Table 4. Effect of precipitation and time of harvest on herbage produced (air-dry) on moderately grazed pasture, Archer 1959-1963.

Year	Fall Harvest Caged Plots	Left, end of Season	Produced in Spring	Precipitation
	— — (pounds)	— —		(inches)
1959	357	256	224	2.37
1960	388	192	298	2.70
1961	786	310	298	7.38
1962	620	328	420	1.54
1963	564	411	299	0.82
AV.	543	299	308	2.96

highly variable and appeared to be dependent upon the interaction of several factors. From 30 to 164 percent more herbage was harvested in the fall than in the spring. In 4 of the 5 years more than half of the herbage was produced by late spring.

The five year study period was too short for obtaining reliable correlations and regression equations for predictive purposes. Seventeen years (1947-1963) of precipitation and clipping data were available from the pastures moderately grazed. From these data correlations and regressions were determined.

The May-June precipitation when correlated with perennial grass yields gave a highly significant correlation coefficient of 0.675. This compares to 0.859 found by Smoliak (1956). The April through August precipitation when correlated with perennial grass yield resulted in a highly significant correlation of 0.745, which is higher than that for May-June precipitation and grass yields. Although statistically significant, only 46 and 56 percent of the variation in perennial grass yields is accounted for by variation in precipitation.

The regression equations derived from the relationship of perennial grass yield to the May-June and April through August precipitation are $Y = 195 + 57.77 X_1$ and $Y = 70.18 + 43.54 X_2$, where $X =$ May-June and $X_2 =$ April-August precipitation (Figure 1). Also shown for comparison is the regression line developed by Smoliak.

A test of homogenity of the regression coefficients calculated by Smoliak and for the moderately grazed pastures at the Archer Substation showed no significant differ-

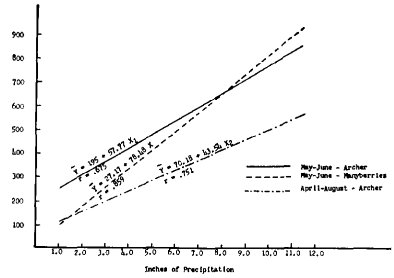

FIGURE 1. Estimated yield for various amounts of precipitation, perennial grasses at Archer and total herbage at Manyberries.

ence. Thus, a given increase of May-June or April through August precipitation results in a comparable increase of herbage at both locations.

On the basis of yield from the caged plots from the moderately grazed pasture, 39 to 73 percent of the annual herbage produced was left at the end of the grazing season. This indicates that the rate of stocking for the upland site was approximately moderate four years out of the five, if the rule of thumb—leave half and graze half—is observed. The criterion used for the proper degree of utilization was to leave an average of 1.2 and 0.9 in. of height on blue grama at the end of the grazing season on the lightly and moderately grazed pastures, respectively.

Summary

A study to determine the kinds and amounts of native vegetation present in late spring on native shortgrass rangeland was conducted at the Archer Substation in Wyoming during the years 1959 through 1963. Clipping studies were conducted in late May on a pasture moderately grazed since 1945 to 1954 and lightly grazed thereafter.

Nearly three times more midgrass was produced on the moderately grazed pasture than on the lightly grazed pasture. Recovery of the pasture grazed lightly since 1955, previously heavily grazed, is slow and not reflected in the clipping data. Observations show that midgrasses are increasing, but the abundance of buffalograss and prevailing climatic conditions have not been conducive to the rapid reestablishment of the desirable species. There was no significant difference in the amount of short or warm-season grasses produced between the moderately and the lightly grazed pastures.

During the 5-year period there was wide variation in the amount of herbage produced and amount of precipitation. Average total herbage for the 5-year period was 308 and 241 pounds per acre, respectively, for the moderately and lightly grazed pastures.

May-June and April-through-August precipitation when correlated with yields gave highly significant correlation coefficients of 0.675 and 0.754, respectively. Regression equations developed from the moderately grazed pasture data were not statistically different from the equation developed by Smoliak at Manyberries in Alberta, Canada.

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SILVER SAGEBRUSH IN EASTERN NORTH DAKOTA

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The range of sagebrush (shrubs of the genus *Artemisia)* is usually shown to include only the Southwest part of North Dakota as roughly limited to the north and east by the Missouri River. Only two shrub species of this important rangeland genus occur in the state, namely *A. tridentata* Nutt. (big sagebrush) and *A. cana* Pursh (silver sagebrush). Silver sagebrush has the wider distribution of the two species.

Outliers of silver sagebrush have

been observed as far east as the 98th meridian, some 140 miles east of the Missouri River. Stevens (1950) describes it as being "frequent from the Missouri River west, rarely occurring east of the Missouri River." He further reports that it occurs locally at Valley City, Jamestown, and in the Pembina Mountains. Beetle (1960), shows the distribution of this species as being in that portion of North Dakota lying south and west from the Missouri River. He also reported occurrances of this species in Barnes and Cass Counties of North Dakota.

The furthest east advancement of the Missouri River in North Dakota is about one half way between meridians 100 and 101. Along the 98th meridian are three areas of similar soil formation which contain silver sagebrush as a conspicious part of the vegetation.

One area containing silver sagebrush (Figure 1, *top*), is within the Pembina Mountains, in Cavalier County, near the Canadian border and less than 50 miles from the Minnesota border. The area is approximately 3 miles long, but less than ¼ mile wide at the widest point and probably containing less than 100 acres. The area lies within sections 25 and 36, T-164 R-58; section 31, T-164 R-57 and sections 6, 7, and 8, T-163, R-57.

FIGURE 2. A plant of silver sagebrush in Section 15, T-140, R-58, near Valley City.

The soils are heavy Chernozem, devoped from clayey till and heavy colluvial-alluvial material derived from Creteaceous shale. Glacial stones and boulders occur in the area. There are three buttes of Pierre shale rising above the surrounding clays.

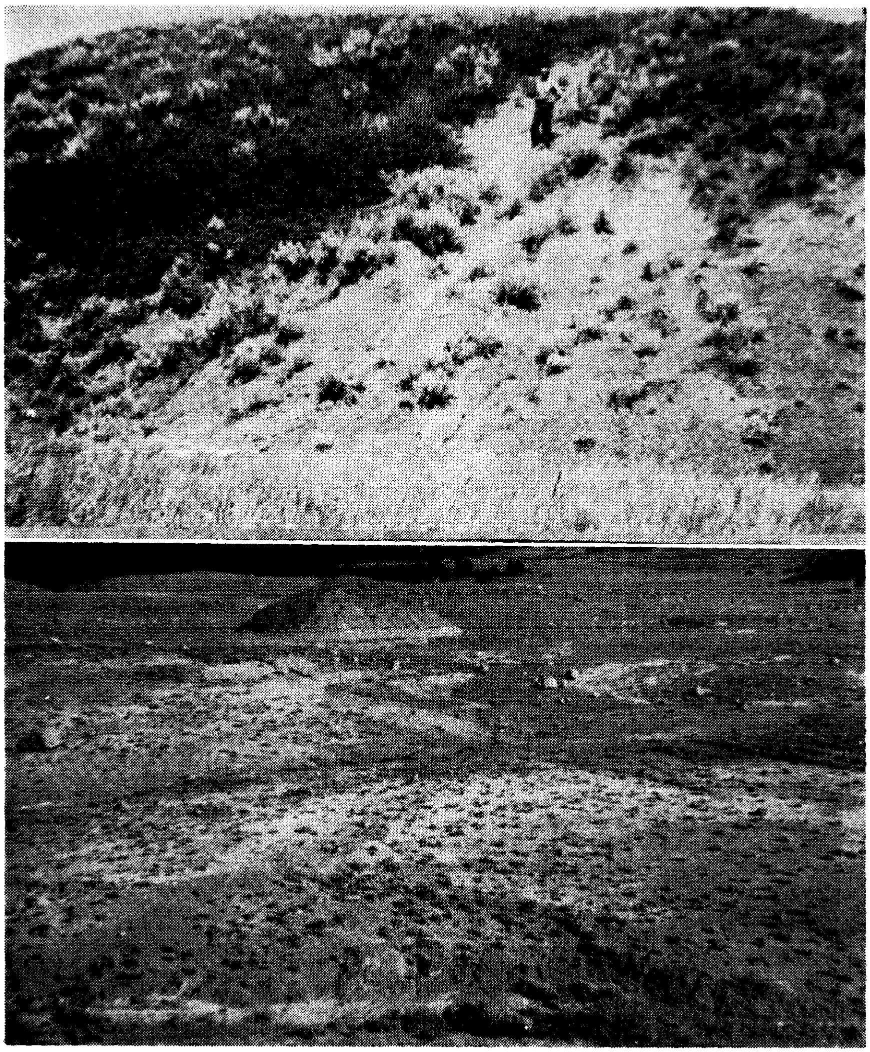

FIGURE 1. Silver sagebrush. *Top*—On a mound of Pierre shale rising above the surrounding colluvial clays, Section 36, T-164, R-58, in the Pembina Mountains. *Bottom*—On clay soils derived from Pierre shale in Section 16, T-145, R-58 in Griggs County. Till soil has eroded away but granite stones and boulders remain on the surface.

Almost due south of this location, a distance of about 115 miles, is a similar one in section 16, T-145, R-58 in Griggs County, near the Cheyenne River (Figure 1, *bottom*). This area of about 60 acres is derived from Pierre shale parent material. Glacial soils have been eroded away but glacier-deposited stones and boulders are strewn over the clays and shales. Occasional mounds of Pierre shale rise above the surrounding landscape.

Also along the Cheyenne River breaks in Barnes County, about 30 miles further south, occasional silver sagebrush plants occur on outcrops of shale and on colluvial clays (Figure 2). Scattered plants can be seen along the hillside in the SE¼ of section 22, T-140, R-58, across the river east of Valley City.

Silver sagebrush is virtually absent on glacial till plains and glacial moraines lying between these areas and the Missouri River but the writer has observed it on clay soils near Krueger Lake in northern Sheridan County.

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