ethanol + CO_2
	1 Lactic Acid → 1 Acetic Acid + CO_2

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HOMOFERMENTATIVE INOCULANT PERFORMANCE

Homofermentative inoculants have been marketed for several decades. There is also an abundance of published research studies using various inoculants. This should form a basis for understanding how, when and where these products work. However, there are relatively few comparisons of a wide variety of commercial products within a given study, and all of these comparisons are on laboratory-scale silos. Evaluations of animal effects are generally limited to one or two products versus an untreated control.

Various scientists have summarized the published literature, and a general picture emerges of what to expect from homofermentative inoculants. In one of the largest surveys, Muck and Kung (1997) reviewed over 230 trial comparisons (inoculated vs. untreated silage) published between 1990 and 1995. Homofermentative inoculants lowered pH and shifted fermentation toward lactic acid and away from acetic acid in approximately 60% of the cases they summarized. These inoculants were most often effective in grass and alfalfa silages. They succeeded in changing silage fermentation less than half the time in corn silage and approximately one-third the time in whole-crop small grain silages compared to untreated silages.

Is it a surprise that these products did not work in all instances? Not really. There are a number of reasons why a product might not change fermentation. First, a product might be a dud or mishandled or misapplied. A significant number of studies never measured the number of lactic acid bacteria in the product they used to make sure that the product contained the number of bacteria claimed on the package. Second, it might be hard to improve upon the unassisted fermentation. Corn and whole-crop small grain silages typically have fermentations that are naturally homofermentative (high lactic to acetic acid ratio) and reach a low pH. If alfalfa at ensiling is low in sugar, there may be little opportunity for an inoculant to significantly affect silage quality. In both of these situations, the inoculated silage may reach a stable pH sooner, but little difference may be observed between treated and untreated silages at silo opening. Finally, the natural or epiphytic population of lactic acid bacteria may be so high that the inoculant bacteria never overwhelm them and dominate the fermentation. We did an experiment where we applied an inoculant at various levels (Muck, 1989). When the inoculant was added at a rate that was at least 10% of the epiphytic population, the inoculant always improved fermentation. When the inoculant was applied at less than 1% of the epiphytic population, the inoculant produced no significant changes in fermentation. The problem with using an inoculant at ensiling is that we do not know what the epiphytic population is until at best 2 or 3 days after ensiling. We have no precise means to know what the competition for the inoculant will be on the day of ensiling.

With alfalfa, we do have a means of estimating the epiphytic population. We did a series of experiments in Wisconsin and New York and found that the epiphytic population principally varied with weather conditions during wilting. Populations were higher with warmer temperatures, longer wilting times and if rainfall occurred during wilting. Using these results and assumptions about cost ($1/treated ton as fed) and return ($3/ton) when it works (an inoculant supplying 100,000 cfu/g crop was assumed to work when the epiphytic population was estimated to be < 1,000,000 cfu/g crop), we were able to develop graphs to predict when an inoculant would be profitable (Fig. 1). These graphs can be useful to target the conditions when a homofermentative inoculant will most likely provide a return on investment in alfalfa.

These graphs assume that there is a return on investment. Where does the return come from? The shift in fermentation to lactic acid does not directly put money in the farmer's wallet. A primary means is by improved DM recovery from the silo. The survey of Muck and Kung (1997) found that DM recovery was improved in 38% of the studies with an average increase of 6 percentage points in the cases with a significant increase. This is more than can be explained by lactic acid bacterial fermentation alone and suggests reduced spoilage in inoculated silages. Averaging over all conditions whether the inoculant

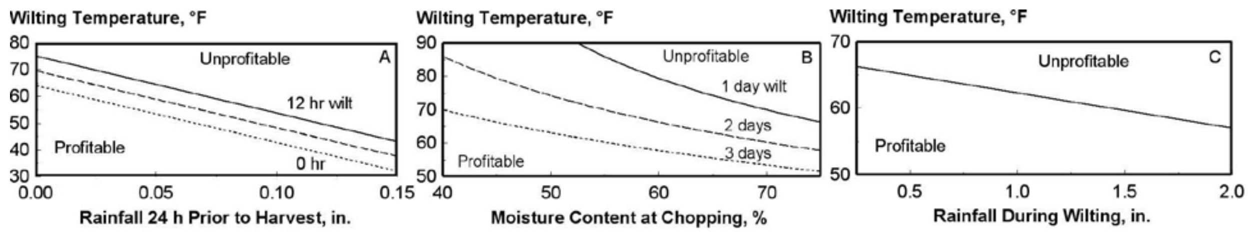

Figure 1. Break-even curves for using an inoculant in making alfalfa silage based on wilting conditions. A) Mowing and chopping the same day, B) 1-3 days wilt, C) 3+ days wilt with rainfall. Adapted from Muck and Kung (1997).

succeeds or not, one can expect a homofermentative inoculant to provide a 2 to 3 percentage unit improvement in DM recovery from the silo.

Improvements in animal performance have also been observed. Gain in growing cattle and milk production in lactating cows have been improved in approximately half the studies surveyed (Kung and Muck, 1997). When the inoculated silage produced a positive effect, the average increase in gain (5%) was somewhat higher than the increase in milk production (3%). The causes for these increases in performance are difficult to explain. Intake of silage was improved in only a fifth of the trials so that the performance boost appears to be related more to the efficiency of silage utilization by the cow rather than the quantity of silage consumed. Recently, we compared a wide range of inoculants on alfalfa silage and measured effects on ruminal *in vitro* gas and volatile fatty acid (VFA) production (Muck, et al, 2007). Intriguingly, inoculants reduced gas production and acetate to propionate ratio compared to those of the untreated silages. By difference, these results suggest an improvement in rumen microbial growth on inoculated silage. The degree of change varied by inoculant, but *in vitro* effects were observed even when the inoculants had little effect on silage fermentation, an observation in a number of animal trials. More research is needed to discover and explain the observed effects. However, we have evidence that homofermentative inoculants can change rumen fermentation in a way that may explain their effects on gain and milk production. The results also suggest that animal effects may be more strain specific than effects in the silo.

A final issue is aerobic stability, i.e., how susceptible a silage is to heat either at the silo face or in the feed bunk. While homofermentative inoculants are often marketed as improving aerobic stability, the observed effects in studies have been small and mixed (Muck and Kung, 1997). There were significant positive effects in less than a third of the studies and significant negative effects in approximately a third of the studies. Most of the positive effects were in hay crop silages whereas as the negative effects were largely in corn and whole-crop small grain silages. Does this make sense? Actually, yes. Small shifts in aerobic stability would be predicted by the changes that homofermentative inoculants make in silage fermentation. A lower pH makes silage acids more inhibitory to yeasts, the usual initiators of heating in silage. Lactic acid is less inhibitory to yeasts than acetic acid. In alfalfa silage, inoculants often produce a 0.2 to 0.3 unit reduction in pH compared to an untreated silage, and this reduction in pH offsets the shift to lactic acid. When the reduction in pH is substantial, aerobic stability should be increased. In corn silage, inoculants often have no effect on pH but do shift fermentation away from acetic to lactic acid. This should have a negative effect on aerobic stability.

HETEROFERMENTATIVE INOCULANT PERFORMANCE

Lactobacillus buchneri is a heterofermentative lactic acid bacterial strain being marketed in the U.S. (*Lactobacillus brevis*, another heterofermenter, has been tested in European research trials and may find its way to the U.S.) This species was introduced to address the problem of aerobic stability that homofermentative inoculants made worse in some cases. The primary purpose of this microorganism is to increase the amount of acetic acid and as a consequence decrease the level of yeasts in a silage.

The meta-analysis of Kleinschmit and Kung (2006) that summarized 43 experiments provides a good overview of the effects of *L. buchneri* on silage quality (Table 2). These inoculants do reduce the amount of lactic acid and increase the amount of acetic acid in silage with a subsequent increase in pH compared with that observed in untreated silages. Inoculated silages had reduced yeast counts, particularly in corn silage, and increases in aerobic stability. In corn silage, there appeared to be a dose response over a wide range of parameters. Inoculants supplying more than 100,000 cfu/g crop had a larger effect on fermentation and aerobic stability than inoculants applied at 100,000 cfu or less per g crop. In grass and whole-crop small-grain silages, the dose response was much smaller and only significant for acetic acid and aerobic stability. The meta-analysis also indicates that there is a cost in DM recovery of about 1 percentage point. This is due to one molecule of CO_2 being released for every molecule of acetic acid produced (Table 1).

Table 2. Effects of *Lactobacillus buchneri* on silage characteristics (Kleinschmit and Kung, 2006).

	Corn Silage			Grass and Small-Grain Silage		
Item	LB0[a]	LB1	LB2	LB0	LB1	LB2
DM, %	30.7	30.7	30.7	31.8	31.7	32.3
pH	3.70	3.75	3.88	4.19	4.41	4.41
Lactic acid, % DM	6.59	5.87	4.79	7.32	3.01	2.76
Acetic acid, % DM	2.18	2.63	3.89	1.38	3.59	4.31
Ethanol, % DM	1.62	1.58	1.47	0.44	0.86	0.84
DM Recovery, %	95.5	95.5	94.5	96.6	94.8	95.3
Yeasts, log cfu/g	4.18	3.10	1.88	0.95	0.56	0.56
Aerobic stability, h	25	35	503	206	226	245

[a] LB0, untreated; LB1, *L. buchneri* applied at ≤ 100,000 cfu/g crop; LB2, *L. buchneri* at > 100,000 cfu/g.

One area not addressed by the meta-analysis was animal performance because there were an insufficient number of published studies at that time. There are concerns that high acetic acid levels (>5% DM), as have been observed in some *L. buchneri*-treated silages, might reduce intake. However, the five available studies at that time did not show any negative effect of acetic acid from *L. buchneri* on intake (Kleinschmit and Kung, 2006). One study with alfalfa reported a small but statistically significant increase in milk production (0.8 kg milk/cow/d), but otherwise animal performance has not been different from that on untreated silage. Few animal trials have been published since this meta-analysis so we do not have a complete understanding of how *L. buchneri*-treated silage affects animal performance. At this point, it appears that *L. buchneri* has little effect on intake and performance beyond keeping silage cool.

Another issue with *L. buchneri* is the speed with which these bacteria work in the silo. With homofermentative inoculants, companies have chosen strains that grow rapidly and dominate the fermentation. The current strains of *L. buchneri* are rather slow. So other lactic acid bacteria may do the primary work of fermentation, but L. buchneri can survive and grow under acid conditions that inhibit other lactic acid bacteria. Thus after active fermentation is done, the *L. buchneri* strains slowly convert lactic to acetic acid. This means that their effect on aerobic stability may take a while to be observed, typically 45 to 60 d.

COMBINATION INOCULANTS

Combination inoculants, ones containing *L. buchneri* plus homofermentative strains, are the most recent additions to the marketplace. These products seek to gain the best of both types of inoculants – an initial fermentation controlled by homofermentative strains giving good DM recovery and animal performance and a later fermentation of some of the lactic acid to acetic acid by *L. buchneri* providing improved aerobic stability. One combination product has an additional wrinkle, a *L. buchneri* strain that also produces a ferulic acid esterase enzyme that should help break the linkages between lignin and the carbohydrates in plant cell walls, potentially improving NDF digestibility.

Most published research trials on this approach have studied these products in laboratory-scale silos. Trials where silos were opened at several times within the first week of ensiling show that the homofermentative portion can increase the speed of fermentation relative to untreated silage. At longer ensiling times (> 50 days), acetic acid and aerobic stability are increased relative to those in untreated silage (Table 3), indicating that the *L. buchneri* portion is doing its job. Abstracts on the combination product containing the *L. buchneri* strain that produces ferulic acid esterase show some improvement in *in situ* NDF digestibility, with increases ranging from 0 to 7 percentage units depending on the trial. The biggest question mark that remains is whether any or all of these combination products can increase animal productivity.

Table 3. Silage characteristics after 5 days aerobic exposure when treated with *L. buchneri*, *L. plantarum* or both species. (Filya, 2003).

Forage	Treatment	pH	CO_2 Production, % DM	Yeasts, log cfu/g DM	Molds, log cfu/g DM
Wheat	Untreated	4.9	2.94	6.8	3.5
	L. buchneri	3.9	0.46	<2.0	<2.0
	L. plantarum	5.3	3.73	8.1	3.1
	Both	4.1	0.68	2.2	<2.0
Sorghum	Untreated	6.4	3.16	7.6	3.7
	L. buchneri	4.3	0.54	<2.0	<2.0
	L. plantarum	6.4	4.53	8.4	3.0
	Both	4.6	0.88	2.6	<2.0
Corn	Untreated	6.1	2.55	6.5	3.3
	L. buchneri	4.2	0.41	<2.0	<2.0
	L. plantarum	5.8	4.76	7.7	2.8
	Both	4.8	0.70	2.0	<2.0

GOAL-ORIENTED INOCULANT USE

How do you pick what type of inoculant, if any, to use on your crop at ensiling? What you choose should be based on your goals or issues. I see three possible goals in which an inoculant might be helpful: avoiding a clostridial fermentation, improving aerobic stability, and making a good silage perform better.

Clostridial Fermentation

Typical situations where you might be concerned about a clostridial fermentation include alfalfa or grass that was rained on during wilting and alfalfa that was ensiled on the wet side to avoid rain damage. In both situations, the main concern is whether the pH from silage fermentation will get low enough to prevent clostridia from growing. A homofermentative inoculant will be the most efficient at producing lactic acid from the sugars in the crop helping to guarantee the lowest possible pH. A product with *L. buchneri* would make the situation more vulnerable to clostridial fermentation and should be avoided because *L. buchneri* will increase pH.

Whether a homofermentative inoculant will be useful in avoiding clostridial fermentation depends upon the severity of the situation. These inoculants generally reduce pH 0.2-0.3 pH units compared to untreated alfalfa or grass silage. This is a relatively small improvement that can overcome light rain damage or putting up a forage a couple of percentage points on the wet side. An inoculant cannot be expected to overcome the problems with heavier rain damage or putting up alfalfa at less than 30% DM although an inoculant might keep the silage from becoming clostridial longer than no inoculant.

Anytime you ensile forage that has a potential to go clostridial, avoid mixing that forage with good crop in a bunker or pile. This can lead to layers that are clostridial and others that are good, potentially creating feeding issues. It is much better to bag or make a separate pile of a crop that has the potential to go clostridial, and then feed it out early before it has a chance to develop significant amounts of butyric acid.

Aerobic Stability

If heating silage is a common problem either at the silo face or in the feed bunk, one should review silage management practices first. Packing the silo well, sealing and maintaining a good seal to keep oxygen out, feeding off the face at or above recommended rates (6 in./day), and keeping the feed-out face smooth without leaving a lot of loose silage at the face overnight will minimize aerobic stability problems.

Aerobic stability problems are less common in alfalfa silage than other silages. When alfalfa is ensiled in a bunker or bag at the proper DM content (35 to 40% DM) and the silo is well sealed before opening, yeast counts will typically be low and you should have aerobically stable silage. From experience, alfalfa ensiled above 45% DM is more susceptible to yeast activity, heating and spoilage. If you are concerned about the potential for heating in alfalfa silage that will be put up on the dry side, what are your options? First, take extra effort to pack the silage well if going into a bunker or pile. Second, plan to feed this silage in the cool half of the year, especially if it is ensiled in a bag silo. Third, an inoculant can increase aerobic stability. With alfalfa, I would lean toward a homofermentative inoculant because the lower silage pH from these inoculants should increase aerobic stability while maximizing DM recovery and animal performance. The exception might be alfalfa silage where the DM content is in the danger zone, > 55 to 60% DM. There I would lean toward a product containing *L. buchneri*, most likely a combination product.

In corn silage, small grain silages and sometimes grass silages, aerobic stability may be a problem in spite of good silage management. Nevertheless, it is good to review silage management practices before looking to an additive to solve the problem. With these crops, a product containing *L. buchneri* would be my first choice of an inoculant to address aerobic stability. However, other silage additives can improve aerobic stability: propionic acid (or mixtures of prop and other acids) and anhydrous ammonia. Anhydrous ammonia is used in some parts of the U.S. to increase the crude protein content of corn silage, with application rates typically set to raise CP by 5 percentage units. There are considerable safety issues with applying ammonia, especially on bunkers or piles where packing tractor operators could be exposed to unsafe levels of ammonia. Propionic acid products are applied at 2 to 4 lbs. per ton of crop at ensiling and can consistently improve aerobic stability unless applied at rates below directions. These products tend to be more expensive than *L. buchneri* inoculants. However, as indicated before, *L. buchneri* products take 45 to 60 days before substantially improving aerobic stability. So a prop product would be a better choice for silage being fed within 2 months of ensiling. If a silage is heating, prop products are really the only choice to keep a silage cool – spraying the face and/or mixing it in the TMR.

Making a Good Silage Better

The homofermentative inoculant is the best type of inoculant for improving silage quality: getting the best DM recovery from the silo and improving milk production in lactating cows and gain in growing animals.

Graphs like those in Figure 1 can help you choose the most profitable times to use homofermentative inoculants on alfalfa. However, in the northern U.S., routine use of a homofermentative inoculant on alfalfa is profitable even though it may not provide a benefit in every harvest. Our knowledge of the epiphytic lactic acid bacteria on other crops is much more limited, but corn and grasses tend to have higher populations of epiphytic lactic acid bacteria than alfalfa. Consequently, homofermentative inoculants will likely be effective a lower percentage of the time on corn and grass silages. So the return on investment will most likely be less than in alfalfa.

ISSUES IN SELECTING AND USING INOCULANTS

There are many inoculants in the market. How do you choose one and then give it the best chance to work for you? You want to look for a product that is labeled for the crop you want to use it on, has the bacteria you want for your situation (homofermentative, *L. buchneri* or both), supplies at least 100,000 cfu bacteria/g crop, and has research to back up claims (preferably independent research).

Another issue is whether to purchase product applied dry or wet. Either can work depending on the situation. However, I lean towards wet products. For an inoculant to be successful, the bacteria need to be alive when applied to the crop and mixed thoroughly with the crop. Keeping the inoculant bacteria alive and well generally means storing these products in a cool, dry place. That is easier with products applied wet because they come in small packages that can be put in a refrigerator. On the day of use, two potential issues may affect the viability of wet products: chlorine and temperature. If your water is chlorinated, the water needs to have less than 1 ppm chlorine (tested with a pool tester) or you need to purchase an inoculant that has compounds that react with the chlorine so that the chlorine doesn't kill the lactic acid bacteria. Inoculant viability is best if the inoculant is kept below 100°F. So a black inoculant tank on a forage chopper might affect the viability of a liquid product in the summer heat. Lactic acid bacteria must be mixed thoroughly with the crop for best results. These bacteria cannot move by themselves. Spraying the inoculant at the chopper affords several opportunities for the inoculant to be mixed with the crop. Finally in drier silages (> 40% DM), the inoculants applied wet can get started faster than the dry products that must be moistened by the crop to be activated. Considering all of these issues, products applied wet generally have an edge over dry products, but for some farm situations the dry product may advantageous.

Final advice is to follow the product's directions. The directions on these products are there to help insure a good result. Applying below recommended rates may work but jeopardizes the overall success rate of the product.

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SILOSTOP BUNKER COVERS

Richard E. Muck[1]

INTRODUCTION

The quality of the seal provided by the plastic cover is a key issue for minimizing losses in bunker and pile silos. Most bunker covers are 6 to 8 mil polyethylene sheets held in place by tires or tire sidewalls. Frequently there are problems with spoilage at the shoulders (i.e., against the walls), and sometimes one finds spoilage immediately below the plastic across the whole top.

A covering system relatively new to the U.S. is a two-step Silostop system. The primary element of this system is a plastic film with an oxygen permeability 1/20 that of polyethylene. It is not only used on top of the bunker but is also used to cover the bunker walls. After filling is done, the plastic film from the walls is lapped onto the top of the bunker and a top sheet is placed over the whole top surface. A plastic mesh tarp is used cover the top plastic film, providing UV and animal protection, and gravel bags secure the film and tarp.

METHODS

We have tested this system on 4 corn and 2 alfalfa silage bunker silos, and compared it to 8 mil white plastic covering just the top and secured with a combination of tires and tire sidewalls. We have split bunkers in half for these trials with one treatment on the front half and the other on the back half. Immediately before covering, core samples were taken on the top of the forage at 0-6, 6-12, 12-18 and 18-24 in. depths and at various locations (24 in. from the wall and in the center) for each half. When the silos were opened for feeding, samples were again taken at similar locations.

Another trial compared a one-step film from Silostop, which is not commercially available, with 8 mil white polyethylene film. The one-step film is designed to have the same low oxygen permeability of their film that is being sold, but it is designed to be used without a tarp and can be secured by either gravel bags or tires. Two bunkers, filled simultaneously with corn, received both covering treatments. The one-step was used on the front half in one silo and back half in the other. Side wall film was used on both treatments. The one-step was anchored with gravel bags around the perimeter and across the middle of sheets while the white polyethylene film was covered with tires and sidewalls.

RESULTS

In five of six trials, the Silostop two-step system substantially improved the quality of silage immediately beneath the cover (0-6 in.) at 2 ft. from the bunker walls. This was shown by the higher pH and ash content for the white polyethylene near the wall. Based on the increase in ash content during ensiling, dry matter loss in the top 6 in. near the wall was on average 17 and 13 percentage units higher under the white polyethylene than the Silostop system for the two alfalfa and three of the four corn silage bunkers, respectively. At deeper locations or in the middle of the top surface, the two systems generally had similar pH values and ash contents, indicating little difference in dry matter recovery. Even where pH and ash content were not significantly affected by the covering system, lactate/acetate ratio was higher or tended to be higher in the top 12 in. under the Silostop system, both at the wall and in the middle of the top

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surface (Table 1). This is additional evidence the Silostop system was more effective at excluding oxygen. In one corn silage bunker, the Silostop system did not provide an advantage over the white polyethylene. This occurred because of an inadequate overlap and seal between the wall sheet and top sheet of plastic film in the Silostop treatment. This indicates that careful management is needed for the Silostop system to work properly.

Table 1. Average silage characteristics below 8 mil white polyethylene compared with Silostop in the middle of the bunker top surface.

Silage	Plastic	Depth	pH	Lactic Acid, % DM	Acetic Acid, % DM	Lactic: Acetic Ratio
Alfalfa	White	0 – 6 in.	4.89	2.5	4.0	0.6
	Silostop	0 – 6 in.	4.82	4.5	2.2	2.1
	White	6 – 12 in.	4.82	4.5	1.7	2.6
	Silostop	6 – 12 in.	4.75	3.8	1.4	2.7
Corn	White	0 – 6 in.	4.02	3.2	1.6	2.0
	Silostop	0 – 6 in.	3.98	3.0	1.2	2.6
	White	6 – 12 in.	4.00	4.1	1.4	2.9
	Silostop	6 – 12 in.	3.97	3.9	1.2	3.1

Dr. Limin Kung at the University of Delaware has done similar comparisons and found comparable results: very significant improvement near the wall and only small effects toward the middle. Consequently, the Silostop system reduces losses at the wall and has small effects elsewhere compared to using 8 mil white polyethylene plastic with very good management. Bigger differences would have been expected if Silostop had been compared with 6 mil plastic. (We have found approximately a 5 percentage point difference in losses in the top 6 in. of silage between 6 and 8 mil plastic.)

In the trial with the one-step film, both films gave similar results (Table 2). Greater differences occurred from location (front half having more spoilage than back; wall sampling locations being of poorer quality than center locations). The one-step film did billow in the wind, and perhaps drew more air under the cover negating the effects of the reduced oxygen permeability of that film. The biggest differences between the two systems have been at the wall.

Could one get much of the benefit of the Silostop system by running white plastic down the walls and using the standard system of white plastic and tires on the top? I think so, but we have not done that comparison. The Silostop system would still have several advantages: 1) the tarp and sand bags do an excellent job of holding the plastic against the crop, 2) the tarp provides better animal and hail protection than plastic alone, and 3) the top sheet, tarp and gravel bags go on faster than plastic and tires. The downside of the Silostop system is that it is about twice as expensive, and you need to reuse the tarp to keep costs down (not so convenient in places like Wisconsin where we have to deal with snow).

RECOMMENDATIONS IN USING THE SILOSTOP SYSTEM

In a bunker, make sure that the side wall sheets are sufficiently long. Anchor the sheet at the floor with the first load of forage that comes into the bunker. At the end of filling, make sure that there is at least 3 ft. of side wall sheet that laps onto the top of the crop. Place the top sheet over the ends of the side wall film. If multiple top sheets are needed, these should be overlapped 3 to 4 ft.

The tarps need to be reused and last for at least 5 years from our experience. Because of the need to reuse, it is easier to have narrow tarps that are laid parallel to the expected feed out face. This is especially true for us where snow is an issue so that you can easily remove a tarp as you empty a silo.

Table 2. Comparison of corn silage characteristics (% DM) at the top of two bunker silos covered half and half with white polyethylene and Silostop one-step films.

	Bunker 1			Bunker 2		
Sample Location and Depth	pH	Lactic Acid	Acetic Acid	pH	Lactic Acid	Acetic Acid
White Polyethylene Film		*Back Half*			*Front Half*	
Near Wall, 0-6 in.	4.09	2.9	1.3	6.02	0.7	0.6
6-12 in.	3.98	4.5	1.5	4.18	3.7	2.2
12-18 in.	3.86	5.5	1.6	3.88	4.9	1.8
18-24 in.	3.84	5.4	1.7	3.84	5.1	1.3
Center, 0-6 in.	3.84	4.7	2.0	4.91	2.3	1.0
6-12 in.	3.84	5.1	1.7	3.85	4.9	1.9
12-18 in.	3.79	6.0	1.8	3.82	3.9	1.3
18-24 in.	3.79	5.8	1.7	3.82	3.7	1.1
One-step Film		*Front Half*			*Back Half*	
Near Wall, 0-6 in.	5.80	0.3	0.7	3.90	3.1	1.5
6-12 in.	4.28	2.6	1.4	3.87	5.0	2.1
12-18 in.	3.96	4.8	1.5	3.84	5.2	1.6
18-24 in.	3.88	5.5	1.5	3.82	5.3	1.2
Center, 0-6 in.	4.62	0.8	1.1	3.81	3.8	1.6
6-12 in.	4.25	2.8	2.1	3.84	5.3	2.0
12-18 in.	3.90	4.9	1.7	3.84	5.5	1.5
18-24 in.	3.86	5.7	1.5	3.84	5.7	1.4

Gravel bags should be filled with gravel or pea gravel, not sand. Sand can absorb water, and the bags can thus gain additional weight when rained on as well as become big ‘bricks’ when temperatures get below freezing. Bags can get frozen in low spots so slope the top and sides to drain rainwater forward. Bags should be placed over all edges and seems – top sheet over side wall sheet, overlap of top sheets, overlap of tarps, etc. Bags need to be butted tightly together in order to form a tight seal. During feed out, keep a row of bags on top of the edge of plastic film near the face to keep oxygen from easily moving under the top sheet during emptying. Done well this system will provide you a bunker or pile without any moldy silage to be pitched.

SOME CONSIDERATIONS IN UNSECURED PERSONAL PROPERTY AND AGRICULTURAL LIENS IN AGRICULTURAL PRODUCT SALES[1]

C. Wilson Gray

As a party who supplies hay, grain or other feed or production inputs to a farm, ranch or dairy, you can be in the position of providing credit. When banks extend credit lines for feed, equipment or livestock those are secured by collateral in the item purchased or other property. Collateral is real or personal property owned by the borrower that is pledged to the lender as security for repayment. A producer providing feed such as hay to a livestock operation may also be in the position of providing "credit" if they are planning on the feed being paid for after delivery.

A Handshake is Good Enough?

Agricultural tradition has it that we should simply trust the other party in a transaction. In those cases the recipient of the commodity (contractor) is not providing any special protection to the farmer supplying the commodity (creditor) such as a security interest or payment contract. Those creditors are unsecured creditors because they delivered certain items such as feed or livestock for which they do not have any property of the contractors that is a security against the balance owed. When times are good financially this arrangement seldom has problems with repayment. When times turn tough financially the contractor may have difficulty repaying some or even all of his creditors, secured and unsecured. According to USDA, contracts covered 41% of the value of U.S. agricultural production in 2005. That compares to 36% in 2001 and only 28% in 1991. Hog and poultry contracts are the largest group.

Are Oral Agreements Legally Binding?

Whether an agreement is legally binding is dependent on the particular circumstances. The basic points required for any contract are: the contract offer; the acceptance of the offer; an exchange of something of value (hay delivered in exchange for money). In addition, under the UCC sales of goods for $500 or more are not enforceable unless there is either a *writing* signed by the parties to be bound, or a *written confirmation*. A *writing* would state the essential terms of the agreement such as price, quantity and delivery terms. A *written confirmation* would consist of a letter sent by one party to the other outlining the terms shortly after agreement is reached. The other party normally needs to respond with any objections within 10 days in writing, or else the oral agreement is usually enforceable. The law and regulations governing transactions are guided by the Uniform Commercial Code (UCC or the Code). The UCC, first published in 1952, is one of a number of uniform acts that have been promulgated in conjunction with efforts to harmonize the law of sales and other commercial transactions in all 50 states within the United States of America. The UCC consists of 11 articles. Article 2 is the most applicable to commercial transactions in the agriculture context. Article 2 of the UCC governs the sale of "goods," which is defined as "all things that are movable at the time of identification to a contract for sale."

The Code, as the product of private organizations, is not itself the law, but only a recommendation of the laws that should be adopted in the states. Once enacted by a state, the UCC is codified into the state's code of statutes. A state may adopt the UCC verbatim as written by ALI and NCCUSL, or a state may adopt the UCC with specific changes. Unless such changes are minor, they can affect the purpose and meaning of the Code in promoting uniformity of law among the various states. Thus persons doing business in different states must check local law.

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What is a Security Interest?

Article 9 of the UCC governs secured transactions. Secured transactions are an integral part of production agriculture because large amounts of credit are often needed, and lenders often provide agricultural producers credit that is secured by collateral such as crops or livestock. Having an agreement using personal property as collateral i.e., forages, may provide a stronger legal position than an oral agreement as outlined above. Under UCC's Article 9, certain tangible personal property such as machinery, livestock or crops can be used as collateral. A security interest is defined as "…a property interest over specific assets that secures performance of an obligation, typically the payment of a debt. The security interest is typically created though a document known as a security agreement and signed in conjunction with the execution of a promissory note or another loan document." (Kunkel, Peterson, Mitchell). A security interest may be created when either the contractor needs to borrow funds and the item (i.e., a tractor) is given as security. It can also be created when the contractor doesn't have funds to pay the full price for the purchase and the seller or creditor provides financing while retaining and interest in the property. This is referred to as a *purchase money security agreement*.

To be enforceable a security interest must be attached to the collateral. For that to occur, the creditor or lender must give value (hay); the contractor or debtor must have rights to the collateral; and the contractor or debtor must authenticate an agreement that contains a description of the collateral. Other terms may apply such as a restriction on the contractor's ability to sell the collateral or how the payments are to be made. In some cases, the creditor may retain possession of the collateral. Other legalities may apply to complete the process of creating a security interest. It is best to consult legal counsel when considering such a program.

What is an Agricultural Lien?

The UCC carves out state statutory agricultural liens that secure payment or performance of an obligation for goods or services furnished or rent on real property leased by a farmer in connection with a farming operation. The perfection and priority of these liens are governed by the specific state lien statute; and not the UCC. These liens can be enforced when the farmer fails to perform any obligation owed to the lien holder. Table 1 shows the lien available to a commodity dealer which could include sales by one ag producer to another.

Idaho statute Title 28, Chapter 9 has several sections dealing with both Agricultural Liens and Security interests. A link is listed in the references.

Table 1: *State of Idaho Statutory Agricultural Lien*

TYPE OF LIEN / CLAIMANT	LIEN CLAIMANT	ATTACHED PROPERTY	POSSESSION REQUIRED	FILING REQUIRED	DATE LIEN ATTACHES	EXPRESS STATUTORY PRIORITY
AGRICULTURAL COMMODITY DEALER LIEN. IDAHO CODE §§ 45-1801 TO 45-1810 (2008).	AGRICULTURAL COMMODITY PRODUCER OR AGRICULTURAL PRODUCT DEALER WHO SELLS, OR DELIVERS UNDER BAILMENT OR CONTRACT AN AGRICULTURAL COMMODITY	RAW OR PROCESSED AGRICULTURAL COMMODITIES, AND PROCEEDS OF THE SALE OF AGRICULTURAL COMMODITIES WHICH ARE PRODUCED WITH USING THE AGRICULTURAL PRODUCTS	NO	TO EXTEND THE LIEN FROM 90 DAYS TO 6 MONTHS, A LIEN CLAIM MUST BE FILED WITH THE SECRETARY OF STATE	DATE ON WHICH THE AGRICULT-URAL PRODUCT IS PHYSICALLY DELIVERED TO A PURCHASER OR WHEN PAYMENT IS DUE AND UNPAID WHICHEVER DATE IS LATER	LIEN IS PREFERREDTO ALL OTHER LIENS OR SECURITY INTERESTS

Summary

Although agriculture has a long tradition of conducting business on a handshake, the business climate is undergoing change and the recession of 2008 is forcing us all to be more cautious in our business dealings. Even agriculture has been slowly shifting to more written agreements in place of the familiar handshake as operations grow larger and, both geographically and personally, distant. While the unscrupulous are still few in number, tough economic times can lead even the very well intentioned to a situation where repayment of obligations becomes problematic. This dictates that buyers and sellers should be very prudent in their approach to conducting business. In the case of contracts, security interests and liens often sound legal advice on the nuances of the law will be a benefit in the larger picture as well.

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WHAT TO DO WITH MOLDY HAY

Glenn Shewmaker, Oliver Neher, Mireille Chahine, and Benton Glaze[1]

Weather conditions prior to, during first cutting, and while making hay have been very moist. Many areas have 2 or more inches of above normal precipitation. Much hay has been rained on or left lying in the field for prolonged time periods due to cool and humid conditions which reduced drying rates. The long drying periods with high humidity allowed field growth of mold on the hay. We will try to state some facts and offer some recommendations for hay producers and livestock producers.

What is the "black dust" that covers my mower or swather?

- The black dust is most likely spores produced by fungal organisms. Spores are how the fungi reproduce and are always present but usually at lower concentration. The black dust on a mower or swather indicates that fungal growth was present prior to cutting.

What is the "black dust" on the hay in the windrow, and coming out of my baler or forage harvester?

- The dust is partially fungal spores which have been produced at any point prior to harvest; but most likely, spores were produced after mowing in the windrow, under high moisture levels.
- Another source of the dust is pulverized and decomposed plant material after drying.

What can I do to prevent fungal growth in the crop prior to mowing?

- There are few options to prevent fungal growth in uncut forage. There are no current registered fungicides for alfalfa forage use, other than Apron™ for seed treatment at planting. Furthermore, it is probably not economic to treat even if you could forecast long term weather problems. For periods with high precipitations, adjust your watering schedule, prevent over irrigation, and allow plants to dry up faster.

You can prevent further mold growth in harvested hay and silage!

- To improve drying and solar radiation on forage: 1) make a wide windrow, 2) mow in sunny weather, 3) rake or invert the windrow at about 40% moisture.
- Hay preservatives such as proprionic acid products and other mold inhibitors can reduce or stop further mold growth in hay and silage, at least temporarily, when applied at baling or chopping. These products will not reduce the damage done before harvest, they merely stop new growth.

What effects do molds have on animals?

- The spores can produce undesirable physical responses from humans and livestock from the physical dust and an allergic response of animals. Horses and other non-ruminants are generally more susceptible to this problem than cattle.
- Feed intake is reduced.
- The spores indicate a possibility of mycotoxin producing organisms.

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- For more information on mycotoxins and molds, see the fact sheet “Moldy Hay” by Undersander et al. 2009.

A mycotoxin is a toxic secondary metabolite produced by an organism of the fungus kingdom, including mushrooms, molds, and yeasts.

We have cultured fungal spores from *Phoma* (alfalfa spring black stem and leaf spot) and *Colletotrichum* from alfalfa in the Kimberly area. These genera are not known to produce mycotoxins, however, there other toxin producing fungi may be present.

Molds commonly found in hay include *Alternaria*, *Aspergillus*, *Cladosporum*, *Fusarium*, *Mucor*, *Penicillium*, and *Rhizopus*. These molds **can produce spores that cause respiratory problems**, especially in horses or other animals fed in poorly ventilated areas and, **under some conditions, will produce mycotoxins**. There is much confusion about mycotoxins in forages because several mycotoxins may be present, diagnostic methods are not consistent, and treatment and control recommendations lack needed research. While most molds do not produce mycotoxins, the presence of mold indicates the possibility of mycotoxin presence and animals being fed moldy hay should be watched carefully for mycotoxin symptoms.

If you suspect the hay has mycotoxins consult your veterinarian or nutritionist.

Strategies for the utilization of moldy hay:

- If hay is dusty (from mold spores) avoid feeding it to sensitive animals and those in areas with poor ventilation. If mycotoxin symptoms are observed, check with a nutritionist to make sure the ration is properly balanced and possibly with a veterinarian to eliminate other disease/health problems. Quick test kits (ELISA kits) are available (listing at http://www.ces.ncsu.edu/gaston/Agriculture/mycotoxins/mycotest.html) to determine presence of a limited number mycotoxins but they can give false positives. Some forage testing laboratories will provide other mycotoxin tests.
- Often, the best strategy is to remove a suspected mycotoxin-contaminated feedstuff from the diet and see if symptoms disappear. If mycotoxins are present, the feedstuff can often be fed at a diluted rate and/or with approved feed additives.
- Dilute the suspected feed by starting with a small amount, gradually increase the proportion, and observe animal behavior and health closely.
- Allow animals to sort through the hay and reject molded forage, and then remove the rejected forage.

In summary:

- Most molds are harmless - not producing known mycotoxins.
- Many of the commonly diagnosed mycotoxins are produced in the field prior to harvest.
- The physical dust problem associated with moldy forage can be reduced by ensiling, mixing with a high moisture feed or wetting the hay, but these actions will not reduce mycotoxins if present.