New Artificial Seeding for Rangelands

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From the very beginnings of range management in the United States, artificial seeding of wildland sites to restore productivity has been deemed a necessary step in many environments. Artificial seeding refers to bringing seeds from off the site and planting them as opposed to allowing plants growing on the site to produce, disperse, and germinate seeds to recruit seedlings. Artificial seeding is necessary when a natural seed source of desired species does not exist on the site. Wildlands refers to range, forest or other lands that are not cultivated for agronomic crop production.

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Biology of Planting Seeds

There are several basic physical and biological parameters that govern seed germination. Most seeds become dormant at maturity through a drying process. If they did not partially desiccate they would germinate while still on the parent plant prior to seed dispersal. Most seeds germinate by hydrating or taking up water from the seedbed. This is accomplished by having a water holding capacity in the seed greater than the water holding capacity of the seedbed. Physically the water is transferred from the soil particles to the seed. The more points of contact between the seed and the soil particles the greater the moisture flow. Especially in the semi-arid to arid west, seeds exposed on the soil surface have to take up moisture from the soil faster than they loose it to the air. Low atmospheric humidity can easily drain seed moisture before the seed has a chance to complete germination. In tropical rain forests where the relative humidity is near saturation this is not a problem.

These physical and biological requirements for germination translate on a practical basis to this: 1) seeds need to be covered to prevent drying, and 2) the seedbed needs to be firm so there is maximum contact between the seed coat and the soil particle of the seedbed.

It would appear simple. All you have to do is bury seeds and they will germinate. Remember that not only do seeds have to germinate, the resulting seedlings also have to emerge from the seedbed to start photosynthesis before the stored food supplies in the seed are exhausted. If the seeds are planted too deep emergence will be inhibited. In practical terms, you have to be able to control the depth of seeding.

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The term *drill* was apparently derived from the old Flemish word drill referring to the shallow rill made in parallel rows in fields for the placement of cereal grain seeds in planting. Farmers discovered in antiquity that placing seeds in drill rows produced a greater and more uniform stand compared to broadcasting the seeds on the soil surface.

During the 19th century the process of planting agricultural seeds became mechanized and the resulting machine became known as a drill. The drill has several simple components and functions:

1. There has to be a container to hold the seeds being planted. It has to be of sufficient volume to make it practical to seed a considerable area without stopping. Generally this container is called a *drill* box.

2. There has to be some way to *meter* the seeds from the box so that the *rate* of seed plant per unit of surface area of the field can be determined. Years of experimentation produced a *fluted shaft* as a simple way of metering seeds. The shaft is connected to the wheels of the drill. Seeds in the drill box are trapped in the flutes. The shaft provides closure for holes in the bottom of the drill box. Adjustments are made by covering more or less of the fluted shaft with sliding sheet metal closures.

3. Obviously, the whole purpose of this drilling procedure is to get the seeds into the ground. There has to be some way to transport the seeds from the box and metering device to the soil. This is done with *tubes.* These are usually flexible tubes that convey the seeds by gravity from outside the metering device to the opener.

4. *Openers* are, as the name implies, some mechanical method of moving the soil aside so the seed can be buried at the correct depth. This can be a fixed shovel where the seed is dropped behind the shovel. Many cereal grain drills use a double disk opener. These are two thin metal, flat disks, set so their bottoms touch and the top of the disk is separated. As the double disk are drawn through the soil they create a small opening or slot. Modern disks use a variety of openers including a fluted coulter that flip out a thin sliver of soil as they turn. Specialized drills for over seeding pasture sod even have power driven openers.

5. The last step in the drilling process is to obtain closure of the drill opening. This is done in several ways ranging from the happenstance to the highly sophisticated. Many agronomic drills use a broad, flat *press wheel* to obtain closure and firming of the seedbed. Sometimes the tumbling action of chain drags is used for closure. A second implement, such as a culti-packer may be towed in tandem behind the drill for closure.

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Agronomic fields were always plowed and harrowed before drilling. This has changed with no-till agriculture where herbicides are substituted for tillage for weed control, and subsequently, drills or drill openers had to change. Most agronomic fields are, in the scale of the drill implement, relatively flat and uniform from side to side. In the 1940s when wide spread seeding of rangelands was undertaken for the first time, it readily became apparent that agronomic drilling equipment was not suited for seeding sagebrush rangelands. The seedbeds were highly irregular in micro topography. The occurrence of rocks and stumps broke soil openers at alarming rates. The very frames of drills could not take the twisting and bouncing associated with rangeland seedings.

Rangeland Drill

Starting with practical minded technicians working in the field, a prototype *rangeland drill* was developed. It featured a standard grain drill box and metering system mounted on a super heavy-duty frame. The most innovative part of the drill was each opener was suspended individually and hinged so it could ride over obstructions. The seed tubes were armored and protected from snagging on brush. A single cupped disk was used for an opener. Placing bands on the disk could control depth.

Operators of rangeland drills soon determined that getting the openers into the ground could be a problem on some soils. They experimented with cutting and bending the angle of the drill arms to get a deeper drill opening. Scientists determined that seedling establishment could be enhanced by creating a deeper furrow. This was accomplished with the rangeland drill by making a more massive arm for the openers where the angle of cupping the disk opener was adjustable. Provisions were made for adding weights to increase the depth of the furrow.

The weak point of the rangeland drill was in obtaining seed placement and coverage. Closure was a hit-or-miss operation provided by towed chain and pipe drags. Sometimes the seeds fall into the drill opening and sometimes they fall along side. In either case they may or may not be covered.

The advent of seeding mixtures of species has greatly complicated seeding operations. There are specialty drills made with multiple types of openers. Special agitation had to be added to maintain the mixture of seeds in the drill box. Enlarged seed tubes are required for seeding the fluffy florets of native grasses. Some seeds of native shrubs need to be pressed into the surface of seedbeds.

The rise in the importance of reclamation of precious metal mining spoils has increased the need for drills capable of seeding a mixture of species over rugged, often rocky, seedbeds. The majority of range seedings in sagebrush environments are done with a rangeland drill. It is very difficult to meet the seedbed requirements of contrasting revegetation species using the standard rangeland drill. For sometime a new concept in drills has been needed for seeding on rangelands.

Air Drills

Such a new concept in seeding is represented by *air drills*. Air drills were developed for planting wheat on the northern Great Plains of the United States and Canada. All the components of traditional drills are present in the air drills, but the conformation of the parts and the seed delivery system are different. The seed box is located in a trailer pulled in tandem either before or after the tool bar that supports the openers. This allows large quantities of seed to be loaded at one time. The flexible delivery system allows very wide banks of openers to be towed by a single power unit. Hitches of 60 to 80 feet wide are common in wheat fields.

Air drills use compressed air from a centrifugal fan to convey material (seed or seed and fertilizer mixtures) through flexible tubing to the opener. Power for the fan is provided by a hydraulic motor, the power take-off on the tractor, or by an engine mounted on the trailer. In most air drills the seed is metered before it enters the air stream. This is done with conventional fluted rollers, counter rotating double rollers, pegged rollers, or auger metering systems. The tricky part of air drills is getting the seed into the pressurized air stream. This is done by the use of a rotating air lock, pressurized tank,

Air drill in operation.

Topography of initial seeding.

or a venturi. Header systems used to distribute the seeds to the individual openers are also different among the various makes of air drills.

Advantages Of Air Seeder

Because the seed box is not mounted on the top of the frame to which the openers are attached, the opener configuration can be quite flexible. The length of the tool bar is broken into variable length sections to conform to irregular micro-topography. Individual sections can be raised to clear obstacles. Each opener is individually suspended to ride over obstructions.

Multiple seed boxes permit sending specific seeds in a seedling mixture to a specific opener. The type of opener, seeding rate, and depth can be varied for each individual opener. With proper adjustment, the metering of seeding rate and the delivery of the seeds to a specific opener can be highly precise.

Field Test

A comparison seeding using an air drill and a conventional rangeland drill was made on an area burned in a wildfire 28 miles south of Lund in southeastern Nevada. The pre-burn vegetation consisted of Wyoming big sagebrush largely with a cheatgrass understory. The most common perennial grass was Indian ricegrass. Portion of the burn had supported black sagebrush and winterfat. Adjacent to the burn there is a stand of the noxious species Russian knapweed. The presence of this noxious weed made it imperative to re-establish perennial grasses, forbs, and shrubs on the burned site. The average annual precipitation for the site was estimated at 8 to 10 inches. The soils had fine sandy loam to loam surface textured. There were occasional cobble sized rocks on the soil surface. The landforms were primarily lower alluvial fans with slopes of 0 to 4%.

Scientific names of plants cited in article.
Wyoming big sagebrush (*Artemisia tridentata* subsp. wyomingensis)
cheatgrass (*Bromus tectorum*)
indian ricegrass (*Achnatherum hymenoides*)
black sagebrush (*Artemisia nova*)
winterfat (*Krascheninnikova lanata*)
Russian knapweed (*Acroptilon repens*)
crested wheatgrass (*Agropyron desertorum*)
globemallow (*Spaeralcea grossularifolia*)
forage kochia (*Kochia prostrata*)
Lewis flax (*Linum lewisii*)

The seeding mixture consisted of 'Nordan' crested wheatgrass, globemallow, 'Emigrant' forage kochia and Lewis flax. Indian ricegrass was seeded in a small portion of the burn with the above mixture, but metered from the secondary distribution system on the air drill with the openers set 1 1/2 inches deep. The air drill was used to seed 225 acres and the rangeland drill 1,040 acres in the burn.

Air drill seedbed. (Shank placement can be modified to obtain a different distance between furrows).

Rangeland drill seedbed

Examining the completed seedbed

Performance of the Air Drill

The biological performance of the air drill and the conventional rangeland drill must wait for stand evaluations to be conducted in future years. The physical function of the drills during the seeding operation can be evaluated. Before this trial was conducted it was not known if the air drill was adaptable to rangeland conditions. No problems were encountered with the air seeder as configured (width of tool bar 15 feet) except in crossing ephemeral streambeds where opener depth control was not maintained. The conventional rangeland drill (12 feet wide) had similar problems. The air drill systems functioned through burned big sagebrush stumps and occasional surface rock. The 15-foot air drill and the conventional full sized rangeland drill were pulled with 125 hp tractors. The air drill could sustain about 2 mph faster than the rangeland drill.

Air drills require additional testing and experimentation, especially with different types of openers for specific soil and seed combinations. The air drill has passed, with flying colors, initial concerns about its potential application to rangeland seedings.

Additional Reading

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