Contour-Furrowing and Seeding on Nuttall Saltbush Rangeland of Wyoming

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Highlight: *A Nuttall saltbush (*Atriplex gardneri*) site in the Big Horn Basin of Wyoming was contour-furrowed and seeded to crested wheatgrass (*Agropyron cristatum*) by the Bureau of Land Management in 1957 as part of a range improvement and watershed management program. In 1962 total herbage production on the treated area was 972 lb/acre compared to 412 lb/acre for untreated range. Greater production was due to both the yield of crested wheatgrass and improved vigor of Nuttall saltbush. By 1972 total production of the treated area declined to 590 lb/acre but was still 54% greater than the control. Coincident with decreased production, foliage cover of crested wheatgrass decreased by 74% and Nuttall saltbush 50%, part of which can be attributed to reduced waterholding capacity of the furrows by about 30% from their original capability. The untreated native range produced 384 lb/acre in 1972, which was not appreciably different from production 10 years previously. Likewise, foliage cover percentages remained relatively stable.*

Contour-furrowing and seeding is a widely used method of range manipulation. These procedures have improved rangelands by increasing availability of moisture, decreasing soil erosion from wind and water, and increasing forage production for livestock and wildlife. Many rangelands of semiarid western Wyoming, with impermeable soils and average annual precipitation values as low as 4 to 6 inches, have been treated with contour-furrowing and seeding. Significant forage increases have often resulted.

The Bureau of Land Management, during the 1950's and 1960's initiated a number of range improvement and watershed management projects on the Fifteen-mile drainage north of Worland in the Big Horn Basin of northcentral Wyoming. A total of 25,000 acres were treated with an expenditure of more than $35,000. The Burnt Wagon project was initiated in 1957 and completed in 1962.[1] Included in this project were contour-furrowing and seeding crested wheatgrass (*Agropyron cristatum*) on 81 acres (Fig. 1) as well as subsequent fencing, stockwater development, and livestock management changes.

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[1] Records on file in the District Office, Bureau of Land Management, Worland, Wyoming.

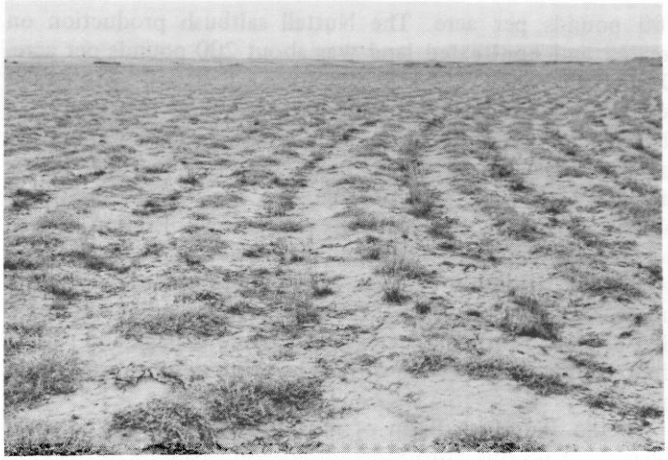

Fig. 1. *General view of the Burnt Wagon study area showing crested wheatgrass and Nuttall saltbush vegetation in contour-furrowed area during July 1972, 15 years after the establishment of the treatment.*

The following report is an evaluation of the Burnt Wagon contour-furrowing and seeding operation.

Review of Literature

Although a number of reports exist which describe contour-furrowing on native rangelands of the western United States, few incorporate reseeding. Additionally, most publications concerned with rangeland seedings do not include contour-furrowing as a seedbed preparation method. The combined operations have, in general, resulted in favorable vegetation production responses primarily because of reduced water runoff, increased soil moisture, and enhanced microhabitat growing conditions (Vallentine, 1972).

Results from contour-furrowing and seeding on shortgrass rangelands in eastern Wyoming have been favorable when furrows were no more than 2 ft apart and at least 4 to 8 inches deep (Barnes, 1952; Rauzi, 1968). Furrows spaced five to ten ft apart were ineffective because only a small portion of the total area was treated, resulting in little or no difference on herbage production.

An area near Fort Peck, Montana, was contour-furrowed and seeded to crested wheatgrass (Branson et al., 1962). After 10 years, vegetation measurements were obtained to determine responses. Before treatment the area had a sparse stand of Nuttall saltbush (*Atriplex gardneri*) and plains pricklypear (*Opuntia polyacantha*). After furrowing and seeding there was a satisfactory stand of crested wheatgrass which yielded 500 to

Table 1. Precipitation (inches) recorded at the Burnt Wagon Study Area.

Year	Total annual	Spring period
1961	6.37	2.55
1962	6.54	3.90
1963	7.44	5.00
1964	6.27	4.63
1965	5.50	2.00
1966	4.14	1.07
1967	7.94	4.20
1968	9.16	3.74
1969	4.42	2.20
1970	4.37	2.10
1971	6.71	2.37
1972	6.48	1.45
Mean	6.28	2.93

700 pounds per acre. The Nuttall saltbush production on treated and nontreated land was about 200 pounds per acre. During the same study, it was found that soil of medium texture was the most favorable for mechanical treatment. On fine and very fine soils, plant production increases were not as great as on soils of medium to medium-fine textures. These latter soils were more suitable for mechanical treatment because of their better capability for water infiltration, as well as interrelated high waterholding capacity. There was no apparent relationship between pH and response to mechanical treatment in the study by these authors, although it was noted that contour-furrowing increased moisture storage and caused the transport of salts from surface layers to depths of 60 cm or more.

In the Big Horn Basin of northcentral Wyoming, crested wheatgrass was broadcast on pitted plots established with an eccentric one-way disc (Fisser, 1964). Adequate stands of crested wheatgrass were present 4 years after treatment on the pitted plots.

Range condition of saltbush range has been investigated by Fisser (1964). Excellent condition Nuttall saltbush range had approximately 10% cover of this half-shrub on heavy and impermeable soils. On lighter textured soils, saltbrush on excellent condition sites sometimes had more than 20% cover. Some decreaser species such as western wheatgrass (*Agropyron smithii*), Indian ricegrass (*Oryzopsis hymenoides*), and winterfat (*Eurotia lanata*) were occasionally present but usually in small quantities. As condition classification decreased the saltbush clumps became smaller and broken down.

Description of Study Area

The study area was located in Washakie County in the Big Horn Basin, approximately 18 miles northwest of Worland, Wyoming. Elevation is 4,252 ft above sea level. Topography is rolling with numerous drainages dividing the area, many of which are deep and sharply cut. The immediate study location was on nearly level upland with a slope of less than 5%.

The major geological unit of this area is the Willwood formation which consists of some 2500 feet of variegated shale and white and yellow sandstones (Van Houten, 1944). Soils of the area are predominately Greybull series, which are shallow clay loams, light colored, and classified as calcic lithosol of the sierozem zone (Soil Conservation Service, 1962).

A 20-year average of climatic conditions recorded by the U.S. Weather Bureau from 1941 to 1960, representing seven stations in the Big Horn Basin, was presented by Vosler (1962). Precipitation averaged 6.5 inches annually while average annual temperature was 45.2°F. For the Worland Station, Nichols (1964a) summarized the long term climatic records and revealed that average annual precipitation from 1914-1962, was 7.76 inches. Almost 50% occurred during the months of April, May, and June. Annual precipitation values exhibited extreme variation and ranged from a low of 2.27 inches to a high of 13.57 inches. Average annual temperature was 44.6°F with June, July, and August the three warmest months.

At the Burnt Wagon study area, precipitation averaged 6.28 inches annually from 1961 through 1972 (Table 1). Average precipitation during the spring period from April 15 through June 30 was 2.93 inches, almost 50% of the total annual moisture regime. In spring 1962 3.90 inches occurred, but only 1.45 inches were recorded in 1972.

The most common vegetation type in the Burnt Wagon area is dominated by Nuttall saltbush. Some rather ephemeral perennials such as leafy musineon (*Musineon divaricatum*) are occasionally abundant, but usually the saltbush type of the area presents an aspect of low productivity and much bare soil.

The study area was located in the Burnt Wagon pasture, a unit of some 25,000 acres with a history of summer cattle use, winter sheep use, and continuous year-around use by wild horses. As administered by the Bureau of Land Management, grazing rates were established at 1,523 AUMs of cattle for a 2-month period, 302 AUMs of sheep for 2 months during winter, and 80 to 120 AUMs of horses for year-around use.

Some water pits and reservoirs were established but livestock distribution is still inadequate. A large proportion of the grazing use of the area has occurred on the contour-furrowed and seeded areas resulting in some overuse of crested wheatgrass and Nuttall saltbush.

Methods and Procedures

The contour-furrowing and crested wheatgrass seeding operation was accomplished with an Arcadia Model B contour-furrowing machine in 1957. Furrows were 10 to 12 inches deep, 5 ft apart, with dams spaced at about 10-ft intervals to hold water within each furrow segment.

Estimates of vegetation cover, composition, and production were obtained in 1962 (Nichols, 1964b), 5 years after the initial furrowing and seeding treatment, and in 1972. Methods and procedures were identical. Sampling was conducted along permanently staked transects 50 ft in length. Ten transects were established in the native rangeland and ten in the contour-furrowed and seeded area.

Table 2. Frequency (%) of occurrence of seeded and native site vegetation (1962 and 1972).

	1962		1972	
Species	Native site	Seeded site	Native site	Seeded site
Nuttall saltbush	42	36	38	19
Crested wheatgrass	–	78	T	43
All others	51	16	38	23

Table 3. Foliage cover (%) of seeded and native site vegetation (1962 and 1972).

	1962		1972	
Species	Native site	Seeded site	Native site	Seeded site
Nuttall saltbush	12	11	9	5
Crested wheatgrass	–	23	T	6
All others	7	3	6	3
Total	19	37	15	14

Cover and composition data were obtained by utilizing a line transect adaptation of the Levy and Madden (1933) point frame procedure. The point frame contained ten pins spaced at 2-inch intervals. The point frame was positioned adjacent to the transect line in a sequential series of 30 contiguous settings to provide 300 point readings for each transect. All forage hits were recorded and later calculated as percentages of cover, composition, and frequency.

Herbaceous forage production was estimated by clipping ten quadrats, 1 foot X 10 feet, in each of the two areas. Locations of the plot frames were determined by restricted random selection for placement adjacent to the permanent transects. Collection of field data was made during the first week in July, both in 1962 and 1972, when the important species were mature but before senescense and decomposition.

Nuttall saltbush and crested wheatgrass were clipped and weighed separately. All species were grouped into three categories—perennial forbs, perennial grasses, and annual forbs—because each species individually contributed relatively little to the total production of the site.

In 1972, depth of furrows were determined by measuring 25 subsamples located by restricted random sampling.

Results

Prominent vegetation changes occurred with the 1957 establishment of crested wheatgrass in the contour-furrowed site. Evaluation and interpretation of the data obtained in 1962 and subsequently in 1972 showed that changes also occurred during the latter 10 year period.

Percent frequency of occurrence of crested wheatgrass declined by almost one-half from 78 to 43% (Table 2). Although the frequency values of Nuttall saltbush remained relatively stable on the native nontreated site, they decreased by half on the seeded site from 36 to 19%. An increase of other species was recorded on the seeded site.

Foliage cover percentages on the native site exhibited a minimal decrease (Table 3), which probably resulted from the arid situation which occurred during spring, 1972. The very significant decrease of foliage cover on the seeded site reflects a concomitant decrease of furrow waterholding capacity. The mean depth of furrows was 4.6 inches, with values ranging from 3.0 to 6.0 inches. Waterholding capacity of the furrowed area in 1972 was estimated to be 25 to 30% of the original furrows constructed in 1957. While the saltbush cover only decreased by about half, the crested wheatgrass decreased by 75%. In addition, it is of interest to note that saltbush cover in 1962, 5 years after treatment, was essentially the same in both the native and treated sites. In 1972 the cover percentage of saltbush on the native site had decreased by 25%, but decreased by 54% on the furrowed and seeded site.

Although 1962 was a moist spring year and 1972 rather dry, the native site vegetation cover composition values (Table 4) were almost identical, with Nuttall saltbush comprising 60% of the vegetation. The remainder consisted primarily of tansyleaf aster (*Machaeranthera tanacetifolia*) and leafy musineon with small amounts of grasses, half shrubs and forbs. On the seeded site, although the saltbush remained relatively constant and comprised about one-third of the cover composition, the percentage value of crested wheatgrass decreased from 62% to 43% while the values of all other species increased from 8% to 21%. This increase was caused by increased amounts of leafy musineon, bluebur stickseed (*Lappula redowskii*), and bottlebrush squirreltail (*Sitanion hystrix*). These native species are better adapted to arid environments than crested wheatgrass and represent a shift to more xeric conditions caused by the decreased waterholding capacity of the furrows.

Table 4. Cover composition (%) of seeded and native site vegetation (1962 and 1972).

Species	1962 Native site	1962 Seeded site	1972 Native site	1972 Seeded site
Nuttall saltbush	63	30	60	36
Crested wheatgrass	–	62	1	43
All others	37	8	39	21

Table 5. Herbage production (lb/acre) of seeded and native site vegetation (1962 and 1972).

Species	1962 Native site	1962 Seeded site	1972 Native site	1972 Seeded site
Nuttall saltbush	266	475	280	145
Crested wheatgrass	–	481	–	334
All others	146	16	104	111
Total	412	972	384	590

Herbage production on the native nontreated site, both in 1962 and in 1972, was about 400 lb/acre (Table 5). The slightly greater production of all other species in 1962 as compared to 1972 reflects the better moisture conditions during the spring of the earlier year. Production of ephemeral annual and perennial forbs is of little importance as livestock forage, however, because of early shattering and desiccation, unless it is used during its relatively short growth period.

Although herbage cover of Nuttall saltbush in 1962 was similar for both sites, production was much greater on the seeded site because of increased plant vigor and more robust growth on the furrowed site. The 972 lb/area production exhibited on the seeded site in 1962 reflects the impact of increased waterholding capacity by furrows. Also, cultivation effects may have released nutrients and improved the soil environment, resulting in significantly greater saltbush production, as well as comparably greater crested wheatgrass yields.

By 1972 the herbage cover of Nuttall saltbush on the seeded site had decreased by 54%, from 11% cover to 5%. Production of saltbush had decreased very significantly from 475 to 145 lb/acre. This decrease appeared to be a function of three factors: (1) several concurrent years (1969-1972) of below-average precipitation especially during spring; (2) decreased waterholding capacity of the furrows, allowing greater runoff and moisture loss; and (3) competition for limited water between Nuttall saltbush and crested wheatgrass.

The decrease of crested wheatgrass production from 481 lb/acre in 1962 on the seeded site to 334 in 1972 indicates a concomitant relationship. Since the crested wheatgrass decreased only by about 30% while Nuttall saltbush decreased by almost 75%, it appears that crested wheatgrass is well adapted to the site, can compete effectively with the native vegetation, and can maintain good production levels even during periods of limited moisture.

Summary

A Nuttall saltbush range area was contour-furrowed and seeded with crested wheatgrass in 1957. Vegetation data obtained in 1962 showed a very marked response to the

improvement program with increased production, a result of improved vigor of Nuttall saltbush and the introduction of crested wheatgrass. Additional waterholding capacity by furrows was the primary stimulus for improved production.

By 1972, when the most recent data were obtained the furrows had been sufficiently filled to reduce the waterholding capacity by 25-30% their original capabity. Nevertheless, forage production of crested wheatgrass was still over 300 lb/acre. Although Nuttall saltbush production was lowest on the contour-furrowed and seeded site, total herbage production was still maintained at a level significantly greater than on the nontreated native rangeland.

The rate at which the furrows continue to fill is expected to decrease in the future. There is a high probability that production on the treated site will remain higher for at least another 20 years.

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