A STUDY OF THE NUTRITIVE VALUE OF OREGON GRASS STRAWS

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Oregon grass seed straws can be an integral part of maintenance rations for livestock. However, livestock producers frequently hesitate to feed their animals grass straws because they do not have information on their relative nutritional value. There have been no comprehensive surveys of the nutritive value of the various grass straws grown in the state. Only the crude protein analysis of individual lots of grass straw have been generally available for comparative purposes.

A study was undertaken in 1975 to determine the range and the mean values of grass straw residues produced in western Oregon. The study was to provide a guide in the selection and feeding of these materials. Several chemical tests are available to assess nutritive value and these were used to provide a guide to proper selection of grass straw for feed purposes.

The crude protein concentration is widely used in evaluating feeds. However, this test is of limited value in rating grass seed straws. The low concentration of protein and the fact that much of the dry matter consists of cellulose and hemicellulose reduces the availability of crude protein to the animal. Some authorities feel that when the crude protein is below 5% it does not contribute to the animal's protein needs.

Several techniques have been developed to more accurately evaluate digestibility. These include:

1. The digestion trial. A direct method in which both the material consumed and the material excreted by a test animal are analyzed. These trials are lengthy and costly. They are accurate and can be used as a standard against which chemical tests are checked.

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8/76

EXT/ACS 20

2. In vitro rumen fermentation techniques. Data from the in vitro technique most closely approximates energy availability or digestibility in forages as measured in the animal. Forage samples are combined with a buffer solution and rumen under controlled conditions. Standardized rumen fluids are needed to obtain uniformity and consistency of results. This test can be carried out on a routine basis by forage analytical laboratories.

3. Chemical techniques. Techniques proposed by Van Soest use detergents to account for lignin and other non-digestible components of the plant. The system attempts to partition plant parts into two classes--cell walls and cell contents.

   Plant cell contents consist of sugars, starch, fructosans, pectin, protein, nonprotein nitrogen, lipids, water-soluble minerals, and vitamins. The true digestibility of each of these cell contents is nearly 100%.

   The cell wall constituents consist of cellulose, hemicellulose, lignin, silica, keratin, waxes, cutin, insoluble minerals, lignified nitrogen compounds, and lignocellulose. The digestibility of this structural portion of the forage is low and affects the volume a feed will occupy in the digestive tract. Feedstuffs with high levels of these cell wall constituents limit the feed consumption by animals. Some forages, including very mature grasses and straws, are high in non-digestible components, making it difficult for animals to obtain adequate nourishment from the volume of feed they are capable of consuming. Therefore, analysis for these constituents does aid in determining a feed's nutritive value.

Methods

This survey was undertaken during the summer of 1975 to evaluate the nutritive value of various grass straws. Representative random samples of straw were collected from seed fields within a few days after combining. These samples were taken from loose material in the field which would normally be picked up in a baling operation.

A Wiley mill with a 20-mesh screen was used to grind samples in preparation for analysis. Crude protein and acid detergent fiber analyses were performed by the Oregon State University Forage Analytical Laboratory. In vitro dry matter digestibility was determined by Dr. Ralph L. Phillips, ARS Animal Scientist at the Eastern Oregon Agricultural Research Center, Union, Oregon. This test was made using rumen fluid from an animal conditioned on grass straw. Enzymatic dry matter digestibility was measured under the direction of Dr. Howard G. Walker, Jr., at the Western Regional Research Laboratory, Albany, California. In vitro dry matter digestibility, cell wall constituents, and cell wall constituent disappearance values of certain samples were determined under the direction of Dr. Vic Lechtenberg, Associate Professor of Agronomy, Purdue University.

Several samples of wheat straw were collected from storage in May 1976 and analyzed for comparison. The samples were ground and prepared for crude protein and acid detergent fiber tests in the same manner as the grass straw by the Oregon State University Forage Analytical Laboratory.

Results

1. Crude Protein

The bluegrasses contained the highest average of crude protein at 7.7 percent (Table 1). The single common bluegrass sample tested was much lower in crude protein than the named varieties (Appendix 1, page 2).

The average for the turf-type perennial ryegrass was slightly lower at 6.7 percent. The turf-type perennial ryegrasses had a much wider range in crude protein than any of the other grasses (4.2 to 11.8 percent).

Tall fescue ranked third with a mean crude protein of 5.7 percent. Tall fescue had the smallest range of any of the grass species (4.8 to 6.4 percent).

Table 1. Crude Protein Content of Oregon Grass Straws

Species	Number of Samples	Protein Content (Dry Matter Basis)	
		Range (percent)	Mean (percent)
Bluegrass	6	5.0- 9.4	7.7
Ryegrass, Perennial Turf-type	15	4.2-11.8	6.7
Fescue, Tall	7	4.8- 6.4	5.7
Bentgrass	18	3.3-10.6	5.2
Ryegrass, Perennial Forage-type	14	2.5- 7.2	4.9
Orchardgrass	15	3.1- 7.7	4.8
Ryegrass, Annual	12	2.7- 5.9	3.7
Fescue, Chewings and Red	11	1.3- 5.1	3.1

Fine-leaved fescues and annual ryegrasses had the lowest average crude protein at 3.0 and 3.7 percent, respectively.

Bentgrass, forage-type perennial ryegrass, and orchardgrass were in the mid-range with a crude protein of 5.2, 4.9, and 4.8 percent, respectively.

2. Dry Matter Digestibility

a. Acid Detergent Fiber

Acid detergent fiber (ADF) is widely used to estimate the dry matter digestibility (DDM) and digestible energy. The ADF values are highly correlated with DDM values in alfalfa, as well as in temperate and sub-tropical grasses.

Bentgrass, turf-type perennial ryegrass, and tall fescue had the lowest fiber content and thus should be the most digestible (Table 2). Orchardgrass, annual ryegrass, and chewings and red fescue had the highest ADF values.

Table 2. Acid Detergent Fiber Content of Oregon Grass Straws

		Acid Detergent Fiber	
Species	No. of Samples	Range (percent)	Mean (percent)
Bentgrass	18	35.8-46.5	41.1
Ryegrass, Perennial Turf-type	15	39.0-45.2	42.4
Fescue, Tall	7	39.0-46.7	42.5
Bluegrass	6	38.2-49.7	43.6
Ryegrass, Perennial Forage-type	14	41.7-52.6	45.5
Orchardgrass	15	44.0-53.8	49.6
Ryegrass, Annual	12	44.4-53.8	50.5
Fescue, Chewings and Red	11	45.2-58.5	51.5

There is considerable overlap in the ADF ranges of these straws, suggesting that selection for digestibility on the basis of species alone is not a completely satisfactory criterion.

b. Cell Wall Constituents

Cell wall constituent has the highest correlation with the voluntary intake of forages. It estimates the rate of digestion which in turn influences the rate of passage and, ultimately, the amount of forage the animal can consume.

Table 3. Average Percentage of Cell Wall Constituents of Oregon Grass Straws

Species	Cell Wall Constituents (percent)
Bentgrass	67.7
Ryegrass, Perennial Turf-type	68.1
Fescue, Tall	69.3
Ryegrass, Perennial Forage-type	72.1
Bluegrass	73.2
Ryegrass, Annual	75.6
Orchardgrass	79.0
Fescue, Chewings and Red	81.1

Bentgrass, turf-type perennial ryegrass, and tall fescue had the lowest average percentages of cell wall constituents. These results indicate that generally the animal intake should be greater with these species.

c. In Vitro Dry Matter Digestibility

Tall fescue, turf-type perennial ryegrass, and bluegrass had the highest available *in vitro* dry matter digestibility. Bentgrass and forage-type perennial ryegrass were in a mid-range. Annual ryegrass, chewings and red fescue, and orchardgrass had the lowest digestibility using this technique.

Table 4. *In Vitro* Dry Matter Digestibility (IVDDM) of Oregon Grass Straws

Species	Number of Samples	Percent Range	Percent Mean
Tall Fescue	7	44.1-53.8	48.8
Ryegrass, Perennial Turf-type	13	42.8-55.9	48.2
Bluegrass	6	40.1-53.9	46.7
Bentgrass	10	37.9-50.7	43.0
Ryegrass, Perennial Forage-type	12	39.7-48.3	42.9
Ryegrass, Annual	11	34.1-41.5	36.8
Fescue, Chewings and Red	6	27.3-38.9	34.9
Orchardgrass	14	28.2-42.0	34.7

d. Enzymatic Dry Matter Digestibility

The enzymatic dry matter digestibility analysis was determined only on selected samples. The ranking of the species is similar to the *in vitro* dry matter digestibility, although the numerical digestibility values differed. Further investigation is necessary to explain differences observed. Data is presented in the appendix.

e. Cereal Straws

Several western Oregon wheat straw samples were analyzed for comparison with the grass straws. The wheat straw samples were very low in crude protein and high in acid detergent fiber. The mean crude protein in the wheat straw was 2.36 percent, which is below the level of all the grass straws tested. The 55.0 percent acid detergent fiber was higher than that of the grass straws.

Table 5. Crude Protein and Acid Detergent Fiber of Wheat Straw

No. of Samples	Crude Protein (DM Basis)		ADF	
	Range	Mean	Range	Mean
6	1.8-3.7%	2.4%	52.1-56.9%	55.0%

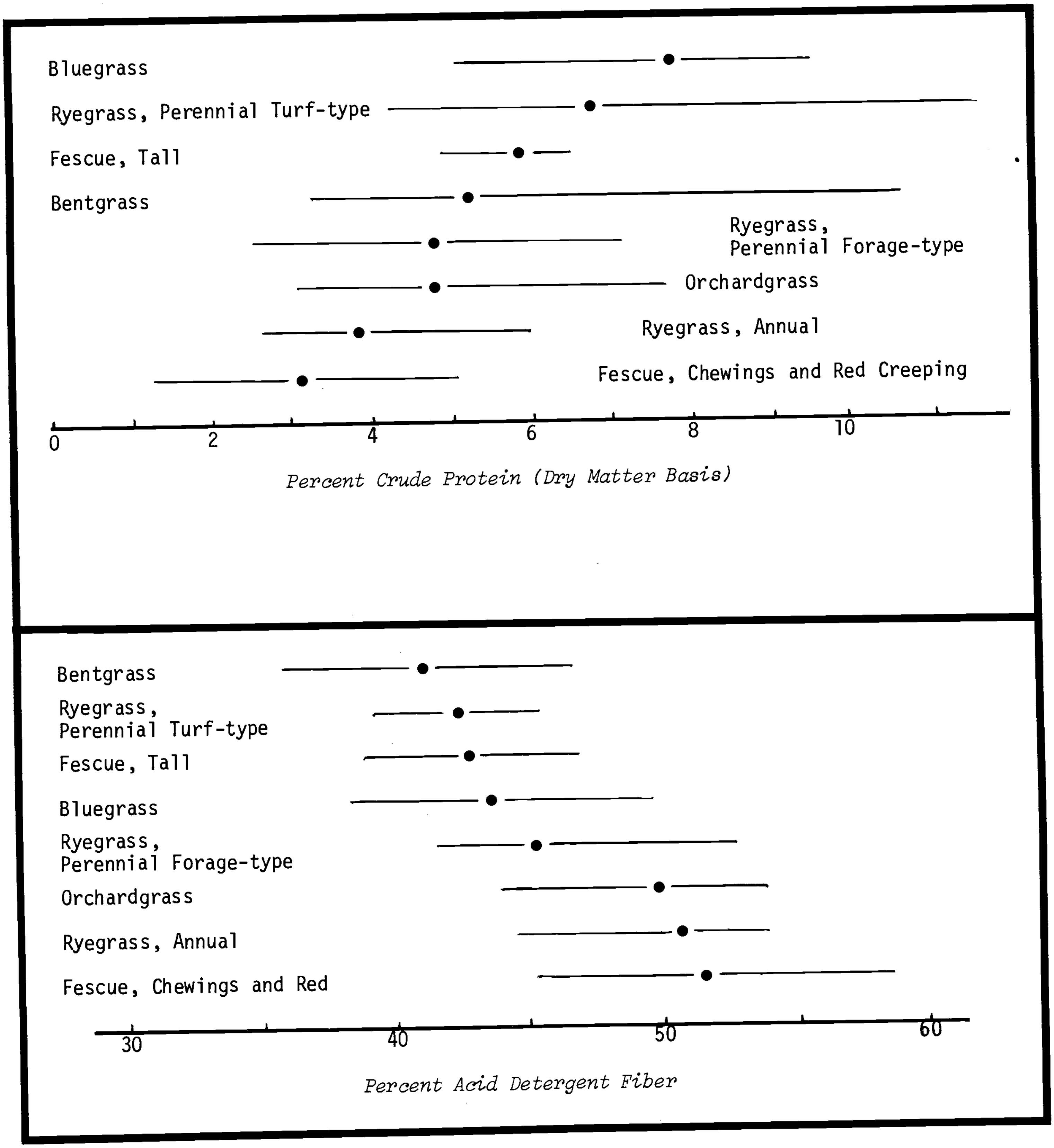
Discussion

Figure 1 provides a graphic comparison of crude protein and acid detergent fiber for the various grass straws analyzed in this study. Turf-type perennial ryegrass and bentgrass had the widest range in crude protein. This indicates that these straws may be quite variable in quality, depending on the source.

Bluegrass, turf-type perennial ryegrass, and tall fescue contained the highest percentages of crude protein. The same grasses plus bentgrass had the lowest acid detergent fiber and cell wall constituent percentages. In general, these grass straws would be preferable for livestock feed.

It is clear from Figure 1 that there is a considerable overlap in crude protein and acid detergent fiber levels in the samples from the different species. The poorer samples in the top groups were usually below the better samples in the lower groups. Each lot of straw must be considered individually. Selection should be based on the amount of leaves, the color, the odor, the condition, and the kind of straw. Characteristics that detract from palatability should certainly not be overlooked such as extreme weathering from sun bleaching and rain damage. Excessive rain damage and prolonged high moisture conditions will induce molds.

Figure 1. Range and Mean Percentages of Crude Protein and Acid Detergent Fiber. Each line represents the range of samples tested and the "●" represents the mean of all samples.



A word of caution should be given to growers, handlers, and buyers of grass seed residues. Since nearly all of the post-harvest residue in grass seed production has been burned in the past, many pesticides now in use were not registered to permit grazing of fields or using straw for livestock feed. When a grower plans to feed or sell straw for feed purposes, he should check the label statement on each pesticide used to assure that grazing or feeding of straw is permitted after treatment. Users of pesticides must stay within the recommended terms and conditions stated on the printed product labels.

Summary

Since there is rather wide variation in quality, even within any particular grass species, chemical analysis should be used whenever possible to determine the relative feeding value of a given lot of straw. Crude protein and acid detergent fiber analyses are available on a routine basis. *In vitro* dry matter digestibility analysis may be commercially available in the future, although standardization of this procedure presents a problem.

Much of the straw residue from the grass seed industry in Oregon can be used as feed for certain classes of livestock. Proper supplementation with feed additives may be necessary. This study has identified some of the species which may be preferable as livestock feed based on their chemical analysis.

APPENDIX

WILLAMETTE VALLEY GRASS STRAW SURVEY, 1975

VARIETY	SAMPLE NUMBER	CRUDE PROTEIN 1/ (DM Basis)	ADF 1/	IN VITRO DDM 2/	ENZYMATIC DDM 3/
		(percent)	(percent)	(percent)	(percent)
Orchardgrass (Late)					
Sterling	27-25	4.45	48.41	34.32	21.0
Sterling	27-31-L	4.96	49.05	---	--
Latar	27-22	5.35	50.92	33.85	20.0
Latar	27-06	3.59	52.35	35.79	25.8
Pennmead	27-05	4.02	51.21	31.89	23.5
Able	24-0-01	4.61	53.31	31.56	23.6
Napier	02-09	5.75	48.15	37.99	24.2
Mean		*4.68*	*50.49*	*34.23*	*23.0*
Orchardgrass (Early)					
S-143	02-01	6.35	44.00	38.49	25.9
Potomac	02-06	4.60	46.15	36.49	24.2
Potomac	02-08	7.65	45.85	41.95	26.6
Potomac	02-12	5.35	50.63	35.15	--
Potomac	27-01	5.52	45.14	37.71	27.4
Potomac	27-04	3.57	52.65	32.38	24.3
Potomac	27-21	3.05	51.90	29.72	--
Potomac	27-30	3.70	53.76	28.16	16.2
Mean		*4.97*	*48.76*	*35.00*	*24.1*
All orchardgrass mean		*4.83*	*49.56*	*34.67*	*23.6*
Tall Fescue					
Alta	22-03	6.10	38.95	51.53	35.6
Alta	27-07	5.00	41.45	51.15	35.2
Fawn	27-08	6.44	41.06	53.80	--
Fawn	27-12	6.55	45.13	44.90	30.3
Fawn	27-18	4.94	40.50	49.49	32.6
Fawn	27-26	4.84	44.05	46.29	28.1
Fawn	36-01	5.70	46.65	44.14	29.3
Mean		*5.65*	*42.54*	*48.76*	*31.9*

1/ Oregon State University Forage Analytical Laboratory
2/ Eastern Oregon Agricultural Research Center, Dr. Ralph L. Phillips
3/ Western Regional Research Laboratory, Dr. Howard G. Walker, Jr.

VARIETY	SAMPLE NUMBER	CRUDE PROTEIN 1/ (DM Basis)	ADF 1/	IN VITRO DDM 2/	ENZYMATIC DDM 3/
Bentgrass					
Highland	02-16	6.71	39.01	50.72	--
Highland	02-18	4.50	40.72	40.54	34.6
Highland	02-19	4.92	42.20	41.96	--
Highland	24-BN-01	5.70	43.71	---	--
Highland	24-BN-02	5.24	41.20	---	--
Highland	24-BN-03	4.10	42.13	---	--
Highland	24-BN-04	4.30	45.55	---	--
Highland	27-33L	6.15	40.53	---	--
Highland	27-34L	5.01	40.68	---	--
Highland	27-36L	4.59	41.13	---	--
Highland	36-04	3.40	38.86	44.87	39.5
Highland	36-05a	3.40	46.53	38.68	--
Highland	36-05b	5.45	39.74	39.95	--
Highland	36-07	3.26	39.22	37.87	--
Astoria	36-02	4.11	39.41	41.23	32.0
Astoria	36-03	5.52	35.81	47.22	35.6
Penncross	02-15	10.55	42.50	47.31	--
Penncross	27-30L	5.85	41.40	---	--
Mean		*5.15*	*41.13*	*43.04*	*35.4*
Bluegrass					
Bonnieblue	24-BL-02	8.90	43.40	50.05	28.4
Merion	24-BL-01	7.75	43.14	46.70	30.1
Merion	24-B-01	6.80	49.66	40.31	23.8
Merion	24-BL-03	8.15	39.96	49.24	32.9
Merion	24-BL-04	9.45	38.24	53.91	38.3
Common	27-14	4.95	47.33	40.11	21.2
Mean		*7.67*	*43.62*	*46.72*	*29.1*
Chewings and Red Fescue					
Chewings	03-03	3.50	54.41	---	--
Cascade	03-02	1.71	55.22	---	--
Highlight	27-02	4.85	46.80	37.37	27.0
Jamestown	24-F-05	3.50	49.77	36.11	22.0
Menuet	24-F-04	5.05	47.72	30.99	19.1
Rainier	02-07	3.60	46.99	38.70	26.3
Pennlawn	03-01	1.95	54.58	---	--
Pennlawn	03-04	2.05	55.08	---	--
Pennlawn	03-05	1.25	58.50	---	--
Pennlawn	24-F-03	3.15	52.20	27.32	17.7
Pennlawn	24-F-01	3.30	45.15	38.94	28.2
Mean		*3.08*	*51.48*	*34.91*	*23.4*

VARIETY	SAMPLE NUMBER	CRUDE PROTEIN 1/ (DM Basis)	ADF 1/	IN VITRO DDM 2/	ENZYMATIC DDM 3/
Perennial Ryegrass (Forage Type)					
Linn	02-02	3.90	43.50	41.06	33.3
Linn	02-04	3.94	45.80	39.59	33.7
Linn	02-05	4.20	44.90	44.41	34.8
Linn	03-06	3.75	52.62	---	--
Linn	22-06	7.15	46.72	44.17	--
Linn	22-07	4.76	45.66	42.62	--
Linn	22-08	3.90	47.79	39.67	--
Linn	22-09	6.20	41.70	46.71	--
Linn	22-10	5.45	44.59	40.98	--
Linn	22-11	6.85	44.65	42.27	--
Linn	27-13	3.52	44.50	42.10	--
Linn	27-32L	2.50	45.55	---	--
Reveille	27-09	6.85	43.77	48.32	--
Taptoe	27-15	4.89	44.55	43.20	35.5
Mean		*4.85*	*45.45*	*42.93*	*34.3*
Perennial Ryegrass (Turf Type)					
Derby	27-28L	4.80	44.75	---	--
Game	02-11	9.05	41.98	48.23	--
Game	22-13	4.20	44.59	42.75	--
Game	27-23	7.25	42.61	49.80	--
Manhattan	02-10	5.90	43.35	47.42	36.3
Manhattan	22-12	11.80 4/	42.01	51.36	--
Manhattan	24-R-02	4.40	44.59	43.73	31.2
Manhattan	24-R-03	5.11	45.20	44.75	--
Manhattan	27-29L	4.25	41.53	---	--
NK-100	27-10	5.15	42.32	44.27	--
NK-200	49-02	11.35 5/	39.41	55.86	--
Pennfine	24-R-01	5.31	42.56	48.65	--
Pennfine	27-16	8.65	40.84	48.82	--
Pennfine	49-01	5.45	41.40	46.17	--
Eton	27-19	7.29	39.03	55.26	--
Mean		*6.66*	*42.41*	*48.24*	*33.8*
Hard Fescue					
Biljart	24-F-02	7.45	40.69	43.63	33.9

4/ Rerun 10.80
5/ Rerun 11.10

VARIETY	SAMPLE NUMBER	CRUDE PROTEIN 1/ (DM Basis)	ADF 1/	IN VITRO DDM 2/	ENZYMATIC DDM 3/
Annual Ryegrass					
HW 51	27-11	2.85	44.40	38.77	--
T-3	27-17	2.65	47.81	35.10	--
HW2	27-24	3.05	53.78	34.56	--
Mammoth Ace	27-27	3.35	48.71	41.49	--
Common	22-01	3.70	49.70	38.03	25.6
Common	22-04	2.90	52.03	34.15	25.1
Common	27-35L	3.36	52.11	---	--
Gulf	02-03	4.90	50.73	38.67	25.2
Gulf	22-02	3.65	52.62	35.03	22.8
Gulf	22-05	4.94	51.62	34.12	--
Gulf	27-03	3.41	52.48	36.64	--
Gulf	27-20	5.90	49.70	38.31	22.6
Mean		*3.72*	*50.47*	*36.81*	*24.3*