Range Tech Tips

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Rangeland Drills: Can Seed Placement Be Improved?

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The rangeland drill is one of the simplest, most robust, and most reliable range seeders on the market. The principle of scuffing the ground, creating a shallow furrow, dropping seed, and lightly dragging dirt over the seed in the furrow is relatively crude, but effective. The forerunner of the rangeland drill was constructed by combining a commercial grain box, reinforced frame, large wheels, and special disk arms. In 1952, the U.S. Department of Agriculture (USDA) Forest Service San Dimas Equipment Development Center investigated the combination and designed what is considered the standard for rangeland drills. The design has changed very little over the last 50 years (figure 1).

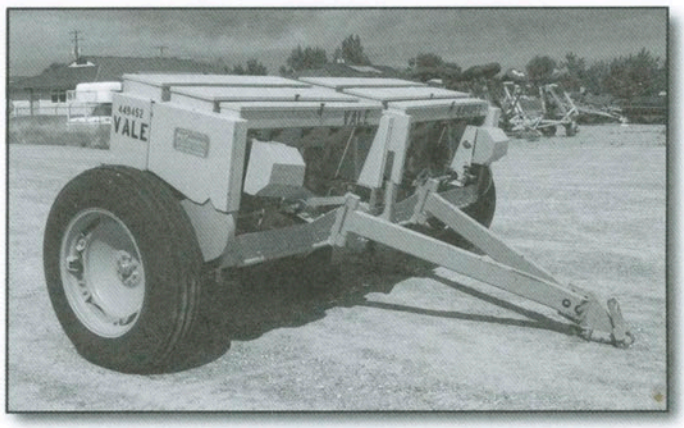

Figure 1—The basic design and function of the rangeland drill has changed little over the last 50 years.

Highlights...

- The standard rangeland drill has been in use for more than 50 years.
- One of the drill's strengths is its simplicity.
- Improvements need to be simple to calibrate, operate, and maintain.
- A hydraulic lift for the disks improves the drill's operability and safety.
- Application errors might be prevented by having a contract administrator onsite or by spot-checking seeding operations to monitor the seed mix, calibration, travel speed, and the area covered.

Some newer rangeland drills, such as the Truax Rough Rider, combine technologies from the original rangeland drill with those of more modern no-till type agricultural drills (figure 2). The furrowing action of heavy concave disks on

Figure 2—This Rough Rider drill manufactured by the Truax Co. incorporates some of the newest advances in rangeland drill technology.

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the USDA drill removes organic surface material to expose the seed to soil. The furrow provides shelter for the seed and helps retain moisture (figure 3). Seed is distributed from the seed box to the middle of the furrow by a seed tube attached to the disk arm. A heavy chain pulled behind the disk and seed tube pulls soil back into the furrow to pack the seed lightly and cover it.

In 2004, Forest Service researcher Pete Robichaud (Rocky Mountain Research Station, Moscow, ID) asked the Missoula Technology and Development Center (MTDC) to modify the existing rangeland drill for improved performance. Robichaud suggested working with staff from the U.S. Department of the Interior Bureau of Land Management (BLM). The Vale District Office of the BLM is responsible for maintaining and delivering over 100 rangeland drills to agency locations throughout the West.

Mike Pellant (BLM, Vale, OR) and David Pyke (U.S. Geological Survey, Corvallis, OR) identified three main priorities for improvements:

- Better depth control on rangeland drills, including those with more than one seedbox
- Better soil-to-seed contact, especially in sagebrush
- Improved calibration for mixing seed varieties

In August 2005, MTDC's Dick Karsky, Scott Gilmour, and Gary Kees traveled to the BLM shop in Vale, OR. While there, they toured the rangeland drill repair facilities, checked inventory, and looked at a prototype commercial seeder.

Figure 3—Heavy curved disks clear vegetation and create furrows for the dropped seed. Weight can be added to each disk arm.

In September 2005, Gilmour and Kees traveled to Big Piney, WY, where they visited Frank Russo, the owner of P&F Services. His company fabricates rangeland drills and has extensive experience with custom seeding. The group observed two full-sized P&F Services rangeland drills seeding pipeline rights-of-way in natural gas production fields (figure 4).

Figure 4—Rangeland drills produced deep furrows on these pipeline rights-of-way in Wyoming. The furrows help collect moisture and protect seedlings from wind.

Drill Performance Problems

The current rangeland drill, when configured and operated correctly, does a good job of seeding most rangeland. There are various reasons why seeding is sometimes unsuccessful. Many problems can be managed through proper operator training and careful contract administration.

Configuration

In an ideal world, multiple seed boxes, tubes, and variable depth delivery systems would control seed depth reliably and calibration consistently. But the rangeland drill doesn't operate in an ideal world. Variability in soils, vegetation, moisture, soil texture, rocks, and obstacles affect the performance of rangeland drills. Adding multiple seed delivery systems may make it more difficult to move materials through the drill, allowing seeds to bridge small

openings and plugging the drill. Trailers carrying two drills, each equipped with three or four seed boxes, can have "wide load" problems (requirements for permits, pilot cars, and so forth) during transport. Trailers carrying drills with two seed boxes have not had this problem.

Calibration and Maintenance

Multiple delivery systems add complexity, maintenance, longer setup times, and costs that may be hard to justify. There's more room for application error from inexperienced field operators and contractors who must understand, properly calibrate, load, and maintain four seed boxes rather than two. Some contractors have been known to dump all the seed in one or two seed boxes because calibrating four seed boxes takes a long time. Several drills have been returned to the P&F Services shop for conversion from four seed boxes to two.

Improving Performance

The problems identified by the BLM — seed depth control, soil-to-seed contact, and calibration of mixed seed varieties — can be addressed in part by consistent operating procedures and equipment setups.

Travel Speed

Travel speed is a major contributor to poor seed placement. At higher speeds, disks bounce higher and travel farther out of the soil when they hit rocks, sagebrush, or other objects in the field. The disk is more likely to float over the surface at higher speeds than it is to dig in and push material aside (figure 5). When surface materials are not removed, seeds are not exposed to soil. At higher speeds, dirt pushed aside by the disks is thrown farther from furrows where it is not easy to pull back into the depression to cover the seed.

High travel speed increases vibration, which segregates mixed seed in seed boxes, especially on hillsides and rough ground. Species won't be planted in the appropriate mixtures if the seeds of some species are at the bottom of the seed box and others are at the top. Contract requirements should include seed placement quality and controlled drill speeds, not just the amount of acres seeded. Controlling drill speed would improve all three of the BLM's priorities.

Figure 5—Good contact between the seed and the soil is difficult in sagebrush. Disks tend to float and bounce over the top of the sagebrush, especially at higher drill speeds.

Furrow Depth

With the current drill design, depth bands (figure 6) should always be used to help control the furrow depth and amount of surface material removed. As disks wear, smaller diameter depth bands should be installed to maintain proper furrow depth and extend the usable life of the disk. Depth bands don't directly control the seed depth.

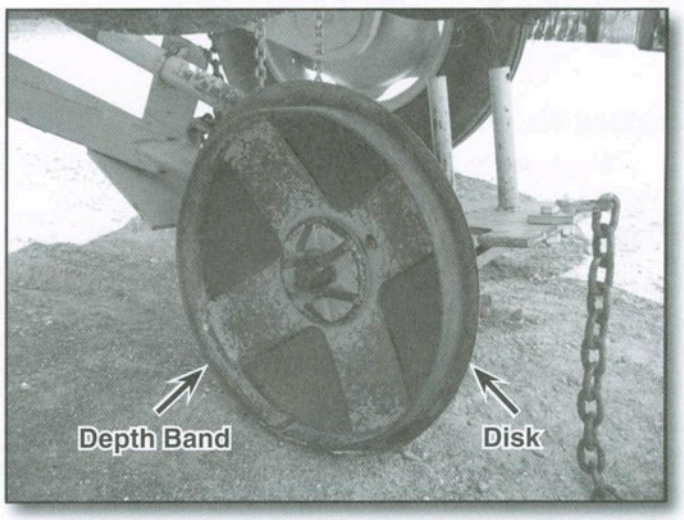

Figure 6—Depth bands help control the depth of the furrow and the amount of surface material removed.

Depth bands control how much surface material is removed and how much soil is pushed aside in the furrow. The amount of soil pushed aside affects seed depth and seed-to-soil contact when the drag chains pull soil back over the seed in the furrow.

Seed Packing Devices

The rangeland drill does not pack the seed once it is distributed in the furrow. Seed-to-soil contact might be greatly improved with some sort of packing device. The only type of packing that might occur with the rangeland drill is from the weight of the drag chains pulled behind the disk. The drag chain preferred by both the BLM and P&F Services is a single chain pulling a round ring with three short chains (like a chicken foot) attached to it (figure 7).

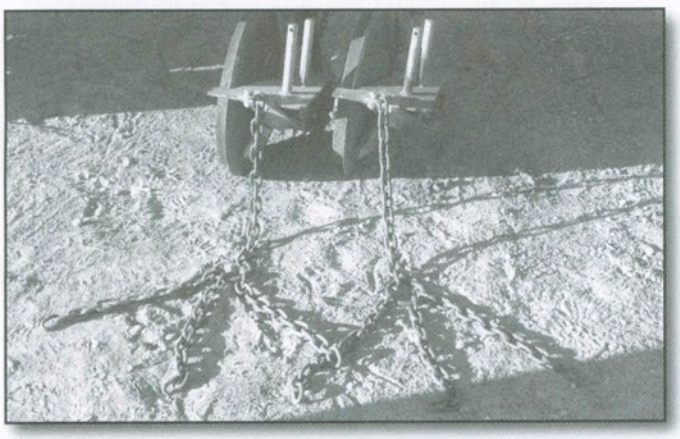

Figure 7—This drag chain design, resembling a chicken foot, is one of the best ways to cover and lightly pack the seed in the furrow.

Added Weight

Weight can be added to each disk arm to help the disk dig, maintain ground contact, and reduce bouncing. The Vale shop personnel and Frank Russo believe operators don't use weights because setup takes longer and chaining up the weighted disks for transport is more difficult. The operators are more likely to weight the disk arms if they can lift the arms hydraulically.

P&F Services representatives said their drills have hydraulic disk lifters (figure 8). During typical operations they use at least one weight, increasing the weight if the ground is hard to penetrate. The range of disk motion on the current P&F Services hydraulic model can be varied with an adjustable chain. A hydraulic lift adds about $3,500 to the cost of the drill.

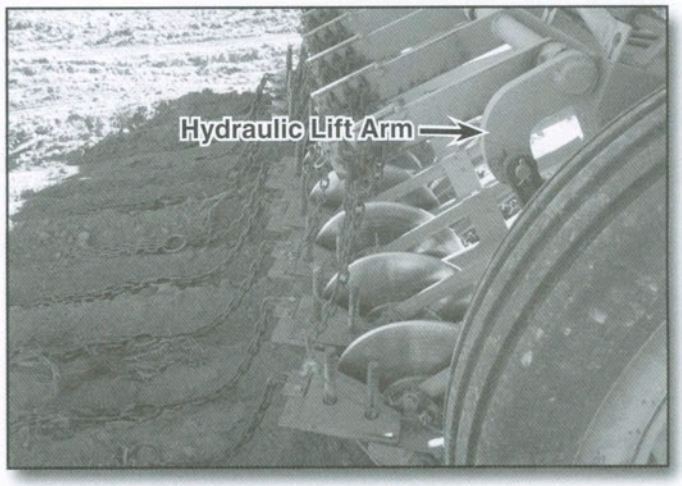

Figure 8—Hydraulic lifts on disks help clear seed tubes, raise disks over large rocks or obstructions, and reduce the risk of injury to operators moving drills.

Future Research

Observations and conversations between participants from MTDC, the Vale BLM shop, and P&F Services were combined with the original BLM priorities to produce several research and technology development suggestions.

Speed Tracking Devices

A speed tracking recording device, perhaps based on the global positioning system, would be useful to track drill speeds, and possibly track the acreage seeded. Contracting officers would have to interpret the data to ensure that contract guidelines (such as drilling speed) were followed. An electronic record of acres seeded could be used as a measure for contract payments. The BLM employees mentioned that a better, more accurate acre counter on the drills would be helpful from a maintenance standpoint.

Seed Packing Devices

A method to pack the seedbed lightly ahead of the drag chain and behind the disk and seed tube would be useful.

Another option might be a packing wheel that would also control the disk depth, thus eliminating the depth band. This approach should improve the contact between the seed and the soil and might help control seed planting depth.

Reducing Seed Segregation

Possible options include modifying the seed-box design, and pelletizing or agglomerating small seeds. In the process, researchers could investigate seed fillers, seed coatings, or suspension materials to reduce segregation. A study or investigation could determine how much seed segregation in the seed box affects distribution of seed to the ground.

Seed Boxes

The seed boxes on older drills are obsolete and parts are no longer available. Replacement seed boxes need to be found for these drills.

Test Plot Experiments

Test plots to show the effect of varying drill speeds, depth bands, disk weights, seed-box design, and possibly a new packing device might be worth pursuing as a research project.

Conclusions

A key to more successful range seeding is to keep the rangeland drill uncomplicated—simple to operate, maintain, and calibrate. When equipment is less complicated, users are more likely to configure drills properly for the job at hand and modify those configurations as conditions change. A solution for application errors may be having a contract administrator onsite or spot-checking seeding operations to monitor the seed mix, calibration, travel speed, and the area covered. Including a hydraulic disk lift on new drills would improve operability and safety, while reducing maintenance. Manufacturers are working on improved drills that will do a better job of placing and covering the seed.

Manufacturers

In the fall of 2006, rangeland drills were available from the following companies:

P&F Services
PO Box 1076
Kemmerer, WY 83101
Phone: 307 877 6455

Truax Co., Inc.
4300 Quebec Ave. North
New Hope, MN 55428
Phone: 763–537–6639
Web site: *http://truaxcomp.com*

Metal Masters
3862 Depot Rd.
Hayward, CA 94545
Phone: 510 352 1230

Nyssa Machine & Welding
219 N 9th St.
Nyssa, OR 97913
Phone: 541–372–3123
Web site: *http://nyssamachine.com*

About the Author

Gary Kees works in the reforestation and nursery, forest health, GPS, and fire programs at MTDC. Gary, who has a degree in mechanical engineering from the University of Idaho, worked for 10 years as a mechanical and structural engineer, project manager, and engineering group leader for the Monsanto Co. in Soda Springs, ID.

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This report identifies three main priorities for improving rangeland drill performance: better depth control, better contact between the seed and the soil, and improved calibration when several types of seed are included in a mix.

Keywords: calibration, furrows, rangeland drills, seed delivery systems, seed packing, seed-to-soil contact, setup

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