Bulletin No. 359 - Dual-Purpose Pastures for the Shortgrass Plains

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DUAL-PURPOSE PASTURES
for the Shortgrass Plains

FRANK RAUZI, ROBERT LANG, AND O. K. BARNES

AGRICULTURAL EXPERIMENT STATION
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Dual-Purpose Pastures for the Shortgrass Plains

By FRANK RAUZI, ROBERT LANG, and O. K. BARNES

GREEN FORAGE FOR EARLY SPRING and fall grazing, and hay for feeding livestock during winter storms, are generally in short supply for farmers and ranchers in the shortgrass plains area. Native grasses are, for the most part, warm-season species and are not adapted to hay production. The need for an early forage has been partially met by use of supplemental pasture seeded to crested wheatgrass and other cool-season species. Barnes and Nelson have shown that pastures containing a mixture of grass and alfalfa had a higher grazing capacity and produced greater animal gains than the same grass species grown without a legume. In view of these grazing needs, a study was set up to determine hay production, fall grazing capacity, forage quality, and period of productivity of four introduced grass species seeded with alfalfa. Results of this study covering a five-year period (1951-1955) are presented in this bulletin.

Description of Area

The experimental pastures used in this study were located at the Archer Substation, 10 miles east of Cheyenne, Wyoming. The station lies on the high plains of southeastern Wyoming at an elevation of about 6,000 ft. The most extensive soil type in the pastures used was designated as Altavan very fine sandy loam.* Native vegetation is typical of the shortgrass plains, the major grass species being blue grama grass and buffalograss with some western wheatgrass, needleandthreadgrass, Junegrass, and Sandberg bluegrass present. Western wheatgrass and needleandthreadgrass reach their greatest abundance on the slopes and in the valleys of the area.

*Complete soil descriptions are shown in Appendix A.
Climatic Conditions

Climatic records (Table 1) from the Archer Substation showed a 43-year mean annual precipitation of 14.84 in. of which 11.69 in. occurred between April 1 and September 30. During the period of study (1951-1955) the average annual and seasonal precipitation was 15.13 and 11.72 in., respectively. Average winter precipitation was very light (less than 25% of the total) and not evenly distributed, especially when snowdrifts occurred. Precipitation for two of the five years of the study was below the 43-year seasonal and the annual average, whereas three years received considerably above both averages. Five-year seasonal precipitation average was almost identical with the 43-year average.

Experimental Procedure

Native sod was first broken at the Archer Station in 1912. The exact year that the 20-acre field used in this study was first broken is not known, but as far as can be ascertained, it was first cropped in 1934 under a three-year rotation plan. From 1934 until 1950 it was managed with various rotations including wheat, corn, barley, and fallow. During the fall of 1950 it was subdivided into five pastures of four acres each, and the following species were seeded in April of 1950 directly into the barley stubble without tillage treatment before seeding:

1. Intermediate wheatgrass* (alone)
2. Intermediate wheatgrass and Ladak alfalfa
3. Russian wildrye and Ladak alfalfa
4. Pubescent wheatgrass and Ladak alfalfa
5. Crested wheatgrass and Ladak alfalfa

Four lbs. of grass seed and two lbs. of alfalfa seed per acre were planted with a standard drill having row spacings seven in. apart.

Even though 1950 proved to be a dry year, good stands were established by 1951; and the spring precipitation in 1951 was above normal. During the last week in June 1951, the pastures were all harvested for hay, and this procedure was used throughout the study except in 1954, when not enough forage was produced to harvest. The late June harvest period was slightly earlier than normal to allow for a longer period of regrowth.

Grade Columbia ewe lambs from the Station flock were grazed on the pastures starting approximately October 1 each year. These lambs averaged about 89 lbs. per head at this date. They were removed from the pastures when they had utilized the grasses to a stubble height of about 2 to 3 inches. The experimental animals were weighed individually on entering and again on the day they were removed from the pastures. A pasture of native vegetation was grazed by ewe lambs for the same time as a check. The native pasture was not grazed before the October 1 date and was not stocked to its full grazing capacity.

*Scientific and common names of all species discussed in this publication are listed in Appendix B.
TABLE 1—Monthly, Seasonal, and Annual Precipitation in Inches for the Years 1951 to 1955 and the 43-year Averages Recorded at the Archer Substation in Southeastern Wyoming

<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>0.54</td>
<td>0.30</td>
<td>0.23</td>
<td>2.16</td>
<td>2.57</td>
<td>2.95</td>
<td>2.13</td>
<td>1.49</td>
<td>1.98</td>
<td>2.52</td>
<td>0.93</td>
<td>0.43</td>
<td>18.23</td>
<td>13.28</td>
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<tr>
<td>1952</td>
<td>0.04</td>
<td>0.43</td>
<td>0.91</td>
<td>1.17</td>
<td>3.75</td>
<td>2.05</td>
<td>0.30</td>
<td>1.76</td>
<td>1.04</td>
<td>0.36</td>
<td>1.05</td>
<td>0.21</td>
<td>13.07</td>
<td>10.07</td>
</tr>
<tr>
<td>1953</td>
<td>0.22</td>
<td>0.93</td>
<td>0.89</td>
<td>1.08</td>
<td>1.02</td>
<td>3.44</td>
<td>3.50</td>
<td>2.98</td>
<td>0.41</td>
<td>0.25</td>
<td>0.54</td>
<td>0.32</td>
<td>15.58</td>
<td>12.43</td>
</tr>
<tr>
<td>1954</td>
<td>0.12</td>
<td>0.04</td>
<td>0.95</td>
<td>0.33</td>
<td>2.01</td>
<td>2.31</td>
<td>1.02</td>
<td>1.92</td>
<td>0.91</td>
<td>0.24</td>
<td>0.20</td>
<td>0.34</td>
<td>10.39</td>
<td>8.50</td>
</tr>
<tr>
<td>1955</td>
<td>0.61</td>
<td>0.68</td>
<td>1.23</td>
<td>0.92</td>
<td>3.35</td>
<td>4.55</td>
<td>1.71</td>
<td>2.09</td>
<td>1.71</td>
<td>0.06</td>
<td>1.09</td>
<td>0.39</td>
<td>18.39</td>
<td>14.33</td>
</tr>
</tbody>
</table>

5-year Av.  
1951-1955: 0.31 0.48 0.84 1.13 2.54 3.06 1.73 2.05 1.21 0.69 0.76 0.34 15.13 11.72
43-year Av.  
1913-1955: 0.34 0.34 0.61 1.78 2.43 2.36 1.98 1.88 1.28 1.06 0.45 0.36 14.84 11.69
The lambs were removed from all pastures at the same time during the first two years of the study because of inclement weather conditions. During the last three years they were taken off pasture when utilization was judged proper.

Protein analysis of the forage was made in 1953, 1954, and 1955 at three random times; in June at the time the hay was harvested, on October 1 just before sheep were put on pasture, and in November, when the sheep were removed. The analysis was made on the grasses and alfalfa separately. Species-composition studies, using a point quadrat, were made in the fall of 1953, before grazing of the pastures, and again in the spring of 1956, when a modified point quadrat was used.

Some Characteristics of the Forage Species Used

Intermediate wheatgrass is a late-maturing, sod-forming species which begins growth fairly early in the spring. It makes good recovery from grazing if moisture is present in late summer and fall. The grass is relished by sheep and has fairly good hay production.

Ladak alfalfa is adapted to the Great Plains Region and has the ability to produce a heavy first crop. It recovers slowly after being cut, but generally good regrowth was obtained by October 1.

Russian wildrye is a drought-resistant bunchgrass adapted to the Great Plains regions. It is outstanding in palatability at this location; sheep will graze it readily at any time of year. The foliage is mostly basal; consequently this species is better adapted for pasturing than for hay production on dryland.

Pubescent wheatgrass is very similar in appearance to intermediate wheatgrass. It is thought to be drought-resistant, has good hay qualities, and is palatable to livestock.

Crested wheatgrass is one of the most valuable introduced forage grasses in the plains region of eastern Wyoming. It is winter hardy and drought-resistant and makes rapid early growth for spring grazing and good regrowth when fall moisture is available.

Results and Discussion

Intermediate Wheatgrass

In 1951 (the year after seeding) a fair stand of intermediate wheatgrass was present on the pasture. A thinning of the stand was noted in 1953 which perhaps resulted from a very dry year in 1952. This thinning of the stand resulted in an invasion of fireweed, which made very little height growth but was very dense in stand. The grass made particularly good growth and regrowth where extra moisture collected in low areas and along a fence which caught and held snow.

Hay production (Table 2) from this
pasture averaged 404 lbs. per acre over the five-year period of study. This was significantly less than from the pasture seeded with crested wheatgrass and alfalfa. The highest yield was in 1952, when 750 lbs. of hay was produced. No hay was harvested in 1954, and the lowest recorded yield was 370 lbs. per acre in 1955.

Fall grazing capacity, as Table 3 shows, averaged 42 lamb days per acre. Average gain per head (Table 4) for the five-year period was 8.6 lbs. (not significantly different from the other seeded pastures), and the average gain per acre (Table 5) was 10.7 lbs. Statistical analysis showed that differences between years for gain per head and gain per acre were significant at the .01 level.

**Intermediate Wheatgrass and Alfalfa**

Intermediate wheatgrass and Ladak alfalfa were seeded together in 1950 and a good stand was present in 1951. By 1953 the intermediate wheatgrass had almost completely disappeared from this pasture except in depressions, where extra water collected after rains. By 1955, alfalfa and fireweed were the dominant plants in the pasture and the fireweed made little growth.

Average hay production from this pasture during the five-year period was 564 lbs. per acre (Table 2). The highest yield was obtained in 1952, when 880 lbs. was produced.

Grazing capacity from the pasture seeded with intermediate wheatgrass and alfalfa (Table 3) averaged 46.1 lamb days per acre. Average gain per head was 12.2 lbs., which was 3.6 lbs. per head more than from the pasture seeded to intermediate wheatgrass alone (Table 4). Average lamb gain per acre was 15.1 lbs. (Table 5), or 4.4 lbs. more than from the pasture seeded to intermediate wheatgrass alone.

**TABLE 3—Fall Grazing Capacity from Seeded Pastures in Terms of Lamb Days per Acre during the Period 1951-1955 at Archer, Wyoming, Substation**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate wheatgrass alone</td>
<td>50</td>
<td>42</td>
<td>38.7</td>
<td>45</td>
<td>35</td>
<td>42.1</td>
</tr>
<tr>
<td>Intermediate wheatgrass and alfalfa</td>
<td>50</td>
<td>42</td>
<td>56.2</td>
<td>57.5</td>
<td>25</td>
<td>46.1</td>
</tr>
<tr>
<td>Russian wildrye and alfalfa</td>
<td>50</td>
<td>42</td>
<td>122.5</td>
<td>75</td>
<td>51.2</td>
<td>68.1</td>
</tr>
<tr>
<td>Pubescent wheatgrass and alfalfa</td>
<td>50</td>
<td>42</td>
<td>62.5</td>
<td>71.2</td>
<td>25</td>
<td>50.1</td>
</tr>
<tr>
<td>Crested wheatgrass and alfalfa</td>
<td>50</td>
<td>42</td>
<td>62.5</td>
<td>71.2</td>
<td>40</td>
<td>53.1</td>
</tr>
</tbody>
</table>

L.S.D., .01 level, species, and year means = 223 lbs. per acre.
TABLE 4—Average Lamb Gain per Head from Five Seeded Pastures and Native Range under Fall Aftermath Grazing from 1951 through 1955 at Archer, Wyoming, Substation

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Intermediate wheatgrass alone</td>
<td>12.3</td>
<td>3.2</td>
<td>8.2</td>
<td>11.8</td>
<td>7.5</td>
<td>8.6</td>
</tr>
<tr>
<td>Intermediate wheatgrass and alfalfa</td>
<td>13.3</td>
<td>6.7</td>
<td>15.2</td>
<td>15.6</td>
<td>10.2</td>
<td>12.2</td>
</tr>
<tr>
<td>Russian wildrye and alfalfa</td>
<td>11.9</td>
<td>5.5</td>
<td>10.0</td>
<td>15.4</td>
<td>11.9</td>
<td>10.9</td>
</tr>
<tr>
<td>Pubescent wheatgrass and alfalfa</td>
<td>13.2</td>
<td>9.4</td>
<td>13.2</td>
<td>21.0</td>
<td>9.3</td>
<td>13.2</td>
</tr>
<tr>
<td>Crested wheatgrass and alfalfa</td>
<td>13.5</td>
<td>-1.3</td>
<td>8.6</td>
<td>15.0</td>
<td>2.7</td>
<td>7.7</td>
</tr>
<tr>
<td>Native range</td>
<td>1.4</td>
<td>-0.8</td>
<td>3.4</td>
<td>9.8</td>
<td>9.3</td>
<td>4.6</td>
</tr>
<tr>
<td>Year Means</td>
<td>10.9</td>
<td>3.8</td>
<td>9.8</td>
<td>14.8</td>
<td>8.5</td>
<td></td>
</tr>
</tbody>
</table>

L.S.D., .01 Level, Species means = 4.71; Year means = 5.17.

Russian Wildrye and Alfalfa

This pasture appeared to be a pure stand of alfalfa during the first two years of study. During the last three years, the alfalfa gradually disappeared until few plants remained in 1955. The Russian wildrye grass became very well established by the third year. Fireweed, which was so common on the intermediate wheatgrass pastures, was very sparse in this pasture (Fig. 1).

Hay production for a five-year period averaged 328 lbs. per acre (Table 2), and the forage was mostly alfalfa. The highest yield was obtained in 1952, when 518 lbs. was produced.

Grazing capacity averaged 68.1 lamb days per acre (Table 3). However, in the third year of grazing, the sheep were removed because of snow. A short time later 48 ewe lambs were put on this pasture for five days to obtain uniform utilization. This resulted in an additional 60 lamb days

FIG. 1—Pasture seeded with Russian wildrye and alfalfa in 1950. Photographed in May 1956. Practically no alfalfa plants remained in this stand.
of grazing for this pasture for a total of 122.5 lamb days of grazing in 1953. The five-year average grazing capacity was more than a third greater than that from either the intermediate wheatgrass alone or with alfalfa. Average gain per head was 10.9 lbs. (Table 4), and the average gain per acre was 13.7 lbs. (Table 5) from this pasture.

**Pubescent Wheatgrass and Alfalfa**

Although a good stand of pubescent wheatgrass was present in 1951, it thinned very rapidly, and the alfalfa stand increased. By 1953 the grass was sparse; alfalfa and fireweed dominated. By 1955 the pasture was practically a pure stand of alfalfa with a low stand of fireweed and only an occasional plant of pubescent wheatgrass (Fig. 2).

Average hay production from the pasture of pubescent wheatgrass and alfalfa at the Archer Station was 609 lbs. per acre (Table 2). The highest hay yield, in 1952, was 923 lbs. The lowest yield was 663 lbs. (almost wholly alfalfa) in 1955.

Grazing capacity averaged 50.1 lamb days per acre (Table 3), average gain per head was 13.2 lbs. (Table 4), and average gain per acre was 16.5 lbs. (Table 5). This pasture produced more lamb per head and per acre than did any of the other seeded pastures. This was undoubtedly because of the large amount of alfalfa present in the pasture.

This grass species did not do well at this location but has proved to be a most desirable species in other pasture studies conducted at the dryland substation near Sheridan, Wyoming. It is not known whether the difference in adaptability of this species between these two dryland stations was because of climatic conditions, strain differences, or management practices.

At the Sheridan Substation, pubescent wheatgrass has maintained an excellent stand through four years on pastures grazed with sheep from May until July (Fig. 3). During this period, 1953 through 1956, precipitation was nearly 20 percent below normal, averaging 13.25 in. annually. Two pastures of pubescent wheatgrass were seeded with Ladak alfalfa in 1953 on

FIG. 2—Pubescent wheatgrass and alfalfa pasture at the Archer Substation showing predominance of alfalfa, September 1953.
rough, class IV land with a sandy to sandy loam soil at Sheridan. Intermediate wheatgrass mixed with Ladak alfalfa on similar soil during this same period had thinned out severely. Intermediate wheatgrass on the heavier, more productive soil had maintained good stands of productive plants during this period.

Results of the past four years at the Sheridan location indicate that pubescent wheatgrass was better suited to the sandier soils than was intermediate wheatgrass and that intermediate wheatgrass produced satisfactorily on the more favorable (mois-

TABLE 5—Average Lamb Gain per Acre from Five Seeded Pastures under Fall Aftermath Grazing from 1951 through 1955 at Archer, Wyoming, Substation

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Intermediate wheatgrass alone</td>
<td>15.4</td>
<td>4.0</td>
<td>10.2</td>
<td>14.7</td>
<td>9.4</td>
<td>10.7</td>
</tr>
<tr>
<td>Intermediate wheatgrass and alfalfa</td>
<td>16.0</td>
<td>8.4</td>
<td>19.0</td>
<td>19.5</td>
<td>12.7</td>
<td>15.1</td>
</tr>
<tr>
<td>Russian wildrye and alfalfa</td>
<td>14.9</td>
<td>6.9</td>
<td>12.5</td>
<td>19.3</td>
<td>14.9</td>
<td>13.7</td>
</tr>
<tr>
<td>Pubescent wheatgrass and alfalfa</td>
<td>16.5</td>
<td>11.7</td>
<td>16.5</td>
<td>26.3</td>
<td>11.6</td>
<td>16.5</td>
</tr>
<tr>
<td>Crested wheatgrass and alfalfa</td>
<td>16.9</td>
<td>11.6</td>
<td>10.7</td>
<td>18.7</td>
<td>2.7</td>
<td>12.1</td>
</tr>
<tr>
<td>Year Means</td>
<td>15.9</td>
<td>8.5</td>
<td>13.7</td>
<td>19.7</td>
<td>10.3</td>
<td></td>
</tr>
</tbody>
</table>

L.S.D., .01 Level, species and year means = 5.59.
ture) sites with heavier soils. All indications to date are that pubescent wheatgrass is approximately equal in forage production to crested wheatgrass. However, it remained palatable over a longer period; its sod-forming habit makes it particularly desirable on loose sandy soil areas.

**Standard Crested Wheatgrass and Alfalfa**

A good stand of both alfalfa and crested wheatgrass occurred in 1951. A composition study in 1953 showed that 59 percent of the vegetation on this pasture was crested wheatgrass and 38 percent alfalfa. Composition in 1955 was 73 percent crested wheatgrass and 25 percent alfalfa (Fig. 4). Invasion of fireweed was very much limited. The fall of 1952 was very dry and regrowth on both crested wheatgrass and alfalfa was very much limited. This resulted in a loss of weight on the experimental animals grazed on this pasture.

Average hay production of 655 lbs. per acre was the most consistent from year to year of the five pastures tested (Table 2). In 1955 the average hay yield was 964 lbs. per acre. This pasture increased in hay production, whereas the others decreased over the five-year study period.

Grazing capacity from the pasture seeded with crested wheatgrass and alfalfa averaged 53.1 lamb days per acre (Table 3). Average lamb gain per head was 7.7 lbs. (Table 4), and the average lamb gain per acre was 12.1 lbs. (Table 5). Average lamb gain per acre was the lowest of the five pastures studied. It is believed this was due to the year 1952, when a net loss of 1.3 lbs. per head was sustained.

**Native Range**

Native range used for comparison of gains per head during the fall grazing period was typical shortgrass range, the dominant species being blue grama, buffalograss, and western wheatgrass. It was rated in good condition and was understocked with ewe lambs (7 ewe lambs on 11.25 acres) so that ample feed was available throughout the grazing period. Average lamb gain per head from the native pasture during the five-year period was 4.6 lbs. (Table 4).
Protein Studies

Beginning in 1953, grasses and alfalfa from the seeded pastures were clipped, bagged, and analyzed separately for determining percentage of crude protein present at three growth stages. Two native grass species were clipped at two different times. In general, the samples for protein analyses were taken during the last week of June either before or at the time hay was harvested from the pastures. Samples were taken also on the first of October before putting the sheep on pasture and again when the sheep were taken off the pastures. This period varied with the years and pastures (November 4 to November 26). Samples taken from the native pastures for protein analysis were also collected on October 1 and when the sheep were removed from the native pasture. The date of removal from

<table>
<thead>
<tr>
<th>TABLE 6—Percentage Crude Protein of Grasses from Seeded Pastures and Native Range at the Archer, Wyoming, Substation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pastures</td>
</tr>
<tr>
<td>Intermediate wheatgrass (alone)</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>Intermediate wheatgrass (with alfalfa)</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>Russian wildrye (with alfalfa)</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>Pubescent wheatgrass (with alfalfa)</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
<tr>
<td>Crested wheatgrass (with alfalfa)</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>October</td>
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<tr>
<td>November</td>
</tr>
<tr>
<td>Native western wheatgrass</td>
</tr>
<tr>
<td>October</td>
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<tr>
<td>November</td>
</tr>
<tr>
<td>Native blue grama</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
</tbody>
</table>

June samples were taken during the last week of the month immediately before or during hay harvest.

October samples were taken usually on October 1, when sheep were put on pasture.

November samples were taken at the time the sheep were taken off pasture, which was from the 4th through the 26th of November.
TABLE 7—Percentage Crude Protein of Alfalfa from Seeded Pastures at the Archer, Wyoming, Substation

<table>
<thead>
<tr>
<th>Pasture</th>
<th>1953</th>
<th>1954</th>
<th>1955</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>Intermediate wheatgrass and alfalfa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>20.90</td>
<td>18.08</td>
<td>21.25</td>
<td>20.08</td>
</tr>
<tr>
<td>October</td>
<td>16.21</td>
<td>18.25</td>
<td>15.62</td>
<td>16.69</td>
</tr>
<tr>
<td>November</td>
<td>7.62</td>
<td>5.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russian wildrye and alfalfa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>21.84</td>
<td>18.44</td>
<td>19.87</td>
<td>20.05</td>
</tr>
<tr>
<td>October</td>
<td>15.90</td>
<td>16.31</td>
<td>16.06</td>
<td>16.09</td>
</tr>
<tr>
<td>November</td>
<td>7.51</td>
<td>7.75</td>
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<td>Pubescent wheatgrass and alfalfa</td>
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<td>17.75</td>
<td>19.06</td>
<td>18.58</td>
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<td>16.06</td>
<td>16.26</td>
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<td>November</td>
<td>8.03</td>
<td>6.19</td>
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<tr>
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<td>20.00</td>
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<td>11.60</td>
<td>7.56</td>
<td>12.31</td>
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</table>

June samples were taken during the last week of the month immediately before or during the hay harvest.

October samples were taken on October 1, when sheep were put on pasture.

November samples were taken when sheep were removed from pasture, which varied from the 4th through the 26th of November.

All protein analysis were made by the Department of Agricultural Research Chemistry, Wyoming Agricultural Experiment Station.

It may be noted that in all cases except the Russian wildrye, 1953, the protein level dropped between October 1 and the November sampling date. In all instances, the introduced species had a higher percentage of crude protein on October 1 than did the native grasses in 1954. Intermediate wheatgrass alone in November 1955 had a lower percentage of crude protein than the blue grama samples at the same date. This may be partially accounted for in that there was very little regrowth after having the intermediate wheatgrass pasture.

In comparing intermediate wheatgrass when grown alone and when grown with alfalfa, it may be noted that in practically every instance the percentage of crude protein in the grass was higher when grown with alfalfa.

The summary in Table 7 for the alfalfa shows a decline in percentage of crude protein between the samples taken on October 1 and those taken in November. This was due to advanced maturity and leaf loss.

Plant Composition

A composition study was conducted in the fall of 1953 before the fall grazing of the pastures and again in the spring of 1956. The point-quadrat system was used in 1953, and in 1956 a modified point quadrat was used. Table 8 shows the vegetational...
compositions as determined by the above methods. Intermediate wheatgrass alone had the same composition in 1956 as in 1953. The major difference noted in this pasture was a much thinner stand, which resulted in more bare ground in 1956. The pastures seeded with intermediate wheatgrass and alfalfa and with pubescent wheatgrass and alfalfa had the highest forb population. The composition change in the Russian wildrye-alfalfa pasture was an increase in grass and a decrease in alfalfa, and only a trace of alfalfa remained in this pasture in 1956. The crested wheatgrass-alfalfa pasture showed an increase in grass and a decrease in alfalfa. The pasture seeded to pubescent wheatgrass and alfalfa had only a trace of pubescent wheatgrass remaining in the spring of 1956.

TABLE 8—Vegetational Composition Analysis of the Seeded Pastures at the Archer, Wyoming, Substation

<table>
<thead>
<tr>
<th>Percentage in Grass</th>
<th>Percentage in Alfalfa</th>
<th>Percentage in Forbs</th>
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<tr>
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<td>1953</td>
<td>1956</td>
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<td>52</td>
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<td>Pubescent wheatgrass and alfalfa</td>
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<td>7</td>
</tr>
<tr>
<td>Crested wheatgrass and alfalfa</td>
<td>59</td>
<td>73</td>
</tr>
</tbody>
</table>

Percentage composition determined by the point-quadrat method.

Summary and Conclusions

Five four-acre pastures were fenced and seeded at the Archer, Wyoming, Substation in the spring of 1950.

The results of this five-year study show the following:

1. The intermediate wheatgrass-alfalfa pasture produced an average of 3.6 lbs. more lamb gain per head and 4.4 lbs. more lamb gain per acre than the pasture seeded with intermediate wheatgrass alone. However, these differences were not statistically significant. Significance at the 1 percent level was found between the gains per head from the intermediate wheatgrass-alfalfa pasture when compared with the native check pasture.

2. Intermediate wheatgrass and pubescent wheatgrass grown with alfalfa did not maintain their stands as well as did crested wheatgrass seeded with alfalfa. It appears that these two grasses cannot withstand the conditions encountered in this work, as pubescent wheatgrass began to thin out after the second year of use, and fireweed invaded these pastures.

3. Russian wildrye grass competed with the alfalfa in the mixture, and the alfalfa stand started to thin out in the second year after planting. By the end of the five-year study period very little alfalfa remained in the stand. Lamb gains per head from the pasture seeded with Russian wildrye and alfalfa were significantly higher at the 1 percent level than those obtained from native check pasture. This pasture also produced the highest grazing capacity of any pasture studied. Hay
yields from this pasture were lower than yields from any of the other pastures except that seeded with intermediate wheatgrass alone. This difference was significant at the 1 percent level. The hay from the Russian wildrye-alfalfa pasture was mostly alfalfa, since under dryland conditions the Russian wildryegrass has mostly basal leaf growth. The yields became less for this pasture as the alfalfa was thinned out by the competition from the grass.

4. The pasture seeded with pubescent wheatgrass and alfalfa was mostly alfalfa after the third year. This pasture produced higher lamb gains per head and per acre than did any of the other pastures. This can be attributed to the presence of a large amount of alfalfa in the pasture. Lamb gain per head from this pasture was significantly greater than the gains per head from the native range or the crested wheatgrass-alfalfa pasture. These differences were significant at the 1 percent level. Hay yields from the pasture seeded with pubescent wheatgrass and alfalfa were significantly greater than hay yields from the Russian wildryegrass-alfalfa pasture.

5. The crested wheatgrass-alfalfa pasture maintained a good stand over the five-year study period. Hay yields averaged 655 lbs. per acre, which was significantly higher than the yields from either the Russian wildryegrass-alfalfa pasture or the pasture seeded to intermediate wheatgrass alone. Lamb gains per head and per acre from this pasture were not statistically different from those obtained from the other pastures including the native pasture.

6. Lamb gain per head from the native range was significantly lower (at the .01 level) than gain per head from any of the seeded pastures except the pastures seeded with intermediate wheatgrass alone and the pasture seeded with crested wheatgrass and alfalfa.

7. The major changes in plant composition of the seeded pastures were the decrease in alfalfa stand in the Russian wildrye-alfalfa pasture and the increase in the amount of alfalfa in the other three pastures. Forbs severely invaded all the pastures except the Russian wildrye-alfalfa and the crested wheatgrass-alfalfa pastures.

8. Protein analyses showed that the grass in the intermediate wheatgrass-alfalfa pasture had a higher protein content at all three sampling periods than did the intermediate wheatgrass seeded alone. Russian wildryegrass also had a higher protein content for the three years at the three dates of sampling than did any of the other grasses.

9. Protein content of the alfalfa was almost identical within pastures throughout the three-year period.
Appendix A

Soil Profile: (Altvan very fine sandy loam)

A\textsubscript{1-1} 0 - 1" Grayish-brown (10YR 4/1.5 dry) to dark grayish-brown (10YR 3/1.5 moist) soft, friable, very fine sandy loam of weak fine-crumb structure; many fine roots; pH about 6.5; sharp break to next horizon.

A\textsubscript{1-2} 1 - 6" Grayish-brown (10YR 4.5/2 dry) to dark grayish-brown (10YR 3.5/2 moist) friable very fine sandy loam of medium to fine-crumb structure; contains up to 5 percent gravel; matted with roots; pH about 6.5. Sharp break to next horizon.

B\textsubscript{2-1} 6 - 10" Brown (7.5YR 4.5/2 dry, 4/2 moist) light sandy clay loam with moderately developed prismatic macro-structure and strongly developed medium-granular micro-structure; contains up to 5 percent gravel; plastic when wet, slightly plastic when moist and hard when dry; many roots, especially between structure aggregates; pH 7.0.

B\textsubscript{2-2} 10 - 18" Brown (7.5YR 4.5/2 dry, 4/2 moist) sandy clay loam with strong prismatic-nuciform structure; contains scattered pebbles. Plastic when wet, slightly plastic when moist, hard when dry; many grass roots follow cleavage planes between aggregates, especially vertically; pH 7.5.

B\textsubscript{2-3ca} 18 - 22" Variegated grayish-brown and light brownish-gray (10YR 5/2, 6/2) when dry, and slightly darker when moist, strong massive-nuciform sandy clay loam. This is the horizon of maximum clay accumulation. The lighter-colored mottles are caused by soft calcium carbonate deposits. Friable when moist, plastic when wet, and hard when dry; pH about 8.0.

B\textsubscript{2-4ca} 22 - 30" Very pale-brown (10YR 7/3 dry) to pale-brown (10YR 6/3 moist) friable (moist and dry) sandy clay loam containing much soft finely divided carbonate of lime; massive to weak nuciform structure; pH about 8.0. This is the horizon of maximum carbonate accumulation.

Cca 30 - 37" Friable, calcareous, massive very fine sandy loam; pH about 8.0.

D 37 - 55" Loose, brown mixture of arkosic rounded stones, gravel and sand with irregular streaks, 6 to 24 in. thick, cemented hard conglomerate, this gives way to uncedmented arkosic gravel and sand at depths ranging from 5 to 8 ft.

Range in Characteristic: Minimum depth to the D (8th) horizon is about 2 ft. and maximum depth is about 6 ft., but the more usual range is from 30 to 60 in. In drier areas the A horizon averages slightly thinner and lighter in color. The A\textsubscript{1-1} horizon is missing in virgin areas, where it has been removed by wind from between clumps of short grass and where it has been mixed with the A\textsubscript{1-2} and B\textsubscript{2-1} by plowing. Much of the plowed land has surface-soil texture of light sandy clay loam.
Appendix B

Common and Scientific Names of Plants Mentioned in the Text

Seeded Species
Ladak alfalfa
Crested wheatgrass
Intermediate wheatgrass
Russian wildryegrass
Pubescent wheatgrass

Native Grass Species
Buffalograss
Blue grama grass
Junegrass
Needleandthreadgrass
Sandberg bluegrass
Western wheatgrass

Forbs
Fireweed

Medicago sativa
Agropyron desertorum
Agropyron intermedium
Elymus junceus
Agropyron tricophorum

Buchloë dactyloides
Bouteloua gracilis
Koleria cristata
Stipa comata
Poa secunda
Agropyron smithii

Kochia scoparia

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