AN ABSTRACT OF THE THESIS OF

Horace Jensen for the MS in Animal Husbandry - Range Management

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Title A Study of Seasonal Variation of the Composition of Forage Plants of southeastern Oregon

Abstract Approved: [redacted]

(Major Professor)

This study was started with the object in mind of determining the seasonal variation in the chemical composition of some of the forage plants in southeastern Oregon. Forage samples had been collected at intervals of about two weeks for the summers of 1938, 1940, and 1941.

The Plants used were five grasses — bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, squirreltail grass, and giant wild-rye grass and one browse plant, bitterbrush.

Complete analyses were run for only the first three grasses for the year 1938. Because of shortage of time only crude protein was determined for the other plants for 1938 and then for all six plants for the other two years, 1940 and 1941. The results of these analyses are shown in the tables of the thesis, and general trends of the crude protein are shown in the figures in the discussion of results.

As the study progressed, information became available which showed that the chemical composition might influence the daily gains of cattle which grazed on that area. Animal weights of 137 cows which grazed the area in 1940 and of 139 cows grazing the same area in 1941 are shown in tables 7 and 8. Weights for 24 calves dropped in March, 1941, are shown in table 9.

An attempt has been made to show a correlation between chemical composition and daily gains of the cows and calves which were pastured on the area.

In summarizing, the results of the study are as follows:

Crude protein content of range grasses ranged from a high during early stages of growth to a minimum when dry and weathered.

Crude protein content of bitterbrush remained high throughout the growing season and might provide a valuable protein supplement to dry range grasses.

Crude fat showed considerable variation throughout the season with no general trend.

Crude fiber showed a tendency to increase in all cases as the plants approached maturity.

Total ash showed no definite trend.

Calcium failed to show any definite trend in the percent content.

Phosphorus showed a very definite trend which followed very closely the trend of crude protein.

Nitrogen-free extract showed increases in percent content as the grasses matured.

Range cows showed rapid daily gains up to 2.34 pounds while having plenty of early growing, green, lush forage and suffered losses in weight up to 2.31 pounds daily when having mature, dry grass as the only source of food.

March calves showed rapid daily gains up to 1.68 pounds early in the season. As the season progressed, smaller gains were made, and in September they actually suffered a daily loss of 0.11 pounds per head.

The writer wishes to suggest that the crude protein content can be used with reasonable accuracy to designate the relative nutritive value of range grasses.

Finally, the efficiency of the use of range forage may depend upon the operator's ability to use the forage during the stage of growth when it is high in nutritive value and to properly supplement the forage when it becomes dry and deficiencies occur.

A STUDY OF SEASONAL VARIATION OF THE COMPOSITION OF FORAGE PLANTS OF SOUTHEASTERN OREGON

by

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A STUDY OF SEASONAL VARIATION OF THE COMPOSITION OF FORAGE PLANTS OF SOUTHEASTERN OREGON

CHAPTER I

INTRODUCTION

The control of experiments which are carried on entirely under range conditions has proved to be very difficult. Wide variations in botanical make-up of the forage on different ranges has materially complicated studies in relation to the nutritive value to grazing animals. However, several informative studies have been carried on, and the results of such work, when applicable, will be sighted throughout the text of this thesis.

It is admitted that chemical analysis is not a complete measure of nutritive value of range plants, but when evaluated in the light of digestion trials of forage crops of similar composition, it may be considered as fairly indicative of the feeding value of the plants, and some generalizations can be stated.

Seasonal changes in the chemical composition of range forage plants have been shown for other areas of the United States, but no similar study to the knowledge of the writer has been conducted in southeastern Oregon. Livestock men are showing more and more interest in the nutritive value of the forage which their livestock depend upon while

feeding on the range. It is hoped that some of the information presented here might be of value to the livestock operators of this and similar areas.

CHAPTER II

REVIEW OF LITERATURE

The trends found in this experiment follow rather closely the results reported by other investigators, including Christensen and Hopper (4), Esplin, Greaves, and Stoddart (7), Greaves (10), Hart, Guilbert, and Goss (12), McCeary (15), Stanley and Hodgson (17), Watkins and Ellis (19), and others. Crude protein, crude fat, nitrogen-free extract, calcium, and phosphorus trends were compared.

McCeary (15) reports that the protein content of grasses at the end of October was little higher than after wintering over and being analyzed in March of the following year. He also reports that oat straw that had wintered over actually had as large a percentage of crude protein as did many of the grasses under similar treatment. Esplin, Greaves, and Stoddart (7) report that plants get so low in crude protein late in the season that they have no more protein than oat straw or like material.

Woodman and Oosthuizen (20) report that the forage produced from July to September was lower in digestibility and nutritive value than was spring forage. Findings of McCall (14) show that there was a large decrease in nutritive value of Idaho fescue (Festuca idahoensis)

from new growth stage to the time of maturity. Stanley and Hodgson (17) found that after maturity range grasses were low in both palatability and digestibility. Further, that the extremely low protein content added materially to their inefficiency as an only source of food.

Watkins and Ellis (19) report crude protein digestible in the following percentages at various stages of maturity, 70 percent in immature range grasses, 50 percent in mature grasses, 45 percent when grasses are slightly weathered, and only 25 percent when grasses are severely weathered. An even greater change in digestibility has been reported by Christensen and Hopper (4) in their work in North Dakota. As a result of digestion trials these men report that crude protein in green growing grass was 52 percent digestible, while in grass which had been wintered over and analyzed in April of the following year the crude protein was only 1.34 percent digestible. They concluded that the weathered grass was of little or no value and that the green grass was good. Garrigus and Rusk (9) found that young Kentucky bluegrass was more completely digested by steers than was the grass at a more mature stage of growth. Digestion trials carried on by Stanley and Hodgson (17) indicate that the dry matter in young plants is highly palatable and digestible. Other investigators have found the same tendency in digestibility.

Guilbert and Rochford (11) report that less than 8 percent total protein in poor roughage and dry range forage of low digestibility is definitely deficient for all classes of cattle.

According to Maynard (13), over 90 percent of the ash of an animal body consists of calcium and phosphorus. Approximately 99 percent of the calcium and 80 percent of the phosphorus of the body are present in bones and teeth.

Phosphorus is present in each individual body cell and in body fluid and plays an important part in metabolism. Phosphorus with calcium plays the main roll in bone formation. Large quantities of both are needed for the building of new structural tissue. Deficiency in these elements will result in porous and defective bones and is commonly evidenced by the animal chewing bones or like material. Watkins (18) found range grasses in New Mexico generally deficient in phosphorus in samples collected between October 1 and December 1, 1941. He stated that only about 60 percent of the phosphorus requirement would be furnished by this forage. These grasses were also low in protein and high in crude fiber.

Work of investigators shows inconsistencies in calcium trends. Watkins (18), Cruickshank (5), Ferguson (8), and Richardson, Trumble, and Shapter (16), report that calcium tended to decrease as plants mature. McCeary (15) and Hart, Guilbert, and Goss (12) found calcium increased as

plants matured. Aston and Co-workers (2) and Daniel and Harper (6) found that percent of calcium varied inversely with the amount of rainfall.

The main function of nitrogen-free extract and fat in the ration is to furnish energy which can readily be converted for either heat or work.

As plants mature, a progressively greater proportion of the crude fiber is lignin, which is not only undigestible itself but also increases the need for energy in mastication and digestion of the feed, and the total net nutritive value is lowered. Esplin, Greaves, and Stoddart (7) state that plants high in fiber and low in fat and protein have low nutritive value and must be supplemented with feeds rich in carbohydrates, fats, and proteins.

Guilbert and Rochford (11) suggest that if fairly palatable species of browse plants are present in sufficient quantities, they constitute a valuable protein supplement to dry grass forage. They state that this also would be an important source of vitamin A which would be low in the dry weathered grass but present in the green browse forage. They state further that deficiency in vitamin A will be evidenced by night blindness and later staggering gait, convulsions, total blindness, clouding of the corneas of the eyes, loss of appetite, and finally death.

Christensen and Hopper (4) report that 550 to 650 pound steers consumed 15.12 pounds daily of green July grass and only 7.49 pounds daily of dry weathered grass. They state that, although the same steers were used for both feeding trials and the animals were larger when fed the green grass, these figures represent a fair index of the palatability of the different grasses.

Guilbert and Rochford (11) report that experiments carried on by Brouse and Sherman in Nebraska showed increases in prairie hay consumed per day from 11.6 pounds to 13.4 pounds when the animals were given cottonseed cake as a protein supplement to this low-protein roughage. The addition of 3/4 of a pound daily not only increased hay consumption but produced over four times as much gain. Black and Co-workers (3) found that in Montana cows fed cottonseed cake on winter ranges carried more flesh at the close of the winter than cows without this supplement and consistently produced heavier calves at birth and weaning time. Calves from cows fed cottonseed cake were, on the average, 1.9 pounds heavier at birth and 13.6 pounds heavier at weaning time than calves from cows receiving no supplement.

CHAPTER III

EXPERIMENTAL PROCEDURE

The Area

The area involved in this study is arid to semi-arid with annual precipitation of from five to fifteen inches. Most of the precipitation comes between October and March with an occasional summer downpour or late spring or early fall storm thrown in. Juniper-studded ranges of rolling topography make up the largest portion of the area, the elevation ranging between 4,000 and 6,000 feet. The summers are dry, rather short and moderate. Winters are rather long and cold but sunny.

This area is used exclusively for range livestock grazing, and the carrying capacity is generally low.

The Vegetation

The vegetation is made up of sagebrush and open juniper with bunchgrass scattered between. Bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass, common in this habitat, make up a large part of the forage cover, with giant wild-rye on the more moist sites and bottlebrush squirreltail grass commonly found on the dry, gravelly portions. Bitterbrush is present in the area but is not as abundant as in other parts of eastern Oregon.

The first forage samples used in this study were collected during April, 1938. Five grasses and one browse plant were chosen for this study. Three of the grasses — bluebunch wheatgrass (Agropyron spicatum), Idaho fescue (Festuca idahoensis), and Sandberg bluegrass (Poa secunda) make up eighty-five percent of the forage in the area. Two other grasses — bottlebrush squirreltail (Sitanion hystrix) and giant wild-rye (Elymus condensatus) are present in sufficient quantity to be included in the study. Bitterbrush (Purshia tridentata) is the important browse plant in the area and was therefore included.

The forage samples were gathered on the various ranges of the Squaw Butte Range and Livestock Experiment Station by the personnel of that station. It was the plan to collect these samples from areas which were being grazed, and in most cases this practice was followed. When the specie did not occur on a range being grazed, it was collected on the ranges where it could be found in sufficient quantity to make possible the collection of a representative sample. The grass culms were cut about one inch above the crown so that all parts of the plant which were available to the grazing animals were included in the sample taken. The browse plant samples included all of the current year's growth, which is considered in usual practice available for grazing. Samples were gathered at

approximately two-week intervals throughout the season.

The samples were placed in muslin and burlap sacks and sent to the Oregon State Experiment Station Department of Agricultural Chemistry for grinding and analysis.

Grinding was done in a hammer mill.

Chemical determinations were made on an air-dry basis.

All chemical analyses were made according to the methods of the Association of Official Agricultural Chemists (1).

The Animals

The area was grazed by Hereford cows. These animals were weighed at the beginning of the grazing season and at the close of the season. Also, group weights were taken each month throughout the summer.

In 1941 there were 24 March calves selected for keeping growth records, and individual weights were taken each month beginning June 3 and continuing throughout the summer. These calves were dropped by cows grazing this area.

CHAPTER IV

DATA SECURED

Complete Analysis for 1938

A complete analysis was run for three of the grasses—bluebunch wheatgrass (Agropyron spicatum), Idaho fescue (Festuca idahoensis), and Sandberg bluegrass (Poa secunda) for the year 1938. The results are shown in Tables 1, 2, and 3.

Crude fat showed considerable variations throughout the year. Bluebunch wheatgrass showed 2.53 percent on May 10 and only 1.95 percent on October 25. A tendency to increase until a maximum of 3.64 percent was reached on September 6 was noted, than a drop to a low of 1.95 percent. Idaho fescue ranged from 2.20 percent on May 10 to 2.00 percent on October 30 with a high of 2.22 percent on June 7 and a low of 1.47 percent on September 6. Sandberg bluegrass ranged from 2.36 percent on May 10 to a low of 1.28 percent on October 30. The highest percent was on June 8.

Crude fiber showed a tendency to increase in all cases as the plants approached maturity. Bluebunch wheatgrass showed only 23.44 percent on May 10 and increased to 30.92 percent on October 30. The crude fiber content in Idaho fescue was 25.40 percent on May 10 and increased to 33.34 percent on September 6. The drop to 30.34 percent

on October 30 is not considered significant. Sandberg bluegrass showed a higher fiber content on May 10 than either of the other grasses. The crude fiber increased from 28.69 percent on May 10 to 31.10 percent on October 30.

Total ash showed no definite trend.

Crude protein was relatively high in all cases on May 10 with a steady decline until October 30 when a minimum was reached. A more complete discussion of crude protein will be made later.

The nitrogen-free extract showed increases in percent content as the grasses matured. Bluebunch wheatgrass contained 38.17 percent on May 10 and 43.53 percent on October 30. Some variations were noted, the highest percent being on July 6 when 47.42 percent was present. Idaho fescue showed much the same trend with 39.38 percent on May 10 and 47.70 percent on October 30. July 6 showed a high percent at 47.62. Sandberg bluegrass was higher at the beginning than the other two grasses. On May 10 it showed 44.89 percent and increased to 49.24 percent on October 30. Variations occurred during the season, the content being highest on September 6.

Calcium failed to show any definite trend in the percent content. Considerable variations were noted through the grazing season.

TABLE 1

SEASONAL VARIATIONS IN THE CHEMICAL COMPOSITION
OF AGROPYRON SPICATUM *
(Air-dry basis)

Date Collected	Moisture	Crude Fat	Crude Fiber	Ash	Crude Protein	Nitrogen-Free Extract	Calcium	Phos-phorus
	%	%	%	%	%	%	%	%
May 10, 1938	9.43	2.53	23.44	12.01	14.42	38.17	0.33	0.21
June 7, 1938	5.85	2.46	28.49	11.57	9.92	41.71	0.32	0.17
July 6, 1938	6.22	2.59	26.64	11.72	5.41	47.42	0.33	0.095
August 4, 1938	7.12	3.44	26.70	13.34	4.84	44.56	0.39	0.068
September 6, 1938	6.62	3.64	30.19	11.45	3.20	44.90	0.37	0.047
October 30, 1938	6.83	1.95	30.92	14.35	2.42	43.53	0.34	0.028

* From the records of the Squaw Butte-Harney Cooperative Range and Livestock Station.

TABLE 2

SEASONAL VARIATIONS IN THE CHEMICAL COMPOSITION
OF FESTUCA IDAHOENSIS *
(Air-dry basis)

Date Collected	Moisture	Crude Fat	Crude Fiber	Ash	Crude Protein	Nitrogen-Free Extract	Calcium	Phos-phorus
	%	%	%	%	%	%	%	%
May 10, 1938	7.55	2.20	25.40	12.98	12.49	39.38	0.27	0.25
June 7, 1938	7.29	2.22	28.57	10.61	6.55	44.76	0.21	0.16
July 6, 1938	8.31	2.21	25.62	11.76	4.48	47.62	0.34	0.095
August 4, 1938	8.58	1.91	32.87	9.64	2.40	44.60	0.22	0.079
September 6, 1938	7.29	1.47	33.34	11.40	2.03	44.47	0.19	0.038
October 30, 1938	8.03	2.00	30.34	8.75	3.18	47.70	0.23	0.031

* From the records of the Squaw Butte-Harney Cooperative Range and Livestock Station.

TABLE 3

SEASONAL VARIATIONS IN THE CHEMICAL COMPOSITION OF POA SECUNDA *
(Air-dry basis)

Date Collected	Moisture	Crude Fat	Crude Fiber	Ash	Crude Protein	Nitrogen-Free Extract	Calcium	Phos-phorus
	%	%	%	%	%	%	%	%
May 10, 1938	7.50	2.36	28.69	7.42	9.14	44.89	0.23	0.250
June 8, 1938	7.51	2.67	27.10	6.75	6.36	49.61	0.22	0.160
July 20, 1938	8.17	2.10	31.63	5.25	4.03	48.82	0.25	0.078
August 8, 1938	8.82	2.29	31.41	5.11	2.98	49.39	0.19	0.063
September 6, 1938	7.53	2.11	30.57	4.54	2.75	52.50	0.16	0.051
October 30, 1938	7.04	1.28	31.10	8.92	2.42	49.24	0.27	0.036

* From the records of the Squaw Butte-Harney Cooperative Range and Livestock Station.

Phosphorus showed a very definite trend which followed very closely the trend of crude protein, a high content in the early growth stages followed by a decrease to a minimum at maturity. The first analyses showed that bluebunch wheatgrass had 0.21 percent and Idaho fescue and Sandberg bluegrass both 0.25 percent. By October the phosphorus content had diminished to 0.028 percent in wheatgrass, 0.031 percent in fescue grass, and 0.036 percent in bluegrass.

Lack of time prevented the running of complete analyses for all plants for the three years. Wheatgrass, fescue, and bluegrass were chosen because these three grasses make up about 85 percent of the forage on the ranges concerned. Considering the similarity of these results and the work that has been done by other investigators on similar plants, it might be reasonable to assume that they are representative of the general trends of all such forage under similar conditions.

Protein Analysis for 1938, 1940, and 1941

Crude protein analysis showed several interesting and highly significant facts. First, that the grasses generally contained relatively high percentages of crude protein early in the growing season. Gradually, rather rapidly at first, the crude protein decreased and only a

small percentage was present at the end of the season. Table 4 shows the percent of crude protein of the six forage plants for the year 1938. On May 10, giant wildrye, wheatgrass, and fescue contained 18.19 percent, 14.42 percent, and 12.49 percent, respectively, and bluegrass contained only 9.14 percent. By June 7 considerably less crude protein was found in these four grasses. Squirreltail grass was collected for the first time on June 7 and showed 10.60 percent. Bitterbrush was also collected first on this date and showed 14.09 percent crude protein.

The five grasses continued their downward trend throughout the season, although several small upturns were noted for some species. An explanation for these periodic increases will not be attempted at this time. Bitterbrush showed only a slight tendency to decrease in percent of crude protein and by December 6 still contained 7.51 percent. This tenacity with which this plant holds up in crude protein content is very significant as will be pointed out later.

The same general trends were shown by the plants analyzed for 1940 and 1941. See Tables 5 and 6 for the results.

TABLE 4

SEASONAL VARIATIONS IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry Basis) *
1938

Species	Date Collected									
	May 10	June 7-8	July 6-8	July 16-20	Aug. 3-5	Aug. 22	Sept. 6	Sept. 27-29	Oct. 30	Dec. 6-8
	%	%	%	%	%	%	%	%	%	%
Agropyron spicatum	14.42	9.92	5.41	6.88	4.84	3.75	3.20	2.98	2.42	3.36
Festuca idahoensis	12.49	6.55	4.48	2.58	2.40	2.26	2.03	1.64	3.18	2.89
Poa secunda	9.14	6.36		4.03	2.98	3.54	2.75	2.27	2.42	2.44
Elymus condensatus	18.19	10.34	7.50	8.98	7.12	4.95	2.39	2.53	2.08	2.60
Sitanion hystrix		10.60	7.26	7.26	5.98	4.63	4.64	6.26	3.23	4.50
Purshia tridentata		14.09	11.15	11.28	11.76	10.48		10.35		7.51

* From the records of the Squaw Butte-Harney Cooperative Range and Livestock Station.

TABLE 5

SEASONAL VARIATIONS IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry basis)
1940

Species	Date Collected									
	April 15	May 10	May 27	June 10	June 25	July 10	July 25	Aug. 10	Aug. 26	Sept. 25
	%	%	%	%	%	%	%	%	%	%
Agropyron spicatum	21.05	15.66	9.52	6.23	5.64	4.37	3.38		2.97	2.64
Festuca idahoensis	18.00	8.86	7.04	6.49	5.25	5.47	5.00	5.05	5.12	5.13
Poa secunda	9.13	8.57	6.08	2.81	3.29	3.91	2.40	2.70	2.91	2.92
Elymus condensatus	24.29	16.47	16.63	12.96	7.54	6.27		4.33	4.83	3.23
Sitanion hystrix	15.33	22.42	12.16	7.99	4.65	5.89	4.06	3.76	3.60	3.13
Purshia tridentata				11.24	10.05	10.25	9.24	9.15	7.81	7.75

TABLE 6

SEASONAL VARIATIONS IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry basis)
1941

Species	Date Collected											
	May 2	May 26-27	June 12	June 25	July 9	July 24	Aug. 12	Aug. 25	Sept. 9	Sept. 25	Oct. 13	Nov. 4
	%	%	%	%	%	%	%	%	%	%	%	%
Agropyron spicatum	17.47	11.93	8.24	5.45	4.84	4.92	3.09	3.78	2.68	2.67	2.25	2.27
Festuca idahoensis	14.86	10.20	5.63	4.45	4.32	2.74	2.40	1.67	3.24	1.73	1.38	2.03
Poa secunda	12.62	8.53	6.11	4.43	2.95	2.60	2.32	1.90	1.94	2.04	1.89	2.01
Elymus condensatus	21.33	16.53	11.44	9.47	7.73	6.41	6.79	4.58	4.97	5.03	1.93	1.72
Sitanion hystrix	17.13	14.12	9.45	7.18	7.05	5.21	3.79	3.80	5.17	3.58	3.80	2.96
Purshia tridentata	9.16	11.17	10.92	10.00	10.50	10.64	11.00	10.13	9.52	9.10	8.65	8.96

Cow Weights for 1940 and 1941

Cow weights for the years 1940 and 1941 are shown in Tables 7 and 8. Using these average weights, which were taken each month throughout the season, average daily gain or loss per animal was figured and is shown in the table. Rapid gains were made by the cows during the months of April and May in 1940, and the gains continued until about August 1. The animals went to pieces rapidly during August, and from August 1 to September 2 they suffered an average daily loss of 2.31 pounds.

The same performance was repeated by the cows in 1941. Large gains were made during the early months, and losses were suffered by the cows during the last two months.

Calf Weights for 1941

The weights of 24 March calves on which growth records were kept are shown in Table 9. On the basis of these average weights, daily gain or loss was figured and is shown in the table. Rapid gains were made by the calves until August, and fair gains were made during August. From September 2 to September 20 the calves suffered average daily losses of 0.11 pounds per head.

TABLE 7

AVERAGE WEIGHTS AND DAILY GAINS OR LOSSES (in pounds) OF 137 COWS FOR 1940 *

Date	Average Weight	Daily Gain or Loss
April 16	713.53	
May 1	741.52	1.86
June 1	808.85	2.17
July 2	848.93	1.29
August 1	853.64	0.16
September 2	779.59	-2.31

TABLE 8

AVERAGE WEIGHTS AND DAILY GAINS OR LOSSES (in pounds) OF 139 COWS FOR 1941 *

Date	Average Weight	Daily Gain or Loss
April 15	693.49	
May 1	774.67	
June 3	852.01	2.34
June 30	912.95	2.26
August 1	919.11	0.19
September 2	861.00	-1.82
September 20	837.25	-1.32

TABLE 9

AVERAGE WEIGHTS AND DAILY GAINS OR LOSSES (in pounds) OF 24 MARCH CALVES FOR 1941 *

Date	Average Weight	Daily Gain or Loss
At birth	65.20	
June 3	183.63	1.55
June 30	229.17	1.61
August 1	281.25	1.68
September 2	316.54	1.10
September 20	314.58	-0.11

* From the records of the Squaw Butte-Harney Cooperative Range and Livestock Station.

CHAPTER V

DISCUSSION OF RESULTS

The most striking characteristic of stage of growth in these range plants was the seasonal variation in the chemical composition as the plants approached maturity. According to the work of McCall (14) the digestibility would be decidedly superior in the young plants. They were high in moisture content, rich in crude protein and phosphorus, and relatively low in crude fiber.

The crude protein in the plants was very adequate in early May, being well above the 8 percent level recommended by Guilbert and Rochford (11). Without exception, the crude protein at this early stage of growth was relatively high as shown in Figures 1, 2, and 3.

Referring to reports by Watkins and Ellis (19), the plants would have highly digestible protein during the months of April and May with a gradual lowering until August, September, and October when only a small percentage of the protein would be digestible. The stage of maturity and not the corresponding month is important because of different stages of growth of the various species of grass at the same time of the year. It was found that by August 1 the three principal grasses—bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass were mature.

Sandberg bluegrass matured about one month earlier, being mature by July 1. Squirreltail grass matured between July 1 and July 15 and giant wild-rye during the later part of August. By coupling low crude protein content with lowered digestibility, it would be possible that after maturing and drying, these range grasses would be extremely inefficient in supplying the protein required for maintenance of the animal body. The grasses would be even less efficient in meeting the requirements for growth and fattening. Grasses of this type might become so inefficient that only enough protein would be supplied to take care of the need for metabolic nitrogen (nitrogen used in digestion) and that very little, if any, would be available to prevent body-protein catabolism.

Protein and phosphorus varied directly and a decrease in protein was accompanied by a decrease in phosphorus. After maturity, the grasses studied here were decidedly low in both.

The normal requirement for calcium is about double that of phosphorus. For best utilization, according to Esplin, Greaves, and Stoddart (7) and others, two parts of calcium for one part of phosphorus are needed in the ration. Since the calcium content did not decrease as the phosphorus decreased, the phosphorus deficiency would be intensified. The calcium seemed to be adequate to meet the requirements

Figure 1. SEASONAL VARIATION IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry Basis)
1938

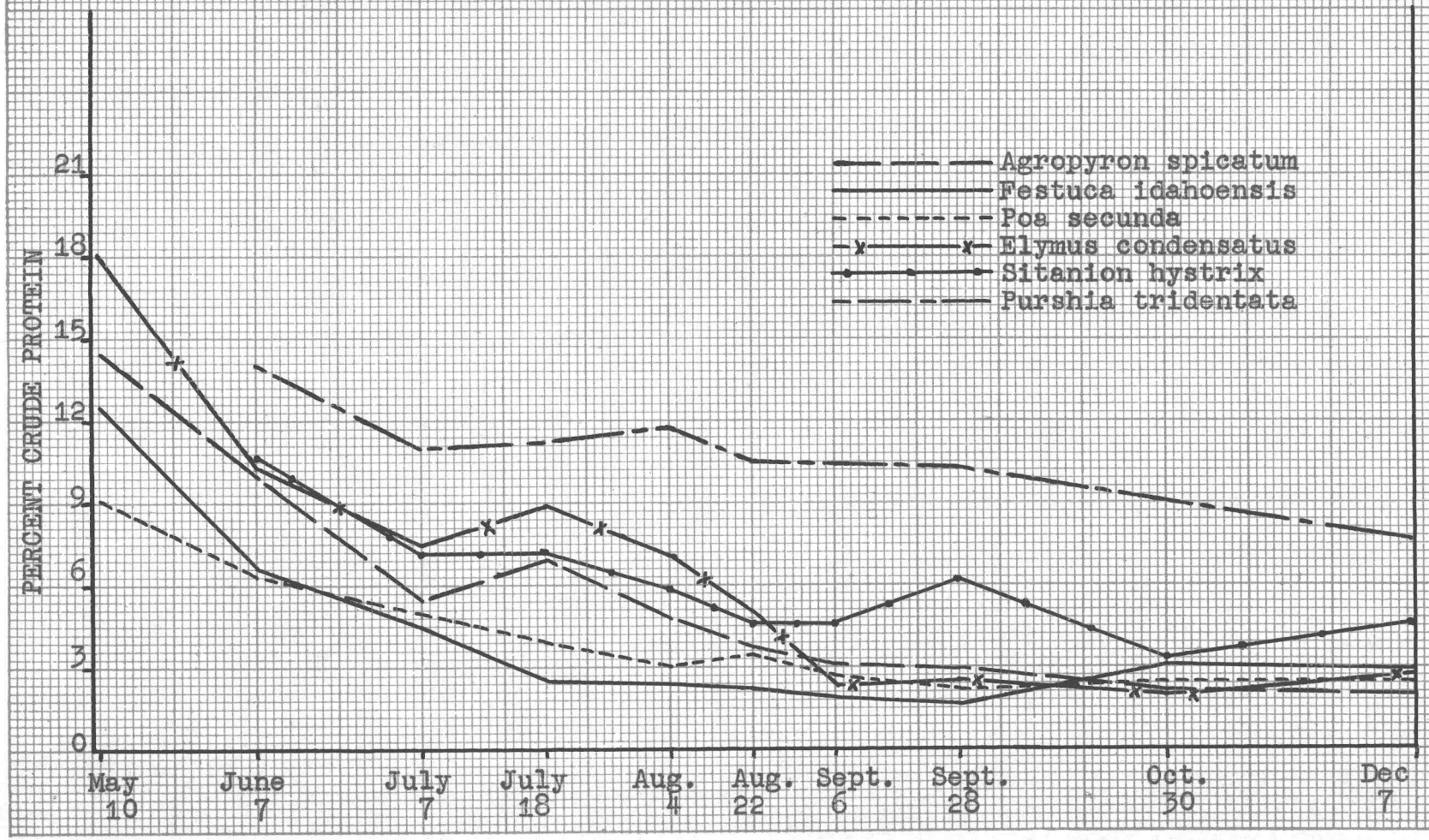


Figure 2. SEASONAL VARIATION IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry Basis)
1940

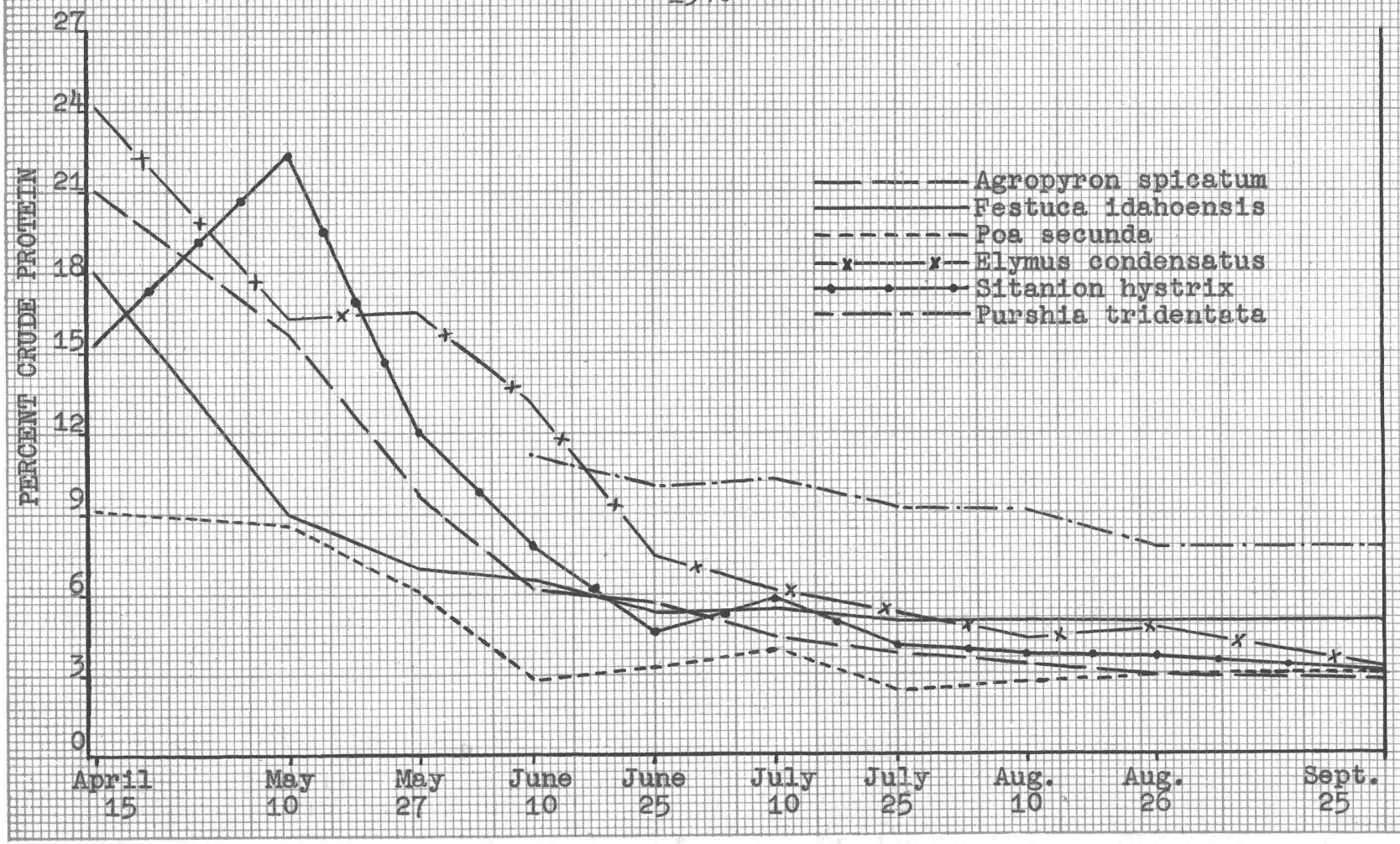
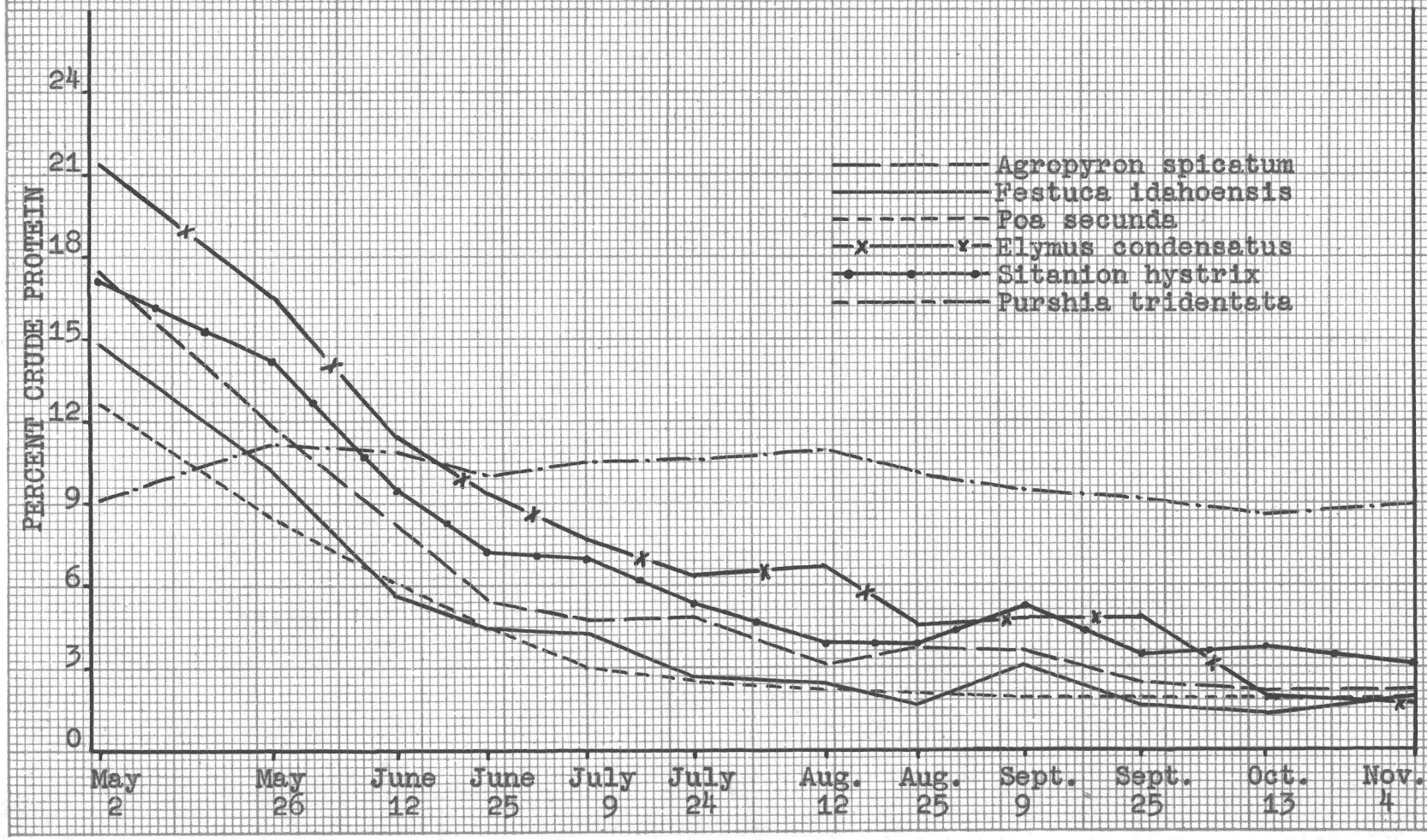


Figure 3. SEASONAL VARIATION IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry Basis)
1941



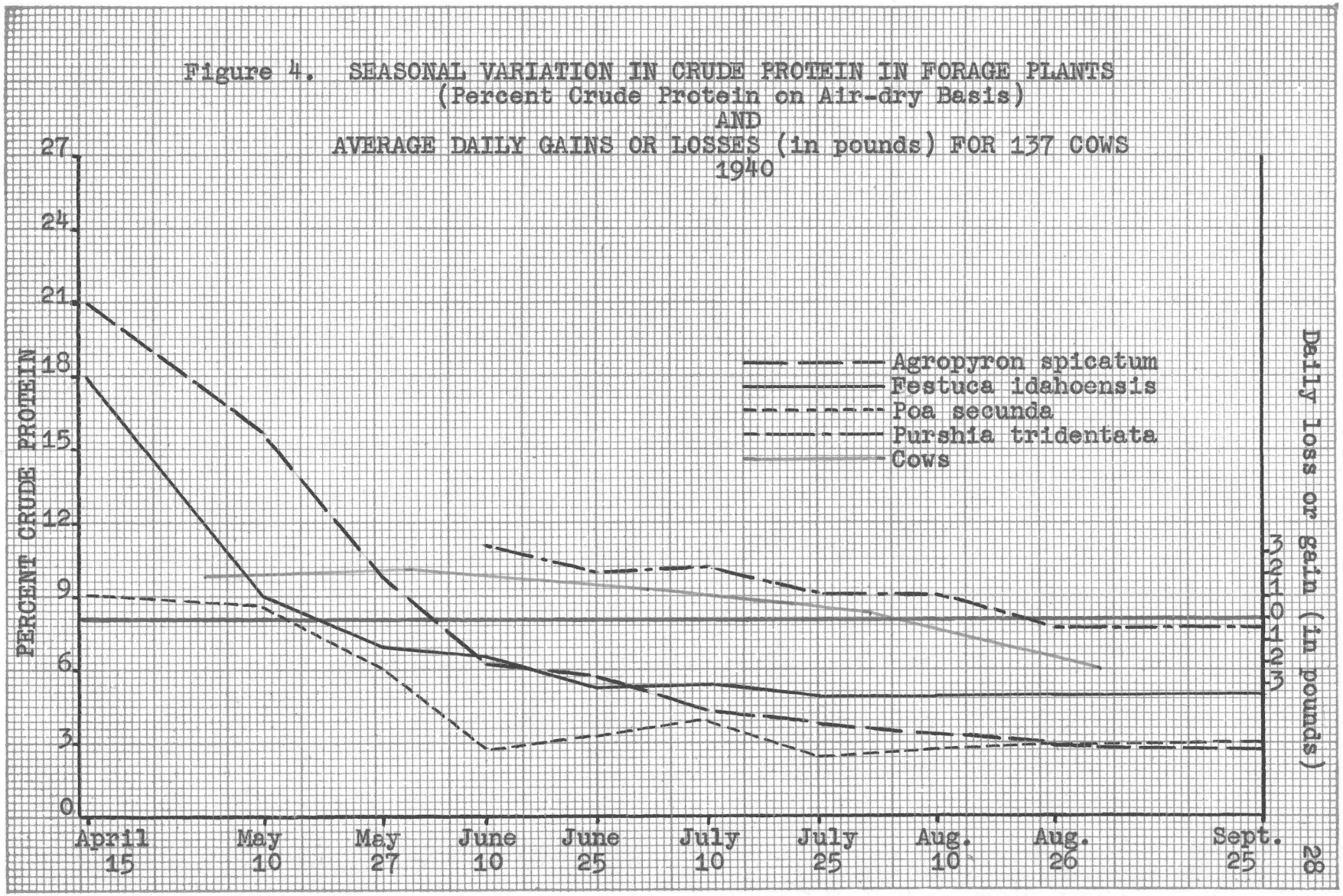


Figure 4. SEASONAL VARIATION IN CRUDE PROTEIN IN FORAGE PLANTS
(Percent Crude Protein on Air-dry Basis)
AND
AVERAGE DAILY GAINS OR LOSSES (in pounds) FOR 137 COWS
1940

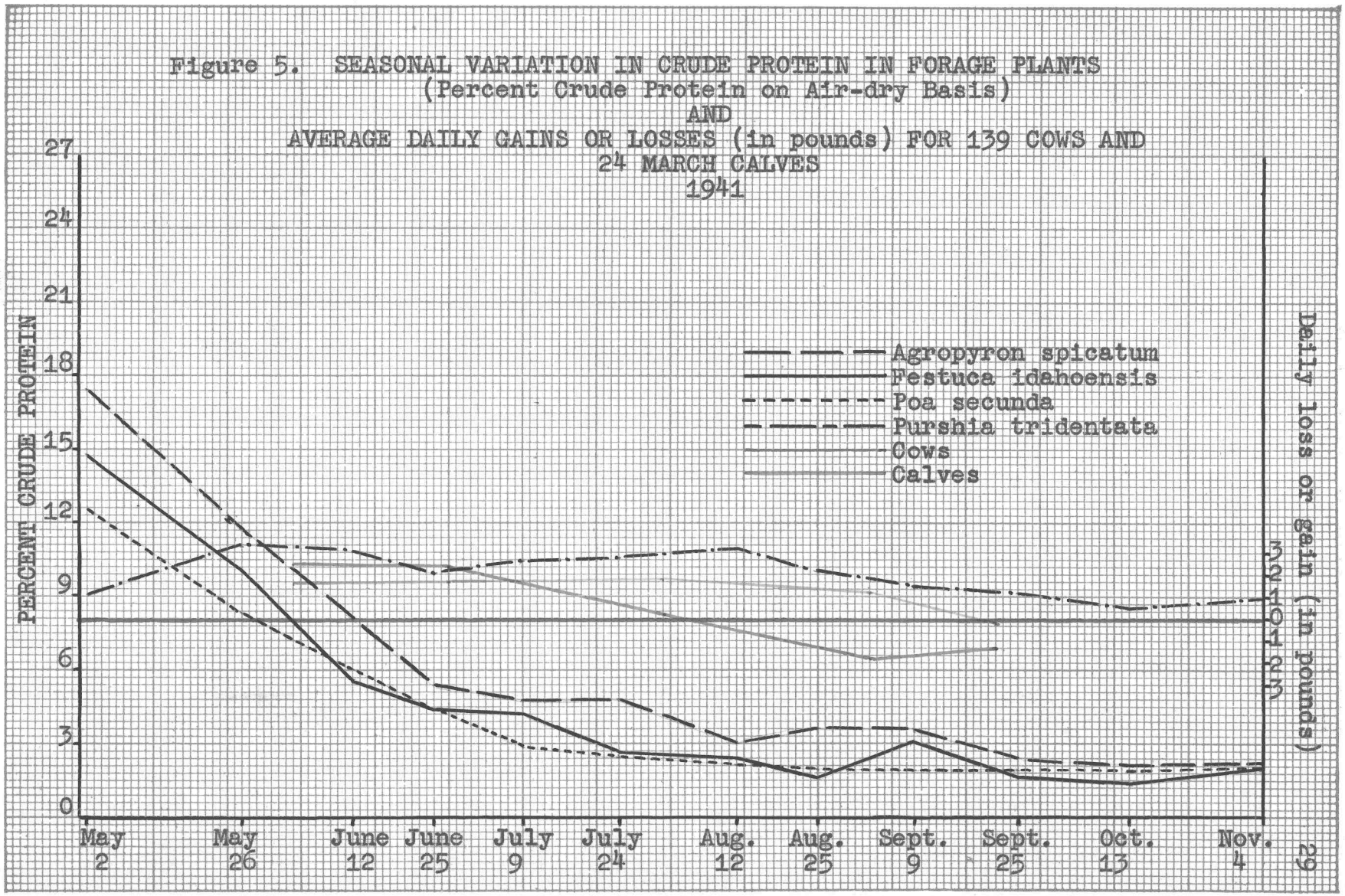


Figure 5. SEASONAL VARIATION IN CRUDE PROTEIN IN FORAGE PLANTS (Percent Crude Protein on Air-dry Basis) AND AVERAGE DAILY GAINS OR LOSSES (in pounds) FOR 139 COWS AND 24 MARCH CALVES 1941

of the livestock. Because of known deficiences in phosphorus in this area bonemeal was provided in self-feeders and was available to the animals at all times. It is believed that enough of this mineral supplement was consumed so that all requirements for these animals were met.

An interesting picture can be seen by referring to Figures 4 and 5. A heavy red line has been drawn to represent the 8 percent crude protein figure given by Guilbert and Rochford (11). This might be considered as a danger line to show when the protein in the feed becomes inadequate to supply the maintenance requirements of cattle. Only three grasses — bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass are shown because these three make up 85 percent of the forage on the area in eastern Oregon. Bitterbrush is shown although it is not very abundant on these particular ranges. Plotted with the crude protein is the daily gain or loss per animal.

The animals were turned onto the ranges both years about the middle of April. Considerable daily gains were made by the cows each year while the forage was in an early stage of growth. The excessively large daily gain shown by the cows in April, 1941, included fill after the animals were brought in from the trail and was not all actual gain in weight. However, by the third of June the 2.34 pound gain appeared normal for this kind of feed.

These gains were made during the month of May when the grass was green and in an early stage of growth. As the plants approached maturity, the cows showed less gain each month and by August 1 were just able to maintain their body weight. August and September were poor feed months, and the cows suffered losses equal to, and in some cases greater than, the gains which were made on the early growing forage. It should not be gathered from this that no net gain in weight was made between April and September. In 1940 the animals showed a net gain of about 66 pounds per head. In 1941 the net gain was 144 pounds. It is important to note that from one-third to over one-half of the early summer gains were lost in August and September after the forage was mature and dry.

Going a step farther in our discussion, it can be seen that the cow gains and losses followed the same general downward trend as the crude protein but with considerable lag.

There is one plant that has received only slight mention before. Bitterbrush is a browse plant and from the tables and figures it can be noted that protein remained fairly constant throughout the grazing season and that the percentage content was above the 8 percent maintenance line, except in September, 1940, when it dropped slightly below.

During the early part of the season when the grasses were green, bitterbrush was not taken except for a twig here and there. After the grasses had matured and dried, the cattle turned to this browse plant to get green forage. This resulted in a higher protein intake which in turn may have aided in maintaining continued gains. I do not propose that this would be the sole explanation for this lag, but it seems altogether possible and warrants further investigation. Such work would undoubtedly bring about new concepts in many areas concerning the value of various browse plants found on cattle ranges.

Guilbert and Rochford (11) report that vitamins A and D are the only vitamins known to be required by cattle. They state that carotene, a yellow pigment found in all green plant tissue, is the primary source of vitamin A. They report further, that carotene decomposes rapidly under exposure to sun and air and that dry range forage is lacking or contains only traces of this essential substance. Finally, that cattle are able to store reserves of this vitamin in the liver and body fat which can be used when the ration is lacking green feed.

From this it might be gathered that when the grasses were green, the animals were able to store up reserves in the liver and body fat. Later on in the season when vitamin A was insufficient to supply current needs, these

reserve supplies were used. If this lack of green feed continued for a long enough period, these reserves would be exhausted and a vitamin A deficiency would result. It is not believed that in this case dry forage was eaten over a long enough period of time to cause a vitamin A deficiency. Furthermore, no evidence of deficiency, such as night-blindness, was observed in the animals.

Vitamin D is essential to calcium and phosphorus utilization according to the above workers. They indicate that this vitamin is present in sun-cured feeds and is developed in the animal body when exposed to direct sunlight. The animals which grazed on this area were constantly exposed to the sun and would not suffer from deficiency of this substance.

Table 9 and Figure 5 show that while the cows were feeding on an abundance of green forage, the calves made good gains of between 1.55 and 1.68 pounds per day. Through August when the feed eaten by the cows was dry, the production of milk for the calves was reduced, and the calf gains went down to 1.10 pounds. When the cows began to lose weight rapidly late in August and in September, the calves were unable to maintain their body weight, and a daily loss of 0.11 pounds per head was suffered. Although the calves made an average net gain of approximately 250 pounds per head, no gains were being made in

the month of September. This would suggest that it may be important for the livestock producers to give more attention to the variation in the rate of gain of the calves rather than to just the net gain over the entire period. In order to have more economical production it is important not only to have the calves show a net gain but also to show continued gains throughout their growing period.

The writer does not propose that protein was the only factor involved in the gain and loss in weight of the cattle, but the gains and losses of the animals as shown by the results of this investigation follow so closely the crude protein content of the forage which they consumed that it should receive adequate consideration. Reference to Figures 4 and 5 will show the correlation between high crude protein and rapid gains and between very low protein and losses in weight.

Another factor which should be considered is the total intake of feed. As the grass forage became mature and dry, the crude protein and phosphorus content decreased, and the crude fiber content increased. No way was provided for measuring the total intake of feed, but it is believed that the animals consumed less of the mature grasses than of the green lush grass. This is supported by the work of Christensen and Hopper (4) in

North Dakota. They state that 550 to 650 pound steers consumed 15.12 pounds daily of green July grass and only 7.49 pounds daily of dry weathered grass. Just how much this factor influenced the results is not known. However, it is believed that eating larger amounts of the low quality feed would not necessarily mean that the deficiencies in the feed would be overcome.

The information presented has lead the writer to conclude that protein may have played an important role in the gains and losses recorded in this experiment; that the crude protein content of the forage was an accurate measure of the nutritive value of the plants involved; and that to get the most efficient use of range forage the operator may have to use the forage during the stage of growth when it is high in nutritive value and to properly supplement the forage when it becomes dry and deficiencies occur.

SUMMARY

Crude protein content of range grasses ranged from a high during early stages of growth to a minimum when dry and weathered.

Crude protein content of bitterbrush remained high throughout the growing season and might provide a valuable protein supplement to dry range grasses.

Crude fat showed considerable variation throughout the season with no general trend.

Crude fiber showed a tendency to increase in all cases as the plants approached maturity.

Total ash showed no definite trend.

Calcium failed to show any definite trend in the percent content.

Phosphorus showed a very definite trend which followed very closely the trend of crude protein.

Nitrogen-free extract showed increases in percent content as the grasses matured.

Range cows showed rapid daily gains up to 2.34 pounds while having plenty of early growing, green, lush forage and suffered losses in weight up to 2.31 pounds daily when having mature, dry grass as the only source of food.

March calves showed rapid daily gains up to 1.68 pounds early in the season. As the season progressed,

smaller gains were made, and in September they actually suffered a daily loss of 0.11 pounds per head.

The writer wishes to suggest that the crude protein content can be used with reasonable accuracy to designate the relative nutritive value of range grasses.

Finally, the efficiency of the use of range forage may depend upon the operator's ability to use the forage during the stage of growth when it is high in nutritive value and to properly supplement the forage when it becomes dry and deficiencies occur.

BIBLIOGRAPHY

1. Association of Official Agricultural Chemists. Official and tentative methods of analysis of the association of official agricultural chemists. Fifth Edition, 1940.

2. Aston, B. C., Grimmett, R.E.R., Brogan, F. J. A., and Sykes, P. H. Mineral content of pasturage. The Wairarapa District. Nutritional Abstracts and Reviews, I:44-45, 1931.

3. Black, W. H., Quesenberry, J. R., and Baker, A. L. Wintering beef cows on the range with and without a supplement of cottonseed cake. U.S.D.A. Tech. Bull. 603, pp. 1-21, 1938.

4. Christensen, F. W. and Hopper, T. H. Effect of weathering and stage of maturity on palatability and nutritive value of prairie hay. North Dakota Agr. Exp. Sta. Tech. Bull. 260, pp. 1-47, 1932.

5. Cruickshank, Ethel M. Investigation on the mineral content of pasture grass and its effect on Herbivora. IV. Report on the seasonal variation in the mineral content of pastures. Jour. Agr. Sci. 16:89-97, 1926.

6. Daniel, Harley A., and Harper, Horace J. The relation between effective rainfall and total calcium and phosphorus in alfalfa and prairie hay. Jour. Am. Soc. Agron. Vol. 27, No. 8, pp. 644-52, Aug. 1935.

7. Esplin, A. C., Greaves, J. E., and Stoddart, L. A. A study of Utah's winter ranges. Utah Agr. Exp. Sta. Bull. 277, pp. 1-47, 1937.

8. Ferguson, W. S. Investigations into the intensive system of grassland management by the Agricultural Research Staff of Imperial Chemical Industries, Ltd. 3. The seasonal variation in the mineral content of pasture, with particular reference to drought. Nutritional Abstracts and Reviews, I:46, 1931.

9. Garrigus, W. P. and Rusk, H. P. Some effects of the species and stage of maturity of plants on the forage consumption of grazing steers of various weights. Univ. of Ill. Agr. Exp. Sta. Bull. 454, p. 467, 1939.

10. Greaves, J. E. Correlation among various constituents of forage plants. Jour. Am. Soc. Agron. 30: 754-59, 1938.

11. Guilbert, H. R. and Rochford, L. H. Beef production in California. Calif. Agr. Ext. Service Cir. 115, pp. 37-60, 1940.

12. Hart, G. H., Guilbert, H. R., and Goss, H. Seasonal changes in the chemical composition of range forage and their relation to nutrition of animals. Calif. Agr. Exp. Sta. Bull. 543, pp. 3-60, Nov. 1932.

13. Maynard, L. A. Animal Nutrition. First Edition. McGraw-Hill Book Company, Inc. 1937.

14. McCall, Ralph. Nutritive value of winter range grasses. Forty-Fifth Annual Report of the Agr. Exp. Sta. of the State College of Wash. Bull. 325, Division of Animal Husbandry, p. 23, Dec. 1935.

15. McCeary, O. C. Wyoming forage plants and their chemical composition. Univ. of Wyo. Agr. Exp. Sta. Bull. 184, pp. 3-22, Aug. 1931.

16. Richardson, A. E. V., Trumble, H. C., and Shapter, R. E. The influence of growth stage and frequency of cutting on the yield and composition of perennial grass, Phalaris tuberosa. Nutritional Abstract and Reviews, II:472-73, 1932.

17. Stanley, E. B. and Hodgson, C. W. Seasonal changes in the chemical composition of some Arizona range grasses. Ariz. Agr. Exp. Sta. Tech. Bull. 73, pp. 451-64, 1938.

18. Watkins, W. E. The calcium and phosphorus contents of important New Mexico range plants. New Mexico Press Bull. 827, April, 1937.

19. Watkins, W. E. and Ellis, G. F. Feeding value of New Mexico range grasses in the fall of 1941. New Mexico College of Agriculture and Mechanic Arts and Agr. Exp. Sta. Press Bull. 935, pp. 1-4, Jan. 1942.

20. Woodman, H. E. and Oosthuizen, P. M. Nutritive value of pasture. XI. The composition and nutritive value of winter pasturage. Jour. Agr. Sci. Vol. 24, No. 4, pp. 547-97, 1934.