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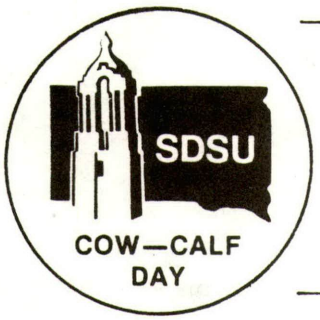
Range Renovation

F. R. Gartner
South Dakota State University

E. M. White



RANGE RENOVATION

F. R. Gartner and E. M. White
Department of Animal and Range Sciences
and Department of Plant Science

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Summary

Mechanical treatments of rangelands are designed to increase water infiltration and increase forage quantity and quality. Storing precipitation where it falls is important to stabilize fluctuations in annual forage production, especially on sites with water uptake problems due to slope, shortgrass sod cover and/or high salt concentrations in the upper horizons.

Soil moisture and vegetation data accumulated over five growing seasons following mechanical renovation of Thin Claypan range sites indicate a great potential exists for increasing range carrying capacity. Both soil moisture and forage production can be improved.

Introduction

Range renovation implies a wide variety of mechanical treatments on an even greater variety of soils, topographic positions, and vegetation successional stages. Droughts are frequent and may alter vegetation response to any given range renovation practice. In some areas of the Northern Great Plains precipitation has been less than 75 percent of "normal" on the average of once in every 5 to 8 years. Mechanical treatments are popular in the Northern Great Plains because they conserve water, assuring its availability for plants even during dry cycles.

Range renovation practices that have been tested and/or applied in South Dakota will be discussed in this presentation. Mention of specific implements, manufacturers or trade names does not imply endorsement by the authors or South Dakota State University. Their use is intended solely to provide recognition of a specific kind of implement.

A wide variety of range renovation methods have been under study by Federal and state researchers for several decades. Some landowners and Federal agencies have applied mechanical treatments on thousands of acres of rangeland in the Northern Plains. According to Mellgren (1966), sites exhibiting the greatest potential for increasing forage, retarding surface flow, and improving soil moisture are those of shale origin on slopes of 10 percent or less. These parameters apply to much of western South Dakota rangeland.

Perhaps the most common thread which assures the success of most mechanical treatments is the widespread distribution of western wheatgrass over the Northern Great Plains. This rhizomatous species has withstood plowing, prolonged drought, flooding, overgrazing, overseeding, and fire,

and has survived and today dominates many range sites. Western wheatgrass has all the attributes to be labelled a "miracle grass." No wonder this species has been designated the state grass in South Dakota, North Dakota, and Wyoming.

Mechanical treatment of rangeland is not a recent innovation. Some photographic evidence has been found which indicates range renovation was practiced in the late 1930's and 1940's in western South Dakota. Apparently poor water infiltration and poor forage yields were recognized as capable of improvement.

In 1945, Barnes and Nelson reported effects of various furrow configurations and spacings on shortgrass range in southeastern Wyoming. Studies of pitting were initiated in 1942 by Soil Conservation Service researchers at the Archer Station near Cheyenne. Vegetative response to furrowing and pitting was marked by an almost immediate increase in western wheatgrass. Grazing capacity was increased by one-third following mechanical treatment of shortgrass range (Barnes 1950).

Newspaper accounts reveal that deep ripping of tight clay soils improved dryland crop production in northeastern Wyoming well in advance of the use of this technique on rangeland. In the late 1950's, a few western South Dakota landowners and range technicians noted with interest the regrowth of native vegetation, especially western wheatgrass, over buried cable lines linking the first missile installations. The most impressive feature was earlier green-up in spring and a longer green-forage season in summer compared with adjacent, undisturbed vegetation. While western wheatgrass was seeded over those trenches, the longer green-forage season was attributed to improved soil moisture conditions.

The Bureau of Land Management in Wyoming, Montana and western South Dakota gained attention in the 1950's and 1960's with a contour furrower and ripper. Initially it was labelled the "Model A Contour Furrower" and, following modifications, was finally called the "Model B Contour Furrower." Range sites furrowed included Clayey, Claypan, and Saline Upland in the 10 to 14 inch precipitation zone. Forage production increases in Butte County, South Dakota, monitored by South Dakota State University range researchers verified a positive vegetation response. While this practice appeared too costly for private landowners at 1960's land values, forage production increases are still evident 20 years after treatment. Treatment costs averaged over the years 1963 through 1965 were reported to be $7.54 per acre, including seed (Mellgren 1966).

In the late 1960's a study was initiated in Butte County, South Dakota, by J. T. Nichols and J. R. Johnson of South Dakota State University to compare a conventional, lister-type interseeder with a tilther-type[1/] implement. The study was continued from 1969 through 1972 by W. W. Thompson and F. R. Gartner. Both methods of furrow construction, without seeding, were more successful than deferment alone for improving range condition (Thompson and Gartner 1973). The success of interseeding alfalfa with these two implements on a Clayey range site was dependent on grazing management following mechanical treatments. These were but a few of the

1/ "Sidewinder Tilther", FMC Corp.

examples of early research and application of mechanical range renovation.

In 1973 a study was initiated to monitor vegetation response to deep ripping of several different Claypan range sites in western South Dakota. Claypans are widespread in western South Dakota and also occur in the other Northern Plains states. Results indicated that forage production, on the average, was nearly doubled after claypan sites were ripped (White and Gartner 1981; White, Gartner and Butterfield 1981). More important, the western wheatgrass portion in ripped claypan nearly always significantly increased two or more times over the untreated control. Some of the deep ripping study sites completed the twelfth post-treatment growing season in 1984, and vegetation improvement remained visually evident. Those studies revealed that some types of claypan respond sooner and to a greater degree than others. That variability may be due to soil chemistry or vegetation attributes or a combination of factors. Deep ripping to be effective should be done when claypans are dry, but power requirements are excessive when soils are too dry.

Chiseling, or shallow ripping, is quite commonly employed in western South Dakota to stimulate western wheatgrass production. Implements have varied from rather lightweight chisels to heavier, deep subsoilers. Like all mechanical treatments, chiseling should be done on the contour. Vegetation response is usually better on "normal" sites, i.e. Clayey and Silty range sites, than on Claypan sites, simply because the latter are difficult to penetrate with lightweight chisels.

Furrowing has been the most popular mechanical treatment in South Dakota. Types of furrowers used have been widely different, having been designed and built by landowners. Furrows have the potential to retain in place all the precipitation that occurs, a factor which seems more critical in dry cycles than during years of normal (or above normal) precipitation.

Description of Study Areas

Two low producing Thin Claypan range sites were located in 1978 on two ranches in western Meade County. Both landowners expressed interest in mechanical renovation to improve forage production.

The W. K. Ranch is located in western Meade County approximately 28 miles east-northeast of Sturgis and 29 miles southeast of Newell. Average annual precipitation is estimated to be about 15 inches, with about 12 inches, or 80 percent, occurring during the growing season.

Soils at the W. K. study area are classified as a Hisle-Slickspots complex on 0 to 2 percent slopes. Runoff is slow and commonly ponds on the surface. Water is absorbed slowly, fertility is low, and content of sodium and other salts is high. The distinction between vegetated and "bare" areas was not well defined. Small rocks and gravel were abundant on the soil surface and occurred in the profile. Soils are typical of those on Claypan or Thin Claypan range sites in western South Dakota, but with more surface gravel.

Western wheatgrass dominates the vegetation, but also occurring are prairie junegrass, blue grama, sedges, and forbs. The abundance of

pricklypear cactus gives the site the appearance of a desert.

The other study area, located on the E. H. Ranch, is north of Elk Creek in southwestern Meade County. Ellsworth Air Force Base is six miles south and Sturgis 24 miles northwest of the study area. Average annual precipitation is approximately 17 inches, using records from the Rapid City Regional Airport (13 miles south). About 13 inches, or 76 percent, normally occurs during the growing season.

Soils at the E. H. study area are a Slickspots complex, probably in the Hisle series, but quite different from those at the W. K. Ranch study area. "Bare" or sparsely vegetated areas (slickspots) were conspicuous and quite large. Soils on the vegetated areas appear to have greater permeability, greater water holding capacity, and higher fertility levels than those on "bare" areas.

A moderate to dense stand of vegetation occupies the micro-ridges, while depressions have only a sparse cover. In most years the depressions appear to be bare. Western wheatgrass is the dominant species, but also occurring are inland saltgrass, prairie junegrass, blue grama, and bluegrasses. Salt tolerant forbs are quite common, and sweetclover is abundant in some years. Pricklypear cactus is present, but not abundant.

Procedures

Mechanical treatments were selected for comparisons at the two locations in order to evaluate various renovation practices in terms of soil water and forage response, longevity, soil physical and chemical changes, power requirements, and costs.

Treatments applied at the W. K. Ranch included:

1) Rip: single shank at 5-6 ft. spacing penetrated to about 18-in. pulled with a Versatile 118 (about 130 h.p.).

2) Subsoiler: three, 38-in. shanks on 3-ft. centers penetrated to about 12-in. pulled with a Massey Ferguson 2-wheel drive with dual wheels (about 92 h.p.).

3) Furrow: two furrows about 24-in. wide, 4-in. deep, on 5-ft. centers (Sparks Furrower) pulled with a John Deere 4010 (84 h.p.).

4) Rip + Furrow: two furrows about 12-16 in. wide, 10-in. deep, on 4-ft. centers (Shearer Furrower) pulled with a Versatile 118.

5) No treatment.

Treatments were applied in October 1978, except the subsoiler treatment which was done in April 1979. All treatments were replicated three times. At the E. H. Ranch, the subsoiler treatment was omitted, but the others were applied in October 1978. The furrow (Sparks) treatment was done with a Case 930 (78 h.p.), and the rip and rip + furrow treatments with a Wagner 4-wheel drive (130+ h.p.). Here, treatments were replicated four

times. Extremely dry soils increased power requirements for all the mechanical treatments and resulted in somewhat abnormal furrow configurations at times.

The W. K. study site was fenced in 1979 to insure that grazing would not affect estimated vegetation yields. The pasture in which the treatments are located at the E. H. Ranch was used for fall grazing, so fencing was not necessary. However, a few cattle grazed the area in June 1983, and an electric fence was installed in 1984 to protect the study area from any summer grazing.

Galvanized, electrical conduit (1 5/8" I.D.) was used as access tubes for measuring soil moisture with the neutron probe. Tubes were installed to a depth of 4½ ft. in all treatments in the summer of 1979. At the W. K. Ranch site two access tubes were placed in each treatment (30 total tubes), and four tubes per treatment (64 total tubes) were installed at the E. H. Ranch site. Soil moisture has been monitored periodically during the growing season since late summer 1979.

Vegetation yields by species or groups of species has been sampled by hand clipping randomly located plots in each treatment since 1980. The aim was to obtain estimates of peak forage production. In some years the leaves of sweetclover, other forbs, and annual grasses dropped to the ground before peak production was thought to have occurred. Samples were oven-dried at 70°C for 24 to 48 hours and weighed to the nearest 0.1 gram. Height and density of western wheatgrass have also been measured at both locations since 1981. Vegetation and soil water data collected through 1984 has not been subjected to statistical analyses.

Results and Discussion

Average or above-average precipitation is usually a prerequisite for positive vegetation response to most range improvement techniques. Pre- and post-treatment precipitation, either annual or growing season, was considerably less than desired when this study was begun.

Annual precipitation at the W. K. Ranch has been below average in four of the past six years (1978-1983). Growing season precipitation has been below average in five of the past eight years. Departures from the average annual and growing season precipitation (from the Newell reporting station) were:

	Annual Dep.	Growing Season Dep.
	(in.)	(in.)
1977	2.38	-2.49
1978	-2.16	-1.32
1979	-3.51	-2.39
1980	-2.20	-2.97
1981	0.08	0.77
1982	11.17	5.33
1983	-2.35	-4.13
1984	---	1.38

Precipitation was somewhat similar at the E. H. Ranch, using records from the Rapid City Regional Airport.

	Annual Dep. (in.)	Growing Season Dep. (in.)
1977	2.28	0.09
1978	-1.55	-0.36
1979	-3.13	-1.78
1980	0.06	-1.26
1981	-2.99	-1.97
1982	8.85	6.05
1983	-0.78	-1.59
1984	---	0.26

W. K. Ranch: Soil Water

Soil water in the upper three feet of the soil profile has been increasingly greater in mechanically treated compared with untreated plots, especially early in the growing season. Exceptions to this trend occurred in late June through mid-August 1983, and on August 1, 1984. Precipitation during the period April through August 1983 was about three inches below average, and one inch below average in July 1984. Therefore, greater forage quantities on treated areas than on the control resulted in greater soil water withdrawal on the former compared with the latter.

During winters of less than average snowfall, mechanically treated areas held much more snow than untreated areas. Micro-relief above the soil surface of mechanically treated soils collects more snow than untreated range. Furthermore, less snow (and water) is lost through evaporation.

W. K. Ranch: Vegetation Response

Annual yields of total vegetation were consistently greater on all mechanical treatments than on the control (Fig. 1). More significantly, the quantity and percentage of total vegetation consisting of western wheatgrass has steadily increased on the treated plots. Annual yields of western wheatgrass on untreated claypan ranged from 26 to 109 pounds and averaged only 70 pounds per acre over the last five years. On mechanical treatments, western wheatgrass comprised from 36 to 53 percent of the total vegetation averaged over five years.

In years when both total annual and growing season precipitation are well above average (e.g. 1982), one can expect extremely large increases in total vegetation on mechanically treated claypan. Averaged over five years, total forage production was from 2 to 3 times greater on treated claypan. Average yields of western wheatgrass over the same period were from 4.8 to 8.6 times greater on treated claypan (or 481 and 836 percent of the control)!

Height of western wheatgrass varies with precipitation, especially that which occurs in April, May and June. On mechanical treatments, western wheatgrass was from 1½ to 5½ inches taller than on the control

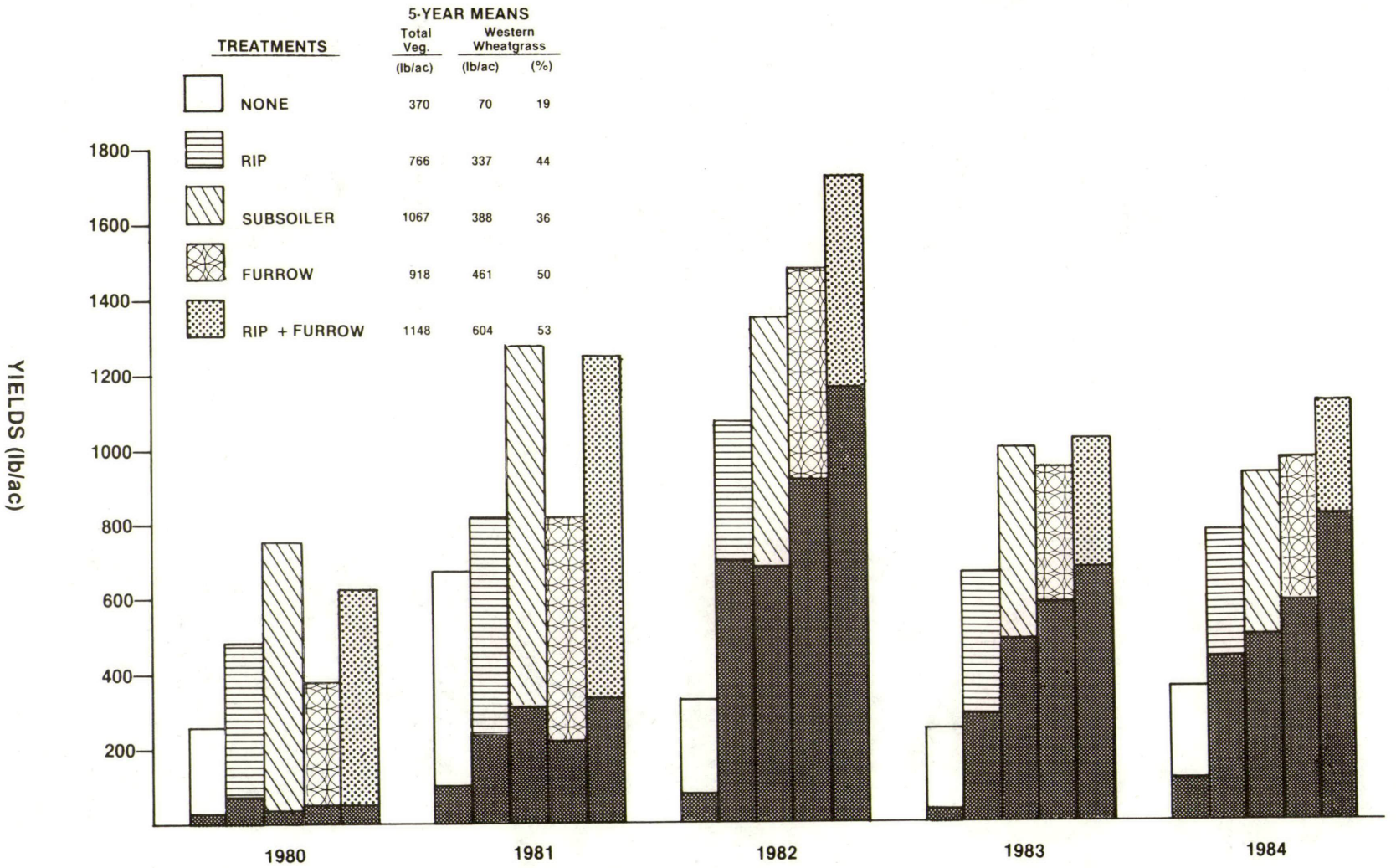

Fig. 1. Oven-dry yields of total vegetation and western wheatgrass portion (shaded) following 1978 renovation of a Thin Claypan range site, W.K. Ranch, Meade Co., South Dakota.

BG-84

over the years 1981 through 1984. Western wheatgrass was consistently taller on the rip + furrow treatment over the past four years. Taller vegetation, if not over-utilized, will collect more snow in winter, subsequently increasing soil water content.

Likewise, density of western wheatgrass was much greater on mechanical treatments than on the control. Each year since 1981 density was greatest on the rip + furrow treatment, ranging from 134 percent of the density on the control in 1981 to 669 percent in 1984.

E. H. Ranch: Soil Water

Soil water in the upper three feet of the soil profile has also been consistently higher on mechanically treated plots at the E. H. Ranch site. At most measurement dates, soil water has been considerably greater in the two furrowing treatments than in the ripping treatment. The physical shattering and lifting of soil normally associated with deep ripping was not evident at the E. H. Ranch as in previous western South Dakota studies. Probable causes were deficient soil moisture when ripped and/or ripping with a single shank on 5-foot centers rather than two shanks on 4-foot centers.

E. H. Ranch: Vegetation Response

Annual yields of total vegetation were greater on all mechanical treatments than on the untreated control (Fig. 2). Total yields on the two furrowing treatments were consistently greater than on ripping or no treatment. During the 5-year period there appears to be no difference between total yields on the two types of furrowing. Western wheatgrass response to treatments was somewhat slower at this location than at the W. K. Ranch. Yet, that species comprised about the same percentage of total vegetation on each of the mechanical treatments imposed at both locations.

Height and density of western wheatgrass each year were greater on all treatments than on the control. Average height on untreated claypan varied with precipitation, ranging from 5.4 in. (1980) to 10.2 in. (1982) with a 5-year average of 8.4 in. On the ripping treatment, average height was only 1 to 2 in. greater than on the control. Average western wheatgrass height on the two furrowing treatments was from 2 to 6.5 in. greater than on the control depending on the year. Average maximum height recorded on those two treatments was about 16 in. in 1982.

Western wheatgrass density on untreated claypan ranged from 148 stems/m^2 (1982) to 400/m^2 (1983). Density was greater than in the control in 1981 through 1983 only in the ripping treatment. Density in the furrowing treatment only exceeded that of the controls in 1984, while density in the rip + furrow treatment was equal to or exceeded that of the control in all years except 1981.

Potential forage production on the E. H. Ranch claypan appears to be greater than on the W. K. Ranch claypan. Five-year average total vegetation on the untreated controls was 965 lb. at the former, but only 370 lb. at the latter (Fig. 1 and 2). Furthermore, 5-year average

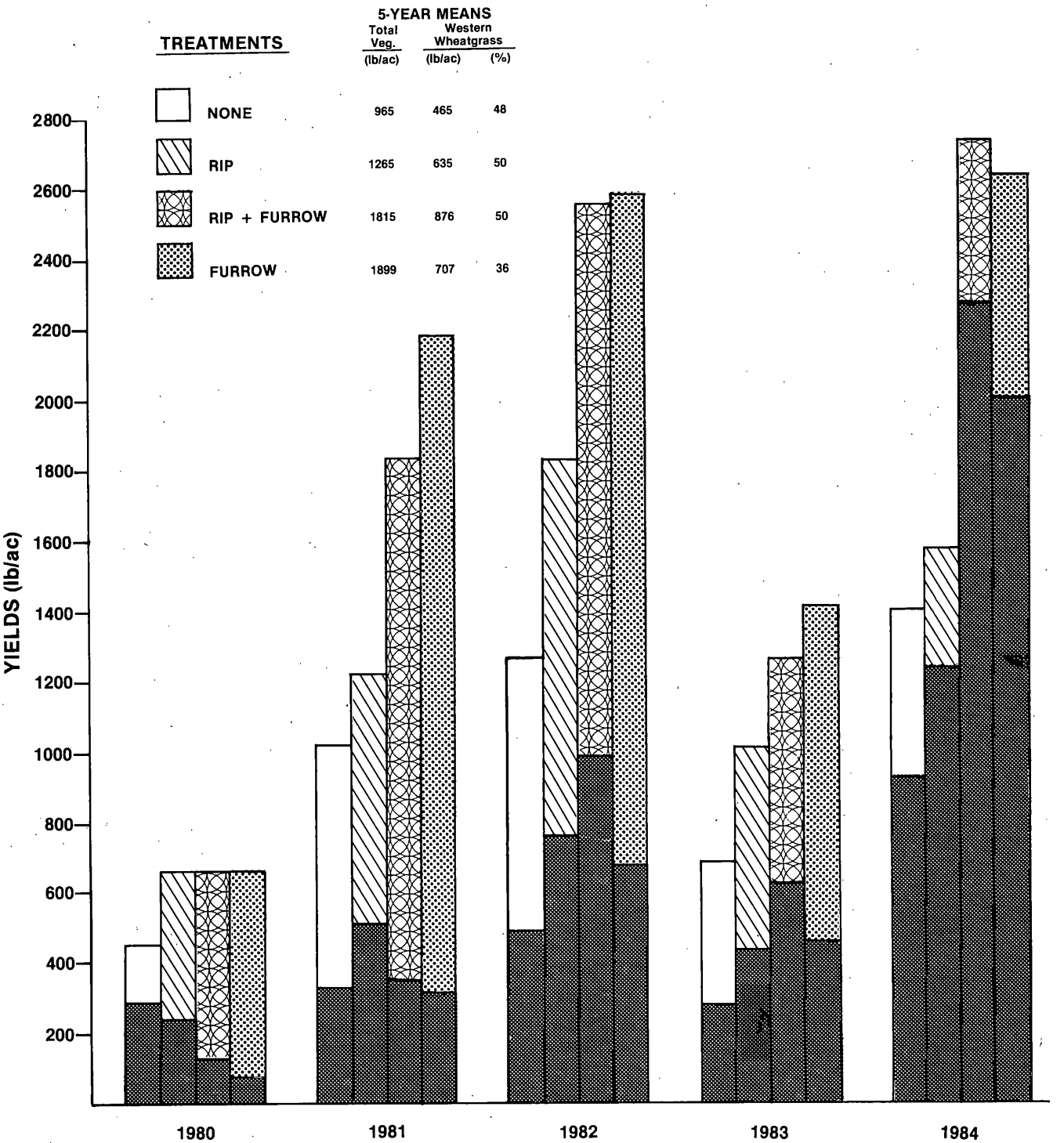

Fig. 2. Oven-dry yields of total vegetation and western wheatgrass portion (shaded) following 1978 renovation of a Thin Claypan range site, E.H. Ranch, Meade Co., South Dakota.

BG-84

production of western wheatgrass on the untreated control at the E. H. Ranch was much greater than average total forage production at the W. K. Ranch over the same period under similar precipitation patterns.

Estimated costs of the various range renovation practices discussed have not been made. Four wheel drive tractors were required when these treatments were applied, but when soil water conditions are more favorable two wheel drive tractors (about 100 h.p.) have adequate power. A landowner who provided acreage for these studies and who has mechanically renovated several hundred acres of rangeland, when asked of his renovation costs replied: "I don't know, but I can't afford not to improve range production."

Assume a renovation technique provides an increase in carrying capacity from 0.2 to 0.4 AUM's per acre on a Thin Claypan range site. For six months of summer grazing only 15 acres is then required per animal unit rather than 30 acres. Mechanical renovation appears to be very cost effective when compared with purchase of additional range at $100.00 per acre. Cost-sharing programs can reduce the final cost of mechanical renovation practices to a landowner.

Both landowners involved in the study are interested in long term potential forage increases. Also of interest will be long term soil chemical and soil water changes, if any, due to mechanical treatment.

Literature Cited

Barnes, O. K. and A. L. Nelson. 1945. Mechanical treatments for increasing grazing capacity of shortgrass range. Wyoming Agri. Exp. Sta. Bull. 273. 35 pp.

Barnes, O. K. 1950. Mechanical treatments on Wyoming rangeland. J. Range Manage. 3(3):198-203.

Mellgren, Don C. 1966. The modifications, performance, and results of contour furrowing in Montana and Wyoming. Interagency Range Seeding Equipment Meeting, New Orleans, LA. 55 pp. mimeo.

Thompson, W. W. and F. R. Gartner. 1973. Interseeding in western South Dakota. Abstr. of Papers, 26th Ann. Meeting, Soc. for Range Manage., Boise, Idaho. p.7.

White, E. M. and F. R. Gartner. 1981. Range claypan soil improvement: properties affecting their response to mechanical treatment. J. Range Manage. 34:116-119.

White, E. M., F. R. Gartner and R. I. Butterfield. 1981. Range claypan soil improvement: response from furrowing and ripping in northwestern South Dakota. J. Range Manage. 34:119-125.