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IMPROVING FORAGE PRODUCTION ON CLAYPAN SOILS

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Mechanical range improvement practices such as contour ripping and furrowing have been used to increase forage production on a variety of range sites in the northern Great Plains. These improvement practices seem to have particular promise on Claypan and Thin Claypan range sites in western South Dakota. Soils on these range sites have a sodium dispersed layer (claypan) at or near the surface. This layer severely reduces the rate of water infiltration, thus causing a greater amount of the precipitation to run off or pool up and evaporate from the soil surface than would happen on soils of similar texture without the claypan layer. Because more precipitation water is lost to runoff and evaporation, less water is available for plant growth. The compact nature of the claypan layer also tends to restrict root growth, further reducing plant growth. Thus, claypan soils are inherently lower in forage production potential than similar soils without the claypan layer. The difference between productivity of the claypan soils and "normal" soils represents the potential increase in forage production if the effects of the claypan layer could somehow be removed.

Mechanical treatments such as contour ripping and furrowing are designed to reduce or eliminate the effects of the claypan layer. They do this by creating depressions in the soil surface to store water and/or by breaking up the claypan layer so that water can infiltrate more rapidly. The additional water moving through the soil can redistribute the sodium and prevent the reformation of the root and water restrictive claypan layer.

Research has been conducted in western South Dakota to determine how much forage production can be increased by ripping claypan soils. In the spring of 1973, a construction ripper, which rips to a depth of about 20 inches, was used on five sites. Two different spacings of the ripper teeth were tried, 2 and 4 feet apart. The spacing of the rips did not affect forage production. Earlier research indicated an advantage for narrower spacing (14 inches) over wider spacing (28 inches) when a shallow (5-inch depth) ripping or chiseling treatment was used on a Claypan site in Harding County (Gartner et al., 1969). Since in the current trials the 2-foot spacing did not produce any more forage, the 4-foot spacing is the recommended treatment because of reduced power requirements.

Three "over treatments" were tried along with the ripping, including broadcast seeding of western wheatgrass (10 pounds per acre), broadcast seeding of sweetclover (2 pounds per acre) and one time application of ammonium nitrate fertilizer (40 pounds nitrogen per acre). None of these over treatments increased forage production over ripping alone.

The western wheatgrass seeding was an attempt to speed revegetation of the ripped area. Seedlings of western wheatgrass were present on the seeded areas (usually only in the furrow left by the ripper shank) but did not contribute to a detectable increase in forage production. Western wheatgrass already present before ripping tends to spread rapidly by rhizomes following ripping. This method of establishment appears to be at least as effective as seeding western wheatgrass.

The sweetclover seeding and nitrogen fertilization were intended to supply additional nitrogen to allow the vegetation to take full advantage of the increased soil water due to ripping. Research on mechanical range improvements in Montana has shown that there is an increase in soil nitrogen available for plant growth for 2 or 3 years following soil disturbing treatments similar to ripping (Wight and Siddoway, 1972). Any increase in available nitrogen probably obscured the effects of the additional nitrogen from the sweetclover and the fertilizer in our studies. The Meade County site was the only one that was examined more than 2 years. It is doubtful that a single application of 40 pounds of nitrogen would have an effect on production after 2 years, especially since 1975 was a wet year. The sweetclover had spread over most of the ripped area by the third and fourth years, so it was difficult to detect its effect on forage production. Previous research in western South Dakota showed that sweetclover increased total forage production as well as perennial grass production on a depleted Dense Clay range site (Nichols and Johnson, 1969). It is likely that a similar relationship would be observed on a ripped area after the effects of the initial nitrogen boost from the soil disturbance were no longer present.

Ripping about doubled forage production on the average, but there was considerable variation between years and sites (table 1). Some of this variation in response to ripping can be explained by variation in precipitation. For example, in 1974 at the Meade County site, the ripped area produced five times as much as the untreated area, while in 1975 the production on the untreated area about equaled that of the ripped area. March through June precipitation at the Rapid City Regional Airport (about 15 miles south of the study site) totaled 4.31 inches in 1974 and 10.68 inches in 1975. Under the relatively dry conditions in 1974, the difference between the ripped and untreated areas was greatly exaggerated, apparently because the ripped area was able to make much more efficient use of the limited precipitation. In 1975 the untreated area was able to produce more because of abundant precipitation. Even with the greater run-off and evaporation from the untreated area, enough water still infiltrated the soil so that forage production was not greatly limited.

While ripping and similar mechanical treatments can dramatically increase forage production on most claypan soils, this fact by itself does not justify their use. Like any other management decision, the economics of mechanical range improvments should be evaluated before they are adopted. The following factors should be considered in making an economic evaluation of mechanical range improvements:

1. Cost of treatment - cost of the type of ripping that was reported in this paper (20 inches deep on 4-foot centers) is about $15 per acre today at contractor prices. This cost could be reduced if the equipment was owned by the individual and used primarily for some other purpose. Also, the cost varies according to the type of treatment (i.e., chiseling, ripping, furrowing, etc.). However, the forage response is also likely to vary with different implements. The relationship of type of implement to forage response is not well understood. Research is currently under way to compare the effects of several types of implements.

2. Cost of deferment - Some type of growing season deferment is generally thought to be necessary in order to take full advantage of the treatment. The typical recommendation is for 1 or 2 years. This cost can be minimized if the treated area can be grazed at sometime other than the growing season.

3. Amount of increase in forage production - As noted previously, forage production increases can vary greatly due to weather conditions, the site and the implement used. Doubling forage production on most claypan soils is probably a reasonable estimate for the ripping treatment described in this paper.

4. Duration of treatment effects - On some claypan soils ripping or furrowing seem to cause permanent improvement, on other claypans the effects last only a few years. The duration of the treatment effect seems to be dependent on the characteristics of the site, the implement used and the grazing management after treatment. Finding an area that was treated several years ago with a similar implement and soils similar to the area in question can be helpful.

5. Value of the additional forage - This is really getting at the reason why the range improvement was considered in the first place. If there isn't a specific need or planned use for the additional forage, then chances are that mechanical range improvements will not pay. The value that is put on the additional forage will vary according to the individual situation. Sometimes the value is easy to determine, for example, when the additional forage is to be substituted for leased pasture.

6. Cost of capital or interest rate - The interest rate is a cost and must be considered. Any improvement practice should provide a return at least equal to the cost of interest on the money being used.

Assuming the following values for the factors listed above, the economics for the type of ripping described in this paper would appear as follows:

1. Cost of ripping - $15 per acre

2. Cost of deferment - Assume the site produces an average of 700 pounds of oven-dry forage per acre before treatment. At 50% utilization this is 350 pounds per acre of usable forage. It takes about 1000 pounds of forage to support an animal unit (mature cow plus calf) for 1 month (AUM). So you have 350 pounds per acre divided by 1000 pounds per AUM or .35 AUM per acre. If we put a value of $8 on an AUM (to be discussed below), then we would be giving up $8 per AUM x .35 AUM per acre = $2.80 per acre for each year of total nonuse. This cost will be less if the area can be used at some time of the year other than the growing season. For this example, we will assume 1 year of total nonuse.

3. Forage increase due to treatment - Assume that we double production from an average of 700 pounds per acre to 1400 pounds per acre. Put another way, this would be a change from 34 acres per cow-year to 17 acres per cow-year or an increase of .35 AUM per acre.

4. Duration of treatment effect - Eleven years from time of ripping or 10 years of grazing use.

5. Value of additional forage - Assume the additional forage will be used in place of pasture that was leased at a rate of $8 per cow per month. Also assume that additional pasture could be leased for the 1 year of nonuse of the ripped area at the same rate. The additional grazing capacity produced by ripping will be worth $8 per AUM x .35 AUM per acre or $2.80 per acre each year.

6. Cost of capital or interest rate - 10%

Costs:		
	Ripping	$15.00 per acre
	1 year nonuse	2.80 per acre
		$17.80 per acre

Benefits: (Value discounted to time ripping was done at a 10% rate)

Year	
1 -	$ 0
2 -	2.55
3 -	2.31
4 -	2.10
5 -	1.91
6 -	1.74
7 -	1.58
8 -	1.44
9 -	1.31
10 -	1.19
11 -	1.08
	$17.21 - present value of ripping (per acre)

Note: These values represent what the $2.80 (annual forage increase) is worth at the time the ripping was done, based on a 10% interest rate.

Net Cost (-) or Benefit (+):		
	Benefit	$17.21 per acre
	Cost	- 17.80 per acre
	Net cost	-$0.59 per acre

The main point to be made with this example is that mechanical range improvements on claypan soils are close to the breakeven point. The situation on any specific ranch may make the range improvement practice considerably more or less profitable than the example. It should also be noted that the way the calculations were done in the example the breakeven point represents a 10% return on the investment. Mechanical range improvement practices can often qualify for ASCS cost-sharing programs, which make the investment look more attractive.

Literature Cited

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Table 1. Forage Production on Ripped and Control (Untreated) Areas at Five Sites in Western South Dakota

County	1974		1975		1976		1977	
	Control	Rip	Control	Rip	Control	Rip	Control	Rip
Meade	199	1161	1253	1555	763	2078	605	1025
Difference	+ 962***[a]		+ 302		+ 1315*		+ 420***	
Ziebach	550	877	1069	1691				
Difference	+ 327*		+ 622**					
Harding 1	388	1117	1826	2540				
Difference	+ 729***		+ 714**					
Harding 2	290	717						
Difference	+ 427***							
Harding 3	554	1234	1047	2554				
Difference	+ 680***		+ 1507***					

[a] *, ** and *** indicate significant increases due to ripping at the 90%, 95% and 99% confidence levels, respectively.