WATER OPERATION AND MAINTENANCE

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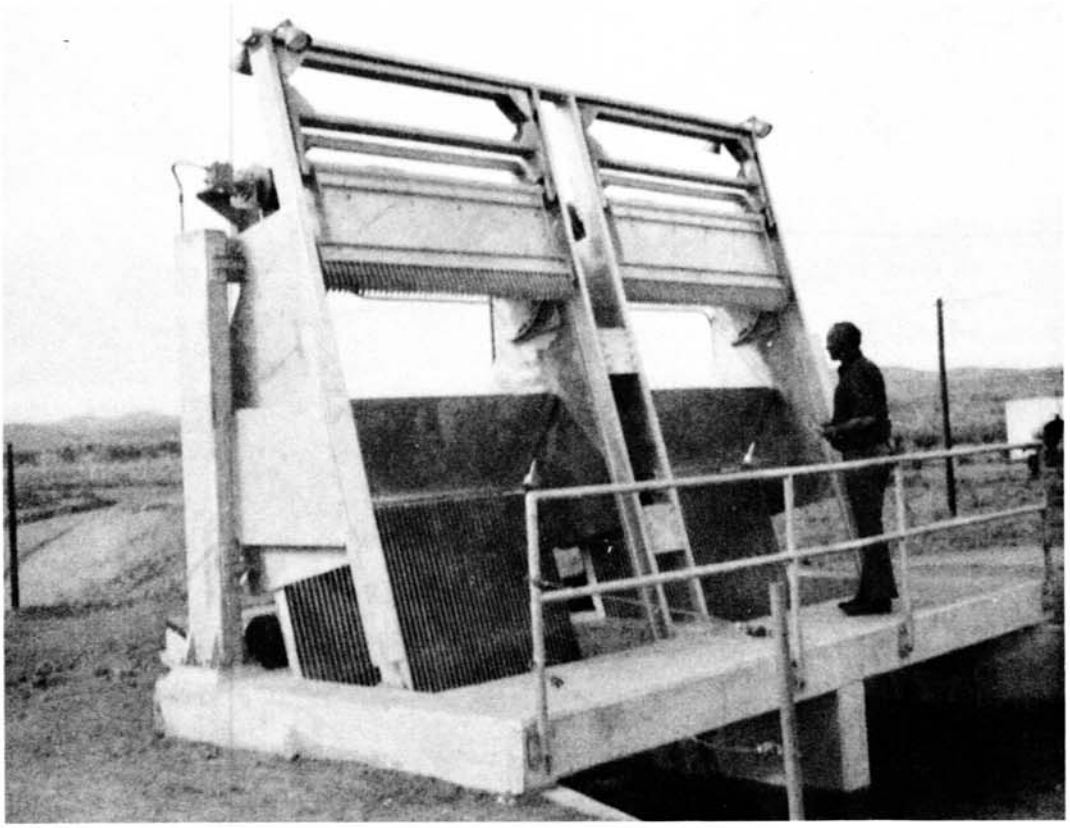

IN THIS ISSUE

EQUIPMENT FOR THE PREVENTION, CONTROL, AND DISPOSAL OF WEEDS ON IRRIGATION PROJECTS

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

COVER PHOTOGRAPH:

Mechanical trashrack for the Hammond Pumping Plant, Hammond project, N. Mex. The rake mechanism operates on a differential water level actuated by trash accumulation. The debris is carried up the face of the sloping trashrack and dumped over the back on a concrete platform.

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PREFACE

Water Operation and Maintenance Bulletin No. 97 is being devoted exclusively to a presentation of equipment and devices suitable for the prevention, control, and disposal of weeds on irrigation systems. It has been prepared after a review of present field practices and a review of previous bulletins in which articles on the subject appeared in an attempt to present newer developments, practices, and procedures. This bulletin supersedes previous Operation and Maintenance Equipment and Procedures Releases No. 3, 8, 16, and 37, and will include much of the material on the subject from more recent issues.

The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water-supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the laborsaving devices and less costly equipment developed by the resourceful water users will be a step toward commercial development of equipment for use on irrigation projects in continued effort to reduce costs and increase operating efficiency.

The bulletin was prepared with the assistance of many Bureau field organizations, water users operating irrigation projects, and others interested in the field of weed control. Special recognition is due Mr. Allan Hattrup, Conservation Agronomist, of the Bureau's Columbia Basin project, Ephrata, Wash., and Mr. Floyd Olliver, Regional Agronomist, Boise, Idaho, for their assistance in the general assembly of material after a review of present practices being used in the control of weeds throughout the western portion of the United States.

Any information contained in this bulletin regarding commercial products may not be used for advertisement or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

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Division of Water Operation
and Maintenance
Engineering and Research Center
Denver, Colorado 80225

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INTRODUCTION

The prevention, control, and disposal of weeds on an irrigation system are essential for the delivery of the quantity and quality of water for which the system is designed. Equipment for handling the weed problems must be adequate to get the job done at the proper time and at the least expense.

Few of the commercial devices available to the operators of irrigation systems are well adapted to the handling of weeds. Manufacturers are unable to spread the cost of designing, tooling, and marketing a few pieces of special equipment and sell the equipment at a cost that project operators can afford. However, excellent components for such equipment, such as pumps, nozzles, burner heads, seed-metering devices, and power units, are available. Most of the machines and devices described herein are adaptations by project operators of these commercially available components and other materials at hand to meet their specific needs.

The Problem

The control of weeds is a worldwide problem that is not limited only to irrigation systems. Most segments of industry and agriculture experience some requirement for weed control in their operation.

The person most immediately concerned with the weed problems on an irrigation project is the one who has direct responsibility for the operation and maintenance of the irrigation system. However, planners, designers, and constructors of the system should be informed of the needs which will occur and plan the system so that motorized weed control equipment can be used.

Other agencies involved in flood control; water conservation; the construction of highway, municipal, and industrial water supply systems; weed and insect control; and power transmission have weed control problems. Many of their problems are similar to those on irrigation projects and require similar types of equipment.

The data in this bulletin primarily apply to the 17 Western States, but could be applicable to other countries in which machine power is less costly than manpower. However, of the pieces of equipment described, many may be useful in irrigation systems where the cost of manpower is relatively low.

Program Timing

As part of the planning, design, construction, and operation of an irrigation system, preventive weed control must be initiated before

weeds become prevalent. The costs of establishing competitive vegetation on an irrigation system are repaid many times in reduced costs for weed control and disposal.

The disposal of weeds, a term used in this bulletin to describe all other practices required after prevention and control have failed or have not been used, is more expensive than prevention or control. "Ten dollars' worth of control is better than thirty dollars' worth of weed removal."

Equipment Design

Rights-of-way on most irrigation systems are long, narrow strips of land which may be wet or dry, sandy or rocky. Slopes are usually steep. Access to the right-of-way, especially on older irrigation systems, may be limited.

Farm-type equipment, designed for cultivating crops on arable land, is not readily adapted to steep canal banks or to rough areas adjacent to the canals. Heavy construction equipment can be and often is used, but only at a high cost, considering the amount and type of work to be done.

The physical needs of two projects may appear to be similar, but considerable variation occurs because of differences in labor costs, water demand, operating practices, and other factors. Before the advent of herbicides and motorized equipment, prevention, control, and disposal of weeds was accomplished primarily by hand methods. One alternative was to let the weeds grow until the use of heavy construction-type equipment could be justified.

Today, preventive maintenance, where weeds are concerned, is as important on an irrigation system as it is on a fleet of automotive equipment. The missing factor is availability of suitable equipment from commercial sources.

To use motorized equipment, there must be access to the canals. Flat berms along the canals must be provided on which the motorized equipment can be operated. Motorized equipment must be designed and constructed to prevent, control, and dispose of weeds efficiently. All these factors are necessary to an efficient and effective weed program.

Seeding, spraying, burning, and weed-disposal equipment is most often mounted "offside." Offside mounting presents a side-draft problem with most motorized equipment. Equipment may be designed and built to fit a given set of circumstances. Certain priciples, however, may

be incorporated into the design of a piece of equipment for performance of similar work elsewhere. These principles are being stressed in this bulletin.

Sources of Additional Information and Assistance

The general principles of prevention, control, and disposal of weeds on irrigation systems will be covered in this publication. Adapted grass species are not discussed because of the wide variety of environmental conditions occurring throughout the 17 Western States. Specific herbicide formulations and detailed application procedures are also not included because of the Federal and State regulations governing them.

Specific data on land weeds usually may be obtained locally for each project from the Agricultural Extension Service, the Soil Conservation Service, the Agricultural Research Service, or other State, county and Federal agencies concerned with crops, soils, and agriculture. Representatives of the herbicide industry are also a good source of weed control information.

Specific information on aquatic weeds is not as readily available from local sources. Much of the available information has been developed cooperatively by project and regional offices of the Bureau of Reclamation and the Division of General Research at the Engineering and Research Center in Denver, Colo. where a team of scientists representing the Agricultural Research Service, Fish and wildlife Service, and the Bureau of Reclamation investigate specific problems and basic data. Copies of reports prepared by these specialists are available. Equipment for the control and disposal of aquatic weeds, based upon project experience and the recommendations of the weed specialists, are included in a separate section of this bulletin.

Other Federal and State agencies may be contacted to obtain information regarding weed control equipment problems encountered on irrigation systems.

Definition of Terms

To better understand the terms used in this bulletin, a few definitions are given. By classification they are:

Weed. - A weed is a plant out of place. Generally, when a plant in a particular situation lacks economic or esthetic value or is injurious, it becomes a weed.

Land or ditchbank weeds*. - Land weeds infesting channel banks, rights-of-way, and farms.

Aquatic or channel weeds. - Aquatic weeds growing in water, below and above the water surface.

Waterline weeds. - Waterline weeds may be water-tolerant land weeds or aquatic weeds which emerge from the water.

Phreatophytes. - Phreatophytes (well plants) are plants which obtain water from the water table. They may remove large quantities of water from land which is wet or dry at the surface.

Weeds, like diseases, must be dealt with. Some weeds, like some diseases, may be prevented; others can be controlled; and still others run their time until disposed of. This bulletin, therefore, is divided into three main sections:

Prevention. - For all practical purposes, prevention includes the acts or means which create a condition under which weeds will not grow in such numbers as to require significant costs for control or disposal.

Control. - Where the prevention of weed growth is less than perfect, as it usually is, weeds grow. The practices necessary to kill the growing weed are termed control.

Disposal. - The term disposal is used in this bulletin to describe all other practices required after prevention and control have proved unsuccessful in solving a particular weed problem.

Environmental Protection and Consideration

Pesticides. - Pesticides have become important tools in the operation and maintenance of most irrigation systems. Herbicides usually make up the majority of the pesticides used, although there will be some minor uses of insecticides and rodenticides. Prior to the use of pesticides on an irrigation system, a thorough analysis should be made of their possible effects on fish, wildlife, desirable vegetation, and water quality.

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* Although the species to be controlled may be the same, control of ditchbank weeds may involve approaches and methods different from those used to control land weeds in sites not adjacent to sensitive waters.

It should be emphasized that under present law, after October 1977, application of restricted-use pesticides can be performed only by certified applicators or persons under their direct supervision. Pursuant to the Federal Environmental Pesticide Control Act of 1972, the states are now establishing requirements for training and certification of applicators for use of restricted-use pesticides. It is the responsibility of managers, supervisors, and applicators to insure that use of pesticides and application equipment is consistent with product registration and labeling. It is important to read and follow label directions and cautions. Persons engaging in misuse of a pesticide in a manner inconsistent with its registration and labeling are subject to criminal penalties under the Federal Environmental Pesticide Control Act of 1972.

Burning. - Burning has long been a favored method of removing dry weeds and other debris from the irrigation system. Recent legislation in some areas prohibits or severely restricts burning, and managers should be aware of any restrictions that may apply to their operation. If burning is allowed, every effort should be made to reduce smoke to a minimum and thus prevent air pollution.

PREVENTION

The prevention of weeds is the creation of an environment which is not suitable for the establishment of a significant number of weeds. The development of equipment for preventing weed growths, particularly for seeding of steep slopes of canal, lateral, and drain banks, has been much slower than the development of equipment for chemical and mechanical weed control and disposal. Possibly this is because the results of chemical and mechanical weed control and disposal are immediate and the cost of special equipment will be returned within a few years. Mechanical and chemical methods of preventing weed growth, though necessary, usually must be repeated. Fire hazards, air and water pollution, and damage to adjacent crops also must be considered.

Establishment of Desirable Vegetation

On most sites, vegetation is desirable or can be tolerated. Grasses are often beneficial in preventing erosion by wind and water and in some instances by traffic. The establishment of desirable vegetation may be the most effective means of controlling weeds on irrigation system rights-of-way, and little maintenance is required.

Well-sodded waterways are a protection against flash floods, heavy runoff, and overflow-type canal breaks in addition to protection against weed invasion. The channel illustrated in figure 1 is an excellent example of desirable vegetation that effectively controls wind and water erosion and prevents the establishment of weeds.

Vegetation is established by sodding, by planting cuttings or whole plants, or by seeding. The high cost of planting living plants on steep slopes often eliminates all methods except seeding. The selection of species is governed by the local environment and its effect on the available or desirable species. Selection is further controlled by such other project conditions as the cropping pattern and the chemical weed control or disposal program. For example, Bermuda grass, a weed as well as a valuable forage crop in some locations, should not be used on a northern project if grass seed crops are to be irrigated with the project water supply. If 2,4-D herbicides are employed to kill weeds in the first 2 or 3 years to aid the development of perennial grasses, few of the desirable legumes will survive.

Selection of a desirable adapted species is a controlling factor in preventive weed control. Equipment for establishing this vegetation is often available from commercial sources, but in many instances existing equipment must be modified to fit the situation.

Figure 1

The establishment of vegetation, although eventually resulting in a more permanent preventive means of weed control, may require 1 to 5 years to develop a stand which will resist the invasion of weeds.

Personnel of the Bureau's Lower Missouri Region consider the planting of desirable adapted grasses as the best method of controlling weeds on irrigation systems in the Kansas and Nebraska areas of the Missouri River Basin project. Experience under the climatic conditions in this area shows that 4 to 5 years after planting the grasses, weed control expenditures are at a minimum. During the 4- to 5-year period that the grasses are becoming established, they must compete with weeds for nutrients, water, and light. Spraying with 2,4-D during that time eliminates most of the weeds and encourages more rapid development of the grasses.

Studies of grass stands previously established have shown that for every dollar invested in seeding grasses, several times that amount is saved in O&M (Operation and Maintenance) costs. A good stand of grass on the banks of a canal on the Mirage Flats project in Nebraska is shown in figure 2.

Figure 2

Preparation for seeding. - Seeding of new construction areas is generally provided for in the construction or grass seeding specifications and, therefore, will not be considered in this section.

Before seeding grasses on established canal banks, it is generally necessary to reshape the banks by filling in erosion cuts and removing most of the weedy vegetation. This may be accomplished by dragging or manually removing boulders and other easily movable debris.

A *Tamer Sloper* has been used on the Columbia Basin project, Wash., for many years to remove berms from channels and reslope canal banks before reseeding with adapted grass species. Figure 3 shows the sloper being used on one of the project laterals. Under good conditions, a motor grader with the sloper attached can reslope a mile of canal bank in about 30 minutes.

In many areas, brush must be removed before seeding grasses. A doubled *anchor chain* as shown in figures 4 and 5 has been used on the Pecos River Basin Water Salvage Project, N. Mex.-Tex., to clear saltcedar. The chain is looped between two tractors and dragged over the area to be cleared. The heavy anchor chain closely follows the contour of the ground and effectively uproots the brush. *Holt root plows*, as shown in figure 6, have been used on the same project to remove larger and more dense growths of saltcedar. During maintenance of cleared areas, a grubbing attachment on a three-point hitch is used to remove scattered individual

Figure 3

Figure 4

Figure 5

Figure 6

plants. Figure 7 shows the *grubbing attachment* on a dual-wheel Ford 5000 tractor. Dual wheels increase the traction and flotation. A LeTourneau *spade plow* is also used on the Pecos River Basin Water Salvage project to remove growths of saltcedar. The

Figure 7

spade plow shown in figure 8 is mounted on a D-7E Caterpillar tractor and has been modified by the addition of "kickers" between the main teeth. The primary usage of this equipment is to control regrowth. Figure 9 shows several 48-inch *Marden choppers*, which have been used to chop saltcedar in the Bitter Lake National Wildlife Refuge, northeast of Roswell, N. Mex.

Seeding. - Seeding may be accomplished by several types of equipment on irrigation systems, including seeders, drills, planters, and under certain circumstances, aircraft. Part of the seeding operation requires that the planted seed be covered, and this can be accomplished by harrows and weeders. From experience it has been found that some types of seeding and covering equipment perform the work better than others. Tables 1 and 2 present the results that may be expected from the use of commercially available equipment for the planting and covering of seed.

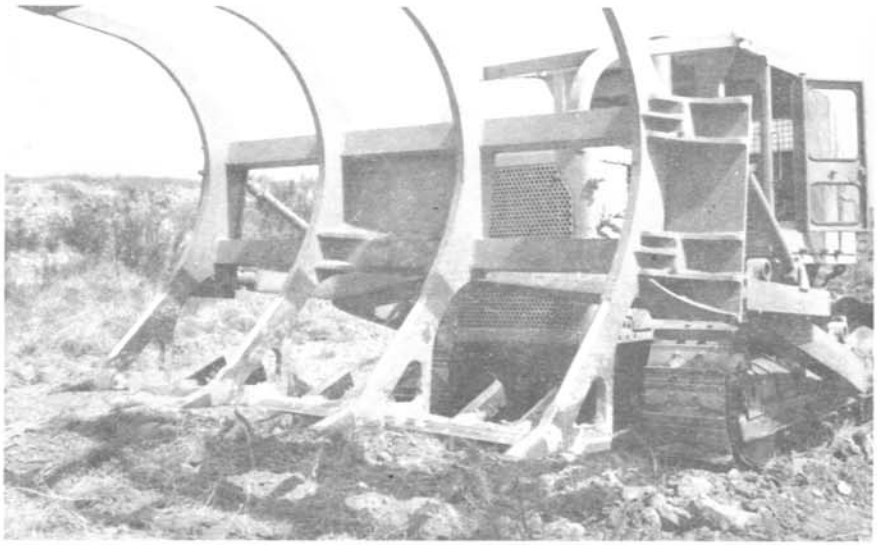

Figure 8

Figure 9

Table 1. - *Field evaluation of commercial seeders in weed prevention on irrigation projects*

Name	Type	Seed placement	Seed coverage	Soil compaction	Adaptation to steep slopes	Portability	Equipment cost
Drill	Single disk	Good	Fair	Fair	Poor	Poor	Moderate
Drill	Double disk press drill	Good	Excellent	Excellent	Poor	Poor	Moderate
Drill	Plow opener rangeland	Good	Excellent	Excellent	Poor to fair	Good	High
Seeder	Roller	Fair to good	Good	Excellent	Poor to fair	Poor to good	Moderate
Planter	Precision row	Excellent	Excellent	Excellent	Poor	Poor to good	Moderate
Seeder	Hand broadcast	Fair	None	None	Excellent	Excellent	Low
Seeder	Electric or gas engine broadcast	Fair	None	None	Excellent	Excellent	Low
Seeder	Strip broadcast	Excellent	None	None	Fair	Fair	Low
Seeder	Waterline dribbling	Good	None	None	Excellent	Excellent	Very low
Aircraft	Fixed wing or helicopter	Fair to good	None	None	Excellent	Excellent	Low

Table 2. - *Field evaluation of commercial seed covering equipment in weed prevention on irrigation projects*

Name	Type	Seed coverage	Soil compaction	Adaptation to steep slopes	Portability	Equipment cost
Harrow	Spiketooth	Fair	Poor	Fair	Fair to good	Low
Harrow	Chain	Good	Poor	Good	Good	Low
Harrow	Disk	Good	Poor	Poor	Fair	Moderate
Harrow	Springtooth	Fair	Poor	Poor	Fair	Moderate
Weeder	Rotary hoe, treader	Good	Good	Fair	Fair	Moderate
Weeder	Finger	Good	Poor	Good	Good	Low

Drill-type seeders. - There are several commercially available grass drills that have been used in many areas to seed a wide variety of grasses on rights-of-way, steep slopes, and other areas. Some drills are capable of seeding many varieties of grasses, either individually or in mixtures. A side-mounted grass drill is one of a few pieces of equipment which does steep-slope grass seeding comparable to that of the flatter range of cropland. This type of seeder operates trouble-free on slopes which are 2 to 1, 3 to 1, or flatter.

The planting of fluffy seed is a problem which usually requires a local solution. Separate seed boxes may be used on the drill, or the fluffy seed may be mixed with other grains such as rye, oats, or cracked corn to promote the feeding of the fluffy seed. Rice hulls, ground corncobs, or sand may also be satisfactory, and occasionally another grass can be added to the mix. Regardless of mechanical agitation or type of additive, it is desirable to inspect the flow of seed frequently.

Figure 10 shows a double disk opener, press-wheel drill used for seeding of various grasses and legumes adjacent to ponded reaches of a wasteway on the Columbia Basin project. The press-wheel drill provides adequate seed placement, covering, and soil compaction even on the lighter non-tilled soils. This type of seeding equipment can seldom be used on steep slopes or on rocky or very heavy soils.

Figure 10

Broadcast seeders. - Broadcast-type seeders are used to advantage on some projects. Seeding equipment used by a contractor on the Columbia Basin project, employed two electrically operated broadcast seeders followed by a 15-foot width of chain harrow (fig. 11). The chain harrow follows small irregularities in the soil and is less subject to clogging with weeds, brush, and debris than a spike-tooth harrow. However, the chain harrow cannot be weighted for scarifying the heavier soils.

Figure 11

The pickup-mounted type of electric seeder shown in figure 12 is used on the Columbia Basin project for the broadcast seeding of grasses on rights-of-way and some wet areas. The controls for this seeder are mounted in the cab of the pickup.

In addition to power-driven broadcast seeders, hand-powered seeders similar to that shown in figure 13 are very useful for seeding small areas. In many cases, an area can be seeded with this type of seeder in the time required to mount the power-driven seeder. Many of the small granular herbicide spreaders are well adapted to grass seeding.

Gravity-flow-type seeders. - Several adaptations have been made of the gravity-flow-type seeder. Seeding of narrow strips of waterline with grasses may require a box only 2 or 3 feet long with two or three seed openings. A lightweight box may be attached to a retractable boom, and a lightweight spike, chain, or springtooth harrow could be attached to follow when covering of the seed is desirable.

Figure 12

Figure 13

An even simpler seeder has been used on some projects in the northwest. This seeder consists of a 1- or 2-quart can with a closeable lid (such as a coffee can). It is attached to a bamboo fishing pole, and redtop, a grass seed which is extremely small but heavy, is seeded at the rate of approximately 1 pound per mile of waterline. Approximately 2 miles of waterline per hour can be seeded by a person walking on the lateral roadway. Seeding is best done in the summer on saturated soil. No seed covering is necessary. An agitator is not required to cause the seed to flow. A single nailhole punched in the bottom of the can is adequate for metering the seed output.

The principal problem in the use of the gravity-flow seeder is design and calibration for seed mixtures, particularly for seeds which do not flow freely.

Hydroseeders. - It has long been recognized that one of the best methods of weed control for areas where vegetation is permitted or desired is a healthy stand of grass. Establishing grass cover on some of the steeper bank slopes can be both discouraging and expensive.

Prompted by the need for grass protection on slopes resulting from the interstate highway program, equipment manufacturers developed the hydroseeder. By use of a centrifugal pump, grass seed, fertilizer, and protective mulch, in combination or separately, are carried to a slope by a stream of water.

The unit, skid mounted or trailer mounted, consists principally of the pump, storage tank with agitator, and nozzle. Units are available in sizes from 100- to 2,000-gallon tanks. The pumps and engines are designed to not only power the agitator, but to deliver a sufficient stream of water to carry the seed, fertilizer, and mulch a distance of 75 to 125 feet.

Care should be exercised, particularly with the smaller units, in the selection of the mulch. The wood cellulose, a partially digested wood pulp product, is less likely to plug the nozzle than is the mechanically shredded product.

For best results, the slopes should be left rough, similar in appearance to having been crossed by a sheepsfoot roller. In addition, the soil should be loose, not crusted.

On new construction or an extensive rehabilitation and betterment program, the hydroseeder provides a means of establishing grass cover on bank slopes, spoil piles, borrow areas, and

other areas not easily accessible to drills and other grass-seeding equipment.

The Finn hydroseeder shown in figures 14 and 15 has been used on the East Bench unit, Missouri Basin project, Mont., to seed grasses on steep slopes and rights-of-way.

Figure 14

Figure 15

There are various sizes and makes of hydroseeders on the commercial market that would be adaptable to seeding on an irrigation system.

Seed covering equipment. - The 14-foot length of *finger weeder*, a flexible, spring-toothed harrow shown in figure 16 being lowered onto a large canal bank, was adequate for covering grass seed on the Columbia Basin project. Seed was broadcast in front of the harrow by means of an electrically operated broadcast seeder mounted on the right front of the small crawler tractor. The center 6-foot section of the finger weeder was clamped to the tubular sidearm drawbar. End sections, each 4 feet long, were hinged to the center section and were free to move over obstructions not common to the whole length of the weeder.

Figure 16

The finger weeder is a common type used on farm equipment, resembling a long-finger-type spring-tooth harrow. A similar weeder is shown in more detail in figure 17, where a section of the device was modified to follow a gravity-type seeder for seeding waterlines.

A major advantage of the combination finger weeder and seeder shown in figure 16 is its adaptability to seeding from the bottom of the slope and from the top. Tines lost or broken on rocky soil are replaced rapidly and at little expense.

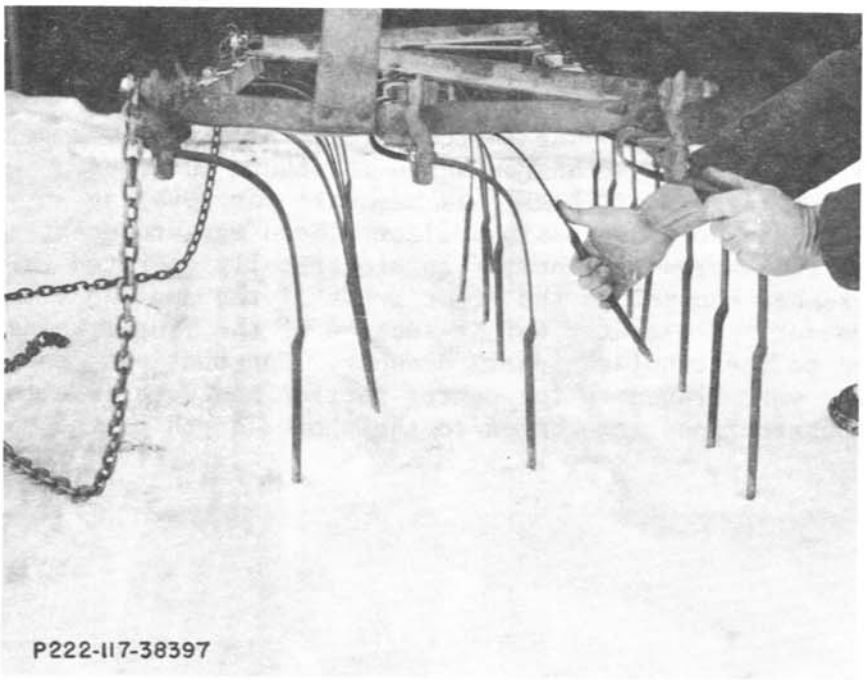

Figure 17

It would be advantageous to include a cable drum, hydraulic, or electric boom lift in the operation of the device. The weeder produced a noticeable side draft on the small tractor used. A larger tractor would be more satisfactory.

In some instances a light chain, weighted at the end to keep it in the bottom of the channel, dragged over new seeding will adequately cover the seed. When both banks of a newly constructed channel are seeded to grass, a light chain attached to a tractor on each bank can be used to cover the seed.

Accessory equipment. - As shown in figure 18, a household-type vacuum cleaner can be used to remove one seed mixture from a grain drill before planting another type mixture. The removal of all seeds of one mixture would normally be necessary only in experimental plantings. A 1,500-watt, 120-volt, alternating-current, portable generator has many uses in the field for driving portable electrical tools such as the vacuum cleaner.

Sand fences, as shown in figure 19, on the Columbia Basin project, may be used to protect a water channel and road in preparation for seeding grass. Windborne soil, which could cover the

Figure 18

seed too deep and prevent germination, is deposited on the leeward side of the fence in the center of the photograph. Fence sections are approximately 3 feet high and 10 feet long, containing two attached braces which fold flat for transport. Wind velocity was reduced for a distance of approximately 30 feet beyond the fence, facilitating seeding operations.

Mulches. - To mulch an area is to cover it with loose straw or other material to prevent erosion and evaporation. There are several ways to protect new grass seedings from erosion and evaporation and in so doing enhance the germination and growth of grass.

Probably the least costly is to acquire a number of bales of old hay, break them apart, and spread the sections over the area to be protected. Care should be taken so that the wind is not channeled between rows of packets, causing increased wind erosion in these areas. This method has worked well in establishing vegetation on sand dunes on the Columbia Basin project. Figure 20 shows packeting. Loose straw or hay scattered lightly over a new grass seeding will reduce erosion and evaporation.

Figure 19

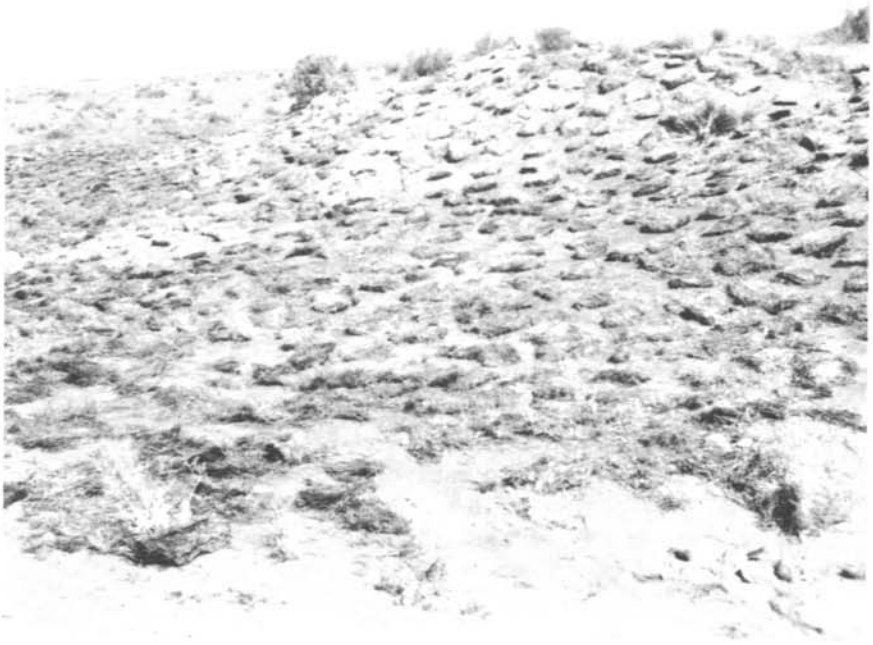

Figure 20

Probably the most effective mulching is through the use of a hydroseeder or hydromulcher as described previously. In these methods, a commercially prepared product is mixed with water and sprayed over the seeded area. Turfiber is one brand of these mulches that is commercially available. It is made of natural wood cellulose fibers and forms a fibrous mat over the area mulched.

Grass seeding specifications. - Much of the ditchbank seeding by the Bureau of Reclamation is done under contract. To indicate how the work is done, two typical seeding specifications are included.

Examination of the specifications will show that they have the necessary flexibility required to meet existing field problems. First, the specification is written to enable Reclamation to make field changes in the seeding methods. For example, it may be necessary to require the contractor to compact or loosen the ditchbanks prior to seeding. Secondly, the specifications enable the contracting officer to direct the contractor to seed miscellaneous spoil areas that are created during construction. That is, if it is determined during construction that an additional bank will be constructed that was not anticipated in the original specifications for the canal or lateral, provisions are made in the contract authorizing the contractor to seed this additional area. Finally, flexibility in the contract is obtained by requiring the seeding of different species of grasses on different areas that are seeded. By going over such areas prior to preparing a specification, it can be determined what grasses are best adapted to the different soil types and drainage conditions encountered.