Wheel-Track Planting on Sagebrush-Bunchgrass Range

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A new machine that performs wheel-track planting of small-seeded grasses has been designed, contructed, and tested in Oregon.[2] The new seeder, which has been accepted for extensive testing by the Inter-Agency Range Seeding Equipment Committee, will be called the Oregon Press Seeder. The authors take this opportunity to introduce the Oregon Press Seeder and the record of its conception, construction, and preliminary testing.

We wish to acknowledge the support provided by R. M. Alexander, Assistant Director, Oregon Agricultural Experiment Station, for the co-operative project that produced the Oregon Press Seeder. The ideas employed in equipment design and construction were largely original with the authors, but valuable suggestions (unfortunately unrecorded by source) were received from personnel of the Oregon Extension Service, the Bureau of Land Management, and the Forest Service. Consequently, a grateful but anonymous acknowledgement is given.

Seeding Problems And Equipment Conception

Conserving Soil Moisture for Seed Germination

Drought and improper planting depths have long been considered as the two most common causes of seeding failures on semiarid ranges. Attention was directed especially to the problem of retaining moisture longer in the surface seed-depth layer of soil. Thoughts regarding moisture transfer within the soil led to the consideration of soil-density effects as influenced by firming operations. The value of firming for seedling emergence has been easy to demonstrate but remains difficult to define because of the complex interactions obtained. Excessive firming produces detrimental effects that have been studied more than the beneficial effects of moderate firming. But there is no way to separate good or bad effects. Rather the effects are progressive with increasing soil firmness, and the interpertation of good or bad depends upon the objective involved.

The work completed at the Squaw Butte Range in Oregon showed that soil firming increased moisture retention in the surface 2 inches of soil and sustained the moisture content above the wilting coefficient about 4 times as long as in unfirmed soils (Hyder, Sneva, and Sawyer, 1955, Hyder and Sneva, 1956). Soil-moisture content in the surface 2 inches of unfirmed soils remained permanently below the wilting coefficient after 3 days. However, the moisture content in the surface of heavily firmed soils exceeded the wilting coefficient throughout a 12-day study period. The studies also showed that wheel-track firming provided soil moisture longer than firming the entire soil surface. In the case of wheel-track firming, soil-moisture samples were obtained only in the tracks.

A recent Russian paper described firming advantages and established that the total soil-moisture supply was reduced by firming (Yarovenko, 1958). Increased evaporation losses, and subsequently a decreased total soil-moisture supply, were anticipated but not found in the Squaw Butte studies. Soil firming is proposed not to save moisture but to permit more effective use of it, which is moisture conservation in the true sense. Firming to increase surface soil-moisture content provides a practical way to use soil moisture more effectively for promoting seed germination and emergence. One may employ wheel-track firming to obtain moisture benefits along planted rows while holding to a minimum the opportunity for evaporation and the susceptibility for wind erosion.

Firming effects extended beyond the realm of seed-soil relations into that of plant-soil relations. Better plant establishment and survival, wider root distribution, hair roots nearer to the soil surface, and higher herbage yields in the first 2 years were reported from the Squaw Butte studies.

Controlling Planting Depth

Rolling to firm and level the soil surface offered an opportunity to improve depth and uniformity of seed placement as well as to improve seed-soil relations. The mechanical problem

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[2] *Plans and shop drawings are available at the cost of duplication ($3.60) from the Extension Agricultural Engineer, Department of Agricultural Engineering, Oregon State University, Corvallis, Oregon.*

of placing grass seeds at a proper depth in soft irregular-surfaced seedbeds is often the paramount reason for seeding failure on semiarid range. Depth bands on drill discs are often ineffective unless the soil has been firmed.

Problems in Seedbed Firming Practices

The documentation of soil-firming benefits on certain range soils apparently has given insufficient basis for promoting rolling practices. Some of the reluctance for, and difficulties involved in, adopting rolling practices are as follows:

(a) Conventional small-diameter packers often skid rather than roll on soft, dry seedbeds. Suitable large-diameter rollers are unavailable on the market.

(b) Conventional packers are generally too light for optimum firming. This deficiency is most apparent when seeding upon a dry seedbed, as is often necessary on semiarid range.

(c) The cost of rolling has not been established as a profitable investment. Therefore, the necessity of maintaining low seeding costs causes many people to question the value of rolling.

(d) A flat, firm soil-surface is more subject to wind and water erosion than a rough one.

(e) In the management of native vegetation any increase in soil density is undesirable because of reduced water intake and other effects. Consequently, range personnel have been trained to associate soil firming with undesirable effects and some are unpracticed in associating it with desirable seed-soil and plant-soil relations that should be achieved in range seeding.

Requirements of a Practical Seeder

The practical objective has been to obtain an optimum in beneficial effects (while minimizing undesirable effects) by soil firming in a manner consistent with mechanical and economic limitations. The authors believed that a satisfactory solution could be achieved by designing and constructing a seeder according to the following requirements:

(a) An ideal seeding operation should plant the seed at a uniform and proper depth with firm soil below the seed and less firm soil above.

(b) After plowing for vegetation elimination, the entire job of firming and planting should be performed by a single machine.

(c) Wheel-track planting should provide the best means of obtaining optimum seed-soil relations with a minimum of undesirable effects.

(d) The equipment should produce tracks about 6 inches wide and spaced about 12 inches from center to center. The problem of soil movement and excessive seed coverage should not cause seeding failure with tracks less than 3 inches deep and 6 inches wide.

(e) An equipment weight of about 500 pounds per foot of wheel width generally should produce sufficient soil firmness, but the equipment weight should be subject to change from about 500 to 1,000 pounds per foot.

(f) The equipment should be flexible so that each row-planting unit would pass independently over an irregular seedbed.

(g) The equipment should plant 10 or 12 rows simultaneously.

(h) The equipment should require a minimum of adjustment, observation, maintenance, and repair, and must be durable enough to encounter boulders and brush without impairing the planting mechanism.

Seeder Design, Construction, And Testing

Two different seed-placement mechanisms were proposed, as follows: (a) Form and weld a V-shaped angle-iron rib with a vertical height of 1 inch around the center of a press wheel face. Thus, the wheel tread would press a V-shaped seed groove in the wheel-track center. A drag chain or plate would be used to cover the seed. (b) Attach cup-shaped cleats to the face of a press wheel. As the wheel rotated seed would be metered into the cups. The cups, in turn, would make depressions in the bottom of the wheel track and deposit the seed as the wheel continued to rotate. A drag would be used to cover the seed.

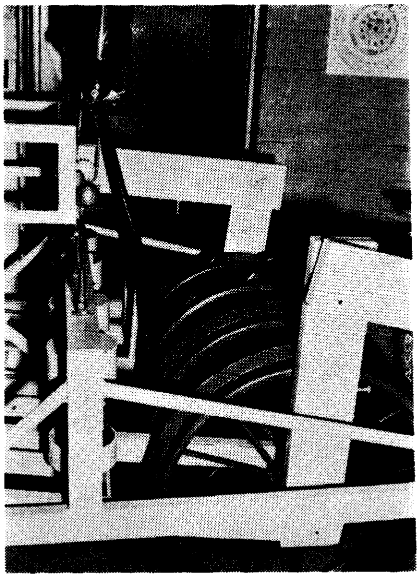
FIGURE 1. Model I was constructed in 1956 to evaluate ribbed and cleated press wheels.

Model I Construction And Performance

Model I, a 4-row seeder, was built in 1956 to evaluate the two mechanisms proposed (Figure 1). In the pilot model, 2 wheels were equipped with cup-shaped cleats and 2 with V-shaped ribs. The wheels were 32 inches in diameter and had a face width of 6 inches. Twelve-inch wheel spacing was used. Individual suspension of the wheels permitted operation on rough ground and over rocks and brush. The machine weight of 1,200 pounds was transmitted to the press wheels through coil springs of the type used in automobile front suspension.

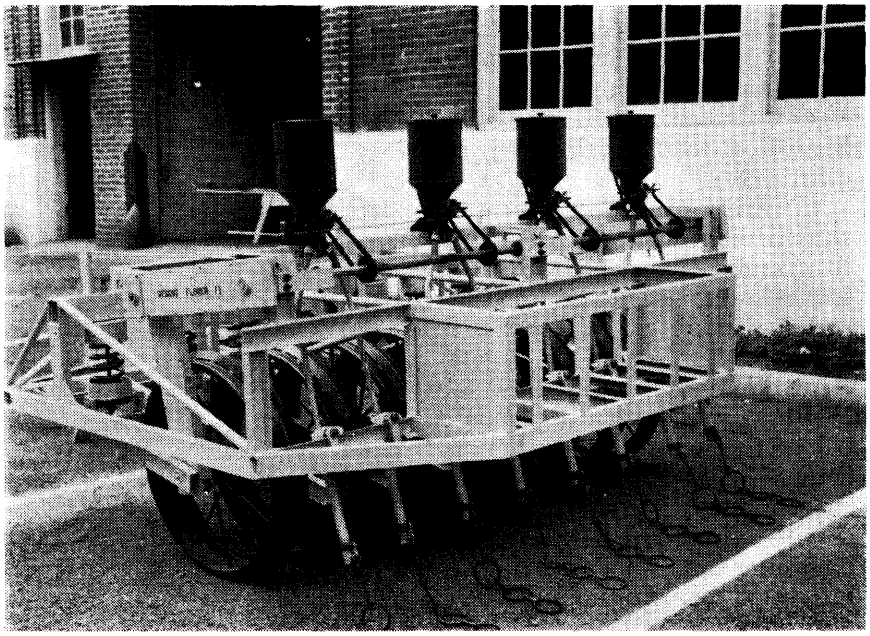

FIGURE 2. Model II, an 8-row machine weighing 2,600 pounds, was constructed and tested on different soils in 1957.

Cleated wheels were unacceptable because the seed were deposited at the front edge of cleat depressions and drag chains pulled the seed to the soil surface. The wheels with V-shaped ribs performed satisfactorily and were chosen for further development.

Model II Construction And Performance

Model II, an 8-row machine weighing 2,600 pounds, was constructed in 1957 (Figure 2). Seeding trials were established at 12 locations in central and southeastern Oregon during the fall 1957. The seeding trials provided opportunity to observe seeding action on different soils that had been prepared for conventional seeding operations. The primary purposes of the trials were to learn to use the equipment properly and discover ways for improving the seeding action. A secondary purpose was to compare seeding results on trial plots with those obtained on the fields seeded with conventional equipment.

The seed were dropped through closely wound plow-lift coil springs clamped to the rear frame member in alignment with the press wheels. The coil springs served as flexible but durable seed tubes. Two difficulties were encountered with the seed tubes: (a) cross winds moved the seed to the side where they were not covered, and (b) the seed tubes sometimes dropped into the soil and became plugged. Subsequently, rubber sleeves were placed on the lower ends of the coil springs to eliminate both difficulties. The rubber sleeves were cut into strips from the bottom upward to about 1 inch below the coil spring outlet. Two-inch wide clamps served as attachment for drag chains, held the rubber sleeves in place, and, by extending below the coil-spring outlet, prevented cutting the rubber sleeves as the seed tubes contacted rocks, brush, and soil.

Standard grain-drill drag chains, attached to the lower end of the seed tubes, covered the seed adequately only when the soil was dry and loose. The seed grooves were not closed in moist soil (Figure 3). Consequently, many different cover drags were tested. Good seed covering was obtained with drags made from ½-inch steel plate cut with a 4-inch width, a 7-inch length, and a tapered front end. Short pieces of rod were welded on the drag faces as an open V to move soil toward the center for seed coverage. Speed of operation was not critical, but with speeds above 5 miles per hour tandem pairs of cover drags were needed to improve drag follow and obtain seed coverage.

The seed hoppers used on the test model gave some difficulty with crested wheatgrass, which was planted in all but one trial. Pubescent wheatgrass was planted in one trial, but the metering device was inadequate. Thus, the seed hoppers were replaced with a standard grain-drill-box.

Additional weights were placed on the machine to obtain distinct wheel tracks and good seeding action on crusted seedbeds. Short pieces of railroad iron were placed in boxes constructed upon both front and rear frame members to maintain equipment balance. The range in gross weight used was 325 to 450 pounds per wheel.

Model II Seeding Results

Seeding rates of crested wheatgrass were 5 pounds per acre with the Oregon Press Seeder

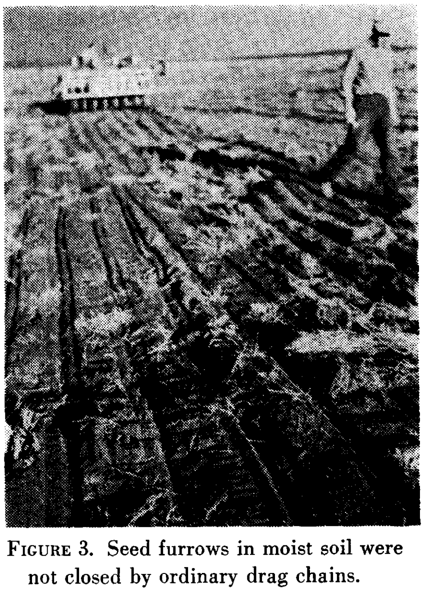

FIGURE 3. Seed furrows in moist soil were not closed by ordinary drag chains.

Table 1. Seeding results with the Oregon Press Seeder and with conventional methods at 12 locations in central and southeastern Oregon.

Soil condition and type	Oregon Press Seeder Density[a]	Conventional seeding Density[a]	Conventional seeding Planting method	Remarks
Very soft, moist sandy loam	1.9	0.1	Rangeland drill	Strong wind erosion after seeding.
Very soft, moist sandy loam	1.1	0.5	Broadcast, log chain drag	Heavy jackrabbit damage.
Soft, dry sandy loam	0.9	0.4	Broadcast, log chain drag	Heavy jackrabbit damage.
Firm, moist sandy loam	4.7	1.5	Commercial single-disc drill	No special difficulties.
Firm, moist sandy loam	2.4	0.8	Commercial single-disc drill	No special difficulties.
Firm, moist sandy loam	2.6	3.8	Rangeland drill	No special difficulties.
Firm, moist very sandy loam	1.4	....	None	Much volunteer rye.
Firm, moist gravelly sandy loam	3.7	1.8	Commercial single-disc drill	Reseeding without new tillage.
Hard, dry gravelly sandy loam	0.5	1.1	Broadcast, log chain drag	Heavy jackrabbit damage.
Hard, moist gravelly sandy loam	0.4	0.3	Rangeland drill	Heavy jackrabbit damage.
Hard, gravelly clay loam	b	b	Rangeland drill	Very heavy volunteer rye.
Wet, red clay loam	0.1	1.2	Rangeland drill	Pubescent wheatgrass seeding.

[a] Number of seedlings per square foot.
[b] Unsampled because of thick volunteer rye.

and about 6 pounds per acre with conventional equipment except a commercial single-disc grain drill, which seeded about 4 pounds per acre. Trial plots included 3 to 5 acres on each field. Seeding results were evaluated by density counts in the summer 1958. Average stand densities are presented in Table 1.

The improvements needed for cleaning wheels, placing seed in seed grooves, and covering the seed were not completed during the seeding trials. Nevertheless, excellent stands of crested wheatgrass were obtained on all trials except those subjected to heavy jackrabbit damage. Seeding was generally more successful on trial plots than on adjacent areas seeded by conventional methods. Differences were most striking on fields with very soft seedbeds at planting time because conventional drilling failed on such seedbeds. On firm or crusted seedbeds both conventional drilling and wheel-track planting were successful. The single trial with pubescent wheatgrass on a wet clay loam was a failure, but conventional drilling was successful. In that case the seeding failure with the Oregon Press Seeder was attributed to the following factors: (a) the seed hoppers did not meter the seed properly, and (b) wet soil collected on wheel faces and prevented the pressing of seed grooves.

Model III Construction And Performance

Model III, an 8-row machine weighing about 3,500 pounds (Figure 4), was released in the fall 1958 for field seeding operations by the Bureau of Land Management personnel in Oregon and Nevada. Those opera-

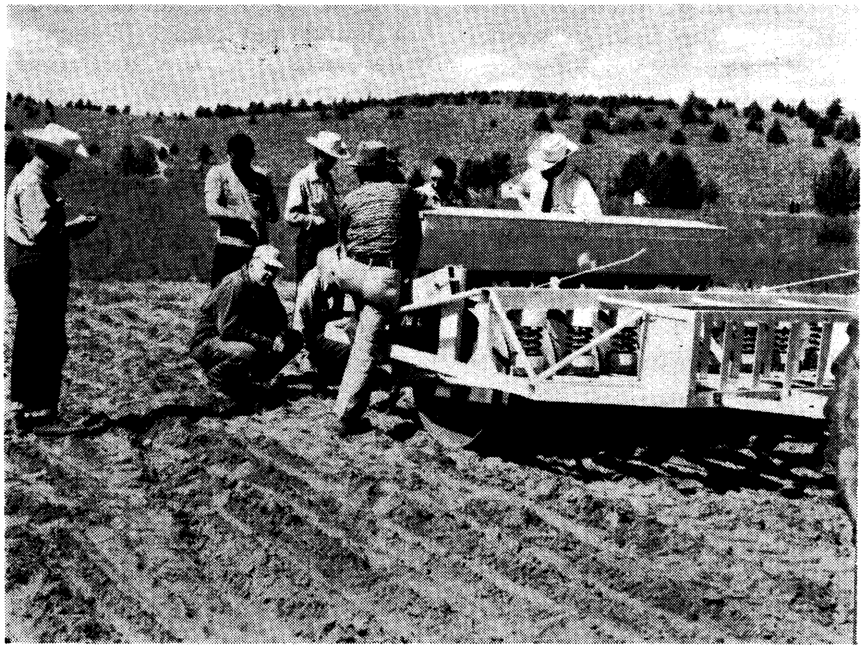
FIGURE 4. Model III was tested on field seeding operations in 1958.

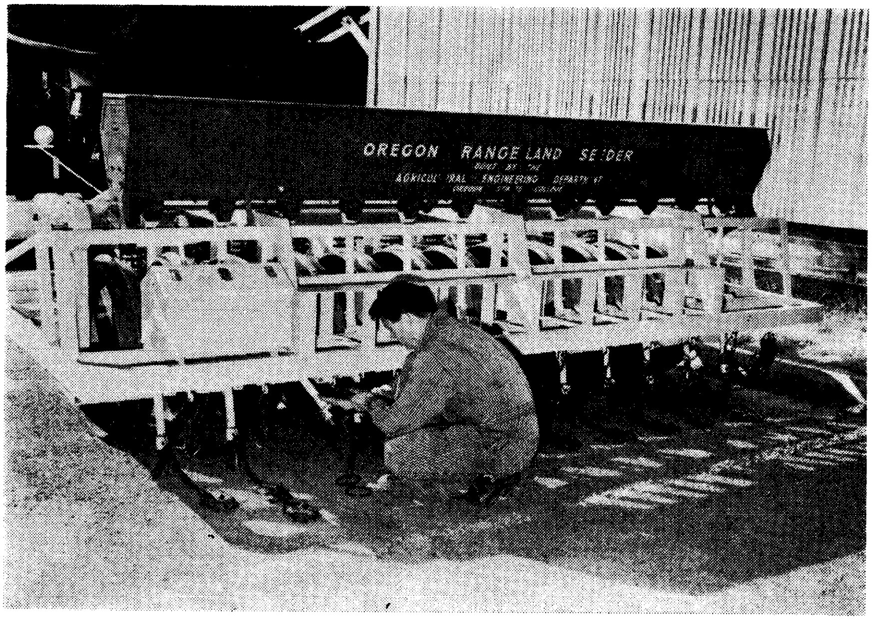

FIGURE 5. Model IV, a 12-row machine weighing 5,000 pounds, was built and tested under field seeding conditions in 1959. The name has been changed to Oregon Press Seeder.

tions provided information about structural weaknesses, maintenance requirements, and personnel reactions. Slight twisting of the wheel-support arms was the only indication of structural weakness. Maintenance requirements were much less than with conventional grain drills, but the loosening of set screws in seedbox drive gears caused some delay. Since the planting mechanism functioned uniformly without continuous attention and adjustment, the field personnel were enthusiastic about the machine operation and the soil-firming principles upon which it was developed. The following proposals were made for improving the seeder: (a) strengthen the press-wheel support arms, (b) install sealed bearings in press wheels, and (c) increase the machine size to plant 12 rows simultaneously.

Model IV Construction And Performance

Model IV, a 12-row machine weighing about 5,000 pounds (Figure 5), was built in 1959 and released to Bureau of Land Management personnel for testing under field conditions. Operational failures were minor. Throughout the seeding trials and field operations it appeared that the objective of trouble free operation had been fulfilled.

The weight of Model IV, about 415 pounds per wheel (6 inches wide), was near the maximum desired wheel load of 500 pounds. It was believed desirable to have a minimum wheel load near 250 pounds to prevent excessive track depth, soil sloughing, and too-deep seed placement in very soft seedbeds. Operational loads with Model II were varied from 325 to 450 pounds per wheel in order to obtain adequate track depths. Consequently, it is desirable to reduce the machine weight of Model IV to about 4,000 pounds—330 pounds per wheel.

Plans and shop drawings were released by Oregon State University to interested parties in January 1960. Further testing and development will be supervised by the Inter-Agency Range Seeding Equipment Committee.

Summary

A planting machine that will operate satisfactorily on soft, plowed seedbeds, which often cause seeding failures with conventional seeders, has been developed in Oregon. The planting mechanism, designed to produce a specific seed-soil relation found desirable in basic research, is a simple and direct fulfillment of wheel-track planting. The machine largely eliminates the problem of planting depths and obtains approximately an optimum seed-soil relation for assurance of successful germination, emergence, and survival of crested wheatgrass. The new seeder, which has been accepted for testing by the Inter-Agency Range Seeding Equipment committee, will be called the Oregon Press Seeder.

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