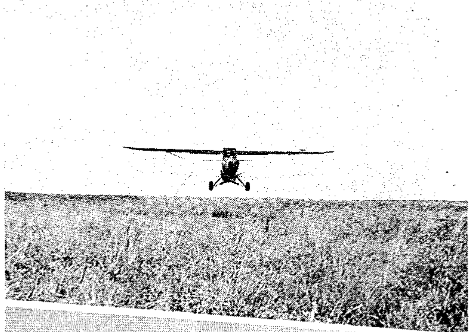
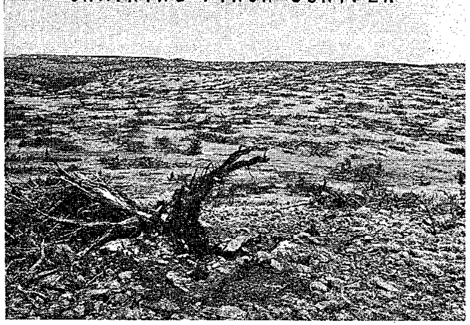
RANGE CONSERVATION - TECHNICAL NOTES

A - CHEMICAL PLANT CONTROL



CHAINING PINON JUNIPER



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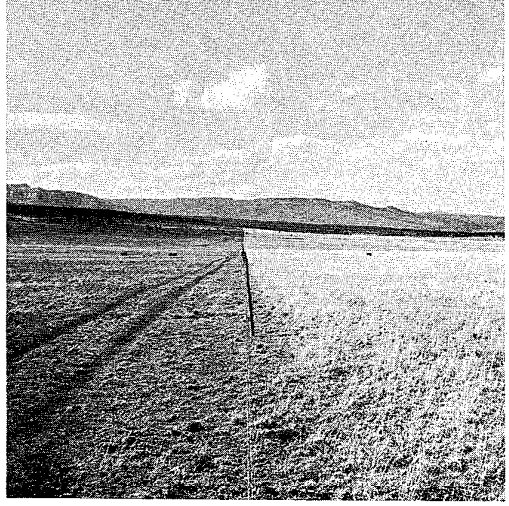
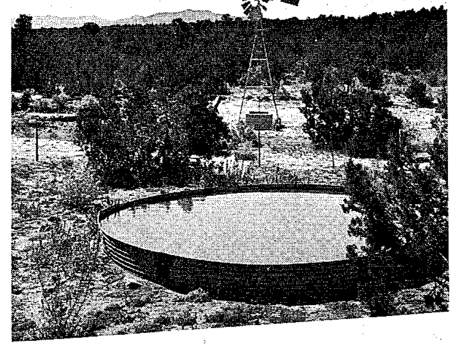


GOOD LIVESTOCK WATERING



CHOLLA CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NEW MEXICO

NOTE NO. 48

February 8, 1972

RE: RANGE - Report - Mechanical Treatment

This Range Technical Note transmits Report no.8 of the New Mexico Interagency Range Committee.

This report can be used as reference for planning and application of mechanical treatment of rangelands.

Attachment

A.C.'S - 1
D.C.'S - 1
Area Range Conservationists - 1
NMSO Records Mgt - 1
Adjoining States - 1
Western Regional States - 1
RTSC - Portland - 5
D. M. Whitt, Director, Plant Science Div. Washington, D.C. - 2

Report No. 8

July 1971

LAND MANAGEMENT PRACTICES FOR THE REDUCTION OF RUNOFF AND EROSION IN NEW MEXICO

New Mexico Inter-Agency
Range Committee

Request Copies From:
Agricultural Research Service
U.S. Department of Agriculture
P. O. Box 698
Las Cruces, New Mexico 88001

PREFACE

This paper presents the results of a field evaluation in July 1971 by the interagency Range Committee of land treatment practices used within the past few years in New Mexico. It was felt that such information would be of benefit to all land managers within the State. Members of the committee are as follows:

Agricultural Research Service	
Dr. Carlton Herbel, Range Scientist	Las Cruces
Bureau of Indian Affairs	
Wilson Gutzman, Area Range Conservationist	Albuquerque
George W. Knoll	Albuquerque
Bureau of Land Management	
Bill Leifeste	Santa Fe
*Fred Wyatt	Albuquerque
*Gordon A. Frashier	Albuquerque
Mervin Noble, Leader, Soil & Watershed Staff	Denver
*Jerry Tipton	Farmington
U. S. Forest Service	
Bill Currier, Range Staff	Albuquerque
R. M. Williamson, Range Staff	Albuquerque
**Wayne Hickey, Range Staff	Albuquerque
*Allyn W. Wasser, Range Conservationist	Taos
Rocky Mountain Forest & Range Experiment Station	
H. Wayne Springfield, Range Scientist	Albuquerque
Oren D. Knipe, Plant Ecologist	Albuquerque
Department of Game and Fish	
**Sam Lamb, Federal Aid Coordinator	Santa Fe
New Mexico ASCS Office	
Ray Wolf	Albuquerque

New Mexico Land Office	
Dr. Eugene Hughes	Santa Fe
New Mexico State University	
**Jesse Gerard, Assistant in Agriculture	Las Cruces
**Dr. Rex Pieper, Professor	Las Cruces
Dr. Robert E. Steger, Extension Range Specialist	Las Cruces
Dr. Walter Gould	Las Cruces
Soil Conservation Service	
**Dan Merkel, Plant Materials Specialist	Santa Fe
**Donell Sylvester, Range Conservationist	Albuquerque

*Non-members participating
**Members participating

INTRODUCTION

Only those, soil disturbing, land treatment practices were considered which have as their purpose the reduction in surface runoff, erosion, or the increase in production of sod-bound turfs.

A few of the practices considered here have been covered in previous reports, but from a different viewpoint. Practices repeated in this report are presented for the purposes stated above.

All of the problems and considerations included in earlier vegetation manipulation reports are applicable here. In order to be effective from either a practical or an economic standpoint, some form of grazing management must accompany the treatment. Otherwise, both the effectiveness and duration of treatment are adversely affected.

PROBLEMS

1. Surface Runoff

Surface runoff is a major problem over the majority of New Mexico. The State, as a whole, is characterized by localized rainstorms of short duration and high intensity. On steep terrain, this runoff follows the drainages and frequently produces "heads" of water which have devastating effects. On the flatter terrain, runoff usually occurs as great spreading sheets which produce deleterious effects of a more subtle nature.

2. Erosion

Erosion is also a major problem in the State due to: (a) the large heads of water built up by excessive surface runoff; (b) sheet runoff from less productive sod-bound areas; and (c) both types of runoff from denuded areas. These heads of water create head cuts, gully erosion, and may even change the course of the existing stream channels. The sheet runoff usually causes sheet erosion; and, although less impressive than gully erosion, the effects upon the overall range productivity are more severe than the gully erosion which is confined to a lesser acreage.

3. Low Productive Sod-bound Turfs

Such sites consist of almost a solid turf of blue grama which produces virtually nothing in the way of forage. (Figure). They contribute greatly to accelerated surface runoff and are of no significant deterrent to sheet erosion. Frequently, this sheet erosion enters downstream channels and contributes greatly to streambank degradation.

CONTRIBUTING FACTORS

1. Topographic

Topography greatly affect climatic factors. Mountain ranges in the Southwest predominantly run in a north-south direction. The prevailing winter storms generally deposit snow in greatest quantity at the higher elevations and northern and western slopes. The prevailing summer storms also generally deposit rain at the higher elevations, northern and eastern slopes. This leaves broad valleys and plateaus between mountain ranges which are in a much more arid or semi-arid state (rain-shadow effect).

Topography also greatly modifies light intensity and especially interception. Many deep valleys are so cold that the growing season is sufficiently short to limit the plant species to a given few.

Topography is commonly thought of as the more dominant terrain figures such as hills or mountain ranges. However, the curvature and relief of major topographic features provides different aspects. Aspect is the position or direction in which a particular terrain feature faces. Wind direction, solar interception, and insolation create entirely different climates on each aspect of a given topographic feature. Over a period of time, this has led to wide differences in character of the soils formed. In a strictly localized site, aspect becomes a very important consideration.

A. Slope. Slope is one of the more important factors contributing to the problems of excessive surface runoff and accelerated erosion. With slopes over 60%, a certain amount of geologic erosion is taking place. However, most of the slopes in New Mexico range from 4% to 35%. These slopes, together with trampling by domestic livestock, produce a great deal of sediment due to the heads of water coming off of them. Many may be treated by mechanical land treatment practices. However, many of the steeper slopes may be helped only through intensive grazing management practices.

B. Aspect. Aspect differences, both in vegetation (composition and density) and soils, are great throughout the State. South and west aspects suffer from the greatest soil erosion due to lack of sufficient vegetation cover. North and east aspects suffer both from surface runoff and low productive sod-bound turfs. Soil depth and productivity generally increases from north to east to west to south.

C. Elevation. Elevational differences are quite great throughout the State.

(1) Lower. At lower elevations in the southern part of the State, problems are often the same as at higher elevations but the causes different. For instance, runoff occurs more in sheets and concentrates in downstream channels and drainage bottoms. Erosion is more frequently caused by wind rather than water. Low productive turfs must largely be treated mechanically to improve the existing turf since conversion to another species is often impossible or impractical.

(2) Upper. At the higher elevations in the northern part of the State, the reverse is frequently true. Wind erosion usually is no great problem. Runoff originates on or near the site of the channels and drainage bottoms. Slopes, hilltops, and mesas dump their runoff more or less directly into drainages and channels. Low productive turfs at the mid-elevation ranges are frequently improved through revegetation with some form of mechanical land treatment. At the higher elevations, mechanical land treatments are either greatly hampered or not feasible. Consequently, improvement of unproductive range lands is accomplished through proper stocking and intensive grazing management systems.

2. Edaphic

A. Texture. The looser, sandier soils of the south are more subject to wind erosion and also more difficult to stabilize. The generally tighter soils, having more clay, in the north are more subject to gully or sheet erosion by water. They are easier to stabilize primarily due to structure and climatic factors.

B. Structure. Arrangement of the soil particles is most important from the standpoint of erosion. The prismatic, columnar structure of shale soils predominantly found in the north and central portion of the State are especially susceptible to erosion. Once gullies are formed, the dried columns separate, fall into the gully, and are flushed out by the first rainstorm producing runoff.

3. Climatic

A. Precipitation. From a problem viewpoint, the amount of rainfall is less important than duration and intensity.

Water, in the form of snow, rain, or both, is the primary factor which determines the vegetative species for a given latitude (range of similar temperatures).

All the physical and chemical processes comprising the entire life cycle of a plant from germination to maturity require water. The great majority of water used by plants is taken from the soil by the root system. This water must be "available" to the root system. Available water is generally spoken of as the difference between "field capacity" and the "wilting point." Field capacity is the moisture held by the soil against the pull of gravity. Wilting point is that point in time when the film of water surrounding the soil particle is held with such tensity that the root system cannot absorb water as fast as the above-ground parts are transpiring it. Some information about the soil concerning the texture and permeability as hydraulic conductivity is therefore necessary.

Regrettably, many of our past recommendations have been made after merely consulting an isohyetal map which provides a mean, annual precipitation. There is no way of determining whether the bulk of such precipitation falls as snow in December or as one torrential storm in July, from such maps. Average annual precipitation is useful only as a rough comparison of two different areas. The primary considerations are precipitation preceding plant growth and precipitation occurring during the most active growth period. Precipitation and its distribution determines the distribution of species within a given latitude.

(1) Overwinter Precipitation. The amount and distribution of overwinter precipitation are important since:

(a) Some areas receive the bulk of their subsoil moisture from snow. This is supplemented by sporadic, minor summer rainfall to provide adequate plant soil moisture.

(b) Other areas receive very little subsoil moisture from snow since overwinter temperatures are such that the bulk of snowfall sublimates or runs off in the spring.

(c) Certain areas need a blanket of snow to protect the plants from prolonged dry and cold spells which result in losses of a great deal of turf.

(2) Growing Season Precipitation. The amount and distribution of growing season precipitation are probably the most important factors:

(a) Amount. The amount of growing season precipitation is often the factor limiting the species for consideration.

(b) Distribution. The distribution of the growing season precipitation frequently is the factor which determines planting dates.

(i) For a given amount of rainfall, the distribution pattern might be skewed toward September-October which would enhance fall planting.

(ii) For the same amount of rainfall, the distribution pattern may be primarily toward June-July which would enhance summer planting.

It must be remembered that a given amount of precipitation may produce two entirely different results depending upon aspect, soils, and many other factors.

(3) Storm Duration and Intensity. This information is quite necessary in the Southwest which is characterized by localized rainstorms of short duration and high intensity.

(a) Duration. Infrequently, rains of 1-3 days occur in the early spring. The majority of such rains occur late in the fall prior to frost. These are the rains which penetrate and provide the most soil moisture. The majority of summer rains are of relatively short duration (less than two hours).

(b) Intensity. Intensity, coupled with duration, must be considered. An inch and a half rain falling in 10-15 minutes often seals the soil surface and results in flash runoff. Such rains are vegetatively unimportant and may destroy a seeding project through sheet erosion.

Short duration, high intensity rainstorms must not entirely be discounted. However, a knowledge of local storm conditions can greatly reduce the hazards of seeding, and mechanical land treatment. A search of existing records also frequently provides an index to the best time of year for encountering low intensity rains of longer duration.

B. Temperature. Temperature is one of the two principal factors influencing where species may be grown in the various latitudes. Each species has a maximum growth temperature beyond which all growth ceases and further increases result in plant mortality. The minimum temperature is a temperature below which growth is impossible. The optimum growth temperature is that temperature at which a given species undergoes its most active growth.

The amount of precipitation necessary for a species varies with the temperature of the area because of the differences in evapotranspiration rates. For instance, a given amount of growing season precipitation may be insufficient at a low elevation, with hot climate, and quite adequate in a higher elevation, with a cool climate.

Temperature has a profound effect on all of the physiological and chemical processes of plants. Plants are at approximately the same temperature as their surroundings which makes temperature data, especially maximum and minimum, secondary only to precipitation in the preparation of treatment recommendations.

"The effect of relief on temperature is not, of course, merely one to be considered from the standpoint of height above sea level. Orientation and the curvature and angle of slopes, in other words, the topographic character of the region, also exert an obvious effect on temperature, particularly in its detailed pattern and regimen." (Tuan, 1969)

(1) Overwinter Temperatures. The most severe hazard to plant life is extended periods of sub-zero weather during dry winters. Even in normal winters, frost presents a danger to plants or plant parts. Low overwinter temperatures cause frost heaving of the soil which breaks or exposes roots. Extended coverage by ice results in smothering of some plants.

Both minimum and average overwinter temperatures must be considered in eliminating those species which would more than likely winter kill and in determining whether certain species have sufficient time to mature seed and cure out into nutritious forage.

When recommending species for areas having low winter temperatures, certain plant adaptations might be considered. Certain cold season growers are well protected under a snow blanket and even produce growth under such conditions. Some perennials have underground adaptations such as rhizomes, bulbs, or tubers which withstand cold. Many annuals (cover crop) complete their life cycle during the frost-free period.

(2) Growing Season Temperatures. Excessive temperatures affect the evapotranspiration rate to varying degrees depending on the hydraulic conductivity or diffusivity rate and the texture of the soil. Extreme heat causes shedding of the seed, dropping of leaves, and ultimately dormancy or mortality of plants. Available soil moisture may vary from 1 to 5 inches and is an important consideration. A soil with a very high water holding capacity may be able to sustain plant life with a minimal amount of summer precipitation. Rain temperature affects the soil in that warm rains in the fall prolong the growing season and warm rains falling in the spring initiate early growth. Just the opposite is true of cold rains. Wet soils are harder to heat due to the higher specific heat of water. This makes for later spring growth in areas receiving the bulk of their moisture as winter snow. Due to their low water holding capacity, sands warm up earliest in the spring and clays conversely are the slowest to warm up.

Maximum and average growing season temperatures are an aid in determining whether to seed warm or cool season growing species.

C. Relative Humidity. The Southwestern Region is characterized by low rainfall, high temperatures, and an absence of large bodies of water. This creates a situation in which relative humidity is very low with the exception of brief periods following summer storms. In 1945, Smith stated, "The small amounts of smoke, moisture and clouds in the atmosphere allow the ready penetration of the heat of the sun to the earth and its equally rapid loss from the earth when the sun is not shining. As a result, temperature ranges between day and night are great." Low humidity coupled with high daytime temperatures and low night-time temperatures frequently result in excessive losses of young seedlings before available soil moisture ever reaches the wilting point.

D. Wind. During the winter months, winds are predominantly out of the northwest from the Pacific Ocean. During the summer, winds are predominantly from the Gulf Stream and blow from the southeast or east. Fall winds following summer rains frequently dry out the soil to a depth where perennial grasses and forbs cease growth prior to maturity. Early spring winds frequently dry out the soil to the point where growth cannot progress until the summer rains begin. For these reasons, the majority of seeding in the Southwest takes place during the latter part of June or first week in July.

E. Evaporation and Evapotranspiration. Evaporation is the source of greatest loss of available plant water. This is largely a result of strong, extended periods of spring winds, low humdity coupled with high daytime temperatures, and high barometric pressures which are so characteristic of the Southwest. High evaporation losses coupled with sporadic, localized summer rains account for the majority of seeding failures.

"Evaporation is influenced by many factors. On an open water surface, these include solar radiation, air temperature, relative humidity, wind, water turbility, and water temperature. From bare soil, evaporation is also affected by soil texture and depth of water table." (Tuan, 1969)

Evapotranspiration is the total water loss as it occurs from evaporation at the soil surface and transpiration from living plant materials.

With the exception of the xerophyte plants, transpiration losses in the Southwest are high. Evapotranspiration rates, therefore, are an important consideration.

F. Light Intensity and Interception. Information along these lines is almost invariably lacking. In the majority of cases, it is of relatively minor importance. On denuded soils subject to slicking over, it becomes important to seedling survival and determines the need for an annual cover crop. Reflected light of high intensity from slicked over soils strike the seedlings and destroy the cellular structure at some point above the soil surface depending upon the time of year and angle of interception.

4. Grazing Management

Grazing management, (Interagency Range Committee Report, #5, April, 1970, 21 pp. proc.) or the lack of it, is probably the major contributing factor to the problems:

A. Surface Runoff. Excessive grazing leaves such a short stubble height that heavy rainfall rises above the surface vegetation faster than the soil can absorb it. This results in rapid surface runoff.

B. Erosion. Livestock concentration areas which are denuded of vegetation are highly susceptible to erosion, both sheet and gully.

C. Sod-bound or Low Forage Producting Areas. Excessive grazing of such species as blue grama tend to form a low productive, sod-bound condition highly favorable to runoff and erosion. Excessive grazing of decreaser species allows low prodicing blue grama types to move into areas for which it is not normally suited. This provides a cover with little or no productive capability and a high runoff capacity.

5. Changes in Composition

The invasion of tree or shrub species into grasslands with its accompanying competition and shading effects tend to reduce ground cover and expose more of the soil surface to erosion. Dense stands of pinyon-juniper are a good example of this occurrence.

The amount of existing desirable vegetation vs. the undesirable vegetation, woody vs. non-woody, the density, amount of ground cover and size of plants will affect the selection of a treatment practice.

6. Equipment

Any land treatment practice for the prevention of runoff and erosion must take into account the residual vegetation of the area. Unless sufficient desirable vegetation remains to naturally seed the area, then a complete seeding job of the area must be considered. The exception to this is the area of sod-bound blue grama where it is desirable that the treatment practice reduce some of the existing competition.

6. SUMMARY OF EQUIPMENT DESCRIPTION, ADVANTAGES, AND LIMITATIONS

Method of Treatment	Type of Equipment	Swath Width	Working Weight	Horsepower Requirement	Advantages	Limitations
Cutters and Crushers	(1) Marden Model L7	7 ft.	8500# water filled 2 sections	40-45 HP TD-14 D-4 D-6	1. Angular alignment between 2 sections intandem allows for better cutting action.	1. Will not kill sprouting brush. 2. Slopes 25% or less. 3. Areas with less than 50% surface rock and no large boulders.
	Model B7	7 ft.	22000# water filled 2 sections	70-90 HP D-7 TD-18 HD-14	2. Double edge reversible blades. 3. Hi-Lo blade arrangement provides a falling action on each blade as it hits the ground.	
	Model TB7	7 ft.	33000# water filled 2 sections	90-125 HP D-8 TD-21		
	(2) Fleco-Single Drum Choppers	7 ft.	11000# water filled 1 section	45-60 HP D-6 TD-14	1. High speed cutter (1 section only) 2. Easy to maneuver and back up. 3. Reversible blades.	1. Size of material is limited to small brush and limbs.
	(3) Tree Crusher	28 ft.	90 tons	Self-Propelled	1. Will handle larger trees than any other machine now available up to 14" DBH. 2. Leaves soil in a condition to take in moisture and prevent erosion.	1. Limited to rock-free soils. 2. Limited to slopes less than 20%. 3. High maintenance cost. 4. Large Acreages per site.

Method of Treatment	Type of Equipment	Swath Width	Working Weight	Horsepower Requirement	Advantages	Limitations
Pitting	(1) Rotary Pitter (Spike Tooth)	5 ft. per unit Generally pull 2 units	11500#/unit when filled with water	2 units 40-45 HP Comparable to TD-14 D-4 D-6	1. Relative cheap to operate. 2. Breakage free under normal operative conditions.	1. Penetration is limited on dry fine textured soils. 2. Not effective on rocky soils or areas with hard pan near surface. 3. Soil disturbance not sufficient for seeding in conjunction with pitting.
	(2) Scranton Cutaway Disc Pitter	20 ft. per unit	1700# per unit	1 unit 30-40 HP Comparable to Farmall "M" Case "L" John Deere "D"	1. All parts are standard, can be purchased locally. 2. Seeding can be done in conjunction with pitting. 3. Hydraulic control enables uniform control of depth of pits. 4. Opposite disc eliminate side draft.	1. Limited to slopes of less than 30%. 2. Will not work in areas of brush infestations. Brush balls up in the disc.
Ripping	(1) Self-Cleaning Ripper	10 ft. (2 units)	1000# per unit	45-60 HP D-6 TD-14	1. Units can be moved in pickup. 2. Self-cleaning of limbs and trash.	1. Self-penetrating tooth will not work in rocky soil or frozen soil.

Method of Treatment	Type of Equipment	Swath Width	Working Weight	Horsepower Requirement	Advantages	Limitations
Ripping (Con't)	(2) Road Ripper	N.A.	Pull type 6000# Tool Bar Type 1000#	125-150 HP D-9	1. Will operate in rocky areas with very little maintenance.	1. Pull type difficult to move from area to area.
	(3) Jay Hawker	7 ft.	10000+	D-8	1. Discernible surface rip. 2. 10" tube at 28" which fractures 3½' each way.	Not suited to rocky areas.
Furrowing	(1) Model B Disc type Contour Furrower Pull Type	8 ft.	6000#	45-60 HP D-6 TD-14	1. Seeding attachment allows furrowing and seeding in one operation.	1. Limited to slopes of 30% or less. 2. Will not work in extremely rocky soil.
	(2) Holt Furrower	N.A.	Double Disc 1400#	35-50 HP D-6 TD-14	1. Continuous trenches or scalping at 4 ft. intervals.	1. Brush less than 50% density and less than 3 feet tall.
			Single Disc 900#	25-35 HP T-2 T-4	2. Reversible disc always throws dirt downhill in trenching.	2. Will not work in rocky soil.
	(3) Front End Mold Board Plow	N.A.	200# per unit Attached to Dozer Point	70-90 HP D-7 TD-18 HD-14	1. Trench is made in front of uphill cat track. Helps level tractor on slopes. 2. Low cost of mold board equipment. 3. Minimum time required to install trenching equipment.	1. Will not work in heavy brush or rocky areas.

Method of Treatment	Type of Equipment	Swath Width	Working Weight	Horsepower Requirement	Advantages	Limitations
Furrowing (Con't)	(4) Mold Board Plows	N.A.	Varies about 500# per bottom	15-20 HP per bottom John Deere "B" Farmall "B"	1. Operating costs are low. 2. Easily moved from area to area.	1. Not adapted to rocky soil.
	(5) Road Main-tainers	N.A.		Self-propelled		1. Very limited application to level, rock-free and brush-free areas.
	(6) Hula Dozer	N.A.	N.A.	Fits any tractor	1. Hydraulic control tilt dozer is an excellent tool for digging contour trenches, ditches for pipeline, etc.	
Plowing	(1) Wheat-land Disc Type Plow Disc Turn	9 ft.	3000#	HD-50 D-6 TD-14	1. Plowing depth is easily adjusted to fit varying soil and vegetation conditions. 2. Will handle steep soils.	1. Frequent adjustments necessary. 2. Light frame causes much breakage. 3. Careful maintenance is necessary.

Method of Treatment	Type of Equipment	Swath Width	Working Weight	Horsepower Requirement	Advantages	Limitations
Plowing (Con't)	(2) Standard Disc Plow Disc Fixed	5 ft. (6 disc)	2000#	60-70 HP D-7 TD-18	1. Works better than moldboard in brushy and moderately stony soils.	1. Narrow cut combined with heavy draft. 2. Cannot be used where there are large embedded rocks.
	(3) Brushland Disc Plow	10 ft.	6000#	60-80 HP D-7 TD-18	1. Extremely low breakage.	1. Initial cost is high. 2. Not commercially available. 3. Hard to transport.

7. Treatments

When selecting a particular piece of equipment for a particular job, several factors must be considered.

A. The degree of reduction of runoff and/or erosion desired.

B. Effectiveness of a given piece of equipment on a given soil.

C. Effectiveness of a given piece of equipment on a given slope.

D. Increased production as a result of the piece of equipment used.

E. Control of grazing livestock.

Livestock Control - With the exception of sod-bound blue grama turfs, any area with high runoff and erosion doesn't have the most desirable vegetation cover for soil protection. The treatment practice invariably increases the available soil moisture to a varying degree to the existing vegetation. This results in an increase, both in forage and seed production. Depending upon the degree of existing vegetation cover, livestock should be excluded, during the growing season, from 1-3 years. This allows time for new plants to become well established. The exception to this is a sparse vegetation cover in an area with a high concentration of rodents. Under such circumstances, the rodents may harvest the entire seed crop. It may therefore be necessary to accompany the land treatment practice with a rodent control program.

Equipment	Runoff Reduction	Erosion Reduction	Slope Effect	Increased Production
Marden & Fleco Cutters and Crushers	2 years, sand 4 years, loam 6 years, clay	1 year, sand 2 years, loam 4 years, clay	Must be on contour	Light
Tree Crusher	3 years, sand 5 years, loam 7 years, clay	2 years, sand 4 years, loam 5 years, clay	Should be on contour	Moderate
Rotary Pitters	1st-2nd rain, sand 1-2 yrs., loam 2-3 yrs., clay	1st rain, sand 1 year, loam 1-2 yrs., clay	Need not be contoured	Slight
Scranton Cutaway Disc	1 year, sand 2 years, loam 3-4 yrs., clay	6 mos., sand 1 year, loam 2 years, clay	Need not be contoured	Light
Rippers	2 years, sand 5 years, loam 8 years, clay	1 year, sand 3 years, loam 4-5 yrs., clay	Must be on contour	Good
Furrowers	4-5 yrs., sand 6-10 yrs., loam 15-20 yrs., clay	2-3 yrs., sand 3-4 yrs., loam 10-15 yrs., clay	Must be on contour	Very Good
Plowing	2-3 yrs., sand 3-5 yrs., loam 6-8 yrs., clay	1-2 yrs., sand 2-3 yrs., loam 5-6 yrs., clay	Need not be contoured	DEPENDS ON SUCCESS OF SEEDING OPERATION

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